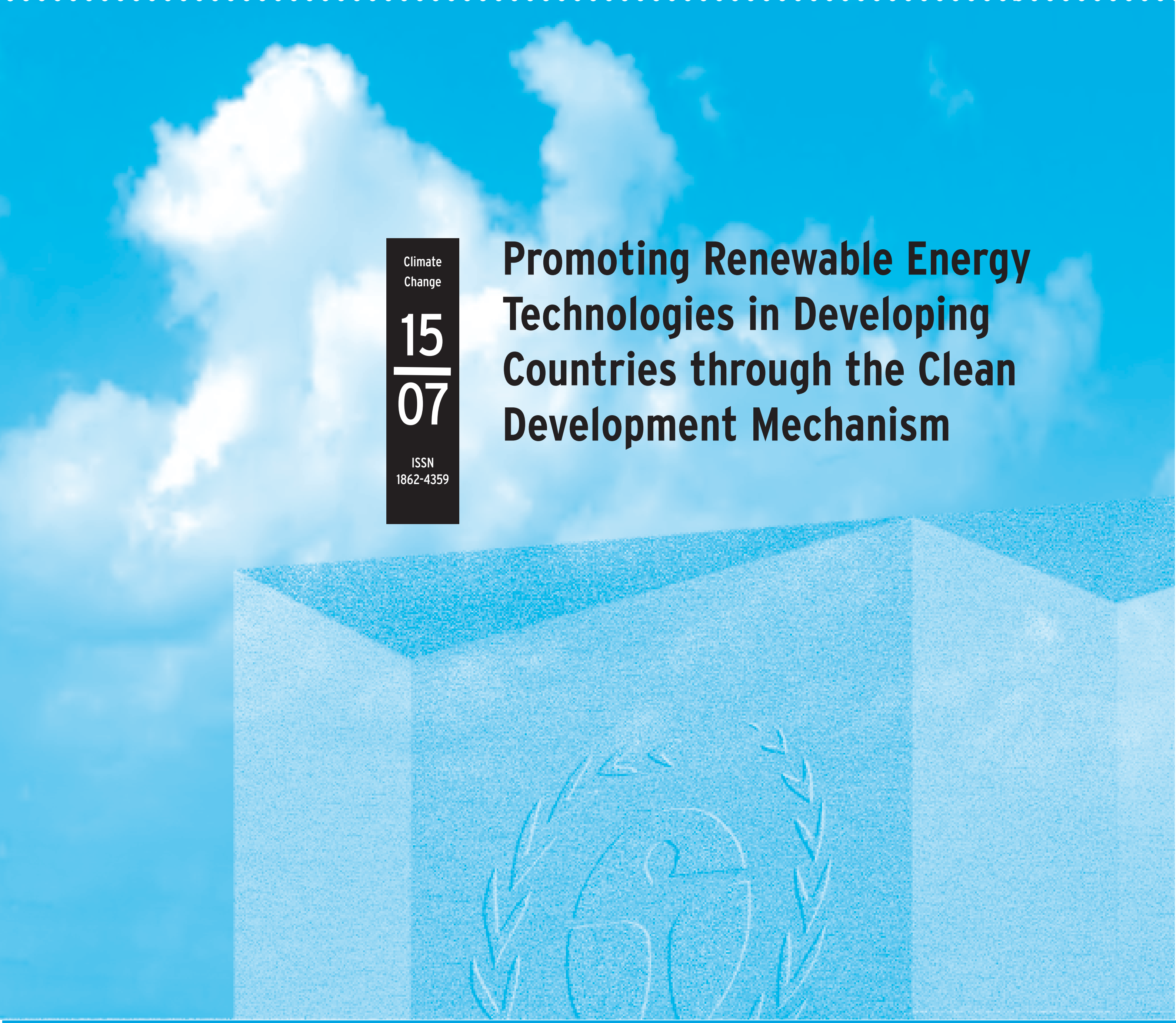
Climate Change



Climate Change

15
07

ISSN
1862-4359

Promoting Renewable Energy Technologies in Developing Countries through the Clean Development Mechanism

Umwelt
Bundes
Amt

Für Mensch und Umwelt

ENVIRONMENTAL RESEARCH OF THE
FEDERAL MINISTRY OF THE ENVIRONMENT,
NATURE CONSERVATION AND NUCLEAR SAFETY

Research Report 203 41 141
UBA-FB 001078

Climate Change

15/07

ISSN 1862-4359

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This Publication is only available as Download under
http://www.umweltbundesamt.de

Publisher: Federal Environmental Agency (Umweltbundesamt)
P.O.B. 14 06
06813 Dessau-Roßlau
Tel.: +49-340-2103-0
Telefax: +49-340-2103 2285
Internet: http://www.umweltbundesamt.de

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Benjamin Lünenbürger

Dessau-Roßlau, October 2007

Science Centre North Rhine-Westphalia
Institute of Work and Technology

Institute for Culture Studies

Wuppertal Institute for Climate, Environment and Energy

Umweltforschungsplan
des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit

Förderkennzeichen (UFOPLAN) 203 41 141

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Wuppertal, 07.12.2006

Final Report

Berichts-Kennblatt

1. Berichtsnummer UBA-FB	2. FuE-Vorhaben FKZ 203 41 141	3.

4. Titel des Berichts
Promoting Renewable Energy Technologies in Developing Countries Through the Clean Development Mechanism

5. Autor(en), Name(n), Vorname(n)
Brouns, Bernd, Dienst, Carmen; Harmeling, Sven, Jesdapipat, Sitanon; Kamel, Sami; Lahbabi, M. Abdelmoughit; Schüwer, Dietmar; Sterk, Wolfgang; Thomas, Jean-Philippe; Wittneben, Bettina

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Umweltbundesamt, Postfach 14 06, D-06813 Dessau

8. Abschlußdatum
07.12.2006

9. Veröffentlichungsdatum

10. UFOPLAN-Nr.
FKZ 203 41 141

11. Seitenzahl
307

12. Literaturangaben
208

13. Tabellen und Diagramme
49

14. Abbildungen
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15. Zusätzliche Angaben

16. Kurzfassung

Ziel des Vorhabens war es, den potenziellen Beitrag des Clean Development Mechanism (CDM) des Kyoto Protokolls für die Verbreitung von Erneuerbare-Energie-Technologien in Entwicklungsländern zu bewerten und Verbesserungsmöglichkeiten zu identifizieren. Die Untersuchung basierte auf der Durchführung von zwei Länderstudien zu Ägypten und Thailand.

Es zeigt sich, dass EE im CDM relativ benachteiligt sind, da sie normalerweise nur Emissionen von CO_2 reduzieren, das ein niedrigeres Treibhauspotenial als die anderen Kyoto-Gase hat. EE-Projekte erzielen daher relativ wenige Certified Emission Reductions (CER). Wenn man zudem noch den derzeitigen CER-Preis in Betracht zieht, hat der CDM derzeit nur einen relativ geringen Einfluss auf die Wirtschaftlichkeit von EE-Projekten.

Die EE-Potenziale sind in beiden Ländern beträchtlich, auf Grund einer Vielzahl von Barrieren werden sie jedoch bislang kaum genutzt. Die meisten Anwendungen von EE sind derzeit noch von hohen spezifischen Investitions- und Energieerzeugungskosten geprägt, und in beiden Ländern liegen die Energiepreise deutlich unter einem Niveau, das nötig wäre, um die Nutzung von EE konkurrenzfähig zu machen. Insbesondere in Ägypten ist der Energiemarkt deutlich durch Subventionen für fossile Energieträger verzerrt. Zudem haben unabhängige Energieanbieter in beiden Ländern keinen garantierten Netzzugang. Darüber hinaus wird die stärkere Nutzung EE in beiden Ländern durch einen Mangel an klaren politischen Rahmenbedingungen behindert.

Die Regierungen der Gast- könnten ebenso wie die der Investorländer EE-Projekten einen klaren Vorzug geben. Insbesondere die Investorländer könnten dazu beitragen, die Barrieren der hohen spezifischen Investitionskosten von EE zu überwinden, indem sie höhere Preise für ihre CER bezahlen und die Mittel bereits im Projektvorfeld zur Verfügung stellen. Dies könnte einschließen, Gold Standard Projekten einen besonderen Vorzug zu geben. Regierungen könnten zudem den neuen Ansatz „programmatischer“ CDM-Projekte befördern, der es, so die Erwartungen, ermöglichen wird, dezentrale kleine Aktivitäten zu Größen zusammenzufassen, bei denen sie wirtschaftlich durchgeführt werden können. Nichtsdestrotz werden aber auch die politschen Entscheidungsträger in Ägypten und Thailand bedeutende Anstrengungen unternehmen müssen, um die Barrieren gegen die Nutzung von EE zu vermindern

Es gibt weitere Diskussionen, den CDM in zukünftigen Kyoto-Verpflichtungsperioden sogar zum Vehikel für die Einführung solcher Politikinstrumente zu machen, indem auch „politikbasierte“ Projekte zugelassen werden. Selbst eine solche Ausweitung des CDM könnte aber voraussichtlich nicht alle seine Begrenzungen aufheben. Vermutlich bedürfte es daher auch noch weiterer Mechanismen für den Technologietransfer und die Investitionsförderung in südlichen Ländern, um auch ärmerer Länder erreichen zu können.

17. Schlagwörter
Clean Development Mechanism, CDM, Erneuerbare Energien

18. Preis	19.	20.

Report Cover Sheet

1. Report No.
UBA-FB

2. FuE-Vorhaben FKZ 203 41 141

3.

4. Report Title
Promoting Renewable Energy Technologies in Developing Countries Through the Clean Development Mechanism

5. Autor(s), Family Name(s), First Name(s)
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7. Sponsoring Agency (Name, Address)

Umweltbundesamt, Postfach 14 06, D-06813 Dessau

8. Report Date
07.12.2006

9. Publication Date

10. UFOPLAN-Ref. No.
FKZ 203 41 141

11. No. of Pages
307

12. No. of References
208

13. No. of Tables, Diagrams
49

14. No. of Figures
44

15. Supplementary Notes

16. Abstract

The aim of the project was to assess the potential contribution the Kyoto Protocol's Clean Development Mechanism can make to the dissemination of renewable energy technologies (RET) in developing countries and identify areas for improvement. The analysis was based on two in-depth country studies of Egypt and Thailand.

It emerges that RET projects are at a relative disadvantage in the CDM since they typically reduce only of emissions of CO_2, which has a lower global warming potential than the other Kyoto gases. RET projects therefore yield relatively few Certified Emission Reductions (CERs). Taking also into account current CER prices, the CDM has currently only a relatively small impact on the viability of RET projects. National framework conditions for RET are therefore key for the success of RET CDM projects.

RET potentials in both Egypt and Thailand are considerable. However, they have so far been utilised to a limited extent only, due a wide variety of barriers which impede the dissemination of RET. Most renewable energy applications are still characterised by high specific upfront investment and power generation costs, and in both countries energy prices are well below the level that would be needed to make them economically viable. Especially in Egypt the "playing field" is significantly distorted by subsidies for fossil fuels. Moreover, in both countries there is no guaranteed access to the grid for independent power producers. RET dissemination is also severely hampered in both countries by a lack of policy clarity. The additional income from the CDM is not sufficient to overcome these barriers.

Non-Annex I as well as Annex I governments could give a clear preference to RE CDM projects. Annex I governments in particular could significantly help to overcome the barriers of high specific upfront investment costs by paying topped-up prices and providing upfront financing for RE CDM projects. This could include giving a special preference to Gold Standard projects. Moreover, governments could promote the new approach of "programmatic" CDM projects that will hopefully allow to aggregate dispersed small-scale RE activities to sizes where they become economically viable. Nevertheless, policy-makers in Egypt and Thailand will also need to make significant efforts to remove barriers to the dissemination of renewable energy technology, only then will the CDM be able to make a significant impact.

There are also discussions to actually make the CDM a driver for such policy instruments in future Kyoto commitment periods by also including "policy-based" projects. However, even such an expansion of the CDM could probably not overcome all its current limitations. It will therefore probably also be necessary to intruduce further instruments for technology transfer and investment promotion to also reach poorer Southern countries.

17. Keywords
Clean Development Mechanism, CDM, renewable energies

18. Price

19.

20.

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IV. List of Abbreviations

ADB	Asian Development Bank
AIT	Asian Institute of Technology
ALGAS	Asia Least Cost Greenhouse Gas Abatement Strategy
ASTEMB	Applications of Solar Thermal Energy in the Mediterranean Basin
BASREC	Baltic Sea Region Energy Cooperation
BCSE	Australian Business Council of Sustainable Energy
BMR	Bangkok Metropolitan Region
BMU	German Federal Ministry for the Environment ("Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit")
BOI	Thailand Board of Investment
BOOT	Build Own Operate Transfer
BOSCH	Biomass One-Stop Clearing House
BREEPP	Bulk Renewable Energy Electricity Production Program
CAIT	Climate Analysis Indicators Tool
CCEC	(Thai) Climate Change Expert Committee
CD4CDM	Capacity Development for the CDM
CDCF	Community Development Carbon Fund
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CERUPT	(Dutch) Certified Emission Reduction Procurement Tender
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COP	Conference of the Parties to the => UNFCCC
COP/MOP	Conference of the Parties serving as Meeting of the Parties to the Kyoto Protocol
CSP	Concentrated Solar Power

DANIDA	Danish International Development Agency
DEDE	(Thai) Department of Alternative Energy Development and Efficiency
Dena	German Energy Agency ("Deutsche Energie-Agentur”)
DNA	Designated National Authority
DNI	Direct Normal Irradiance
DOE	Designated Operational Entity
DOEB	(Thai) Department of Energy Business
DSWH	Domestic Solar Water Heater
EA NRW	Energy Agency North Rhine Westphalia (“Energieagentur Nordrhein-Westfalen)
EB-CDM	Egyptian Bureau for CDM
EC	European Commission
EC-CDM	Egyptian Council for CDM
ECHEM	Egyptian Petrochemicals Holding Company
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egypt Electricity Holding Company
EET	Energy Efficiency Technologies
EGAS	Egyptian Natural Gas Holding
EGAT	Electricity Generating Authority of Thailand
EGPC	Egyptian General Petroleum Company
ENCON	(Thai) Energy Conservation Promotion Fund
EPPO	(Thai) Energy Policy and Planning Office
ERPA	Emission Reduction Purchase Agreement
Ganope	Ganoub El-Wadi Petroleum Holding Company
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GMI	Global Market Initiative for Concentrating Solar Power
GOST	German Organization for Sewage Treatment
GSR	Guaranteed Solar Results
GTL	Gas to Liquid
GWh	Gigawatt hour

HFC	Hydrofluorocarbon
HKF	Hamburg Climate Protection Foundation
HVDC	High Voltage Direct Current
IAP	International Action Programme (of the renewables 2004 conference)
IEA	International Energy Agency
IETA	International Emission Trading Association
IGES	(Japanese) Institute for Global Environmental Strategies
IPP	Independent Power Producers
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
KfW	German Reconstruction Loan Corporation ("Kreditanstalt für Wiederaufbau")
KP	Kyoto Protocol
l	Litre
LE	Egyptian Pound
LNG	Liquefied Natural Gas
MEA	(Thai) Metropolitan Electricity Authority
MEDREP	Mediterranean Renewable Energy Partnership
MENA	Middle Eastern and North African Countries
MENAREC	Middle East and North Africa Renewable Energy Conference
MOEE	Ministry of Electricity and Energy
MOEN	(Thai) Ministry of Energy
MONRE	(Thai) Ministry of National Resources and Environment
MSEA	(Egyptian) Ministry of State for Environmental Affairs
MSW	Municipal Solid Waste
Mt	Megatonne
MTBE	Methyl Tertiary Butyl Ether
MW	Megawatt
N_2O	Nitrous Oxide
NCCC	(Thai) National Climate Change Committee
NEB	(Thai) National Environment Board
NGO	Non-Governmental Organization

NRE	New and Renewable Energy
NREA	(Egyptian) New and Renewable Energy Authority
NSCC	(Thai) National Subcommittee on Climate Change
NSS	National Strategy Study
ODA	Official Development Assistance
ODA	Official Development Assistance
OEP	Organization for Energy Planning
OPEC	Organisation of the Petroleum Exporting Countries
PDD	Project Design Document
PEA	Provincial Electricity Authority
PIN	Project Idea Note
PPA	Power Purchase Agreement
PPP	Purchasing Power Parity
PRESSEA	Promotion of Renewable Energy Sources in South East Asia
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RET	Renewable Energy Technologies
RPS	Renewable Energy Portfolio Standard
SCE	Supreme Council of Energy
SCF	Standard Cubic Feet
SIPH	Solar Industrial Process Heat
SNAP	Support for National Action Plan
SPP	Small Power Producers
STEG	Solar Thermal Electricity Generation
STPP	Solar Thermal Power Plants
TWh	Terawatt hour
TPES	Total Primary Energy Supply
TREC	Trans-Mediterranean Renewable Energy Cooperation
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development

US-$	United States Dollar
VSSP	Very Small Power Producers
WWF	World Wide Fund for Nature

V. Units & Conversion Factors

Table IV.1: Algebraic Sign for Energy Units

k	Kilo	10^{3} (Thousand)
M	Mega	10^{6} (Million)
G	Giga	10^{9} (Billion)
T	Tera	10^{12} (Trillion)
P	Peta	10^{15} (Quadrillion)
E	Exa	10^{18} (Quintillion)

Table IV.2: Conversion Factors for Energy Units (relating to calorific value)

		kJ	kcal	kWh
1 Kilojoule	kJ	1	0,2388	0,000278
1 Kilocalorie	kcal	4,1868	1	0,001163
1 Kilowatt hour	kWh	3.600	860	1
1 kg Crude Oil Unit (1 t Oil Equivalent)	ROE (t_{oe})	41.868 (x 1.000)	10.000 (x 1.000)	11,63 (x 1.000)

VI. Executive Summary

The utilisation of renewable energy sources is, alongside measures to improve energy efficiency, the central pillar of sustainable energy systems. The Kyoto Protocol's Clean Development Mechanism (CDM) sets incentives for the dissemination of low-emission technologies and practices in developing countries and should therefore be able to help to overcome some of the barriers that impede the increased use of renewable energy sources in developing countries. This study therefore aimed to undertake an in-depth examination of the contribution the CDM can make to the dissemination of renewable energy technology (RET) and identify areas for improvement. This question was examined on the basis of two country studies on Egypt and Thailand.

VI.1 Current Trends of Renewable Energy Projects in the CDM

Having started with many difficulties and delays, the supply side of the CDM is now fully functional and expanding rapidly. As of the date of writing this report, 1,393 projects have already been registered or are at the validation stage, expecting a cumulative 1.5 billion CERs by 2012. Among these, there are 803 renewable energy projects, equalling 58% of the project portfolio.

However, the picture changes when breaking down the expected CERs according to project type as a measure of how much "carbon financing" each respective project type receives. From this perspective, the market is dominated by projects reducing hydroflurocarbons (HFCs), nitrous oxide (N_2O) and methane (CH_4), which in total account for about two thirds of all expected CERs. This is due to the high global warming potential of these gases, which in the case of HFC is 11,700 times that of CO_2, with abatement costs of about US-$ 0.50 per tonne. By contrast, the huge number of renewable energy projects accounts for only 22% of all expected CERs. The reasons are that RE projects typically reduce emissions of CO_2, which has a global warming potential of 1, and are often small-scale applications. Projects therefore yield relatively few CERs and as a result the increase in the internal rate of return from the sale of CERs of a CO_2-based renewable energy project is relatively low at current CER prices, estimated at 1-2%, and considerably less than in the case of projects involving other greenhouse gases.

It also emerges that the demand side is predominantly focussed on acquiring as many CERs for as low a price as possible, irrespective of whether projects contribute to sustainable development, as mandated by the Kyoto Protocol. While there are some signs of a market differentiation such as programmes that pay higher prices for CERs from certain types of projects or the CDM Gold Standard[1], these initiatives are so far very limited.

VI.2 Potential and Barriers to Renewable Energy CDM Projects

The country studies have shown that the limited emission reductions so far achieved by RE projects are not due to a lack of potential. In particular Egypt has a massive potential for utilising renewable energy sources. Not only the solar potential of this country lying in the Earth's "Sunbelt" is tremendous but also the wind speed and potential is one of the best worldwide. The overall economic potential for power generation by RET in Egypt is six times higher than the country's current electricity production. In total, more than 600 TWh could be produced by RET. Renewable energy resources in Thailand are more limited than in Egypt but still significant. Summarising official figures on potential and consumption, a rough estimate is that a potential of about 24,000 ktoe/year (279,120 GWh) remains to be exploited, particularly in the area of biomass. The Thai government is putting a particular emphasis on biofuels to reduce import dependence. However, the potential in this field appears to be limited. By 2011, all of the domestic production of cassava would need to be converted into ethanol for replacing only 3% of the future demand for benzene.

In both countries so far only a fraction of the available potential is used and there is a wide variety of barriers which impede the dissemination of RET. The key barriers are energy prices and the monopolistic structure of the energy market. Most renewable energy applications are still characterised by high specific upfront investment costs, and in both countries energy

[1] The CDM Gold Standard aims to enhance the environmental and socio-economic integrity of the CDM by defining quality criteria that exceed those established within the Kyoto regime, thus creating a 'premium product' on the emission certificates market. It is based on the expectation that buyers will be willing to pay more for CERs generated by certified high-quality projects.

prices are well below the level that would be needed to make them economically viable. Especially in Egypt the 'playing field' is significantly distorted by subsidies for fossil fuels. Moreover, in both countries there is no guaranteed access to the grid for independent power producers, which, as the German experience has shown, is a key prerequisite for a wider uptake of RET.

RET dissemination is also severely hampered in both countries by a lack of policy clarity. While both countries have announced ambitious targets for the increased utilisation of renewable energy technology, these have so far not been sufficiently backed up by policies and measures. Thailand has several support instruments in place but policy-makers have been discussing for two years whether to introduce a Renewable Energy Portfolio Standard or not, which undermines business confidence. Egypt has so far put hardly any RE policy instruments in place and the quickly rising energy demand is supposed to be met by a massive expansion of gas-fired thermal power plants. RET expansion in Egypt has thus so far to a very large extent depended on development cooperation projects. Another important barrier in both countries has been the lack of technical standards or their enforcement, which has led low-quality products and a bad reputation of RE applications. Finally, in both countries there is a severe lack of awareness of the potential for the use of RET and the associated benefits.

The CDM is supposed to promote projects implementing low-emission technologies such as renewable energy technology by providing additional revenue, which should serve to alleviate in particular economic and financial barriers. However, both the overview of the global CDM pipeline as well as the country studies show that RE projects get a disproportionately low financial benefit out of the mechanism. On the basis of current prices for CERs the additional revenue therefore has only a limited impact on the profitability of a project and is certainly not able to counterbalance fundamental distortions in national energy markets. In Egypt, subsidies tilt the energy market that much against RE that the CER revenues are not sufficient for even one of the RE CDM projects currently in the pipeline to become economically viable. Instead, they all depend on additional financing from official development assistance. In Thailand, project developers have freely stated that the CDM is actually not necessary to make biomass projects viable but rather is an "optional extra". As for other RE projects, at a price of € 10 per CER and an exchange rate of 47 Baht / €, the CDM would add Baht 0,235 per kWh, which is nowhere near enough to close the gap between current electricity tariffs of about 2.5 Baht and the cost for wind energy and PV, which are 5-6 and more than 10 Baht respectively.

VI.3 Options for Promoting Renewable Energy CDM Projects

Since there are manifold barriers that discriminate against RET in energy markets, addressing only a single barrier is not enough. To be effective, strategies must take into account the complex interplay of barriers, which usually requires a mix of well-designed and mutually supportive policy instruments.

When designing the next policy steps to advance renewable energy, it would therefore be useful to discuss the role the CDM could and should play in the overall energy policy setting. This should mean looking for the best ways to combine domestic policy instruments with the CDM in order to maximise CDM benefits and thus the increase in renewable energy use.

Table VI.1 gives an overview of key measures that can be taken to promote renewable energy.

The most important issue is the economic performance of RET compared to the energy sources that presently dominate the energy markets. In principle, there are two approaches to addressing this problem, both of which are indispensable in developing promising strategies:

- Bringing down the costs of RET and their related energy services
- Abolishing market distortions that discriminate against these technologies, such as direct subsidies for fossil fuels or lacking internalisation of external costs

As to the first approach, there is evidence that policies can effectively induce technological progress and cost savings by creating enabling frameworks. The latter is often described as ‘levelling the playing field’ in which RETs and conventional energy technologies have to compete.

Table VI.1: Options for Overcoming Barriers to RE CDM Projects

Measure	Actor(s) Responsible / Involved	Barrier(s) Addressed
Reduce subsidies for fossil fuels and for electricity tariffs	Host country government, researchers, utilities	Lack of level playing field and willingness to finance 'expensive' investments in RET
Ambitious targets for renewables expansion	Host country government	Lack of policy clarity
Open access to grids and other distribution networks, facilitating market entry	Host country government	Lack of guaranteed grid access for independent producers
RE feed-in tariffs, tax credits, investment subsidies, green certificates	Host country government	High specific up-front investment costs for RET
Dedicated loan facilities	Host country government, banks, business associations	High specific up-front investment costs Insufficient purchasing power among potential users
Lower taxes and customs duties	Host country government, researchers, manufacturers, industry associations	Taxes and customs duties on RET equipment
Establish and enforce manufacturing standards	Host country government, manufacturers, industry associations, researchers	Inadequate appliance quality
Practical support for RET users Capacity building	Host country government, regional or municipal governments, consumer associations	Lack of technical capacity and knowledge
RET promotion	Host country government, media, celebrities, educational bodies, project developers, industrialised country governments	Lack of awareness and capacity Lack of RE success stories which create positive image Perception of RE as old-fashioned Inadequate, insufficient education of consumers/RE system users Lack of social acceptance
Speedy and transparent CDM approval process	Host country government	Transaction costs
CDM capacity building and promotion	Host country government, media, celebrities, educational bodies, project developers, industrialised country governments	Lack of awareness and capacity
Integrate CDM into national energy and economic development planning	Host country government	Lack of clear signal to government officials to support CDM
Preference to RET CDM Projects	Host country government, industrialised country governments	Competition from low-cost high-yield projects
Using CDM Gold Standard	Host country government, industrialised country governments	High specific investment costs Competition from low-cost high-yield projects
Topped-up prices and up-front financing for RET CDM projects	Industrialised country governments	High specific up-front investment costs Competition from low-cost high-yield projects
Pursue CDM Programmes of Activities	Host country government, regional or municipal governments, project developers, industrialised country governments	High specific up-front investment costs Lack of incentive system for certain technologies

Priority measures are to reform energy markets by reducing subsidies for fossil fuels, giving independent power producers access to the grid and carefully raising prices to a level where RET become viable. Setting clear and ambitious targets for the expansion of renewable energy use and introducing supportive policies to push RET into the market, achieve economies of scale and quickly ‘buy down’ technology costs are also highly desirable. Examples of supportive policies include feed-in laws that provide remunerative tariffs for renewable energy, tax credits and investment subsidies.

It would also be highly desirable to establish and enforce quality standards for RE equipment, to establish dedicated loan facilities, give practical support to those who implement renewable energy technology, and to substantially raise awareness of renewable energy and build technical capacity.

Apart from improving general domestic conditions, there are several other ways to improve the use of the CDM to promote renewable energy. One key prerequisite for attracting CDM projects is to have a DNA with sufficient competent staff to operate a speedy and transparent CDM approval process. Moreover, in view of the CDM’s tendency to concentrate on large, rapidly industrialising nations, an extremely pro-active approach will probably be needed in many countries. Governments could work to identify potential projects and advertise CDM opportunities to potential business partners and CER buyers. Egypt has taken strong steps in this direction by developing a project portfolio of 24 projects and advertising it at international carbon conferences and through other means. The CDM should also be integrated into the general energy and development planning of a country.

Non-Annex I as well as Annex I governments could give a clear preference to RE CDM projects. Annex I governments in particular could significantly help to overcome the barriers of high specific upfront investment costs by paying higher prices and providing upfront financing for RE CDM projects. This could include giving a special preference to Gold Standard projects.

Moreover, in 2005 it was decided to allow “programmatic” CDM projects, i.e. projects that combine decentralised activities into one overall framework. This approach is supposed to allow aggregating dispersed small-scale RE activities to sizes where they become economically viable. It might be very helpful if public institutions from both host and investor countries conducted pilot projects to explore and overcome methodological problems potentially connected to this new approach.

There are also discussions to actually make the CDM a driver for effective policy instruments in future Kyoto commitment periods by also including “policy-based” projects. Under such an approach, countries might be able to register the introduction of policies such as feed-in tariffs as CDM projects and use the CER revenues to fund policy implementation.

However, even such an expansion of the CDM could probably not overcome all its current limitations. Due to its construction, the CDM can only be effective where there are emissions to be reduced. Moreover, it can be assumed that only a limited number of developing countries disposes of the necessary technical capacity to implement such complex projects. Some of these problems might be overcome through increased capacity building, but it will probably also be necessary to introduce further instruments for technology transfer and investment promotion to also reach poorer Southern countries.

VII. Zusammenfassung

VII.1 Hintergrund und Fragestellung

Die **Nutzung erneuerbarer Energieträger** ist neben Maßnahmen zur Energieeffizienz die zentrale Säule eines zukunftsfähigen Energiesystems. Die Treibhausgasemissionen der Entwicklungs- und Schwellenländer sind zum großen Teil energiebedingt und werden voraussichtlich in den nächsten Jahrzehnten stark anwachsen. Die Verbreitung der Nutzung erneuerbarer Energieträger in den südlichen Ländern ist daher, neben der Verbesserung der Energieeffizienz, unabdingbar für die Verhinderung einer gefährlichen anthropogenen Störung des Klimasystems, dem zentralen Ziel der Klimarahmenkonvention. Zudem kann die Nutzung erneuerbarer Energieträger auch wichtige andere Vorteile mit sich bringen, etwa die Verminderung der lokalen Schadstoffbelastung, die Möglichkeit der Elektrifizierung ländlicher Gebiete, ohne zunächst eine kostspielige Netzinfrastruktur aufbauen zu müssen, oder die Verminderung der Abhängigkeit von Brennstoffimporten.

Der **Clean Development Mechanism (CDM)** ist ein projektbasierter Mechanismus, der durch Art. 12 des Kyoto-Protokolls zur Klimarahmenkonvention etabliert wurde. Unter dem CDM können öffentliche und private Projektentwickler so genannte Certified Emission Reductions (CER) aus Projekten wie Erneuerbare-Energien-Projekten generieren, die Treibhausgasemissionen in Entwicklungsländern reduzieren. Er hat eine zweifache Zielsetzung:

- Er soll die Gastländer bei ihrer nachhaltigen Entwicklung unterstützen
- Er erlaubt es den Industrieländern, die sich unter dem Kyoto-Protokoll auf ein Emissionsziel verpflichtet haben, die CER aus CDM-Projekten zu erwerben und diese auf ihre Kyoto-Ziele anzurechnen.

Durch die Erlöse aus dem Verkauf der CER soll der CDM finanzielle Anreize für die Verbreitung emissionsarmer Technologien und Verfahren in südlichen Ländern setzen und könnte so einen Beitrag leisten zur Überwindung der Barrieren, die der Verbreitung der Nutzung erneuerbarer Energieträger in diesen Ländern entgegenstehen.

Vor diesem Hintergrund hat die vorliegende Studie zum Ziel, den potentiellen Beitrag des CDM für die Nutzung erneuerbarer Energieträger in südlichen Ländern eingehend zu untersuchen und Verbesserungsmöglichkeiten aufzuzeigen. Im Detail sind die Forschungsfragen wie folgt:

- Was ist das Potenzial für die Nutzung erneuerbarer Energieträger in ausgewählten Entwicklungsländern (Ägypten und Thailand)?
- Welche Barrieren behindern die Nutzung erneuerbarer Energieträger?
- Inwieweit kann der CDM zur Überwindung dieser Barrieren beitragen?
- Welche Optionen existieren, um das Funktionieren des CDM zu verbessern, und welche anderen Politikmaßnahmen müssten parallel zum CDM eingeführt oder verändert werden, um die identifizierten Barrieren nachhaltig zu überwinden?

VII.2 Methodik

Die Forschungsfragen wurden auf Grundlage von Länderstudien untersucht. Die zur Erarbeitung der Länderstudien hauptsächlich verwendeten methodischen Ansätze waren Literaturrecherchen, Interviews mit Expertinnen und Experten sowie Workshops zur Diskussion und Validierung der Ergebnisse. Das Forschungsteam wurde bei jedem Schritt von Partnern aus den untersuchten Ländern unterstützt. Die Forschungsschritte waren im Einzelnen:

- Vorstudien zu den vom Auftraggeber vorgegebenen Ländern Ägypten, Marokko, Senegal und Thailand;
- Auf Grundlage der Vorstudien Auswahl von zwei Ländern (Ägypten und Thailand) für eine intensive Untersuchung;
- Weitere Literaturrecherche zu den beiden ausgewählten Ländern;
- Interviews mit deutschen Expertinnen und Experten aus der Entwicklungszusammenarbeit und der Erneuerbare-Energien-Branche;

- Vor-Ort-Besuche in Ägypten und Thailand zur weiteren Literaturrecherche sowie zur Durchführung von Interviews mit Expertinnen und Experten vor Ort;
- Durchführung von je einem Workshop in Ägypten und Thailand zur Diskussion und Validierung der Zwischenergebnisse mit Expertinnen und Experten vor Ort;
- Diskussion der Ergebnisse mit dem Projektbeirat aus Mitgliedern des Bundesumweltministeriums und des Umweltbundesamtes.

VII.3 Gegenwärtiger Trend Erneuerbarer-Energien-Projekte im CDM

Nachdem der CDM zunächst mit großen Schwierigkeiten und Verzögerungen gestartet war, ist er inzwischen voll funktional und expandiert rapide. Der Markt ist jedoch noch sehr intransparent, es existiert kein öffentliches Transaktionsregister und kein international anerkannter Preisindex. Die meisten Transaktionen werden zwischen den Beteiligten direkt abgewickelt, und es werden kaum Details öffentlich gemacht.

Der projektbasierte Markt (der auch Joint Implementation, den zweiten projektbasierten Kyoto-Mechanismus, einschließt) wird derzeit von Käufern aus Europa und Japan dominiert. Die meisten Käufer sind private Akteure, die Zertifikate entweder zu Pflichterfüllungszwecken oder aber zum Wiederverkauf auf dem Zweitmarkt erwerben. Von Regierungsseite haben bisher neun EU-Mitgliedstaaten insgesamt € 2,7 Mrd. bereitgestellt, um bis 2012 365 Millionen Tonnen (Mt) CO_2-Äquivalent aus dem Ausland zuzukaufen. Japan hat angekündigt, dass es bis 2012 100 Mt CO_2-Äquivalent erwerben will. Die Schweiz wird in der Periode 2008-12 jährlich bis zu 1,6 Mt CO_2-Äquivalent erwerben. Demgegenüber hat die neue konservative Regierung Kanadas, das unter der liberalen Vorgängerregierung bis zu 100 Mt CO_2-Äquivalent jährlich erwerben wollte, vorläufig alle Aktivitäten für den Erwerb von Zertifikaten eingestellt.

Der Preis für CER liegt derzeit bei € 5-6 pro Tonne CO_2-Äquivalent für Optionsgeschäfte mittleren Risikos, € 7-8 für Optionsgeschäfte mit geringem Risiko, € 8-11 für registrierte Projekte und um € 11-13 für ausgestellte CERs.

Zum Zeitpunkt der Erstellung dieses Berichts sind 1393 Projekte entweder bereits registriert oder im Validierungsstadium und erwarten bis 2012 eine kumulierte Menge von 1,5 Mrd. CER. Erneuerbare-Energien-Projekte sind mit 803 Projekten - dies entspricht **58% aller Projekte** - zahlenmäßig die größte Projektkategorie. Darunter sind 307 Biomasseprojekte, 232 Wasserkraftprojekte (einschließlich großer Wasserkraftprojekte), 171 Windenergieprojekte und 77 Biogasprojekte. Bemerkenswert ist allerdings, dass sich darunter nur 7 Solar- und 8 Geothermieprojekte befinden.

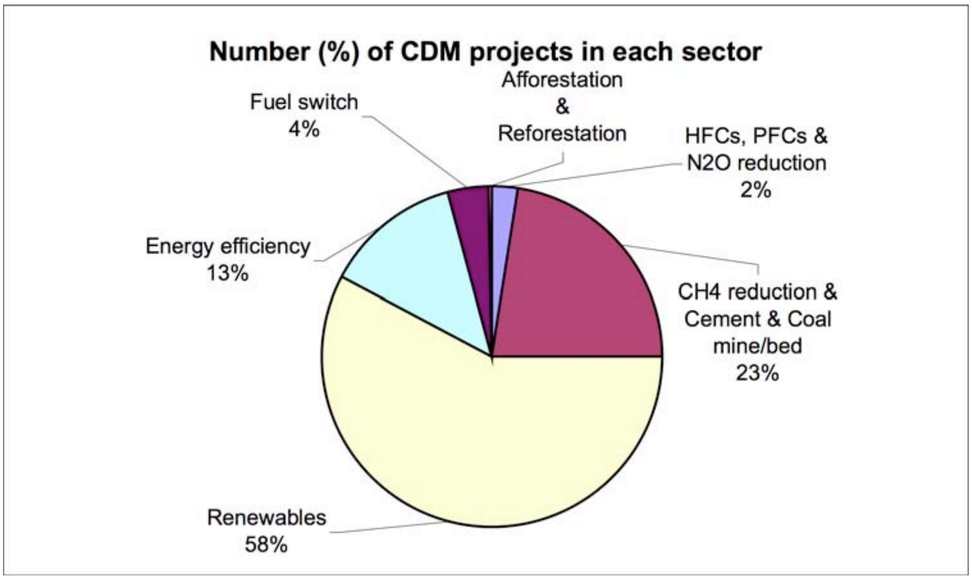

Abbildung I.1: Anzahl (%) der CDM-Projekte pro Sektor

Quelle: Fenhann 2006

Das Bild ändert sich weiter, wenn man die pro Projekttyp erwarteten CER betrachtet als Maßstab dessen, wie viel „carbon financing“ in den jeweiligen Projekttyp fließt. Hier beträgt der Anteil der Erneuerbare-Energien-Projekte nur **22% aller erwarteten CER**. Die Gründe hierfür sind, dass Erneuerbare-Energien-Projekte normalerweise Emissionen von CO_2 reduzieren, das eine Klimawirksamkeit von 1 hat, und oft relativ kleine Anwendungen sind. Erneuerbare-Energien-Projekte werfen daher nur relativ wenige CER ab und erhalten somit nur eine relativ geringe finanzielle Förderung durch den CDM. Die interne Verzinsung CO_2-basierter Erneuerbarer-Energien-Projekte verbessert sich durch den CDM bei den derzeitigen CER-Preisen nur um schätzungsweise 1-2%.

Aus der Perspektive der erwarteten CER wird der Markt klar von Projekten dominiert, die teilhalogenierte Kohlenwasserstoffe (HFCs), Lachgas (N_2O) und Methan (CH_4) vermeiden. Diese sind in der Summe für rund zwei Drittel aller erwarteten CER verantwortlich. Methan die 21fache, HFCs sogar die 11.700fache Wirkung von Kohlendioxid. Entsprechend werfen die Projekte sehr viele CER ab und erhalten einen sehr großen Anteil des „carbon financing".

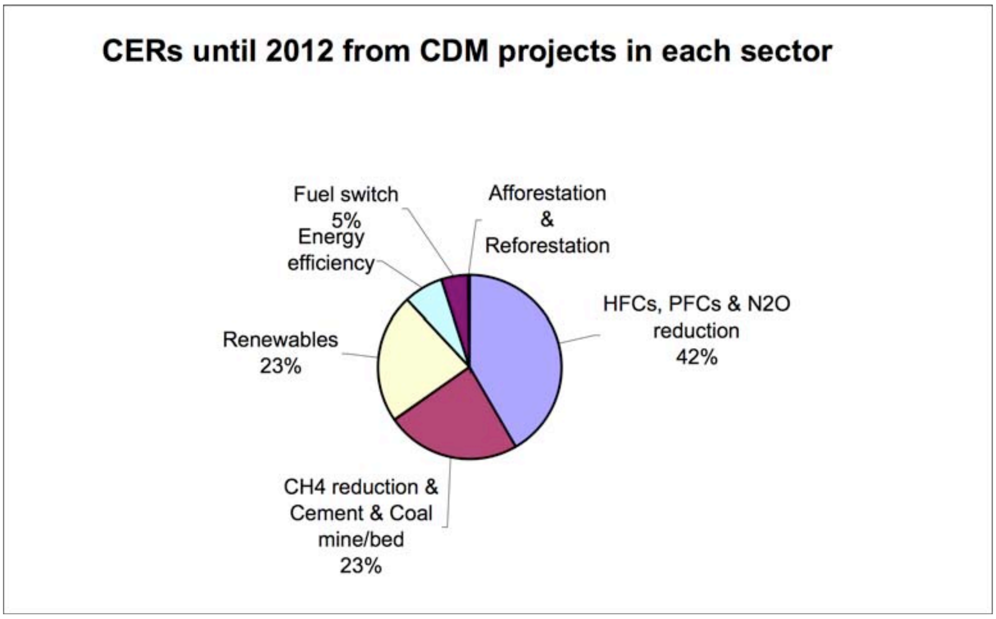

Abbildung I.2: Annual CERs from CDM projects in each sector

Source: Fenhann 2006

Man muss diesbezüglich auch in Betracht ziehen, dass der Großteil der Emissionen der südlichen Länder energiebedingte Emissionen sind. Der Großteil der durch den CDM vermiedenen Emissionen ist jedoch nicht energiebedingt, der CDM hat damit bisher nur einen relativ geringen Einfluss auf die Emissionstrends in den für die Bekämpfung des Klimawandels wichtigen Schlüsselsektoren.

Die geographische Verteilung des CDM ist ähnlich unausgeglichen. Drei Viertel aller Projekte finden in den Ländern Indien, Brasilien, China und Mexiko statt, davon allein in Indien 36%. Demgegenüber werden im sub-saharischen Afrika sowie in der Region Nordafrika/Naher Osten nur jeweils 2% aller Projekte durchgeführt. Als marktbasierter Mechanismus, der der Mobilisierung privater Investitionen dienen soll, konzentriert sich der CDM offensichtlich auf die Länder, die wirtschaftlich bereits relativ weit entwickelt sind und damit neben umfangreichen Emissionsreduktionspotentialen auch über ein verhältnismäßig günstiges allgemeines Investitionsumfeld verfügen.

Bisherige Ansätze zur Förderung Erneuerbarer-Energien-Projekte im CDM sind insbesondere:

- Fonds und Ankaufprogramme mit einer Präferenz für Erneuerbare-Energien-Projekte;
- Der CDM Gold Standard;
- Maßnahmen zum Kapazitätsaufbau.

Bezüglich der Fonds und Ankaufprogramme muss allerdings festgestellt werden, dass diese sich überwiegend allein auf die Anzahl der CER konzentrieren. Es gibt zwar einige Ansätze zu einer Marktdifferenzierung in dem Sinne, dass einige Käufer gewillt sind, für CER aus Projekten mit klarem Nachhaltigkeitsnutzen einen höheren Preis zu zahlen. Diese sind jedoch bisher vereinzelt. Die allermeisten Käufer konzentrieren sich bei der Auswahl ihrer Projekte ausschließlich auf die Menge der CER und den Preis. Zudem leisten die meisten Käufer keine Investitionen in die Projekte selber, sondern nehmen lediglich nach der erfolgreichen Durchführung des Projekts die generierten CER ab. Die Projektentwickler sind damit vor das Problem gestellt, die Finanzierung der Projekte über andere Quellen oder aus eigener Kraft leisten zu müssen.

Diese Konzentration auf Anzahl und Preis der CER trifft auch den CDM Gold Standard. Der CDM Gold Standard hat zum Ziel, die ökologische und sozio-ökonomische Integrität des CDM zu verbessern, indem er Qualitätsstandards definiert, die über die des Kyoto-Regimes hinausgehen. Er schafft so ein „Premiumprodukt" auf den Emissionshandelsmärkten. Ihm liegt die Erwartung zu Grunde, dass Käufer gewillt sein werden, höhere Preise für CER aus zertifiziert hochwertigen Projekten zu zahlen. Die Nachfrage nach gemäß dem Gold Standard zertifizierten Projekten ist derzeit jedoch nur sehr schwach. Repräsentanten von staatlichen Ankaufprogrammen und private Käufer erklären explizit, dass der Gold Standard für sie nicht interessant sei, da sie hauptsächlich darauf abzielten, so viele CER so günstig wie möglich zu erwerben. Die mangelnde Nachfrage blockiert auch die Entwicklung eines Angebots von

Gold Standard-Projekten, bisher führt die Datenbank des CDM Gold Standard nur sechs Projekte auf.

Insgesamt lässt sich also feststellen, dass der CDM zwar einen Beitrag zur Verbreitung der Nutzung erneuerbarer Energieträger leistet, dabei jedoch auch Grenzen hat. Diese liegen insbesondere darin begründet, dass der CDM allein die Emissionsreduktionsleistung eines Projektes vergütet, diese bei Erneuerbare-Energien-Projekten jedoch relativ gering ist im Vergleich zu Projekten, die die Freisetzung anderer Treibhausgase verhindern.

VII.4 Ergebnisse der Länderstudien

Potenzial und gegenwärtige Nutzung erneuerbarer Energieträger

Die günstige Lage im „Sonnengürtel" der Erde sowie exponierte und stets windreiche Küstenregionen machen **Ägypten** zu einem der „reichsten" Länder in Bezug auf technisch – und unter fairen Marktbedingungen auch wirtschaftlich – leicht zu erschließende Potentiale an Sonnen- und Windenergie. In Zahlen ausgedrückt liegt das gesamte Potential für die elektrische Nutzung von erneuerbaren Energieträgern bei ca. 620 TWh, was 6fach den aktuellen Verbrauch Ägyptens übersteigt. Davon könnten allein 500 TWh aus der Anwendung solarthermischer Kraftwerke (CSP) und 90 TWh aus der Windenergie gewonnen werden. Solarthermisch ist zudem noch ein erhebliches Potential für die Wärme- und Kältenutzung sowie für die Meerwasserentsalzung gegeben, das in vielen der bislang veröffentlichten Studien zu den Potentialen Erneuerbarer-Energien-Technologien nur unzureichend Beachtung fand. Auch das Potential an Biomasse ist nicht zu vernachlässigen, rund 20 TWh elektrisch sowie zusätzlich eine vergleichbare Menge für die Wärmegewinnung könnten laut einer Studie nutzbar gemacht werden.

Bislang wurden, wenn man die Wasserkraft außer Acht lässt, allerdings nur sehr wenige Projekte umgesetzt und Anlagen installiert, welche v.a. im Bereich der Windkraft zu finden sind. Am Golf von Suez wurden und werden von der staatlichen Agentur für Erneuerbare Energien (NREA), finanziert durch ausländische Entwicklungshilfegelder, mehrere große Windparks aufgebaut. Aktuell ist auch eine große solarthermische Anlage in Planung, die ebenfalls mit ausländischen Hilfsgeldern finanziert wird.

Im Bereich der Wasserkraft sind die vorhandenen Potentiale bereits seit den 60er Jahren erschlossen worden (aktuell 2745 MW installiert), so dass nur noch geringe Zuwächse zu erwarten sind. Insbesondere im Zusammenhang mit der Restaurierung alter Stauwehre kann eine kombinierte Erneuerung mit Turbinen erfolgen, wie es derzeit in 2 CDM-Projekten der Fall ist. Die Dominanz der Wasserkraft im Bereich des Stromsektors, wo sie 1974 noch über 70 % des Strombedarfs deckte, wurde von der Stromproduktion in thermischen Gaskraftwerken abgelöst. Wasserkraft trägt heute nur noch zu 12 % zur Gesamtstromproduktion bei, mit weiter fallender Tendenz.

Die Angaben zu wirtschaftlichen und technischen Potentialen Erneuerbarer-Energien-Technologien in den vorhandenen Studien müssen relativiert werden, da in keiner der Untersuchungen die hohen Subventionen des gesamten Energiesektors in Gänze Berücksichtigung finden. Diese Subventionierung findet in 2 Stufen statt: erstens wird das heimisch gewonnene Gas unter dem internationalen Preis an die Kraftwerke abgegeben, zweitens entsprechen auch die Tarife für die Stromkunden nicht den wahren Kosten der Stromproduktion. Von daher können in Ägypten aktuell Erneuerbare-Energien-Technologien wirtschaftlich nicht mit den fossilen Energieträgern konkurrieren.

Die ägyptische Regierung hat ihren Willen zur Verbreitung Erneuerbarer-Energien-Technologien bekundet und verschiedene Zielsetzungen (bis zum Jahr 2020 ca. 28.000 GWh/a) formuliert. Umfangreiche staatliche Förderprogramme sind bislang jedoch nicht vorhanden. Für die Deckung des stark steigenden Energiebedarfs sind vor allem weitere thermische Kraftwerke geplant, welche mit den heimischen Vorkommen an fossilen Ressourcen (v.a. Erdgas) befeuert werden sollen. Wie unter diesen Umständen das Regierungsziels von 14 % Anteil der erneuerbaren Energieträger am Strombedarf bis 2020 erreicht werden soll, ist nicht erkennbar.

Thailand verfügt zwar nicht über vergleichbar hohe Potenziale für die Nutzung von erneuerbaren Energieträgern wie Ägypten, sie sind aber dennoch beachtlich und werden bisher ebenfalls nur zu einem kleinen Teil genutzt. Solarenergie und Biomasse sind dabei die Ressourcen mit den höchsten Potenzialen. Gegenwärtig sind ca. 1200 MW zur Elektrizitätserzeugung aus erneuerbaren Energieträgern installiert, was weniger als ein Zehntel des geschätzten wirtschaftlichen Potenzials an erneuerbaren Energieträgern ist. Die

Nutzung fester Biomasse ist mit deutlichem Abstand die Hauptquelle in der Stromerzeugung aus erneuerbaren Energieträgern und unter gegebenen Marktbedingungen bereits nahe an der Wettbewerbsfähigkeit. Wind- und Solarenergie spielen hingegen noch eine sehr geringe Rolle im thailändischen Elektrizitätsmix. Die größten Wachstumsraten finden sich bei der Stromerzeugung aus Biogas und bei der Produktion von biogenen Flüssigtreibstoffen, wenngleich von einem niedrigen Niveau ausgehend. Das Wachstum bei den Biotreibstoffen wird vor allem durch die hohen Ölpreise angetrieben, die die thailändische Wirtschaft durch deren hohe Importabhängigkeit stark treffen. In der Wärme- und Kälteerzeugung spielen erneuerbare Energieträger bisher noch keine Rolle (mit Ausnahme der „traditionellen“ Biomasseverbrennung).

Aufgrund begrenzter Datenverfügbarkeit ist es schwierig, den Gesamtanteil am thailändischen Energieverbrauch zu beziffern, den erneuerbare Energieträger potenziell leisten könnten. Zu den offiziellen Zahlen der Potenziale lässt sich zusammenfassend sagen, dass eine grobe Schätzung ein bisher ungenutztes Potenzial von rund 24.000 ktoe/Jahr (279.120 GWh) sieht, was in etwa der Hälfte des Endenergieverbrauchs Thailands entspricht. Bezieht man die beachtlichen Solarenergie-Potenziale mit ein – bisher allerdings nur für 1% der Landesfläche berechnet – existieren weitere 554.071 ktoe/Jahr (6.443.845 GWh) an Potenzialen. Das legt den Schluss nahe, dass es zumindest theoretisch möglich sein könnte, den gesamten Energiebedarf durch erneuerbare Energieträger zu decken, auch wenn dies unter heutigen Marktbedingungen und Technologiekosten für erneuerbare Energieträger derzeit nicht wirtschaftlich ist. Allerdings belaufen sich Schätzungen über die wirtschaftlich nutzbaren Potenziale im Elektrizitätsbereich auf nur etwa die Hälfte der heutigen Gesamtkapazität der thailändischen Elektrizitätswirtschaft.

Seit Mitte der 1990er Jahre hat die thailändische Regierung damit begonnen, Fördermechanismen für die Nutzung erneuerbarer Energieträger einzuführen. Im Jahr 2003 wurden Ausbauziele für erneuerbare Energieträger bekannt gegeben, die bis zum Jahr 2011 ihre Nutzung um den Faktor 24 gegenüber 2003 erhöhen würden. Dies würde den Anteil am Endenergieverbrauch von 0,5% auf dann 8%, vergrößern, bei einem erwarteten Energieverbrauchswachstum von ca. 50%. Verschiedene Politikmaßnahmen wurden zur Erreichung der Ziele angekündigt, von denen manche bereits umgesetzt wurden (z.B. im Bereich der Biotreibstoffe), während andere weiterhin diskutiert werden (z.B. ein Renewable

Energy Portfolio Standard). Auch Einspeisegesetze sind in der Diskussion. Der CDM spielte dabei bisher eine untergeordnete Rolle. Beim gegenwärtigen Stand bedarf es jedoch absehbar weiterer Maßnahmen zur Zielerreichung.

Barrieren gegen die Verbreitung Erneuerbarer-Energien-Technologien

In beiden betrachteten Ländern besteht eine Vielzahl von Barrieren gegen die stärkere Nutzung von erneuerbaren Energieträgern. Die Identifizierung der Barrieren ist eine Voraussetzung dafür, angemessene Maßnahmen auf allen Ebenen (lokal, regional, national) zu entwickeln, um die Barrieren zu überwinden.

Die Schlüsselbarrieren sind in beiden Ländern die **niedrigen Energiepreise** sowie die **monopolistische Struktur des Energiemarktes**. Die meisten Anwendungen von erneuerbaren Energieträgern sind derzeit noch von hohen spezifischen Investitionskosten geprägt, und in beiden Ländern liegen die Energiepreise deutlich unter einem Niveau, das nötig wäre, um die Nutzung erneuerbarer Energieträger konkurrenzfähig zu machen. Insbesondere in Ägypten ist der Energiemarkt deutlich durch **Subventionen für fossile Energieträger** verzerrt. Zudem haben unabhängige Energieanbieter in beiden Ländern **keinen garantierten Netzzugang**, was, wie das deutsche Beispiel zeigt, eine Schlüsselvoraussetzung für die breitere Verwendung erneuerbarer Energieträger ist.

Darüber hinaus wird die stärkere Nutzung erneuerbarer Energieträger in beiden Ländern durch einen **Mangel an klaren politischen Rahmenbedingungen** behindert. Während sich beide Länder anspruchsvolle Ziele für die Nutzung erneuerbarer Energieträger gesteckt haben, sind diese bislang nicht ausreichend mit politischen Maßnahmen wie beispielsweise Anreizsystemen unterlegt worden. Ägypten hat bisher nahezu keine Maßnahmen für die Förderung der Nutzung erneuerbarer Energieträger eingeführt und der bisherige Ausbau fand hauptsächlich im Rahmen von Projekten der Entwicklungszusammenarbeit statt. Thailand hat demgegenüber zwar bereits einige Maßnahmen zur Förderung von kleinen unabhängigen Anbietern eingeführt, die Politik debattiert jedoch bereits seit zwei Jahren und bisher ergebnislos die Einführung weiterer Mechanismen, vor allem eines Renewable Energy Portfolio Standard. Ein Einspeisegesetz – wesentlich motiviert durch die Erfolge in Deutschland – nimmt in den aktuellen Diskussionen allerdings eine zunehmend prominentere Rolle ein. Eine weitere wichtige Barriere ist ein **Mangel an technischen Standards** bzw.

deren Durchsetzung, was in der Vergangenheit zu schlechten Produkten und in der Folge zu einem schlechten Ruf Erneuerbarer-Energien-Technologien geführt hat.

Schließlich besteht in beiden Ländern bisher noch ein deutlicher **Mangel an Bewusstsein über die Potenziale** für eine stärkere Nutzung erneuerbarer Energieträger und die damit verbundenen Vorteile sowie ein **Mangel an technischen und personellen Kapazitäten**.

Potenzial des CDM zur Überwindung der Barrieren gegen die Verbreitung Erneuerbarer-Energien-Technologien

Der CDM soll Projekte, die emissionsarme Technologien wie Erneuerbare-Energien-Technologien anwenden, fördern, indem er eine zusätzliche Einnahmequelle bereitstellt, die insbesondere bei der Überwindung finanzieller und wirtschaftlicher Probleme helfen soll. Die globale CDM-Pipeline zeigt, dass der CDM einen Einfluss auf Erneuerbare-Energien-Projekte hat. Sowohl die Pipeline als auch die Länderstudien zeigen aber auch, dass hierbei deutliche Grenzen bestehen. Da Erneuerbare-Energien-Projekte nur relativ wenige CER abwerfen und bei den derzeit relativ niedrigen CER-Preis haben die zusätzlichen Einnahmen aus dem CDM oft nur einen relativ geringen Einfluss auf die Wirtschaftlichkeit Erneuerbarer-Energien-Projekte.

Der CDM ist insofern insbesondere nicht in der Lage, fundamentale Verzerrungen der nationalen Energiemärkte in den Gastländern auszugleichen. In Ägypten ist der Energiemarkt derart durch Subventionen für fossile Energieträger verzerrt, dass die CER-Einnahmen bei nicht einem der derzeit in der Pipeline befindlichen Erneuerbare-Energien-Projekte ausreichen, um es wirtschaftlich zu machen. Stattdessen hängen sie alle von zusätzlicher Finanzierung aus Mitteln der Entwicklungszusammenarbeit ab. In Thailand erklären demgegenüber Projektentwickler offen, dass der CDM für Biomasseprojekte oft gar nicht mehr nötig, sondern vielmehr ein „optionales Extra“ sei. Diese Projekte wären damit nicht als CDM-Projekte zulässig. Andere Erneuerbare-Energien-Projekte sind jedoch in einer schlechteren Position. Für Projekte, die CO_2-Emissionen reduzieren, würde der CDM bei einem Preis von € 10 pro CER und einem Wechelskurs von 47 Baht / € Einkünfte von 0,235 Baht / kWh hinzufügen. Dies ist weit davon entfernt, die Differenz zwischen den derzeitigen Strompreisen von 2,5 Baht und den Kosten etwa für Windenergie, die bei 5-6 Baht liegen, auszugleichen.

Zudem bestätigt sich die allgemeine Schlussfolgerung, dass CDM-Projekte sich dort konzentrieren, wo die Rahmenbedingungen für Investitionen am günstigsten sind, auch mit Blick speziell auf Erneuerbare-Energien-Projekte. Insbesondere Brasilien, China und Indien haben schon seit längerem deutlich stärkere Maßnahmen zur Förderung Erneuerbarer-Energien-Technologien unternommen als die hier betrachteten Länder Ägypten und Thailand.

VII.5 Optionen für die Förderung Erneuerbarer-Energien-CDM-Projekte

Da Erneuerbare-Energien-Technologien von einer Vielzahl von Barrieren behindert werden, ist es nicht ausreichend, nur eine Barriere anzugehen. Um effektiv zu sein, müssen Maßnahmen das komplexe Zusammenspiel von Barrieren in Betracht ziehen, das normalerweise eine Mischung von wohldefinierten und sich wechselseitig unterstützenden Politikinstrumenten erfordert.

In der Entwicklung der nächsten politischen Schritte zur Förderung erneuerbarer Energien wäre es daher nützlich, zu diskutieren, welche Rolle der CDM im Gesamtrahmen der Energiepolitik spielen soll. Dies bedeutet, die besten Wege zu identifizieren, nationale Politikmaßnahmen mit dem CDM zu kombinieren, um seinen Nutzen zu maximieren und dadurch die Nutzung erneuerbarer Energien zu steigern.

Tabelle VII.1 bietet einen Überblick über die in dieser Studie identifizierten zentralen Politikoptionen.

Das wichtigste Thema ist die Wirtschaftlichkeit von Erneuerbare-Energien-Technologien im Vergleich zu den Energieträgern, die derzeit die Energiemärkte dominieren. Prinzipiell existieren zwei Ansätze, dieses Problem anzugehen, die beide unverzichtbar sind:

- Die Senkung der Kosten von Erneuerbare-Energien-Technologien und den von ihnen erbrachten Energiedienstleistungen
- Die Abschaffung von Marktverzerrungen, die gegen diese Technologien diskriminieren, wie beispielsweise direkte Subventionen für fossile Brennstoffe oder die mangelnde Internalisierung der externen Kosten

Tabelle VII.1: Optionen für die Überwindung von Barrieren gegen Erneuerbare-Energien-Projekte im CDM

Maßnahme	Verantwortlicher/Beteiligter Akteur	Adressierte Barriere(n)
Reduzierung der Subventionen für fossile Brennstoffe und Strompreise	Regierung des Gastlandes, Forschung, Energieunternehmen	Mangel fairer Wettbewerbsbedingungen und der Bereitschaft, „teure" Investitionen in Erneuerbare zu finanzieren
Ehrgeizige Ziele für den Ausbau Erneuerbarer	Regierung des Gastlandes	Mangel an klaren politischen Rahmenbedingungen
Offener Zugang zum Stromnetz und anderen Verteilernetzen, Erleichterung des Markteintritts	Regierung des Gastlandes	Mangel an garantiertem Netzzugang für unabhängige Anbieter
Stromeinspeisevergütungen für Erneuerbare, Steuererleichterungen, Investitionszuschüsse, grüne Zertifikate	Regierung des Gastlandes	Hohe spezifische Vorlaufkosten für Erneuerbare
Spezielle Kreditfazilitäten	Regierung des Gastlandes, Banken, Unternehmensverbände	Hohe spezifische Vorlaufkosten Mangelnde Kaufkraft potentieller Nutzer
Senkung von Steuern und Zöllen	Regierung des Gastlandes, Forschung, Hersteller, Unternehmensverbände	Steuern und Zölle auf Erneuerbaren-Anlagen
Festlegung und Durchsetzung von Fertigungsstandards	Regierung des Gastlandes, Forschung, Hersteller, Unternehmensverbände	Unzureichende Qualität von Anlagen
Praktische Unterstützung für Nutzer von Erneuerbaren Kapazitätsaufbau	Regierung des Gastlandes, regionale und kommunale Regierungen, Verbraucherverbände	Mangel an technischer Kapazität und Wissen
Werbung für Erneuerbare	Regierung des Gastlandes, Medien, Prominente, Bildungseinrichtungen, Projektentwickler, Regierungen industrialisierter Staaten	Mangel an Bewusstsein und Kapazitäten Mangel an Erfolgsgeschichten, die ein positives Image schaffen Wahrnehmung von Erneuerbaren als altmodisch Unzureichende Bildung von Verbrauchern/Nutzern von Erneuerbaren Mangel sozialer Akzeptanz
Zügiges und transparentes CDM-Genehmigungsverfahren	Regierung des Gastlandes	Hohe Transaktionskosten
CDM-Kapazitätsaufbau und Werbung	Regierung des Gastlandes, Medien, Prominente, Bildungseinrichtungen, Projektentwickler, Regierungen industrialisierter Staaten	Mangel an Bewusstsein und Kapazitäten
Integrierung des CDM in nationale Energie- und Entwicklungsplanung	Regierung des Gastlandes	Mangel an klaren Signalen an Regierungsverantwortliche, den CDM zu unterstützen
Bevorzugung von Erneuerbare-Energien-CDM-Projekten	Regierung des Gastlandes, Regierungen industrialisierter Staaten	Konkurrenz von Projekten mit niedrigen Kosten und hohem Ertrag
Nutzung des CDM Gold Standard	Regierung des Gastlandes, Regierungen industrialisierter Staaten	Hohe spezifische Investitionskosten Konkurrenz von Projekten mit niedrigen Kosten und hohem Ertrag
Höhere Preise und Vorfinanzierung für Erneuerbare-Energien-CDM-Projekte	Regierungen industrialisierter Staaten	Hohe spezifische Vorlaufkosten Konkurrenz von Projekten mit niedrigen Kosten und hohem Ertrag
Verfolgung von CDM „Programmes of Activities"	Regierung des Gastlandes, regionale und kommunale Regierungen, Projektentwickler, Regierungen industrialisierter Staaten	Hohe spezifische Vorlaufkosten Mangel eines Anreizsystems für bestimmte Technologien

Bezüglich des ersten Ansatzes hat die Erfahrung gezeigt, dass Politikmaßnahmen durch die Schaffung günstiger Rahmenbedingungen effektiv technologischen Fortschritt und Kostensenkungen befördern können. Der zweite Ansatz wird auch als „leveling the playing field“ bezeichnet, auf dem Erneuerbare-Energien-Technologien und konventionelle Energietechnologien miteinander konkurrieren.

Zentrale Maßnahmen hierbei sind die Reform der Energiemärkte durch die Reduktion der Subventionen für fossile Energieträger, die Schaffung eines verlässlichen Netzzugangs für unabhängige Anbieter sowie die behutsame Anhebung der Energiepreise auf ein Niveau, auf dem erneuerbare Energieträger wirtschaftlich genutzt werden können. Förderlich sind auch die Festlegung klarer und anspruchsvoller Ziele für den Ausbau erneuerbarer Energien sowie konkrete Fördermaßnahmen, um die Markteinführung von Erneuerbare-Energien-Technologien zu beschleunigen und auf diese Weise Größenvorteile und Kostendegression zu erzielen. Beispiele für Fördermaßnahmen sind Einspeisegesetze, die kostendeckende Vergütungssätze für Strom aus erneuerbaren Energiequellen festschreiben, Steuererleichterungen oder Investitionszuschüsse.

Es wäre zudem sehr wünschenswert, technische Qualitätsstandards einzuführen und durchzusetzen, Anwender von Erneuerbare-Energien-Technologien in ihrer praktischen Umsetzung zu unterstützen, das Bewusstsein für die Vorteile der Nutzung erneuerbarer Energieträger deutlich zu erhöhen sowie technische bzw. personelle Kapazitäten aufzubauen.

Abgesehen von der Verbesserung der allgemeinen Rahmenbedingungen gibt es auch verschiedene Wege, um die Nützlichkeit des CDM zur Förderung erneuerbarer Energien zu verbessern. Entscheidend ist zunächst, dass das Gastland eine Genehmigungsbehörde mit ausreichenden und kompetenten Mitarbeitern einrichtet, die ein zügiges und transparentes Genehmigungsverfahren durchführen können. In Anbetracht der Tendenz des CDM, sich auf die großen Schwellenländer zu konzentrieren, ist zudem ein sehr proaktives Vorgehen der Gastländer ratsam. Deren Regierungen könnten es selber in die Hand nehmen, potenzielle Projekte zu identifizieren und diese international zu bewerben. So hat Ägypten ein Portfolio von 24 Projekten entwickelt und dieses auf internationalen Konferenzen und mit anderen Mitteln beworben. Auch sollte der CDM in die allgemeine Energie- und Entwicklungsplanung eines Landes integriert werden.

Die Regierungen der Käuferländer könnten Projekte mit klarem lokalen Nachhaltigkeitsnutzen und speziell Erneuerbare-Energien-Projekte bevorzugen und einen höheren Preis für die CER aus diesen Projekten bezahlen. Dies könnte einschließen, Gold Standard-Projekten einen besonderen Vorzug zu geben. Sie könnten zudem zumindest einen Teil der Finanzierung bereits im Vorfeld der Projektdurchführung zur Verfügung stellen. Dies würde helfen, das Problem der hohen spezifischen Investitionskosten Erneuerbarer-Energien-Technologien zu beheben.

Die erste Konferenz der Vertragsstaaten des Kyoto-Protokolls im Dezember 2005 in Montreal entschied, „programmatische“ CDM-Projekte zuzulassen. Dieser Ansatz soll es, so die Erwartungen, ermöglichen, dezentrale kleine Aktivitäten zu Größen zusammenzufassen, bei denen sie wirtschaftlich durchgeführt werden können. Er könnte es auch erlauben, weniger wirtschaftliche Aktivitäten querzusubventionieren, indem sie mit hoch wirtschaftlichen Aktivitäten kombiniert werden. Letzterer Ansatz wurde in der Thailand-Studie des vorliegenden Projektes untersucht. Auf Grund der erhöhten Komplexität solcher Projekte wird es allerdings möglicherweise oft erforderlich sein, dass sie unter Beteiligung öffentlicher Stellen in den Gastländern stattfinden. Die Regierungen der Annex I-Staaten könnten als Investoren ebenfalls einen deutlichen Beitrag zur Umsetzung dieses neuen Projekttyps leisten. Öffentliche Institutionen von Gastländer- und Käuferseite könnten Pilotprojekte durchführen, um etwaige methodische Probleme dieses neuen Ansatzes zu analysieren und Wege zu deren Überwindung aufzuzeigen.

Insbesondere in Thailand war die Diskussion über die Einführung von Förderinstrumenten für Erneuerbare-Energien-Technologien bisher durch die Befürchtung gehemmt, Erneuerbare-Energien-Projekte würden dadurch nicht mehr das CDM-Kriterium der Zusätzlichkeit erfüllen können. Das CDM Executive Board hat jedoch bereits 2005 entschieden, dass nach 2001 eingeführte Politikmaßnahmen, die emissionsärmere Projekte begünstigen, bei der Erstellung der Baseline und der Feststellung der Zusätzlichkeit nicht berücksichtigt werden müssen. Von Seiten des CDM steht damit der Einführung wirksamer Politikinstrumente für Erneuerbare-Energien-Technologien nichts entgegen.

Es gibt weitere Diskussionen, den CDM in zukünftigen Kyoto-Verpflichtungsperioden sogar zum Vehikel für die Einführung solcher Politikinstrumente zu machen, indem auch

„politikbasierte“ Projekte zugelassen werden. Nach diesem Ansatz soll es Ländern möglich sein, die Einführung von Politikinstrumenten wie Einspeisetarifen als CDM-Projekte anzumelden und die CER-Einnahmen zu verwenden, um die Politikumsetzung zu finanzieren.

Selbst eine solche Ausweitung des CDM könnte aber voraussichtlich nicht alle seine Wirkungsbegrenzungen aufheben. Zum einen kann der CDM nur wirksam werden, wo Emissionen reduziert werden können, zum anderen würden voraussichtlich nur relativ wenige südliche Staaten über die notwendigen technischen Kapazitäten verfügen, um solche komplexen Projekte durchführen zu können. Einige dieser Probleme könnten durch verstärkte technische Zusammenarbeit überwunden werden, vermutlich bedürfte es aber auch noch weiterer Mechanismen für den Technologietransfer und die Investitionsförderung in südlichen Ländern, um auch ärmere Länder erreichen zu können.

1. Introduction

The utilisation of renewable energy sources is, alongside measures to improve energy efficiency, the central pillar of sustainable energy systems. The majority of emissions from developing countries are energy-related and set to grow significantly over the coming decades. The dissemination of renewable energy technologies (RET) in developing countries is therefore, alongside the improvement of energy efficiency, crucial to "prevent dangerous anthropogenic interference with the climate system", the ultimate goal of the UNFCCC. The use of RET also entails significant other benefits such as reduction of local pollutants, allowing the electrification of rural areas without having to first make costly investments in extending the grid infrastructure, reducing fuel import dependency, and others.

In June 2004, the German government organised the conference "renewables 2004" to promote the international dissemination of renewable energy technology. With more than 3,000 participants from more than 150 countries, the conference underlined the associated benefits as well as the need for a rapid global introduction of RET. The conference highlighted that this will only be possible through improved international cooperation and the utilisation of existing multi- and bilateral instruments.

The Clean Development Mechanism (CDM) is a project-based mechanism established under Art. 12 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). It has a twofold objective:

- It shall assist countries not included in Annex I to the UNFCCC ("developing countries") in achieving sustainable development, and
- It allows countries that are included in Annex I to the UNFCCC and have inscribed specified greenhouse gas (GHG) emission targets in Annex B to the Kyoto Protocol (the traditional "industrialised countries") to acquire Certified Emission Reductions (CERs) from CDM project activities undertaken in Non-Annex I Parties and count them towards their Kyoto targets.

The CDM thus sets incentives for the dissemination of low-emission technologies and practices in developing countries and should therefore be able to help to overcome some of the barriers that impede the increased use of renewable energy sources. This study therefore aims to undertake an in-depth examination of the contribution the CDM can make to the dissemination of RET in developing countries and identify areas for improvement. In detail, the research questions are as follows:

- What is the potential for the utilisation of renewable energy sources in selected developing countries?
- What are barriers to the increased utilisation of renewable energy sources?
- To what extent can the CDM help to overcome these barriers?
- What are options for improving the functioning of the CDM and what other policy measures would need to be modified or introduced alongside the CDM to effectively overcome the barriers identified and promote renewable energies?

The project's research questions were examined on the basis of two country studies on Egypt and Thailand. The following first presents the study's research methodology. Second, the study gives a general overview of the current status of renewable energy (RE) projects in the CDM to be able to put the results from the country studies in a broader context. Third, the study introduces a technology matrix to categorise renewable energy technologies as a basis for the country analysis. The study closes with a synthesis of the country studies with the aim of drawing conclusions that are also applicable to other developing countries.

2. Methodology

2.1 General Research Methodology

The project's research questions were examined on the basis of country studies. The country studies have the following basic approach:

- As first steps, the studies identify the general political and socioeconomic framework conditions, the current structure of energy supply and the potential for utilisation of renewable energy sources

- Secondly, the studies analyse the current status of energy policy, climate policy and CDM implementation

- Based on these steps, the studies identify the barriers that currently impede renewable energy dissemination

- Finally, the studies discuss the potential of the CDM to help overcoming these barriers and policy options for promoting renewable energy projects

The main methodological approaches used in elaborating the country studies were desk research, expert interviews and expert workshops. In each step, the research team was supported by expert partners from the countries analysed. In detail, the research was conducted as follows.

Desk Research Phase

The research team first conducted a preliminary analysis of four countries preset by the project funders, the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety and the German Federal Environment Agency, namely Egypt, Morocco, Senegal and Thailand. The analysis was mainly based on desk research, supported by expert partners from each of the four countries. The results were compiled in a first interim report.

Based on the results of the preliminary analysis, two countries, Egypt and Thailand, were selected for an in-depth analysis in a workshop with the project's advisory board (for more details on the selection process, see Annex 15). The preliminary studies on Morocco and Senegal are contained in Annex 11 and Annex 14.

The first step of the in-depth analysis consisted of desk research on previously published studies, governmental publications and other relevant material. Again, the research team was supported by expert partners from each of the two countries in finding and synthesising the material.

Interview Phase

In parallel the desk research phase, the research team conducted interviews with experts and stakeholders in Germany, in particular members of German development cooperation organisations and employees of German renewable energy companies that are active in Egypt and/or Thailand. The interviews were conducted on the basis of interview guidelines that had been elaborated on the basis of the results from the desk research, recorded electronically and transcribed afterwards.

After the interviews in Germany had been concluded, the research team undertook two-week research visits to Egypt and Thailand to conduct further interviews with experts in both countries who had been identified with the help of the expert project partners from the two countries. The interviews were conducted on the basis of interview guidelines that had been revised on the basis of the interviews in Germany, recorded electronically and transcribed afterwards. During the Thailand visit, there was also the opportunity to attend the German Technology Symposium (GTS) with several discussions and presentations on renewable energy and other environmental technologies. These were also incorporated into the report where appropriate.

Some of the interviewees expressed the wish to remain anonymous. They are therefore referred to as “EE” for experts on Egypt from Egypt, “EG” for experts on Egypt from Germany, and as “Interviewees A-H” for experts on Thailand.

The results of the desk research and interview phases were compiled in a second interim report. The first draft of the report was reviewed by the expert project partners in Egypt and Thailand before being submitted to the project funders.

Workshop Phase and Final Results

After the desk review and interview phases, the research team discussed the preliminary results with key experts and stakeholders at workshops in Cairo and Bangkok.

The subsequently revised version of the second interim report was then discussed with the project advisory board. The final results are contained in the present final report.

Table 2.1: Key Project Steps

1 June 2005	Start of Project
19 July 2005	Draft First Interim Report
29 July 2005	Country Selection Workshop (Dessau)
16 August 2005	First Interim Report
August till December 2005	Desk Research Phase
August till December 2005	Interviews with Experts and Stakeholders in Germany
21 October to 11 November 2005	Research Visit to Thailand
13 to 20 January 2006	Research Visit to Egypt
15 February 2006	Stakeholder Workshop Thailand (Bangkok)
8 March 2006	Second Interim Report
30 March 2006	Stakeholder Workshop Egypt (Cairo)
3 August 2006	Revised Second Interim Report
17 August 2006	Workshop with Project Advisory Board (Berlin)
29 September 2006	Final Report

2.2 Defining Categories of Barriers

The barriers are the key aspect of this study. Although RET can realise benefits in all three dimensions of sustainability (economic, ecological, social), their implementation and dissemination in most countries of the world is still not very much advanced (REN21 2005). The identification of the barriers that are behind this lack of implementation is a prerequisite for designing appropriate measures to promote RET.

It is important to note that barriers do not only exist in the sense of market barriers in a narrow understanding but have rather different dimensions. As Meyer-Stahmer has shown, the development, implementation and dissemination of new technologies is influenced by the "technological" capabilities at different levels of a society (Meyer-Stahmer 2002). In this sense, Wilkins refers to the term barrier as any "technical, economic, institutional, legal, political, social or environmental factor impeding the deployment of renewable energy technologies" (Wilkins 2002: 120). Neglecting or ignoring one of these dimensions may seriously lower the effect of policies and measures to promote RET.

In general, barriers can be differentiated at two levels: First, following e7 (2003), they can be divided into micro and macro barriers, which are distinguished by whether they can be resolved by the project participants themselves or not. Second, based on Painuly/Fenhann (2002), they can be differentiated according to four main dimensions: financial & economic; institutional & political; technological; awareness & information (see Table 2.2). This study employs the latter approach.

Table 2.2 Classification of Barrier Types, Following Painuly / Fenhann 2002

Barrier type	Example
Financial & Economic	Inadequate financing arrangements (local, national, international) for RET projects; unfavourable costs, taxes (local and import), subsidies and energy prices.
Institutional & Political	Institutional capacity limitations (R & D, demonstration and implementation); unfavourable energy sector policies and unwieldy regulatory mechanisms.
Technical	Lack of access to technology, inadequate maintenance facilities, bad quality of products; R&D requirements for improvement of RETs.
Awareness / Information / Capacity	Lack of awareness / access to information on RETs; lack of skilled manpower and training facilities (Capacity barriers).
Others	Lack of social acceptance and local participation (Social barriers); visual pollution, lack of valuation of social and environmental benefits (Environmental barriers).

Source: Based on Painuly/Fenhann (2002).

2.3 General Remark on Data on Potential

Sources often do not sufficiently distinguish between different types of potential:

- **Theoretical Potential**

  Naturally given potential due to solar radiation, water topography, median wind speed etc.

- **Technical Potential**

  That part of the theoretical potential that could be converted with currently available technologies

- **Economic Potential**

  That part of the technical potential that could be converted profitably via currently available technologies

- **Expected Potential**

  That part of the technical potential that actually will be converted (normally a part of the economic potential)

The variations between the different types of potential can be considerable. This holds true for all of the four countries analysed in this study.

As an example of data on potential, the following two figures present a world map and a map of Africa with data on the technical potential for generating power in solar thermal power plants. It can easily be seen that the technical application potential for Thailand is almost zero (Figure 2.1), whereas in the three other countries Senegal (West Africa), Morocco (North West Africa) and Egypt (North East Africa), which are located in the "sunbelt" of the Earth, there are predominantly excellent solar radiation conditions (Figure 2.2).

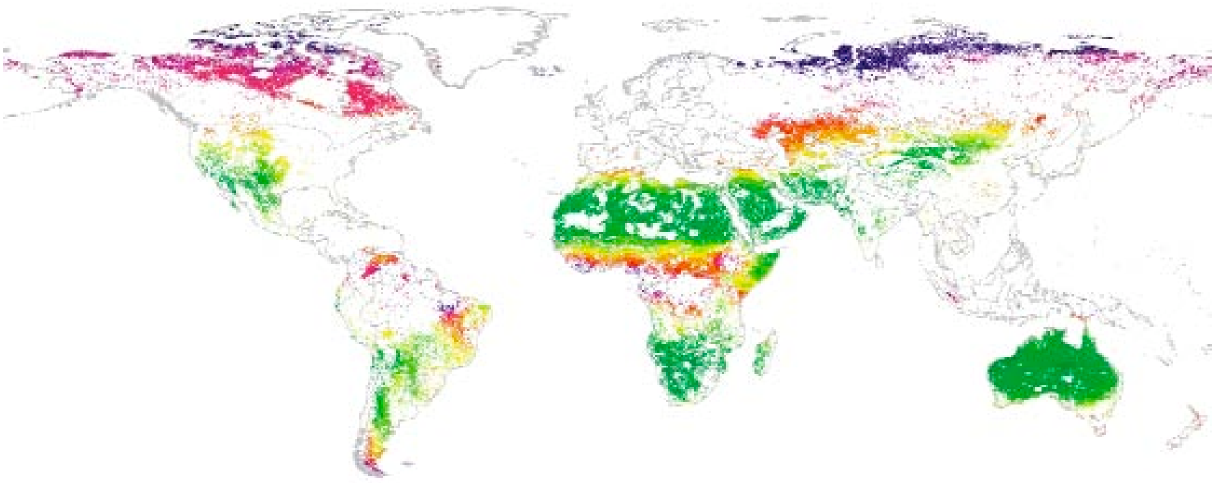

Figure 2.1: Global Technical Potential for Solar Thermal Power Generation (power yield per year and square kilometre of available land area; resolution of radiation data: 125 x 125 km^2 at the equator)

Source: DLR 2005

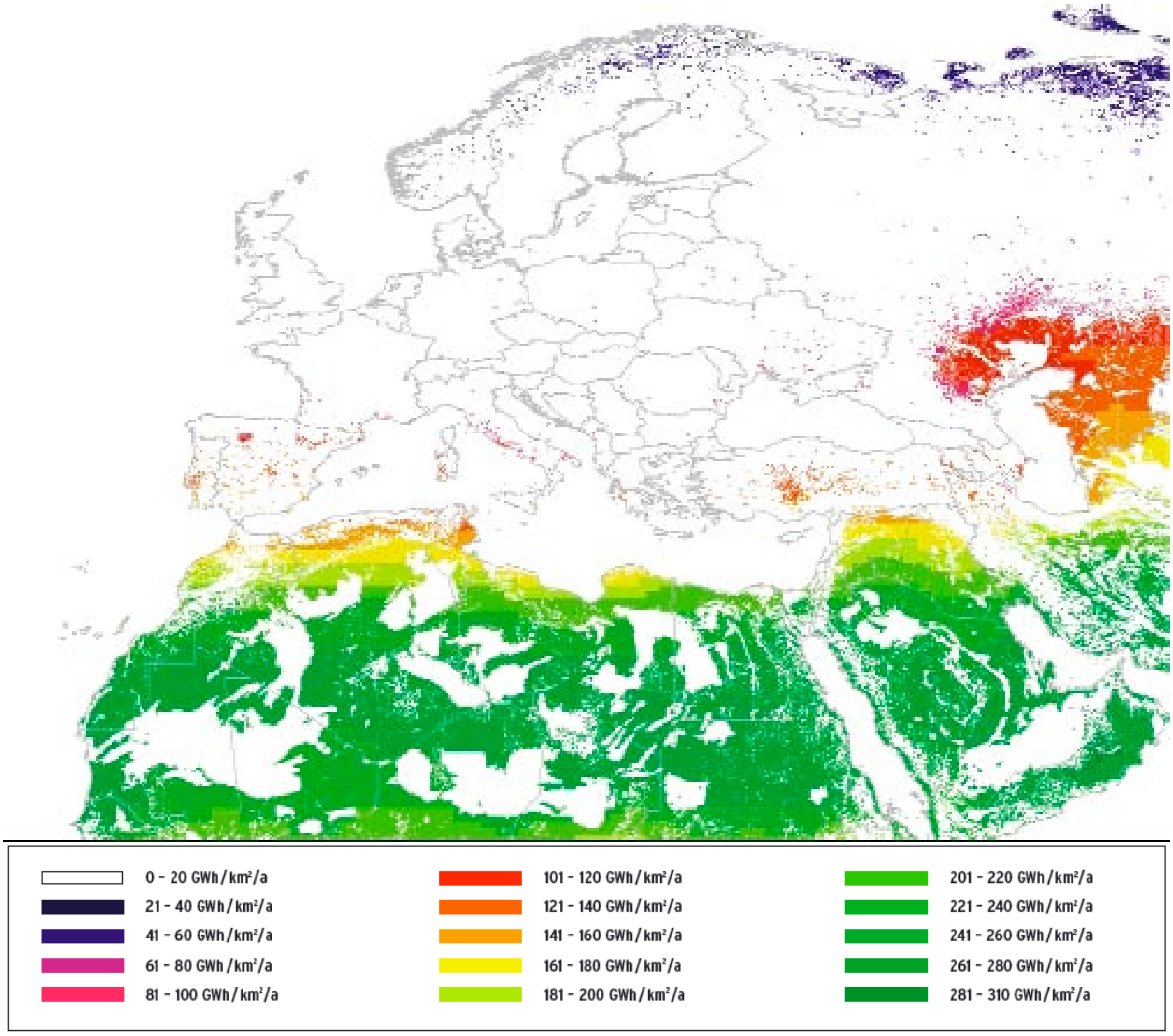

Figure 2.2: Technical Potential for Solar Thermal Power Generation (power yield per year and square kilometre of available land area) in the Mediterranean Region

Source: DLR 2005

3. Current Trends of Renewable Energy Projects in the CDM

3.1 How the CDM Works

To qualify for CDM approval and issuance of CERs, projects have to successfully complete a predefined project cycle (see Figure 3.1). The project cycle is designed to safeguard the mechanism's environmental integrity.

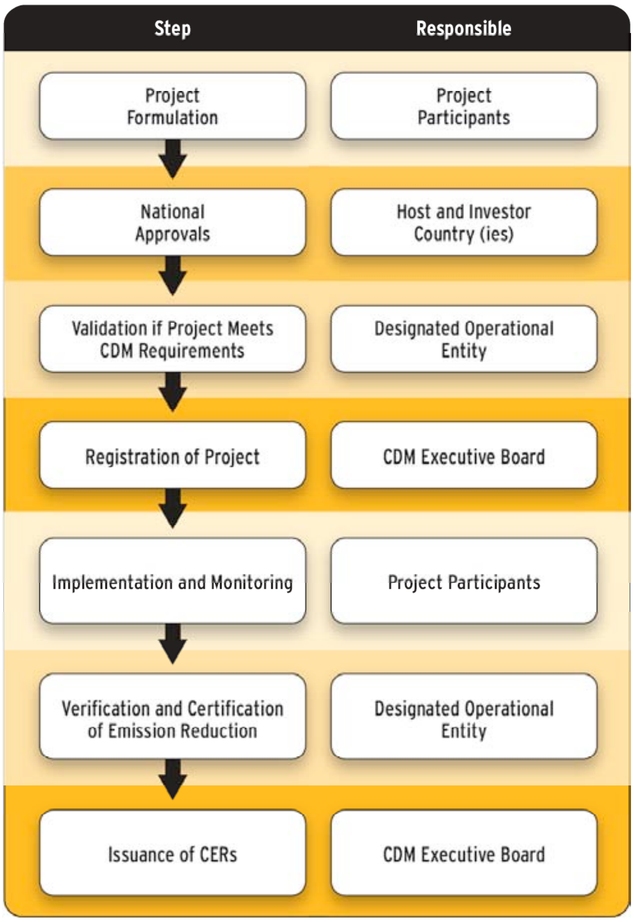

Figure 3.1: The CDM Project Cycle

Source: Wuppertal Institute

Projects need to demonstrate that their envisaged emission reductions are real, measurable and additional to any that would have occurred in the absence of the project. To demonstrate ‘additionality’, project developers have to establish a scenario of what would most likely have happened under business-as-usual conditions (the ‘baseline’) and demonstrate that their project is not the baseline. The two basic approaches to demonstrating additionality are an investment analysis showing that the project would not be profitable without the additional revenue from the CERs or a barrier analysis showing that there are significant barriers that would prevent project implementation under normal circumstances. The baseline needs to be established on a project-specific basis according to approved methodologies. Project-related emission reductions are determined by subtracting the project’s emissions from the emissions that would have occurred without implementing it.

The CDM is supervised by a CDM Executive Board elected by and responsible to the Meetings of the Parties to the Kyoto Protocol. The Executive Board accredits private certification companies (Designated Operational Entities) to validate that projects meet the CDM requirements and to verify and certify the emission reductions achieved. The CERs are issued by the Executive Board on the basis of the Operational Entity’s verification and certification.

3.2 The CDM Market

Having started with many difficulties and delays, the CDM is now fully functional and expanding rapidly. However, the market currently is still very intransparent since there is no public registry of transactions and no internationally recognized price index. Most transactions are over the counter with hardly any details made publicly available (World Bank / IETA 2006: 9).

The project-based market (which also includes Joint Implementation, the other project-based Kyoto Mechanism) is currently dominated by buyers from Europe and Japan, which in 2005 and early 2006 accounted for 56% and 38% of volumes respectively. In Japan, almost all purchases were carried out by a limited number of trading houses with the intent of later re-selling the CERs on the secondary market. In the EU, the share of the private sector was almost 70%, composed of traders as well as companies covered by the EU emission trading system (EU ETS) buying for compliance. Most volumes were transacted by buyers from the UK (15%), followed by Italy (11%) and the Netherlands (8%) (World Bank / IETA 2006: 24).

As for governments, so far nine EU Member States have set aside a combined amount of € 2.7 billion to acquire 365 million tonnes (Mt) CO_2e from all flexible mechanisms through 2012 (EEA 2005). Japan has announced that it will acquire another 100 Mt CO_2e. Switzerland is going to purchase up to 1.6 Mt CO_2e per year over the period 2008-12 with the revenue from its "climate penny" introduced in 2005. By contrast, the new Conservative government of Canada, which under the previous Liberal government had announced to purchase more than 100 Mt CO_2e *per year* over the period 2008-12, has for the time being stopped all purchase activities (Koths, Sterk 2006).

The price for CERs has increased significantly over the last year and become tied to the price for EU Allowances, the currency within the EU emissions trading system. Current prices are € 5-6 for medium-risk forwards, € 7-8 for low-risk forwards, € 8-11 for registered projects, and € 11-13 for issued CERs (GTZ 2006a), which compares not unfavourably to current EU Allowance prices of about € 7 for the current trading period from 2005-2007 and up to € 18 for the second trading period from 2008-2012.[2] Calculations in the study assume a medium CER price of € 10.

3.3 Current Situation of Renewable Energy CDM Projects

There are several possible ways to analyse the CDM project portfolio. One is to consider the projects which are currently under validation or have already been registered. Another possibility is to also consider those projects whose methodologies are awaiting approval. Finally, one could also include projects which are currently being developed.

However, there is no public database on the projects which are currently under development. Some studies have gone to considerable lengths and inquired with governments and Designated Operational Entities (DOEs), but they also consider to have captured only part of the projects under development (e.g. Ellis et al. 2004). Moreover, it is unclear whether the projects that would thus be taken into consideration will ever be registered. The same holds

[2] Current EU Allowance prices are available at http://www.pointcarbon.com/.

for projects whose methodologies are currently in the approval process. The following therefore concentrates on the projects that are currently undergoing validation or have already been registered.

As of the time of writing this report, 1393 projects have been registered or are at the validation stage, expecting a cumulative 1.5 billion CERs by 2012. [3] Among these, biomass projects are the most numerous, counting 307, followed by 232 hydropower projects (including large hydro). There are also 171 wind energy and 77 biogas projects. In total, there are 803 RE projects, equalling 58% of the project portfolio.

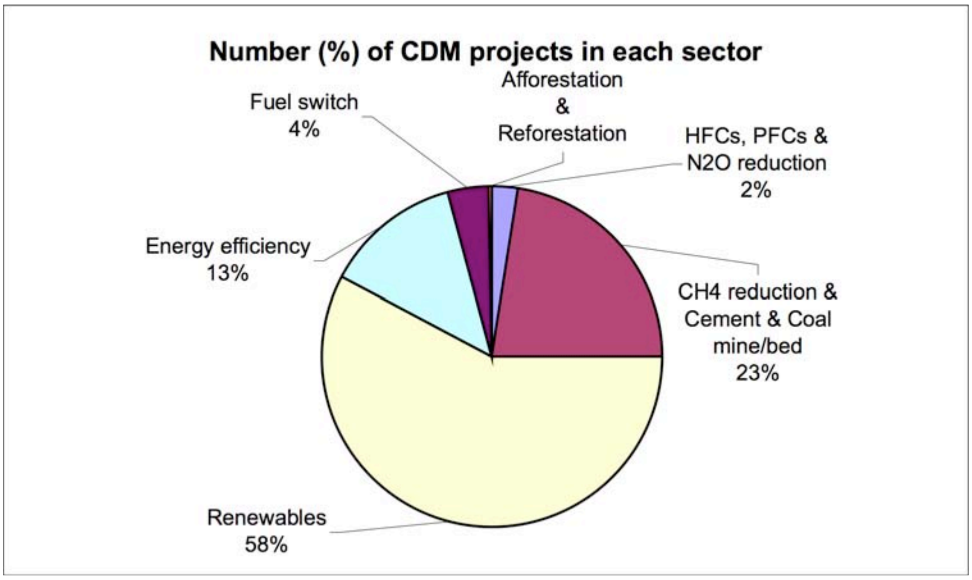

Figure 3.2: Number (%) of CDM projects in each sector

Source: Fenhann 2006.

However, it is noteworthy that so far there are only 7 solar and 8 geothermal projects. The picture changes further when breaking down the expected CERs according to project type. This seems to be a more appropriate criterion for the benefits renewable energies gain from the CDM since it measures how much "carbon financing" each project type receives.

Here, RE projects are at a relative disadvantage since they typically reduce CO_2 emissions and are frequently of a relatively small scale. The market is clearly dominated by projects

[3] These and all the following figures on the CDM portfolio have been taken from Fenhann, J. (2006): CDM pipeline overview. Updated 14 September 2006. UNEP Risoe Centre. Available on the internet at: http://www.cd4cdm.org/Publications/CDMpipeline.pdf (accessed on 15.09.2006).

reducing hydroflurocarbons (HFCs), nitrous oxide (N_2O) and methane (CH_4), which in total account for about two thirds of all expected CERs. This is due to the high global warming potential of these gases, which in the case of HFC is 11700 times that of CO_2, with abatement costs of about US-$ 0.50 per tonne (Cosbey et al. 2005: 20f). In fact, a mere 22 HFC and N_2O reduction projects account for 42% of all expected CERs.

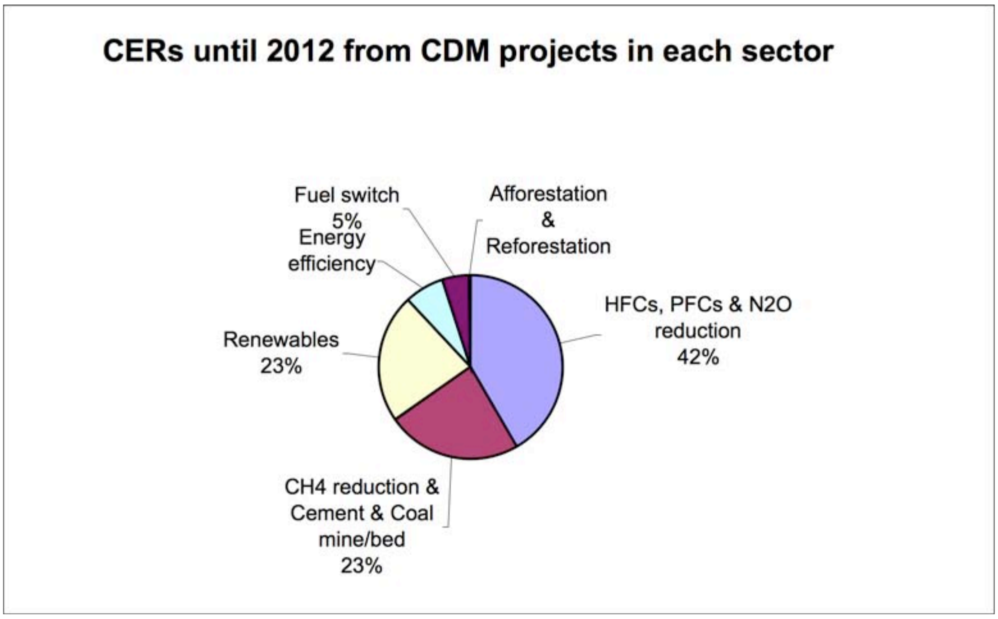

Figure 3.3: Annual CERs from CDM projects in each sector

Source: Fenhann 2006.

The huge number of RE projects therefore accounts for only 23% of all expected CERs. As a result, the increase in the internal rate of return from the sale of CERs of a CO_2-based RE project is relatively low at current CER prices, estimated at 1-2%, and considerably less than in the case of projects involving other greenhouse gases (Willis, Wilder, Curnow 2006). Finally, one also has to take into consideration that the majority of developing country emissions are in fact not emissions of industrial gases but are energy related. The CDM thus currently has only a limited impact on emissions trends in what are the key sectors for climate change mitigation (Baron, Ellis 2006: 12).

The geographical distribution is equally imbalanced. Of the 1393 projects, no less than 501 or 36.0% are located in India. India, Brazil, China and Mexico combined account for about three quarters of all projects, all other countries are far behind. By region, Asia and the Pacific is decisively in the lead with 61.2% of all projects, followed by Latin America with 35%, while Sub-Saharan Africa and North Africa and the Middle East each account for less than 2%.

Annex 1 and Annex 2 provide a detailed breakdown of projects by project type and region.

3.4 Activities to Promote Renewable Energy Projects in the CDM

In general, one can distinguish three types of activities for promoting RE projects in the CDM, which will subsequently be presented in more detail:

- Funds and purchasing programmes that give preference to renewable energy projects;
- The CDM Gold Standard;
- Capacity building.

3.4.1 Funds und Purchasing Programmes

There are some signs for market differentiation in the sense that some buyers are willing to focus on projects with high development benefits and pay a higher price for their CERs.

For instance, the Dutch Certified Emission Reduction Procurement Tender (CERUPT)[4] differentiated its prices and offered € 5.50 per CER from RE projects whereas prices for other project types were 20 to 40% lower. The German federal government has also taken some steps. It invested € 5 million in the „Testing Ground Facility“ of the Baltic Sea Region Energy Cooperation (BASREC). The focus of this investment is to be on RE and energy efficiency projects. The Facility covers only Joint Implementation projects, but the German government has also invested € 8 million in the climate protection fund of the German Reconstruction Loan Corporation (*Kreditanstalt für Wiederaufbau, KfW*)· which covers both project-based mechanisms. This investment is also supposed to promote primarily RE projects (Forth 2005: 4).

The probably most prominent example of a programme focussing on projects with high development value is the Community Development Carbon Fund (CDCF) the World Bank has installed in cooperation with the International Emissions Trading Association (IETA).

[4] SenterNovem – CarbonCredits.nl: http://www.carboncredits.nl (accessed on 26.08.2006).

This fund is to concentrate explicitly on small-scale projects with clear and measurable development benefits, with a focus on RE, energy efficiency and waste to energy projects. In order to reach small-scale and micro projects, the CDCF intends to bundle projects, standardise procedures and documents and make use of local mediators like local enterprises, banks or non-governmental organisations. The World Bank has also established the capacity building programme CDCFplus to establish und support local institutions and thus create the infrastructure necessary for CDM projects. [5]

Nevertheless, the overall focus in the CDM is on emissions reductions. The vast majority of buyers focuses on this aspect only (Ellis et al. 2004: 29; World Bank, IETA 2006: 30). Thus, RE projects are at a disadvantage since the generate less emission reductions than other project types and their abatement costs are higher. Moreover, due to perceived technical risks of some RET, buyers may prefer to support more straightforward project types such as methane flaring or HFC destruction. Finally, buyers have so far mostly limited their role to simply purchasing CERs with payment to be made on delivery instead of actually investing in projects. Project developers have therefore been forced to finance their projects from other sources (Willis, Wilder, Curnow 2006).

Sourcing project financing for RE CDM projects is also made difficult by the fact that such projects often have an economic lifetime of up to 30 years while the Kyoto Protocol's first commitment period expires in 2012 and there is so far no certainty whether there will be a follow-up. Buyers have therefore been unwilling to enter into purchase agreements for the time beyond 2012. There is thus a significant risk that the CER revenue will be available for a small part of a project's lifetime only. Given that the added value from the CERs for RE projects is relatively small in any case, project developers may consider that there is no sufficient economic basis for starting a project (Willis, Wilder, Curnow 2006).

3.4.2 The CDM Gold Standard

Another approach to promoting RE in the CDM that aims at a differentiation of the market is the CDM Gold Standard. It was developed by an international expert panel at the initiative of the World Wide Fund for Nature (WWF) and supported inter alia by the German

[5] Carbon Finance at the World Bank: Community Development Carbon Fund: http://www.communitycarbonfund.org (accessed on 26.08.2006].

government.[6] It defines quality standards that exceed those laid down in the Kyoto Protocol and the Marrakesh Accords, hoping that buyers will be willing to pay a higher price for CERs from certified high quality projects. The Gold Standard is supposed to thus also reward non-climate sustainability benefits and in this way promote high quality projects (Sterk/Langrock 2003).

The criteria include extended provisions for demonstrating a project's additionality, for examining its socio-economic and ecological impacts and minimum requirements for consulting local stakeholders. Only renewable energy and demand-side energy efficiency projects are eligible for the Gold Standard. However, one has to consider that using the CDM Gold Standard increases project development costs. Moreover, in order to safeguard the additionality of projects it prohibits the use of Official Development Assistance (ODA) which might be a problem for small-scale projects in particular.

Project developers and buyers have so far not shown much interest in the CDM Gold Standard. At the conference "Climate Protection as Development Opportunity" organised by the Hamburg Institute of International Economics in June 2004, representatives from state purchasing programmes and private businesses explicitly stated that the Gold Standard was not of interest to them since they primarily aimed at procuring as many CERs at as low a price as possible (Michaelowa 2004). Unsurprisingly therefore, the CDM Gold Standard's project database currently lists only seven CDM projects, of which five are at least at the validation stage. [7]

3.4.3 Capacity Building

International development cooperation can contribute to fostering the implementation of projects in general and thereby also of RE projects in particular by supporting the establishment of local capacity and infrastructure in host countries and thus improving local framework conditions. For example, Germany has conducted capacity building projects in Indonesia, Peru, China and Morocco, among others. These projects are, for example, pilot projects to examine the feasibility of certain measures such as project bundling. Others are dedicated to establishing a national climate protection strategy or developing a CDM project

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6 Gold Standard: http://www.cdmgoldstandard.org (accessed on 26.08.2006).
7 Gold Standard: http://www.cdmgoldstandard.org (accessed on 08.12.2006).

pipeline.[8] Most other industrialised countries are also implementing capacity building measures, as is the United Nations Environment Programme (UNEP).

One example where capacity building is undertaken as a joint initiative by state and private actors is the programme “Kyoto Coaching Cologne” which is being conducted by the TÜV Rheinland Group and the German Investment and Development Company (*Deutsche Investitions- und Entwicklungsgesellschaft, DEG*). This programme is to advise project developers and investors in all stages of the CDM project cycle and is directed in particular at enterprises that want to implement RE projects.[9]

3.5 Conclusions

The CDM project portfolio is dominated by a handful of countries, in particular India, Brazil, China and Mexico. RE projects dominate in terms of numbers, but in terms of CERs expected the Mechanism is dominated by projects reducing emissions of HFCs, N_2O and CH_4.

These imbalances have been noted by observers for some time already (e.g. Ellis et al. 2004, Cosbey et al. 2005). In consequence, many CDM host countries demanded at COP 10 in Buenos Aires and at MOP 1 in Montreal to take steps to rectify these deficits (Ott et al. 2005; Wittneben et al. 2006). The non-governmental organisation CDMWatch even accused the CDM of complete failure. Being a market-based mechanism focussed on the generation of emission credits, the Mechanism was in their view fundamentally inadequate to really foster sustainable development (Pearson 2004).

This statement may have been somewhat exaggerated. 665 renewable energy projects are a sizable number, even though one obviously cannot automatically assume that any renewable energy project also fosters local sustainable development. Some, such as large-scale hydropower projects, might actually have significant negative impacts on the local population and environment. Nevertheless, one can state that earlier fears that RE projects and other project types might be crowded out of the market by low-cost high-yield projects such as HFC and N_2O projects seem to have not been justified.

[8] GTZ. Klima: http://www.gtz.de/de/themen/umwelt-infrastruktur/umweltpolitik/3958.htm (accessed on 26.08.2006).
[9] Kyoto-Coaching-Cologne: http://www.kyoto-coaching-cologne.net (accessed on 26.08.2006).

However, when looking at the numbers of CERs expected, RE projects clearly do not get as much out of the CDM as other project types. The reason is that RE projects typically reduce only CO_2 emissions and thus yield fewer CERs per tonne of emissions reduced than other project types. Moreover, the abatement costs RE applications are typically relatively high when compared to other project types. These deficits could be partially offset if buyers differentiated prices according to the sustainability benefits of projects, but CDMWatch's assessment that the CDM is primarily focussed on the generation of CERs seems to be valid. Purchasing programmes that take sustainable development criteria into account are the exception to the norm. Another indicator is the limited success of the CDM Gold Standard.

It therefore seems valid to conclude as a preliminary observation that the CDM is fostering the use of RET in developing countries but also has some significant limitations in this regard. The following chapters will take an in-depth look at the strength and limitations of the CDM in fostering RE in Egypt and Thailand.

4. Development of a General Technology Matrix to Categorise Renewable Energy Technologies

There is a huge number of possible applications of renewable energy sources. This chapter therefore presents a clear and comprehensive arrangement of the various options to provide a basis for the following steps of the country analysis.

RE can be categorised according to different criteria:

- Form of provision (electricity, heat/cooling, fuel)
- Energy source (solar, wind, water, biomass, biogas, geothermal)
- Site of application (central/decentralised and on-grid/stand-alone system respectively)
- Type of application (application as hybrid power station, application in combined heat (cooling) and power)
- Sector of application (residential, commercial, industry, power, transport)
- Plant size (small, medium, large)

The following two matrices (Table 4.3 and Table 4.4) classify RE from two different points of view: In the first case a supply-oriented top-down approach, in the second case a demand-oriented bottom-up approach that is based on the needs to be satisfied. This two-track approach has been chosen to ensure that all technology options can be categorised and no potential field of application is left out.

Based on the three forms of provision - electricity, heat/cooling and fuel - the supply-oriented classifies different renewable energy sources top-down. The main energy sources (e.g. solid biomass) are differentiated into sub-groups (e.g. wooden and agricultural residues, energy crops), which are then further differentiated into resources (e.g. wooden residues from forestry / industry) and technologies respectively (e.g. Dish-Stirling, parabolic trough in the case of the sub-group solar-thermal power generation).

In the case of solar heat generation, the field of application is also stated, because – different from most of the other technologies – this technology normally is matched with the specific application (e.g. solar cooking, hot water generation, heating etc.). The further columns of state in which sector the technology is located typically, whether it is compatible with CH(C)P and/or hybrid applications,[10] if it is normally designed as a stand-alone or as an on-grid system and the scale of its power output. In the column "Energy Benchmarks resp. Energy Potential", specific country characteristics (e.g. median solar radiation of 1 000 kWh per m^2 and year) as well as absolute potential within the respective country (e.g. biomass potential of 10 TWh per year) can be indicated. The column "CO_2 Reduction Potential" notes whether the climate protection effects of the individual technologies predominantly result from the substitution of fossil energy sources (baseline, see last column of table), from the destruction of Green House Gases (GHG Destruction), or from a combination of both respectively. In the last block of the top-down table, specific properties as well as non-technical implications and co-benefits of the technologies considered can be entered. This includes both quantifiable economic aspects (specific investment costs resp. specific electricity, heating and fuel costs) and ecological, socio-economic and further aspects that can only be indicated qualitatively as exemplified in Table 8.1 (from BMU 2004) which are relevant in this context are summarised in Table 4.2.

The last column of is reserved for country-specific observations and specifies the main competing conventional technology[11] that would be replaced by the application of renewable energies (important for the determination of the baseline). This indication is particularly important for CDM projects in order to be able to assess the CO_2 abatement potential.

[10] CH(C)P refers to combined heat (cooling) and power generation, i.e. combined and therefore more efficient generation of power and heat (and where applicable also cooling) within one process. "Hybrid systems" are energy generating units (e.g. PV-Diesel or PV-Wind) that are composed of different renewable and fossil energy sources, which by their combination clearly improve the availability (and hence often also the profitability) of the system.

[11] Fossil energy sources and non-sustainable use of biomass.

Table 4.1 Exemplary Catalogue of Criteria for the Assessment of the Sustainability of Energy Systems

	Criterion	Indicator
Ecological aspects	Climate protection	Specific emission of greenhouse gases per kWh Specific emission of air pollutants per kWh
	Saving of Resources	Consumption of non-renewable energy
	Protection against noise	Noise emissions
Socio-economic aspects	General interest	Potential for economic development Cultural compatibility Degree of supply equity Degree of participation
	Individual interests	Employment effects Health / sanitary effects
Economic aspects	Low costs and prices	Specific investment costs per kW Cost of generating electricity per kWh
	Repairs and maintenance	Requirements on specialists and procurement of spare parts
	Economic independence	Degree of import dependency and regional self-supply Security of supply / availability
	Potential for the future	Degree of know-how development

The above remarks on the top-down are generally valid for all three fields, electricity, heat and fuel. However, in the fuel matrix, instead of the sector of application (residential, industry, power) the type of fuel generation (thermal-chemical / physical-chemical / biochemical / electrical) is entered. Moreover, the matrix gives cost indications in Euro per kilowatt hour, per mega joule and per litre of fuel respectively.

At this stage, the top-down has been completed in a rudimental and exemplary manner only. While some points can be assessed in general, most have to be assessed by country (e.g. potential, implications), which will take place in the following chapters.

The second, **demand-oriented** matrix (Table 4.4), by contrast, starts bottom up from the development needs and infers the technologies that are most adequate for meeting these needs. Such a need can for instance be the desire for lighting, to communicate or the desire for cooling of rooms and food. The table first presents the needs that can be met through the application of electricity (sum = 5), second the needs that can be met through the application of electricity or heat/cooling (sum = 3), third the needs that can be met through the application of heat/cooling only (sum = 4), and finally the needs that can be met through the application of fuels (development need mobility, sum = 1). Just as in , the bottom-up matrix also presents the general applicability of the technology for CH(C)P and hybrid applications. In addition, the power output and potential for integration in the grid or in stand-alone systems is noted. The last column again notes the competing technologies (baseline) that can be replaced by the application of renewable energies.

In contrast to top-down, the bottom-up Table 4.4 is already fully completed since it is rather universally applicably and does not depend that much on local conditions.

In addition to the application-oriented bottom-up table, Figure 4.1 presents an overview of stand-alone renewable energy systems. This includes direct applications (small power output), which supply only a single unit with power, small-scale networks supplying clusters of buildings, commercial facilities as well as small village network (medium to large power output).

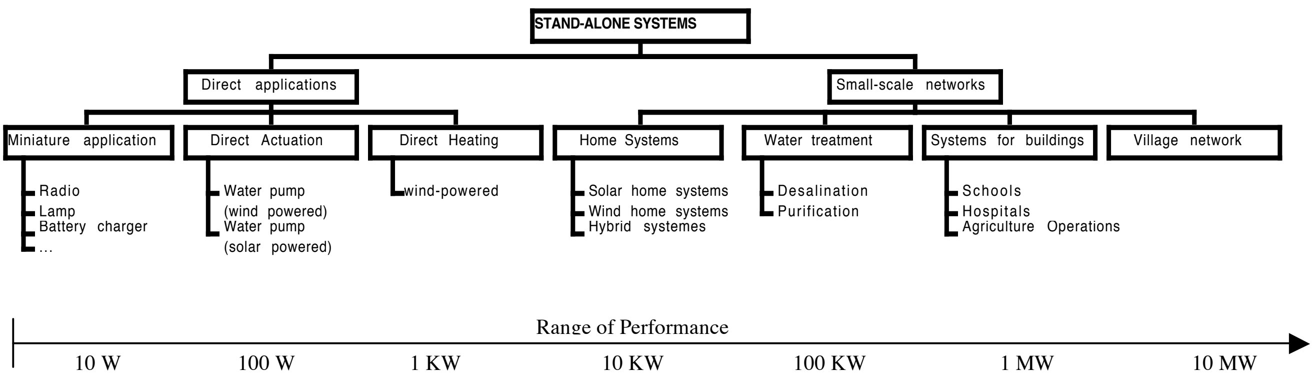


Figure 4.1 Classification and Power Output of Stand-alone Systems

Table 4.2 Guidelines for a Sustainable Energy Supply

Equality of access:	Equal opportunities in accessing energy resources and energy services shall be assured for all.
Protection of resources:	The different energy resources shall be maintained for the generations to follow, or there shall be comparable options created to provide sufficient energy services for future generations.
Compatibility with environment, climate and health:	The adaptability and the ability for regeneration of natural systems (the "environment") may not be exceeded by energy-related emissions and waste. Risks for human health – by e.g. an accumulation of problematical pollutants and harmful substances – shall be avoided.
Social compatibility:	It shall be assured when realising the energy supply systems that all people affected by the system are able to participate in the decision-making processes. The ability of economic players and communities to act and shape may not be restricted by the systems being set up, but rather shall be expanded wherever possible.
Low risk and error tolerance:	Unavoidable risks and hazards arising from the generation and use of energy shall be minimised and limited in their propagation in space and time. Human errors, improper handling, wilful damage, and incorrect use shall also be taken into consideration in the assessment.
Comprehensive economic efficiency:	Energy services shall – in relation to other costs in the economy and of consumption – be made available at acceptable costs. The criterion of "acceptability" refers, on the one hand, to specific costs arising in conjunction with the generation and use of the energy and, on the other hand, to the overall economic costs while taking the external ecological and social costs into consideration as well.
Availability and security of supply:	The energy required to satisfy the human needs must be available according to the demand and in sufficient quantities, in terms of both time and location. The energy supply must be adequately diversified so as to be able to react to crises and to have sufficient margins for the future and room to expand as required. Efficient and flexible supply systems harmonising efficiently with existing population structures shall be created and maintained.
International co-operation:	Developing the energy systems shall reduce or eliminate potential conflicts between states due to a shortage of resources and also promote the peaceful co-existence of states by a joint use of capabilities and potential.

Source: BMU (2004)

Table 4.3: Supply-Side Technology Matrix (Top-down Table)

		Energy Source			Sector Compatibil					System		Power				CO_2-Red.-Potential		Implications & Co-Benefits[4] Economy		Ecology[3]	Social economy	Further	Baseline
Energy Type	Main Group	Subgroup	Ressources / Technologies (Examples)	Application	Residential	Industry/Business	Power Sector	CHP	Hybrid[5]	On-Grid	Standalone	Small	Medium	Large	Energy Benchmark resp. Energy potentials [TWh]	Energy Substitution	GHG-Destruction	Spec. Invest Costs [€/kW]	Spec. Energy Costs [€/kWh]			Qualification Spare Parts Participation ...	(only relevant for country specific analysis!)
HEAT	**Biomass[1]** (Co-firing)	Residues (Wood)	Wood residues from forestry Wood residues from industry (incl. sawdust)												Biomass: x TWh (if applicable broader differentiated) resp.: y kWh per $qm_{cultivation}$ and year	x							
		Residues (agricultural)	Straw													x							
		Energy crops (renewable raw material)	Short-rotation plantations													x							
	Biogas[1]	Residues (Wood)	Wood residues from forestry Wood residues from industry (incl. sawdust)												Biogas: x TWh (if applicable broader differentiated)	x							
		Residues (organic)	Bagasse, coconut shells, rice husk												resp.:	x							
			Biological waste (Municipal solid wate)	Power generation Cooking											y kWh per $t_{dry\ matter}$ and year	x	x						
			Sludge gas	Power generation												x	x						
			Landfill gas	Power generation												x	x						
		Residues (agricultural)	Crop residues (incl. gras)																				
			Manure slurry													x	x						
			Zoo mass													x	x						
		Energy crops (renewable raw material)	Grain, starchy plants, wood from short-rotation plantations																				
	Coal Bed Methane[1]																						
	Solar[1]			Solar stove																			
				Solar drying																			
				Warm water																			
				Heating																			
				Process heat																			
				Process cooling																			
	Geothermal[1]	Near surface (heat pump)			x	x					x	x											
		Hydrothermal				x	x	x		x			x	x									
		HDR technology[6]					x	x		x				x									
ELECTRICITY	**Hydro**	large (> 10 MW)	Storage, run-of-river																				
		small (< 10 MW)	Storage, run-of-river																				
		micro (< 100 kW)	run-of-river																				
	Wind	large (> 100 kW)																					
		small (< 100 kW)																					
	Solar[1]	PV			x	x																	
		Solar thermal	Dish-Stirling			x	x																
			Parabolic trough				x																
			Solar tower				x																
			Solar chimney																				
	Geothermal[1]	Hydrothermal																					
		HDR technology[6]																					
	Ocean energy	Waves																					
		Tides																					
		Thermal (OTEC[7])																					

					Production					System					CO_2-Red.-Potential		Implications & Co-Benefits[4]					
																	Economy		Ecology[3]	Social economy	Further	Baseline
Energy type	Main Group	Subgroup	**Ressources / Technologies** (Examples)		thermal-chem.	phys.-chem.	biochemical	electrical		On-Grid	Stand alone		Energy Benchmark resp. Energy potentials [TWh]		Energy Substitution	GHG-Destruction	Spec. Fuel costs [€/kWh] resp. [€/MJ]	Spec. Fuel costs [€/l]			Qualification Spare Parts Participation ...	(only relevant for country specific analysis!)
F U E L S	**Liquid**	Vegetable oil	Rape, sunflower, Jatropha, palm oil etc.			x					x											
		Bio diesel (FAME [2])	see above			x					x											
		Bio ethanol	Starchy plants (Maize, grain, potatoes)				x				x											
			Sugar plants (Sugar beet, sugar cane)				x				x											
		Bio methanol	from Biogas		x						x											
		BTL (Fischer-Tropsch)	from Biogas		x						x											
	Gaseous	Hydrogen	Wind, solar, biomass		x		(x)	x		x	x											
		Bio methan (= Biogas)	Biomass		x		x			x	x											

Note
1) in principle applicable for combined heat and power generation
2) FAME: Fatty Acid Methyl Ester, among RME (Rape Methyl Ester)
3) e.g. acidification potential, Eutrophication Potential, Ozone Depletion Potential and ozone-forming potential, toxicity
4) s.a. under "Guidelines for a sustainable power supply" named aspects
5) e.g. Diesel/PV- or Wind/PV-Systeme
6) HDR: Hot Dry Rock
7) OTEC: Ocean Thermal Energy Conversion

Further technologies / options:
- Solar architecture
- Sea water desalination

Table 4.4: Application-Orientated Technology Matrix (Bottom-up Table)

				Energy type			Energy source									Aptitude		System		Capacity			Baseline
Development Need	Example	Sector	Typical stand alone energy services	Electricity	Heat / Cold	Fuel	Solar (PV)	Solar (Collector)	Solar (CSP)	Hydro	Wind	Biomass (solid)	Biogas	Firedamp	Geothermal	CHP(C)	hybrid [1)]	Mains	Stand alone	small	medium	large	Main Competing Fossil Technology resp. Non-Sustainable Biomass Utilisation
Access to Electricity Grid		Electricity utility, IPP		X			X		X	X	X	X	X	X	X	X		X			X	X	Fossil electricity mix
Illumination		Residential	5 h/d with 20 W per household	X			X			X	X						X		X	X			Kerosene lamp, wax candle
Entertainment & Information	Radio, TV, Music	Residential	5 h/d with 5-30 W per household	X			X			X	X						X		X	X			Batteries, Diesel generator
Communication	Telephone, Fax, Mobile Phone	Residential	2 h/d with 10-20 W per household	X			X			X	X						X		X	X			Batteries, Diesel generator
Freshwater Conveyance & Irrigation	Fountain water, river water	Residential, Agriculture	ca. 5 litres/day per household	X			X				X						X		X	X	X		Diesel pump
Freshwater Production	Sea water desalination (Evaporation / reverse osmosis), water treatment	Residential, Waterworks	24 h/d	X	X			X	X		X					X		X	X		X	X	Drinking water transport per tank lorry, fossil based sea water desalination
Cooling	Air conditioning (absorption cooling, free cooling)	Residential, Commercial	24 h/d	X	X			X	X							X			X	X	X		Electr. compressor air conditioning (Fossil power)
	Cooling units for food, medicine...	Medicine, gastronomy, residential	24 h/d	X	X		X	X	X							X			X	X	X		see above
Heating	Residential heating	Residential			X			X	X			X	X		X	X		X	X	X			Gas, oil, Non-sustain. biomass
	Warm water				X			X	X			X	X		X	X		X	X	X			see above
Cooking		Residential, Commerical (canteen kitchen)			X				X			X	X			X			X	X			LPG, Non-sustain. biomass
Commercial & Industrial Process Heating & Cooling		Industry & Commercial			X			X	X			X	X	X	X	X			X		X	X	Non-sustain. biomass
Mobility						X						X	X						X	X	X		Diesel, petrol

Note:
1) e.g. Diesel/PV- or Wind/PV-Systems

Abb.:
CSP: Concentrating Solar Power
RE: Renewable Energies
DL: Developing countries
GHG: Greenhouse Gas
IPP: Independent Power Producer
CHP(C): Cogeneration of Heat, Power (and Cold)

5. Country Study Egypt

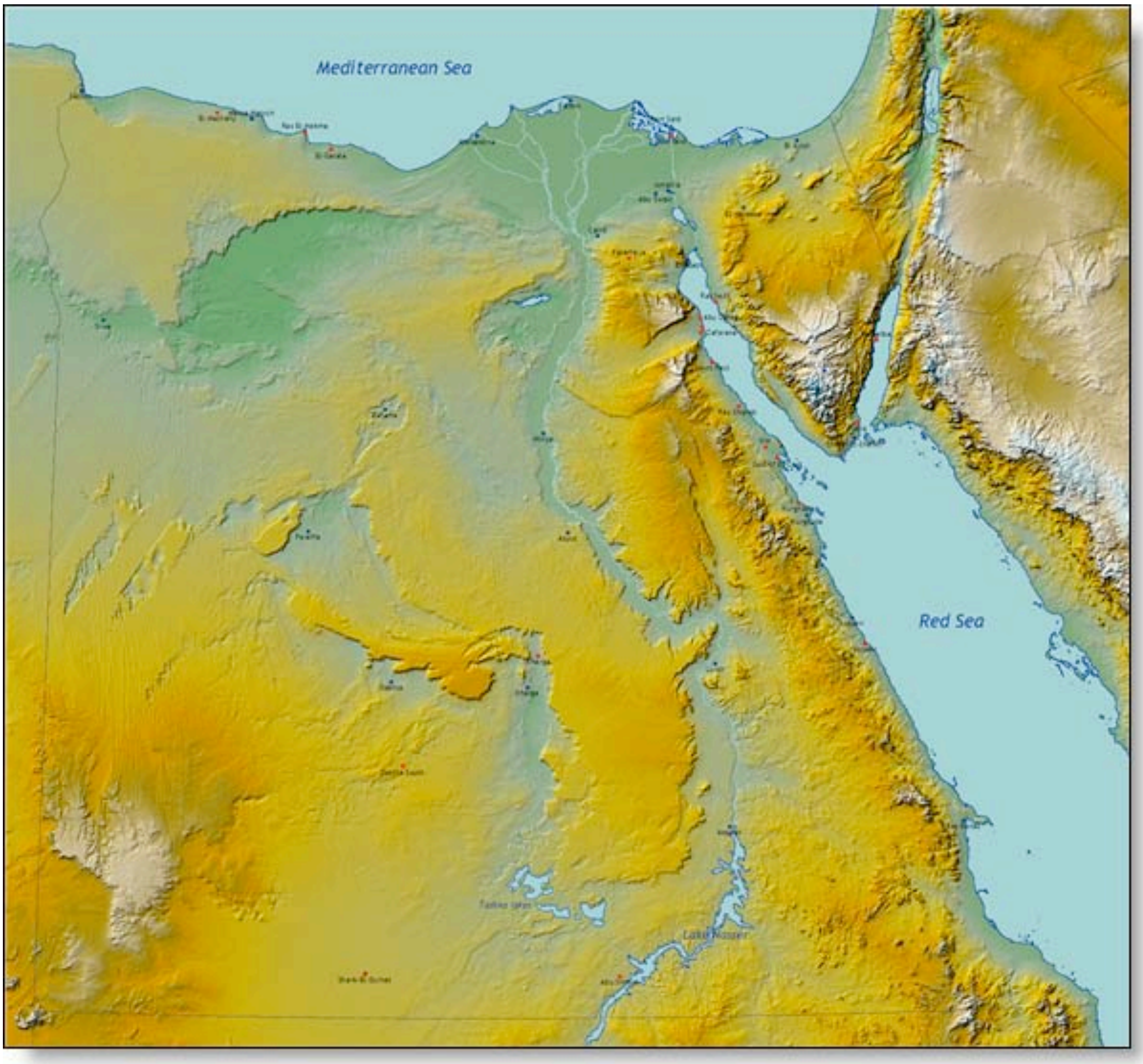


Figure 5.1: Physical Map of Egypt

Source: Wind Atlases of the World (2006).

5.1 Political and Socioeconomic Framework Conditions

Table 5.1: Egypt – Key Data and Indicators

Population (in mio., 2003)	67.6
Average annual population growth (in %, 1990-2003)	1.9
Country area (in thousand km²)	1,001
Population density (in pers./km², 2003)	68
Share of rural population (in %, 2003)	57
Literacy rate of people older than 15 years (in %, 2002)	55.6
Share of population below national poverty line (in %, 1992)	22.9
Share of population with less than US-$ 2 per day (in %, 2000) (international definition of poverty line)	43.9
GDP in PPP (in bill. US-$, 2002)	252.6
GDP in PPP per capita (in US-$, 2002)	3.810
Average annual growth in GDP (in %, 1990-2003)	4.5
GINI-Index (1999/2000)	34.4
Human Development Index (2002)	0.653; Rank 120; medium human development
Foreign Direct Investment (in mio. US-$, 2003) (1990)	237 (734)
Share of Foreign Direct Investment of GDP (in %, 2003)	0.3
Official Development Assistance (ODA) received (in Mio. US-$, 2002)	1,286.1
Official Development Assistance received as share of GDP (in %, 2002) (in %, 1990)	1.4 (12.6)

Source: World Bank (2005a), UNDP 2004

The Arab Republic of Egypt has been a presidential republic since 1953 and has been governed by president Hosni Mubarak, head of the ruling National Democratic Party, since 1981. He was re-elected for the fifth time in Egypt's first multi-candidate presidential election in 2005 (European Commission 2005). Although Egypt fulfils the major requirements of a democratic system, notably a multi-party system and the ratification of most UN human rights conventions, there are critical voices, e.g. regarding the state of emergency which has been in force almost continuously since 1967. Among other things, it permits the government to prohibit demonstrations or strikes and to censor or close down newspapers in the name of national security (Human Rights Watch 2003). Devastating terrorist attacks in recent years have also had a negative impact on development, in particular in the tourism sector, which is an important economic factor in Egypt. Thus, the *International Country Risk Guide* considers the situation to be rather difficult, as reflected in a mark of only 6.5 out of 12 (World Bank

2004: 248). Economic growth rates in recent years have nevertheless averaged 4.5%, but this growth has mainly been driven by the expansion of natural gas production.

Mainly due to its relatively strong economy, Egypt is one of the major regional powers. It is therefore one of the "anchor countries" of German development cooperation (Stamm 2004: 10). [12] Stamm assigns Egypt a particular importance in the area of ecological sustainability as a MDG7 focal country[13] (Stamm 2004: 18).

Economic Relations between Egypt and Germany: Trade relations between Germany and Egypt are relatively intensive. Egypt is Germany's third most important trading partner in the Middle East, behind Saudi Arabia and the United Arab Emirates. The German-Arab Chamber for Industry and Commerce has been located in Cairo for more than 50 years. Egypt is a focal country and one of the largest recipients of German development assistance. Renewable energies are one focal area of these activities (Auswärtiges Amt 2005a).

5.2 Structure of Energy Supply in Egypt

Table 5.2: Key Data of the Egyptian Energy Sector

Total primary energy supply (in Mtoe, 2003) (1990)	53.9[1] (31.9)
Primary energy supply per capita (in toe, 2003) (1990)	0.80 (0.61)
Generated Power (TWh) (2004)	101
Electricity consumption per capita (in kWh, 2005)	1,372
Electrification rate[2] (in % of the population, 2004)	98.7

Source: World Bank (2005a); MOEE (2004); IEA (2005a), ENC-WEC (2005).

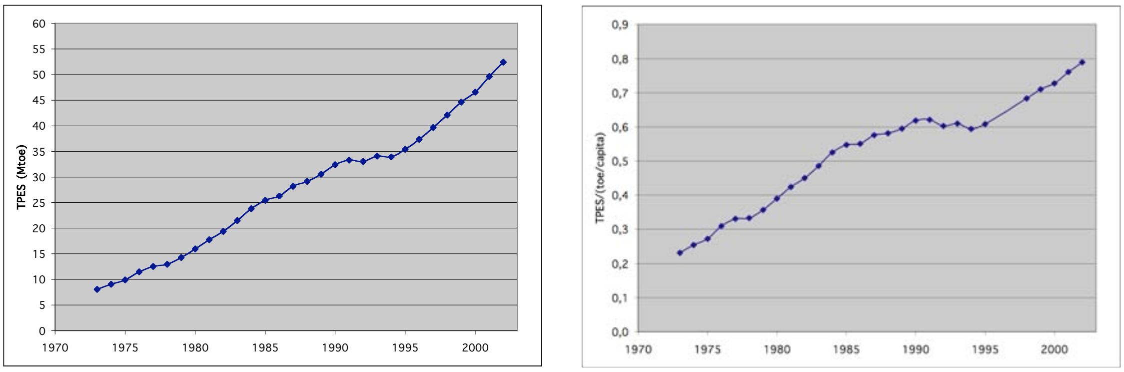
1: Data from IEA (2005a), different figure (51.4 Mtoe) in ENC-WEC (2005); 2: electricity supply to about 98,7% of Egyptians (MOEE 2004)

Egypt's total primary energy supply (TPES) has steadily increased in the last three decades, from 8 Mtoe in 1973 to 32 Mtoe in 1990 and 53.9 Mtoe in 2003 (see Table 5.2; Figure 5.2). The driving forces for this growth have been, on the one hand, the growth of the Egyptian

[12] The concept of anchor countries was introduced by the Germand Development Institute (DIE) in 2004. "Anchor countries" are those countries which are seen as having an outstanding importance in their regional context (see Stamm 2004; BMZ 2004). Other "anchor countries" in North Africa and the Middle East are Iran and Saudi Arabia.

[13] MDG7 denotes the seventh of the "Millenium Development Goals" declared in 2000, namely securing ecological sustainability by 2015. Stamm's definition is based on the factors climate and/or resource protection.

economy and the almost doubling of the Egyptian population, and, on the other hand, an increase of per capita demand by nearly 3.5 times to 0.80 toe/capita (Figure 5.2). The vast majority of the Egyptian population, about 98.7%, has access to electricity, mostly connected to the grid (see Table 5.2).



a) Total Primary Energy Supply (in Mtoe) *b) Per capita Primary Energy Supply (in Mtoe)*

Figure 5.2: Primary Energy Supply in Egypt

Data source: IEA (1998); IEA (2001); IEA (2004a).[14]

5.2.1 General Overview of Egypt's Energy Market

The Egyptian energy sector is dominated by the domestic production and use of fossil fuels, namely crude oil and natural gas,[15] followed by hydropower. Egypt discovered its oil reserves in the 19th century and exploitation started in 1910. Domestic oil production and consumption used to dominate the TPES, but its share has been decreasing since the beginning of the 1990s when oil production started to decline. Nowadays, it contributes around 45% to the TPES, while in 1971 it was more than 80% (IEA 2004b; ENC-WEC 2005). The shares of the different energy resources in total primary energy supply are indicated in Table 5.3.

In 1967, more than five decades after oil exploitation started, natural gas reserves were found. The share of natural gas in Egypt's primary energy supply has significantly increased in the last three decades, up to 50% in 2003/4 (ENC-WEC 2005) (see Table 5.3). In 2002, Egypt

[14] As IEA newly calculates its figures every year, there can be slight deviations (up to 3 %) between figures in different reports.

[15] Egypt possesses only limited coal reserves, adding up to 27 Mt proved recoverable reserves as of 2003/4 (ENC-WEC 2005). The exploitation has recently begun but the production is still quite low so that coal demand is almost completely met by coal imports.

was the second largest producer of natural gas in Africa (WEC 2004). In the last decade, almost all power generation plants have switched from heavy fuel oil to natural gas (EE[iii], EE[viii]).[16]

Although Egypt's oil production has decreased in recent years, total domestic energy production is increasing due to the growing production of natural gas (IEA 2004b; ENC-WEC 2005). In 2003/4, domestic primary energy production (64.4 Mtoe) exceeded the Egyptian TPES (53.9 Mtoe)[17] by more than 20% (ENC-WEC 2005). This is due to exports of crude oil, petroleum products and, to a lesser extent, exports of liquefied natural gas (LNG) that have recently started in 2005 (IEA 2005).

Table 5.3: Primary Energy Supply / Consumption by Source in Egypt

	TPES* **IEA 2004** (in Mtoe, 2002)	**Share 2002**	**Primary Energy Consumption*** **ENC-WEC** (in Mtoe, 2003/4)	**Share 2003/4** Only Total Petroleum Energy + Hydro
Coal	0,632	1.2%	0.936	
Crude Oil and Petroleum Products	27,368	52.2%	22.23	44.0%
Natural Gas	21,832	41.7%	25.39	50.5%
Hydro	1,204	2.3%	2.86	5.7%
Combustible Renewables and Waste	1,355	2.6%	n.s.	
Solar/Wind	0,019	0.04%	n.s.	
Total	**52,410**	**100%**	**51.42**	**100%**

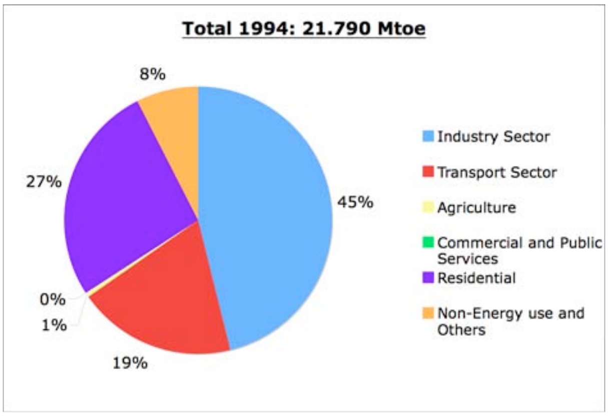
Source: IEA (2004a); ENC-WEC (2005); n.s.: not specified; * different figures given in literature

The petroleum sector currently accounts for around 8.1% of Egyptian GDP (ENC-WEC 2005). As domestic demand is highly subsidised and growing, export revenues are increasingly reduced by national consumption. In its scenarios for the next three decades, IEA does not expect these subsidies to be significantly reduced (IEA 2005a).

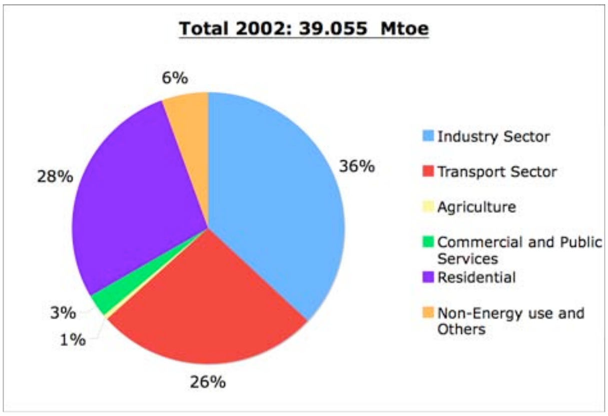
Comparing sectoral consumption, the industrial sector still uses most of the final energy although its share has substantially decreased in the last decade, from 45% in 1994 to 36% in

16 See methodology chapter for an explanation of the references.
17 Different figure of 51.4 Mtoe in (ENC-WCN 2005).

2005 (see Figure 5.3). While the shares of most other sectors have been stable, the contribution of the transport sector to total energy consumption has increased from 19% to 26% in the same period. In 2002, it almost reached the level of the residential sector, which is the second largest energy consumer. Due to the rising demand in the transport sector, the need for oil products in Egypt is expected to grow by 3.7% per year in the next three decades (IEA 2005a).



a) Energy Consumption by Sector in (1994, in %)



b) Energy Consumption by Sector in (2002, in %)

Figure 5.3: Final Energy Consumption by Sector

Data source: IEA (1997); IEA (2004a)

5.2.2 Electricity Sector

In the fiscal year 2004/05, total electricity generation was about 101 TWh (see Table 5.4). Installed capacity and generated electricity have increased substantially in recent years. From 1999/2000 to 2003/04, power generation increased by almost 38% from 73 TWh to 101 TWh and installed capacity grew by around 27% from 14.5 GW to 18.5 GW. The latest figures of the Ministry of Electricity and Energy (MOEE) show an increase of the peak load from 14.7 GW in 2003/4 to 16.7 GW in August 2005 (MOEE, 2005b).

Electricity generation is dominated by thermal power generation, which accounts for around 73.8% (see Table 5.4; Figure 5.5). Most is based on natural gas electrification in steam power plants and combined-cycle power plants. Around 92% of the fuel used in the electricity sector is natural gas[18], which accounts for around 63% of the total primary gas supply in 2003/4 (ENC-WEC 2005). Only 6% of electricity is generated through firing oil.

Figure 5.4 shows the grid and power system of Egypt Unsurprisingly, the main connections and power supply lines are to be found along the river Nile, Egypt's lifeline.

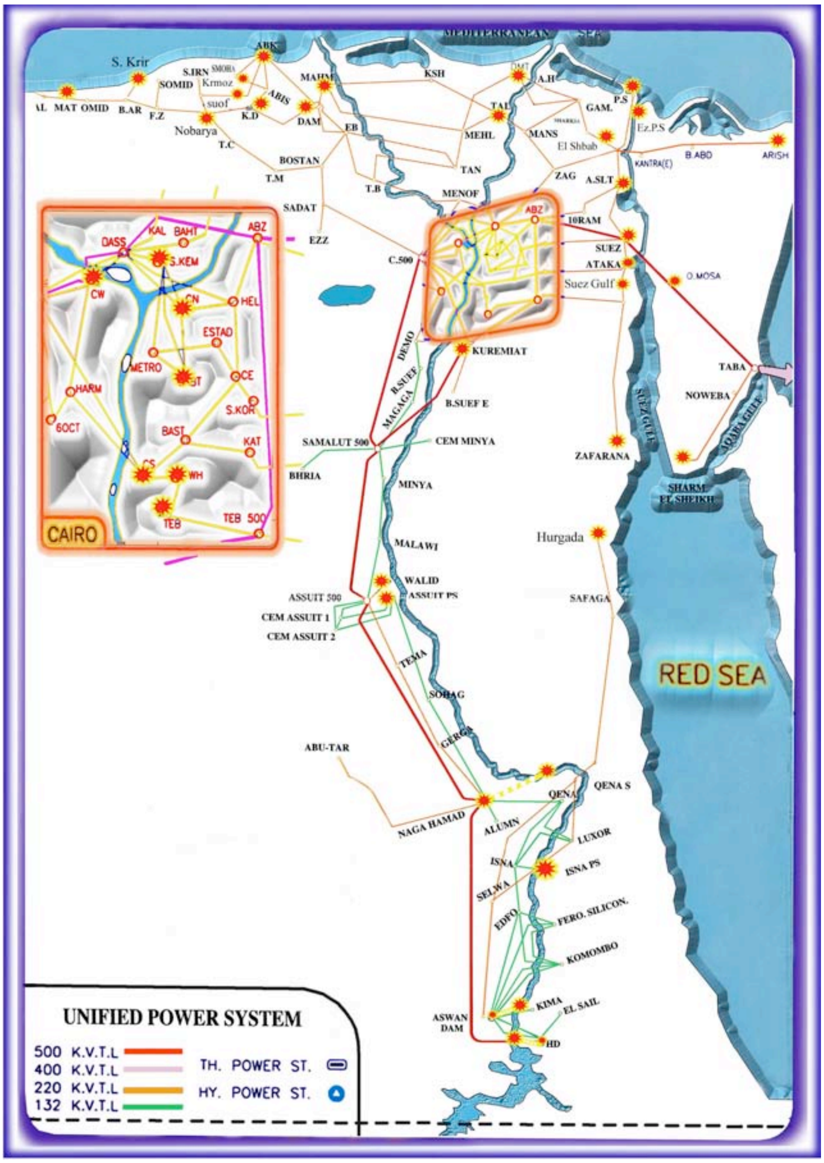


Figure 5.4 Map of the Power System of Egypt

Source: MOEE (2006)

[18] Exceptionally, the share of natural gas in fiscal year 2004/5 was lower than normal, namely around 76 %, due to problems in gas production, while heavy oil had a share of 24%. As the export of liquefied natural gas is expected to increase in the next decade, the conditions and shares on the national level might change. A possible return to the use of heavy oil could have a significant impact on GHG emissions.

Another 12.5% of electricity is generated by large hydropower plants located in the Nile river basin (IEA 2005a; MOEE 2005b). Egypt started to use hydropower from large dams as a source for electricity generation in 1960. Aswan I, the first dam, had originally been constructed to control irrigating water. The biggest power plant project, the "High Dam", was built in 1967 and consists of 12 turbines each with 175 MW, i.e. a total installed capacity of 2,100 MW. Three more plants (Aswan II, Esna, Naga Hamady) were built afterwards between 1985 and 1993. In total, 2,745 MW of hydropower are installed in Egypt. The electricity generated in the large dams is around 12-15 TWh per annum, depending on the water level of the Nile. As no new hydropower plants have been constructed in recent years while total electricity production has continued to increase substantially, the contribution of hydropower to Egypt's total electricity production has declined from 72% in 1974 to less then 13% in 2004/05 (MWRI 2001; MOEE 2004).

Table 5.4: Installed Capacity and Electricity Generation by Source

Description	**Installed Capacity 1999/00** (in MW)	**Power Generated** 1999/00 (in GWh/a)	**Installed Capacity** 2004/05 (in MW)	**Power Generated** 2004/05 (in GWh/a)	**Share of power generated** 2003/04
Total Thermal*	11,818	58,628	15,689	74,560	73.8 %
Hydro	2,745	14,659	2,745	12,644	12.5 %
Wind	(5)**	23.5	140	523	0.5 %
Generated from BOOT[19]	-	-	2,047	13,200	13.1 %
Grand Total	**14,563**	**73,310**	**18,544**	**100,996**	**100 %**

Source: (MOEE 2004); ENC-WEC (2005); * including independent power producers, ** not connected to the grid

The proportion of Egyptians having access to the electricity grid is quite high, at about 98% (MOEE 2004), compared to other North African countries such as Morocco (71.1 %; World Bank, 2005a). This is mainly due to the fact that the vast majority of Egypt's population (95%) lives in the Nile delta region and the valley of the river Nile between Alexandria and Aswan. In 1998, the grid was connected to Libya and Jordan, but the power export rate is quite low, less than 1% of total generated power in 2003/4. In the years to come a

[19] BOOT: "Build Own Operate Transfer" (see chapter 5.4.1.), these are all conventional fossil fuel power plants.

Mediterranean Power Pool is to be created that is to interconnect the electricity grids of North Africa, Spain, Turkey and the Middle East (MOEE 2004).

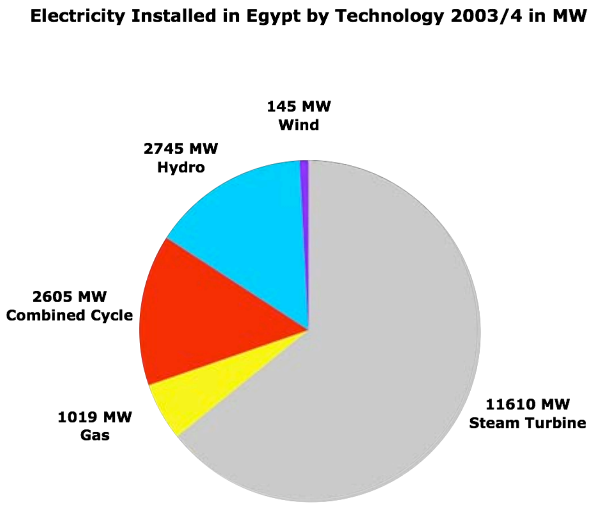


Figure 5.5: Electricity Installed in Egypt by Technology 2003/04 in MW

Source: MOEE (2006)

5.3 Renewable Energy Sources in Egypt

Egypt has a huge potential of renewable energy sources, especially as regards wind and solar energy but also biomass and hydro energy. Inspite of this potential, the share of RE[20] in TPES is less than 3% (see Table 5.3)[21], in electricity generation it is even less than 1% (see Table 5.4) if electricity generated by large hydropower plants is excluded.

In this chapter we outline past and future trends as well as the potential of renewable energy sources in Egypt. Renewable energy policy in Egypt is reflected afterwards in section 5.4.4.

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20 This includes energy produced by waste treatment.

21 Allal (2005) refers to a share of 11 % of TPES for renewable energy. This deviation is due to different calculation methodologies, in particular the inclusion of "traditional" biomass consumption in the calculation of TPES that accounts for share of almost 9 % of TPES.

5.3.1 Hydropower

The current use of hydropower in large hydropower plants has been described in chapter 5.2.2. The government intends to construct a few new hydropower plants in the years to come. In total, Egypt expects to reach 3,000 MW of total installed hydro capacity compared to currently 2,745 MW. Thereby almost the total economic potential of hydropower would be developed. According to the Ministry of Water and Irrigation and information given by EEHC, projected projects are located in Naga Hamadi (64 MW), Assiut (40-43 MW), Damietta (13 MW), Rosetta (10 MW), Zefta (3.5 MW) and Tawfiki Heat Regulator (2.6 MW) (MWRI 2001; EE[i]). In the new scenario of the Ministry of Electricity and Energy, Naga Hamadi is planned to be built in 2007 and will be connected to the grid in 2008 (MOEE 2005c). The smaller hydro units are to be installed in the period of 2009 – 2011.

Three projects are going to be implemented under the CDM, all in co-operation with the German KfW. All of them are small hydropower plants at barrages of the Nile River. The barrages are to be rebuilt which offers the opportunity to install small power plants at the same time (EG[i]; EE[ii]). As the potential of hydropower is almost fully developed, no new hydropower CDM projects are expected for the future.

5.3.2 Wind Energy

Some areas in Egypt belong to the windiest regions in the world. This is one reason why Egypt is one of the most successful wind energy countries in Africa, next to Morocco. Currently it has 145 MW installed capacity and is developing its potential continuously (InWent 2004; MOEE 2006). The huge wind energy potential is located at coastal areas (6-6.5 m/s annual average wind speed at the Mediterranean Sea and 8-10.8 m/s at the Red Sea) and in the South Western Region (7 m/s) (NREA 2004; World Bank 2005b; Aboulnasr 2002). The potential for power generation in the area west of the Gulf of Suez is estimated at about 20,000 MW (NREA 2004). In a study commissioned by the German Federal Ministry for the Environment (BMU), the total economic wind power potential for Egypt is estimated to be 90 TWh per year (DLR 2005)[22], which is the highest among countries in the Mediterranean region. A first wind atlas for the Gulf of Suez was published in 1996.[23] In cooperation with

[22] The technical wind potential is around 7,650 TWh/year (DLR 2005).

[23] The wind atlas includes wind data from 1991 to 1995 of four sites (Abou Eldarag, Zafarana, Elzayt Gulf, Hurghada).

the Danish Government, a wind atlas that covers the whole of Egypt has been developed. The wind atlas includes data from 30 stations from 6 regions, which were chosen to represent the most promising areas for wind exploration. It was published in February 2006 (Mortensen/Sadi/Badger 2006).

To support the local wind energy industry, the New and Renewable Energy Authority (NREA) established a Wind Energy Technology Centre at Hurghada in co-operation with Denmark. Its aim is to develop, test and certify wind turbine components and to train local staff (NREA 2006a).

The first pilot project of a wind farm started in 1988 at Ras Ghareb on the Red Sea Coast. Four imported 100 kW turbines were installed and the electricity was delivered to an oil company (NREA 2004; 2006a). Four years later, in 1992, a second wind farm was installed at Hurghada with 4x100 kW and connected to the local network, which in 1998 was connected to the national grid. The electricity generated is used for seawater desalination (NREA 2006a). In 1993, the first large wind farm was implemented at the same location in Hurghada, consisting of 42 turbines of different technologies with a total capacity of more than 5 MW, generating 9 GWh per year. It has been connected to the local grid in stages since 1993 (NREA 2004). [24]

After the implementation of these demonstration projects, Egypt decided to promote large-scale wind projects connected to the grid. As a consequence, the government allocated NREA an area of 80 km^2 on the Gulf of Suez at Zafarana to implement wind farms. In addition, another area west of this site was earmarked for a later extension (NREA 2004). Up to now, 140 MW have been installed in the first two phases. One wind farm with a capacity of 63 MW was finalized in 2001 in cooperation with the Danish International Development Agency (DANIDA).[25] The other one was financed by the German KfW and has been implemented in two stages: in November 2003, windmills with a capacity of 30 MW started operating and half a year later another 47 MW were connected to the grid.[26] According to NREA, further

[24] Half of the components installed in both Hurghada projects have been manufactured locally, namely blades, towers and other mechanical parts.

[25] This wind farm consists of 105 wind turbines of 600 kW each, manufactured by Nordex/Germany.

[26] This wind farms consists of 117 wind turbines of 660 kW each, manufactured by Vestas/Germany.

wind projects with a total capacity of 850 MW are to be built in Zafarana by 2010 (NREA 2006; EE[iii]; see Table 5.5). Some projects are already in progress:

- A 85 MW wind farm being built in cooperation with Spain, located in Zafarana, is planned to be connected to the grid in 2006;
- A 120 MW wind farm being built in cooperation with Japan, located in Zafarana, is planned to start operating by 2007/8;
- A 80 MW wind farm being built in cooperation with the German KfW, located in Zafarana (4th stage), is expected to be finalized by 2007;
- A 120 MW wind farm being built in cooperation with Denmark, located in Zafarana (3rd stage).

(NREA 2004, Kamel 2004)

Table 5.5: Existing and Planned Wind Power Capacity and Electricity Generation (2000 to 2010)

Year	Installed Capacity (in MW)		Expected Generation (in GWh)	
	Annually New	Cumulative	Annually New	Cumulative per Year
2001	5	5	10	10
2002	63	68	2337	247
2003	0	68	0	247
2004	77	145	2290	537
2005	0	145	0	537
2006	85	230	320	857
2007*	200	430	718	1,575
2008*	120	550	400	1,975
2009*	80	630	301	2,276
2010*	220	850	828	3,104

Source: NREA 2006a, *supplemented by NREA 2006b and own calculations.

5.3.3 Solar Energy

Egypt is part of the African sunbelt region and therefore has an enormous potential for the different applications of solar energy. The potential is even larger than the one from wind energy. In 1991, a solar atlas was published by NREA to support the utilisation of this potential (NREA 2004). It shows an average annual global radiation[27] which varies between 1900 and 2600 kWh/m^2 per year, while the Direct Normal Irradiance[28] (DNI, see Figure 5.6 and Figure 5.7) ranges from 2000 to 3200 kWh/m^2 per year from North to South (NREA 2005a, NREA 2004). By comparison, annual global radiation in Germany is only half as high, with an average of around 1000 kWh/m^2.

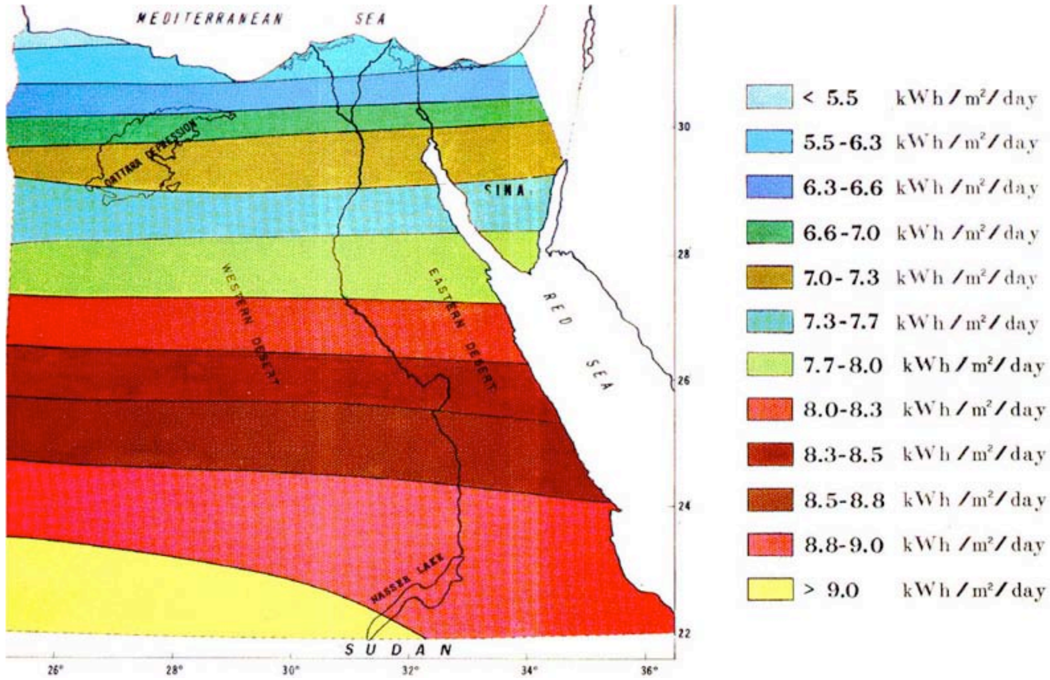


Figure 5.6: Daily Direct Normal Irradiance (DNI) in Egypt

Source: NREA

The potential, status quo and trends of the different applications are as follows.

Concentrating Solar Power (CSP): Egypt's technical as well as economic potential[29] is estimated to be around 73,655 TWh per year for the electricity supply side (DLR 2005). This is more than a hundred times beyond Egypt's estimated future electricity demand (631 TWh/y

27 Global Radiation is defined as the the sum of direct *and* diffuse solar radiation on a *plane* area.

28 Direct Normal Irradiance is defined as the *direct* share of solar radiation upon an area *right-angled* to the sun.

29 The calculation of the *technical* potential is based on all non-excluded areas with a Direct Normal Irradiance higher than 1800 kWh/m^2/y;
The calculation of the *economic* potential is based on all non-excluded areas with a Direct Normal Irradiance higher than 2000 kWh/m^2/y, regardless of the energy market situation in the respective Mediterreanean country.

in 2050 according to the CG/HE-scenario[30]) and even more than twice as much as the estimated world power demand in 2050. If restricted to coastal areas not higher than 20 meters above sea level (a.s.l.), the economic potential is reduced to 496 TWh per year (see Figure 5.7 and Figure 5.8), which would still cover almost 80% of the expected electricity demand in 2050.[31]

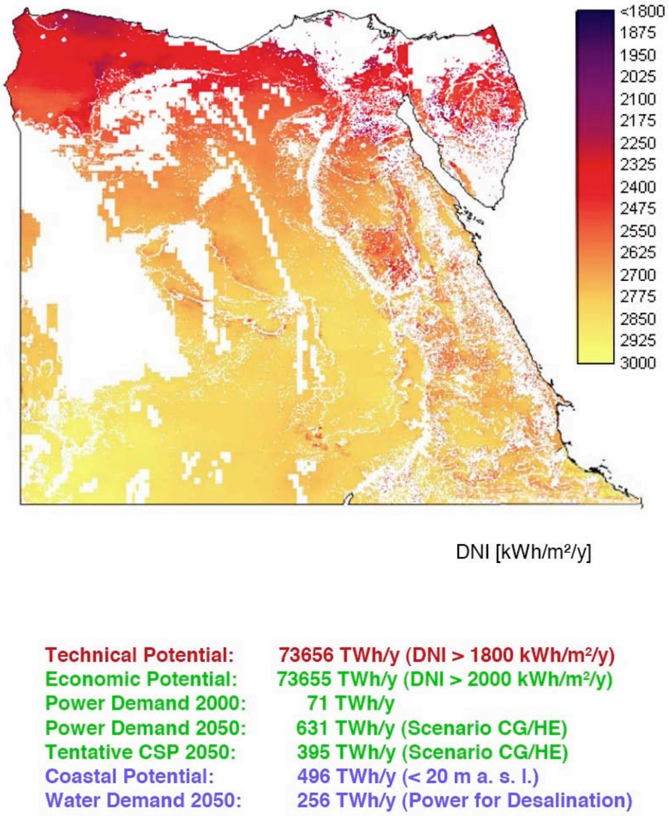


Figure 5.7 Distribution of the Annual Direct Normal Irradiance (DNI) in Egypt and total CSP Potential and Demands for Electricity

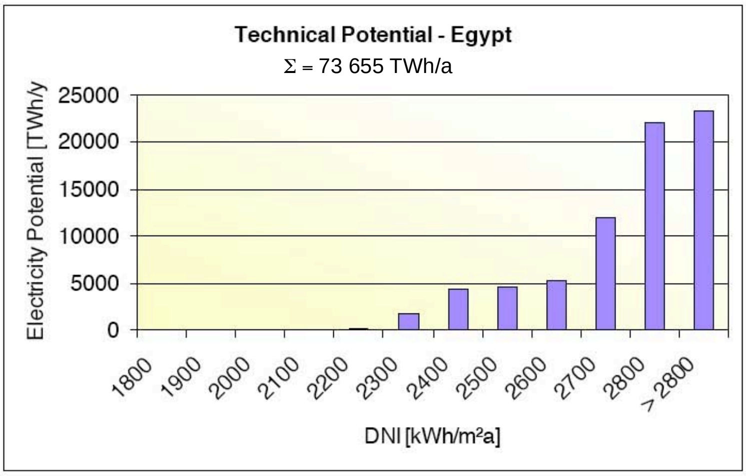
Source: DLR (2005)

DLR (2005) emphasises the high potential of CSP in the field of desalination. According to Nokraschy (2005), the use of solar thermal electricity in combination with utilising the waste heat for desalination could become the most economic option within 10 to 15 years. Figure 5.8 shows how much electricity (TWh/y) can be generated in each class of Direct Normal

30 CG/HE-scenario: Closing Gap/High Efficiency scenario (DLR 2005).

31 The exclusion criteria used for the regional analysis by DLR are very rigorous (e.g. altitude < 20 m a.s.l., full priority for agricultural land etc.). Therefore it is possible that an in-depth country analysis allowing e.g. the use of agricultural areas in higher regions by multi-purpose plants could yield sufficient potential for that purpose, too.

Irradiance (kWh/m^2/y): The first histogram defines the technical potential as a CSP performance indicator of Egypt, the second one defines the technical potential for CSP plants with combined seawater desalination close to the coast (max. 20 meters a.s.l.).



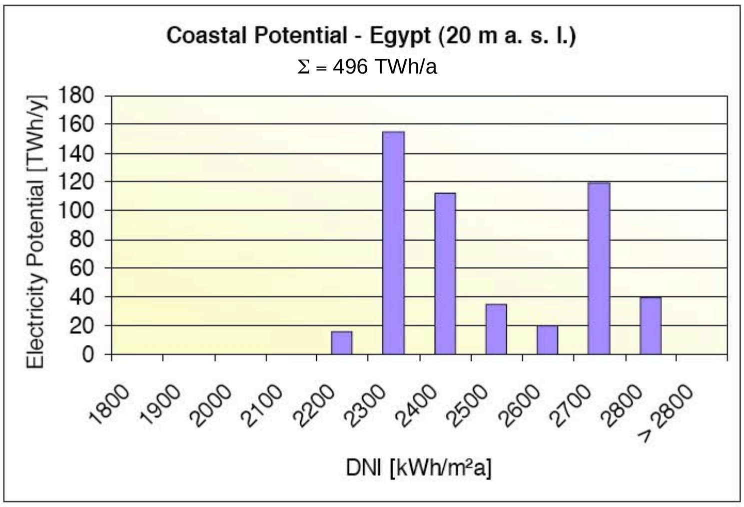


Figure 5.8 Comparison of Egypt's Technical and Coastal CSP Potential in kWh/m^2/y DNI

Source: DLR (2005).

At the moment, a solar thermal power plant is to be built in Kuraymat (NREA 2004). The project is supported by the Japan Bank for International Cooperation (JBIC), which expressed the interest to finance the balance of the plant, and the GEF, which finances the incremental cost of 50 million US dollar resulting from the solar component (NREA 2004; Solarpaces

2006). The solar thermal power plant[32] is designed with a total capacity of 150 MW_{el}, including 30 MW_{el} solar, and shall start operation in 2009. The share of the energy generated by the solar component will be about 6.6% (NREA 2005b).

CSP for Solar Industrial Process Heat (SIPH): Next to the use of CSP for electricity generation, solar industrial process heat (SIPH) is another solar energy technology with high importance and huge potential. The industrial sector consumes around 36% of total energy supply (see Figure 5.2), while 60% of the energy demand of the industrial sector is process heat (Kamel 2001). Studies have revealed that 20-30% of this energy is wasted due to inefficient processes, insufficient maintenance and other reasons (Zannoun 2001).

As part of a NREA program for field-testing and dissemination of "Solar Industrial Process Heat and Waste Heat Recovery System" two pilot projects have been conducted. In the first project, low temperature SIPH systems with additional waste heat recovery were implemented within the textile and the food industry. The projects were co-financed by the United States Agency for International Development (US AID). The second pilot project was implemented using solar parabolic concentrator technology to generate process steam in the medium temperature range. This project was implemented at a pharmaceutical company in cooperation with the African Development Fund. The fuel savings of this project add up to 0.13 Mtoe/y (NREA 2004; Aboulnasr 2002). NREA aims at saving 0.67 Mtoe/a by SIPH using parabolic troughs in the industrial sector by 2017 (NREA 2005a).

Domestic Solar Water Heaters (DSWH): Solar water heaters have been manufactured in Egypt since the 1980s. In the 1990s, 65% of total energy savings from RE applications already resulted from solar thermal applications, in particular DSWH (Kamel 2001). Up to now, the use of domestic solar water heaters is the most widespread solar application in Egypt. In the mid-1980s, the government passed a law to promote the technology, which made the installation of solar water heaters in residential buildings in new satellite towns compulsory. Unfortunately, this law did not have a lasting effect. One of the major obstacles was a lack of execution by the local authorities and another was that the quality of the solar water heaters used was often poor, resulting in a bad reputation of the technology (Kamel

[32] The total area of solar collectors is about 220,000 m^2; the field comprises parallel rows of solar collector arrays, sets of typical glass mirrors forming parabolic troughs that focus on an absorber pipe located along it's focal line (HCE) (NREA 2004).

2004). Another new concept for supporting an increased use of solar water heaters is the "Guarantee Solar Results" (GSR), which was elaborated and demonstrated in project "Applications of Solar Thermal Energy in the Mediterranean Basin" (ASTEMB) funded by the European Commission. The idea is to arrange an agreement between the consumer and the company supplying the system to assure to the consumer adequate energy supply, efficient operation, maintenance and performance. A pilot project started operating in 2004 (Solarmed 2006).

In spite of the existing obstacles, the total installed collector area has doubled from 200,000 m^2 in 1995 to 400,000 m^2 in 2005 (Word Bank 2005b; NREA 2005a). In 2002, there were nine local manufacturers producing solar water heater components and systems (Gelil 2002). The yearly production capacity is around 25,000 m^2/y of domestic solar water heaters (NREA 2005a). Nowadays, tourist villages, hotels and other commercial buildings are the most important customers of the solar water heater industry (Kamel 2004).

Photovoltaic: Photovoltaic (PV) technology is not used on a wide scale in Egypt. The latest figures state an installed capacity of 3 MW_{peak} (NREA 2004), although NREA mentioned in 2001 that projects with a total capacity of 10 MW_{peak} were to be implemented in the following years (Kamel 2001). Yet, there is one local manufacturer who annually produces PV modules with a capacity of 500 kWp (World Bank 2005b). Market introduction has been successful in some fields of application, such as telecommunication systems or navigation aid lights, while others, such as village electrification, are still at the demonstration and field-testing stage (Aboulnasr 2002). The main reason why PV is not very widespread is the high rate of electrification through the grid, which PV cannot compete with economically. Nevertheless, 121 potential villages were identified for electrification with PV by a MEDREP project (Iancomelli 2005).

Egypt is one of the largest markets in the world for water pumping technologies. Thus, PV could be a promising application in this field (Kamel 2004). However, due to the low electricity tariffs, which are about US-$ 0.01 for the agricultural sector (EEUCPRA 2005), and more importantly the subsidized diesel fuel available in the local market, the use of PV for pumping is commercially unattractive in both on- and off-grid regions.

5.3.4 Biomass

There is a remarkable potential for the use of biomass. In rural areas, biomass is still used to cover 50% of the people's energy needs. However, it is burned with an efficiency of less than 10% (Kamel 2001; Zannoun 2001). This low efficiency is due to the traditional use in open combustion without applying any energy efficient technology (NREA 2005a).

The data obtainable for biomass consumption and potential in Egypt cover a wide range. The total yearly consumption stated by international agencies is about 1.3-1.4 Mtoe per year (Enerdata 2004; IEA 2004b). This represents a share of 2.6% of TPES. Local sources state a significantly higher consumption in the range of 3.6-5.2 Mtoe per year, almost 7 to 10% of TPES (Kamel 2001; NREA 2005a). Similar differences occur when looking at potential. While a World Bank report refers to a potential of 90,200 Gcal (377.000 GJ) per year, which is equivalent to about 9 Mtoe (World Bank 2005b), another source refers to 5.5 Mtoe, excluding industrial wastes (Kamel 2001).

The Agricultural Research Centre estimates that 800 small-scale biogas digester units have been installed in Egypt, but less than half of these units are still working. Nevertheless, the potential for such systems is estimated to be about one million units (Kamel 2001).

In 1996, NREA, supported by DANIDA, conducted a study on biogas showing that about 20 TWh electricity per year and a similar amount of process heat could be generated using available organic residuals (NREA 2005a). According to DLR (2005), the potential is around 15.3 TWh per year.

However, large-scale biogas applications have not gone beyond the status of pilot projects yet. The latest application is an 18 MW_{el} biogas plant with a digester size of 220,000 m^3 constructed by the General Organization for Sewage Treatment (GOST) (NREA 2005a; Kamel 2001). Another study in cooperation with DANIDA on "Biogas Experience in Egypt" in 2000 stressed that the implementation of biogas plants as well as the rehabilitation of existing ones should be fostered. This could be done by giving technical advice and financial support, by developing a framework for the establishment of a proper maintenance service and by recommending biogas technology for the use in industry and large farms (NREA 2005a). NREA currently supports a project in the governorates of Assiut and El-Fayoum that will cover the installation of anaerobic biomass digesters, a briquetting system of biomass for rural enterprises and households, efficient biomass stoves, furnaces and dryers as well as biomass gasification for the production of fuel gas for process heat, pumping etc. (NREA 2005a).

A major constraint for electricity generation using biogas is that the regions with abundant agricultural wastes are already grid-connected and biogas plants cannot compete with grid electricity (Kamel 2004).

5.3.5 Other

Studies on the potential of **geothermal energy** in Egypt show only a negligible potential for the commercialisation of geothermal applications that is located in the south of the Red Sea (Kamel 2004).

It is worth mentioning another project in the context of modern energy applications that is not directly related to renewable energies. This is a demonstration project for **fuel cell** buses in Cairo by the GEF which started in 2001 (GEF 2005). The progress of this project has been very limited and it has not been implemented on a broader scale. Although the project has not been cancelled officially, the Egyptian government determined in 2004/5 that the project should not be continued. The implementation arrangements were not negotiated and neither the co-financing by the government nor the project documentation was finalized (UNDP/GEF 2006).

5.3.6 Summary of RE Potential in Egypt

The sections above have shown that the Egyptian conditions are among the best globally for the economic and efficient use of renewable energy technologies. Not only the solar potential of this country lying in the Sunbelt is tremendous but also the wind speed and potential is one of the best worldwide. Up to now only a fraction of this potential has been used, mostly as regards hydropower where almost the total economic potential is already in use for electricity production.

To total up the potential outlined for the individual technologies, Figure 5.9 shows the economically feasible potential for power generation in Egypt. The overall economic potential for power generation from RET in Egypt is six times higher than current electricity production. In total, more than 600 TWh could be produced from RET. Almost 500 TWh, 80% of the total potential, could come from the use of Concentrated Solar Power plants, counting only coastal sites.[33] Another 15% or around 90,000 GWH could come from wind and the rest from efficient biomass technologies and hydropower. So even without using one of the most promising technologies, CSP, the other three other options could produce more than 120 TWh, which exceeds the Egyptian electricity production of 2004.

However, when looking at the economic potential outlined in the study of DLR, one has to be aware that they did not take into account the current situation of the energy market and subsidies in Egypt. Instead, they assumed for all Mediterranean countries that areas not higher than 20 meters above sea level (necessary for the access to cooling water) and with a direct Normal Irradiance higher than 2000 kWh/m^2/year can be regarded as technically and economically viable for solar power production. In reality, current Egyptian energy prices significantly lower the economic feasibility, but the figures given can be considered as a sound estimation for the future.

There are also considerable potential for uses other than electricity production, like for heat and cooling. For example, the potential for production of process heat from biomass is similar to the potential for electricity generation (around 20 TWh/year). In addition, the potential of CSP for industrial process heat as well as for cooling processes is huge. However, based on the data available an overall estimate of the potential for the other uses of renewable energy sources cannot be given.

[33] According to DLR (2005) the total economic potential for CSP is even twice as high as world power demand.

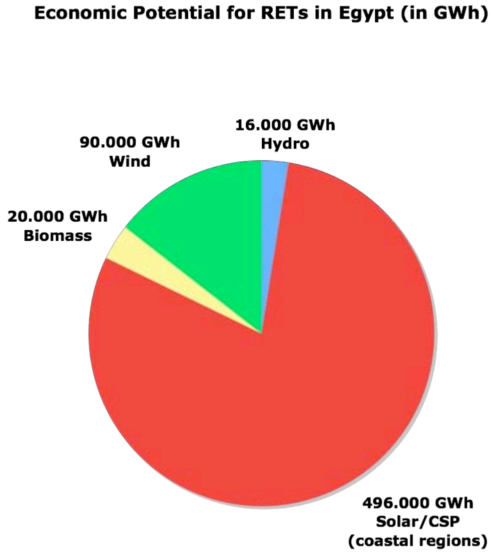


Figure 5.9: Economic Potential for Electricity from Renewable Energy Technologies in Egypt (estimated values in GWh)

Source: DLR 2005; NREA 2005a

The following table, which has already been described in general for developing countries in chapter 4, synthesises the current and future economic potential for the utilisation of RET that have been identified for Egypt. Where possible, furthermore country specific energy indicators (such as wind speed, solar insolation etc.) are given. Note that some of the figures are just rough estimations (e.g. biomass). In cases where further potential for particular technologies are expected but no sound figures are available, there is a general note "additional potential" (e.g. in the case of solar heat). The crosses indicate those technologies that are assumed to be relevant for Egypt. Since alternative fuels are not yet significant in Egypt and there is no specific data for this sector available, it has been completely left out (for exemplary data on the fuel sector see the country analysis of Thailand in Section 6).

Table 5.6: Supply-Side Technology Matrix for RE in Egypt (Top-down Table)

																CO_2-Red.-		Implications & Co-Benefits[4]					
	Energy Source				Sector Compatibil					System		Power				Potential		Economy		Ecology[3]	Social economy	Further	Baseline
Energy Type	Main Group	Subgroup	Ressources / Technologies (Examples)	Application	Residential	Industry/Business	Power Sector	CHP	Hybrid[5]	On-Grid	Standalone	Small	Medium	Large	Energy Benchmark resp. Energy potentials [TWh]	Energy Substitution	GHG-Destruction	Spec. Invest Costs [€/kW]	Spec. Energy Costs [€/kWh]			Qualification Spare Parts Participation ...	(only relevant for country specific analysis!)
HEAT	**Biomass**[1] (Co-firing)	Residues (Wood)	Wood residues from forestry Wood residues from industry (incl. sawdust)																				
		Residues (agricultural)	Straw																				
		Energy crops (renewable raw material)	Short-rotation plantations																				
	Biogas[1]	Residues (Wood)	Wood residues from forestry Wood residues from industry (incl. sawdust)																				
		Residues (organic)	Bagasse, coconut shells, rice husk																				
			Biological waste (Municipal solid wate)	Power generation Cooking	x	x	x	x		x	x	x	x		Electricity: 20 TWh/y Heat: 20 TWh/y	x	x						Non-sustain. biomass Fossil fuel electricity mix
			Sludge gas	Power generation			x			x			x			x	x						
			Landfill gas	Power generation			x			x			x			x	x						
		Residues (agricultural)	Crop residues (incl. gras)																				
			Manure slurry		x	x	x			x	x	x	x			x	x						
			Zoo mass				x			x			x	x		x	x						
		Energy crops (renewable raw material)	Grain, starchy plants, wood from short-rotation plantations																				
	Coal Bed Methane[1]																						
	Solar[1]			Solar stove	x	x										x							Non-sustain. biomass Fossil fuel Electricity
				Solar drying	x	x										x							
				Warm water	x	x									additional potentials	x							
				Heating	x	x										x							
				Process heat		x										x							
				Process cooling		x										x							
	Geothermal[1]	Near surface (heat pump)																					
		Hydrothermal					x	x		x			x	x		x							Fossil fuel Electricity
		HDR technology[6]					x	x		x				x		x							
ELECTRICITY	**Hydro**	large (> 10 MW)	Storage, run-of-river				x			x				x		x							Fossil fuel electricity mix
		small (< 10 MW)	Storage, run-of-river			x	x			x			x		16 TWh	x							
		micro (< 100 kW)	run-of-river			x				x	x	x				x							
	Wind	large (> 100 kW)				x	x		x	x				x	90 TWh	x							Fossil fuel
		small (< 100 kW)			x	x			x	x	x	x			(6...11 m/s)	x							electricity mix
	Solar[1]	PV			x	x	x		x	x	x	x	x		1500 kWh/y/kW_{peak}	x							Batteries, Fossil fuel electricity mix
		Solar thermal	Dish-Stirling			x	x			x	x	x	x		additional potentials	x							
			Parabolic trough				x	x	x	x			x	x	495 TWh (coastal)	x							
			Solar tower				x	x	x	x			x	x	(DNI > 2000 kWh/m^2/y)	x							
			Solar chimney																				
	Geothermal[1]	Hydrothermal					x	x		x			x		additional potentials	x							
		HDR technology[6]					x	x		x			x		additional potentials	x							
	Ocean energy	Waves																					
		Tides																					
		Thermal (OTEC[7])																					

Energy type	Main Group	Subgroup	Ressources / Technologies (Examples)	Production: thermal-chem.	Production: phys.-chem.	Production: biochemical	Production: electrical	System: On-Grid	System: Stand alone	Energy Benchmark resp. Energy potentials [TWh]	CO2-Red.-Potential: Energy Substitution	CO2-Red.-Potential: GHG-Destruction	Implications & Co-Benefits[4)] Economy: Spec. Fuel costs [€/kWh] resp. [€/MJ]	Economy: Spec. Fuel costs [€/l]	Ecology[3)]	Social economy	Further: Qualification Spare Parts Participation ...	Baseline (only relevant for country specific analysis!)
F U E L S	Liquid	Vegetable oil	Rape, sunflower, Jatropha, palm oil etc.		x				x									
		Bio diesel (FAME [2)])	see above		x				x									
		Bio ethanol	Starchy plants (Maize, grain, potatoes)			x			x									
			Sugar plants (Sugar beet, sugar cane)			x			x									
		Bio methanol	from Biogas	x					x									
		BTL (Fischer-Tropsch)	from Biogas	x					x									
	Gaseous	Hydrogen	Wind, solar, biomass	x		(x)	x	x	x									
		Bio methan (= Biogas)	Biomass	x		x		x	x									

Note
1) in principle applicable for combined heat and power generation
2) FAME: Fatty Acid Methyl Ester, among RME (Rape Methyl Ester)
3) e.g. acidification potential, Eutrophication Potential, Ozone Depletion Potential and ozone-forming potential, toxicity
4) s.a. under "Guidelines for a sustainable power supply" named aspects
5) e.g. Diesel/PV- or Wind/PV-Systeme
6) HDR: Hot Dry Rock
7) OTEC: Ocean Thermal Energy Conversion

Further technologies / options:
- Solar architecture
- Sea water desalination

Guidelines for a sustainable power supply
- Equality of access
- Protection of resoucres
- Compatibility with environment, climate and health
- Social compatibility
- Comprehensive economic efficiency
- Low risk and error tolerance
- Availability and security of supply
- International co-operation

Source of Sustainability Guidelines:
Renewable energies - Innovation for the future.
Publication of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Berlin 2004

5.4 Energy Policy

5.4.1 General Aspects of Energy Policy in Egypt

Energy policy in Egypt is formulated by the Supreme Council of Energy (SCE), which works in close consultation with the parliamentary committee for industry and energy. The council consists of the ministers of energy and petroleum (Kamel 2001). Technical and scientific assistance to the council is provided by the Organisation for Energy Planning (OEP), a governmental body founded in 1983. The main energy policies and goals focus on the oil and gas sector and include:

- The increase of oil and gas exploration activities to enlarge proven reserves and enhance production rates
- The comprehensive development of the refining industry
- The maximisation of the value-added of natural gas inter alia by gas to liquids projects (GTL)
- The optimisation and enlargement of oil and gas exports
- The encouragement of an increased utilisation of natural gas in different sectors

(ENC-WEC 2005).

Most of Egypt's hydrocarbon resources are state-owned and administered through the Petroleum Ministry. Four state-owned companies control the different resource areas, namely EGPC (Egyptian General Petroleum Company), EGAS (Egyptian Natural Gas Holding Company), ECHEM (Egyptian Petrochemicals Holding Company) and Ganope (Ganoub El-Wadi Petroleum Holding Company). In contrast to other major oil exporting Middle Eastern and North African countries, Egypt is not a member of OPEC and is therefore responsible for its own oil policy (EIA 2005).

The electricity sector is controlled by the Egyptian Electricity Holding Company (EEHC[34]), which consists of 5 regional power generation companies, 9 regional power distribution companies and one transmission company. The EEHC is directly subordinated to the Ministry of Electricity and Energy (MOEE 2004; EEUCPRA 2005).

[34] In 2000, the name changed from Egyptian Electricity Authority to Egyptian Electricity Holding Company.

Apart from the state-owned power plants, there are private BOOT[35] power generation companies with a market share of about 14% of electricity generation (see Table 5.4). BOOT power plants are built, owned and operated by private foreign investors and will be transferred to the Egyptian authorities after a fixed period agreed beforehand. The electricity generated by these companies must be sold to EEHC at a fixed price that, until recently, was denominated in foreign currency. However, as the EEHC generates its income in local currency and the floating of the Egyptian Pound (LE) led to a substantial devaluation of the currency (Dena 2003), this arrangement became a serious financial constraint for EEHC. The regulation was therefore changed in 2003 and nowadays new BOOT companies receive only local currency for the electricity sold. This has lead to a breakdown of investments in new BOOT plants. In total, there are currently only three BOOT plants, one of which has been commissioned in 2002 and the other two in 2003 (MOEE 2004; IEA 2005a).

5.4.2 Subsidies and Energy Prices in the Egyptian Energy Market

Energy is highly subsidised in Egypt. The system is very intransparent and includes several sub- and cross-subsidies. There are firstly subsidies for fossil fuels and secondly subsidies to lower consumers' electricity rates.

Regarding the electricity subsidies embedded in the tariffs, EEIGGR (2006) describes cross-subsidies of four different types. On the one hand there are indirect subsidies to the power sector as a whole and on the other hand there are subsidies embedded in the electricity tariffs that can be differentiated into three different types:

- Inter-class cross-subsidisation
- Intra-class cross-subsidisation
- Inter-distribution company cross-subsidization

Indirect subsidies to the power sector: The Ministry of Petroleum owns the natural gas resources and sells the gas to the EEHC at a price that is lower than the international price level ("shadow price"). At present, the electricity companies pay only around 56.4% of the current international price of natural gas, 36.2% of the international price of heavy fuel, and

[35] BOOT: "build own operate transfer".

53.3% of the international price of gas oil. The difference between the two prices is considered a debt by the petroleum companies, whereas the electricity companies consider it to be a subsidy, that is, to be non-repayable (EE[iv]).

The rate of return on investment that the Government receives as shareholder of the power companies is also below what would be acceptable in the private sector. In total, the Government of Egypt is transferring a huge indirect subsidy to the power sector, exceeding LE 7.5 Billion annually (or US-$ 1.3 billion) (EEIGGR 2006).

The term *inter-class cross-subsidization* denotes the fact that distribution companies receive much higher returns on sales to some customer classes than for sales to others. For example, the Alexandria Distribution Company receives a 424% return on sales to its commercial customers compared to a -140% return on sales to residential customers. The *intra-class cross-subsidization* refers to subsidies within a customer class, meaning some customers pay less than others even though the cost of supply is judged to be the same (see tariffs below). *Inter-distribution company cross-subsidization* refers to the fact that all customers within a class are paying the same tariff regardless of geographic location and cost of supply, so that customers served by one distribution company are subsidized by customers of another distribution company (EEIGGR 2006).

For diesel fuel there's a different kind of subsidy. Even though Egypt is a net crude oil exporter, it has to import diesel due to capacity constraints, as the local refineries are not able to address the local demand. Although these prices have increased in the last months, the new price is still lower than the international price that the government has to pay for the import of diesel (EE[v]). Fuel and oil product prices were raised in July 2006. Prices for heavy fuel were increased from LE 300 to LE 500 per tonne, for natural gas from US-$ 1 to US-$ 1.25 per 1000 SCF, gas oil from LE 0.6 to LE 0.75 per litre and gasoline with octane No. 90 from LE 1 to LE 1.3 per litre. This was the third price raise since March 2005 (EE[iv]).

There are different figures as regards the total amount of governmental subsidies. According to one interviewee, Egyptian energy subsidies sum up to US-$ 2 million per year (EE[vi]). Regarding electricity prices, an amount of LE 2.6 billion was mentioned (EE[vii]). As for fuel subsidies, a number announced by the government is LE 40 billion (or US-$ 6.96 billion) for hydrocarbon products, including petroleum products and natural gas. However, there is no transparency as to what exactly was included in the calculation of this figure (EE[iv]).

The government has the authority to regulate electricity prices and does so by setting fixed prices for eight major tariff groups with several subcategories. In 2004, tariffs were, for the first time since 1992, increased by 8.6% on average. Depending on the consumption, electricity tariffs in Egypt currently vary from Ct_{EUR} 0.68 to 4.25 per kWh (Ct_{US} 0.87 to 5.40 per kWh) for the residential sector and from Ct_{EUR} 2.71 to 6.51 per kWh (Ct_{US}/3.45 to 8.28 per kWh) for the industrial/commercial sector (see Table 5.7). The government envisages to further raise the tariffs by 5% annually until 2009 [EG[i]]; [EE[ii]]; [EE[iii]].

Table 5.7 Egyptian Electricity Tariffs (in Millim, Euro-Cent, US-Cent per kWh) for the Industrial, Residential, Commercial and Public Sectors

Tariff group (1 Euro-Cent = 73 Millim)	Energy Tariff (Dec. 2005) [Millim/kWh]	[Ct_{EUR}/kWh]	Power Factor Charge	Increase since Oct. 2004 [%]
1 Ultra High Voltage (220,132 kV)	103	1,41	yes	44,1%
2 High Voltage (66, 33 kV)	125	1,71	yes	5%
3 Housing companies	120	1,64	yes	5%
4 Medium (22, 11, 6.6 kV) & Low Voltage (380, 220 V)				
More than 500 kW				
- Annual credit [LE/kW] / [EUR/kW]	96	1,32		-
- Energy Price [Millim/kWh]	170	2,33	yes	-
Agriculture	90	1,23	no	-
- Other consumers	200	2,74	yes	-
5 Residential				
0 - 50 kWh/month	50	0,68	no	0%
51 - 200 kWh/month	90	1,23	no	5,1%
201 - 350 kWh/month	125	1,71	no	7,7%
351 - 650 kWh/month	180	2,47	no	12%
651 - 1000 kWh/month	255	3,49	no	12,9%
More than 1000 kWh/month	310	4,25	no	14%
6 Commercial				
0 - 100 kWh/month	198	2,71	no	5%
101 - 250 kWh/month	287	3,93	no	5%
251 - 600 kWh/month	366	5,01	no	5%
601 - 1000 kWh/month	453	6,21	no	5%
More than 1000 kWh/month	475	6,51	no	4,9%
7 Offices and clinics	200	2,74	no	-
8 Public lighting	331	4,53	no	5%

Source: Tariffs: www.egyptera.com/en/Bill_Tariffs.htm

Increase: (EEiv)

		US Cent/kWh
Power Service on Medium & Low Voltage		
More than >500 KW		
	Demand Charge (US$/kW-month)	1.39
	Energy Rates	2.96
c-Residential :-		
	1) First 50 kWh monthly	0.87
	2) 51 - 200 kWh "	1.60
	3) 201 - 350 kWh "	2.18
	4) 351 - 650 kWh "	3.14
	5) 651 - 1000 kWh "	4.44
	6)More Than 1000 kWh "	5.40
d - Commercial:-		
	1) First 100 kWh monthly	3.45
	2) 101 - 250 kWh "	5.00
	3) 251 - 600 kWh "	6.38
	4) 601 - 1000 kWh "	7.89
	5) More Than 1000 kWh "	8.28

Source: SINDICATUM CARBON CAPITAL LTD (July 2006)

5.4.3 Future Development in the Energy Market

Based on recent development trends, power production is projected to increase on average by 2.7% per year until 2030 (IEA 2005a), with a rapid growth in the first decade that will slow down in the 2020s. To meet the expected demand and substitute power stations that need to be retired, the Ministry of Energy and Electricity aims to further expand the electrification capacity by about 29 GW in the period 2007-2022 (MOEE 2004). For the next two decades 7 steam power plants and 14 combined cycle units are planned to be built but also additional renewable energy generation capacity (MOEE 2005c). The growth of the total and the to be added capacity for the next 10 years is shown in Figure 5.10.

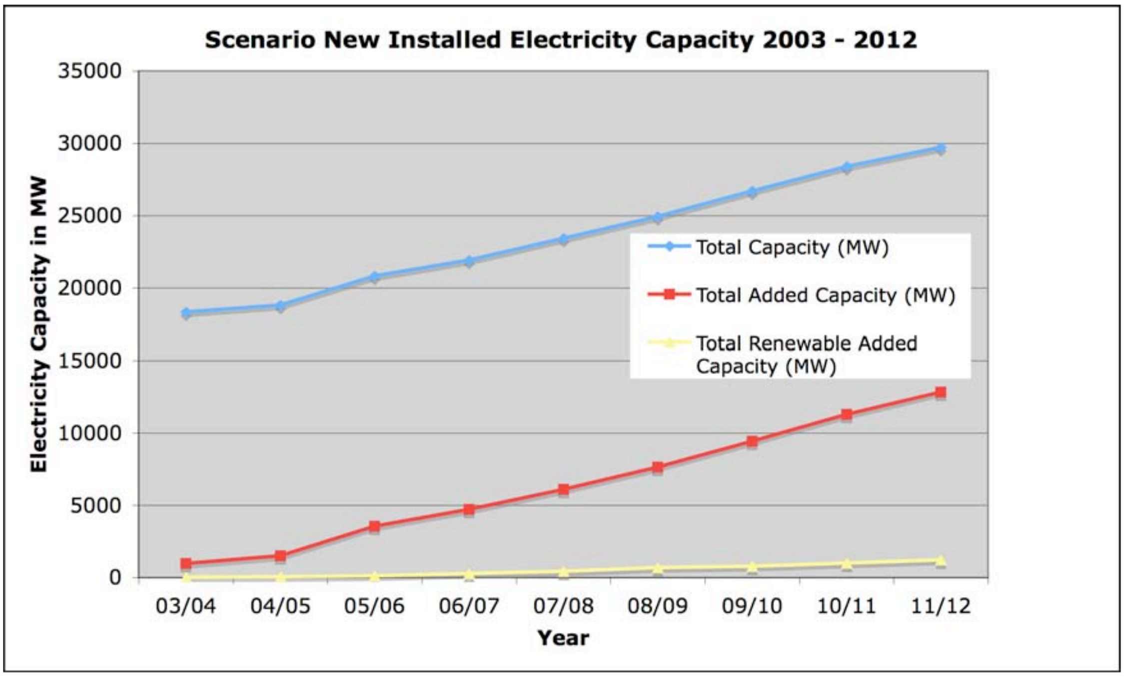


Figure 5.10: New Installed Electricity Capacity Planned for 2003 – 2012

Data source: (MOEE 2005c)[36]

The oil companies[37] involved in the Egyptian market are investing in enhanced drilling equipment and the exploration of new oil fields to compensate for the decreases in production (EIA 2005). However, despite these efforts the growing domestic demand will most probably in the future exceed production. It has been estimated that Egypt might become a net oil importer by around 2015 (WEC 2004; IEA 2005a).

In the years to come, Egypt plans to increase exploitation of its natural gas reserves. The reason is not only increasing domestic demand but also planned LNG exports by ship to Europe and natural gas exports to Syria, Lebanon and possibly Turkey through a pipeline that is under construction. These gas exports are to compensate for the decreasing revenues from oil exports. Nonetheless, the Egyptian natural gas strategy emphasizes that securing domestic demand is a top priority and therefore the amount available for exports will be limited to one third of production (EGAS 2005). In the near future, the competition between domestic use of natural gas for power generation and the expansion of exports might become a severe problem

[36] Obviously, not all planned wind power plants are included in this scenario.

[37] Production sharing agreements (PSA) between state-owned and European private oil companies, such as Shell, BP and FINA.

for energy policy and the relevant institutions in Egypt. This could lead to a switch from natural gas back to heavy fuel oil (Mazut)[38] in the electricity sector, resulting in an increase of energy-related CO_2 emissions (EG[viii]).

5.4.4 Renewable Energy Policy

5.4.4.1 National Policy

The limitation of the fossil fuel resources has been a policy issue since the early 1980s. In 1982, a national strategy for the development of energy conservation measures and renewable energy applications was formulated as an element of national energy planning (NREA 2004; Kamel 2001). As a consequence, the New and Renewable Energy Authority (NREA) was founded in 1986 within the Ministry of Energy and Electricity to introduce renewable energy technologies and develop commercial applications with a high share of locally produced components. NREA is also responsible for the cooperation with national and international organizations, for capacity building, as well as for the implementation and technical management of the projects (NREA 2004, 2005a). The focus of NREA is mainly on wind energy, solar and partly biomass projects. The responsibility for hydropower is in the hands of the Hydro Power Projects Execution Authority.

Egypt's National Strategy Study on the CDM includes a national strategy on RE (EEAA 2003). The main strategic objectives of RE policy are to expand the lifetime of conventional energy resources, to diversify the energy supply mix and to limit the growth of greenhouse gas emissions. To achieve these objectives, the Ministry of Electricity and Energy has undertaken the following measures:

- Developing policies and programs
- Carrying out studies for the survey and evaluation of RET
- Continuing studies and research for the development of resources, keeping up with the latest international developments on technologies
- Modifying and adapting international standards to local conditions, issuing certificates for RET equipment and systems
- Using evaluation results of pilot projects and investigating the possibility of local manufacturing

[38] Mazut is heavy fuel oil with high sulfur content.

- Preparing an advanced new and renewable energy information system
- Evaluating possibilities for energy efficiency in all economic sectors

(EEAA 2003)

Regarding the share of RE in electricity generation, different target figures and projections have been proclaimed in the past. Some have been proven to be too optimistic, such as the target to reach 5% of primary energy supply in 2005 (World Bank 2005b) or the projection in the five years plans for the development of wind energy and for solar thermal electricity generation. Currently, NREA aims at realizing a 3% share of renewable energy sources (excluding hydropower) in electricity production by 2010 (NREA 2005a; REN21 2005). Within this aim, wind energy is projected to contribute 2.8% and solar thermal power 0.2%. At the Bonn conference "renewables 2004", Egypt announced the target to meet 14% of electricity demand from RE by 2020, equal to a production of 27,880 GWh/a.[39] This target includes large hydropower, which is expected to generate around 16,000 GWh, up from the current 12,644 GWh, about 57% of the total contribution from renewable energy sources targeted (IAP 2004).[40]

In line with this target, the government intends to establish an additional hydropower capacity of 135 MW until 2020 (IAP 2004), as outlined in section 5.3.1. Moreover, 2,600 MW of wind power are to be installed. In total, wind power capacity is expected to reach 2,750 MW with a generation of about 11,560 GWh/a by 2020 (IAP 2004). Figures given by NREA forecast to reach 3,500 MW by 2024, with an expected generation of 21,800 GWh/a (NREA 2006; EE[iii]). Another commitment which was submitted at the "Renewables 2004" is a feasibility study for the development of a new wind farm with the capacity of 4,000 MW envisaged at the Coast of the Red Sea and supported by the BMZ through the KfW (IAP 2004).

Since 1994, when the Bulk Renewable Energy Electricity Production Program (BREEPP) focussing on large-scale power generation was initiated, the development of solar thermal electricity generation (STEG) potential has been a major target of NREA. As a future target, 750 MW_{el} of STEG shall be installed by 2017, producing 7.0 TWh/a. The long-term vision is

[39] Expected results: 3,000 MW total installed Hydro Capacity (16,000 Gh/a); 2,750 MW total installed Wind Capacity (11,560 GWh/a), 750 MW total installed Solar Thermal Plant Capacity (the solar share out of which 150 MW, generating bout 320 GWh/a).

[40] According to these figures, the expected electricity demand for Egypt will double until 2020, reaching about 200 TWh/a.

to also export electricity to neighbouring countries and Europe via interconnected grids (NREA 2005a).

However, while the targets announced are ambitious, there are so far only few national programmes to support renewable energy projects. Most of the current projects therefore rely on funding from Official Development Assistance (ODA). As outlined at the March 2006 workshop in Cairo, the main support instrument currently is a fund established between the Ministry of Electricity and the Ministry of Petroleum. Through this fund, the revenue from the export of natural gas that did not need to be utilised in Egypt because of the power generated by wind farms is split equally between both ministries. The share that goes to Ministry of Electricity is used to support renewables.

5.4.4.2 International Cooperation

Next to national ambitions, the “Global Market Initiative for Concentrating Solar Power” (GMI) aims to support the creation of adequate market conditions for new CSP plants. The initiative is also part of the “renewables 2004” International Action Programme and has been established by governments of 8 countries (Algeria, Egypt, Germany, Israel, Italy, Jordan, Morocco and Spain). Its target is the installation of 5,000 MW_{el} of new CSP plants by 2015 globally, in particular in the participating Mediterranean countries.

In addition to these technology-specific targets, Egypt is also member of more general international co-operations programmes. One important initiative is the Mediterranean Renewable Energy Partnership (MEDREP) that was launched as a type-II partnership at the World Summit on Sustainable Development in Johannesburg (NREA 2004) and was also referred to in the IAP (IAP 2004). The expected result of the initiative is the development of a sustainable renewable energy market system in the Mediterranean Region through tailored financial instruments and mechanisms; strengthening of policy frameworks and removal of barriers; and strengthening of the private sector infrastructure, considering the positive role of Tradable Renewable Certificates and CERs (IAP 2004). Apart from this initiative, NREA is also part of the MEDENER Association that was created in 1997 and includes 12 energy agencies from both sides of the Mediterranean. It is working toward the development of a common approach to energy issues and the exchange of experience among its members (MEDENER 2006). The MEDNET initiative intended to establish a network between the

OPET network[41] and MEDENER to foster the further collaboration on renewable energy projects and policies between the EU members and the South basin Mediterranean countries. Considering that the last newsletter of MEDNET was published in spring 2004 and that only limited information on activities is given on the MEDNET online forum as well as on the MEDENER web page, it seems that the initiative as well as the network are not very active, though. Another cooperation between European countries and the MENA region is the Trans-Mediterranean Renewable Energy Cooperation TREC.[42] This cooperation was founded in the autumn of 2003 on the initiative of the Hamburg Climate Protection Foundation (HKF) and with support from the German Association for the Club of Rome. TREC is a network of experts aiming to support the role of concentrated solar power technologies in the MENA energy market (NREA 2004).

Next to the network activities in the Mediterranean region, three regional conferences have been held. The first Middle East and North Africa Renewable Energy Conference (MENAREC) was held in Yemen in 2004 in preparation for the Renewables 2004 conference in Bonn. The second one was hosted by Jordan one year later. In June 2006, the third MENAREC conferences took place in Cairo, Egypt, supported by the German environment ministry and UNEP. One of the outcomes was the “Cairo Declaration”, signed by the participants (ministers and representatives of 20 countries and 20 organizations) to encourage the Middle Eastern and North African countries to take necessary measure and develop plans to promote renewable energy technologies. Herein they stress the need for strategies and policies, financial assistance, capacity building and co-operation between the EU and Middle Eastern and North African countries for the broad implementation of renewable energy technologies in the Middle East and North African (Menarec 2006). In addition to the declaration, a “Memorandum of Understanding” was signed by the German and the Egyptian Government on co-operation regarding CDM project activities (BMU 2006). Also, an “Egyptian German Renewable Energies Foundation” was established and acknowledged in the declaration (Menarec 2006).

In addition to the support of technologies and networking with other countries and institutions, capacity building is another objective which is to be promoted in the coming

41 Organisation for the Promotion of Energy Technology, initiative of the European Commission.
42 TREC includes 18 EU members and 20 members from the MENA region.

years. Currently, the Egyptian government plans the establishment of a "Renewable Energy Center", which will be supported by the German government through the KfW (EE[iii]). Besides this centre, the Egyptian National Committee of the World Energy Council intends to establish a "World Energy Council's Centre of Excellence for Sustainable Energy" (CESE), which was also mentioned in the IAP of the Bonn conference.[43]

5.4.4.3 Conclusion

Egypt has announced ambitious targets for the future use of renewable energy sources and is optimistic to generate foreign exchange revenues by exporting electricity from renewable energy sources and from the trade of CERs generated by CDM projects (IAP 2004). This appears to be quite ambitious taking into account the continuing increase of electricity demand and the focus on natural gas power plants. Regarding the future forecast of MOEE for the amount of electricity generation and the implementation of new power plants (see Figure 5.3), renewable energy sources do not play an important role yet. Therefore, other experts foresee a declining market share of renewable energy sources (including hydropower) in electricity production below the level of 10% (Allal 2005). Other experts except that due to the predicted increase of fossil fuel prices in the next two decades, RE might gain more importance. Thus, according to Nokraschy (2005) a share of 55% in electricity generation might be achievable by 2050. However, compared to the projections of IEA (2005a), according to which only 6% of electricity will be generated by hydropower and RE in 2030, this projection may be somewhat too optimistic.

Although in the past there have been several studies on potential, pilot projects, international co-operations and other programs such as the Bulk Renewable Energy Electricity Production Program[44], renewable energy sources have not become a major source of energy yet. As long as fossil fuels are heavily subsidised, tariffs for electricity are low and there are no major policy instruments to support renewable energy technologies, they will continue to face difficulties in becoming competitive with the currently prevalent fossil fuel technologies (see chapter 5.6).

[43] http://www.worldenergy.org/wec-geis/wec_info/work_programme2007/regional/africa/africa.asp.

[44] In 1994 NREA initiated the Bulk Renewable Energy Electricity Production Program (BREEPP) that focussed on large-scale power generation, namely solar thermal energy generation and wind energy.

5.5 Climate Policy and Implementation of the Clean Development Mechanism

5.5.1 Emissions Profile

Between 1990 and 2000, Egypt's greenhouse gas (GHG) emissions increased by almost 40% from 127.3 to 177.5 Mt carbon dioxide equivalents (CO_2e).[45] This growth rate is four times higher compared to the trend of global greenhouse gas emissions in the same period and also above the average growth rate of non-Annex I countries. Due to the dependency of Egypt's energy sector on fossil fuels, CO_2 is the main greenhouse gas, contributing more than 70% to overall (CO_2 equivalent) GHG emissions. The emissions of methane (CH_4) sum up to almost one fifth, followed by nitrous oxide (N_2O) with 9%. These relative shares remained constant between 1990 and 2000. Compared to the group of non-Annex I countries, the contribution of CO_2 is above average while CH_4 as well as N_2O emissions are below non-Annex I average. A reason for this distribution is the relatively high share of emissions stemming from Egypt's energy sector (2000: ~7%) and a smaller contribution by agriculture (2000: 14%) compared to the non-Annex I average.

On a per capita basis, Egypt's GHG emissions increased by 17% from 2.4 to 2.8 t CO_2e between 1990 and 2000. Although this growth rate is well above the average rate of non-Annex I countries, Egypt's per capita GHG emissions in 2000 were still below the non-Annex I average and only half of the global per capita emissions level. Considering the high carbon intensity of the economy (2002: 566 t CO_2/Mill. Intl. $), which is above both, world and non-Annex I average, this is an indication for the low average per capita income in Egypt. The carbon intensity of electricity production is rather low which is mainly due to the dominance of natural gas in electricity production and the contribution of hydropower. Taking into account the high values for the carbon intensity of the whole economy this means, however, that the non-electricity sectors are even more carbon intensive, indicating a high potential for emission reductions through energy efficiency measures.

[45] As in most non-Annex I countries, the availability of greenhouse gas emissions data is limited. This chapter is based on data from the Climate Analysis Indicators Tool (CAIT) of the World Resources Insitute (WRI 2006). The table included in Annex 3 also lists emissions data as submitted by Egypt to the UNFCCC secretariat and CO_2 emissions data as reported by the International Energy Agency.

5.5.2 National Climate Policy

The establishment of institutions dealing with environmental issues in Egypt started already in the early 1980s. In 1982, the Egyptian Environmental Affairs Agency (EEAA) was established as the main governmental body designing and executing environmental policy. This was followed by the foundation of the New & Renewable Energy Authority (NREA) in 1986 as already mentioned, although NREA was not established for purely environmental reasons. However, it took another decade until the Egyptian government established a separate Ministry of State for Environmental Affairs (MSEA) in 1997, with the EEAA becoming the executive agency of the Ministry.

As a country that is highly vulnerable to the impacts of climate change, Egypt ratified the United Nations Framework Convention on Climate Change (UNFCCC) in December 1994. This was the starting point for Egypt's national climate policy.[46] Just a few months later in 1995, EEAA launched two major programs addressing climate change: the "Support for National Action Plan" (SNAP) and the project "Building Capacity for Egypt to Respond to the UNFCCC". These projects resulted in Egypt's first National Communication to the UNFCCC submitted in June 1999 (EEAA 1999), in the National Action Plan on Climate Change (August 1999) as well as in the establishment of a Climate Change Unit at EEAA (December 1999). Since then, this unit has served as the focal point for coordinating all climate change activities and complemented the institutional structure to address climate change that mainly consisted of the inter-ministerial National Climate Change Committee. This committee was formed in October 1997 and its membership covers a wide range of governmental and non-governmental stakeholders. It is chaired by the Chief Executive Officer of the EEAA.

The National Action Plan on Climate Change of 1999 contained a detailed list of measures on mitigation and adaptation activities, complemented by identified research needs as well as measures in the area "Public Awareness, Education & Training". As regards RET, it set a focus on wind energy, integrated solar thermal systems and, to a lesser extent, on PV technologies. It also highlighted the need for (further) research on the use of agriculture

46 Chapter 1.3 and 4 of the National Strategy Study on the CDM provide a good overview of Egypt's climate policy and its actors (EEAA 2003).

residues as an energy source, use of renewable energy technologies in the building sector, alternative transportation fuels and solar cars (ENC-WEC 2005).

Egypt's climate policy was up-dated in the National Action Plan on Climate Change for the years 2002-2007, based on the National Environmental Action Plan of Egypt for 2002-07. After Egypt's ratification of the Kyoto Protocol in January 2005, discussions started to renew the institutional setting of climate policy. There are currently proposals under review to up-grade EEAA's Climate Change Unit to a Climate Change Department and to expand the Climate Change Committee by including also experts from academia and industry (EE[ix]). The committee should also serve as the steering committee for the second National Communication to the UNFCCC which is currently under preparation.

Table 5.8: Milestones of Egyptian Climate Policy

Milestones of the Egyptian Climate Policy	Date
▪ Ratification of the UN Framework Convention on Climate Change	5th of December 1994
▪ First "National Communication"	June 1999
▪ Ratification of the Kyoto Protocol	12th of January 2005
▪ Establishment of the CDM-DNA	14th of March 2005

Source: http://unfccc.int; http://www.cdmegypt.org

5.5.3 CDM Implementation

Egypt's activities to prepare an institutional structure for CDM implementation date back to 2000 when Egypt, supported by the World Bank and the government of Switzerland, started to prepare its National Strategy Study (NSS) on the CDM. The study was finished in 2002 and outlined an action plan to accelerate the implementation of CDM activities (EEAA 2003). This was followed by the UNEP-led capacity building project "Capacity Development for CDM" that has worked at enhancing technical and institutional CDM capacities of Egypt since 2002 (see http://www.cd4cdm.org).

These projects prepared the basis for the establishment of Egypt's Designated National Authority (DNA) for CDM by ministerial decree in 2005. The DNA consists of two bodies (see Figure 5.11):

1. The **Egyptian Council for CDM** (EC-CDM) is headed by the Minister of State for Environmental Affairs and its current composition is as follows:

- 6 representatives from the Ministry of State for Environmental Affairs;
- 1 representative from each of the following ministries: Ministry of Foreign Affairs, Ministry of Electricity & Energy, Ministry of Transportation, Ministry of Industry & Foreign Trade, Ministry of Agricultural & Land Reclamation, Ministry of Petroleum, Ministry of Investment, Ministry of Finance;
- 1 NGO representative.

A steering committee emanating from the EC-CDM and consisting of five of its members is delegated some expedited and intermediate responsibilities related to the process of implementation under the supervision of the EC-CDM.

The EC-CDM meetings are held on a quarterly basis, but specific meetings can be convened upon request by the Steering Committee that meets more frequently depending on required action in the project evaluation and approval process.

2. The **Egyptian Bureau for CDM** (EB-CDM) acts as the permanent secretariat of the EC-CDM and is headed by the EEAA CEO. Its current composition is as follows:
   - 5 representatives from the Ministry of State for Environmental Affairs;
   - 1 representative each from the Ministry of Electricity & Energy and from the Ministry of Industry & Foreign Trade.

To ensure an effective performance of the Egyptian DNA, the responsibility for the internationally defined functions and additional tasks set at the national level are divided between the two DNA bodies (MSEA/EEAA 2004a).

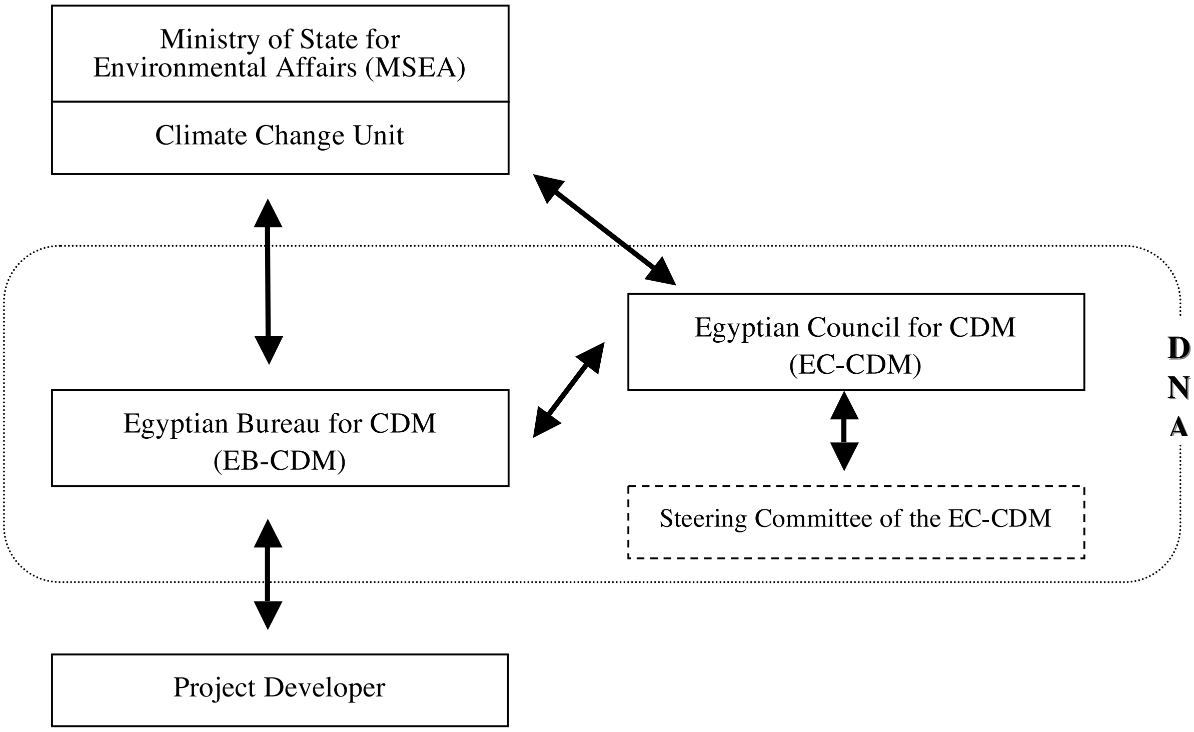


Figure 5.11: Institutional Setting of Egypt's Designated National Authority

The functions and tasks covered by the EC-CDM[47] include:

- Establishing project application guidelines to ensure that project proposals conform to (inter-)national programme objectives and standards
- Setting project evaluation criteria and procedures (e.g. criteria/requirements for additionality, monitoring & validating criteria and sustainable development)
- Establishing a project review and approval process
- Evaluating and approving projects
- Raising local awareness of the CDM
- Promoting Egyptian CDM project opportunities internationally and representing national interests at UNFCCC negotiations
- Overseeing monitoring, verification and reporting of approved CDM projects
- Annual reporting to Egyptian authorities

[47] Some of the duties of the EC-CDM are delegated to its steering committee.

As the executive secretariat of the EC-CDM and the "one stop desk" for CDM project developers, the EB-CDM is responsible for the following tasks:

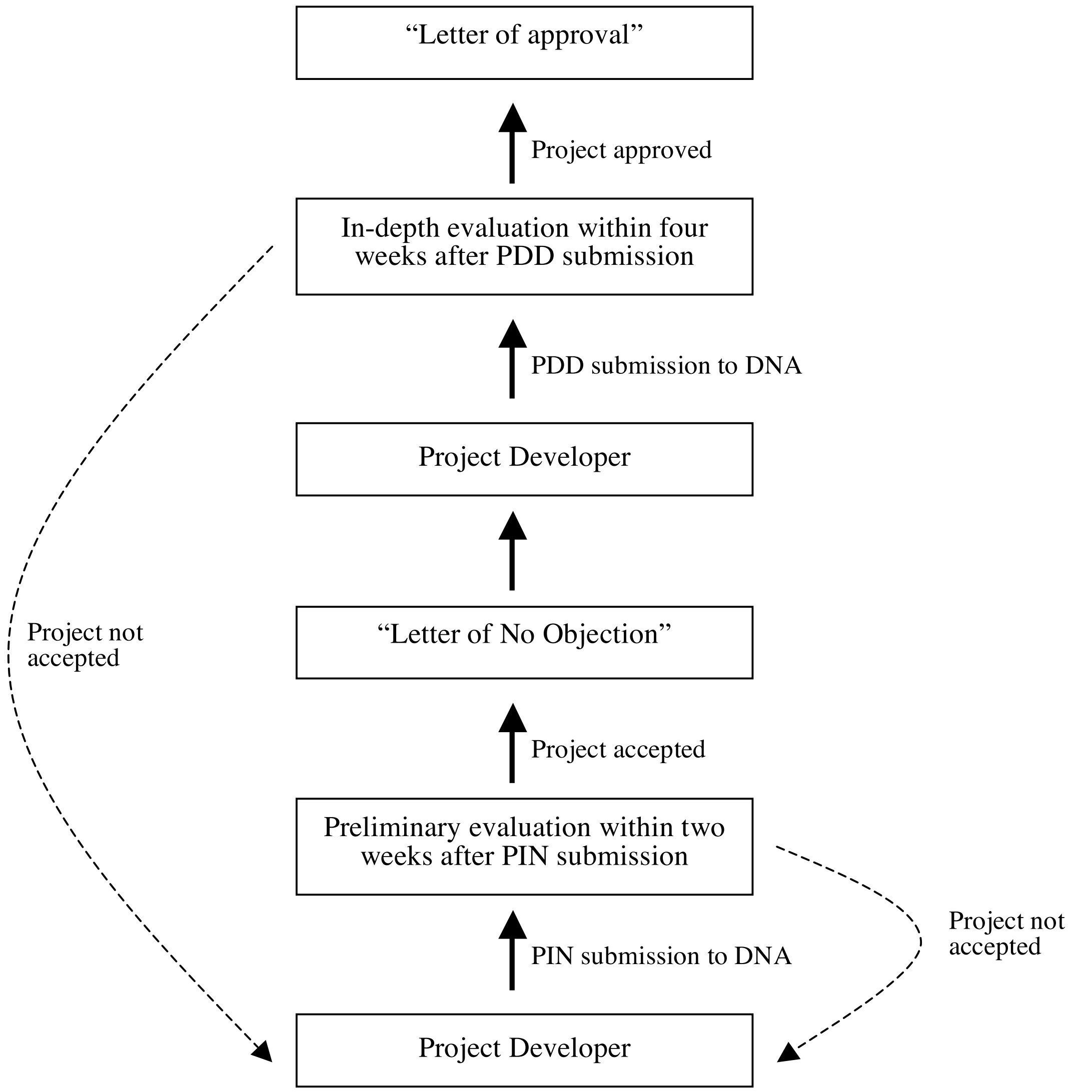
- Being the spokesperson, nationally and internationally, for the EC-CDM
- Pre-evaluating project proposals and transmitting them to the EC-CDM
- Communicating with the CDM Executive Board and up-dating the EC-CDM on the evolution of international rules and procedures
- Initiating/keeping contacts with potential CDM stakeholders
- Ensuring the monitoring of projects throughout their life cycles
- Organising meetings of the EC-CDM
- Preparing the annual report of the EC-CDM

This institutional setting was positively assessed in most interviews with Egyptian CDM stakeholders and builds the basis for the effective operation of the DNA during the project approval procedures as described below.

5.5.4 Project Evaluation and Approval Procedures

Egypt's DNA has established a two-step procedure to approve and evaluate project proposals (see Figure 9.12; MSEA/EEAA 2004a). Before preparing a detailed Project Design Document (PDD) as required by international regulations, the project proponent needs to submit a short Project Idea Note (PIN) to the EB-CDM which outlines key elements of the planned project. To minimise efforts for the project proponent and standardize the information submitted, the EB-CDM provides a template for the preparation of the PIN. The EB-CDM evaluates the PIN regarding conformity of the proposed project with international requirements and national sustainable development criteria. Based on the results of this pre-check it consults the EC-CDM which issues a "letter of no objection" within two weeks after PIN submission if the evaluation of the PIN is positive. The EC-CDM via the EB-CDM might ask for further information on the project if there are doubts regarding its conformity with CDM criteria. The aim of this preliminary evaluation is to give the project proponent a clear indication whether a project might be acceptable as a CDM project at an early stage of project preparation.

Figure 5.12: Project evaluation and approval procedure



If the preliminary evaluation of a project proposal is successfully completed, the project proponent needs to submit a detailed PDD based on the templates provided by the CDM Executive Board for an in-depth evaluation. Core part of this evaluation is the "sustainability assessment" that assesses the benefits of a project for Egypt's sustainable development according to a set of environmental, social and economic criteria (see Annex 4) (MSEA/EEAA 2004). As the preliminary evaluation of the first PINs revealed deficiencies as regards the sustainable development benefits of some projects, the EC-CDM is planning to oblige project proponent to compensate for these deficiencies by providing funds for two purposes. First, every project proponent has to pay a percentage of the CER revenues to the

Environmental Protection Fund.[48] The percentage level differs according to project types (see Table 5.9). Additionally, the DNA can oblige the project proponent to financially support environmental or social activities in the communities close to the project. The level of this funding is not standardised but decided on a project-by-project basis.

Table 5.9: "Sustainability" Share of CER Revenues to be Provided for the Environmental Protection Fund

Project Type	Share of CER revenues for EPF
Renewable energy	1% (small scale: 0.5%)
Energy efficiency, fuel switching	3% (small scale: 1.5%)
Landfill, afforestation, biofuels	6% (small scale: 3%)
N_2O, CFC	8%

Source: EE[ix]

The project proponent will receive a response from the EB-CDM within four weeks after submission of the PDD. Projects that have been evaluated with a positive result will receive a "letter of approval" confirming the voluntary participation of Egypt in the CDM activity and its contribution to sustainable development. This letter is the prerequisite for entering the international project cycle starting with the validation of the project activity by a Designated Operational Entity (DOE) and ending with the registration as a CDM project by the Executive Board of the CDM.

5.5.5 Project Portfolio

Egypt's current CDM project portfolio comprises 24 projects. Concerning the number of projects across different project types and categories, its composition is well balanced (see Table 5.10). Most projects are listed in the categories "renewable energy", "fuel switching" and "energy efficiency" with each including six projects. However, this balance changes if the expected annual CERs of projects are compared. The overall CER volume of the current project portfolio is about 4.7 Mt CO_2e per year which is slightly more than 40% of the potential that was identified in Egypt's National Strategy Study for 2010, based on the

48 The Environmental Protection Fund (EPF) was established in 1994. The EPF offers financial support (e.g. soft loans, grants, subsidies) to stimulate investment in the environmental sector.

assumption of a CER price of 8.5 US-$ (EEAA 2003).[49] More than 60% of these CERs are going to be generated in four N_2O emissions abatement projects (project category "industry"). One of these projects ("Abu Qir Fertilizer N_2O Abatement") is expected to reduce about 1,500,000 t CO_2e per year which is almost one third of the overall amount of CERs.

As of September 2006, two CDM projects are awaiting registration and two further projects are at the validation stage (Fenhann 2006).

Table 5.10: CDM Project-Portfolio in Egypt

Project Category	**Number of Projects**	**Annual CERs** (1000 t CO_2e)	**Remarks**
Renewable energy	6	825.2	1 small-scale project (see also Table 5.11) 1 at validation
Industry	4	2,900.0	All projects N_2O abatement 1 request for registration
Energy efficiency	6	101.4	4 small-scale projects
Fuel switching	6	446.9	4 small-scale projects 1 at validation
Waste management	1	400.0	Request for registration
Afforestation	1	100.0	
Total	24	4,773.5	9 small-scale projects

Source: EEAA 2005; http://www.cdmegypt.org, Fenhann (2006).

The share of RE projects in overall CERs generated annually is projected to be about 17%. They include wind and hydropower projects as well as a solar combined cycle power project (see Table 5.11). All of these projects are implemented by public entities with the financial support of foreign donor organisations.

[49] Assuming a CER price of US-$ 8.5 (2.1), the expected emission reduction potential is about 11 (9.5) Mio. t CO_2e by the year 2010 (EEAA 2003). This was calculated using a "bottom up" approach based on proposed projects. Thus, the actual CDM potential may be significantly higher.

Table 5.11: Renewable Energy CDM Projects in the Current Project Portfolio

Project Title / Project Type	**Annual CERs** (t CO_2e)	**Installed Capacity** (MW)	**Project Location** (City / State)	**Project Proponent**	**Cooperating Donor Organisation**
Zafarana **Wind** Power Plant	211,900	120	Zafarana / Suez	New & Renewable Energy Authority (NREA)	JBIC / Japan
Zafarana **Wind** Farm Project	155,313	85	Zafarana / Suez	NREA	Spain
Damietta Barrage Small **Hydro-**power Project	47,058	20	Al-Qanater Al-Khairvah / Qalyoubia	Hydro-Power Plants Executive Agency (HPPEA)	KfW / Germany
Naga Hamadi Barrage **Hydro-**power Project	183,138	64	Naga Hamadi / Qena	HPPEA	KfW / Germany
Assiut Barrage **Hydro**power Project	134,330	40	Assiut / Assiut	HPPEA	KfW / Germany
Kuraymat Integrated **Solar** Combined Cycle Power Project	93,408	30[a]	Kuraymat / Giza	NREA	GEF / JBIC

a: The capacity of the solar component is about 20 % of the total capacity installed (150 MW). The "solar" contribution to electricity generation, however, will be less than 10 % (NREA 2004).

Source: PINs as available at http://www.cdmegypt.org.

Four more wind farms with a total capacity of 540 MW are currently under preparation by NREA and should also become CDM projects. These projects will be implemented in cooperation with KfW, DANIDA and JBIC and will be located in Zafarana and El-Zeit Gulf, which is a new site to be developed. This focus on wind energy is in line with the results of the National Strategy Study (NSS). The NSS predicted a large potential for wind energy whereas other renewable energy projects such as solar-fossil combined cycle power stations were regarded as less qualified for implementation under the CDM and should rather be implemented under classical development assistance schemes (EEAA 2003). However, NREA aims at registering all future renewable energy projects as CDM projects. Besides, there are plans to get retroactive credits for the already established wind farms in Zafarana (140 MW).

5.5.6 Conclusion

Egypt is one of the most advanced CDM host countries in Africa. This is at least partly due to Egypt's participation in international programmes for the development of institutional and personal capacities for the CDM. The preparation of the National Strategy Study already informed and trained the involved decision makers and experts in CDM issues. Besides, the study provided not only a good analytical basis but also a concrete action plan to accelerate the implementation of CDM activities. Many elements of this action plan were taken up by Egypt's activities within UNEP's "CD4CDM" programme, thereby facilitating the establishment of the Egyptian DNA and the promotion of the CDM among stakeholders.

Whereas the CDM has encouraged some private actors' investment in areas like "fuel switching" and "N_2O abatement", all RE project activities of the current CDM portfolio are being implemented by public entities. This reflects the structure of Egypt's energy sector which is still almost completely public sector driven despite recent privatisation processes (see chapter 5.2). Besides, foreign donor organisations are involved in the project financing in all RE projects. Due to the low (and subsidised) energy prices in Egypt, this is still the main precondition for any RE project to proceed. CER revenues only play a minor role in the project financing. This already points to the main barrier for RET in Egypt, the subsidisation of conventional energy sources. This mix of project funding could also cause some difficulties in the CDM registration process as it may conflict with the CDM criterion of non-diversion of ODA.

5.6 Barriers to the Implementation of Renewable Energy Technologies in Egypt

The development and use of renewable energy sources in Egypt are facing several barriers that have to be addressed to widen production and usage and to achieve the targets set by the government. The barriers are grouped according to Painuly / Fenhann (2002; see chapter 2.2).

5.6.1 Financial and Economic Barriers

RET are characterized by specific high investment costs per amount of power produced and low (for biomass technologies) or zero (for wind, solar, water or geothermal power technologies) fuel costs. This leads to two main problems: First the willingness and/or the ability to finance "expensive" investments in RET is quite low and second the subsidised fuel and electricity prices in Egypt nullify the RET advantage of low operation costs.

Many interviewees stated that **high upfront capital costs**[50] of RET are affordable for neither public nor private investors [EG^{x}]. Large projects - e.g. the realisation of a solar thermal power plant - often fail to be implemented due to high initial investment costs [EG^{xi}]. As a consequence, the government only implements RE projects if soft loans are provided by foreign donor agencies, even if a project would be profitable over its lifetime. However, getting soft loans or other types of financial assistance from donor organisations is possible only for large entities that can manage the complicated application procedures. Besides, the risk of exchange fluctuations further complicates the financing of projects with need of special foreign equipment (e.g. revolving absorber for Desiccant Cooling Systems or heliostats for STPP) [EG^{x}].

As is typical for developing countries, upfront costs are one of the most important criteria for investment decisions. Often only specific investment costs in [€/kW] rather than specific electricity generation costs in [€/kWh] are compared to those of conventional power plants. Since the first benchmark generally is much lower for fossil fuel plants and the latter is diminished by the high Egyptian fossil fuel subsidies, RET often have no real chance for implementation from an economic and financial perspective [EG^{x}].

However, in particular for solar power plants even the simple comparison of the electricity generation costs sometimes is not suitable if the solar electricity costs are compared to (fossil fuel) baseload electricity costs: CSP plants as well as PV plants generate electricity especially at midday and in the summer, when electricity demand (e.g. for cooling applications) is very high. Peak load can be significantly more expensive than baseload electricity.[51] Electricity generation costs of CSP plants nowadays are in a range of 12 to 20 Ct/kWh and are expected

[50] There have been significant price decreases and technological progress for some technologies in recent years (e.g. wind turbines, PV cells) but in particular some of those RET with a huge potential in developing countries are still very expensive (e.g. solar cooling).

[51] In free spot markets (which does not exist in Egypt), peak load electricity can reach prices of more than 20 Ct/kWh.

to be considerably below 10 Ct/kWh in future.[52] But many potential investors or political decision-maker only set the base load price of e.g. 2 to 4 Ct/kWh as reference [EG[xii]].

The **low electricity tariffs** in Egypt are the main disincentive for getting any private investor to invest in RET. The planned tariff increase by 5% per year would slightly remove this barrier [EE[xiii]]. However, even if this plan was realised, it would take14 years to double the present prices for electricity and they still would be on a relatively low level then.

The subsidies granted to fossil fuels create an uneven “playing field”, the levelling of which is judged as an indispensable prerequisite for bringing RET into the market [TG[xiv]]. But decreasing these subsidies is politically very difficult since it might lead to social unrest (see the nation-wide protests against attempts to diminish subsidies for bread in Tunisia or Morocco) [EG[xv]]. In the absence of subsidy decreases, the main opportunity area for RET applications might be electricity exports since the difference between export revenues and local tariffs could improve the economic situation of RET.

Apart from the high initial investment costs and low tariffs there are further financial barriers: **Taxes and customs** for imported equipments make installations of RET even more expensive. Additionally, there is hardly any incentive set by the government for encouraging the use for example PV systems (EE[xiii]). Thus, PV can compete only in remote/small villages that are far from the grid, if at all. However, the **income** of people living in these peripheral regions is often far below the average income so that they cannot afford paying for the “hardware”. Moreover some RET face barriers due to their rather **decentralized and small-scale nature** which produces higher transaction costs. Thus implementation is only possible if grants are available to cover incremental hardware and / or transaction costs. This is the reason why PV is almost only used by the private sector in the telecommunication infrastructure and advertisements on highways (EE[xiii]).

Solar cooling could be a very useful application.[53] As one interviewee reported, an estimated 70% of the harvest of fruits and vegetables goes off due to gaps in the cooling chain from the producer to the consumer. However, destroying the major part of the crop is still cheaper than

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[52] E.g. the MED-CSP study 2005 by DLR reveals future costs for electricity from CSP of about 5 Ct/kWh in 2020 and 4 Ct/kWh in 2040 respectively (DLR 2005).

[53] One great advantage of solar cooling is the coincidence of solar supply and cooling demand.

establishing solar cooling systems [EG[x]]. Therefore it is important to overcome the financial start-up difficulties to realise the significant potential for economies of scale.

5.6.2 Institutional and Political Barriers

In industrialised countries as well as in developing countries many institutional barriers are based on the historical development of the energy sector: Decision-makers have grown up in a fossil fuel world and institutions are designed accordingly. While the New and Renewable Energy Authority (NREA) was established in 1986 already, the main responsibility for the development of the electricity sector still lies with the Egyptian Electricity Holding Company (EEHC) that does not pay much attention to RET. There is therefore still a **lack of a powerful institution** for RET promotion.

The strong **hierarchical structure** of public institutions also impedes the diffusion of new knowledge and ideas. The technical expert on a lower hierarchical level may have a good understanding of the benefits of the promotion of RET but has hardly any influence on the decision-making process whereas the person with decision-making competence may lack this expertise (EG[xii]). Ministers often take decisions without any consultation with the technical experts. This hierarchical structure also results in a rather passive behaviour of lower hierarchy personnel. Therefore, well-established personal contacts to upper level bureaucrats are required for investors of projects, which could be a serious barrier for small and medium enterprises [EG[x]][EG[xi]].

Another problem that can only be solved through political action is the **monopolistic** structure of the **energy "market"**. At the electricity market, EEHC is the central actor to whom all Independent Power Producers have to sell their electricity. As decentralized RET lose one important competitive advantage in countries with a high rate of grid-connected electrification such as Egypt, ensuring grid access for smaller projects is crucial to exploit decentralized potential.[54]

There are special barriers for biomass energy as result of the involvement of different ministries (Ministry of Environment, Ministry of Local Development and Ministry of

[54] See also (GTZ 2004: 14): "In particular, technological standards, codes or non-discriminating, free third-party access to heat or electrical grids can be significant for the development of renewables".

Agriculture) and **unclear responsibilities**. As a consequence, hardly any governmental institution takes care of the promotion of biomass. The most competent actor is the Agriculture Research Centre whose focus, however, is rather on research than on implementation. The Ministry of Electricity and Energy, on the other hand, is dominated by engineers who often do not see the added value of biomass compared to large fossil plants since project implementation takes longer and less electricity is generated. Another indication for the weak standing of biomass is that the respective unit in NREA has little influence compared to other units and makes hardly any progress [EG[xvi]].

5.6.3 Technical Barriers

Technological barriers very much depend on the RET considered. As there is hardly any RET production industry in Egypt, most RET need to be imported, creating some financial barriers (see Chapter 5.6.1). Efforts to introduce RETs in Egypt have frequently been set back by insufficient quality of the appliances. As outlined in section 5.3.3, in particular solar water heaters have gotten a bad reputation due to frequent malfunctioning, which is a major barrier to their further dissemination.

While these problems can be remedied relatively easily, in particular in the case of solar thermal power plants (STPP) with their vast potential in Egypt there are still major technological barriers to overcome before large-scale implementation can start.

The generally favourable conditions for CSP electricity generation in the Mediterranean region are well known, but to implement STTP there is a need for specific information on the solar radiation at different sites. As there are **no solar radiation world atlases** for the “Direct Normal Insolation” (DNI)[55] in high definition yet, the solar input needs to be evaluated for every single location, which further raises up-front investment costs.[56]

One important restriction for the utilization of **STPP** is the **need for cooling water**. Therefore, coastal locations or locations nearby rivers are at first most favourable. Once the potential of these locations has been exhausted, however, process designs with dry cooling

[55] The yearly amount of Direct Normal Insolation (DNI) is an important benchmark for the utilisation of CSP systems.

[56] An important programme to tackle these barriers is the Solar and Wind Energy Resource Assessment (SWERA) carried out by UNEP and GEF for a number of countries.

systems need to be developed so that also sites with less water supply can be used.[57] Up to now, dry cooling (especially in hot regions) is accompanied by efficiency losses which result in slightly higher electricity generation costs. This disadvantage could in the future be compensated by economies of scale.

Whereas STPP have already proven their reliability for more than 15 years (there is more than 350 MW_{el} installed capacity in California, for example), **solar thermal storage at large scale** – which is necessary for exclusive solar operation – is still at the **demonstration stage**. The first experience with commercial applications will be gained by the two 50 MW_{el} CSP projects AndaSol 1 and 2 in Andalusia/Spain that are to start electricity production in 2007/2008.

If STPP are implemented in the hybrid version (solar energy *and* fossil fuel), the steam turbine must be larger to accommodate to the additional solar-generated steam. If such a turbine is operated in pure fossil mode (e.g. at night), it operates in the unfavourable part-load operational range. U.S. American and German experts have quarrelled about the resulting amount of efficiency losses [EG[xvii]].

To transmit RE electricity from Egypt to European countries, a connection system with little losses will be essential. Therefore, in the long term the transfer of large quantities of solar or wind electricity will require a totally new **grid infrastructure** of High Voltage Direct Current (HVDC)[58] interconnections **between MENA states and Europe** [EG[xii]]. A new study (DLR 2006) suggests a step-by-step erection of two to twenty HVDC lines (of 5 GW each) between 2020 and 2050 which at the final stage would allow a electricity transfer of 700 TWh per year to the main demand centres in Europe. In this scenario, the study assumes electricity costs in 2050 to be 5 Ct/kWh, including 1 Ct/kWh for transportation (see Table 5.12).

Another interviewee commented that those special interconnections were not absolutely necessary; in his opinion a meshed feed into the European net would be sufficient [EG[xvii]].

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[57] Incidentally, the technical challenges concerning the re-cooling of solar cooling systems are similar.

[58] Such a HVDC interconnection already exists for example between Morocco and Spain. At present Spain delivers fossil-fuel based electricity to Morocco, but in the future Morocco could feed RE electricity into the European grid via this connection.

Table 5.12 Results from the TRANS-CSP Scenario 2020 till 2050 (5 GW lines)

Year		2020	2030	2040	2050
Transfer Capacity GW		2 x 5	8 x 5	14 x 5	20 x 5
Electricity Transfer TWh/y		60	230	470	700
Capacity Factor		0.60	0.67	0.75	0.80
Turnover Billion €/y		3.8	12.5	24	35
Land Area km x km	CSP	15 x 15	30 x 30	40 x 40	50 x 50
	HVDC	3100 x 0.1	3600 x 0.4	3600 x 0.7	3600 x 1.0
Investment Billion €	CSP	42	143	245	350
	HVDC	5	20	31	45
Elec. Cost €/kWh	CSP	0.050	0.045	0.040	0.040
	HVDC	0.014	0.010	0.010	0.010

Source: DLR (2006)

5.6.4 Awareness / Information / Capacity Barriers

Being a fossil fuel producing country, there is only limited **awareness** of the (ancillary) benefits the application of RET could yield for Egypt. Besides, the huge potential of some RET are still underestimated. This is even more true for newer technologies such as solar thermal electricity generation (STEG). Combining STEG with cooling applications and/or seawater desalination (in thermal, electrical or combined processes) and considering that peak load electricity has a higher value than base load (see chapter 5.6.1), solar power plants could in the mid-term deliver electricity and fresh water at competitive prices. Another indication for the lack of mainstreaming RET awareness in the governmental institutional setting are the activities of the Rural Electrification Authority that mainly focuses on conventional energy sources [EE[xiii]].

A further obstacle is the **lack of personnel** capacity: lack of skilled and trained personnel is not only problematic for technical maintenance, but for RE market development in general. Human capacity is needed for the implementation, maintenance and distribution of RET and also for financial arrangements on the local level.

Moreover, while there are several institutions in Egypt that are concerned with supporting RETs on the policy level, there is so far little infrastructure to directly support practitioners in the actual implementation of RETs on the ground. In particular, interviewees indicated that there is only little support for small-scale RET applications [EG[x]].

Table 5.13: Overview of the Barriers Identified and the Effects that Hinder RET Implementation in Egypt

Barrier group	Barrier	Effect/Impact
Financial & Economic	High specific upfront costs of RET versus low fuel prices and electricity tariffs (through high subsidies for fossil fuels and electricity)	No level playing field, low willingness and/or ability to finance "expensive" investments in RET
	Comparison of costs in [€/kW] instead of specific electricity generation costs in [€/kWh]	RET investments are not implemented even if a project would be profitable over its lifetime
	Taxes and customs on imported equipment	RET installations become even more expensive
	Insufficient purchasing power of potential users	Potential RET applications are not implemented
	High transaction costs due to small-scale and decentralised nature	Potential RET applications are not implemented
Institutional & Political	Institutions for RET promotion are relatively powerless	Government concentrates on fossil energy, RET potential not realised
	Strong hierarchical structure of public institutions	Impeding of the diffusion of new knowledge and ideas from bottom up (especially serious barrier for small and medium enterprises)
	Monopolistic structure of the energy market	No guaranteed grid access and feed-in tariffs for independent RE power producers
	Unclear ministerial responsibilities for RET especially in the biomass sector	Weak promotion of biomass in Egypt
Technical	Insufficient quality of appliances	RET get a bad reputation, impeding their further dissemination
	Need for cooling water for Solar Thermal Power Plants (STPP)	In the market launch phase potential locations are restricted to coastal (or river) areas; later dry cooling systems (with the disadvantage of efficiency losses) have to be developed
	Solar thermal storage at large scale – necessary for exclusive solar operation – is still at demonstration stage	Start up with hybrid fossil/solar power plants is economically sounder than monovalent solar operation
	Great efficiency losses for RE electricity transport over long distances (e.g. from MENA states to central Europe)	Establishment of a new international grid infrastructure of High Voltage Direct Current (HVDC) interconnections on the long run necessary for long-distance exports
Awareness / Information / Capacity	Lack of awareness of the potential and the multiple benefits of RET utilization among decision-makers on different political and administrative levels	Potential and positive side benefits of some RET are still underestimated
	Lack of qualified personnel	Problems in technical implementation, maintenance and financial arrangements hinder RET market development in general
	Inadequate, insufficient education of consumers/RE system users	Technological mistrust in case of system breakdown, monetary losses for consumers

5.7 The Potential of the CDM to Overcome Barriers to the Dissemination of Renewable Energy Technologies in Egypt

5.7.1 Financial and Economic Barriers

The huge **subsidies** for fossil energy and the associated **low energy tariffs** which negate the operating cost advantage of RET are one of the key barriers to the dissemination of RET in Egypt. Through the added revenue from the generation and sale of CERs, the CDM should be able to alleviate this barrier.

However, as discussed in chapter 3 of this report, RE projects do not get as much out of the CDM as other project types. Since emission reductions from RE projects are usually reductions of CO_2, rather than of the other, more potent, Kyoto gases, and RE applications are often small-scale, dispersed activities (e.g. solar water heaters), only relatively few CERs are gained. This situation is further exacerbated in the case of Egypt where electricity is predominantly generated from natural gas, which has a relatively low carbon intensity. In 2002, the carbon intensity of electricity production in Egypt was 443.2 g CO_2/kWh, as opposed to 916.2 g CO_2/kWh in China or 896.1 g CO_2/kWh in India (WRI 2006). RE electricity projects therefore generate even fewer CERs than would be the case in other countries.

As a result, CER revenues often have only little impact on the profitability of RE projects. In fact, in the cases of all the RE CDM projects that are currently in the pipeline these revenues will not be enough to close the financial gap to make the projects profitable. They therefore all depend on soft loans or other financial support from foreign donor organisations for their implementation [EE[xiii]], [EE[xviii]], [EE[xix]].

However, this need for additional funding might come into conflict with the CDM requirement not to divert Official Development Assistance. So far, all projects have received a “letter of non-diversion of ODA” that ensures that the donor organisation will not claim any compensation in form of CERs for its financial assistance. Besides, the implementing entities try to minimize the conflicting potential by agreeing on separate “Emissions Reduction Purchase Agreements” (EPRA) that are not linked to the ODA financing. However, although there are registered CDM projects with similar financing arrangements (e.g. Essaouira wind power project in Morocco[59]) it remains to be seen if this creates any obstacles during the validation and registration process.

The other key financial barrier are the **high specific upfront costs** of RET. Here the CDM may actually exacerbate the problem since the project cycle projects have to undergo entails high transaction costs going up to the six-digit range. Most of these occur at the front end of the project, that is, they add to the disadvantage of RET. On the other hand, the CDM could become a solution to the upfront cost problem if buyers were willing to frontload their payments. In this case RET project developers would receive the CER revenues when they most need them. However, as outlined in chapter 3.4, while there are some purchasing programmes were this is possible, in general buyers have so far mostly limited their role to simply purchasing CERs with payment to be made on delivery. Project developers have therefore been forced to finance their projects from other sources.

The CDM could also help to remedy the **insufficient purchasing power** of potential users. The CER revenues could be used to distribute RET applications at subsidised prices. There is one solar cooker project in Burkina Faso with plans in this direction (Schroeder, Sterk, Arens 2006). The CER revenues might also help to alleviate the **taxes and customs** on imported equipment by making the overall project more profitable, though this is evidently a rather indirect effect.

On the downside, the CDM **transaction costs** add to the already high transaction costs of small-scale decentralised RET applications.

5.7.2 Institutional and Political Barriers

Evidently, the CDM could at best have an indirect impact on institutions and policies in Egypt. The prospect of new foreign investments looking for fertile ground might induce policy-makers to streamline administrative process and put flanking policies into place. Being a mechanism established by international policy, the CDM might give project developers better access to decision-makers compared to traditional private investments, in particular if

[59] More information on this project is available at http://cdm.unfccc.int/Projects/DNV-CUK1114607705.27/view.html (accessed on 27.02.2006].

they have the official backing of the investor country. This might help to alleviate some of the problems associated with the hierarchical nature of Egyptian institutions.

At the moment, however, CDM projects in Egypt are confronted with similar barriers as RET projects in general, in particular those linked to the hierarchical structure of government agencies and ministries and to the imperfect energy market. It is noteworthy that all of the CDM RET projects currently in the pipeline are being implemented by state agencies, not one is from private investors.

There is also an additional barrier in that the CDM is not part of Egypt's national economic development plan. Government experts at the technical level therefore have no clear signal to promote CDM projects.

Some actors in Egypt also perceive the international CDM requirements as a serious barrier that delays the approval process. In their view, in particular the issue of "non-diversion of ODA" and the additionality criteria should be simplified. In the case of RET projects it was even suggested to consider them per se as additional.

5.7.3 Technical Barriers

Evidently, the impact of the CDM as a finance mechanism on technical problems is rather limited. Being optimistic, one might hope that the acceleration of RET dissemination the CDM might (hopefully) achieve will catalyse further technology development to overcome the problems identified.

5.7.4 Awareness / Information / Capacity Barriers

Equally, the CDM might make an indirect contribution to overcoming awareness and information barriers. By adding a price tag to GHG emissions and thus opening new business opportunities, the CDM might help to raise awareness of climate protection in general and of RET in particular.

At the moment, though, there is still only very limited awareness of the CDM in the business sector, despite various CDM capacity building activities (see section 5.5.3). Even those who know about the CDM do often not fully understand the procedural requirements at the national and international level (EE[xx], EG[xxi]). It would therefore seem that awareness of the

CDM first needs to rise significantly higher before it can help to raise awareness of RET and their potential benefits.

5.8 Conclusions and Options for Promoting RE CDM projects in Egypt

The dissemination of RET in Egypt faces a variety of financial and economic, institutional, political and technical barriers as well as obstacles in the areas of awareness, information and capacity. Being a finance mechanism, the CDM can at best make a limited indirect impact on most of these barriers. Even in its core area, the financial balance sheet of projects, subsidies for fossil fuels and the resulting low energy tariffs tilt the playing field so far against RET that the CDM is not enough to make the RET CDM projects that are currently in the pipeline economically viable. The CDM thus appears to be not enough to overcome these financial barriers and could therefore only play a major role for promoting RET in Egypt if energy subsidies causing price distortions in the market decreased.

However, there is no single “magic bullet” for removing all the barriers that currently impede the dissemination of RETs. Rather, a wide variety of measures will need to be taken.

5.8.1 Removing Key Economic and Financial Barriers

5.8.1.1 Reduction of Subsidies

Interviewees unanimously agreed that it is absolutely essential to decrease the subsidies for electricity, natural gas, and diesel fuel as a prerequisite for the dissemination of RETs. Another reason for redesigning subsidy policies is that prices for fossil fuels (and products from fossil fuels like electricity) will most probably keep rising globally as well as in Egypt due to their increasing scarcity and rising world energy demand. Keeping the subsidies at current levels would therefore result in an ever-increasing burden on public budgets.

The challenge is to cut back the subsidies in a manner that avoids social unrest. This could probably be achieved by implementing a continuous digression of subsidies over a certain period of time rather than making an abrupt cut.

Apart from cutting back subsidies, they should be allocated in such a way that more subsidies per kWh are provided to consumers with low energy consumption. On the one hand, this would guarantee that poor people still can afford energy, and on the other hand this would set incentives for using energy more efficiently. A part of the saved fossil subsidies could be taken to support the initial dissemination of RETs.

Besides, it will be necessary to communicate these changes to the population in a transparent manner and to highlight the long-term necessity and advantages.

5.8.1.2 RE Feed-In Tariffs

Setting fixed feed-in tariffs for RET has been one of the world's most successful energy policy instruments for their dissemination. For example, in Germany the "Renewable Energy Sources Act" (EEG) resulted in a doubling of the share of RE electricity between 1999 and 2005 (from 5,4% in 1999 to 10,2% in 2005). The most important components of the EEG are:

- Guaranteed access to the grid for independent RE producers
- Guaranteed tariffs for RE electricity fed into the grid over a certain period (e.g. for 20 years beginning with the commissioning of the RE plant), paid by the grid operator
- Technology-specific tariffs (e.g. 6 Ct/kWh for wind energy and 12 Ct/kWh for CSP)
- Decreasing support for new installations (e.g. an annual digression factor of 2% for wind energy and 5% for PV)
- Financing of the fed-in RE electricity by all electricity consumers (with charges differentiated according to the amount of electricity purchased).

To give an example, Table 5.14 provides the feed-in tariffs and digression factors of the German EEG. One has to take into account that due to the different national circumstances appropriate feed-in tariffs in Egypt would probably be much lower. In particular the initial feed-in tariffs for CSP electricity could probably lie substantially below the current tariffs for solar energy (which nowadays exclusively comes from PV in Germany).

Table 5.14 Exemplary Feed-in Tariffs and Digression Factors of the German EEG (basis 2005) for RE Electricity

	Feed-in tariff 2005 [Euro-Ct/kWh]	Yearly digression factor [%]
Hydropower	6.65 - 9.67	0 %
Biomass	8.27 - 17.33	1.5 %
Geothermal energy	7.16 - 15.00	1.0 %
Wind energy (onshore)	5.39 - 8.53	2.0 %
(offshore)	6.19 - 9.10	2.0 %
Solar energy	43.42 - 59.53	5.0 % - 6.5 %

This measure would tackle two of the key barriers that currently inhibit RET dissemination in Egypt, namely the low tariffs and the difficulties of private suppliers in getting access to the grid. One strength of this policy measure is that investors are provided with stable investment conditions so that the huge cost reduction potential of RETs can be realised. In Germany, for example, stable investment conditions have led to considerable success in decreasing the cost of electricity production from wind energy. As a result of the technical progress - mainly induced by two feed-in laws “StrEG” (from 1991) and “EEG” (from 2000) - the tariffs could be lowered in the past and will be lowered in the future as well (see Figure 5.13).

Feed-in tariffs for the promotion of RET in Egypt could be established in two different ways:

a) At the national level (in Egypt)
to promote the local implementation of RET in small and large-scale projects (wind, biomass, solar energy…)

b) At the European / German level
for imported RE electricity, e.g. from large solar thermal power plants in Egypt[60]

A combination of these measures could also be undertaken.

[60] The initial feed-in tariffs for CSP electricity could probably lie substantially below the current German tariffs for solar energy (which nowadays exclusively comes from PV) of about 50 Ct/kWh (see Table 5.14). For example, the Spanish feed-in law for solar thermal electricity, which guarantees prices of approximately 20 Ct/kWh could help as an initial benchmark for South European CSP application with a potential of a high yearly degression factor in the range of 5-10 %. CSP electricity production from North African countries (with higher insolation conditions) could be realised with accordingly lower tariffs at similar degression factors.

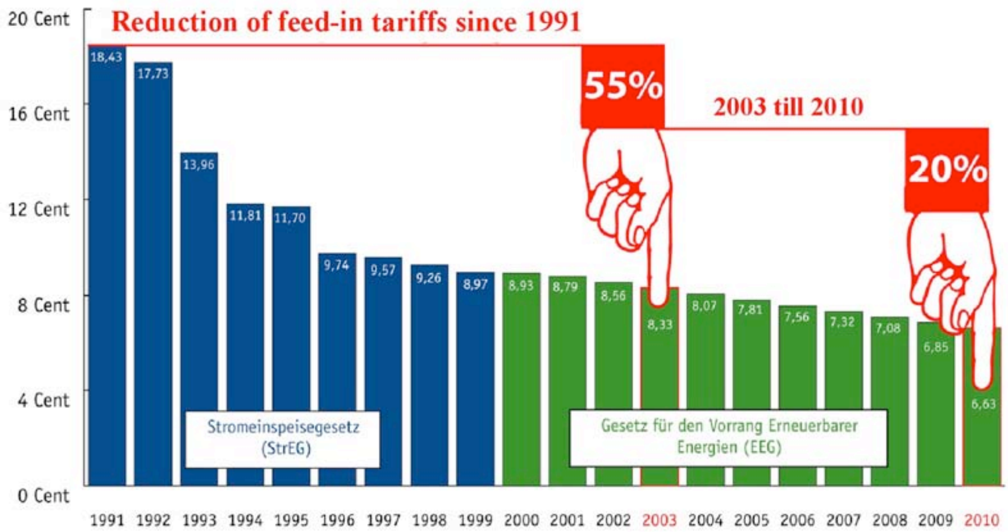

Figure 5.13 Reduction of German Feed-in Tariffs for Wind Energy due to Market Success and Technical Progress

Source: Bundesverband Windenergie (BWE) 2005

5.8.2 Other Measures to Address Economic and Financial Barriers

5.8.2.1 Lowering Taxes and Customs Duties

Apart from high investment costs, the viability of RET is also affected by taxes and customs duties on imported RET equipment. While such duties may be sensible in cases where equipment is produced by Egyptian manufacturers to shield them from outside competition, it might be beneficial to lower them for equipment that cannot be manufactured locally at present.

5.8.2.2 Dedicated Loan Facilities

Even if the profitability and competitiveness of RETs has been improved through instruments such as the removal of subsidies or the introduction of feed-in tariffs, there is still the problem of high investment costs. Kamel (2001) therefore suggests that dedicated loan facilities with low interest rates should be established in Egypt to provide (micro)financing for RETs on preferential conditions. These facilities should be open for commercial RET installations as well as for private end-users wishing to utilise small-scale RET applications such as solar water heaters.

5.8.2.3 Pursuing "Programmatic CDM"

RET projects are often dispersed small-scale applications, for example solar water heaters. However, the CDM offers the option of bundling small-scale activities into larger projects. The first Conference of the Parties Serving as Meeting of the Parties to the Kyoto Protocol (COP/MOP 1) in Montreal also opened the door to aggregate dispersed activities into "programmatic" projects, i.e. projects consisting of decentralised activities which are coordinated by one entity.

One example could be to establish a programme for the installation of solar water heating devices in a particular city district. One programmatic project that has already been registered is the Kuyasa housing project in South Africa. It consists of upgrading the energy efficiency of more than 2,000 households and is coordinated by the City of Cape Town and the organization SouthSouthNorth. As another example, dedicated loan facilities for RETs as described above could probably also be established under programmatic CDM projects, with the CER revenues being used to subsidise low interest rates.

One possible national programme that could be implemented as programmatic CDM is a programme to replace diesel fuel water pumps in the agriculture sector with PV pumps. Egypt has the second largest water pumps market in the world (after India). The current water pump of choice is the diesel fuel pump, mainly due to the generous diesel fuel subsidy offered by the government. Revenue from the CERs could be used to cover part or all of the incremental cost associated with the high initial cost of the PV water pump.

In principle, project developers can pursue this venue by themselves, but it might also be useful to have a body or organisation to specifically promote and assist (bundled) small-scale RET projects. Small-scale operators are frequently not able to cope with the requirements set by the CDM project cycle. The task of such an entity would therefore be to deal with the CDM requirements so that the operators would be free to focus on the implementation of the actual RET project activity on the ground. This task might be given to a new entity or it might be given to an already existing organisation. It might in particular be one of the tasks of an organisation for directly supporting RET practitioners as described further below.

Through their investments, Annex I countries can also make a contribution to promoting this new project type. It might be helpful if public entities from host and investor countries support pilot programmatic projects to analyse and overcome potential methodological problems of this new approach.

It might also be worthwhile to explore the boundaries of what may constitute a "programmatic" CDM project activity. The current situation is that COP/MOP 1 has decided that programmatic project activities are eligible under the CDM whereas policies and standards are not. However, there is so far no definition for these different types of projects and how they are distinct from each other, nor is there guidance how to implement programmatic projects from the CDM Executive Board. It might therefore be worthwhile to explore if, for example, local applications of the principles behind RET feed-in tariff or RPS, where an entity gives incentives to a clearly defined set of actors to implement RET projects, might qualify as programmatic CDM projects.

5.8.2.4 Designated Operational Entities

One of the main barriers to CDM implementation is high CDM specific transaction costs. One of the main cost drivers are the fees that need to be paid to the Designated Operational Entities (DOEs), which are so far almost exclusively from Annex I countries. One means to lower the transaction costs would therefore be to establish non-Annex I DOEs. Rates of Annex I DOEs are around US-$1,000 per day, whereas the rates of non-Annex I organisations would probably be around US-$ 200 per day (Gouvello / Coto 2003). There would therefore be significant scope for cost savings. Evidently, establishing a DOE faces significant barriers, but still entities from Colombia and South Korea have successfully completed the first steps of the accreditation process.[61] It might therefore be worthwhile to examine the potential for establishing DOEs in Egypt. The establishment of further non-Annex I DOEs might also be an area for assistance from Annex I governments. Such a DOE would be expected to operate at the regional, if not the global, level, given that the number of CDM projects in Egypt is not expected to be high enough for a local DOE to be sustainable.

[61] CDM: List of AEs issued with indicative letters: http://cdm.unfccc.int/DOE/ListIL (accessed on 26.07.2006).

5.8.2.5 Action from Annex I Countries

While Annex I Countries are usually called on to increase capacity building, it would also be very useful if the buyers of CERs based their buying decisions not only on the CER volumes and prices but also on the sustainable development impacts of the underlying projects. In the present context, this would in particular entail paying topped-up prices for CERs from RE projects and providing up-front financing for them. While there are some purchasing programmes where up-front financing may be provided under certain circumstances, only a few such as the World Bank's Community Development Carbon Fund give a clear preference as to the types of projects they prefer.

5.8.2.6 Standardisation of Plants

As many frontrunner RE projects have to be designed according to the special specifications of the clients, the developing costs for those projects are quite high. Some project developers have therefore started to standardise their products (e.g. offering solar thermal power plants with a fixed size of 50 MW_{el}) [EG[xii]].

5.8.2.7 Solar Cogeneration

By using the by-products of solar heat in CSP systems, the specific electricity generation costs can be reduced. Solar power generation can be combined with the use of waste heat e.g. for space heating, for the generation of hot water, process steam, cold (in absorber refrigerating machines) or for the desalination of seawater. Project developers could use this option by themselves, but political measures, for example incentives for CHP, would be beneficial. Furthermore, authorities like NREA could help commercial project developers to identify and to develop potential projects and locations respectively.

5.8.3 Measures to Address Political and Institutional Barriers

5.8.3.1 Integrating the CDM into the National Economic Development Plan

Apart from improving the regulatory framework for RET in general, the regulatory framework for the CDM in particular could be improved by integrating the Mechanism into the national economic development plan. This could serve to mainstream awareness of the CDM and its potential at all levels of government and give government staff a clear signal to promote CDM projects.

5.8.3.2 „Small is beautiful“

To lower bureaucratic obstacles, it can be useful to start projects in small sizes, where lower budgets are required and fewer stakeholders have to be involved. Once the project has been implemented successfully, it can be used as a showcase for potential future investors with the option of upscaling. This is especially applicable to RET applications which have not yet been sufficiently proven to be viable. By contrast, applications like the grid-connected wind farms in the Zafarana region will always be large scale.

5.8.4 Measures to Address Technical Barriers

5.8.4.1 Establishment and Enforcement of Manufacturing Standards

Efforts to introduce RET in Egypt have frequently been set back by insufficient quality of the appliances. In particular solar water heaters have gotten a bad reputation due to frequent malfunctioning, which is a major barrier to their further dissemination. There is therefore a need for establishing suitable manufacturing standards and specifications and strictly enforcing them.

In addition, policy instruments and incentives could be introduced to encourage local manufacturers of RET to export some of their production to regional RET markets, especially in North Africa and the Eastern Mediterranean. By targeting the export market, local manufacturers would have an incentive to improve the quality of their production and would seek to obtain international RET certificates. As a result, the local market of RETs would also benefit from the improved quality of products.

5.8.5 Measures to Address Awareness / Information / Capacity Barriers

5.8.5.1 Practical Support for RET Users

RET are in most cases complex and difficult to apply for project developers as well as for end-users. While there are several institutions in Egypt that are concerned with supporting RET on the policy level, there is so far little infrastructure to directly support practitioners in the actual implementation of RET on the ground. In particular, interviewees indicated that there is only little support for small-scale RET applications.

It might therefore be sensible to complement quantifiable “hard” policy measures such as feed-in tariffs or a RPS with the “soft” measure of charging institutions with giving free and independent advice on the practical implementation of RET and energy efficiency measures.

This task could either be undertaken by an already existing institution or a new institution could be established, whichever may be more appropriate. The examples of the German „dena“, the „EA-NRW“ or the “Centres for Consumer Advice” may give an indication of the tasks this body could perform.

The “**German Energy Agency - dena**” (www.dena.de) works at the national level. It serves to link the legislature with the stakeholders that are relevant for the utilisation and dissemination of RETs and energy efficiency technologies (EETs). For example, the agency undertook a study on the possibility of a large-scale integration of wind energy into the German electricity grid. Other activities include an awareness-raising campaign promoting energy efficiency applications to the end consumer and the development of an Energy Performance Certificate system for buildings. Under this system, the energy demand of a building is determined and proposals for saving energy are developed.

The “**Energy Agency North Rhine-Westphalia - EA NRW**” (www.ea-nrw.de) operates at the federal state level. Its main objective is the practical support for potential RET and EET user in the *industrial and commercial sector* by giving free, competent and independent initial advice. Apart from direct personal advice, the agency also offers an internet platform with extensive information on technologies, applications, best practice examples and possibilities for receiving state aid.

Last but not least, the decentralised “**Centres for Consumer Advice**” (organised at the federal state level and represented in every major city) offer free, competent and independent initial advice for *end consumers in the residential sector*.

All three institutions are funded through national / federal state support and third party project financing.

5.8.5.2 RET Promotion and Awareness Raising

Generally, awareness of RET and their potential benefits is still very low in Egypt, among both government officials and the general public. Low awareness and lack of knowledge about how to operate RET are a major barrier to their dissemination and have in the past contributed to high failure rates of RET applications. The development of effective public awareness and promotion campaigns making use of all media but focussing especially on the TV and newspapers can therefore be expected to yield a substantial dividend. Such campaigns should provide information on the concept, the benefits and the operating requirements of RET. This could be one of the tasks of a body as described above.

It is also important to create a calibre of engineering graduates who understand RET. This would require the introduction of graduate degrees and diplomas focusing on RET at Egyptian higher education institutions. Having local engineers experience in RET would contribute to reducing the transaction cost associated with RET project identification and design.

5.8.5.3 CDM Promotion

As for promoting the CDM in particular, it might be advantageous to have a distinct body responsible for this task. Currently, this is one of the tasks of the DNA, but a situation where the same body is responsible for both promoting and authorising CDM projects might give rise to conflicts of interest. An organisation that has heavily invested in getting a project off the ground might not be as stringent when assessing whether it meets the criteria as would otherwise be the case. These tasks might therefore be divided among separate organisations so that each one could fully focus on their respective tasks.

5.8.6 Other options

5.8.6.1 Giving Preference to RET CDM Projects

A further option could be for Egypt to give a clear preference for RET projects within the CDM. One option for doing this might be a staggered tax on the CERs generated as has been spearheaded by China, where projects are charged with a rate that escalates in proportion to the degree to which they are felt to be desirable, from 2% for projects with priority such as renewable energy and energy efficiency projects up to 65% for HFC and PFC projects.[62] As outlined in section 5.5.4, Egypt plans to introduce a similar tax, though with a much lower rate for HFC and other projects and with a rate of 1% for RET projects. Given the relatively low benefit of CER revenues for the viability of RET projects, it might make sense not to charge them at all.

5.8.6.2 Using the CDM Gold Standard

Project developers, the Egyptian DNA as well as buyer countries might make use of the CDM Gold Standard. The Egyptian governments might use the CDM Gold Standard as a basis for which projects to authorise while Annex I governments could use it to select which projects to buy CERs from and pay topped-up prices. This would serve to alleviate the competition from low-cost high-yield projects as well as the problems related to the high specific investment and power generation costs of RE projects.

5.8.6.3 Careful Selection of Target Groups

A careful selection of target groups can also help minimising bureaucratic, financial and economic problems in project development. For example, the tourism sector often offers good prospects: In many cases tourism managers are open to RET applications in order to cultivate a "green" image, the decision structures are flat and the economic basis is sound. Concerning technical aspects, when using solar cogeneration a further advantage is that, due to the activity fluctuations in the tourism sector, the fluctuations in solar radiation supply coincide with the fluctuations in cooling, hot water and drinking water demand at the seasonal as well as at the daily scale.

[62] Clean Develoment Mechanism in China: http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=905 (accessed on 26.06.2006).

5.8.7 Overview of Options for Overcoming Barriers to RE CDM Projects

Table 9.16 summarises the measures and the barriers that would be addressed, sorted by which actors would need to take these measures or would be otherwise involved. As discussed, framework conditions for RE projects in Egypt are still severely lacking and the CDM is not a panacea for overcoming all of them. Policy-makers will therefore need to make significant efforts to remove barriers to the dissemination of renewable energy, only then will the CDM be able to make a significant impact. Priority measures are to reform energy markets by reducing subsidies for fossil fuels, giving independent power producers access to the grid and raising prices to a level where renewable energies become viable. It would also be highly desirable to establish and enforce quality standards for RE equipment, to establish dedicated loan facilities and give practical support to those who implement RET, and to substantially raise awareness of renewable energies and build technical capacity. The Egyptian and Annex I governments could also give a clear preference to renewable energy CDM projects. Annex I governments could significantly help to overcome the barriers of high specific upfront investment costs by paying topped-up prices and providing upfront financing for RE CDM projects.

Table 5.15: Overview of Options for Overcoming Barriers to RE CDM Projects

Actor(s) Responsible / Involved	Measure	Barrier(s) Addressed
Government of Egypt, science, utilities	Reduce subsidies for fossil fuels and electricity tariffs	- Lack of level playing field and willingness to finance "expensive" investments in RET
Government of Egypt, science, utilities	RE feed-in tariffs	- High specific upfront investment costs for RET - Lack of guaranteed access to grid for independent producers
Government of Egypt, banks, business associations	Dedicated loan facilities	- High specific upfront investment costs - Insufficient purchasing power of potential users
Government of Egypt	Integrate CDM into national economic development plan	- Lack of clear signal to government officials to support CDM
Government of Egypt, science, manufacturers, industry associations	Lower taxes and customs duties	- Taxes and customs duties on RET equipment
Government of Egypt, manufacturers, industry associations, science	Establish and enforce manufacturing standards	- Insufficient quality of appliances
Government of Egypt, media, celebrities, educational bodies, project developers, Annex I governments	RET and CDM Promotion	- Lack of awareness and capacity
Government of Egypt, regional or municipal governments, consumer associations	Practical support for RET users	- Lack of technical capacity and knowledge
Government of Egypt, Annex I governments	Capacity building	- Lack of knowledge and technical capacity
Government of Egypt, Egyptian auditing companies, Annex I governments	Establish local DOEs	- High transaction costs
Government of Egypt, regional or municipal governments, project developers, Annex I governments	Pursue "programmatic CDM"	- High specific upfront investment costs - Lack of incentive system for certain technologies
Government of Egypt, Annex I governments	Preference to RET CDM Projects	- Competition from low-cost high-yield projects
Government of Egypt, Annex I governments	Using CDM Gold Standard	- High specific investment costs - Competition from low-cost high-yield projects
Annex I governments	Topped-up prices and upfront financing for RET CDM projects	- High specific upfront investment costs - Competition from low-cost high-yield projects
Project developers	Standardisation of plants	- High specific upfront investment costs
Project developers	Solar Cogeneration	- High specific electricity generation costs
Project developers	"Small is beautiful"	- Lower bureaucratic obstacles
Project developers	Careful selection of target groups	- Minimising bureaucratic, financial and economic problems

6. Country Study Thailand

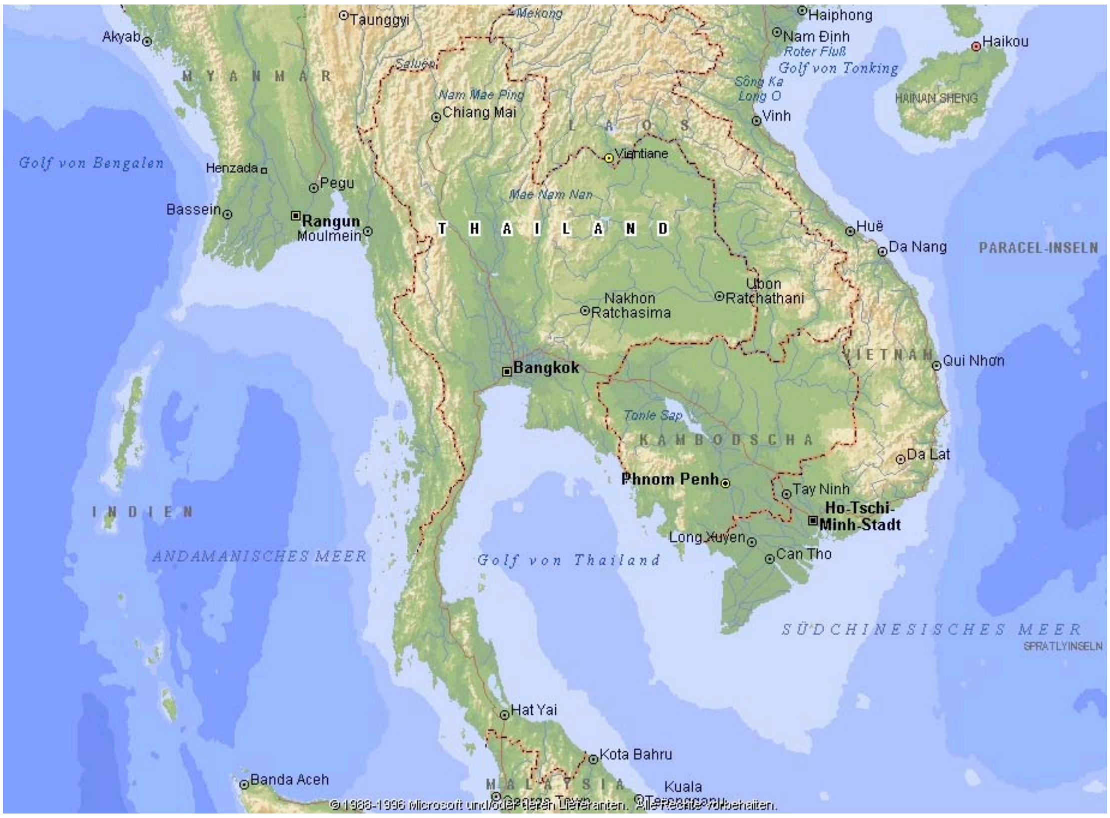

Figure 6.1: Physical Map of Thailand

Source: Microsoft Encarta (1996).

6.1 Political and Socioeconomic Framework Conditions

Table 6.1: Thailand – Key Data and Indicators

Population (in mio., 2003)	62
Average annual population growth (in %, 1990-2003)	0.8
Country area (in thousand km^2)	513
Population density (in pers./km^{2,} 2003)	121
Share of rural population (in %, 2003)	80
Literacy rate of people older than 15 years (in %, 2002)	92.6
Share of population below national poverty line (in %, 1992)	13.1
Share of population with less than US-$ 2 per day (in %, 2000) (international definition of poverty line)	32.5
GDP in PPP (in bill. US-$, 2002)	431.9
GDP in PPP per capita (in US-$, 2002)	7,010
Average annual growth in GDP (in %, 1990-2003)	3.7
GINI-Index (2000)	43.2
Human Development Index (2002)	0.768; Rank 76; medium human development
Foreign Direct Investment (in mio. US-$, 2003) (1990)	1,949 (2,444)
Share of Foreign Direct Investment of GDP (in %, 2003)	1.7
Official Development Assistance (ODA) received (in Mio. US-$, 2002)	295.5
Official Development Assistance received as share of GDP (in %, 2002) (in %, 1990)	0.2 (0.9)

Source: World Bank 2005a; UNDP 2004.

Thailand is a constitutional monarchy characterised by relative political stability. The governing party rules with a two-thirds majority in parliament. However, during the first half of 2006, Thailand went through a serious political crisis. Due to allegations of corruption within the government, demonstrations with tens of thousands of participants demanded the resignation of Prime Minister Thaksin. The crisis finally culminated in a non-violent coup d´état led by the military which forced the prime minister to resign in the middle of September 2006.

The Thai economy has recovered from the devastating Asian crisis of 1997/98, with an economic growth of 6.1% in 2004 and 4.5% in 2005. In 2003/2004, the national budget featured a surplus, which helped to reduce the state’s foreign debts (Auswärtiges Amt 2006). The International Country Risk Guide gave Thailand a score of 8.5 out of 12 points maximum (World Bank 2004). Similar to Egypt, Thailand has also been classified as “anchor country” of German development cooperation, which attributes Thailand an outstanding position in its regional context, primarily due to its economic power.[63] However, there is a mixed perception by the neighbouring countries. On the one hand they recognize the power and relatively advanced state of development of Thailand, on the other hand the policies under Thaksin have become more nationalistic and focussed on Thailand's perceived national interest, which is viewed very critically by the surrounding countries (Interviewee H[xxii]). Also in the field of environmental sustainability (MDG 7), Stamm (2004) considers Thailand to be a country of special importance.

Economic Relationship between Thailand and Germany: Germany is Thailand's most important trading partner within the European Union. More than 400 German companies are represented in Thailand, many of them medium-scale enterprises. The development cooperation between Thailand and Germany has a history of more than 40 years and has had a total volume of € 1 billion in ODA. One of the core issues of the present development cooperation is to foster the eco-efficiency of small and medium-scale enterprises. However, due to Thailand's relatively advanced development status, the development cooperation is currently being phased out and will increasingly be substituted by economic cooperation.

6.2 Structure of Energy Supply in Thailand

Table 6.2: Energy Figures

Energy figures	
Primary energy consumption (in Mtoe, 2002) (1990)	83,339 (43,860)
Primary energy consumption per capita (2002) (1990)	1,353 (789)
Electricity consumption per capita (in kWh, 2003)	1,696
Electrification rate in % of villages (households) (2000)	98.5 (83.9)

Sources: World Bank 2005; UNDP 2004; DEDE 2004a.

In 2002, primary energy consumption amounted to about 83,339 Mtoe, an increase of more than 30% compared to 1997 and more than 90% compared to 1990 (BP 2005; IEA 2005b). Total energy supply has increased significantly since the 1980s, alongside the country's

[63] The concept of anchor countries was introduced by the Germand Development Institute (DIE) in 2004. "Anchor countries" are those countries which are seen as having an outstanding importance in their regional context (see Stamm 2004; BMZ 2004). Other "anchor countries" in East Asia and the Pacific region are China and Indonesia.

economic development. Overall energy demand has risen more than sixfold between 1971 and 2003, per-capita consumption almost fourfold (see Figure 6.2). Meanwhile, the energy intensity of the Thai economy (energy supply per unit of GDP) has not changed significantly.

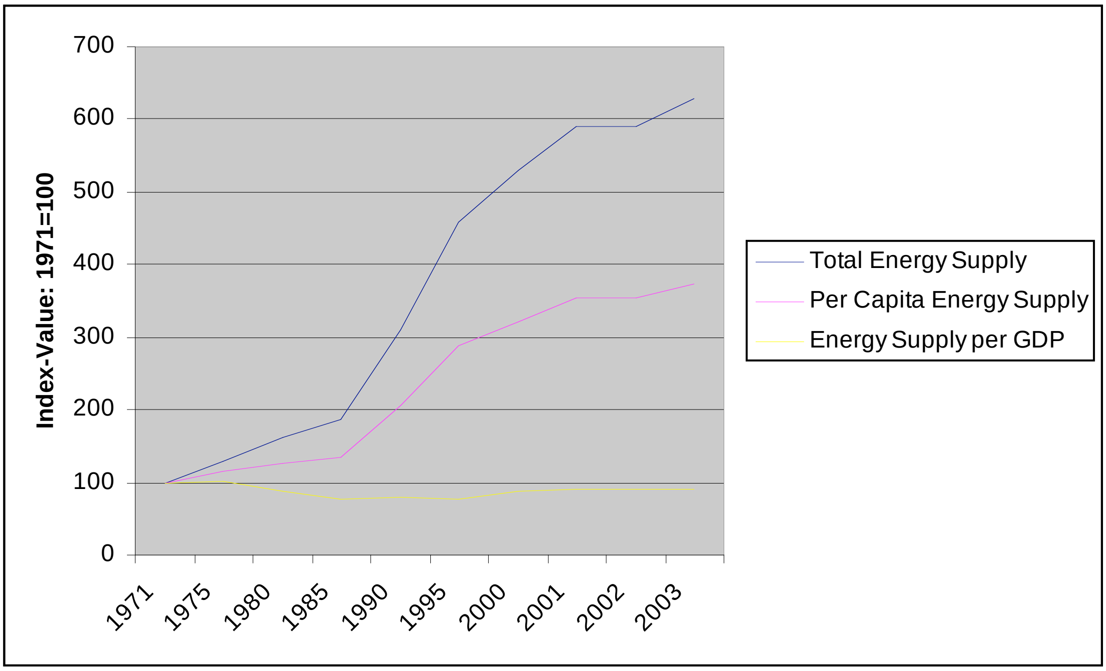

Figure 6.2: Energy Supply: Relative Trends, Thailand 1971-2003

Source: Based on figures from IEA 2005b

6.2.1 General Overview of Thailand's Energy Market

Although Thailand has its own oil and gas resources, it is highly dependent on the import of fossil fuels. Only 35% of current oil consumption is covered by domestic production, while Thailand's natural gas production covers about 75% of its consumption (DENA 2005). Reducing energy import dependence is the major driver for national policies to diversify energy supply. Apart from oil and gas, coal and lignite also play a major role, with some domestic lignite reserves in the north of Thailand and on the Malakka peninsula (DENA 2005).

For the years to come, the Thai government expects annual energy consumption growth rates of 7%. Although the overall energy intensity is comparable to Asian and European averages (WRI 2006a), the oil intensity (oil consumption per unit GDP) is relatively high, which makes

Thailand vulnerable to rising world oil prices. According to Menke (2005), Thailand is the world champion in oil intensity: the country uses five times as much oil as Germany per unit of GDP, and still 50% more than countries like Mexico or Taiwan. The large share of natural gas in electricity production increases this vulnerability due to the coupling of the natural gas price with the oil price.

Although primary energy use is dominated by the use of the fossil fuels oil, gas and coal, the dependence is less than in electricity generation due to the higher share of biomass (see Table 6.3).

Table 6.3: Primary Energy Use and Electricity Generation by Sources in 2002

Resource	Oil	Gas	Biomass	Coal	Hydro power	Total
Share of total primary energy use	45.6%	26.3%	16.5%	10.8%	0.8%	83,339 ktoe
Share of total electricity generation	2.5%	72.3%	1.9%	16.5%	7.1%	109,013 GWh

Source: IEA 2004b.

The sectoral distribution of final energy consumption is shown in Figure 6.3. More than two thirds are consumed by industry and the commercial sector. Total demand increased by 27.7% from 2000 to 2004, in 2004 alone it increased by 8.5% compared to 2003. Consumption in the industrial sector in 2004 was more than 10% higher than in 2003 and thus the most important driver of Thailand's final energy consumption (DEDE 2006a).

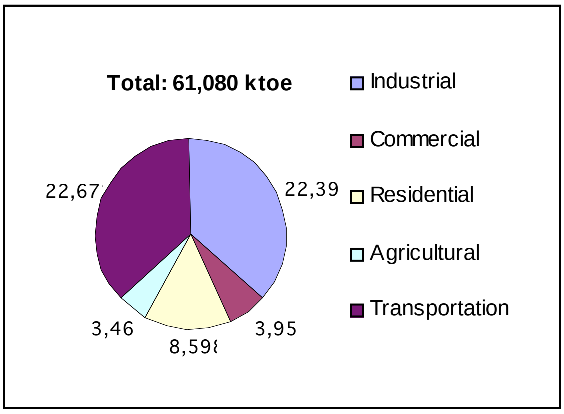

Figure 6.3: Final Energy Consumption by Sector in ktoe in 2004

Source: DEDE 2006a

6.2.2 Electricity Generation and Consumption

Thailand's electricity generation has increased rapidly in recent years and is expected to grow further to 185,430 GWh in 2010, which would be twice the figure of the late 1990s, accompanied by a rising share of electricity imports from Laos and Malaysia (from 2.9% in 2004 to approx. 9.8%) (Cogen 3 2004; DEDE 2006b).

Most of the conventional and large hydropower plants are under the control of the state-owned Electricity Generation Authority (EGAT) (see also section 6.4.1) and there has been only little change in generation in the last five years. Only the generation of electricity from sources under the Small Power Producers (SPP) programme, which comprises most of the non-EGAT plants generating power from renewable energies (see also section 6.4.4.2), and the generation from other Independent Power Producers (IPP) have constantly grown during the last five years, and have thus have been primarily responsible for covering the growing electricity demand (see Figure 6.4). The overall installed capacity was estimated to be about 24,805 MW in 2003 (DEDE 2004a).

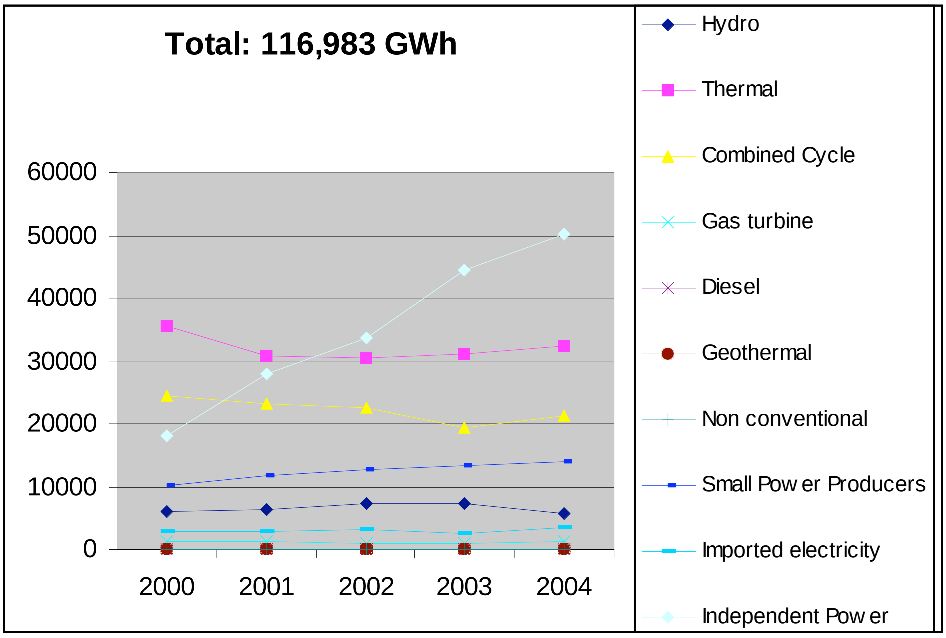

Figure 6.4: Electricity Generation by Type of System in GWh

Source: based on data from the EGAT Energy Policy and Planning Office, in DENA 2005

The sectoral distribution of electricity consumption as shown in Figure 6.5 reveals the important role of the industrial sector which accounts for about 44.0% of overall electricity consumption, followed by the commercial sector (32.4%) and the residential sector (23.2 %). While in the industrial sector electricity consumption grew by a moderate 3.7%, the growth rates of the commercial and residential sectors were 9.7% and 14.2% respectively (DEDE 2006b).

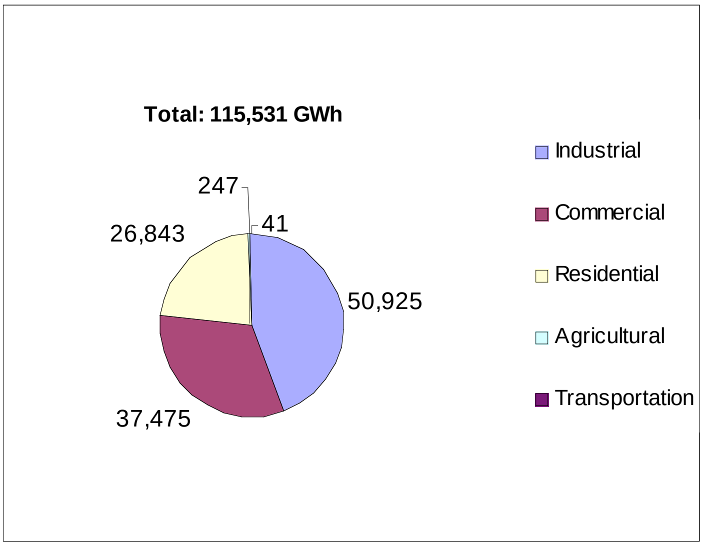

Figure 6.5: Electricity Consumption by Sector in 2004 (GWh)

Source: DEDE 2006a

6.3 Renewable Energies in Thailand

Thailand has significant experience with using renewable energy sources. Particularly in rural areas “traditional” forms of using biomass and solar power prevail until today. Wood is burnt directly for cooking, fruits and seafood are dried in the sun, while in the North tobacco leaves as well as some agricultural products are dehydrated using heat from hot springs. In Bangkok, solar water heaters are increasingly being installed on rooftops. The use of “modern” renewable energy technologies (or “New and Renewable Energy” (NRE) according to official Thai government definitions) still is limited, however, although different policy instruments have been introduced by the government for more than ten years (see section 6.4).

Thailand's Definition of Renewable Energy (according to DEDE 2004b)

RENEWABLE ENERGY means alternative energy from non-depleted resources which can be renewable such as liquid biofuels, biogas, solid biomass energy, geothermal energy, hydro energy, solar energy, tidal energy, wave energy and wind energy.

NEW AND RENEWABLE ENERGY (NRE) means renewable energy which excludes thermal energy from solid biomass energy in the residential sector and energy from hydropower plants with an installed capacity above 10 MW.

6.3.1 Current Use and Potential of Renewable Energy Sources in Thailand

The current share of new renewable energies in Thailand is small, still less than 0.5% of final energy consumption (DEDE 2004b), although there has been some significant increase in the use of some sources during the last years, as shown in Figure 6.5.

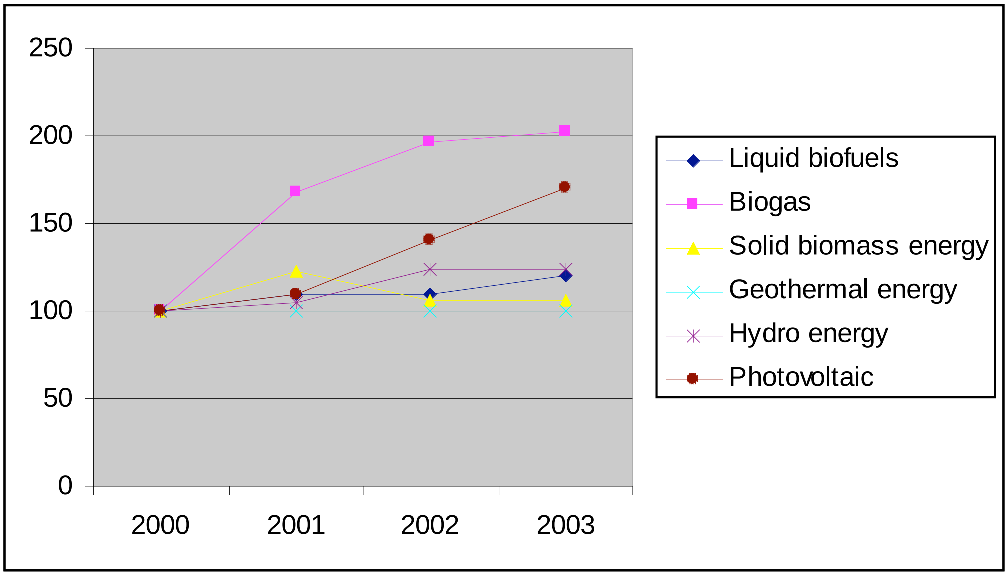

Figure 6.6: Renewable Energy Use in Thailand 2000-2003: Base Year 2000

Source: own calculations, based on DEDE (2004b): the values are indexed to the year 2000 figure (2000=100)

6.3.2 Power Generation from Hydro Energy

In 2004, the grid-connected installed hydro energy capacity (including large hydro) was estimated to be nearly 3,475 MW, generating approximately 6,040 GWh or 4.8% of Thailand's electricity consumption (DEDE 2006b). Electricity generation in 2004 was 17.2% lower than in 2003 even though according to figures from the Department of Alternative Energy and Energy Efficiency the installed capacity had significantly increased compared to the years 2000-2003, namely by about 500 MW to 3,476 MW (DEDE 2006b). The reason is probably the drought that affected the country from autumn 2004 until early 2005. A BBC News report in March 2005 explicitly mentioned the negative impacts on hydropower generation (BBC 2005).

Until 2002, about 130 MW of the installed capacity were plants with an individual installed capacity in the range of 200 to 6,000 kW (Greenpeace 2002; PRESSEA 2000), generating an estimated 180,000 MWh (DEDE 2004b).[64] This would account for 3.8% of RE electricity generation. More than 90% of this amount is generated in the Northern and Northeastern region of the country (DEDE 2004b). However, most of the small hydro power plants were installed in areas remote from the electricity grid. Since some of them were dismantled after the areas they serviced had been connected to the grid, the exact number of plants actually in use is unclear (DENA 2005).

The estimates of the available hydro energy potential (including large hydro) vary depending on the calculation method. EPPO refers to 15,155 MW in Thailand (EPPO 2003a), while DEDE refers to about 25,500 MW, which includes options in international rivers such as the Mekong and about 1000 MW for small hydropower (DEDE 2004a). Given the projected increasing importance of these imports, it makes sense to include these figures to some extent. In this context, DENA mentions plans to build a 1070 MW hydropower plant in Laos, which from 2009 would export about 90% of its electricity production to Thailand (DENA 2005). However, according to DEDE, the remaining potential in small hydro energy is about 25% of the currently installed hydro capacity, meaning another 690 MW (DEDE 2004b).

[64] For 2004, no new data on the installed micro hydro capacity were available at the time of preparing this report (September 2006).

Hydro energy is estimated to grow only moderately within the coming years, namely by another 350 MW installed capacity by 2011. But since all this new capacity is to be composed of small hydro, this would result in a large number of new plants (DEDE 2004b). The "Alternative Energy Scenario", conducted by Greenpeace Southeast Asia in 2002, claimed that targets of a total of 3,180 MW by 2010 and 3,876 MW by 2020 could be realized. However, according to latest figures from DEDE, the capacity in 2004 already amounted to more than 3,400 MW.

6.3.3 Power Generation from Wind Energy

Currently, wind is mainly used to power water pumps in remote areas. Only 1 MW is installed for electricity production, and about 0.2 MW is connected to the grid (Greacen 2005b). There is not even one wind power plant producing electricity under one of the most important support schemes for renewables introduced by the Thai government, the Small Power Producers (SPP) programme (see section 6.4.4.2).

In fact, natural conditions allow only limited use of wind energy for electricity production. The southern coasts at the Gulf of Thailand and the Andaman Sea (Indian Ocean) have the highest wind potential (Forsyth 1999, see also Figure 6.7). Greacen mentions potential of 1,600 MW installed capacity (Greacen 2005a). This is also the figure the government seems to relate to (Du Pont 2005). DEDE indicates a potential of only 12.3 ktoe/year, based on a map that gives almost not data for most of Thailand (DEDE 2004b). Although no official conversion of this figure into generating capacity exists, inferring from the figures presented for the other sources yields a capacity of less than 1 MW.[65] This low figure has to be viewed very critically and is in contradiction to the other, much higher estimates. One of the most recent and probably most sophisticated assessments of the wind energy potential in Thailand is the "Wind Energy Resource Atlas Southeast Asia" prepared by the World Bank. It found that "good" wind conditions exist at elevations of 65 meters in an area of about 750 square kilometres (0.2 % of the total area), with an annual average of 7-8 m/s.

[65] E.g. present biogas-related energy consumption is 44.3 ktoe according to DEDE (2004b), with only a couple of MW installed capacity.

Figure 6.7: Map of Wind Energy Resources in Thailand[66]

Source: World Bank 2001

[66] The map shows the results of measurements in the months from June to August at 65m heigth, the time period with the highest wind power detected.

Table 6.4: Wind Energy Potential of Thailand at 65 m[67]

Characteristic	**Poor (< 6 m/s)**	**Fair (6-7 m/s)**	**Good (7-8 m/s)**	**Very Good (8-9 m/s)**	**Excellent (< 9m/s)**
Land Area (Sq. km)	477,157	37,337	748	13	0
% of Total Land Area	92.6	7.2	0.2	0.0	0.0
MW Potential	NA	149348	2992	52	0

Source: World Bank 2001

The relevant areas are mainly the mountain chains of western Thailand and the Malay Peninsula, where there are strong winds from time to time, mainly from December to February and from June to August. The figures presented result in a technical potential of about 3,044 MW installed capacity, when summarising good and very good levels. However, the authors underline that these figures "should not be construed as a realistic estimate of how much wind energy could be developed in the future, but rather as an extreme upper bound on the wind energy resource in each country. The much smaller *developable potential* depends on many factors, such as electricity demand, availability of transmission lines, road access, the economic and industrial infrastructure of the country, and a variety of topographical and siting constraints." (World Bank 2001: 18). The authors conclude that in Thailand there possibly are opportunities for large-scale wind energy development because of its well-developed energy infrastructure and moderate resource potential. It has to be noted that no figures at all are given nor conclusions drawn regarding offshore wind energy potential, which even in Europe is a relatively new and untested technology. Further assessments to explore these potential could be helpful.

The government plans to exploit the existing resources far more intensively than so far. Until 2011, at least 100 MW are to be installed (DEDE 2004b). However, this is still a small share of the potential. According to the aforementioned Greenpeace scenario, 117 MW until 2010 and 722 MW until 2020 would be feasible.

[67] "For large wind turbines only. Potential MW assumes an average wind turbine density of 4 MW per square kilometer and no exclusions for parks, urban, or inaccessible areas. Wind speeds are for 65 m height in the predominant land cover with no obstructions." (World Bank 2001)

6.3.4 Power Generation from Solar Energy

According to DEDE, the average daily solar radiation is about 18.5 MJ/m^2/day (DEDE 2004b). For the whole country, DEDE estimates 554,071 ktoe per year, distributed over the country as shown in Figure 6.8. There are some seasonal variations. While most parts of the country receive maximum solar radiation intensity between April and May (20-24 MJ/m^2/day), the northern region and some parts of central Thailand receive in average 20 MJ/m^2/day throughout the year (DENA 2005).

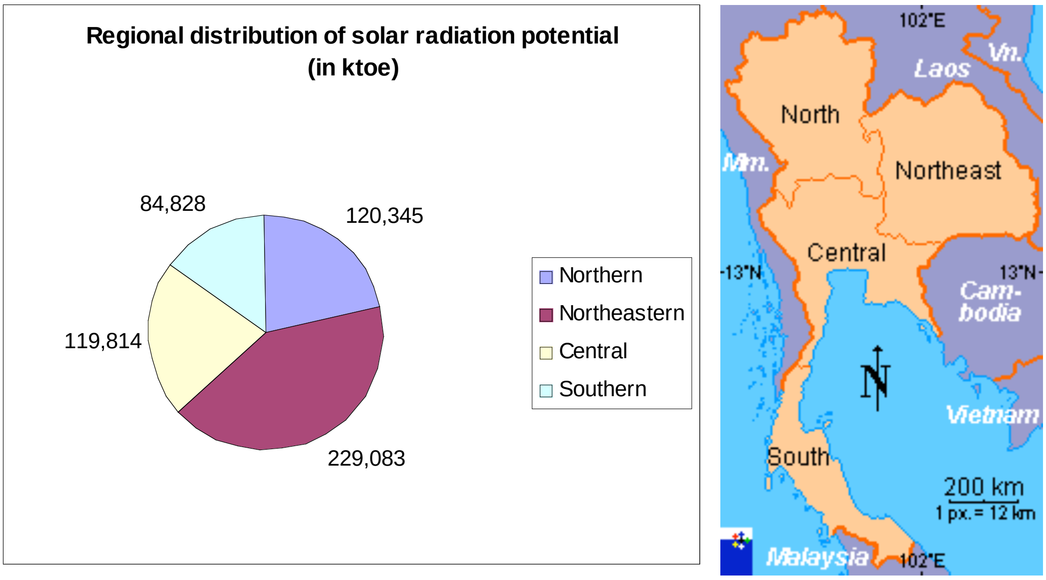

Figure 6.8: Regional Distribution of Solar Radiation Potential (in ktoe)

Source: DEDE 2004b.

About 6 MWp photovoltaic capacity had been installed by March 2005 (Sutiratana 2005), about a third of that to run water pumps. According to estimates of DEDE, 5,918 MWh electricity was produced in 2003, which accounts for only 0.1% of total renewable energy electricity generation (DEDE 2004b). About 60% of this production was generated in the northern region and another 21% in the central region. Government bodies, in particular DEDE, have installed most of the systems. Table 6.5 gives an overview of systems installed by different institutions. Greacen estimates the amount of grid-connected PV capacity to be 1 MW (Greacen 2005b).

Table 6.5: PV Capacity Installed by Different Institutions

Institution	Capacity (kWp)
DEDE	1,702
Dep. Of Public Works and Town&Country Planning	1,635
Telecommunication Authority of Thailand (TAT)	1,003
EGAT	572
Provincial Electricity Authority, PEA	148
Ministry of Defence, MOD	360
Universities, research institutions etc.	322
Total	**5742**

Source ICRA 2004, in DENA 2005.

A critical analysis of past PV programmes suggests that the mere installation figures may have to be judged very carefully since they do not consider the problem of systems that have been installed but are out of operation due to a lack of maintenance and other factors. Green estimates that in 2002 only two thirds of the systems that had been installed so far were still in operation (Green 2004). Against this background, the fact that the latest government programme has been started without concepts or financing for a maintenance programme needs to be viewed very critically. The sustainability of these government initiatives thus seems to be very doubtful (Greacen 2005c; Hirshman/Ruppik 2006).

The cost of electricity generated by PV ranges from 10 to 19 Baht/kWh (Energy for Environment 2004), which is 4 to 8 times higher than the average electricity costs of about 2.5 Baht/kWh, making PV very uncompetitive. Thus, at present it is more economically feasible to supply the truly remote and mountainous areas with PV rather than to foster on-grid installations. This is the target of the abovementioned programme, for example in Mae Hongson Province in Northern Thailand.

The government has announced the objective to increase the installed capacity by 250 MW until 2011 (DEDE 2004b). According to the “Alternative Energy Scenario” of Greenpeace Southeast Asia, 196 MWp would be possible by 2010 and 2,442 MWp by 2020 (Greenpeace 2002).

Although at the moment there is not yet a decision on the future RE support system for the electricity sector, increased regulatory support for the PV market is expected.

In 2003, Thai Photovoltaics Ltd. started the production of solar cells, while BP Thai Solar and Solartron produce PV modules. Solartron recently announced that it started construction of a new PV cell factory in January 2006, planning to start commercial production in early 2007 (Hirshman/Ruppik 2006). Local manufacturers also produce smaller parts of the equipment, like batteries and accumulators (DENA 2005).

6.3.5 Power Generation from Biomass

Biomass is currently the most important domestic energy source. After the Asian economic crisis in 1997/98 there has been a significant increase (25%) in biomass use for energetic purposes. In 2002, about 22% of the primary energy demand was covered from biomass. While the share of wood energy has decreased from 80% in 1998 to 62% in 2002, Bagasse has increasingly won importance and is now the second largest bioenergy resource, ahead of charcoal (Suwannakhanthi 2004; see Table 6.6), and dominates the projects under the Small Power Producers (SPP) programme. In 2005, the installed electricity capacity amounted to about 1017 MW, of which about 450 MW supplied electricity to the grid (EPPO 2005). This share and the related amount of electricity generated are strongly dominated by solid biomass, which accounts for 4,508,828 MWh or 95.7% of all electricity generated from renewable energy sources (as of 2003). Biogas plants produced only 12,444 MWh, approximately 0.2% of renewable energies' share in electricity production (DEDE 2004b). More than 50% of biomass electricity is generated in the central region, in and around the capital Bangkok, another 25% in the northeastern region (DEDE 2004b).

Table 6.6: Biomass Consumption in Thailand from 1998 to 2002 (final energy) in ktoe

Source	1998	1999	2000	2001	2002
Fuel Wood	3,188	3,279	3,258	3,265	3,342
Charcoal	3,188	2,218	2,277	2,286	2,307
Paddy Husks	778	733	828	903	896
Bagasse	1,665	2,092	2,236	1,989	2,498
Total	**7,885**	**8,322**	**8,599**	**8,443**	**9,043**

Source: Suwannakanthi (2004)

According to Suwannakhanthi (2004), biomass energy is mainly consumed in two economic sectors in Thailand. About 55.8% of total biomass consumption, which was 9.04 Mtoe in 2002, was used in the residential and the commercial sector, while the rest was used in the manufacturing sector. Regarding types of biomass energy use, charcoal and fuel wood are mainly used for cooking, process heating and the cottage industry in the residential and commercial sectors. Bagasse, paddy husks and fuel wood are used mostly for process heating in the manufacturing sector (Suwannakhanthi 2004). Still, the major share of biomass used for energetic purposes is consumed in "traditional" ways using rather inefficient technologies (DENA 2005). Within the manufacturing sector, there are different sub-sectors which make use of biomass for their energetic needs: food, non-metallic, chemical and the wood/furniture sector. Especially sugar, rice and palm oil mills, pasta producing and tobacco drying factories rely on bioenergy. Bioenergy plays a major role within the government's targets for RE expansion.

6.3.6 Power Generation from Solid Biomass

As the agricultural sector still plays a very important role in the Thai economy, the importance of bioenergy is not surprising. Thailand is among the biggest rice and sugar cane producers. Their residues bear a huge energetic potential, as shown in Table 6.7.

Table 6.7: Energetic Potential of Solid Biomass (Based on Production in 2001)

Source	Production (in 10^6 kg)	Residues	Mass of Residues (in 10^6 kg)	Energy Content (ktoe)
Sugar cane	49,070	Bagasse	2,965	1007.43
		Max.	14,612	6011.92
Rice	25,608	Rice husk	2,904	980.37
		Straw	7,830	1896.94
Palm oil	4,089	Total	12,711	3313.22
Coconut	1,396	Total	697	268.49
Manioc	17,330	Total	621	270.50
Maize	4,397	Total	804	343.28
Peanut	135	Total	44	13.06
Cotton	26	Total	116	39.89
Soy bean	324	Total	656	301.61
Millet	148	Total	120	54.63
Total	**102,553**		**17,643**	**14,501.00**

Source: Cogen 2004, in DENA 2005.

However, there are diverging views on the exact potential in terms of MW installed capacity. Black and Veatch published the following calculations of the technical potential:

Table 6.8: Estimated Technical Electricity Generation Potential from Solid Biomass

Biomass resource	Potential (MW)
Bagasse	2,500
Wood residues	950
Rice husk	500
Biogas	385
Maize	54
Distillery Slop	49
Coconut	43
Palm oil residues	43
Total	**4,524**

Source: Black and Veatch 2000, in DENA 2005.

The Black & Veatch study estimated the commercially viable potential for power production to be between 779 to 1,043 MW installed capacity, about one fourth of the technical potential, but this differs from the DANCED study of 1998, which estimated a much higher potential of about 2,985 MW, assuming that efficient boilers and cogeneration technology are fully adopted across all industries (DANCED 1998). If other on-farm residues were also harvested and used in power production, this potential could be increased to 9,440 MW. According to the Bangkok Post, dated March 6, 2005, the Research and Development Programme on Public Health Policy and Health Impact Assessment of the Health System Research Institute, Thailand, the potential was estimated to be around 7,000 MW—perhaps an acceptable range between the two cited figures (Jesdapipat 2006).

Though these figures are noticeable, the additional power that could be produced from biomass pales in comparison to the present demand of 24,000 MW. Moreover, this total demand has been projected to increase by 1,580 MW annually. Another estimation of the potential is presented by Greacen, which sums to about 2,000 MW from the major residues (Greacen 2005a). Figure 6.9 depicts the regional distribution of the residues of the major crops.

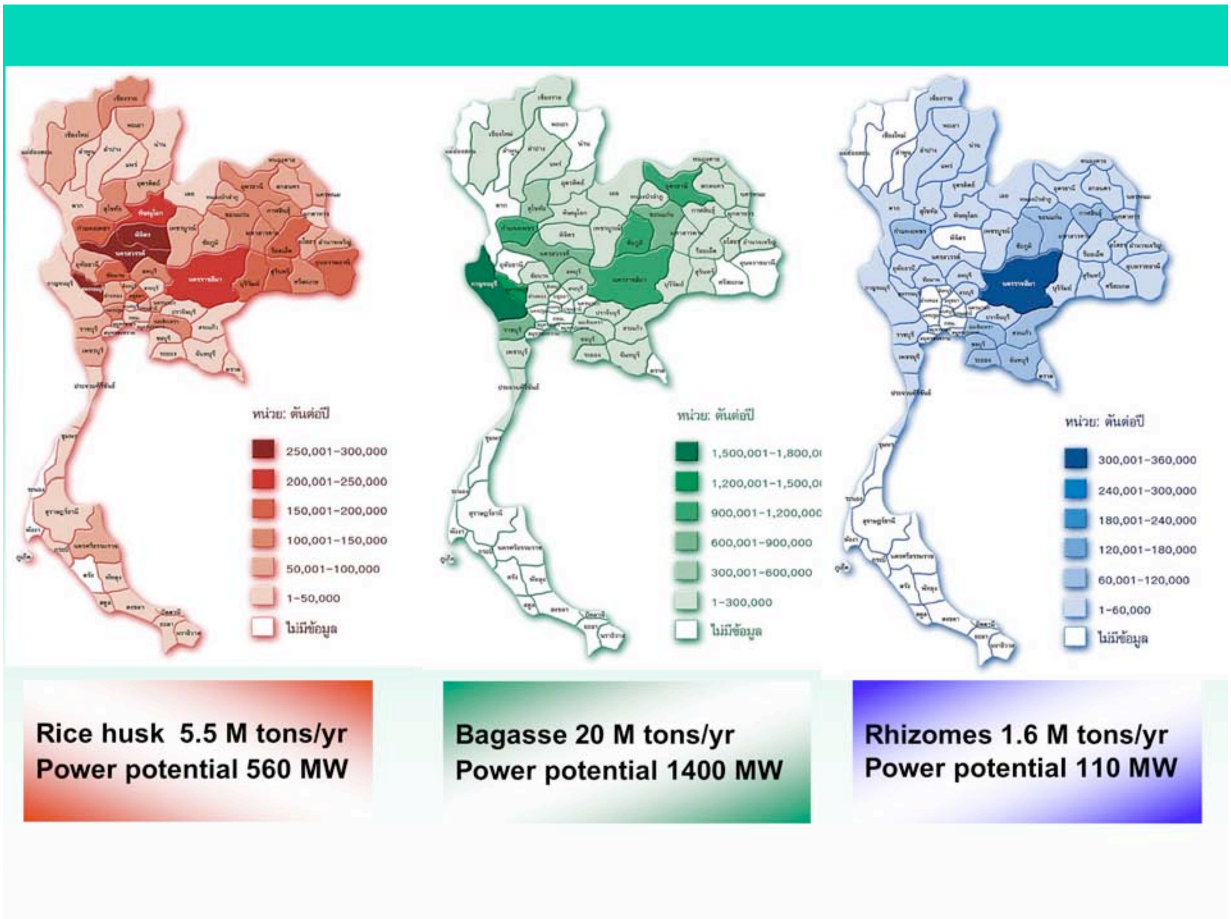

Figure 6.9: Power Potential from Rice Husk, Bagasse and Rhizomes

Source: Greacen 2005a.

Realistically, the potential role of biomass for power generation therefore is to meet the future increase in demand rather than to displace current power production. In its renewable energy plans, the Thai government envisages an increase of electricity production from solid biomass. However, whether these targets will actually be met also depends on factors such as competing uses, technological improvement and the relative prices of fuels. Most important are perhaps the competing uses, especially the use for biofuels, in view of the high perceived need for alternatives to oil in the transport sector. Therefore, the potential and the actual supply for electricity generation might be quite different from each other.

6.3.7 Power Generation from Biogas

Although the energetic use of biogas has been very limited so far, the potential and expectations are very high. As will be discussed later, biogas has a decisive comparative advantage in the CDM context: the energetic use of methane bears a much greater greenhouse gas reduction potential since the Global Warming Potential (GWP) of methane is 21.

Increasing attention to this issue is being paid in pig farms. The majority of the 5.4 million pigs per year are bred in large-scale farms which are suitable for the application of modern, efficient biogas technologies. Despite the fact that policies have not been flexible enough to promote commercial exploitation, some large pig farms have nevertheless begun exploiting this potential for use within the farm and for limited commercial ventures. In addition, DENA reports neighbourhood protests which raise the pressure for the farms to tackle their biowaste problem (DENA 2005). Thus, the implementation of biogas technologies can also realise social and local environmental benefits.

Supported by the German development cooperation with Thailand, the biogas technology has been improved quite significantly, spear-headed by the Biogas Technology Centre associated with Chiangmai University. Currently, the Ministry of Energy has set a target to produce about 30 GWh per year from biogas from one million pigs. This is equivalent to a 4.0 MW power plant. There are a few small power producers (SPP) who use pig manure to produce electricity. The Than Kaseam Farm in Saraburi Province, for instance, has been able to halve its electricity bill by investing Baht 12 million to convert pig waste into electricity. The investment could be recovered in 10 years. Also other benefits such as fertiliser production could be realised from this kind of management (Jesdapipat 2001). So far, there is one small-scale CDM project in the validation process which is supposed to produce electricity from pig farms liquid waste, the Ratchaburi farms biogas project, a bundled project for three farms with about 200,000 pigs (Ratchaburi Farms 2005).

Biogas could be produced from other industries as well. In the Northeast of Thailand, for example, starch[68] and food processing[69] enterprises are able to produce sufficient electricity supply for their own needs and as well as for nearby rural communities. Especially in the food-processing industry, the wastewater usually contains a high share of organic material

[68] Sanguanwong Cassava Processing in Nakhon Rajsima Province will export to the grid with 2.8 MW of electrical capacity, out of its total 6.1 MW capacity, once the project is completed, as reported by the Bangkok Post, March 6, 2005 (Jesdapipat 2006).

[69] Mitr Kalasin Sugar Co. uses bagasse from its sugar refinery to use 5-12 MW capacity for grid export during the off- and on-season milling capacity. The surplus is sold to EGAT to supply other communities in the same province.

and environmental regulations on wastewater treatment have helped to raise the attention to such technologies (DENA 2005). According to BCSE, "the bulk of commercial biogas potential is in the cassava processing industry where there is an estimated 300 MW of possible development, but financing is appearing to be a key constraint." (BCSE 2005: 5). Du Pont estimates that within the next 10 years US-$ 100 million will be invested in Thai biogas, though an additional US-$ 200 million would be required to fully develop the sector (Du Pont 2005).

According to DEDE, the biogas potential from animal waste and industrial wastewater is estimated to be 322.0 ktoe (from animal waste) and 246.5 ktoe (from industrial wastewater) (DEDE 2004b). While industrial wastewater's potential are similar across the country (with a focus east of Bangkok), animal waste's potential are more concentrated in the northeastern and the central region of the country.

For power from biogas, the Thai government has set targets of 11.8 MW in 2006 and 22 MW in 2011. Electricity generation from solid biomass is supposed to grow much faster, though, up to 1,700 MW in 2006 and 2,700 MW in 2011 (Berthold/Dewey 2004). The Greenpeace scenario regards installation figures of 2,164 MW in 2010 and 8,674 MW in 2020 from biomass as possible, assuming annual growth rates between 20 and 30% (Greenpeace 2002).

6.3.8 Fuel Potential from Biomass

The production of biofuels is another important – and politically driven – branch of renewable energy development. As shown in Table 6.9, the potential for ethanol production is concentrated in the central and northeastern region, while biodiesel raw materials are mostly found in the southern part of the country. The aggregated potential of both is the highest in provinces east of Bangkok, which is a structural advantage since Bangkok as the major city probably consumes a significant share of Thailand's fuel demand. This could reduce energetic losses from long transports.

Gasohol is a new source of fuel for Thailand, and its potential is enhanced greatly by the presently skyrocketing prices of fossil fuels, which Thailand has to import almost exclusively from overseas. It is mixed from benzene and ethanol. Useful raw materials for ethanol production are residues from the intensive industrial sugarcane use, emolasse and cassava.

Biodiesel is also considered a new fuel for Thailand, compared to others. It was first produced by villagers who aimed at finding alternative fuels to substitute diesel whose prices continued to surge. The government then supported more standardized research and development. Most resources come from palm oil and coconuts, but also Jatropha is thought to be produced and consumed increasingly.

Table 6.9: Raw Materials for Ethanol Production / Biodiesel in 2003

Region	**Raw materials for ethanol production (in tonnes)**			**Raw materials for biodiesel production (in tonnes)**	
	Molasse	Industrial sugarcane	Cassava	Oil palm	Coconuts
Whole kingdom	3,536,340.0	74,258,407.0	16,868,307.7	4,587,742,4	2,456,880.3
Northern	669,712.9	14,971,239.0	2,298,345.8	-	94,216.2
North-eastern	1,480,099.2	31,018,324.0	8,791,605.7	-	110,398.4
Central	1,386,527.9	28,268,844.0	5,778,356.2	255,245.8	1,174,911.6
Southern	-	-	-	4,332,496,6	1,077,354.0
Overall potential of liquid biofuels	241,532,361.2 litres	?	945,042,371.7 litres	17,435.6 tonnes	4,879.4

Source: DEDE 2004b.

6.3.9 Power Generation from Geothermal Energy

Power generation from geothermal energy as well as research in this field are still at the beginning. EPPO refers to 64 potentially exploitable spots (EPPO 2003a), but so far only one power plant is in operation. In 1989, a 300 kW binary cycle power plant was constructed in the Fang (Province Chianmai), which produces about 1,020 MWh annually (DEDE 2004b). The rest heat with a temperature of 80° C is used locally for air conditioning and drying of crops (WEC 2005).

The government strives for an increasing amount of power generation from geothermal sources. Until 2011, 7.8 MW of installed capacity are to be installed (Berthold/Dewey 2004). The potential referred to by DEDE, almost totally concentrated in the far north, is estimated at 527.0 ktoe, which is about 60,000 MWh, 60 times of what is generated today. Greenpeace's "Alternative Energy Scenario" considers 9 MW by 2006 and 45 MW by 2020 to be possible (Greenpeace 2002).

6.3.10 Heat Production from Solar Energy

The market for solar thermal applications is still relatively small and without political incentives. According to figures from PRESSEA from 2000, about 50,000 m^2 of thermal flat collectors were installed in that year, primarily on commercial buildings, hospitals and private houses.[70] The annual growth was estimated to be 3,000 to 3,500 m^2 for 1999 (WEC 2005). Solar thermal water heaters have become a kind of status symbol for well-off families. DENA (2005) describes the market to be mostly saturated and dominated by imports from Australia. There is no information on political incentives to foster solar thermal applications so far. The government's RE plans envisage a significant increase in renewable thermal energy use from about 1,000 ktoe to 3,910 ktoe, but without specifying how much is to come from solar thermal applications or from other sources such as biomass.

There is also a limited use of solar thermal energy for crop drying. Applications are supported by DEDE and one project is supported by GTZ (DENA 2005). There is no information available on the use of solar thermal applications in industrial use.

6.3.11 Municipal Solid Waste

With rising living standards and a growing population, the treatment of municipal solid waste (MSW) is becoming an issue of growing importance in Thailand. MSW has become a major problem in Thailand's cities. A common practice for MSW disposal is landfilling, which usually generates landfill gases (mainly methane (CH_4), and carbon dioxide (CO_2)). Of these, methane can be used as a fuel for combustion.

In 2002, about 8,000 tonnes of MSW were created daily in Bangkok alone (Sajjakulnukit et al. 2002). DEDE estimates the overall annual amount of MSW to be 13,501,458.8 tonnes with an energetic potential of 1.2 ktoe. About half of this is located in the central region (DEDE 2004b). Technologies for the energetic use of MSW are gaining support from Thailand's government. As part of the energy strategy for 2011, 100 MW installed electrical capacity from MSW are envisaged. DENA (2005) lists a couple of partly grid-connected demonstration projects.

[70] DENA (2005) refers to the same figures and describes them as the current state of distribution, although they seem to come from the same source (PRESSEA 2004).

6.3.12 Overall Use and Potential for Renewable Energies in Thailand

Table 6.10 gives an overview of the present electricity generation from renewable energy sources, its regional distribution (figures from 2003) and the estimates of the installed capacity (figures from 2005) as outlined in the chapters above.

Table 6.10: Renewable Energy Electricity Generation by Energy Type and Region

Energy type	Electricity generation by region before distribution (in MWh, in 2003)					Installed capacity in MW (2005)*
	Northern	Northeastern	Central	Southern	**Total generation**	
Biogas	431	1,007	11,006	-	**12,444 (0.2%)**	1017
Solid biomass energy	631,777	1,230,191	2,461,409	185,451	**4,508,828 (95.7%)**	
Geothermal energy	1,020	-	-	-	**1,020 (0.0%)**	0.3
Small hydro energy	112,578	52,002	2,929	12,104	**179,613 (3.8%)**	130
Solar energy (PV)	3,377	326	1,258	956	**5,917 (0.1%)**	6
Wind energy	-	-	-	-	**0**	1
Total	**749,183 (15.9%)**	**1,283,526 (27.3%)**	**2,476,602 (52.6%)**	**198,511 (4.2%)**	**4,707,822 (100%)**	**1,154**

Source: DEDE 2004b; *different sources[71]

In sum, the central region, which includes the capital Bangkok, has the highest share of RE in electricity generation. But there is a significant difference regarding the different energy types. Geothermal, hydro and solar energy are generated mostly in the north of the country. Remarkably, wind energy is currently not used for electricity generation.

It is difficult to give a final statement on the share of total energy consumption that renewable energies could eventually deliver. Summarising the "official" figures on potential and consumption, as presented by the Department for Alternative Energy Development and Efficiency (DEDE) (see Table 6.11), a rough estimate is that a potential of 23,691.9 ktoe/year (about 279,120 GWh) remains to be exploited. However, it has to be noted that the wind energy potential estimates seem to be very conservative, as has been outlined above.

71 See specific chapters on each renewable energy source respectively.

Table 6.11: Overview of Renewable Energy Potential in Thailand in 2003

Source	Primary potential (in ktoe)	Energy consumption (in ktoe)	Remaining potential (in ktoe)	Estimates of the potential of electricity generation capacity (in MW)*
Liquid biofuels	609.1	0.2	608.8	
Small hydro energy	2,067.9	1,671.8	396.1	700
Wind energy	12.3	-	-	> 1,600
Solid biomass	30,612.7	8,977.9	21,634.7	>7,000
Biogas	569.8	44.3	525.5	
Solar	554,070.6	3.7	-	> 5,000
Geothermal	527.0	0.2	526.8	15**
Wave energy	0.5	-	0.5	
Tidal energy	0.0	-	0.0	

Source: DEDE 2004b; *Du Pont 2005; **own estimate

When incorporating the solar energy potential as calculated for 1% of the total area of the country, an additional 554,071 ktoe/year (about 6,443,845 GWh) exists. According to DEDE, the total final energy consumption in 2002 was 52,939 ktoe/year, while the primary energy consumption was about 83,000 ktoe (DEDE 2004b; IEA 2004b). This suggests that it might theoretically be possible to cover all the energy needs from renewable energy sources, although this is not commercially viable under present market conditions and technology costs for renewables.

However, in the case of electricity generation, for example, the estimated potential in terms of installed capacity seem to be significantly lower than the presently installed capacity, with at least 14,300 MW of RE potential compared to 24,000 MW total installed capacity in 2003. It also needs to be remarked that the output of RE technologies per MW installed generally is lower than for conventional power plants since the inconstant resource flows of wind and solar energy reduce the load hours. The present potential estimates therefore do not suggest that renewables can cover the major part of the electricity consumed, even less when considering the expected increase of demand. However, the assumptions behind the estimations are not clear, and, although the remaining potential seems to be limited compared to the overall energy demand, exploiting it to a greater extent seems reasonable to reduce import dependency and lower greenhouse gas emissions from non-renewable sources.

Regarding the use of biofuels, even with the realisation of the ambitious targets for biofuels production their share would still be low compared to the demand for conventional transport fuels. Jesdapipat (2006) estimates that by 2011 all of the domestic production of cassava would need to be converted into ethanol for replacing only 3% of the future demand for benzene. It thus seems to be very likely that although the production of biofuels (biodiesel and ethanol) will probably be increased substantially, it will not suffice to meet the increasing demand. However, there does not seem to exist a well-founded assessment of this issue at the moment.

The following table, which has already been described in general for developing countries in chapter 4, synthesises the current and future economic potential for the utilisation of RET that have been identified for Thailand. Where possible, furthermore country specific energy indicators (such as wind speed, solar insolation etc.) are given. Note that some of the figures are just rough estimations (e.g. biomass). In cases where further potential for particular technologies are expected but no sound figures are available, there is a general note "additional potential" (e.g. solar heat). The crosses indicate those technologies that are assumed to be relevant for Thailand.

Table 6.12: Supply-Side Technology Matrix for RE in Thailand (Top-down Table)

Energy Type	Main Group	Energy source: Subgroup	Energy source: Ressources / Technologies (Examples)	Application	Sector: Residential	Sector: Industry	Sector: Power	Compatibl: CHP	Compatibl: Hybrid[5]	System: On-Grid	System: Stand alone	Power: Small	Power: Medium	Power: Large	Energy Benchmark resp. Energy Potentials [TWh]9)	CO_2-Red.-Potential: Energy Substitution	CO_2-Red.-Potential: GHG-Destruction	Implications & Co-Benefits[4] – Economy: Spec. Invest Costs [€/kW]	Implications & Co-Benefits[4] – Economy: Spec. Energy Costs [€/kWh]8)	Implications & Co-Benefits[4] – Ecology[3]	Implications & Co-Benefits[4] – Socio Economic	Implications & Co-Benefits[4] – Further: Qualification Spare Parts Participation ...	Baseline (only relevant for country specific analysis!)
HEAT	Biomass[1] (Co-firing)	Residues (Wood)	Wood residues	Heating, cooking	x	x					x				356,02 TWh	x			0.059 - 0.080				
		Residues (agricultural)	Rice husk, bagasse, manioc, maize, coconut, palm oil residues	Power generation	x	x	x	x		x	x	x				x	x						Conventional electricity grid mix, methane
		Energy crops (renewable raw material)																					
	Biogas[1]	Residues (Wood)	Wood residues												6,61 TWh; MSW: 0,013 TWh								
		Residues (organic)																					
			Landfill gas from municipal solid waste (MSW)	Power generation			x			x		x				x	x						Conventional electricity grid mix, methane
		Residues (agricultural)	Bagasse, coconut shells, rice husk	Power generation			x	x		x	x	x	x			x	x		0.057 - 0.074				Conventional electricity grid mix, methane
		Energy crops (renewable raw material)																					
	Coal bed Methane[1]																						
	Solar[1]			Solar stove											6443,83 TWh								
				Solar drying																			
				Warm water	x	x					x					x							Firewood, natural gas
				Heating																			
				Process heat																			
				Process coolling																			
	Geothermal[1]	Near surface (heat pump)													6,13 TWh								
		Hydrothermal		Warm water, air conditioning, crop drying			x				x	x				x							Biomass heating
		HDR technology [6]																					
ELECTRICITY	Hydro	Large (> 10 MW)	Storage, run-of-river	Power generation			x			x				x	24,04 TWh	x							Conventional
		Small (< 10 MW)	Storage, run-of-river	Power generation			x				x	x				x			0.044 - 0.106				
		Micro (< 100 kW)	Run-of-river																				
	Wind	Large (> 100 kW)													0,14 TWh				0.095-0.127				Conventional grid electricity mix
		Small (< 100 kW)		Electricity for water pumps	x						x	x				x							
	Solar[1]	PV		Power generation	x	x				x	x				6443,83 TWh	x			0.214 - 0.412				Conventional
		Solar thermal	Dish-Stirling																				
			Parabolic trough																				
			Solar tower																				
			Solar chimney																				
	Geothermal[1]	Hydrothermal		Power generation			x			x		x			6,13 TWh	x							Conventional
		HDR technology [6]																					
	Ocean energy	Waves													0								
		Tides																					
		Thermal (OTEC [7])																					

Energy Type	Main Group	Subgroup	Ressources / Technologies (Examples)		Production: thermal-chem.	Production: phys.-chem.	Production: biochemical	Production: electrical		System: On-Grid	System: Stand alone		Energy Benchmark resp. Energy Potentials [TWh]9)	CO2-Red.-Potential: Energy Substitution	CO2-Red.-Potential: GHG Destruction	Implications & Co-Benefits[4)] Economy: Spec. Fuel Costs [€/kWh] resp. [€/MJ]	Economy: Spec. Fuel Costs [€/l]	Ecology[3)]	Social economy	Further: Qualification Spare Parts Participation ...	Baseline (only relevant for country specific analysis!)
F U E L S	Liquid	Vegetable oil				x							7,08 TWh	x							
		Bio diesel (FAME [2)])	Palm oil, coconut oil	transport (mixed with conventional diesel)		x							Palm oil: 17435 tonnes;	x			0.62				Conventional diesel
		Bio ethanol	Starchy plants (Molasse, cassava)	transport (mixed with gasoline)			x						Molasse: 241,532,361 liter; Cassava: 945,042,371 liter	x			0.34-0.63				Conventional gasoline
			Sugar plants (industrial sugar cane)			x							Bagasse: no specific figures	x							
		Bio methanol	from Biogas																		
		BTL (Fischer-Tropsch)	from Biogas																		
	Gaseous	Hydrogen	Wind, solar, biomass																		
		Bio methan (= Biogas)	Biomass																		

Note
1) in principle applicable to combined heat and power generation
2) FAME: Fatty Acid Methyl Ester, among RME (Rape Methyl Ester)
3) e.g. Acidification Potential, Eutrophication Potential, Ozone Depletion Potential and Ozone-forming Potential, toxicity
4) see also aspects named in "Guidelines for a sustainable power supply"
5) e.g. Diesel/PV or Wind/PV Systeme
6) HDR: Hot Dry Rock
7) OTEC: Ocean Thermal Energy Conversion
8) based on: 1 Euro = 47 Baht; range in feed-in-tariff calculations
9) "official" potential figures: DEDE 2005

Further technologies / options:
- Solar architecture
- Sea water desalination

6.4 Renewable Energy Policy

6.4.1 General Aspects of Energy Policy in Thailand

Responsibilities for Thai energy policy are shared between different institutions. At the government level, the main actors are as follows:

- The Ministry of Energy (MOEN) was founded in 2002 and is responsible for the regulation of the energy market
- The Energy Policy and Planning Office (EPPO) is responsible for the overall development of the energy market and general energy policy
- The Department of Energy Business (DOEB) is a regulatory authority to ensure the quality and security of energy production and supply
- The Department of Alternative Energy Development and Efficiency (DEDE) is responsible for the development of renewable energies and energy efficiency policies and measures

Although the electricity market has been gradually liberalized since 1992, it is still characterized by monopolistic structures. The publicly owned enterprise Electricity Generating Authority of Thailand (EGAT) dominates the market and controls electricity generation and marketing. About 70% of Thailand's electricity generation is produced by EGAT. However, since Independent Power Producers (IPP) were allowed to enter the market in 1992, their share has increased continuously. EGAT is currently in the process of being privatised. Originally, the government planned to sell the company at the stock market in November 2005. The energy ministry in the past proposed the privatization as "the only means to strengthen the organisation" through mobilising non-state capital (Chiangmai Mail 2004). However, a lot of critics and protests accompany this process. For example, two interviewees expressed the need for an independent body to regulate the energy market before privatising EGAT to prevent it from abusing its market power (Interviewee A, Interviewee B)[xxiii]. In April 2006, the Supreme Administrative Court criticised that the privatisation as conceived by the government "only benefits a certain group of people, particularly politicians", and stopped the process (The Nation 2006).

The distribution of electricity is separated between the Metropolitan Electricity Authority (MEA) covering Bangkok, Nonthaburi and Samutprakam, and the Provincial Electricity Authority (PEA) for the rest of Thailand (DENA 2005). The Bangkok Metropolitan Region (BMR) alone consumes about 35% of the electricity consumption of the entire country (DEDE 2004a).

6.4.2 Thailand's New Energy Strategy and Renewable Energy Targets

Energy has become a central issue in Thai economic and development policy. In 2003, the new "Energy strategy: Energy for Thailand's competitiveness" was approved with the prime objective to reduce import dependency on fossil fuels as a means to ensure an adequate, secure and cost-effective energy supply (EPPO 2003b). The "Strategic Plan for Renewable Energy Development" is one part of the new energy strategy. The following measures were presented as the basic pillars of the government's strategy to increasingly develop RE:

- Establish a Renewable Portfolio Standard (RPS) for new power plants according to which 3-5% of their generation capacity would have to be generated from renewable energy sources;
- Devise incentives encouraging the purchase of power generated from renewable energy sources, such as tax credits, privileges, and subsidies from the Energy Conservation Promotion Fund (ENCON) (see also section 6.4.4.1);
- Support research and development (R&D) on renewable energy sources of which Thailand has a high potential, such as solar, micro-hydropower, wind and biomass (agricultural wastes and municipal wastes);
- Encourage participation and partnership of local communities in renewable energy-fuelled power plants.

The government of Thailand has set detailed quantitative targets for the dissemination of RE, which are part of the new energy strategy. This fact in itself can be judged as clear indication of the growing esteem for the potential role of RE. Thailand is highly dependent on fossil fuel imports and, at the same time, most of the scenarios predict an increasing energy demand. By 2011, the fossil energy demand is expected to grow by 50% compared to today. The overarching goal of the government is to reach a share of 8% of final energy consumption to come from renewables in 2011 (DEDE 2004b; see Figure 6.10) and to at the same time reduce the growth in energy demand (or energy intensity) to a factor of 1.1 times the economic growth compared to a factor of 1.4 today (Sutiratana 2004).

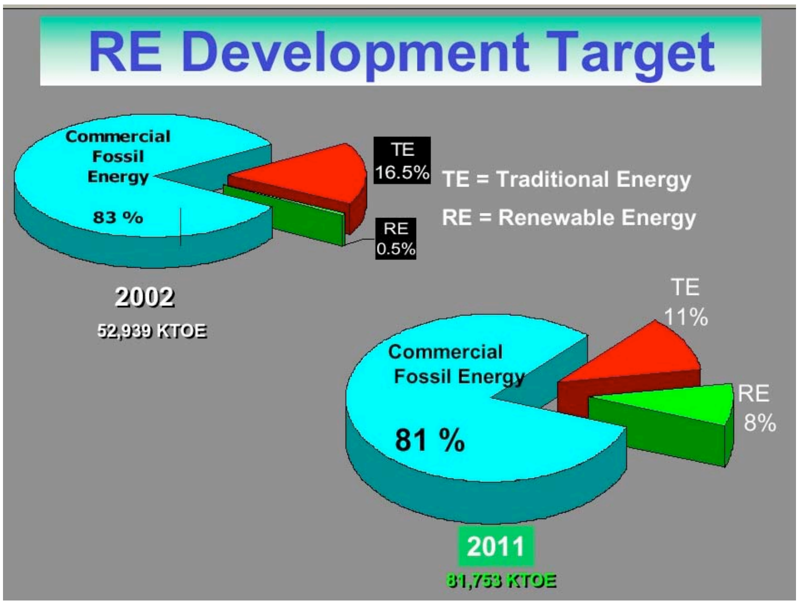

Figure 6.10: Thailand's RE Development Target

Source: Sutiratana 2004.

A RE share of 8% in 2011 would equal a final energy consumption of 6,540 ktoe. In absolute terms, the targeted increase would mean a growth of energy utilisation from new renewable energies by the factor 24. As is shown in Figure 6.10, the government also sees a need to reduce the overall share of "traditional" energy.

The target has been broken down into specific targets for renewable power, heat and liquid fuel production, as can be seen in Figure 6.11. Most of the renewable energy content is expected to come from renewable heat (3,910 ktoe), followed by biofuels (1,570 ktoe) and electricity from renewable sources (1,060 ktoe). In terms of installed capacity, 2,400 MW are envisaged for 2011, compared to 560 MW in operation in 2003.

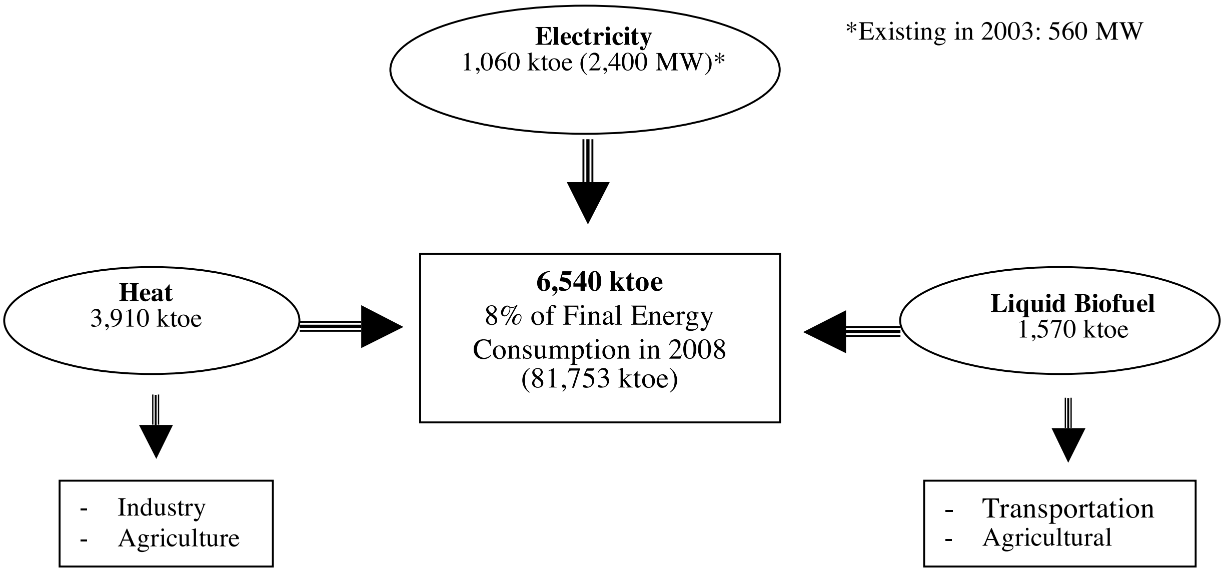

Figure 6.11: Renewable Energy Development Target in 2011

Source: DEDE 2004b

A recent analysis reviewing the RE targets suggests that there has been a slight change in the figures presented above. According to Greacen/Loy, in a 2 November 2005 presentation the Thai Ministry of Energy referred to 1,000 ktoe (11,600 GWh or 2,200 MW installed capacity) of RE electricity generation per year, 2,500 ktoe per year to come from renewable transport fuels (ethanol and biodiesel) and 4,200 ktoe per year to come from RE use for heat (Greacen/Loy 2006).

When the government published its RE development strategy, in the case of renewable power generation specific policy measures were suggested to achieve a certain share of the capacity increase, as shown in Figure 6.12. The Renewable Portfolio Standard was thought to set incentives for a minor share of the extension target (400 MW out of 1,840 MW) only, while the rest (1,440 MW) is to come from several incentive mechanisms that already exist, like the guaranteed buy-back price from the Small (SPP) and Very Small Power Producers (VSPP) Programmes. These incentive systems will be analysed in more detail in the following sub-chapters.

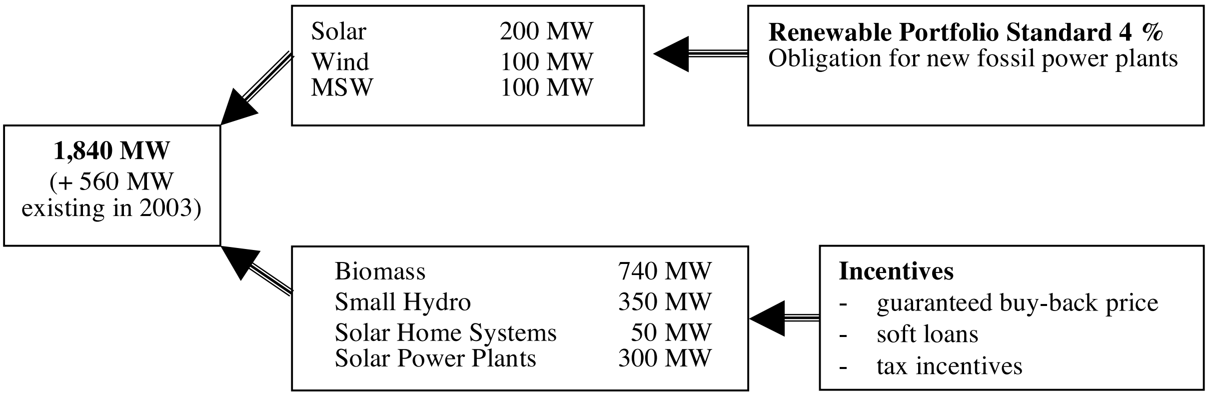

Figure 6.12: Renewable Electricity Generation Targets for 2011

Source: DEDE 2004b

The most important policy measures are described in more detail below. The focus has been on electricity generation through renewables and recently on biofuel production for transport. Although a number of solar heaters exist on hotels and private houses, the heat sector, especially industrial heat, has not been subject to major policy initiatives so far.

6.4.3 The Costs of Renewable Energy Electricity Generation in Thailand

Costs and cost projections are among the most important factors for the realisation of the different RE potential. One major driver for the Thai government to strive for greater use of renewables is the rising macro-economic cost of imported fossil fuels. At the same time, under existing market conditions the electricity generation costs for some of the renewables are significantly higher than the current market price for electricity. The challenge thus is to find the right balance between the short-term costs of accelerated RE use and the long-term economic benefits (including social and environmental benefits).

As has been experienced in Germany, for example, significant cost decreases can be achieved with technological learning processes. Technological learning can be defined as the cost reductions in a specific technology that occur when experience with the application of this technology can be accumulated, on the production side as well as on the installation and marketing side (see e.g. McDonald/Schrattenholzer 2001). When production of the technologies increases, economies of scale and other effects can be realised to bring down costs. For example, between 1990 and 1999 the average investment costs of a wind energy plant in Germany was reduced from 2,150 €/kW to 865 €/kW (Bechberger/Reiche 2006a).

As regards biomass, a swift increase in biomass use may produce problems because demand growth may lead to a price increase of biomass resources. Within the energy sector, this could lead to price increases for the electricity produced, but also impacts on other sectors may occur if there are competing uses for a certain resource.

Table 6.13 gives a brief overview of the estimated production costs of electricity from the different RE sources. The table has been compiled by combining the estimates of different studies. Increasing efforts are being made in Thailand to determine appropriate feed-in tariffs to foster RE electricity generation. More than 30 countries worldwide have adopted feed-in based RE support systems where a guaranteed price is paid to renewable energy generators per kWh fed into the grid for a certain period. Germany is an outstanding example of how such a system can significantly incentivise investments into these technologies (Bechberger/Reiche 2006a; Greacen/Loy 2006).[72]

According to DEDE, the average electricity price per kWh in 2003 was 2.66 Baht/kWh in the Metropolitan Area (Bangkok and surroundings) and 2.42 Baht/kWh in the areas of the Provincial Electricity Authority (DEDE 2004a).

According to Greacen/Loy, a study entitled "Economic and Financial Analysis of Renewable Energy Development in Thailand" by the Promotion of Renewable Energy Technologies (PRET) group at Thai Ministry of Energy DEDE is the most recent effort towards determining appropriate feed-in tariffs (Greacen/Loy 2006; DEDE 2005). The Federation for Thai Industries (FTI) also developed a proposal for feed-in tariffs (Jaimsin 2005). Assuming a market-based Internal Rate of Return (IRR) of 11%, the Energy for Environment Foundation calculated levels of feed-in tariffs which could be interpreted as costs (left price column) (EforE 2004). Du Pont calculated the commercial production costs in 2004 for different

[72] Greacen/Loy (2006) give a very recent overview of the different studies and concepts and develop further recommendations. See also for details regarding the different tariff calculations presented in Table 6.13.

sources[73] (DuPont 2005). The comparison with findings from the international level allows for an estimation of the market maturity of the different RE sources in Thailand (REN21 2005).

When comparing the current production costs with average prices paid today by consumers for a unit of electricity, it is important to note that the end consumers' price also contains additional costs like, for example, the profit of the grid operator and certain taxes. This means that the end consumers´ price for RE would be higher than the feed-in tariffs presented in the table.

Table 6.13: Cost Estimations for Electricity from Renewable Energies

Source	**Price in Baht/kWh**				
2003 average grid electricity tariff (DEDE 2004a)	2.42 - 2.66				
	Feed-in tariff calculation (DEDE 2005)	Feed-in tariff proposal FTI (Jaimsin 2005)	Feed-in tariff calculation (E for E 2004)	2004 commercial production costs (Du Pont 2005)	International comparison[74] (REN 21 2005)
(Pig farm) Biogas	-	3.4 – 3.5	2.7	1.8	-
Solid Biomass	3.2 – 3.8	2.6 – 2.8	2.8	<1.85	2.0 – 4.8
Small & micro-hydro	3.0	-	2.1 – 5.0	1.74	1.6 – 2.8
Wind	5.0	6.0	4.5	5.2	1.6 – 2.4
PV	15.0	16.0	19.4	10.1	8.0 – 16.0

Summarising the table, one can conclude that electricity generation from biomass is almost competitive given the average Thai electricity prices and has generation costs similar to international cost estimates. The almost non-existent exploitation of the wind energy potential is also reflected in relatively high generation costs, although in many other countries wind energy is among the cheapest renewable electricity applications. The PV cost estimates show a wide range, more on the upper end of international cost estimates.

73 All references to "commercial viability" or "commercial costs" for renewable energy assume generators are compensated according to commercial arrangements that apply to renewable energy generators "*currently in operation* as of March 2005." (Du Pont 2005). Wind and solar could only operate with subsidies. It has to be remarked that this analysis does not incorporate aspects of external costs of fossil fuels, such as air pollution or the contribution to global warming, thus not representing a comparison based on macro economic costs.

74 Calculated based on an exchange rate of 1 US-Dollar = 40 Baht.

6.4.4 RE Support Policies

Policies can improve the market conditions for renewable energies, help “levelling the playing-field” and incentivise cost reductions through increased implementation. A number of incentive programs have already been put in place.

6.4.4.1 ENCON Fund

The Energy Conservation Promotion (ENCON) Fund was established under the Energy Conservation and Promotion Act of 1992. It is financed through an extra tax on fossil energy (except natural gas). While the focus of project support is on energy conservation, there is an increasing share of RE projects. The ENCON Fund covers a wide portfolio of measures that can be supported, such as technological research by universities, projects undertaken by NGOs, project developers or existing power suppliers. Between 2000 and 2004, the budget was Baht 29,110.61 million (ca. € 572 million), of which 12.3 % was given to RE projects. The SPP programme was supported with Baht 2,060 million (€ 40.5 million) (Jesdapipat 2006).

Under current Thai policies, renewable electricity generators can sell electricity to the Thai grid under two different arrangements: the Small Power Producer (SPP) and Very Small Power Producer (VSPP) programmes. The SPP programme accounts for over 99% of RE capacity owned by private companies that supply energy to the grid, while the VSPP programme currently accounts for less than 1%.

6.4.4.2 Small Power Producers

In 1992, the Thai government started to open up the electricity market for Independent Power Producers (IPP). At the same time, the Small Power Producer (SPP) programme was initiated that allows small power producers – defined by an upper limit of 90 MW installed capacity dedicated to electricity export to the grid, with a typical installed capacity of 5 MW and more – to feed electricity into the grid. The programme applies to renewable energy and to cogeneration (generally using natural gas or coal). SPP generators above 8 MW installed capacity must connect to high voltage (69 kV or 115 kV) lines (IGES 2006a).

In the beginning, the overall amount of electricity generation capacity under this programme was limited to 300 MW accumulated capacity, but in 1996 the limit was extended to 3,200

MW. Since 1997, there is no upper limit on the grid access. The programme was adjusted after the Asian economic crisis which led to a relative boost of the renewable SPPs (DENA 2005).

With financing from the ENCON Fund, the programme provides assistance in the form of pricing subsidies per unit of electricity (in kWh) generated for independent power producers. According to Greacen, Small Power Producer (SPP) generators, whether coal, gas or renewable, receive the same tariff, varying between 1.77 Baht/kWh and 2.20 Baht/kWh (Greacen 2005b).[75]

The latest figures (March 2006) from EPPO count 72 RE projects, out of a total of 103 in operation. Most of the RE projects run with biomass (mainly bagasse and paddy husks), only one is a hydro power plant and two are related to waste use. About 636.50 MW of installed capacity sell to the grid, with the remainder (1238.6 MW minus 445.8 MW) being used within the factories that host the SPP generators.[76]

6.4.4.3 The Very Small Power Producer Program (VSPP)

The Very Small Power Producer (VSPP) programme was established in Mai 2002 and, based on the introduction of NetMetering[77], allows generators with up to 1 MW installed capacity to feed in electricity. Compared to the SPP, regulations have been simplified and are more flexible. Raising the eligibility limit to 6 MW for a single installation is under debate, and expectations are high that this will lead to a significant increase of applications installed (Greenpeace 2006; Interviewee A[xxiii]).

The VSPP is not obliged to conclude a contract with EGAT but can feed in the power directly after having being registered by the government. Sometimes the period between submitting the proposal and the first power supply only takes 45 days (DENA 2005).

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75 The process of tariff determination is explained in Greacen 2005b.

76 A list of plants, generation capacities, and contracted sales to EGAT is available at http://www.eppo.go.th/power/data/data-website-eng.xls.

77 "**Net metering.** Allows a two-way flow of electricity between the electricity distribution grid and customers with their own generation. When instantaneous consumption exceeds self-generation, the meter runs forward. When instantaneous self-generation exceeds consumption, the meter runs backward and power flows to the grid. The customer pays for the net electricity provided in each billing period and may be allowed to carry over net generation from month to month" (REN21 2005).

Table 6.14: RE Projects Supported under the VSPP Programme

Fuel	Number of Projects	Max. Capacity to Grid (kW)
1. Solar cell	39	112.3
2. Wood Chips	1	90.0
3. Paddy Husk	2	2,000.0
4. Biogas	6	379.2
5. Waste	3	2,700.0
6. Palm Shell	1	800.0
Total	**48**	**6,081.5**

Source: EPPO[78], accessed on 15.01.06.

According to Greacen (2005b), Thai utilities are leaders in the region as regards grid-interconnection of small-scale renewable energy. Nevertheless, there have been complaints, for instance regarding solar electric installations that had been allowed to connect to MEA but not been paid for electricity generated because of disagreements over certification of inverters used. Some VSPP generators have also complained that the paperwork and permits required are excessive, despite the simplified rules.

6.4.4.4 Renewable Energy Portfolio Standard

As mentioned before, the government decided to introduce a so-called "Renewable Energy Portfolio Standard" (RPS). This standard would couple investments in RE with the construction of conventional energy power plants. Operators building new conventional plants would have to source between 3 and 5% of this capacity from renewable energy resources, depending on the exact regulations yet to be defined. The government expects the RPS system to significantly contribute to the RE expansion plans, and it is perceived that this approach gains most of the government's attention at the moment. According to the original plans, at least 400 MW installed capacity are to be installed through the RPS, 200 MW solar, 100 MW wind power, 100 MW Municipal Solid Waste (MSW) (DEDE 2004b). DENA (2005) mentions an additional 37 MW of biomass and hydropower. According to DENA, the RPS system shall substitute fossil energy equal to monetary savings of about 490 Mio. €/year (DENA 2005). Figure 6.13 shows the role of RPS and its quantitative targets in relation to the overall extension targets for renewable energy electricity generation. The obligation is

78 A list of plants, generation capacities, and contracted sales to EGAT is available at http://www.eppo.go.th/power/pw-vspp-name-status.xls.

intended to apply only to newly-built fossil fuel plants coming on line after the year 2008. Fossil fuel generators can either build RE generation capacity on their own, purchase electricity directly from RE generators, or purchase RE certificates (RECerts) (Greacen/Loy 2006). Thus, only a minor share of the overall increase envisaged would come from the RPS, the major part is to be initiated by other support schemes.

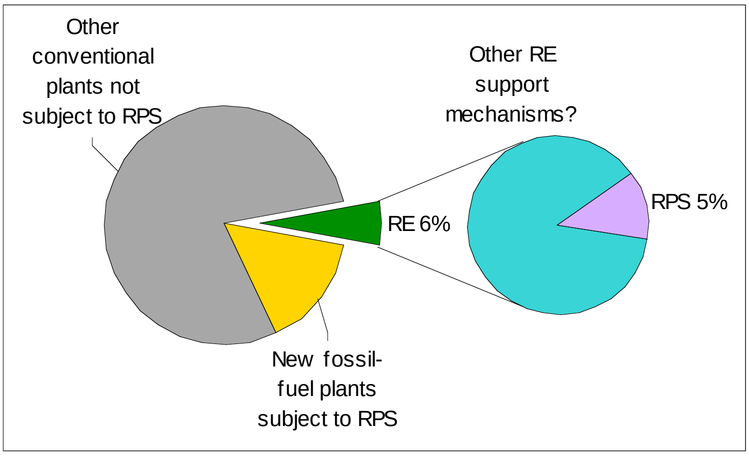

Figure 6.13: The Role of RPS in the Government´s Quantitative Targets on Extending Renewable Electricity Capacity by 2011[79]

Source: Greacen 2005b

The detailed rules for the implementation of the RPS still remain to be finalised, as Greacen/Loy noted in April 2006

However, according to our interviews, there seems to be an increasing discussion, outside as well as inside the responsible energy ministry, if the RPS approach is the right one for the promotion of renewable energies in Thailand or if some kind of feed-in law would be a preferable – or complementary – option. Several interviewees addressed this issue as being perhaps the most important debate for further RE implementation (Interviewee C[xxiv], Interviewee D[xxv], Interviewee A[xxiii]), and most of them referred to the (German) success of a feed-in based policy approach (see also Greacen/Loy 2006).[80] Latest information from Thailand from June 2006 suggests that the RPS loses importance within the government

[79] The left-hand side denotes the 6% share RE are to have in total electricity capacity by 2011, the right-hand side indicates the share the RPS would contribute to this capacity increase.

[80] For a European cross-country comparison regarding the differing support schemes, see for example European Commission 2005; EREF 2004.

plans. The recent debate refers to around 140 MW of additional installed RE capacity, with the Government´s attention shifting to the discussion about feed-in tariffs (Greacen 2006; Greacen/Loy 2006).

Critics of the RPS approach argue that the degree of RE implementation is tied to the installation of new conventional plants, the responsibility for which lies with the large power producers, especially with EGAT, which is guaranteed a 50% share of Thailand's generating capacity (Interviewee A[xxiii]; Greacen/Loy 2006). Greacen also raises the point that RPS – which is in economic theory linked to a liberalised market – would work in Thailand in a "semi-regulated monopoly environment", which casts doubts on the cost-effectiveness of such a scheme in the Thai context (Greacen 2005b: 22). Improving the grid access for decentralized small-scale RE plants is not a priority under the RPS, but sought for by different stakeholders, such as environmental NGOs (Interviewee C[xxiv]). Another point of criticism is the potential for corruption since the RPS would include a bidding process, based on the argument of supporting the most cost-effective and efficient projects (Interviewee A[xxiii]). Last but not least, according to calculations of Greacen (Greacen 2005b), the RPS would only lead to a renewable electricity capacity equal to 0.7% of total installed capacity, which compares unfavourably to the government's target of 6%.

Accordingly, just implementing the RPS would not be sufficient to achieve the goals set for 2011 and additional measures would have to be taken. Greacen/Loy (2006) even argue that, given the minor role that RPS is to play in reaching the RE electricity targets and the ambivalent experience in other countries, "it may be wisest to minimize confusion, abandon the RPS, and turn limited Ministry of Energy resources towards implementing an effective, successful feed-in tariffs program."

6.4.5 Fiscal Incentives through the Board of Investment

The Thailand Board of Investment (BOI) offers fiscal incentives for certain areas of high priority. RE businesses have been granted this status for their various economic, environmental and social benefits. The basic incentives are (according to DENA 2005):

- Reduction of the corporation tax for 8 years
- 50% reduction of duties for imported technical equipment

- 100% reduction of duties for private power producers that hold a license from EGAT
- 100% import duty exemption for machines operating in the so-called “economic zone II”

Thus, these fiscal incentives also serve regional economic policy purposes. These incentives improve investment conditions especially for biomass projects in rural areas.

6.4.6 Measures to Promote Biofuels

Specific targets for the increased production and use of biofuels were announced in the context of the “Strategic Plan for Renewable Energy Development”. In 2003, before policy measures on biofuels were implemented, liquid biofuels consumption stood at 0.2 ktoe, compared to the target of 1,570 ktoe in 2011 (DEDE 2004b). According to the latest figures available, present production is about 10,000 litres/day of biodiesel and 200,000 litres/day of ethanol (Coovattanachai 2006), which approximately equals 100 ktoe/year.[81] On 18 January 2005, the cabinet approved a production target of 8.5 million litres/day of biodiesel by 2012, and a roadmap for biodiesel development was developed (see Figure 6.14). With 5% and later 10% blending of conventional diesel, this would result in a total of 85 million litres of fuels sold by 2012. Palm oil and jatropha are the two resource pillars the strategy builds on. The government calculates that approximately 6,400 km^2 of additional land area will be needed domestically for the palm oil production and another 1,600 km^2 in neighbouring countries (Jesdapipat 2006; Choopiban 2005). However, latest information from the government suggests that the palm oil demand will be covered by domestic production, with no need of imports (Pattaya 2006).

[81] Conversion factor of 1.33 ktoe per 1 million liter biofuels (aggregated ethanol and biodiesel); extrapolated from Berthold/Dewey 2004: 47

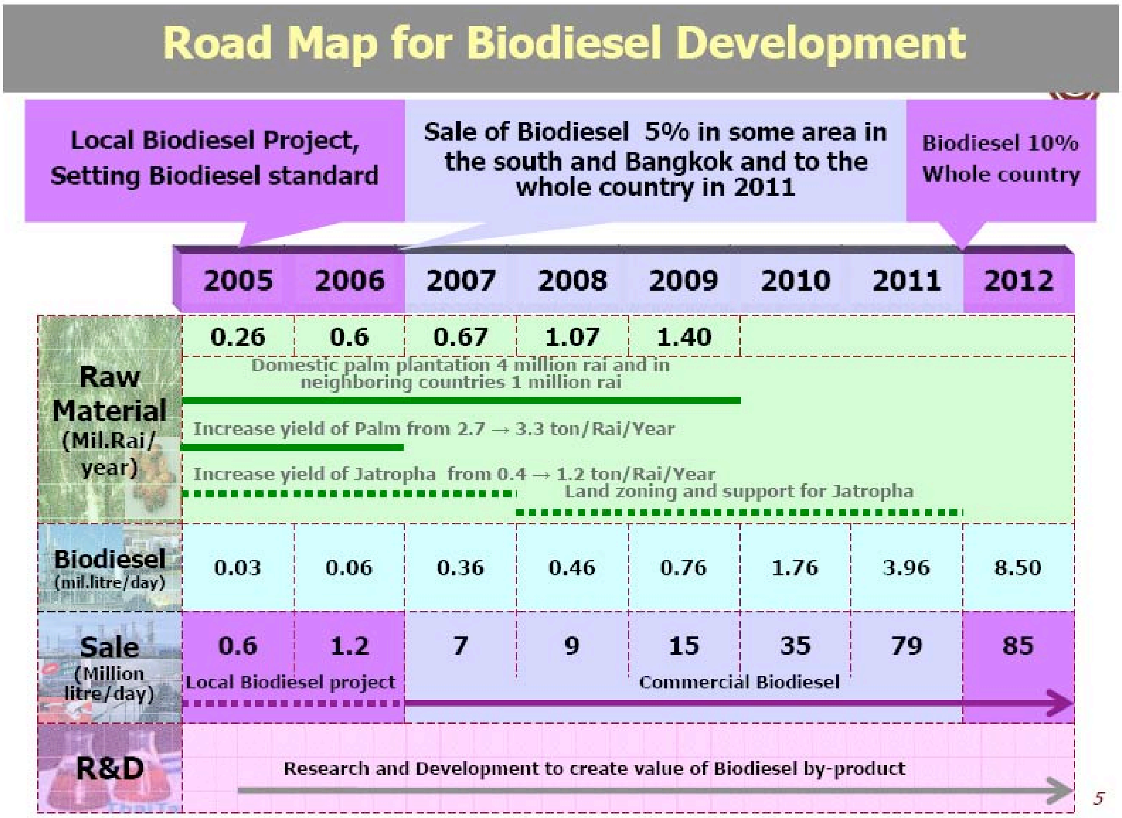

Figure 6.14: Road Map for Biodiesel Development

Source: Choopiban 2005

The targets are to be achieved through different measures: There will be a tax adjustment to lower the tax on biodiesel so that it is less than that of diesel fuel which is Baht 0.75 (1.5 Euro-cent)/litre. In addition, efforts will be made to increase the crop yield of palm oil and jatropha (Choopiban 2005). The government will inject Baht 1,300 million (approx. € 27 million) to match another Baht 130,000 million from the private sector. Some attention is paid to develop biodiesel projects as a means for rural community development (Choopiban 2005). For example, DEDE supported one project in the area of Chiang Mai (Northern Thailand) for the production and local use of 2,000 litres biodiesel per day, including information campaigns among the local population (BOI 2005).

The present policy of the government supports additional production of oil from plants, which will be used to produce 0.85 million litres of Methyl Ester per day. The government is constructing a prototype biodiesel refinery and, if successful, this is to be followed by 85 refineries up to 2012 (Jesdapipat 2006). In addition, the government set tax incentives for car importers to encourage the import of cars which are prepared to use higher shares of biodiesel (DENA 2005). Since uncertainty about the technical preparedness of cars to run with biofuels is reported to be an important barrier in this field, this could drive car importers and manufacturers to address this problem (Interviewee B[xxvi]).

Ethanol/Gasohol

The Thai government also developed an ethanol strategy with the following objectives (see DEDE 2005):

- To create sustainable energy security for the country and communities;
- To enhance the potential of communities to be energy production sources;
- To support domestic bio-chemical industry development.

The Ministry of Energy had set the target of using an ethanol for Methyl Tertiary Butyl Ether (MTBE) substitution in gasoline 95 of 1 million litres/day by 2006 and on using an ethanol for MTBE substitution in gasoline 95 and for oil substitution in gasoline 91 of 3 million litres/day by 2011 (DEDE 2005). The Ministry has undertaken different measures to pursue these targets. On 19 April 2005, the cabinet approved a plan to enhance the use of gasohol to replace octane-95 benzene. The targets aim at halving the benzene consumption at the estimated rate of 4 million litres per day by the end of 2005. The gasohol is to be supplied by about 4,000 service stations, and also a requirement on the 413 gas stations located within government and state enterprise campuses to change to selling only gasohol has been announced. At the beginning of 2007, the bctane-95 benzene will be phased out completely (Jesdapipat 2006). Besides, a price guarantee (15 Baht/ litter) and tax adjustments will be used to ensure that the retail price of gasohol will be maintained at Baht 1.50 (approx. 3 Euro-cent) less than the price of the octane-95 benzene (DEDE 2005). By the end of 2006 there are to be 24 distillers to produce 4.225 million litter of ethanol per day (Jesdapipat 2006; DENA 2005). This amount of ethanol could produce more than 42 million litres of gasohol per day. The present formula for blending ethanol and benzene to produce gasohol allows partial direct replacement of benzene. In effect, this amount could substitute 33.8 million litres/day of benzene.[82] Nevertheless, by 2011 all of the domestic production of cassava would be required for replacing only 3% of expected future demand for benzene (Jesdapipat 2006). This share is rather small, but impacts of gasohol production on the agricultural sector may increase significantly. This is an inter-sectoral aspect that must be considered.

6.4.7 Measures to Promote Renewable Energy Heating

As has been described before, the government also defined targets for the increased use of new renewable energies for heating (excluding “traditional” biomass use for heating). According to DEDE, the 2011 target of 3,910 ktoe would mean almost quadruplicating of the thermal consumption in the year 2000. In addition, the increase between 2000 and 2003 was only marginal, up to about 1,100 ktoe in 2003. This leads to the assumption that there is no market dynamic to rely on and that further policies might be essential to meet the targets. At present, the debate very much focuses on the electricity and the transport sector. Different analyses show that RE heating policies so far have been neglected by policy-makers, although heating is the dominant energetic purpose e.g. in the rural areas and the residential sector (for cooking, boiling etc.) (Shrestha et al. 2006). More research seems to be necessary on what policies are needed to implement the RE heating target (Greacen 2005b).

6.4.8 Preliminary Conclusions on Renewable Energy Potential and Policies in Thailand

The government of Thailand has agreed on ambitious targets for the increased use of renewable energy sources. The major policy driver is the reduction of the high fossil energy import dependency, the price increases of which lead to macro-economic burdens. At present, about 0.5% of primary energy use are based on RE. Their share is intended to grow to 8% until 2011. In addition, the targets include specific figures for RE use in electricity generation, heat and biofuels production.

Thailand’s economy has significant potential for the increased use of renewables. Of outstanding importance is biomass, which – in its different forms – is available all over the country and already today is the cheapest option for renewable energy electricity generation.

[82] In September 2005, Thailand experienced shortages of ethanol. The government decided to allow imports. This incidence shows that for the first time, renewable energy begins to find its way into common daily life of the citizen, and its role will be increasingly gaining ground as prices of fossil fuels continue to climb. But this also shows that energy resource autonomy is not easy to achieve and a too rapid increase of biomass demand poses new problems.

While hydropower extension potential is very limited, wind power potential have so far been neglected.

Thailand has been very early in establishing support schemes for RE in the electricity sector (e.g. the SPP, VSPP programmes) and also in gradually opening up the grid for independent power producers, although the market is far from being liberalised. This means that the country already has gained important experience regarding some options and limits of bringing renewables into the market, which may be very helpful for the implementation of further incentive mechanisms (Greacen/Loy 2006).

At present, the progress achieved since the announcement of the targets in 2003 is not easy to judge because the official figures available do not cover the years after 2003. According to recent documents of the Thai Ministry of Energy, the installed capacity for RE power generation stood at between 860 MW and 883 MW at the end of the year (Thai Ministry of Energy 2005; see also Greacen/Loy 2006). This would mean an increase of 300 MW since the announcements of the targets in 2003. To reach the targets for 2011, between 1,300 and 1,500 MW additional capacity need to be installed (Greacen/Loy 2006). The discussion about RPS and feed-in tariffs will be of importance in this regard.

In the case of biodiesel, although the production is still very limited, a road map to achieve the targets exists and some measures have already been put in place (also for ethanol). The impact of the measures will have to be examined over the years to come until 2011 and, if necessary, these will have to be adjusted. One critical factor for the further development could be the issue of conflicts over land use, since a significant extension of palm oil plantations is needed to reach the targets in the case of biodiesel.

Since there seems to be no market dynamic for the dissemination of RE heating technologies which would be sufficient to reach the 2011 target, and since at the same time this issue has been neglected in the political debate so far, it seems likely that the targets will be missed, unless additional efforts are undertaken in this area.

For the further discussion about the role of the CDM in this context it needs to be remarked that no special attention is paid to the CDM in the official “Strategic Plan for Renewable

Energy Development". The potential role of the CDM to foster RE will be analysed in more detail in the following.

6.5 Climate Policy and Implementation of the Clean Development Mechanism

6.5.1 Emissions Profile

Between 1990 and 2000, Thailand's greenhouse gas (GHG) emissions increased from 175.5 to 264.5 Mt carbon dioxide equivalents (CO_2e), that is by more than 50%.[83][84] This growth rate is five times higher compared to the trend of global greenhouse gas emissions in the same period and also substantially above the average growth rate of non-Annex I countries (29%). Latest figures indicate a continuing growth of CO_2 emissions by another 23% between 2000 and 2004 (DEDE 2006a).

On a per capita basis, Thailand's GHG emissions increased by 37.5% from 3.2 to 4.4 t CO_2e between 1990 and 2000. This growth rate is well above the average rate of non-Annex I countries (10%). Thailand's per capita GHG emissions in 2000 were significantly above the figure of 3.3 t which is the non-Annex I average, but still well below the Annex-I country average of 14.1 t. The carbon intensity of the Thai economy (2002: 489.6t CO_2/Mill. Intl. $) is not only below both the world and non-Annex I average but also below Annex I country average. The carbon intensity of the electricity mix plays an important role with regard to the promotion of RE through the CDM since very often the substitution of grid electricity is the most important factor contributing to CO_2 reduction through RE projects. This especially holds true for non-biomass RE sources which do not profit from methane reduction, like wind or solar electricity (see 6.5.4.1). According to the database CAIT, Thailand was ranked 63 in the world in 2002, with 500.8 g CO_2/kWh. It has to be remarked that in the internal logic of the CDM this is a disadvantage compared to other relevant non-Annex I countries, like China or (916.2 g CO_2/kWh, Rank 11) or India (896.1 g CO_2/kWh, Rank 13) (WRI 2006b). For one unit of grid electricity substituted by renewables, projects in China could generate almost twice the amount of CERs than in Thailand.

83 The table included in Annex 5 gives a detailed overview of emission trends in Thailand.

84 As in most non-Annex I countries the availability of greenhouse gas emissions data is limited. This part of the chapter is based on data from the Climate Analysis Indicators Tool (CAIT) of the World Resources Insitute (WRI 2006).

6.5.2 National Climate Policy

After the ratification of the UN Framework Convention on Climate Change (UNFCCC) on 28 December 1994, the government of Thailand established two committees: the National Climate Change Committee (NCCC) and the Climate Change Expert Committee (CCEC) (Jesdapipat 2002: 6). These bodies advise the government in the implementation of climate protection measures. The National Economic and Social Development Plans are drawn up every 5 years and integrate climate protection activities with measures for sustainable development, especially through the Environmental Quality Management Plans and the National Agenda 21 Action Plan. Aspects of sustainable development also appear in the new constitution approved in 1997. The climate strategy of the government puts emphasis on adaptation to climate change, especially regarding drought and erosion resulting from expected sea level rise (Tummakird 2005). Since the capital Bangkok lies relatively low, the Megacity is directly endangered by sea level rise. Thailand ratified the Kyoto Protocol (KP) in August 2002.

Thailand gained early experience with the flexible mechanism by joining the Activities Implemented Jointly (AIJ) pilot phase through cooperating with Japan in five climate protection projects. In addition, multilateral cooperation on the project level has been conducted with the Asian Development Bank (ADB) to devise an Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS). Further, together with the World Bank, a national strategy on the CDM has been prepared, which formed the basis for the initial structure of the Designated National Authority (DNA). Also, there have been some projects carried out in cooperation with the World Bank, GEF, UNDP and the Japanese government in the past (Jesdapipat 2002).

6.5.3 CDM Implementation

The Clean Development Mechanism has been and continues to be subject to controversy in Thailand. Until autumn 2002 the government of Thailand had rejected the CDM based on the argument that developed countries have to reduce their own greenhouse gas emissions domestically in the first place (Point Carbon 2005a). Moreover, since the financial crisis at the end of the 1990s, the population of Thailand has become somewhat cautious when it comes to rapid economic expansion based on foreign investment (Tummakird 2005).

The administration eventually decided to support the mechanism and set up complex procedures to safeguard the national interest and ecological integrity of projects. According to a DNA official, local initiatives continue to urge government bodies to ensure that CDM projects do not lead to the loss of natural resources to foreign companies or to negative impacts on the environment or society (Interviewee F[xxiii]).

The Thai DNA was inaugurated in June 2004 and is presently housed within the Ministry of Natural Resources and Environment (MONRE), at the Office for Natural Resources and Environmental Policy and Planning (ONEP). An elaborate decision-making structure had been set up to ensure that CDM projects are environmentally and socially sound and contribute to the national interests of the country. A CDM project proposal in form of a Project Design Document (PDD) initially was going to have to be approved by several entities, including Thailand’s highest environment-related decision body, the National Environment Board (NEB) and the Cabinet. (A diagram and description of the initial CDM institutional process is attached in Annex 6).

However, this initial structure is under review. The large number of project idea notes (PINs) and PDDs being submitted to the Thai DNA (see Annex 8) are putting much pressure on the government to quickly move forward with its policy and mechanisms to accommodate such high interest in the CDM. This point of discussion was also prominent at the February workshop, where several participants raised it with the environment ministry’s representative.

An official at the MONRE informed us during the February workshop that Prime Minister Thaksin had expressed particular interest in expediting the national CDM approval process and had thus initiated the formation of a new organization to take on the tasks of the Thai DNA. The latest draft on the approval procedure available at the ONEP website in August builds on this idea, with the “Thailand Greenhouse Gas Management Organisation (TGM)” at the core of the decision-making process, as can be seen in Figure 6.15.

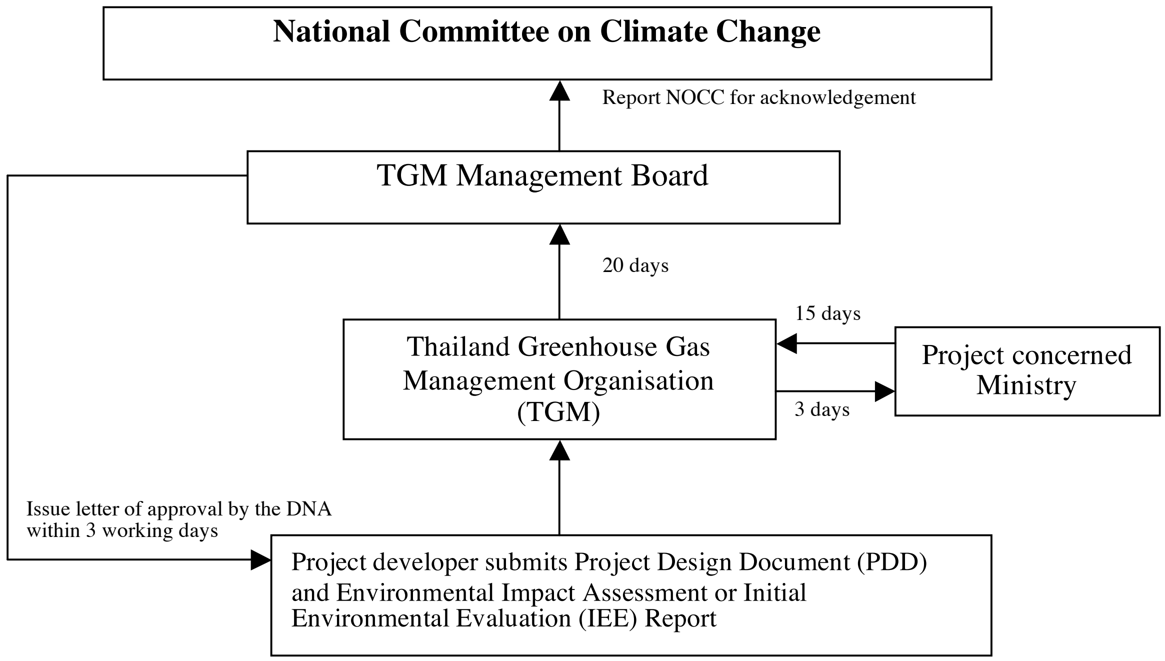

Figure 6.15: Draft Approval Procedure of CDM in Thailand, as of August 2006

Source: http://www.onep.go.th [accessed 23 August 2006]

According to the ONEP website, the procedure for review and approval will consist of four steps:

1. TGM will forward the project documentation to experts and relevant government ministries within 3 working days after receiving a request from the project proponent.

2. Experts and relevant ministries will give their comments to the TGM within 15 working days.

3. TGM will prepare a summary of comments and submit them to the TGM Board for review within 20 working days.

4. After the review by the TGM Board, a response (in case of approval, a Letter of Approval (LoA)) will be issued to the project proponent and the National Committee on the UNFCCC will be notified.

The newly proposed DNA structure is currently awaiting approval by the Cabinet.[85] Since it simplifies the procedure compared to the initial DNA approach (see Annex 3), it would help to accelerate the process required to obtain a Thai Letter of Approval.

The Thai government puts emphasis on CDM projects which include technology transfer and capacity building benefiting the local population. The projects need to contribute to the National Sustainable Development Plan. The proceeds of CERs go directly to the project developer. However, PDD submission to the DNA is supposed to be connected to a fee. According to the latest information from the ONEP CDM website, the project proponent must pay a review fee of Baht 15,000 (ca. € 320) per project, of which Baht 10,000 will go to compensate the review panel and Baht 5,000 are to cover miscellaneous expenses associated with the process.[86]

The current draft of the Road Map singles out the energy sector, wishing to kick start a process by which the private sector can participate in RE projects. Succinctly, the draft reflects the following main features:

- RE is Thailand's number one priority for the CDM. Specifically, there are four areas of priorities stipulated in the CDM Road Map:
    - Energy efficiency in buildings, cooling, boilers, fuel switching, and renewable energies (specifically, biomass, solar, wind, waste recovery, micro- and small-hydros, bio-energies, and biogas from livestock, garbage, and factories)
    - Industrial sector energy and processes
    - Transportation sector
    - Waste-to-energy projects

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85 The coup d´etat in the middle of September 2006 raises new uncertainty regarding the further process of finalising the DNA structure and procedures.

86 http://www.onep.go.th/CDM/en/cdm.html (accessed on 30.08.2006).

- Project criteria include, but are not limited to, six areas of consideration: That the proposed CDM project
  - Is voluntary
  - Is technically sound
  - Meets local sustainability
  - Meets long-term sustainability of the country
  - Is consistent with local laws and regulations, and lastly
  - Allows participation of local communities.

Specifically, the local sustainability criterion includes the usual three pillars of sustainability: environment, social and economic dimensions. The Draft Road Map gives more details on indicators which measure various aspects of each dimension (see Annex 7).[87]

In terms of documentation, the Thai DNA requires the following documents for project approval:

- Project submission form (which has not been designed yet)
- Project Design Document (PDD)
- Letter of approval from a related ministry (i.e., Ministry of Energy)
- Proof of qualification of the project developer(s)
- Validation report
- Initial Environmental Evaluation
- Intellectual Property Rights Agreement
- Project Evaluation Fee (Baht 15,000)

These are common documents for project approval, but most of the related forms have not yet been produced by the DNA.

6.5.4 Project Portfolio

Enabling the DNA to operate efficiently is a critical issue voiced by many CDM participants in Thailand. The DNA office is faced with a large number of CDM candidate projects waiting at its doorstep. In early 2006, there were some 30 projects awaiting an official nod

[87] For a general discussion of sustainability indicators see Olhoff et al. 2003.

(see Annex 8). Almost half of these are supported by Japan and at least a further quarter by Denmark. Two-thirds of them are in RE, but only biomass or biogas. This reflects what kinds of projects can be expected from the CDM in Thailand in the near future. A more recent, detailed project pipeline could not be obtained. However, as of August 2006, the UNEP Risø CDM analysis lists a total of 12 CDM projects from Thailand in the pipeline, eight in biomass energy, three in biogas and one landfill gas project, with an expected amount (by 2012) of 9,331 kCERs (Fenhann 2006). There is also one biogas wastewater management project being developed with the involvement of the German Technical Cooperation Agency GTZ (ENVIMA/Perspectives 2006).

6.5.4.1 Analysis and Some Conclusions on Present RE-CDM PDDs in Thailand

In early 2006, a number of PDDs from Thailand were presented on the UNFCCC CDM websites. These were analysed in order to draw some conclusions on the structure and emission estimates of CDM projects being developed in Thailand. However, during the last months until August 2006, no new PDDs appeared on the UNFCCC website, which is an indication for the slow progress in Thailand's CDM process.

The portfolio of eight available PDDs[88] from Thailand is dominated by bioenergy projects, but with differing characteristics. When electricity or heat is produced from biomass – be it from wastewater, solid biomass or others – the conventional electricity (or electricity mix) or heat substituted makes up one part of the emission reduction to be calculated. Another one may be the CH_4 (methane) that is released into the atmosphere if the biomass is not used for energetic purposes. Since methane has a global warming potential of 21 on the one hand, and biomass in different forms plays a major role in the Thai economy on the other hand, these issues will be assessed in more detail below.

It is important to note that these analyses are based on the calculations done in the PDDs, and that mistakes or miscalculations done there cannot be judged regarding their liability. Since already a lot of biomass energy projects exist, e.g. under the SPP programme, some Thailand-based experts have raised doubts regarding the additionality of the projects proposed for the CDM.

[88] Source: cdm.unfccc.int, 5 projects under "validation" and 3 in the "archive", as of 26 January 2006.

Once the DNA has started its work and Thai projects will be examined by the Executive Board, issues such as additionality of the projects will be clarified. Probably this might add new aspects for Thailand's internal discussion about the role of CDM as an instrument to foster renewable energies.

6.5.4.1.1 Additionality

Analysing the demonstration of the additionality of the project activities proposed helps understanding CDM options in the Thai energy sector.

Although the project type "Bio-energy cogeneration" – the subject of the PDDs from Dan Chang and Phu Kieo – is not new to Thailand, the project developers argue that the CERs would generate the additional benefit that is necessary to introduce more efficient, state-of-the-art-technology. In addition, the energetic use of cane leaves is claimed to be new and adds to the CERs a smaller ratio of methane reduction (between 11 and 13% of the CERs from CO_2 reduction) (Dan Chang Bio-Energy Co., 2005). If true, the CDM would in this case fulfil its original purpose, to support additional projects which introduces new, more efficient technologies.

Regarding the wastewater treatment projects in Nakorn Ratchasima and Chachoengsa, GHG reductions do not come from electricity substituted. Instead, heat from fossil fuels and rice husks is substituted by producing heat from methane capture. According to the PDDs, the "returns from the sale of electricity are insufficient to justify the system upgrade". Thus, the returns from the CERs supposedly make the project economically viable and thus additional. As outlined above, there has so far been no political initiative – besides RE targets being announced – to tackle the RE potential for heat production and the reduction of fossil fuel in this type of energy demand. In this case, the CDM therefore sets important incentives to increase financial viability of these projects in a field where no relevant support systems exist.

Table 6.15: CDM Projects in Thailand

	CDM project	Electricity capacity/ average annual generation	Average annual CO_2e reductions (tonnes)	Method of CO_2e reduction	Baseline and monitoring methodologies applied	CER buyer/project partner
1	Wastewater Treatment with Biogas System in a starch Plant for Energy & Environment Conservation at Nakorn Ratchasima (only heat substituted)	-	217,330	(i) by avoiding the release of methane from open lagoons into the atmosphere, and (ii) by replacing the existing fossil fuel used for process heating	AM0013/Version 2	Denmark
2	Wastewater Treatment with Biogas System in a starch Plant for Energy & Environment Conservation at Chachoengsa (only heat substituted)	-	204,489	(i) by avoiding the release of methane from open lagoons into the atmosphere, and (ii) by replacing the existing fossil fuel used for process heating	AM0013/Version 2	Denmark
3	Small-scale Ratchaburi swine farms biogas project	14,977 MWh[89]	100,380	(i) CH_4 and reduction in the indirect emissions of GHG associated with bought-in grid electricity, (ii) by virtue of biogas capture and on-site power generation	Type III.D – Methane recovery (AMS-III.D) Type I.C – Thermal energy for the user Type I.D – Renewable energy generation for a grid (AMS-I.D)	Denmark

89 Estimate by the author, no clear indication in PDD.

4	Phu Khieo Bioenergy co-generation	41 MW/ 209,583 MWh	99,031	(i) displacement of CO_2 emissions from electricity generation by other sources (displacement of grid electricity); and (ii) avoidance of CH_4 emissions from uncontrolled burning or decay of biomass	ACM006, Version 01, Sectoral Scope: 01, 30	Denmark
5	Dan Chang Bioenergy co-generation	41 MW/ 195,129 MWh	92,177	(i) displacement of CO_2 emissions from electricity generation by other sources (displacement of grid electricity); and (ii) avoidance of CH_4 emissions from uncontrolled burning or decay of biomass	ACM006, Version 01, Sectoral Scope: 01, 30	Denmark
6	Korat Waste to Energy project	3 MW / 18,333 MWh	323,046	(i) fugitive methane mitigation; (ii) fuel switching to use biogas; (iii) electricity generation to use biogas	AM0022	IFC-Netherlands Carbon Facility ("INCaF")
7	Surat Thani biomass power generation project in Thailand (small scale)	9.9 MW/ 61,679 MWh	196,314	(i) Substitution of fossil fuel intensive grid electricity; (i) burning unutilised biomass reduces methane emissions	ACM0002	N/A
8	Jaroensompong Corporation Rachathewa Landfill gas to energy project	1 MW/ 7,200 MWh	99,139	(i) combustion of LFG from the Ratchathewa landfill site through electricity generation; (ii) displacement of grid electricity	ACM0001	N/A

6.5.4.1.2 Emission Reductions from Sources other than Electricity Generation

As has been shown above, already today – without one CDM project approved – bioenergy is the dominating project type when looking at Thailand's "modern" renewable energy portfolio (except for large hydro). But this has almost exclusively been limited to solid biomass. Many of these projects are already economically competitive under existing conditions. Another option is biogas from different sources.

The use of biogas on the one hand offers the opportunity to reduce emissions from methane, which, having a Global Warming Potential of 21, can gain significant extra CERs compared to the sole reduction of GHGs from fossil energy electricity substitution. On the other hand, thermal energy from fossil fuels can also be substituted by biogas. To assess the role that especially methane reduction can play in the CDM context, the ratio of CERs from methane reduction to the CO_2 CERs from electricity reduction has been calculated. It has to be mentioned that two projects also include a small share of CO_2 reduction from fossil heat substitution.

Table 6.16: CER-Based Analysis of 6 PDDs from Thailand

Annual average	CERs from electricity substitution	CERs from methane reduction	CERs from CO_2 reduction other than grid electricity substitution	Ratio $CH_4/CO_{2\,elect}$	Ratio $CERs_{non\text{-}elect}/CERs_{elect}$
Small-scale Ratchaburi swine farms biogas project	7,938	88,639	4,572	11.20	11.74
Phu Khieo Bioenergy co-generation	89,795	12,078	-	0.13	0.13
Dan Chang Bioenergy co-generation	84,374	9,768	-	0.11	0.11
Korat Waste to Energy project	10,881	283,258	29,557	26.03	28.86
Surat Thani biomass power generation project in Thailand (small scale)	23,743	119,528	-	5.03	5.03
Jaroensompong Corporation Rachathewa Landfill gas to energy project	4,176	94,963	-	22.74	22.74

The Ratchaburi swine farm project shows a ratio of 11.2, whereas the Surat Thani project, using empty fruit branches from palm oil milling process, shows 5.03. The landfill gas project in Ratchathewa and the Korat Waste to Energy project have outstanding ratios of 22.74 and 26.03 respectively. From this analyses we can conclude that the reduction of methane leads to a significant extra benefit for these projects, which is much more important than the displacement of fossil fuels through the generation of electricity.

6.5.4.1.3 CER Revenues per Unit of Electricity Produced

Assuming that the primary objective of RE promotion in the electricity sector is the generation of kWh or MWh, it is interesting to have a look at the potential benefits from the CDM. Calculating the ratio of CERs per MWh generated indicates where the CDM plays an important role to foster electricity generation from renewable energies. The Korat Waste to Energy Project (17.62) and the Ratchathewa Landfill Gas Project (13.76) dominate this analysis with their high share of methane, followed by Ratchaburi Swine Farms Biogas Project (6.7) and Surat Thani Biomass Project (3.18). This analysis could be broken down to financial revenues per kWh, based on an assumed CER price of € 10 and a currency exchange rate of Baht 47 / € (as of 15 February). The ranking of the different projects does not change, but when comparing the revenue with the average price paid per kWh in Thailand, the additional economic benefit through the CDM becomes very obvious. The Korat Project (Baht 8.28) and the Ratchathewa Project (6.47) can benefit from gains that approximately triple the average kWh price in Thailand of Baht 2.42 /kWh (Provincial Energy Authority, see DEDE 2004a). This CDM impact would increase significantly when assuming CER prices double or trice as high.

Table 6.17: CERs and Revenues per kWh Produced from 6 PDDs

	Average CERs/MWh	CER revenue Baht / kWh*	Estimated generation cost per kWh[90]
Small-scale Ratchaburi Swine Farms Biogas Project	6.7	3.15	2.7-3.5
Phu Khieo Bioenergy Co-generation	0.47	0.22	2.8-3.8
Dan Chang Bioenergy Co-generation	0.47	0.22	2.8-3.8
Korat Waste to Energy project	17.62	8.28	4 – 6[91]
Surat Thani Biomass Power generation project in Thailand (small scale)	3.18	1.49	2.8-3.8
Jaroensompong Corporation Rachathewa Landfill Gas to energy project	13.76	6.47	4 – 6[92]

*based on € 10 per CER; 47 Baht / €;

It has been mentioned before that the PDDs have not yet been examined by the UNFCCC Executive Board, and this uncertainty has to be kept in mind when considering interpretations and conclusions.

These results doe not mean that the projects that are not based on methane reduction and consequently have less CER revenues, such as the two bioenergy co-generation projects in Phu Kieo and Dan Chang, will not benefit from the CDM. But their climate and thus financial benefit is limited to the substitution of electricity from the grid, and the extra value of the

90 The PDDs do not contain figures on the electricity generation costs. Thus, estimates from literature are referred to (see Table 6.13).

91 See Greacen/Loy 2006

92 See Greacen/Loy 2006

CERs is little compared to the revenue from the electricity sold. This result is confirmed by other studies that analyse the CDM impact of RE project's viability (ONEP 2005).

This would also be the case for solar or wind energy projects for which no data are given here, since no PDDs for these project types are available now. These are generally assumed to be less cost-effective renewable energy technologies when reduced to their climate benefits. But when thinking from the point of view of Thai energy policy, based on the objective to increase electricity generation from RE – and to become less import dependent - the potential of the CDM to contribute to this objective might be judged by focusing on this criterion. The question should be raised whether CDM activities should be focused on these most-effective methane-based project types, while support for others – like wind or solar energy – should be given through other, probably more effective policy instruments.[93]

6.5.4.2 Biofuels for Transport and the CDM

Liquid biofuels for transport play an important role in Thailand's current renewable energy discussion. This was also highlighted by the commentator Dr. Pongpisit Visetkul during our February workshop in Bangkok (Visetkul 2006). To address this discussion, we will briefly review the current state of liquid biofuels for transport in the CDM. However, it needs to be remarked that only very little literature dealing with this issue exists.

In countries where agriculture plays an important role, possible effects of increased biofuels production such as rising prices for agricultural commodities due to increased demand, competition for land cultivated for other purposes such as food production, or the extension of agricultural production to areas of high ecological value such as tropical rainforests have to be considered very carefully. There is not a general answer on the net sustainability balance of biofuels production. Rather it is a very complicated issue depending on many factors such as the plant used, the area cultivated etc.

As of September 2006, not even one CDM project in the field of biofuels for transport has been registered. One key reason is that the methodologies for biofuels are very controversial, so far not one has been approved by the CDM Executive Board. For example, a PDD for the "Khon Khaen fuel ethanol project" together with a proposed methodology was originally

[93] Some calculations on this idea are presented in Annex 6.

submitted to the Executive Board (EB) in October 2004 (methodology NM0082) (Khon Khaen 2004), but has so far not been approved. The methodology development process of this project in Thailand gives some insight into the complex nature of determining the emissions and emissions reduction in such a project. The use of biofuels – be it ethanol or biodiesel – is not per se CO_2-neutral, since systematic agricultural production of the resources used causes emissions of greenhouse gases, although varying from plant to plant. Large-scale biofuel production often relies on the use of synthetic fertilizers. Usually these are produced with high energy intensity and lead to significant indirect N_2O emissions. Table 6.18 gives an overview of the aspects that need to be included for a life-cycle analysis:

Table 6.18: Life-Cycle Analysis of Emissions from the Production of Transport Biofuels

Production and Calculation Process	**GHG emitted**
Diesel consumption during agricultural operations	CO_2
Emissions associated with fertiliser production and use	CO_2, N2O
Emissions associated with field burning of crop residues	CO_2
Emissions associated with transport of cane to the sugar/bio-ethanol factory	CO_2
Emissions from the industrial production of bio-ethanol	CO_2
Emissions associated with the transport of bio-ethanol to the place of blending/distribution	CO_2

Source: CDM Meth Panel 2006

This complicated assessment may also be the reason why a wide range of results of the net emission reductions of different types of biofuels has been reported (see e.g. Larson 2005).

The abatement costs are another important factor for the application of the CDM to biofuels. No data on Thailand could be found, but studies on other countries show a wide range of cost estimations (see Figure 6.16), which is not surprising given the differing estimations of net emission reductions. When analysing the potential benefit of the CERs on biofuels projects´

financial viability, another study underlines that they play a very minor role, increasing the return on equity (ROE) by approximately 1-2% (ONEP 2005).[94]

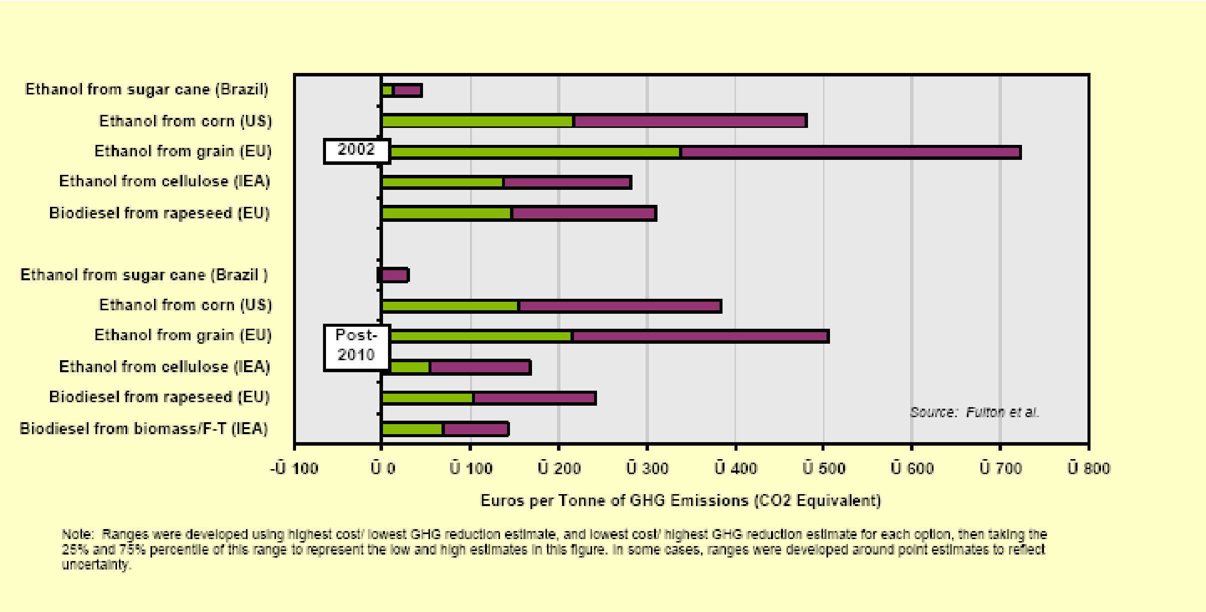

Figure 6.16: GHG Emission Reduction Costs of Different Biofuels in Different Regions

Source: Taken from GTZ 2006

There are thus various reasons why CDM as a means to foster large-scale biofuel production should be considered very carefully, with no reason for high expectations. At present, there is no reason to expect that the CDM will play a major role in the biofuel expansion planned in Thailand.

6.5.5 Capacity Building Activities and Needs

Several workshops on the CDM have so far been held in Thailand. The Japanese Institute for Global Environmental Strategies (IGES) informed about 30 selected participants in two seminars about the CDM process. The World Bank carried out one workshop with more than 100 participants in cooperation with the Japanese and the Danish government (Tummakird 2005). The Danish government has further been involved in trainings on the CDM in general and PDD preparation in particular.

[94] The study assumes a CER price of US-$ 5 per tonne.

Policy makers as well as industry and civil society representatives are thus being exposed to much capacity building efforts from a cross section of donor countries and research institutes. However, the Thai public is not necessarily being addressed by these capacity building initiatives. Whether the Thai public is well-informed about the CDM or not is a pertinent question because one of the requirements for CDM project approval is consultation of the stakeholders. Prior to the ratification of KP, rather limited awareness raising activities were conducted by relevant governmental agencies. On-going awareness raising activities then came mainly from non-governmental organizations (NGOs) and universities. As a result, the ratification was almost an isolated official decision. There have been some efforts by NGOs to guide communities in a participatory approach to making energy related-decisions. The public needs to be further empowered to ensure that they can participate fully in the stakeholder consultation process required under the CDM.

6.6 Barriers to Renewable Energy Dissemination in Thailand

The development and use of renewable energy sources in Thailand are facing several barriers that have to be addressed to widen production and usage and to achieve the targets set by the government. The barriers are grouped according to Painuly / Fenhann (2002; see chapter 2.2).

It is important to remark that there are some general barriers while others relate to specific RE sources, such as the limited wind energy potential or the much higher costs for photovoltaic technology. For biomass, the need for constant supply produces specific characteristics.

6.6.1 Financial and Economic Barriers

As with most countries in the world, the Thai energy portfolio is still dominated by fossil fuels. Under existing market conditions, where negative externalities of fossil fuels are only to a very limited degree incorporated in energy and electricity prices[95], **specific renewable energy costs often are still above conventional energy prices**. Especially wind and solar electricity are still far from being competitive at the current average electricity price. This is one reason why there is a growing debate about further incentives like fixed feed-in tariffs differentiated according to the differing costs. Several participants of the Bangkok workshop

[95] The ENCON Fund is financed by a levy on petroleum products, which could be interpreted as some kind of first step of internalisation.

remarked that the existing support schemes are still not sufficient to cover the costs and to guarantee an appropriate minimum internal rate of return that attracts the necessary investments (see also Greacen/Loy 2006). In addition, **subsidies for fossil fuels** produce an unlevel playing field. For example, in 2005 fossil oil consumption was subsidised with more than 2 billion dollars (ADB 2006).

One major problem of financing RE also found in Thailand is the relatively **high specific upfront investment costs** compared to fossil fuel technologies (AIT et al. 2005; Shrestha et al. 2006; see also GTZ 2004a). The upfront cost problem especially holds true for smaller systems which cannot realise the economies of scale of larger systems. In the case of fossil fuels, costs are to a higher extent spread over the whole system lifetime (though there are additional risks from uncertainty about resource prices).

In addition, financiers may consider such projects **highly risky**, which leads to costly high-risk premiums (Wilkins 2002). But it is very likely that this situation is changing with the growing experience with renewables. Moreover, developments like the rise in oil prices lead to an increasing awareness of the risks of fossil fuels which are often understated when compared with RE (Sonntag O´Brien/Usher 2004).

In the case of biomass, the **availability and price of the resource** used influence the financial viability of projects. The situation differs with the type of resource used and the area in terms of agricultural structure. For example, in the field of bagasse the producers of biomass generally are identical with those who use it for energy purposes. However, the case of rice husks, for instance, is different since most of the rice mills are too small to use the husks for electricity generation. This leads to a situation where a rice husk-fired plant relies on purchasing rice husks from a number of millers. For example, a power plant developed by AT Biopower relies on purchasing rice husk from at least 30 rice mills (Watanatada 2004). Opening up a power plant – or even more than one – in a certain area could lead to rapidly increasing demand and thus rising resource prices (Interviewee A[xxiii]). This could raise electricity generation production costs, or lead to shortcomings in resource supply, both impacting the financial viability of a project. For a project developer, securing long-term fuel supply, e.g. through contracts, is very important, but can also be difficult (Wilkins 2002). The price increase in biomass is already being felt today and affecting business, as was reported by one workshop participant. Since even today electricity generation from biomass is the most important modern RE technology in Thailand and given the plans to expand biofuel production and domestic use, this development has to be watched carefully when designing further support systems.

6.6.2 Institutional and Political Barriers

In the past, **insufficient coordination** within the government, meaning between different bodies responsible for energy-related issues, has been described as one major barrier. In late 2002, Sajjakulnuki et al. referred to the varying functions and responsibilities in energy-related issues and identified poor coordination of these as an important institutional barrier (Sajjakulnuki et al. 2002). Lack of coordination when several actors are involved may complicate planning of activities, impact on the effective enforcement of regulations and also prolong decision-making processes. Even the allocation of stringent responsibilities was absent. The situation improved after the establishment of an own Ministry of Energy in 2002, "the outlook is better", as Berthold/Dewey state (Berthold/Dewey 2004). However, there are still different bodies involved: the Energy Policy and Planning Office and the Department of Alternative Energy Development and Efficiency (DEDE) within the Ministry of Energy; and now with CDM the Ministry of Environment and Natural Resources also plays a more important role in discussions about energy, since climate policy is strongly linked to energy policy. Sometimes different ministries are involved when certain types of technologies are applied. For example, in the case of biomass the Ministry for Agriculture is involved (Shrestha et al. 2006). In addition, since other institutional responsibilities are also affected by energy legislation, the intra-ministerial discussions are accompanied by interventions by, for example, the Ministry of Industry (Interviewee A[xxiii]). This situation creates some uncertainty for investors, as was also remarked by participants of the Bangkok workshop from the business sector.

At least for bioenergy, improvement can be expected from the establishment of the Biomass One-Stop Clearing House (BOSCH)[96], which has been established to provide high quality and professional services to potential clients on anything relating to biomass, i.e. information, promotion and utilisation.

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96 Further information on BOSCH is available at http://www.efe.or.th/index.php?option=content&task=section&id=3&Itemid=26 .

As for renewables in general, however, the shared responsibilities also lead to **lack of policy clarity**. Setting clear targets and schedules for RE dissemination as has been done in Thailand is one important step towards investment security (GTZ 2004a). However, the longer the specific policies and measures await implementation, the higher the risk that distrust towards the political will to foster renewables grows among investors and project developers. Interviewees in Thailand discussed the "struggle" over the right support system (and how it should be designed) in the electricity sector, be it an RPS or a kind of feed-in system, as hindering since it has been going on for about two years. While the DEDE prefers the feed-in system, the EPPO works towards the implementation of the RPS (Interviewee D[xxv], Interviewee A[xxiii], Interviewee C[xxiii]). Workshop participants also referred to the lack of clarity about the Government´s strategies to create the necessary conditions for the achievement of the targets. This is in part also due to conflicting political interests.

Another problem is **conflicting objectives leading to a lack of coherence**. On the one hand, the Ministry of Energy is striving for cheap energy prices; on the other hand the Ministry set ambitious RE targets which most probably will put a certain upward pressure on energy prices (Interviewee D[xxv]).

Another policy barrier lies in specific characteristics of the support systems put in place so far. As Berthold/Dewey (2004) point out, how the SPP and VSPP systems promote REs is very much **dependent on buy-back tariffs set out by EGAT**: **"**Adjustment of those tariffs to encourage more participation of new RE power generation is dependent on how EGAT's internal policy could fit the overall government energy policy". This describes the situation that the player still dominating the electricity market – EGAT – has significant influence on the conditions that allows new players – which are competitors for EGAT despite their much smaller size - to enter the market. The same is reported by Wilkins (2002) for the Provincial Electricity Authority in the case of biomass cogeneration projects and was also underlined by one workshop participant. Berthold/Dewey (2004) also criticise the systemic SPP bias in favour of large-scale and low-production cost SPPs, which bears comparative disadvantages for smaller-scale or higher-cost projects. The crucial point is that a **uniform buy-back tariff** is paid for electricity produced, without differentiating between smaller and larger-scale projects, of which the latter ones can better realise economies of scale and thus operate with less costs. In Germany, for example, there is a differentiation of feed-in tariffs according to the plant size, to balance this scale disadvantage to a certain extent (Bechberger/Reiche 2006b).

A major barrier, which can be solved politically, is the **lack of provisions for guaranteed fair and non-discriminatory access to the grid** and their enforcement. These are necessary to create a level playing field between small generators and the grid operators and to speed up RE technology implementation. There has been some hope expressed by an interviewee (Interviewee C[xxiii]) that the CDM can encourage policy makers to open the grid. The SPP has opened the grid temporarily for eligible small producers but it is not clear whether the energy ministry will do this for a CDM project developer.

6.6.3 Technical Barriers

One important technical barrier seems to be the **lack of technical standards** and **inadequate technical design –** meaning, for example, neglect of the users´ needs (see e.g. DENA 2005, Berthold/Dewey 2004; Sajjakulnukit et al. 2002; AIT et al. 2005; Prasertsan/Sajjakulnukit 2005). Interested consumers therefore find it difficult to identify products that are reliable and stable regarding their performance or quality. Having had negative experience with a certain PV system, for example, often leads to the rejection of the use of PV in general. For biomass-based technologies, there is lack of standards for assessment of performance that hinders their development and implementation (Prasertsan/Sajjakulnukit 2005).

In this context, Interviewee D[xxv] also mentioned technical problems when connection to the grid is sought under the VSPP or SPP programme, since negotiations over the technical conditions imposed by the Provincial Electricity Authority lead to a longer waiting time until operation can start (see also Greacen/Loy 2006).

Specific RE **technologies** in Thailand are **not yet sufficiently developed**. For example, existing biogas digesters remain overly sensitive to the quality of the organic matter utilised. The technology requires frequent maintenance and a major overhaul every 3-5 years due to corrosion problems that are caused by the presence of hydrogen sulphide in the biogas (Amatayakul/Greacen 2002). Green refers to similar problems in the case of PV projects (Green 2004).

6.6.4 Awareness / Information / Capacity barriers

Different studies list the **lack of information and awareness about RE** in general as one important barrier. They identify this barrier on the side of the consumers as well as on the side of investor (DENA 2005; Shrestha et al. 2006; Prasertsan/Sajjakulnukit 2005).

This is especially valid for wind energy. In most of the literature the wind energy potential is described as being very limited (see e.g. EPPO 2003a; DENA 2005; AIT et al. 2005). When looking at DEDE's official report on the state of renewables for example, it seems as if the figures of the World Bank's wind energy assessments were not known or at least not incorporated. DEDE's analysis lacks data for most of the country (DEDE 2004b), although the World Bank Southeast Asia Wind Energy Atlas has made such an assessment. Wind energy use in Thailand also suffers from **a lack of sufficiently accurate wind data** to allow wind site identification and **a low level of technology development, local manufacturing and distribution capacity** (BCSE 2005). However, since internationally wind energy is one of the technologically most advanced and cheapest RET, there is most probably enough wind energy potential that makes sense to be exploited, as for example Meetam or the Australian Business Council for Sustainable Energy argue (Meetam 2005, BCSE 2005).

Sajjakulnukit et al. also mention the **lack of success stories** as an information barrier. In their perception, successful cases of RE applications are still limited. It is felt that demonstration of successful cases is essential to build confidence in RE within the private sector as well as among consumers (Sajjakulnukit et al. 2002; AIT et al. 2005).

Decentralized RE systems are at present often the most feasible option where there is no access to the grid (BCSE 2005), at least as long as the opportunity to feed in electricity generated is lacking. People sometimes neglect and disconnect existing decentralised RE systems when their communities get connected to the grid. They **perceive** these **technologies as old-fashioned** (Shresta et al. 2006). This has for instance been reported for small hydropower installations (DENA 2005; BCSE 2005; Greacen 2004).

Especially for decentralised use of small-scale RE technologies, such as PV, it is important that the **users are adequately educated** on how the systems work, warranty issues etc., and also what are the limits of the technology in order to avoid unreasonable expectations, followed by discontent (Interviewee C[xxiv]; Interviewee A[xxiii]; Hirshman/Ruppik 2006). Especially in rural areas, capacity building is needed to ensure the sustainable functioning of such technologies. Prasertsan/Sajjakulnukit see a lack of adequate technical experts in biomass gasification, due to limited experience with, and competitiveness of the technologies (Prasertsan/Sajjakulnukit 2005).

Inefficient means of data collection and information transfer have been identified as another barrier by Sajjakulnukit et al (2002). Especially with more complicated technological processes such as with biomass conversion, information such as burning characteristics of particular types of biomass and collection, preparation and transportation costs are very important for project developers, energy planners and equipment manufacturers but are often not available.

A barrier related to biomass power plants is the issue of externalities**,** such as air pollution, from biomass conversion. There are examples that these are a cause of alarm and concern for local communities. AIT et al. (2005) also note social discontent related to small hydropower plants. Sometimes people hesitate to accept any type of new plant in their surroundings due to negative previous experience with for example coal power plants (AIT et al. 2005). In many cases, part of the problem can be resolved by applying abatement technologies which reduce external effects. If the proposed project does not produce significant negative externalities, the **lack of acceptance** probably can often be overcome through better information on the benefits of RE and the inclusion of the people into the planning process.

Table 6.19: Overview of the Barriers Identified

Barrier type	Barrier	Effect/Impact
Financial & Economic	High specific generation costs	Renewable energies cannot compete with conventional energy sources, higher risk premiums
	High specific upfront investment costs	Renewable energies cannot compete with conventional energy sources, higher risk premiums
	Risk of resource availability and procurement security	Entails financial risks, complicates financial calculations, may lead to higher costs
Institutional & Political	Insufficient coordination between responsible government agencies	Hampered policy preparation process
	Lack of policy clarity	Increasing distrust in government's will to foster RE, investors hold back investments
	Conflicting objectives and interests amongst policy makers	Shifts power to powerful lobbyists, hinders objective policy formulation, lack of coherence of policy
	Electricity tariffs set by one dominant market actor, EGAT	RE expansion depends on fitting in with EGAT's objectives
	Uniform tariff	Favours large-scale, low cost providers, thus produces systemic disadvantage for REs, strengthens power of conventional suppliers
	Lack of provisions for guaranteed fair and non-discriminatory access to the grid	Increasing investment insecurity, especially decentralized, small-scale RE potential will remain unrealized and will be kept out of the market
Technical	Lack of technical standards and inappropriate technical designs	May lead to low-quality equipment, raises transaction costs for consumers identification of appropriate products
	RE technologies not yet sufficiently developed	Increased costs, reduced uptake
	Negative externalities (e.g. air pollution from biomass projects)	Lack of social acceptance may hinder project implementation
Awareness / Information / Capacity	Lack of information and awareness	Prevents uptake of RE
	Perception that potential only limited (especially wind energy)	Neglect of existing potential
	Lack of RE success stories which create positive image	Consumers/investors underestimate and mistrust benefits and potential of REs
	Perception of RE as old-fashioned	Neglect and disconnection of installations
	Inadequate, insufficient education of consumers/RE system users	Technology breakdown, exaggerated expectations followed by discontent
	Inefficient means of data collection and information transfer	Insufficient information basis may lead to no or wrong decisions of project developers, investors etc.
	Lack of social acceptance	Local resistance to RE installations

6.7 The Potential of the CDM to Overcome Barriers to the Implementation of Renewable Energies in Thailand

6.7.1 Financial and Economic Barriers

The CDM is supposed to overcome financial barriers to carbon reducing activities in developing countries, such as **high specific generation costs** of RE. However, energy from biomass incineration is already competitive in Thailand, especially if a company produces enough biomass as a by-product to fuel one power plant. Participants of the February workshop also mentioned their doubts about the additionality of biomass projects and one even expressed his view that project developers purposely calculate their projects in a way to make the CDM appear to be necessary for their financial viability (Interview D[iii]). However, this assumption could not be verified through the literature. It will be important how the CDM Executive Board will decide on biomass projects' performance in this regard when the first project from Thailand is submitted for registration.

By contrast, wind and PV applications are not yet competitive. However, these project types usually reduce only CO_2 emissions rather than emissions of the other, more potent, Kyoto gases, and in particular PV applications are usually small-scale, dispersed activities. The CER yield is therefore relatively low. This situation is further exacerbated by the low carbon intensity of the electricity mix of 500.8 g CO_2/kWh, which ranks Thailand number 63 in the CAIT database, which compares unfavourably to countries like China (916.2 g CO_2/kWh, Rank 11) or India (896.1 g CO_2/kWh, Rank 13) (WRI 2006b). At a price of € 10 per CER and 47 Baht / €, the CDM would add Baht 0,235 per kWh, which is nowhere near enough to close the gap between current electricity tariffs of about 2.5 Baht and the cost for wind energy and PV, which are 5-6 and more than 10 Baht respectively (see Table 6.13).

The other key financial barrier are the **high specific upfront costs** of RET. Here the CDM may actually exacerbate the problem since the project cycle projects have to undergo entails high transaction costs. Most of these occur at the front end of the project, that is, they add to the disadvantage of RET. On the other hand, the CDM could become a solution to the upfront cost problem if buyers were willing to frontload their payments. In this case RET project developers would receive the CER revenues when they most need them. However, while there are some purchasing programmes were this is possible, this transaction model is far from becoming the dominant one.

Thus, although the CDM can support RE by bringing in carbon finance, there may be much more powerful mechanisms that promote these alternative energy sources, such as a feed-in-tariff, that are already being discussed in Thailand (see e.g. Greacen/Loy 2006). Several workshop participants highlighted the importance of higher electricity tariffs to make RE projects more competitive.

A study compiled in late 2005 analyses the financial impacts of CERs and a higher tariff for RE electricity respectively and shows interesting results in this regard (ONEP 2005). For example, for a 5 MW biomass back pressure plant that at present receives 2.2 Baht/kWh from the SPP programme, raising the tariff to 4 Baht/kWh would increase the return on equity (ROE) by more than 30%, while the sales of CERs would have an effect of about 3% at US-$ 5 per tonne. Even current CER prices of about € 10 would thus yield only about 6%. The results for mini hydro and wind power plants are very similar.

In the case of biogas electricity and biogas landfill projects, the CDM is a much more important factor, even at the relatively low assumed price of US-$ 5 per tonne. Here the CDM does significantly raise the profitability of RE applications since they reduce methane emissions which yield 21 CERs per tonne of methane reduced. The high yield might be used to cross-subsidize other more expensive RET applications. This idea is further outlined in Annex 10, which estimates the CER revenues from a Municipal Solid Waste programme (with a high share of methane) and how many kWh from other renewable energy sources (wind, solar, biomass and biogas) could be paid from this revenue.

However, the study also suggests that for projects which at present electricity tariff rates (2.20 to 3.40 Baht/kWh) have a very low or even negative return on equity, such as PV, biomass condensing plants (7-10 MW) or biomass absorption cooling, the CDM may be the factor which lifts projects above the threshold of profitability, although with a still very low ROE. Although the calculations of the mentioned study present results which are more in another order of magnitude than is generally valid for each respective project type, these are helpful results (ONEP 2005).

6.7.2 Institutional and Political Barriers

In theory, the CDM might contribute to reconciling differences between the energy and the environment ministries. Since it offers investment incentives for modern and environmentally friendly energy (and other) technologies, it serves environmental as well as energy policy objectives. At the moment, though, the **insufficient coordination between responsible government agencies** and the **lack of policy clarity** which has been diagnosed for Thailand's RE policy is mirrored in its approach to the CDM. The government has in the past exhibited a very sceptical approach towards the mechanism and the ministry of energy has still not fully embraced the concept of the CDM (Interviewee B[xxvi]). This also becomes obvious in the renewable energy strategy which mentions a couple of incentive mechanisms but not the CDM.

Since the DNA has not yet given out any letters of approval, RE CDM projects actually currently face a barrier additional to those that hamper RE dissemination in general. The process of establishing and reforming the DNA indicates that effective coordination is still an important challenge. This obstacle also has been underlined by several interviewees and workshop participants to be of crucial importance. At least the political will to simplify the procedures by establishing a kind of one-stop institution has been expressed. This indicates that there is awareness on the coordination barrier among the government actors involved.

As regards the approval process itself, Jesdapipat (2006) criticises that most of the sustainable development indicators foreseen remain vague and their practical implementation is often difficult. For example, it is not clear if all of the indicators have to be met, while some may not be applicable in some cases, such as those regarding the amount of toxins in the soil and the conservation of underground freshwater. Another example is the sub-indicators for benefit distribution, which are health, knowledge dissemination, improved labour skills and others (which are not yet defined) and may not all be applicable to a specific project, either. Jesdapipat also recommends that a benchmark should be defined for these criteria to judge projects against. Finally, there is a requirement for a stakeholder consultation process but no details how this should be undertaken have been specified.

The Thai government has made RE projects a priority in the CDM. There seem to be a lot of expectations that CDM will play an important role to foster renewables, as also several participants of the workshop remarked.[97] Once approvals can be granted, Thai CDM projects may appear in great numbers, as there is a rather large backlog of project proposals in the Thai project pipeline (see Annex 8). In fact, some project developers have gone ahead with the official UN validation process anticipating that the Thai DNA will soon be operational.

However, even if the issues highlighted here were resolved, there would still be the barriers of **EGAT's dominant position in the electricity market**, the **uniform tariff** it pays which disadvantages RE and the **lack of provisions for guaranteed fair and non-discriminatory access to the grid**.

6.7.3 Technical Barriers

Evidently, the impact of the CDM as a finance mechanism on technical problems is rather limited. Being optimistic, one might hope that the acceleration of RET dissemination the CDM might (hopefully) achieve will catalyse further technology development to overcome the problems identified.

6.7.4 Awareness / Information / Capacity Barriers

Equally, the CDM might make an indirect contribution to overcoming awareness and information barriers. By adding a price tag to GHG emissions and thus opening new business opportunities, the CDM might help to raise awareness of climate protection in general and of RET in particular.

The obligatory stakeholder participation in the preparation process of the PDD offers the opportunity to inform local people about the benefits of RET and the overall climate policy background as well.

The CDM has brought numerous capacity building workshops to Thailand under various flags – governments such as Denmark or Japan, World Bank and other actors. These workshops mainly serve to inform about the international CDM process and do not necessarily address the difficulties when implementing RE technology. Nevertheless, the German Technology

[97] Interestingly, several participants not only referred to the financial incentive function of the CDM to support modern energy technologies but also expressed the expectation that the CDM will help to increase awareness of climate change and the need to reduce greenhouse gas emissions among industries for purely environmental reasons. One participant even criticised the government for neglecting the environmental dimension of this debate and focusing too much on energy security/import dependency concerns.

Symposium in Bangkok, for example, featured numerous RET and offered an opportunity for business people to exchange experiences in this field.

6.8 Conclusions and Options for Promoting RE CDM Projects in Thailand

As has been shown, first attempts to promote RE were already undertaken 15 years ago and since then a lot of experience with political instruments has been gained, although the share of renewables is still very small. For the years to come, targets have been set for the further increase of renewables in electricity generation, biofuels and thermal energy use. Especially with regard to electricity generation, the debate about the most effective instruments to achieve these targets is dynamic and ongoing. RPS and feed-in tariffs are gaining more attention. The CDM has so far played only a minor role in these discussions.

As can be concluded from the PDDs that were available in the past, projects including methane reduction bear the potential to become successful under the CDM and effectively and efficiently lower Thailand’s greenhouse gas emissions. Due to their higher investment costs and greenfield operations, other renewable energy sources will be more costly to set up and hence less likely to be supported by the market of global carbon finance. In addition, other regulatory energy policy instruments may be more effective in encouraging use of renewable energy sources in Thailand, as experience from other countries suggests. This leads to the conclusion that, when designing the next policy steps to foster RE development, it might be useful to discuss the role the CDM could and should play in the context of the overall energy policy setting. However, this could also mean looking for ways to most effectively combine domestic policy instruments with the CDM in order to maximise the increase of renewable energy use through maximising Thailand's CDM benefits.

6.8.1 Measures to Overcome Financial and Economic Barriers

6.8.1.1 Exploring “Programmatic CDM”

Recently, the international debate about sectoral approaches, “programmatic CDM” and “policy CDM” has increasingly gained importance and offers new approaches for CDM beyond single-site projects (see e.g. Sterk/Wittneben 2005; Figueres 2006; Ellis 2006).

COP/MOP 1 also opened the door to aggregate dispersed activities into "programmatic" projects, i.e. projects consisting of decentralised activities which are coordinated by one entity.

It might be worth to explore the option if CDM activities and governmental efforts to promote RE could be focused on those technologies with high CER revenues (such as Municipal Solid Waste or biogas), and complement – or even cross-finance – other domestic instruments which first of all serve other purposes than the reduction of greenhouse gases, such as feed-in tariffs (see Annex 10). However, since the feed-in tariff debate in Thailand is far more advanced than the clarification of opportunities and limits of the new CDM approaches, this discussion needs to be handled with care in order to not further slow down the decision-making process in Thailand. This could be a consequence when adjustment of domestic instruments to the sometimes very slow progress in international climate policy negotiations was sought for.

In the case of renewable heating and cooling, Thailand apparently still has no clear perspective of how to foster appropriate technologies. In this context, programmatic CDM approaches might offer opportunities, as can be concluded from a South African CDM project. The already registered Kuyasa housing project in South Africa consists of upgrading the thermal performance of low-income housing units, providing energy efficient lighting and solar water heating in more than 2,200 households by the City of Cape Town and the organization SouthSouthNorth.[98] Although some information suggests that the market of solar water heaters is saturated in Thailand (for the well-off households), this may gradually change with further increases in fossil fuel prices, especially in the Northern region where the heating demand is higher. Exemplary calculations show that e.g. biomass or biogas absorption cooling technologies can significantly profit from the CDM (ONEP 2005).

In addition, since the industrial sector is one of the major consumers of coal, renewable process heat offers some potential, which has so far mostly not yet been exploited. There is increasing experience with RE technologies for this purpose, for example with solar thermal

[98] See http://www.southsouthnorth.org.

systems developed in Germany.[99] Since the industrial sector's energy demand is one of the key areas identified in the government's CDM strategy, a "programmatic renewable heating CDM project", e.g. with solar thermal applications, could be an option to enter an area that has been relatively neglected so far, also when looking at the whole range of CDM projects registered.

Although no information could be obtained on how much electricity is consumed by air conditioning in Thailand, it can be assumed that the demand is high especially in the southern areas that are much visited by tourists. Solar thermal applications for cooling offer the opportunity to use solar energy when peak supply coincides with peak demand for air conditioning. Supporting the design of a programmatic CDM project that addresses this situation could widen the portfolio of technologies applied in Thailand and in the CDM in general. Project developers´ involvement can be supportive. Foreign governments could also play a role to support such an approach, e.g. through capacity building or financing part of the development costs and buying CERs. This could work as a kind of start-up financing in order to facilitate the learning process with "programmatic CDM".

6.8.1.2 Offering Fixed Tariffs for Renewable Energy Electricity

As is already being discussed in Thailand, fixed feed-in tariffs for RET in the field of renewable electricity generation are an approach to offer investment security for, and attract investments in RET. The experience from several countries suggests that this is an important factor to bring down the costs of these technologies since the realisation of economies of scale depends on a stable investment perspective. For example, in Germany the "Renewable Energy Sources Act" (EEG) resulted in a doubling of the share of RE electricity between 1999 and 2005 (from 5,4% in 1999 to 10,2% in 2005). The most important components of the EEG are:

- Guaranteed access to the grid for independent RE producers
- Guaranteed tariffs for RE electricity fed into the grid over a certain period (e.g. for 20 years beginning with the commissioning of the RE plant), paid by the grid operator
- Technology, site and size-specific tariffs

[99] See e.g. http://www.solitem.de; the technologies developed by the company Solitem have received several prizes and are increasingly being installed, e.g. in the Turkish tourism sector.

- Decreasing support for new installations (e.g. an annual digression factor of 2% for wind energy and 5% for PV)

- Financing of the feed-in RE electricity by all electricity consumers.

A basic pillar of the German approach is that it does not see RE promotion from a least-cost perspective on renewables as a whole but recognises the differing costs of different sources and also the different technological development status. That is why PV is guaranteed a price about eight times the amount paid for one kWh of wind power. But the digressive support for new installations provides incentives to bring down the costs. The tariff paid per kWh is performance-based which also is preferable to a capacity-based support mechanism, which is often applied without appropriately guaranteeing the systems´ continuous performance.

The fact that Thailand's electricity grid reaches most of the population is supportive of establishing such a nation-wide framework, in order to distribute the costs among a large number of people and thus reduce the costs for each individual. German experience also shows that a sound information basis is important to set the tariffs, the previous work done on this issue may therefore prove very helpful to set the tariffs appropriately. Inclusion of science and project developers as well as manufacturers is important to consider the best information available. However, the system could be designed with some flexibility (e.g. adjustments after 3-4 years). Fixed feed-in tariffs also have one advantage over RE premiums paid additional to the average electricity price: if conventional energy sources and electricity becomes more expensive, which has been the case in Thailand during the last years and probably will continue to do so, the gap between conventional energy prices and RE prices may slowly, but steadily decrease.

Moreover, fixed feed-in tariffs may help breaking up the monopoly power of EGAT that still dominates the tariff structure. However, at present, it is still unclear if the continued discussion will lead to some kind of an advanced feed-in system, be it for all RETs or just for some specific ones.

6.8.2 Measures to Overcome Institutional and Political Barriers

6.8.2.1 Finalise the Establishment of the DNA

Development of the CDM in Thailand is still hampered because the DNA fails to come into operation. Until this process is finalised, which we recommend, no substantiated conclusions can be drawn regarding the functioning of the CDM in Thailand. In addition, the general RE policy discussion may help to spend resources for CDM development most efficiently and effectively. In the case of electricity generation, "domestic" renewable energy policy – compared to the CDM – may possibly lead to more concrete and faster results if the discussions about RPS and feed-in approaches come to a constructive conclusion.

6.8.2.2 Remove Barriers for Grid Access

A major barrier, which can only be solved politically, is the lack of provisions for guaranteed fair and non-discriminatory access to the grid and their enforcement. These are necessary to create a level playing field between small generators and the grid operators and to speed up RET implementation. For example, it is beyond doubt that in a near monopoly market like in Thailand, stringent government regulation is needed to allow new stakeholders to enter the market and to ensure a minimum level of investment security. This needs to be one important goal when striving to accelerate the implementation of decentralised RE in the electricity sector. Examples of feed-in based instruments exist where this guaranteed fair and non-discriminatory access to the grid is a basic pillar, for example in Germany.

6.8.2.3 Join Exchange on Renewable Energy Feed-in Tariffs Systems

As part of its contribution to the International Action Programme of the renewables 2004 conference, the German government – together with Spain – initiated an international feed-in cooperation to exchange experience and knowledge about the political approach of feed-in systems to foster renewable energy implementation in the electricity sector.[100] Since there is an increased discussion about feed-in options in Thailand and the country already gained significant experience with RE support systems, it could be helpful to consider inviting policy-makers and representatives from the relevant ministries to join a meeting of the feed-in cooperation. This regulatory know-how transfer may improve understanding, but also

[100] See http://www.feed-in-cooperation.org; a next workshop is scheduled for the end of November 2006 in Madrid.

adaptation of such regulatory systems to the Thai conditions. It may also build trust in RE among the Thai administration.

6.8.3 Measures to Overcome Technical Barriers

6.8.3.1 Establishment and Enforcement of Manufacturing Standards

One barrier identified is the lack of technical standards and sometimes inappropriately designed technologies that do not address target groups´ specific demands. There is therefore a need for establishing suitable manufacturing standards and specifications and strictly enforcing them. This could also include the establishment of centres for testing and certifying products. Strategies set up by the government to address this problem should involve the experience and the knowledge of manufacturers, industry associations and science. Also, benefits may be realised from sharing information with foreign partners since there are many initiatives by other government in this field.

6.8.4 Awareness / Information / Capacity Barriers

6.8.4.1 RET Promotion and Awareness Raising

Although renewable energy technologies are not totally new to Thailand, there still seem to be misperceptions and a lack of awareness in the general population as well as in most sectors of the economy. Low awareness and lack of knowledge about how to operate RET are also a major barrier to their dissemination and have in the past contributed to high failure rates of RET applications. The development of effective public awareness and promotion campaigns making use of all media but focussing especially on the TV and newspapers can therefore be expected to yield a substantial dividend. Such campaigns should provide information on the concept, the benefits and the operating requirements of RET. This could be combined with increasing awareness on climate change and its expected impacts on Thailand. To some extent the Thai government already has established measures to raise awareness, like the Thailand Renewable Energy Awards, which in 2006 were awarded in three electricity related categories (on-grid, off-grid and biomass cogeneration)[101]. Hosting an international climate change conference, such as the UNFCCC Conference of the Parties (COP), may also be an important tool to inter alia increase awareness. According the ONEP representative participating in the

[101] See http://www.dede.go.th (accessed on 29.08.2006).

February workshop, this has been proposed to the environment minister for COP 13 (2008). However, due to the political turbulences it is unclear if this idea has been further pursued.

6.8.4.2 Human Resource Development

Since renewable energy systems are relatively new to the market, it will also be increasingly necessary to have properly **planned** human resource development to support the promotion and ensure the maintenance of RE systems (Berthold/Dewey 2004; DENA 2005). RE systems, for example biomass combustion, function very differently from comparable fossil fuel processes which technicians are used to (Interviewee E[xxvii], AIT et al. 2005). Improving the overall performance of these systems also requires systematic data collection and transfer of information which has so far not been done sufficiently. This also holds true for rural areas, where, e.g. for PV systems or wind energy, sufficient knowledge and educated manpower for system maintenance is often lacking (DENA 2005; AIT et al. 2005). One interviewee also identified the lack of trained personnel as a very important obstacle to the increased dissemination of solar thermal systems (Interviewee D[iii]).

There are different means to support human capacity development in this regard. For example, the government could establish regional RE capacity building centres. It is recommended that a capacity building strategy would include those that are directly involved in developing and implementing technical systems, like manufacturers and project developers. However, it is likely that this needs to be integrated into a market development strategy. Capacity building alone will very likely not create the markets needed to realise economies of scale and to increase the competitiveness of RET.

6.8.5 Overview of Options for Overcoming Barriers to RE CDM Projects

Table 10.20 summarises the measures and the barriers that would be addressed. The prime responsibility for the measures listed is attributed to the national government. However, in most cases there are additional stakeholders which would play an important role in the implementation of the actions recommended. The general framework for renewable energy projects is more auspicious than in Egypt, but CDM implementation has so far been blocked by the failure to establish the DNA and approval process. Putting these in place is therefore a priority. Another priority is giving independent power producers a guaranteed access to the grid. The sometimes insufficient quality of RE equipment and the lack of knowledge and technical capacity regarding RET and the CDM should also be tackled, Finally, it would be very helpful if the government discussed and clarified the role the CDM should play in energy policy as a whole.

Table 6.20: Overview of Options for Overcoming Barriers to RE CDM Projects

Actor(s) Responsible / Involved	Measure	Barrier(s) Addressed
Government of Thailand	Finalise the establishment of the DNA	- Lack of political clarity regarding CDM, leading to uncertainties for project developers
Government of Thailand, project developers, industry, donor/foreign governments	Clarify the role of the CDM in the overall energy policy discussion	- Lack of coherence/coordination and conflicting objectives
Government of Thailand, project developers, donor/foreign governments	Exploring "Programmatic CDM" i.a. for renewable heating and cooling	- Lack of incentive systems for certain technologies - High investment costs
Government of Thailand, manufacturers, industry associations, science, external cooperation	Establishment and enforcement of technical standards	- Lack of technical standards and sometimes inappropriately designed technologies - Lack of social acceptance may hinder project implementation
Government of Thailand, science, project developers	Develop feed-in based RE support system to improve grid access and investment framework	- Lack of provisions for guaranteed fair and non-discriminatory access to the grid - High specific generation and up-front investment costs - Electricity tariffs set by one dominant market actor, EGAT
Government of Thailand, German and Spanish governments	Join international feed-in cooperation	- Lack of political clarity
Government of Thailand, media, celebrities, educational bodies, project developers	RET promotion and awareness raising	- Lack of RE success stories which create positive image - Perception of RE as old-fashioned - Inadequate, insufficient education of consumers/RE system users - Lack of social acceptance
Government of Thailand, manufacturers, project developers, educational bodies	Establish mechanisms and incentives for planned human resource development	- Inefficient means of data collection and information transfer - RE technologies not yet sufficiently developed

7. Domestic Renewable Energy Policy and the CDM

The country studies of Egypt and Thailand suggest that national framework conditions for renewable energy applications are key for the prospects of renewable energy CDM prospects. While an in-depth analysis of the CDM in other countries is beyond the scope of this study, this analysis seems to be borne out when taking a brief look at Brazil, China, India, and Mexico, the most successful CDM host countries so far.

Table 7.1: RE CDM Projects in Brazil, China, India and Mexico.

	Brazil	**China**	**India**	**Mexico**
Total number of CDM project in the pipeline	179	120	362	67
RE projects in the CDM pipeline	96	83	214	11
RE projects registered	30	7	56	2
RE installations in MW capacity	2377	3402	2994	814,5
CERs from renewables expected by 2012 (in kt)	36954	55931	73248	8479
Total CERs expected by 2012 (in kt)	145579	395405	239028	50719
% CERs Renewables to total of country CERs	25,38	14,15	30,64	16,72
% CERs Renewables to total CERs from renewables	14,88	22,52	29,49	3,41

Source: compiled from Fenhann 2006

Table 7.1 summarises the current status of RE CDM projects in these countries. Together, they at present account for more than 70% of the total global amount of CERs from RE projects. The projects sum up to almost 10,000 MW installed capacity. The total amount of CERs from renewables by 2012 is estimated at about 175,000 kt. India is by far the country with the highest number of RE CDM projects, with 56 projects already registered and a total of 214 projects in the pipeline. These account for more than 30% of the CERs generated in India. In China, only a small number of RE projects have been registered so far, but a higher number is in the pipeline. Moreover, the power production capacity to be installed by these projects is remarkably higher than in India. Especially large wind power projects play an important role in China, while most projects in India are biomass projects and usually entail lower capacities. The comparably lower share of RE projects in China's expected CERs is due to seven HFC projects presently in the pipeline which alone account for more than 300,000 kt per year (Fenhann 2006).

Although an in-depth analysis of the CDM success factors of these countries cannot be done here, some remarks can be made. The overall market and energy consumption growth, especially in China, India and Brazil, attracts foreign investors, especially in the field of energy supply. And there is an overall need of expanding the energy infrastructure. Furthermore, especially China and India have a long history of renewable energy support policies and lend high priority to RE development.

- China has steadily increased its support for renewables since the 1990s. This has culminated in the Promotion for Renewable Energy Act and targets to promote renewable growth (IAP 2004). Even today the use of RE is already remarkable, with more than 100 billion kWh from small hydropower and the highest number of solar thermal heaters globally (REN21 2005).

- India is the only country worldwide to have a separate ministry for new and renewable energy sources and government incentives have supported the creation of a fairly large and diversified renewable energy manufacturing base and infrastructure. Initiatives at state level often effectively complement federal policies and programmes. A total of fourteen state governments have so far announced promotional policies for power from renewables; these include remunerative feed-in tariffs, renewable energy purchase obligations and tax incentives (IGES 2006c).

Such policies considerably improve the relative economic performance of renewable energy technologies compared to conventional sources and thus address an important identified barrier.

But this does not mean that only rapidly industrialising countries can play a role in the CDM, even if they benefit most in absolute terms. Guatemala for example has a number of hydro energy projects in the pipeline (297 MW in facility sizes ranging from 3.9 to 94 MW). In Honduras, another least developed country (LDC), 11 biomass CDM projects are in the pipeline, the same number as in Chile.

Plans to introduce new policy instruments supporting renewable energy use have often been hampered by concerns that energy policy cutting reliance on fossil fuels and encouraging utilisation of renewable energy sources may have a negative impact on CDM opportunities, since it may result in many projects no longer being 'additional'. This has also been the case in Thailand. However, at its last meeting of 2005, the CDM Executive Board ruled that baseline setting need not take account of domestic policy efforts put in place after 2001. Instead, the baseline may be calculated on the basis of a hypothetical scenario without the policy (UNFCCC 2005b). Contrary to the concerns voiced by some, the CDM does not prevent the introduction of other climate-friendly policy instruments.

However, as Willis, Wilder and Curnow (2006) point out, it may be easier said than done to calculate a baseline based on a hypothetical scenario, in particular since developing countries do not dispose of the sophisticated emission inventories required from Annex I countries. A public database on baseline data as recommended by Michaelowa (2005: 21) might help to alleviate this problem.

8. Synthesis and Conclusions

Current Trends of Renewable Energy Projects in the CDM

Having started with many difficulties and delays, the supply side of the CDM is now fully functional and expanding rapidly. However, the market is currently still very intransparent, most transactions are over the counter with hardly any details made publicly available. The project-based market is currently dominated by buyers from Europe and Japan, which in 2005 and early 2006 accounted for 56% and 38% of volumes respectively. Most transactions are carried out by the private sector, with companies buying either to sell on the secondary market or for compliance. Current CER prices are € 5-6 for medium-risk forwards, € 7-8 for low-risk forwards, € 8-11 for registered projects, and € 11-13 for issued CERs.

Currently, 1,145 projects have already been registered or are at the validation stage, expecting a cumulative 1.3 billion CERs by 2012. Among these, there are 665 renewable energy projects, equalling 58% of the project portfolio. However, it is noteworthy that so far there are only 7 solar and 6 geothermal projects.

The picture changes further when the expected CERs are broken down by project type as a measure of how much 'carbon financing' each project type receives. Here, renewable energy projects account for only 22% of all expected CERs. The main reasons are:

- Renewable energy projects typically reduce emissions of CO_2, which has a global warming potential of 1
- Many renewable energy projects are relatively small scale

Renewable energy projects thus yield only a relatively low number of CERs and hence receive a correspondingly low small financial benefit from the CDM. At current prices, the increase in the internal rate of return from the sale of CERs of a CO_2-based renewable energy project usually is about 1-2%.

In terms of CERs, the market is dominated by projects to reduce hydrofluorocarbons (HFCs), nitrous oxide (N2O) and methane (CH4), which in total account for about two thirds of all expected CERs. This is due to the high global warming potential of these gases, which in the case of HFC-23 is 11,700 times that of CO_2. In fact, a mere 22 HFC and N_2O reduction projects account for 42% of all expected CERs from the 1,145 projects in the project cycle.

One also has to take into consideration that the majority of developing country emissions are in fact not emissions of industrial gases but are energy related. The CDM thus currently has only a limited impact on emissions trends in what are the key sectors for climate change mitigation.

It also emerges that the buy side is predominantly focussed on acquiring as many CERs for as low a price as possible, irrespective of whether projects contribute to sustainable development, as mandated by the Kyoto Protocol. While there are some signs of a market differentiation such as programmes that pay higher prices for CERs from certain types of projects or the CDM Gold Standard, these initiatives are so far very limited. Moreover, instead of actually investing in the projects, the dominant transaction model has so far been to pay on delivery of the CERs once a project has been successfully implemented. Project financing is therefore not supported by the CDM. Instead, project developers have to look for other sources of funding.

Renewable Energy Potential and Current Use in Egypt and Thailand

The country studies have shown that the limited emission reductions so far achieved by RE projects are not due to a lack of potential. In particular Egypt has a massive potential for utilising renewable energy sources. Not only the solar potential of this country lying in the Earth's "Sunbelt" is tremendous but also the wind speed and potential is one of the best worldwide. The overall economic potential for power generation by renewable energy technologies in Egypt is six times higher than current electricity production. In total, more than 600 TWh could be produced by renewable energy technologies. Almost 500 TWh, 80% of the total potential, could come from the use of Concentrated Solar Power plants, counting only the coastal sites. Another 15% could be produced from wind with around 90,000 GWh and the rest from efficient biomass technologies and hydropower. So even without using one of the most promising technologies, CSP, the other three other options could produce more than 120 TWh, which exceeds the Egyptian electricity production of 2004. There are also considerable potential for uses other than electricity production, like for heat and cooling. However, based on the data available an overall estimate of the potential for the other uses of renewable energy sources cannot be given. One also has to note that the studies consulted did not take into account the current situation of the energy market in Egypt in their calculation of the economic potential.

Renewable energy resources in Thailand are more limited than in Egypt but still significant. Summarising official figures on potential and consumption, a rough estimate is that a potential of 24,000 ktoe/year (279,120 GWh) remains to be exploited, particularly in the area of biomass. When incorporating the solar energy potential as calculated for 1% of the total area of the country, an additional 554,071 (6,443,845 GWh) ktoe/year exists. Total final energy consumption in 2002 was 52,939 ktoe/year, while primary energy consumption was about 83,000 ktoe. This suggests that it might theoretically be possible to cover all the energy needs from renewable energy sources, although this is not commercially viable under present market conditions and technology costs for renewables. However, as for electricity generation, the estimated potential in terms of installed capacity seems to be significantly lower than the presently installed capacity, with 14,300 MW of RE potential compared to 24,000 MW total installed capacity in 2003. It also needs to be remarked that the output of RE technologies per MW installed generally is lower than for conventional power plants since the inconstant resource flows of wind and solar energy reduce the load hours.

The Thai government is putting a particular emphasis on biofuels to reduce import dependence. However, the potential in this field appears to be limited, by 2011 all of the domestic production of cassava would need to be converted into ethanol for replacing only 3% of the future demand for benzene.

Barriers to Renewable Energy Dissemination

In both countries so far only a fraction of the available potential is used and there is a wide variety of barriers which impede the dissemination of renewable energy technology. Identifying barriers is a prerequisite in designing appropriate measures to overcome them at the various levels (local, national and regional). Table 8.1 summarises the barriers that have been identified in this study.

The key barriers are energy prices and the monopolistic structure of the energy market. Most renewable energy applications are still characterised by high specific upfront investment costs, and in both countries energy prices are well below the level that would be needed to make them economically viable. Especially in Egypt the “playing field” is significantly distorted by subsidies for fossil fuels. Moreover, in both countries there is no guaranteed access to the grid for independent power producers, which, as the German experience has shown, is a key prerequisite for a wider uptake of renewable energy technology.

Renewable energy technology dissemination is also severely hampered in both countries by a lack of policy clarity. While both countries have announced ambitious targets for the increased utilisation of renewable energy technology, they have so far not been sufficiently backed up by policies and measures. Thailand has several support instruments in place but policy-makers have been discussing for two years whether to introduce an RPS or not, which undermines business confidence. Egypt has so far put hardly any RE policy instruments in place and the quickly rising energy demand is supposed to be met by a massive expansion of gas-fired thermal power plants. Except for hydropower, RET expansion in Egypt has thus so far to a very large extent depended on development cooperation projects.

Table 8.1: Barriers and Effects that Hinder RET Implementation

Barrier Group	Barrier	Effect / Impact
Financial & Economic	High specific up-front costs of RET versus low fuel prices and electricity tariffs (as a result of subsidised fossil fuels and electricity)	No level playing field; lacking willingness and/or ability to finance "expensive" investments in RET; higher risk premiums
	Comparison of installation costs in €/kW instead of specific electricity generation costs in €/kWh	RET investments not implemented even if a project would be profitable over its lifetime
	Taxes and customs on imported equipment	RET installations become even more expensive
	High transaction costs due to small-scale and decentralised nature of RET applications	Potential RET applications not implemented
Institutional & Political	Conflicting objectives and interests among policy-makers	Shifts power to powerful lobbyists, hinders objective policy formulation, lack of policy coherence
	Institutions for RET promotion relatively powerless compared to institutions favouring use of fossil fuels	Government concentrates on fossil energy; RET potential not realised
	Unclear ministerial responsibilities and insufficient coordination between government agencies responsible for RET	Weak promotion of RET both generally and in specific sectors (e.g. biomass)
	Strong hierarchical structure of public institutions	Impedes bottom-up diffusion of new knowledge and ideas (especially serious barrier for small and medium enterprises)
	Monopolistic energy market	No guaranteed grid access and no fair feed-in tariffs for independent RE power producers; decentralised, small-scale RE potential in particular will not be realized and will be kept out of the market
Technical	Inadequate appliance quality; lack of technical standards and inappropriate technical designs	Gives RET a bad reputation, impeding their further dissemination
	Some RE technologies / components (e.g. solar thermal power plants, large-scale thermal storage) not yet commercially tested	Increased investment cost; financial risk for plant operators
	Negative externalities (e.g. air pollution from biomass projects)	Lack of social acceptance may hinder project implementation
Awareness / Information / Capacity	Lack of awareness of potential and the multiple benefits of RET utilisation among decision-makers at different political and administrative levels	Potential and positive side benefits of some RET still underestimated
	Lack of qualified personnel	Problems in technical implementation, maintenance and financial arrangements hinder RET market development in general
	Inefficient resources for data collection and information transfer	Insufficient information basis may lead to no, or wrong, decisions by project developers, investors etc.
	Inadequate, insufficient education of consumers/RE system users	Technological mistrust in case of system breakdown; overblown expectations followed by discontent; monetary losses to consumers

Another important barrier in both countries has been the lack of technical standards or their enforcement, which has led to low-quality products and a bad reputation of renewable energy applications. Other technical barriers are the need for more research and development for the improvement or adaptation of RET to meet national and local conditions (e.g. wind turbines designed for heavy sand storms) and to refine technologies that are particularly well suited to large-scale use of RET (e.g. energy storage technologies) until they reach a marketable stage.

Finally, in both countries there is a severe lack of awareness of the potential for the use of renewable energy technology and the associated benefits.

The Potential of the CDM to Overcome Barriers to the Dissemination of Renewable Energy Technologies

The CDM is supposed to promote projects implementing low-emission technologies such as renewable energy technologies by providing additional revenue, which should serve to alleviate in particular economic and financial barriers. The basic economic barrier is the relatively higher electricity generation costs for RET, although the scale of the difference varies from technology to technology and from country to country. For example, in Thailand costs for electricity from biomass are almost competitive with the average electricity tariff, while wind electricity is about double the average price. The revenues attained from selling CERs from a CDM project can help compensate for this price difference to an extent. However, both the overview of the global CDM pipeline as well as the country studies show that renewable energy projects get a disproportionately low financial benefit out of the mechanism. At current CER prices, the increase in the internal rate of return from the sale of CERs from a CO_2-based renewable energy project is estimated at about 2%.

By contrast, the CDM strongly promotes renewable energy projects (biogas for example) that avoid methane emissions. Methane has 21 times the global warming impact of CO_2. Projects thus yield high volumes of CERs and this has a very strong impact on profitability. Since renewable energy projects typically reduce CO_2 emissions, though, the additional revenue in most cases has only a limited impact on the profitability of a project.

This is underlined by the two country studies. In Egypt, subsidies tilt the energy market that much against renewable energy technologies that the CER revenues are not sufficient for even one of the RE CDM projects that are currently in the pipeline to become economically viable. Instead, they all depend on additional financing from official development assistance. In Thailand, project developers have freely stated that the CDM is actually not necessary to make biomass projects viable but rather is an “optional extra”. As for other RE projects, at a price of € 10 per CER and an exchange rate of 47 Baht / €, the CDM would add Baht 0,235 per kWh, which is nowhere near enough to close the gap between current electricity tariffs of about 2.5 Baht and the cost for wind energy and PV, which are 5-6 and more than 10 Baht respectively.

The other key financial barrier is the high specific up-front costs of RET. The CDM could alleviate this problem if buyers were willing to front-load their payments. RET project developers would then receive the CER revenues when they most need them. However, while there are some purchasing programmes where this is possible, buyers have mostly limited their role to purchasing CERs for payment on delivery. As a result, project developers have been forced to finance their projects from other sources.

The CDM could also help to remedy the insufficient purchasing power of potential users. The CER revenues could be used to distribute RET applications at subsidised prices.

Although not originally designed for the purpose, the CDM also offers limited potential to overcome institutional barriers. To an extent, the opportunity for foreign investment and access to modern technology incentivises relevant government bodies to cooperate better on energy policy issues and to streamline decision-making and approval procedures. Energy policy is no longer exclusively designed by energy ministries since most aspects of climate policy – and thus the CDM debate – are the responsibility of environment ministries. Moreover, renewables are gaining ever-greater importance beyond environmental considerations. This is due to their benefits regarding the more ‘conventional’ purposes of energy policy, especially energy security and reducing dependency on imports.

Since it financially rewards the climate benefit of low-carbon technologies, the CDM offers an important argument for using RET in addition to, say, reducing fossil fuel imports. This attracts greater attention from political decision-makers and the private sector.

Being a mechanism established by international policy, the CDM can also give project developers better access to decision-makers compared to traditional private investments, especially if they have the official backing of the investor country. This might help to alleviate some of the problems associated with the hierarchical nature of some host country institutions.

In conclusion, the CDM can alleviate barriers against RET dissemination, but it is not a cure-all. The CDM can make renewable energy projects more profitable and also help to procure up-front financing. It may also contribute to streamlined decision-making, greater awareness of RET options and better access to decision-makers. However, additional revenues are limited and cannot counterbalance fundamental distortions in national energy markets. Policy-makers will therefore need to make significant efforts to remove barriers to the dissemination of renewable energy technology, only then will the CDM be able to make a significant impact.

Policy Options for Promoting Renewable Energy

Since there are manifold barriers that discriminate against RET in energy markets, addressing only a single barrier is not enough. To be effective, strategies must take into account the complex interplay of barriers, which usually requires a mix of well-designed and mutually supportive policy instruments.

When designing the next policy steps to advance renewable energy, it would therefore be useful to discuss the role the CDM could and should play in the overall energy policy setting. This should mean looking for the best ways to combine domestic policy instruments with the CDM in order to maximise CDM benefits and thus the increase in renewable energy use.

Table VI.1 in the Executive Summary gives an overview of key measures that can be taken to promote renewable energy.

Removing Key Barriers

The most important issue is the economic performance of RET compared to the energy sources that presently dominate the energy markets. In principle, there are two approaches to addressing this problem, both of which are indispensable in developing promising strategies:

- Bringing down the costs of RET and their related energy services

- Abolishing market distortions that discriminate against these technologies, such as direct subsidies for fossil fuels or lacking internalisation of external costs

As to the first approach, there is evidence that policies can effectively induce technological progress and cost savings by creating enabling frameworks. The latter is often described as levelling the playing field in which RET and conventional energy technologies have to compete.

Reforming energy markets by reducing subsidies for fossil fuels

Where they exist, it is absolutely essential to reduce the subsidies for electricity and fossil fuels as a prerequisite for the dissemination of RET. Another reason for redesigning subsidy policies is that prices for fossil fuels (and fossil-fuel products like electricity) will most probably keep rising due to their increasing scarcity and growing world energy demand. Keeping subsidies at current levels would therefore result in an ever-increasing burden on public budgets.

The challenge is to cut back subsidies in a manner that avoids social unrest. This could possibly be achieved by implementing gradual reductions in subsidies over a period of time rather than making an abrupt cut. Besides, the money saved by the government could also be used to reduce consumers' bills for fossil fuels by subsiding renewable energy and energy efficiency. This would also directly lead to further reductions in the amount of subsidies needed. It will also be necessary to communicate these changes to the population in a transparent manner and to highlight their long-term necessity and advantages.

Setting ambitious targets for renewables expansion

Setting clear and ambitious targets for the use of renewable energy sources provides planning certainty and helps to create an environment that is favourable to long-term investments. Ideally, there should be an overall target for renewable energy use that is then broken down to sector-specific targets for renewable electricity, heat and liquid fuels.

Giving independent power producers access to the grid

Due to their decentralised nature, renewables must be implemented by a higher number of operators than those operating large-scale fossil fuel plants. There is thus a need to strengthen the role of independent power producers (IPPs). Giving priority to the interests of renewable energy-based IPPs has been a key driver of RET market growth in the German electricity sector. This principle has also found its way into China's renewable energy law.

Implementing supportive policies

Apart from removing policies that negatively impact RET, it is also essential to introduce policies that positively support them in order to push them into the market, achieve economies of scale and quickly 'buy down' technology costs. RET still harbour huge cost saving potential. When taking into account the external costs of conventional energy technologies, falling RET prices and the rising prices for conventional energy are set to intersect within the next two decades. Examples of supportive policies include feed-in laws, market incentive programmes, tax reductions and green certificates.

Other Supportive Measures

Establish and enforce quality standards for renewable energy equipment

Efforts to introduce RET have frequently suffered setbacks due to poor-quality appliances. There is thus a need to establish suitable manufacturing standards and specifications and to strictly enforce them.

Also, policy instruments and incentives could be introduced to encourage local RET manufacturers in developing countries to export some of their production to regional RET markets. By targeting the export market, local manufacturers would have an incentive to improve their production quality and would seek to obtain international RET certification. The local RET market would in turn benefit from better quality products.

Establish dedicated loan facilities

Even if RET profitability and competitiveness is improved with measures such as the removal of subsidies or the introduction of feed-in tariffs, there is still the problem of high up-front investment costs. One means of addressing this problem is to establish dedicated loan facilities with low interest rates to provide (micro)finance for RET on preferential terms. These should be open both to commercial RET facilities and to private end users wishing to utilise small-scale RET applications such as solar water heaters. Micro-credit linked to micro-enterprise has proven highly successful in promoting renewable energy and reducing poverty.

Lower taxes and customs duties on RET equipment

Apart from high investment costs, the viability of RET is also affected by taxes and customs duties on imported RET equipment. While such duties may be sensible as a means of shielding domestic equipment manufacturers from outside competition, it might be beneficial to lower them for equipment that cannot currently be manufactured locally.

Give practical support to those who implement renewable energy technology

In most cases, RET are complex and difficult to apply, both for project developers and for end users. Many countries do not have the infrastructure to directly support practitioners in RET implementation. It would make sense, therefore, to complement quantifiable 'hard' policy measures like feed-in tariffs with the 'soft' measure of establishing institutions to give free and independent advice on practical implementation of RET and on energy efficiency measures.

Substantially raise awareness of renewable energy and build technical capacity.

Low awareness and lack of knowledge about how to operate RET are a major barrier to their dissemination and have in the past contributed to high failure rates in RET application. Hence development of effective public awareness and promotion campaigns which make use of all media but focus primarily on TV and newspapers can be expected to yield a substantial dividend. Such campaigns should provide information on the RET concept, its benefits and its operating requirements. Identification and dissemination of 'success stories' and public-private demonstration projects play a key role in raising awareness and promoting replication.

It is also important to produce a cadre of high-calibre engineering graduates who understand RET. This would require the introduction at domestic higher education institutions of graduate degrees and diplomas which focus on RET. Having locally qualified RET engineers would help reduce the transaction costs associated with RET project identification and design.

Using the CDM to Promote Renewable Energy

Apart from improving general domestic conditions, there are several other ways to improve the use of the CDM to promote renewable energy.

Speedy and Transparent CDM Approval Process

One key prerequisite for attracting CDM projects is to have a DNA with sufficient competent staff to operate a speedy and transparent CDM approval process. An approval process of this kind will decrease legal uncertainty and lower transaction costs for project developers. Countries such as Egypt and Morocco have established a two-step approval process. In the first step, project developers need only present a brief document setting out key aspects of the project. This enables the DNA to give a very early indication of whether or not a project is acceptable and to identify likely major obstacles, thus saving unnecessary paperwork.

CDM Promotion and Capacity Building

In many countries, awareness of the CDM is still relatively low. Given the complexity of the instrument, substantial capacity building will be needed among businesses and stakeholders. Considering the CDM's tendency to concentrate on large, rapidly industrialising nations, an extremely pro-active approach will be needed in many countries. Governments could work to identify potential projects and advertise CDM opportunities to potential business partners and CER buyers. Egypt has taken strong steps in this direction by developing a project portfolio of 24 projects and advertising it at international carbon conferences and through other means.

Integrating the CDM into National Energy and Economic Development Planning

Apart from improving the regulatory framework for RET in general, the regulatory framework for the CDM itself could be improved by integrating the mechanism into national energy planning and overall economic development. This could serve to mainstream awareness of the CDM and its potential at all levels of government and give government staff a clear signal that they should be promoting CDM projects.

Giving Preference to Renewable Energy CDM Projects

The governments of developing and industrialised countries could give clear preference to renewable energy CDM projects. Industrialised countries in particular could significantly help to overcome the barriers of high specific up-front investment costs by paying topped-up prices and providing up-front financing for renewable energy CDM projects. This could include giving special preference to Gold Standard projects.

Exploring CDM Programmes of Activities

It has recently been made possible to implement ‘programmatic’ CDM projects. A programmatic project is defined as coordinated action by a private or public entity which leads to GHG emission reductions via an unlimited number of activities under the programme. This approach is supposed to allow consolidation of dispersed small-scale renewable energy activities to sizes where they become economically viable. Examples include replacing diesel-powered water pumps currently used in agriculture with solar-powered pumps and installing solar water heaters in all houses in a particular city district.

Given the greater complexity of such projects, it might often be necessary for them to be coordinated by public institutions in host countries. Through their investments, industrialised country governments could also make a significant contribution to the implementation of this new project type. A further boost could come from pilot projects conducted by public institutions in CDM host and buyer countries to explore and overcome methodological problems potentially connected to this new approach.

Interplay of the CDM and National Policy

In particular the Thai discussion about introducing new policy instruments to support the utilisation of RE has been hampered by concern that powerful energy policy that reduces the reliance on fossil fuels and encourages RE may lead to a higher baseline for future CDM projects and in fact put in question their additionality. However, the CDM Executive Board has ruled in their last 2005 meeting that baseline setting does not need to take into account domestic policy efforts that have been put in place after 2001. Since Thailand’s ambitious RE targets have been published in 2003 and yet most of the instruments that could effectively lead to achieving these targets still remain to be put in place, Thai policy does not conflict with this decision.

There are also discussions to actually make the CDM a driver for such policy instruments in future Kyoto commitment periods by also including “policy-based” projects. Under such an approach, countries would be able to register the introduction of policies such as feed-in tariffs as CDM projects and use the CER revenues to fund policy implementation. There are still various open questions connected to this proposal but this avenue should nevertheless be further pursued.

However, even such an expansion of the CDM could probably not overcome all its current limitations. Due to its construction, the CDM can only be effective where there are emissions to be reduced. Moreover, it can be assumed that only a limited number of developing countries disposes of the necessary technical capacity to implement such complex projects. Some of these problems might be overcome through increased capacity building, but it will probably also be necessary to introduce further instruments for technology transfer and investment promotion to also reach poorer Southern countries.

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10. Annex

Annex 1: CDM Projects by Project Type

	S	T	U	V	W	X	Y	Z	AA
4	Type	number		CERs/yr (000)		Accumul. 2012 CERs (000)		CERs Issued (000)	
5	Biomass energy	307	22%	17394	7%	119563	8%	2748	13%
6	Hydro	232	17%	16502	7%	98880	6%	1054	5%
7	Wind	171	12%	15023	6%	97991	6%	557	3%
8	Agriculture	158	11%	5374	2%	37765	2%	995	5%
9	EE Industry	154	11%	15125	6%	104027	7%	277	1%
10	Landfill gas	101	7%	22426	9%	147703	10%	73	0%
11	Biogas	77	6%	3298	1%	22943	1%	85	0%
12	Fossil fuel switch	54	4%	12007	5%	74170	5%	0	0%
13	Cement	28	2%	3292	1%	28793	2%	0	0%
14	Coal bed/mine methane	20	1%	12864	5%	79835	5%	0	0%
15	HFCs	17	1%	78059	32%	494700	32%	14128	66%
16	N2O	15	1%	25644	11%	153324	10%	1254	6%
17	EE Supply side	12	1%	638	0%	3745	0%	0	0%
18	EE Service	10	1%	59	0%	541	0%	0	0%
19	Fugitive	10	1%	9385	4%	70150	5%	278	1%
20	Geothermal	8	1%	1774	1%	10976	1%	27	0%
21	Solar	7	1%	185	0%	1151	0%	0	0%
22	EE Households	4	0%	87	0%	510	0%	0	0%
23	Afforestation & Reforestation	4	0%	428	0%	2389	0%	0	0%
24	Transport	2	0%	253	0%	1785	0%	0	0%
25	PFCs	1	0%	86	0%	542	0%	0	0%
26	Tidal	1	0%	315	0%	1104	0%	0	0%
27	Energy distrib.	0	0%	0	0%	0	0%	0	0%
28	Total	1393	100%	240219	100%	1552587	100%	21476	100%
29	HFCs, PFCs & N2O reduction	33	2%	103789	43%	648566	42%	15382	72%
30	CH4 reduction & Cement & Coal mine/bed	317	23%	53341	22%	364246	23%	1346	6%
31	Renewables	803	58%	54492	23%	352610	23%	4472	21%
32	Energy efficiency	182	13%	16162	7%	110607	7%	277	1%
33	Fuel switch	54	4%	12007	5%	74170	5%	0	0%
34	Afforestation & Reforestation	4	0%	428	0%	2389	0%	0	0%

Source: Fenhann (2006)

Annex 2: CDM Projects by Region

	A	B	C	D	E	F	G	H
119								**2012 CER**
120	**Total in the CDM Pipeline**	**Number**		**kCERs**	**2012 kCERs**		**Population**	**per cap.**
121	Latin America	481	**34,5%**	46082	308602	**19,9%**	559	0,55
122	Asia & Pacific	852	**61,2%**	177068	1132946	**73,0%**	3529	0,32
123	Europe and Central Asia	16	**1,1%**	820	4646	**0,3%**	149	0,03
124	Sub-Sahara Africa	24	**1,7%**	11285	76073	**4,9%**	752	0,10
125	North Africa & Middle-East	20	**1,4%**	4964	30320	**2,0%**	278	0,11
126	Less developed World	1393	**100%**	240219	1552587	**100%**	5266	0,29

Source: Fenhann (2006)

Annex 3: Egypt – Greenhouse Gas Emissions Data

Emission data \ Data source	**UNFCCC**	**IEA**	**WRI**
Total GHG emissions without LUCF (in Mt CO_2e)			
- 1990	117.266	-	127.3
- latest available year	117.266 (1990)	-	177.5 (2000)
Total GHG emissions with LUCF (in Mt CO_2e)			
- 1990	107.366	-	130.3
- latest available year	107.366 (1990)	-	180.5 (2000)
Average annual growth rate of GHG emissions without LUCF, 1990-2000 (in %)	-	-	3.4
Total growth of GHG emissions without LUCF, 1990-2000 (in %)	-	36,3 (only CO_2)	39.5
GHG emissions by gas:			
CO_2 emissions without LUCF (in Mt CO_2 and % share of total)			
- 1990	84.459; 72.0%	78.6	90.8; 71.4%
- latest available year	84.459 (1990); 72.0%	122.2 (2003)	126.7; 71.4% (2000)
CO_2 emissions with LUCF (in Mt CO_2)			
- 1990	74.559	-	93.9
- latest available year	74.559 (1990)	-	129.7 (2000)
CH_4 emissions without LUCF (in Mt CO_2 and % share of total)			
- 1990	22.174; 18.9%	-	24.4; 19.2%
- latest available year	22.174 (1990); 18.9%	-	34.3; 19.3% (2000)
N_2O emissions without LUCF (in Mt CO_2 and % share of total)			
- 1990	10.633; 9.1%	-	11.5; 9.0%
- latest available year	10.633 (1990); 9.1%	-	16.0; 9.0% (2000)

GHG emissions by sector:			
Energy (in Mt CO_2e and % share of total)			
- 1990	83.290; 71.0%	-	89.2; 71.9%
- latest available year	83.290 (1990); 71.0%	-	127.6; 72.4% (2000)
Industrial processes (in Mt CO_2e and % share of total)			
- 1990	10.276; 8.8%	-	7.9; 6.4%
- latest available year	10.276 (1990); 8.8%	-	12.9; 7.3% (2000)
Agriculture (in Mt CO_2e and % share of total)			
- 1990	18.012; 15.4%	-	17.9; 14.4%
- latest available year	18.012 (1990); 15.4%	-	24.7; 14.0% (2000)
Waste (in Mt CO_2e and % share of total)			
- 1990	5.688; 4.9%	-	9.2; 7.4%
- latest available year	5.688 (1990); 4.9%	-	11.1; 6.3% (2000)
Emissions or removals by LUCF (in Mt CO_2e)			
- 1990	-9.900	-	3.1
- latest available year	-9.900	-	3.0 (2000)
Other GHG indicators:			
GHG emissions per capita without LUCF (in t)			
- 1990	-	-	2.4
- latest available year	-	-	2.8 (2000)
CO_2 emissions per capita without LUCF (in t)			
- 1990	-	1.50	1.7
- latest available year	-	1.81 (2003)	2.1 (2002)
Carbon intensity of primary energy supply (t CO_2 per TJ)			
- 1990	-	58.82	-
- latest available year	-	55.76 (2003)	-

Carbon intensity of electricity production (g CO_2 per kWh)			
- 1990	-	521	
- latest available year	-	418 (2003)	443.2 (2002)
Carbon intensity of the economy (t CO_2 per Mill. Intl. $)			
- 1990	-	510	592.9
- latest available year	-	480 (2003)	566.4 (2002)

Source: IEA 2005b; WRI 2006; UNFCCC 2005a.

Annex 4: Egypt – Sustainable Development Criteria for CDM Projects

Egypt, as a host country, must certify that the activities of CDM projects contribute to its sustainable development. The CDM must be oriented to improve the quality of life of the population, especially the most impoverished segments.

The CDM must consider the following criteria in the design of activities for emission reductions and/or uptake (sequestration) of GHG in proposed projects:

Environmental Criteria

- GHG Emission Reduction
- Reductions of emission from particulates and other elements that affect the quality of the local environment (indicators include levels of pollution avoided, improvement in the quality of environmental factors such as water, air, soil, etc.)
- Reduction of the local environmental pressure (indicators include pressure on biodiversity, pressure on water resources, on soil resources, reduction of natural disaster risks, increase of the resilience of local communities in relation to climate change, increase of capacities for adaptation to climate change).
- Effects of environmental impacts on local health (indicators include index of toxicity of emissions, incidence of respiratory problems or other diseases caused by the environmental impacts of the project, etc.).
- Sustainable use of local resources (indicators include the existence of a Management Plan, accomplishment of the goals of this Management Plan, maintenance or increase of local biodiversity, maintenance or increase of the population of local species, improvement in the management of soils, increased in the productivity of ecosystems).

Social Criteria

- Effects on poverty levels (indicators include increase in employment levels, increase of per capita income, percentage of the population living under the poverty line, other variables for quality of life and poverty).
- Improved quality of life for the members of local communities with regard to social variables (indicators include those on health, education, housing, employment).
- Increase of equity levels (indicators include level of participation of local stakeholders, level of ethnic, generational and gender equity, levels of marginalization of social actors, distribution of benefits).
- Respect of local cultures (indicators include integration of project activities with local stakeholders, appropriate adaptation by local or traditional cultures to the technology used, generation of local engineering and social capacities).

Economic Criteria

- Overall positive impact on the national economy: contribution in creating / expanding / replacing infrastructure, enhancement of export potential / import substitution, improving the performance of the national economy, contribution to saving energy (related savings of fuel subsidies, improvement of the balance of payments).
- Effects on the level of local production (indicators include rate of variation of local GDP, effects on levels of prices).
- Effects on the level of monetary income of local stakeholders (indicators include percentage of monetary income for service/remuneration of local stakeholders, percentage of investment used in services of Egyptian companies or agencies, etc.).
- Generation of new investment (indicators include: increased flows of financial resources into national economy, creation of new investment consistent with the needs of local stakeholders, gross formation of fixed capital).
- Effective transfer of technology (indicators include efficient technology in the use of natural resources, technology with a minimum negative impact on the environment than the one used traditionally).

Source: Egypt (2004)

Annex 5: Thailand – Greenhouse Gas Emissions Data

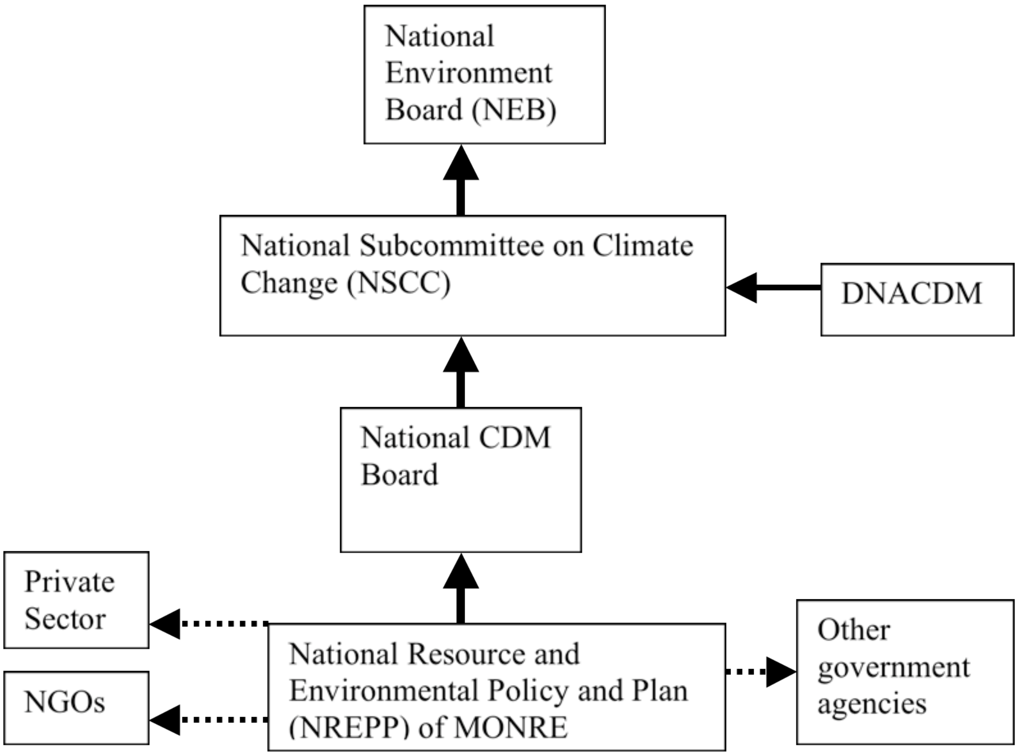
Emission data \ Data source	**UNFCCC**	**IEA**	**WRI**
Total GHG emissions without LUCF (in Mt CO_2e)			
- 1990	-	-	175.5
- latest available year	223.977 (1994)		264.5 (2000)
Total GHG emissions with LUCF (in Mt CO_2e)			
- 1990	-	-	215.4
- latest available year	285.831 (1994)		312.2 (2000)
GHG emissions by gas:			
CO_2 emissions without LUCF (in Mt CO_2 and % share of total)			
- 1990	-	78.6	90.3; 51.5%
- latest available year	141.453 (1994); 63.2%	188.4 (2003)	174.9; 66.1% (2000)
CO_2 emissions with LUCF (in Mt CO_2)			
- 1990	-	-	130.2
- latest available year	201.929 (1994)		222.5 (2000)
CH_4 emissions without LUCF (in Mt CO_2 and % share of total)			
- 1990	-	-	72.8; 41.5%
- latest available year	65.335 (1994); 29.2%		75.9; 28.7% (2000)
N_2O emissions without LUCF (in Mt CO_2 and % share of total)			
- 1990	-	-	12.2; 7.0%
- latest available year	17.190 (1994); 7.7%		13.1; 4.9% (2000)

GHG emissions by sector:			
Energy (in Mt CO_2e and % share of total)			
- 1990	-	-	91.6; 53.0%
- latest available year	129.868 (1994); 58.0%		175.6; 67.5% (2000)
Industrial processes (in Mt CO_2e and % share of total)			
- 1990	-	-	9.1; 5.3%
- latest available year	15.977 (1994); 7.1%		13.4; 5.1% (2000)
Agriculture (in Mt CO_2e and % share of total)			
- 1990	-	-	65.6; 38.0%
- latest available year	77.393 (1994); 34.6%		63.8; 24.5% (2000)
Waste (in Mt CO_2e and % share of total)			
- 1990	-	-	6.5; 3.8%
- latest available year	0.740 (1994); 0.3%		7.4; 2.9% (2000)
Emissions or removals by LUCF (in Mt CO_2e)			
- 1990	-	-	39.9
- latest available year	61.854 (1994)		47.6 (2000)
GHG indicators:			
GHG emissions per capita without LUCF (in t)			
- 1990	-	-	3.2
- latest available year	-		4.4 (2000)
CO_2 emissions per capita without LUCF (in t)			
- 1990	-	1.41	1.6
- latest available year	-	3.04 (2003)	3.3 (2002)
CO_2/TPES (t CO_2 per TJ)			
- 1990	-	42.79	
- latest available year	-	50.69 (2003)	-

Carbon intensity of electricity production (g CO_2 per kWh)			
- 1990	-	626	-
- latest available year	-	528 (2003)	500.8 (2002)
CO_2/GDP-PPP (t CO_2 per Mill. Intl. $)			
- 1990	-	320	363.4
- latest available year	-	420 (2003)	489.6 (2002)
Average annual growth rate of GHG emissions without LUCF, 1990-2000 (in %)	-	-	4.2
Total growth of GHG emissions without LUCF, 1990-2000 (in %)	-	100.8	50.7

Source: IEA 2005b; WRI 2006b; UNFCCC 2005a.

Annex 6: Thailand – Initial Structure for the CDM



The Thai DNA is presently housed within the Ministry of Natural Resources and Environment (MONRE). It is composed of three major divisions: the Secretariat, the Energy Division (under the care of the Ministry of Energy) and the Green Division (under the care-taking of the Royal Forest Department, RFD, in MONRE). This DNACDM is supervised by a 29-member committee, called the National Subcommittee on Climate Change (NSCC)—chaired by the Minister of National Resources and Environment. The NSCC is appointed by the National Environment Board (NEB), Thailand's highest environmental policy setting and environment-related decision body. The NEB is chaired by the Prime Minister, but normally a Deputy Prime Minister is asked to chair the NEB on his behalf. The NSCC in turn established a small national CDM Board to advise it on CDM matters—see figure above. Presently, the DNACDM is a fully-pledged government agency. Its future status has not been decided. Another current thinking wishes to detach it to be a semi-governmental body or an independent private entity in order to assure business efficiency and technical competency. The other sees future DNACDM as a public organization. It is not clear at the time of this writing what form DNACDM will eventually take.

Annex 7: Thailand – Sustainable Development Indicators for CDM Projects

Goal	Objectives	Project indicators
Environment	To protect local environment and lead to real and measurable reductions of GHGs Lead to a reduction of non-renewable resources, such as underground water and non-renewable energy Having systematic management, including after CERs ends	Reduce pollutants, including GHGs Air pollutants, including SO_2 NOx PM10 Water pollutants, the amount of wastewater The amount of waste generated The amount of chemicals used in soil
		Having procedures and measures in the protection of biodiversity and reducing impacts on natural and cultural resources
		Conservation of underground water
		Reduce dependence on non-renewable energy
		Encourage sustainable resource management (i.e., Reduce, Recycle and Reuse)
		Having measures to mitigate environmental impacts
		Having procedures and measures in administering and maintenance after CERs ends
Social	Public participation is the heart of sustainable development, to avoid local conflict The project must acquire permits from local and national concerned agencies Encourage distribution of benefit to local communities	Consistent with laws including Initial Environment Evaluation
		Dissemination of project information to public
		Distribution of benefits to communities Health Knowledge Skills development Other benefits to communities
Economic	To enhance local economy	Year (duration) of employment Per household income Improved well-being

Annex 8: Thailand – Thailand's Unofficial Pipeline of CDM Projects

	Project Name	Developer	Type	CER buyers
1	Korat Waste to Energy Project	Korat Waste to Energy Company Ltd.	Renewable Energy	The Netherlands
2	Green Power from Swine Farms	SPM Feedmil, Nong Bua Farm, VCF Group	Renewable Energy	Denmark
3	Thai Agro Energy ethanol and biogas plant	BOSCH and Thai Agro Energy Co., Ltd.	Renewable Energy	Denmark
4	Natural Palm Oil 640 kW electricity and biogas plant	BOSCH and Natural Palm Oil Co., Ltd.	Renewable Energy	Denmark
5	Dan Chang bio-energy cogeneration	Mitr Phol Group	Renewable Energy	N/A
6	Phu Khieo bio-energy cogeneration	Mitr Phol Group	Fuel Switching	N/A
7	Siam Cement biomass gasifier with waste heat recovery	Siam Cement	Renewable Energy	Denmark
8	Ratchasime small power producer expansion project	Agrinergy Ltd. And Wangkanai Group	Renewable Energy	Denmark
9	Ethanol production from Morasses/bagasses	Marubeni Technolosystem Co. (NEDO)	Renewable Energy	Japan
10	Electricity generation from biogas	Takuma Co. (GEC)	Renewable Energy	Japan
11	Power generation from landfill gas	Oobayashi. Co. (GEC)	Renewable Energy	Japan
12	Cogeneration Business Utilizing the Bagasses and Rice Husk in Thailand	Kansai Environmental Engineering Center, Co. Ltd. (GEC)	Renewable Energy	Japan
13	Biodiesel production project using sunflower as resource crops in Thailand	PowwowPool Cp. Ltd. (GEC)	Renewable Energy	Japan
14	Cogeneration at the industrial centre in west Thailand	Hokkaido Power Co. Ltd. (GEC)	Industrial Process	Japan
15	Electricity generation from rice husks	Cyubu Power Co. Ltd and A.T. Biopower (GEC)	Renewable Energy	Japan
16	Electricity generation from landfill gas	Mitsubishi Security (NEDO)	Renewable Energy	Japan
17	Energy efficiency project for the Aluminium industry	Nippon Koukan Co. Ltd. (NEDO)	Energy Efficiency	Japan
18	Energy efficiency through introducing ESCO service at the commercial building	Tokyo Gas Co. Ltd. (NEDO)	Energy Efficiency	Japan

19	Bang Pakong thermal electricity power	Mitsubishi Heavy Industries Ltd. (NEDO)	Energy Efficiency	Japan
20	Modernisation of thermal power plant in North Bangkok	Cyubu Power Co. Ltd and Sumitomo Corporation, Hitachi (NEDO)	Energy Efficiency	Japan
21	Thachana palm oil 640 kW electricity and biogas plant	BOSCH and Thachana Palm Oil Co., Ltd.	Energy Efficiency	Denmark (under negotiation)
22	Green power from swine farms	BOSCH and Kanchana Group	Energy Efficiency	Denmark (under negotiation)
23	Electricity generation from rice husks	BOSCH and Mungcharoen Green Power Co. Ltd	Energy Efficiency	Denmark (under negotiation)
24	C. Gigantic Carbon Company Limited (CGC), Fuel Switching Project	BOSCH and C. Gigantic Carbon Co. Ltd	Fuel Switching	Denmark (under negotiation)
25	Electricity generation from rice husks	BOSCH and Siam Thanyachart Co. Ltd	Renewable Energy	Proposal
26	Electricity from empty fruit bunches (EFB)	BOSCH and Natural Palm Oil Co., Ltd.	Renewable Energy	Proposal
27	Thai Tallow palm oil biogas plant	BOSCH and Thai Tallow Co., Ltd.	Renewable Energy	Proposal
28	Electricity generation from tapioca rhizome	BOSCH and Toyota Tsusho Co., Ltd	Renewable Energy	Proposal
29	Surat green energy	Surat Green Energy co., Ltd	Renewable Energy	N/A

Annex 9: Thailand – Overview of the 5 PDDs presented to the public on UNFCCC website, as of 26 January 2006

At the time of preparing the preliminary report, five CDM projects were in the state of validation, as published on the UNFCCC website on 18 January 2006. Three others were found in the "archive" section of the website on 28 January, meaning that the public comment period had already finished.

The five projects will be introduced shortly, regarding the project description, CERs calculated, methodologies applied and the explanation of the project activity's additionality, to gain some more insight into relevant determinants. In fact, these five projects cover three different project types. At present, the information on Thailand's unofficial CDM projects in the pipeline lists 29 projects, of which 21 are related to renewable energies. It is remarkable that all projects are based on the use of bioenergy or wastewater, while there is not one project using solar or wind energy.

1. Wastewater Treatment with Biogas System in a starch Plant for Energy & Environment

Conservation at Nakorn Ratchasima and Chachoengsa (two projects)

1.1 Project description

Two projects of the same type have been submitted for application to the UNFCCC by SIMA Interproduct Co., one in Nakorn Ratchasima province (250 km in the east of Bangkok) and one in Chachoengsa province (eastern Thailand).

The proposed projects will install an anaerobic wastewater treatment facility at existing starch manufacturing plants:

"The present wastewater treatment facility is a lagoon based ponding system to treat the wastewater before it is discharged into the water body. The quality of the water discharged to water bodies should be as per the effluent standards regulated by the authority. Though the present facility is able to treat the wastewater to meet the effluent standards, which the in case of existing starch mill is not relevant as all the wastewater is reused in the plant, the methane (a greenhouse gas (GHG)) produced in lagoons from anaerobic digestion of the organic content in the wastewater is released into the atmosphere. The use of UASB to treat the wastewater generated in the plant will enable the capture of methane produced in the process while meeting the effluent standards as well. This will help reduce the emission of GHG.

The project will use the captured methane as fuel in existing heat generating devices at the plant, and the surplus methane, if any, will be flared. The plant presently uses rice husk and fuel oil to fire the heat generation boilers, used for supplying heat to dry the wet starch. The use of fuel oil results in CO_2 emissions, a GHG, which will be reduced by using the captured methane in place of fuel oil. The use of rice husk as fuel doesn't result in any net CO_2 emission, but does result in some methane emission. These too will be reduced to the extent rice husk fuel is substituted by the captured methane as fuel. The project proponents, though, will not claim credits for avoided methane emission from rice husk burning."

1.2 Emissions reduction envisaged:

- 217,330 tonnes CO_2e in 10 years crediting period (Nakorn Ratchasima)
- 204,489 tonnes CO_2e in 10 years crediting period (Chachoengsa)

1.3 Methodologies applied:

Baseline methodology:

"Forced methane extraction from organic waste-water treatment plants for grid-connected electricity supply and/or heat production (AM0013/Version 2)"

Approved monitoring methodology: AM0013

1.4 Explanation of project activity's additionality:

"In the absence of the proposed activity, high organic wastewater will continue to be anaerobically treated in open lagoon systems where the methane generated as result of anaerobic degradation of biogenic material, escapes into the atmosphere. Without the availability of methane gas as an alternate fuel, the plant will continue to use fuel oil and rice husk as fuel to meet the process heat requirements. Thus, the proposed project results in the reduction of human-induced GHG emission (i) by avoiding the release of methane from open lagoons into the atmosphere, and (ii) by replacing the existing fossil fuel used for process heating."

2. Small-scale project activity „Ratchaburi farms biogas project"

The project activity is a bundled swine farm biogas project, which comprises three farms with a total of about 205,000 swines (Veerachai Farm – 70,000 fattening swines; Nong Bua Farm – 65,000; SPM Feedmill farm – 70,000).

2.1 Project description

"The Ratchaburi farms biogas project ("the project") involves the capture of methane (CH_4) rich biogas produced during the treatment of swine barn flushing wash waters and its combustion for heat and power generation at swine farms in the Ratchaburi Province of Thailand.

All three farms have recently invested in a high-rate continuous flow closed anaerobic treatment reactors to treat 100% of all barn flushing effluents produced from their swine rearing operations. All farms have constructed these facilities to replace low-rate open anaerobic lagoon barn flushing effluent treatment systems. The treatment of swine wastes by way of anaerobic degradation processes leads to the production of a biogas consisting of 60-70% CH_4. In the previous open lagoon system, produced biogas is released direct to the atmosphere. In the closed high-rate system, the vast majority is collected and, because of the high calorific value (between 28-34 MJ/m 3), is combusted using spark ignition engines for the production of electricity for use on-site (and in one case using a cogeneration/boiler system to generate electricity and steam). This power replaces electricity previously brought-in from the Thai electricity grid. Investment in these treatment facilities has been prompted by the potential revenue available to the farmers from the sale of certified emissions reductions (CERs) to the Royal Danish Embassy, Bangkok.

Revenue from the sale of CERs will serve to offset some the significant financial and technical risks involved for the farmer in making this type of investment. The purpose of the project activity can be summarised as:

- Treatment of swine barn flushing wastewaters so as to improve the quality of effluent to the level where it can be recycled for use on the farm for barn flushing purposes;
- Avoidance of CH_4 emissions from the old open anaerobic lagoon system previously used to treat barn flushing wastewater;
- Capture of biogas for use in onsite heat and power generation.
- Reduction of atmospheric emissions of the greenhouse gas (GHG) CH_4 and reduction in the indirect emissions of GHG associated with bought-in grid electricity, by virtue of biogas capture and on-site power generation

- Use of the CDM process to offset some of the financial and technical risks associated with the investments through the sale of CERs to the Danish Carbon Fund operating in Thailand."

2.2 Emissions reduction envisaged:

- 1,003,797 CERs in 10 years crediting period

2.3 Methodologies applied:

Baseline and monitoring methodologies:

Type III.D – Methane recovery (AMS-III.D)

Type I.C – Thermal energy for the user

Type I.D – Renewable energy generation for a grid (AMS-I.D)

2.4 Explanation of project activity's additionality:

The project delivers reductions of anthropogenic GHG emissions in two ways:

(i) Direct atmospheric emissions of CH_4 from anaerobic degradation of swine wastes in an open lagoon system are virtually eliminated, as this gas is now captured in the closed high-rate anaerobic reactor system. Some fugitive emissions of biogas are possible in the new barn flushing effluent treatment scheme (for example, from pipe work, tanks and biogas storage etc); these emissions would have occurred in the absence of the project (via open lagoon treatment of the effluents);

(ii) Fossil-derived grid electricity and heat previously bought-in by the farm is displaced by renewable electricity and hot water generated from the combustion of the captured methane rich biogas. This electricity is used on the farm's electricity distribution system, and in applications requiring hot water (Nong Bua Farm only).

3. Phu Khieo and Dan Chang Bio-Energy Cogeneration project (PKBC/DCBC)

Date of PDD completion: 30 November 2005

Two bio-energy co-generation PDDs have been submitted to the UNFCCC in November 2005. The PKBC project takes place in Chaiyaphum province 450 km northeast of Bangkok, the DCBC project takes place in Suphanburi province 150 km northwest of Bangkok.

3.1 Project description

PKBC and DCBC project activity comprise the capacity expansion of existing biomass cogeneration systems located next to sugar mills .

"The proposed project activity involves the installation of two new high-pressure boilers (70 bar), one 41 MW double casing turbine generator, one cooling tower and the construction of an 115kV substation. During the design of the power plant, the project proponent received technical assistance from Annex I countries through the EC COGEN programme in designing a heat balance of the cogeneration.

The proposed project will enable PKB to increase its electricity export to the grid from 6 MW on a non-firm year-on-year contract to 29 MW on a 21-year firm contract. As the firm contract requires the power producer to dedicate a minimum capacity to generate electricity to the grid, it can be counted upon as 'reliable capacity' to the system. In contrast, the electricity supply from non-firm power producers is unpredictable as they are free to supply electricity only when they have excess electricity. Therefore, switching from non-firm to firm contract will significantly increase the system capacity and greatly enhance stability of the electricity system. The project will use bagasse supplied by the sugar mill as primary fuel. In general, bagasse produced by the sugar mill can generate more electricity than is required by the sugar mill. However, the existing backpressure cogeneration cannot utilise excess bagasse due to limited demand for steam from the sugar mill. The proposed project, through the installation of a condensing turbine generator, will allow PKB to generate pure electricity all year round, irrespective of the sugar mill's operation. The project also proposes to collect cane leaves in the sugar cane plantations as supplementary fuel to compensate for any shortfalls in sugar cane throughput. The utilisation of cane leaves will avoid the current practice of burning the leaves before harvesting to save labour. As such, the air quality in the proximity of the plantation area will improve significantly during the harvest season."

3.2 Emissions reduction envisaged:

- 990,309 CERs in 10 years crediting period (constant annual share) (Phu Kieo)
- 921,770 CERs in 10 years crediting period (constant annual share) (Dan Chang)

3.3 Methodologies applied:

Baseline and monitoring methodologies:

Consolidated baseline methodology for grid-connected electricity generation from biomass residues, ACM006, Version 01, Sectoral Scope: 01, 30

3.4 Explanation of project activity's additionality:

"The project activity, which generates electricity from agricultural residue (bagasse, cane leaves, and rice husk), reduces greenhouse gases due to (i) displacement of CO_2 emissions from electricity generation by other sources (displacement of grid electricity); and (ii) avoidance of CH_4 emissions from uncontrolled burning or decay of biomass.

The emission reduction would not occur in the absence of the proposed project activity due to high investment and unattractive return. Despite the recognised role of small power producers for promoting renewable energy in Thailand, high efficiency cogeneration is still an uncommon practice in Thailand. There are a series of high risks associated with the use of a new technology and the decision to generated biomass electricity for the grid on a firm contact basis. When signing a long-term firm electricity contract a given sugar mill has to be confident enough that it will produce sufficient biomass to supply its cogeneration project. Although it seems easy to predict, the variation of sugarcane productivity ranges from 75 to 95 tonnes of sugarcane per hectare annually depending on the rainfall. The proposed project goes beyond the common practice in the sugar industry in Thailand by generating a much larger amount of electricity than what is needed for the sugar mill's energy requirements and selling it to the grid on a firm contract basis, thus insuring a continuous supply of biomass energy to the grid all year round. Moreover, the proposed project is investing in state-of-the-art technologies that will be tested at commercial scale for the first time in Thailand and using an added fuel source (cane leaves) not currently utilised in Thailand.

Cane leaves will be used in cogeneration project for the first time in Thailand, as there is no end-market for this type of biomass in Thailand, due to high collection costs. Therefore, the project will avoid CH_4 emissions that would otherwise occur from uncontrolled burning of this biomass on the fields."

Annex 10: Thailand – Financing Feed-in Tariffs Through Programmatic CDM – Sample Calculation

Based on the calculations and conclusions presented in Chapter 6.5.4, we would like to explore options to use CER revenues from project types with higher CER yields per electricity generated to cross-finance feed-in tariffs for other RE sources with a lower yield, based on the following premises:

From a governmental point of view, the following option and steps could be explored to increase electricity generation from REs:

1. Identify those project types which in the internal logic of the CDM are the most cost-effective – like landfill gas or waste to energy projects – and thus can generate significant gains from selling large amounts of CER
2. Set up a program to support these project types on a larger scale which fulfils the requirements of a (unilateral) programmatic CDM project: this could be done for example by setting guaranteed feed-in tariffs for a certain amount of kWh from such project types with the objective to reduce a certain amount of GHG emissions
3. Take the net revenues (or a share of them) of the CERs to finance renewable energy feed-in tariffs outside the CDM for those technologies which are less competitive in the CDM logic but increase RE electricity generation. This approach would limit the transaction costs for CDM approval procedure to the high-yield projects. The other projects would be supported through feed-in tariffs, the application of which is assumed to be less complex for project developers

At least in theory, viewed from the renewable energy targets, an optimal solution could be if the Thai government used this option to not only finance part of a feed-in tariff support scheme, but take the revenues to even increase the scale and effectiveness of a programme of the latter kind.

This could be summarised in the formula: Maximising the increase of electricity generation from renewables through maximising Thailand's CDM benefits.

The following calculations give a theoretical example how this could work in the case of waste to energy projects. More advanced calculations would have to incorporate aspects such as the change of the CO_2 intensity of the grid electricity mix over time (although the CO_2 reduction is almost negligible compared to the reduction of methane emissions), decreasing technology costs for renewable energy technologies leading to decreasing feed-in tariffs etc.

The target of the government for electricity production from municipal wastes is 100 MW of installed capacity until 2011. When this capacity would be implemented incrementally, not proposed as one specific programme, one can assume that only a certain share would be eligible as CDM projects, since with increased dissemination of one technology later installations might fail the additionality test. Also, with increasing mass production, decreasing technology costs and thus lower feed-in tariffs can be assumed.

Taking Korat Waste to Energy project's determinants as reference, which is a 3 MW project, this could result in the following.

The calculation is divided in six steps and can be explained as follows: First, the amount of electricity to be generated in 2011 by the 100 MW MSW is estimated (based on the figures of the Korat PDD) (a). Second, this amount is multiplied with the number of CERs per MWh in the Korat example to determine the total amount of CERs (b). Third, this is multiplied with an assumed CER price of 10 Euro per CER and converted into the Thai currency Baht (c). This amount of Baht is expected to by generated by the MSW electricity generation in 2011. Fourth, it is assumed that the amount of MWh generated is paid with a feed-in tariff of 5 Baht/kWh. This price functions as the incentive to implement the plants (d). In the fifth step, the net revenue is calculated: the revenues from the CERs minus the sum paid for the feed-in tariff (e). Finally it is estimated how much kWh of other renewable energy sources could be paid through this net revenue (f).

a) Electricity generation in 2011 of 183,333 MWh/10 (years) x 100MW/3MW = 611,110 MWh
b) CER of 611,100 x 17.62 (CER per MWh) = 10,776,758 CERs
c) Based on 10 Euro per CER: 107,767,580 Euro = approx. 5,065,076,260Baht
d) Feed-in for the MWh produced (5 Baht/kWh): 3,055,550,000 Baht
e) Net revenue (c-d): 2,009,526,260 Baht (app. € 42.8 mio.)
f) Amount of kWh from other applications that could be paid for from this revenue:

Source	Feed-in tariff: Baht per kWh (DEDE 2005; E for E 2004)	Possible amount of kWh paid through net revenues in 2011	Rough estimates of additional CO_2e reduction (tonnes)
Pig farm biogas	2.68	749,823,231	5,023,815[102]
Biomass	3.2	627,976,956	2,964,051[103]
Wind	5	401,905,252	190,904[104]
PV	15	133,968,417	63,634
Waste to energy from 100 MW	5	611,110,000	

This would lead to increased renewable energy electricity generation on the one hand and to an additional reduction of greenhouses gases outside the CDM on the other hand and thus lead to real reductions.

These analyses are just very rough theoretical examples. But they perhaps lead into a direction how the inherent weaknesses of the CDM to foster certain renewable energies could be overcome by linking different policy instruments that have different purposes. In this context, it is important to note that the international discussion about “programmatic” CDM is becoming more important after COP/MOP 1 in Montreal, as well as the will of developing countries to introduce renewable energies.

References for this Annex:

Figueres, C. (2005): Executive summary of the Study on Programmatic CDM project activities: Eligibility, methodological requirements and implementation.

Project PDDs as presented in chapter 6.5.

[102] A factor of 6.7 per MWh is taken from the Ratchaburi swine farm case.
[103] Afactor of 4.72 per MWh is taken from the Dan Chang Bio-Energy co-generation case.
[104] An grid electricity intensity factor of 0.475 tCO2/MWh for the year 2011 is assumed, based on EGAT 2004

Annex 11: Country Study Morocco

Figure 10.1: Physical map of Morocco

Source: Microsoft Encarta (1996)

Political and Socioeconomic Framework Conditions

Table 10.1: Morocco – Key Data and Indicators

Population (in mio. 2003)	30.1
Average annual population growth (in %, 1990-2003)	1.7
Country area (in thousand km^2)	447
Population density (in pers./km^2, 2003)	67
Share of rural population (in %, 2003)	43
Literacy rate of people older than 15 years (in %, 2002)	50.7
Share of population below national poverty line (in %, 1998-99)	19
Share of population with less than US-$ 2 per day (in %, 1999) (Poverty line according to international definition)	14.3
GDP in PPP (in bill. US-$, 2002)	112.9
GDP in PPP per capita (2002)	3.810
Annual growth in GDP (in %, 1990-2003)	2.7
GINI-Index (1998/1999)	395
Human Development Index (2002)	0,61; Rank 125; medium human development
Foreign direct investments (in mio. US-$, 2003) (1990)	2.279 (165)
Share of foreign investment in GDP (in %, 2003)	5,3
Official Development Assistance (ODA) received (in mio. US-$, 2002)	636.2
Share of ODA in GDP (in %, 2002) (in %, 1990)	1.8 (4.1)

Source: World Bank 2005a; UNDP 2004.

Morocco is a constitutional monarchy with a powerful position of king Mohammed VI (Auswärtiges Amt 2005b). Due to terrorist attacks, the domestic situation is strained. Nevertheless, Morocco has a favourable rating in the *International Country Risk Guide (ICRG)* (9 out of 12 points maximum) (World Bank 2004).

When looking at the employment data, agriculture is still the most important economic sector with a 43 % share of total employment. Other important sectors are construction, energy, mining and tourism. In 2004, the Moroccan economy had a significant foreign trade deficit due to a 58 % increase in expenditures for oil imports (Auswärtiges Amt 2005b).

Economic Relations between Morocco and Germany: There has been a German chamber of foreign trade in Morocco since 1997. According to the German Department of Foreign Affairs, around 80 German companies are active in Morocco. The focus of German development cooperation with Morocco is the drinking water supply, wastewater treatment, environmental protection, rural development including natural resource protection, and the competitiveness of the Moroccan economy, which includes professional training. The funds of the German KfW for a wind park (see below) account for a high share of total German ODA funding (Auswärtiges Amt 2005b).

Preliminary Study on Renewable Energies

Energy Figures	
Primary energy consumption (in Mtoe, 2002) (1990)	10.753 (6.725)
Primary energy consumption per capita (2002) (1990)	363 (280)
Electricity consumption per capita (in kWh, 2001)	569
Electrification rate (in % of population, 2000)	71.1

Source: World Bank 2005a; UNDP 2004.

Structure of the Energy Sector

According to the IEA (IEA 2004a), primary energy consumption in 2002 was about 10,75 Mtoe, a growth of around 60 % compared to 1990. Energy consumption has grown continuously over the last 30 years with an average of around 4 % per year, resulting in a four-fold increase. In parallel, per capita consumption has merely doubled (WRI 2003a; see Figure 10.2). Thus, one important driver for the increase in energy demand was the high population growth. Even more distinctive was the increase of the electricity consumption with around 6 % annual growth from 1986 to 2002. In 2002, electricity demand was around 17 TWh and is expected to double by 2010. Regarding the sectoral distribution of primary energy supply, in 1999, 27 % was used by industry and 24 % by the residential sector. The highest share of around 35 % was used by "non-energy uses and other consumption" (WRI 2003a; see Figure 10.3).

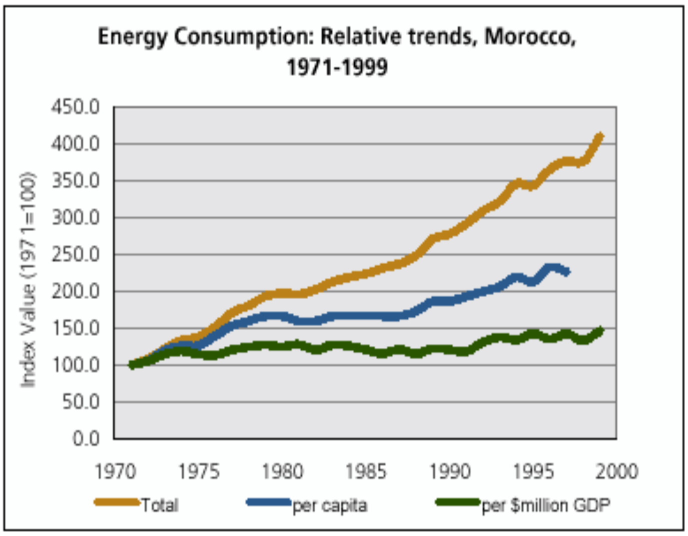


Figure 10.2: Energy Consumption in Morocco (1971-1999)

Source: WRI 2003b.

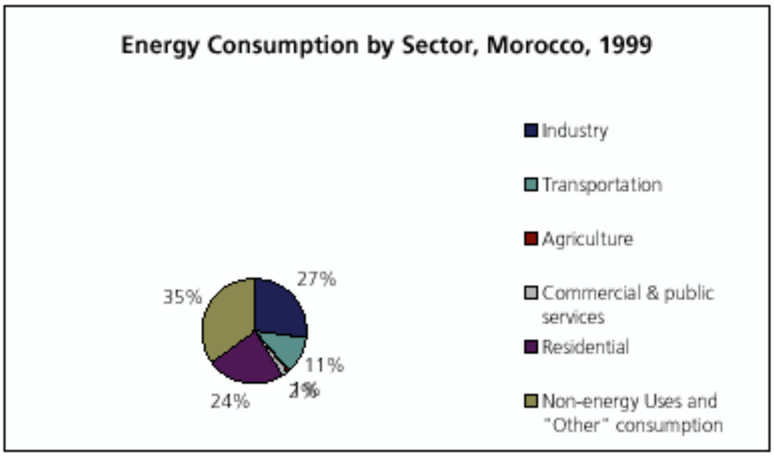


Figure 10.3: Energy Consumption by Sector, Morocco (1999)

Source: WRI 2003b.

Morocco's energy demand is covered predominantly from fossil fuels. In the electricity sector, which has a total capacity of 4,400 MW, imported coal and oil are dominant (around 72 % share of the total capacity), followed by hydropower (26 %) and wind power (2 %). The use of coal has been increasing in the last decade (GTZ 2004b) (see Table 10.2).

Table 10.2: Electricity Supply by Sources (1998-2002)

In GWh	1998	1999	2000	2001	2002
Thermal	9,936	10,571	10,771	12,091	13,068
Hydropower	1,760	817	706	856	842
Wind power	2	4	65	207	194
Imports	715	1,846	2,363	1,564	1,392
Total	12,413	13,643	13,904	14,718	15,496

Source: GTZ 2004b: 7

Electrification has been pushed ahead in recent years. According to ADS Maroc (2005), today around 72 % of the population have a basic electric power supply, compared to only 18 % in 1994. The aim is to increase the electrification rate up to 100 % until 2007. Not only an extension of the electricity grid but also decentralized solutions like Solar Home Systems are being pursued. The envisaged further liberalisation of the power market will open new options for Independent Power Producers (IPP) and might tend to result in more investments in RET. These could then feed electricity into the grid without having to agree individual contracts with the dominant Moroccan utility, Office National de l'Electricité (ONE) (GTZ 2004b).

From 1990 to 2002, CO_2 emissions resulting from the combustion of fossil fuels increased by around 70 % to 33 Mt. From a sectoral perspective, the most important emitters are the public energy utilities, the manufacturing industry and "others" (IEA 2004a).

Renewable Energies: Status Quo, Targets and Potential[105]

Apart from hydropower, renewable energies do not play an important role in electricity generation. In total, only about 0.2 TWh are generated from renewable energies, which is equivalent to 1.5 % of total electricity generation in Morocco (Allal 2005; see Figure 10.4, Figure 10.5).

[105] It needs to be added that most of the literature does not differentiate between the different types of potential. See chapter 2.3.

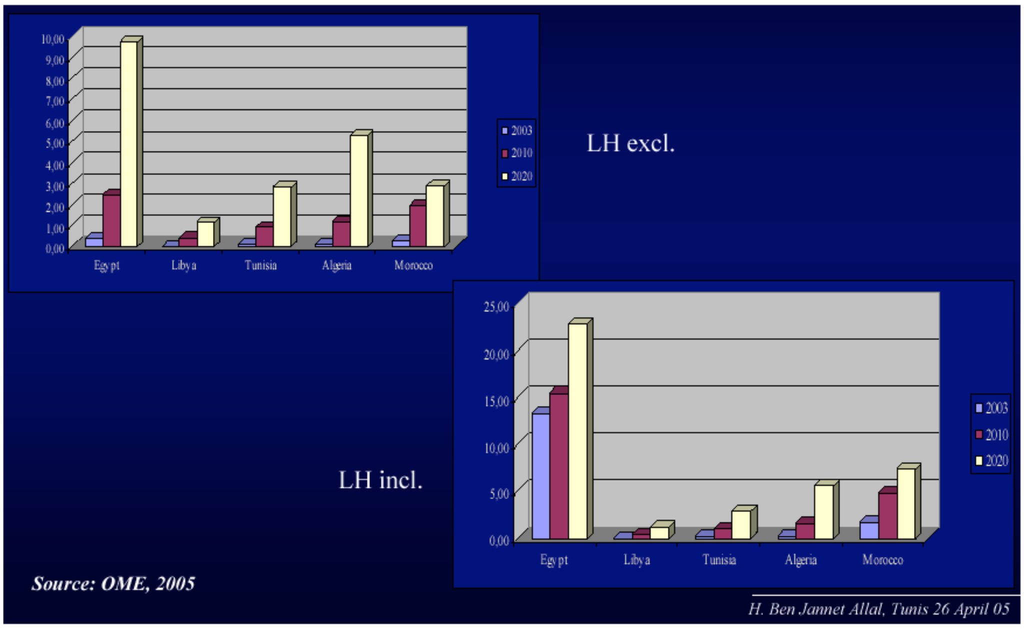


Figure 10.4: Electricity Generation from RE – Comparison of Different Countries, in TWh

Source: Allal 2005: 18.

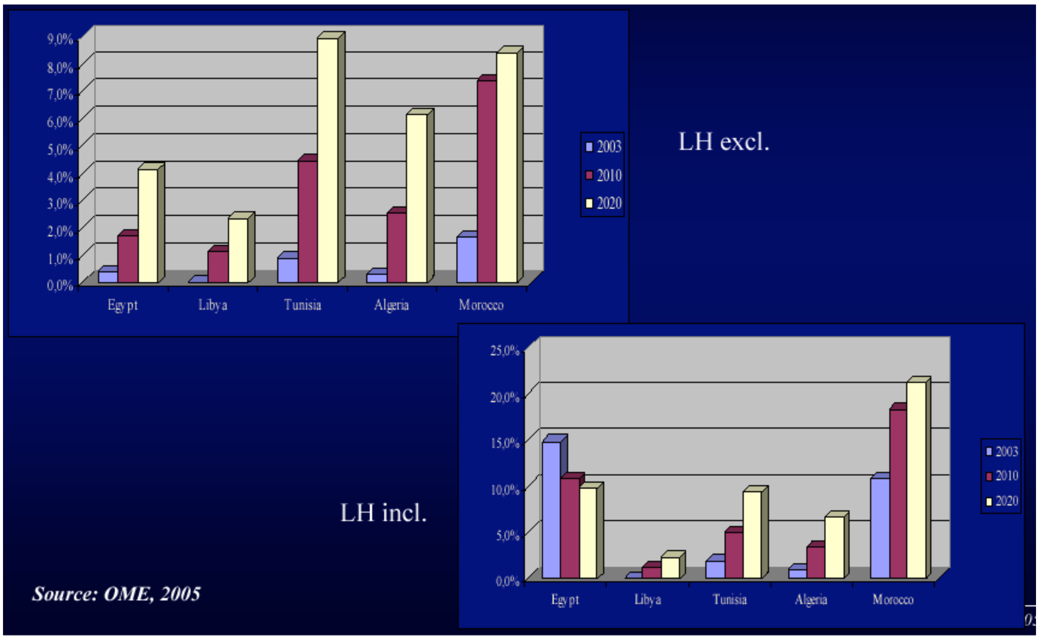


Figure 10.5: Share of RE in Power Generation – Comparison of Different Countries, in %

Source: Allal 2005: 18

Currently, the most important renewable energy source is *hydropower*. According to GTZ (2004b), the technical potential is around 2,500 MW installed capacity, whereof

37 % are already in use today. In 2002, around 842 GWh power were generated from hydropower, which is around 5% of the total production of electricity. One technical barrier to utilisation is the high variance in precipitation. Due to droughts, power generation in 1998 was twice as high as in 2002 (ADS Maroc 2005). A new storage power station with a capacity of 470 MW was scheduled to be finished by the end of 2004.

Morocco has a huge potential for wind energy of around 5,000-6,000 MW (installed capacity). Wind conditions range from good to very good, wind speed in some instances exceeds 11 m/s. Currently, there are 50 MW of wind mills connected to the grid and another 350 MW are planned to be installed by 2006. The aim of the Moroccan government is to increase the share of wind power up to 4% of power production by 2010. Next to the grid-connected wind power plants, there are several stand-alone windmills (around 300) that are not connected to the grid as well as 5,000 water pumps driven by wind energy (GTZ 2004b, according to CDER).

Biomass is currently mainly being used in the form of fuel wood. However, the high amount of around 11 Mt of fuel wood per year is not being produced sustainably (GTZ 2004b). The government therefore promotes a more efficient use of fuel wood. Regarding the potential, there are different figures. While GTZ (2004b) speaks of 5 mio. ha, the Moroccan project partner assumes that an amount of around 9 mio. ha of forest could potentially be used as biomass, GTZ is (GTZ 2004b; ADS Maroc 2005). In addition, there is a huge amount of domestic waste (8,000 t daily) that is appropriate for energetic use as well as of wastewater (around 1.1 mio. m^3 daily) that might be used for biogas generation. Currently, around there are 300 small biogas plants (GTZ 2004b). According to the International Action Programme of the renewables 2004 conference, the government intends to commission a feasibility study on the potential of biomass and options for their utilisation (IAP 2004).

Based on the average annual global radiation, the potential for *solar energy* use are enormous, with around 5 $kWh/m^2/day$. According to our project partner, there are around 3,200 sunshine hours per year, which means 2,5 MWh/m^2 per year in usable energy (ADS Maroc 2005).

A map of the solar irradiance intensity in the Mediterranean region shows that there is a high technical potential for *solar thermal energy generation* of around 140 to 280 GWh/km^2/a (see Figure 2.2).

The government aims to triple the amount of 50,000 *solar home systems* that had been in place in 2002 by 2007. In total, around 7 MWp are currently installed. Besides, the role of solar thermal power generation is to increase in the future. Currently, there are plans for a combined gas power plant with a capacity of 200 MW. Between 1998 and 2004, the surface area used for solar thermal energy generation has increased remarkably from around 20,000 m^2 to around 110.000 m^2. Projections envisage an increase up to 400.000 m^2 by 2010 and to 1.000.000 m^2 by 2020 (Allal 2005).

Geothermal power generation has so far not been used for power generation nor been investigated in detail. According to Rimi (2000), the potential are quite low (Rimi 2000), but according to the International Geothermal Association (IGA) they could be used for heat generation (GTZ 2004b). Only in the Northeast region and in some areas of the Sahara temperatures reach a maximum of 120 °C (at 3,000 m below the surface) (see Figure 10.6).

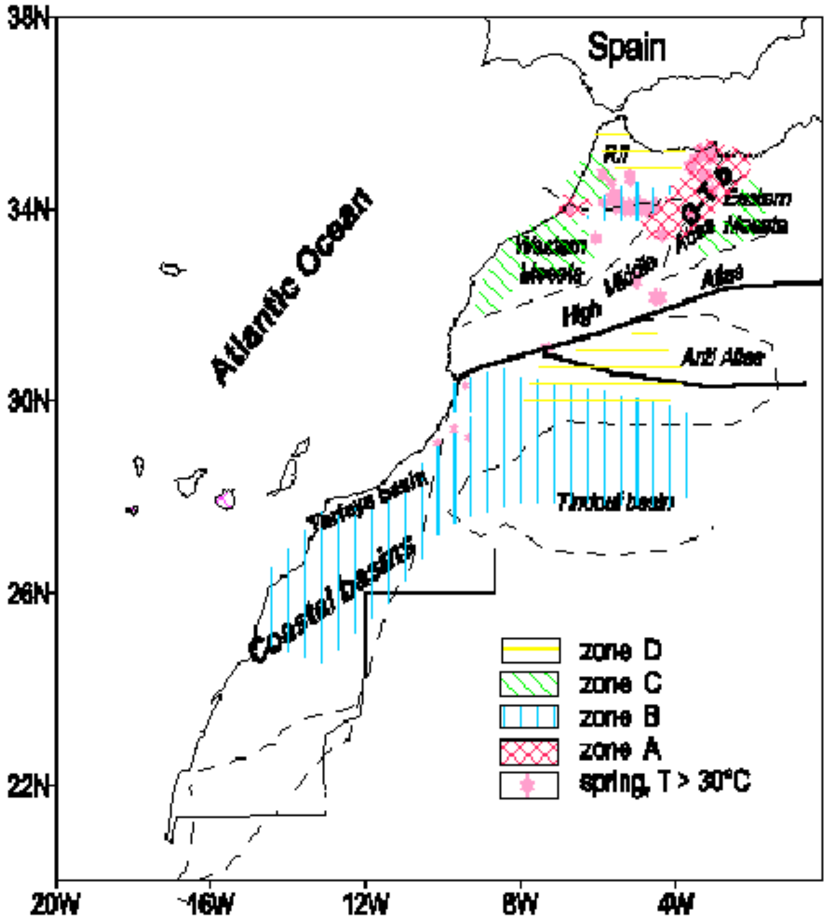


Figure 10.6: Zones with Geothermal Potential[106]

Source: Rimi 2000: 398.

[106] Comment on Figure 10.6: "The map in Figure 3 synthesises the levels of Moroccan geothermal potential as follows: class A characterizes the zone extending since the southern Rif and northern Middle Atlas to eastern Morocco. The temperature of the aquifers existing up to 3.000 m of depth can reach 120 °C. The zones of class B are of an average geothermal vocation, the temperature of the aquifers may exceed 100 °C but the aquifers are of moderate importance. In this category, we have the Saharan basins and the southern Rif. The zones of class C are sedimentary basins of great extents where the temperature varies between 30 and 90 °C, the depth to which one can obtain hot water can be so great that this class C cannot be considered like potential resource in the immediate future. Finally the class D shows areas without geothermal possibilities." (detailed information in Rimi 2000)

Renewable Energies in Energy Policy

The Moroccan government has made significant efforts towards an increased implementation of renewable energy technologies in the last two decades and specifically in the last years. The establishment of the ”Centre de Developpement des Energies Renouvelables” (CDER) took place in 1982. The tasks of the CDER are surveys, capacity building and quality control of installations, particularly PV systems, as well as the training of experts.

The national strategy for the development of renewable energies of 2001 sets specific targets: an increase of the share of renewable energies in electricity supply to 10 % by 2010 and to 20 % by 2020. The International Action Programme (IAP) of the renewables 2004 also mentions targets for rural electrification in Morocco, namely the creation of energy services for 150,000 households through PV, small-scale hydropower plants and windmills. Further goals for the different renewable energy resources have already been described in the sections above. The political aims mentioned are a reduction of the dependence on imports, access to energy in rural areas, increase of electrification, strengthening of economic capability, employment creation and reduction of CO_2 emissions (IAP 2004).

Morocco is also member of the Johannesburg Renewable Energy Coalition (JREC) that was founded at the World Summit for Sustainable Development in 2002. In addition it is a partner in the ”Mediterranean Renewable Energy Partnership” (MEDREP), a Type II partnership launched at WSSD and in the ”EU Initiative Energy for Poverty Eradication and Sustainable Development”. Apart from the national strategy for renewable energies, Morocco also takes part in the Global Market Initiative for ”Large Scale Solar Thermal Power and Desalination as a Joint Development Effort by North Africa, the Middle East and Europe”.

Conclusion

The share of renewable energies in the energy supply of Morocco is still quite low, at around 1.5 % of electricity supply (excluding large hydropower), but the political relevance of an increased use of renewable energies has grown significantly over the last years. Particularly the security of energy supply and the high dependence on imports of fossil fuels are important political and economic factors. There has been a high increase in dissemination of decentralised solar thermal collectors and PV systems over the last years, which has led to a high increase in electrification. High potential for the future can be seen in the area of solar thermal power generation and in the wind energy sector. Morocco is a partner in several international initiatives and action programmes for the promotion and implementation of RE, which underlines the government's high interest in sustainable energy systems and their future promotion.

Preliminary Study on the Clean Development Mechanism (CDM)

Emission indicators	
CO2 emissions (in Mt, 2002) (IEA sectoral approach) - in %, change since 1990	33.26 69.3
CO_2 emissions per capita (in t, 2002)	1.12
CO_2/TPES (t CO_2 per TJ) - in %, change since 1990	73.87 5.9
Total GHG emissions (in mio. t CO_2e, 1990)	44.7
Total GHG emissions (in mio. t CO_2e, 2000)	58.3
Annual growth rate (in %)	2.7
Total growth 1990-2000 (in %)	30.2

Source: IEA 2004a; WRI 2005.

Milestones of Moroccan climate policy	**Date**
▪ Ratification of UNFCCC	28 December 1994
▪ Ratification of Kyoto-Protocol	25 January 2005
▪ First national communication	October 2001
▪ Establishment of CDM-DNA	September 2002

Source: http://unfccc.int, http://www.mdpmaroc.com.

CDM in the Context of Morocco's Environmental and Development Policies

Like in most developing countries, the emphasis of Moroccan environmental policy is on areas with local relevance such as water, desertification and air pollution. This becomes apparent in the national environmental and sustainability strategy of 1995 and in the environmental action plan which is intended to support implementation of the strategy. However, since Morocco is extremely vulnerable to the impacts of climate change – Morocco has, for example, experienced an increasing number of droughts in recent years – it is one of the internationally most committed countries in regard to climate policy on the African continent (Morocco 2001). The engagement particularly manifested itself in being host to the Seventh Conference of the Parties to the UN Framework Convention on Climate (COP 7), which took place in Marrakesh in October/November 2001.

Already the first *National Communication* of Morocco highlights the importance of the CDM as means for mobilizing additional funding for domestic climate protection actions (Morocco 2001). The Moroccan government has stressed that they expect the CDM to make an important contribution to sustainable development and the achievement of their national environmental strategy. Our project cooperation partner Dr Lahbabi also emphasised that next to the positive impacts on climate protection projects, Morocco also expects positive effects on rural areas, poverty reduction, additional funding (next to ODA/GEF) and technology transfer. Therefore, Morocco aims to give priority to projects with socio-economical and environmental impact. Key issues named in this context are renewable energies, energy efficiency in the residential, industry and service sectors as well as improvements in the transport sector and waste management. In addition, reforestation has been mentioned as a measure to combat desertification (MDP Maroc 2004).

With support from UNDP/UNEP, a strategy for the promotion of CDM was developed and almost completely implemented in 2003 to 2005. The three most important objectives are: 1) Establishment of the necessary institutional framework (particularly the DNA); 2) National capacity building in the private and public sectors; 3) Promotion of the Moroccan CDM potential at the international level (MDP Maroc 2004).

DNA Structure

The Moroccan DNA was established by ministerial decree on 18 September 2002 as part of environment ministry's subdivision "Climate Change Services". It is subdivided into two parts, the "CDM National Council (CDMNC)" and the „Permanent Secretariat of the National Council". The CDMNC has 20 members from 13 ministries. The other members are from companies, banks or public institutions. It is chaired by the Moroccan environment minister. There are four thematic subcommittees. The secretary supports the CDMNC, stays in contact with the CDM-EB and is the central contact point (“one-stop-desk”) for CDM project participants.

Apart from the tasks in the CDM project cycle that have been defined internationally, the DNA is also responsible for capacity building on technical issues like baseline-setting and monitoring and is to work actively towards a diversified and high-quality project portfolio. The main responsibility for the implementation of these tasks lies with the secretariat.

The establishment of the Moroccan DNA was strongly supported by the UNEP/UNDP-programme “CD4CDM”[107] (“Capacity Development for the Clean Development Mechanism“), which is supported by the Dutch government. Up to now the work was funded by the ministry of the environment. In medium term they would like to add additional (international) financial sources.

DNA Procedures

Morocco has established a two-stage procedure for the assessment and approval of incoming CDM project proposals with the aim of providing investment incentives through the provision of a transparent and speedy approval system (see Annex 12). First a preliminary project evaluation is done, aiming at two targets. On the basis of a standardized “Project Idea Note” (PIN), the DNA checks whether the Moroccan requirements are fulfilled. In addition, the DNA checks whether the project will lead to a real and measurable reduction of greenhouse gas emissions, whether it complies with the national sustainable development criteria and whether no negative effects are associated with the project. The preliminary evaluation shall be completed within two weeks after the submission of the PIN.

If a positive assessment is given by the DNA, the following step entails a detailed evaluation on basis of the Project Design Documents (PDD). The DNA checks the project’s compliance with the international CDM regulations as well as the compatibility with the national sustainable development criteria. The examination shall be completed within four weeks after the submission of the PDD.

[107] Egypt was also a partner of the UNEP/UNDP-programme ”CD4CDM”, which helps to explain the similarity of the DNA structure and procedures in both countries.

The “sustainability-check” of the project is done by the DNA on the basis of a list of “National Sustainable Development Criteria” that was agreed in November 2003 (see Annex 13). According to these criteria, the project has to fall within one of the priority areas of the national sustainability strategy, has to conform to national legislation – which implies an environmental impact assessment – foster renewable energies or energy efficiency and have a positive impact on the local population. The project is evaluated on the basis of a list of indicators with a scale from –3 to +3, which includes the following aspects: emission reduction, abatement of local environmental problems, employment creation, long-term profitability, positive contribution to macro-economic planning, cost effects, increase of technological autonomy, contribution to the sustainable use of natural resources (CN MDP 2005).

Capacity Building

The GTZ study of 2001 concluded that there was a high need for training and capacity-building measures. Numerous activities have been conducted since[108] and comprehensive information material has been prepared for project participants. For example, there is a guideline for the development of small- and large-scale projects and since May 2003 a monthly newsletter has been published. The French version of the DNA website was even named as “best DNA website existing so far globally” by Point Carbon (Point Carbon 2005b). Most of these measures have been implemented with the support of UNDP/UNEP. Hence it can be assumed that the need for capacity building observed in 2001 has been reduced considerably

[108] See http://www.mdpmaroc.com/realisations.html)

Project Portfolio

As of summer 2005, the Moroccan "CDM National Council" had approved 6 PDDs and another 15 PINs (see Table 10.3). The PDDs of two wind energy projects were being validated by DNV (*Det Norske Veritas*). Another 19 projects were being developed and had already been announced to the DNA.

The project portfolio was quite balanced with 15 projects in the field of renewable energy technologies (see Table 10.3). Landfill gas projects were the second most frequent project type. Measured by the expected CER volume, the RE projects had the highest share with about 46 % of the total project portfolio. The largest project planned was also a renewable energy project: The establishment of a solar-gas hybrid power plant which was to reduce CO_2 emissions by 993.000 t CO_2 annually.

The Moroccan energy monopolist "National Office of Electricity" (ONE) was involved in 8 of the 21 projects of which there was a PIN or PDD. The other projects were mostly municipal. It seemed that most of the projects were unilateral projects, i.e. without a project partner from an Annex I country. The German KfW was involved in two projects, one wind park project and one photovoltaic project for rural electrification (with approved PDD) (Morocco 2005).

Table 10.3: CDM Project Portfolio in Morocco as of Summer 2005

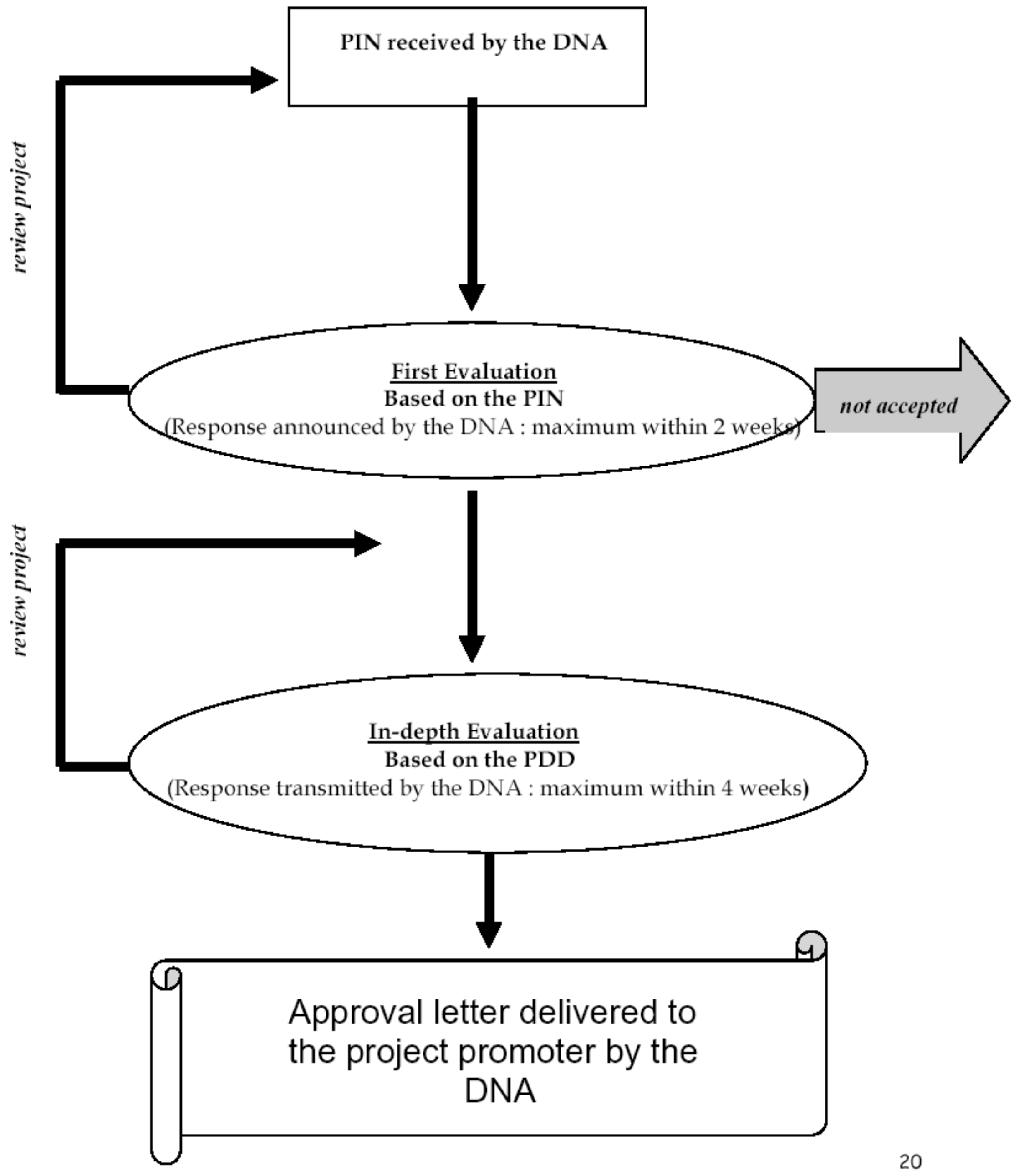
Project Type	**Number of Projects** (incl. Pipeline)	**CER-Volume** (1000 t CO_2e p.a.)	**Remarks**
Renewable Energy	15 (4 PDD, 5 PIN)	2391	1 project without CER-data; 5 small-scale-Projects; 8 x wind; 2 x hydropower; 3 x solar thermal; 2 x photovoltaic
Energy Efficiency	9 (1 PDD, 2 PIN)	649,7	1 project without CER data; 1 small-scale-project
Afforestation	5 (1 PIN)	742,2	1 project without CER data; 1 biofuels project with 618,7 t CO_2e
Waste Management	11 (1 PDD, 7 PIN)	1436,8	1 small-scale project
Total	40 (6 PDD, 15 PIN)	5219,7	7 small scale projects

Source: Own compilation on the basis of DNA data (http://www.mdpmaroc.com).

Conclusion

Morocco can be seen – and sees itself – as a country with a well-developed CDM infrastructure and a balanced project portfolio (JIQ 2005). Point Carbon stresses that "institutionally, Morocco is the most advanced CDM host country in Africa" (Point Carbon 2005b). Nevertheless, the interest on the buyer side has so far been comparatively low.

Annex 12: Procedure of CDM Project Approval in Morocco



Source: MDP Maroc 2004.

Annex 13: CDM Sustainable Development Criteria in Morocco

- The project must be integrated into a developing country's main objectives and be a part of the defined priorities in the National Sustainable Development Strategy.
- The project must conform to current country laws and in particular the ones related to the environment and its preservation. It is particularly essential that an environmental impact study be realized in conformity with the national regulations on environmental impact studies.
- The project must aim towards the development and/or diversification of national clean energy potential, and in particular the promotion of Renewable Energy and of the Energy Efficiency
- The project must use clean and confirmed technologies and avoid any out-dated technologies.
- The project must have a tangible positive impact on local populations: creating jobs; creating wealth; increasing quality of life, and building capacity on clean development and on sustainable environment.
- The project must induce a level of competitive spirit for enterprises concerned in by its activity.
- The project would also be able to develop the country's capacity to combat the adverse effect of Climate Change and to adapt to this change.

A matrix serving a basic for the evaluation of the conformity of CDM Morocco projects with the Sustainable Development National Policy has been established by CDM-DNA Morocco. It is based on the following aspects :

1. Contribution to the mitigation of global CC
2. Contribution to the sustainability of the local environment
3. Contribution to the creation of employment
4. Contribution to the durability of balance of payments
5. Positive Contribution to the macro-economic plan
6. Effect on costs
7. Contribution to technology autonomy
8. Contribution to the sustainable use of natural resources

Source: MDP Moroc 2004.

Annex 14: Country Study Senegal

Figure 10.7: Physical Map of Senegal

Source: Microsoft Encarta 1996

Political and Socioeconomic Framework Conditions

Table 10.4: Senegal – Key Data and Indicators

Population (in mio., 2003)	10.2
Average annual population growth (in %, 1990-2003)	2.6
Country area (in thousand km^2)	197
Population density (in pers./km^2, 2003)	53
Share of rural population (in %, 2003)	50
Literacy rate of people older than 15 years (in %, 2002)	39.3
Share of population below national poverty line (in %, 1998-99)	33.4
Share of population with less than US-$ 2 per day (in %, 1999) (Poverty line according to international definition)	67.8%
GDP in PPP (in bill. US-$, 2002)	15.8
GDP in PPP per capita (2002)	1,580
Annual growth in GDP (in %, 1990-2003)	4.0
GINI-Index 1995	41.3
Human Development Index (2002)	0.437; Rank 157; low human development
Foreign direct investments (in mio. US-$, 2003) (1990)	78 (57)
Share of foreign investment in GDP (in %, 2003)	2.7
Official Development Assistance (ODA) received (in mio. US-$, 2002)	448.8
Share of ODA in GDP (in %, 2002) (in %, 1990)	8.9 (14.4)

Source: World Bank 2005a; UNDP 2004.

When compared with other countries in West Africa, Senegal can be described as being politically relatively stable and democratic while facing difficult environmental conditions. After the elections in 2000, which ended the 40-year single party rule of the Parti Socialiste, the new governing party SOPI (“change”) rules the country with a two-thirds majority. The demand for independence voiced by the Casamance region in the south entails potential for conflicts, but at present the situation seems to be relatively calm (Auswärtiges Amt 2005c).

Strong population growth, the expansion of the Sahel and a monocultural, export-oriented agriculture (most important good: peanuts) put serious pressure on the environment. When comparing common development indicators with the other countries in the region, Senegal is relatively well-off. The economic reforms of the last couple of years induced a constant growth. The *International Country Risk Guide (ICRG)* assigns Senegal 8 out of 12 points maximum (World Bank 2004). However, Senegal belongs to the group of “Highly Indebted Poor Countries” (HIPC). Thus, some relief can be expected from the debt relief initiative agreed on during the 2005 G8 summit in Gleneagles, UK. Agriculture and forestry, cattle-breeding and fishery sustain about 75% of the population but only contribute one fifth to the country's GDP. Moreover, the economy is highly dependent on imports (Auswärtiges Amt 2005c).

Economic Relations between Senegal and Germany: While trade is low, both countries envisage to intensify their development cooperation (Auswärtiges Amt 2005c).

Preliminary Study on Renewable Energies

Energy Figures	
Primary energy consumption (in Mtoe, 2002) (1990)	3,192 (2,238)
Primary energy consumption per capita (2002) (1990)	319 (305)
Electricity consumption per capita (in kWh, 2001)	151
Electrification rate (in % of population, 2000)	30.1%

Source: World Bank 2005a; UNDP 2004.

Structure of the Energy Sector

According to the IEA (2004a), primary energy consumption in 2002 was about 3.19 Mtoe, a growth of more than 40% compared to 1990. Energy consumption in Senegal has continuously grown throughout the last 30 years, but without significant changes in per capita consumption and mostly due to population growth (see Figure 10.8).

Accounting for more than 50% of consumption, the residential sector is still the major consumer (WRI 2003b; see Figure 10.9). In 2001, the electrification rate was 31.4% (GNESD 2004; see Table 10.5), with an annual growth of about 2% since 1998. However, in the rural areas only 260 villages out of 13,000 or 7% of the population are connected to the grid (ENDA 2005).

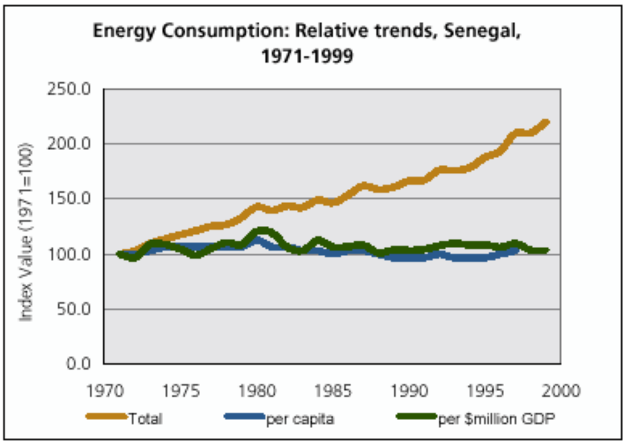
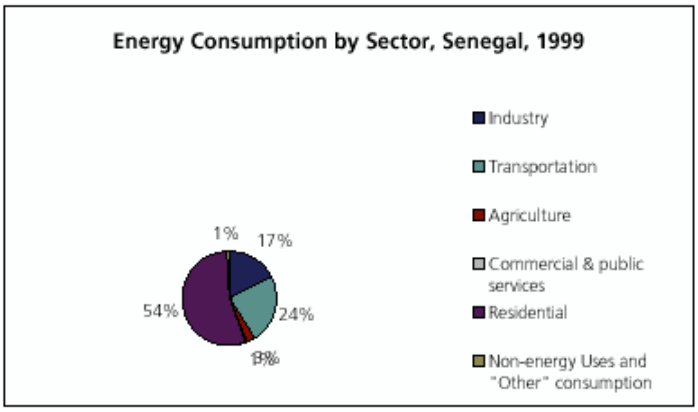


Figure 10.8: Energy consumption in Senegal (1971-1999)

Source: WRI 2003b.

Figure 10.9: Energy Consumption in Senegal by Sector (1999)



Source: WRI 2003b.

Table 10.5: Key Indicators of the Electricity Sectors in Mali and Senegal (2001)

	Senegal	Mali
Population (million)	9.8	11.1
Installed capacity (MW)	422.3	186.1
Electricity generation (GWh)	1651.0	521.4
Electricity consumption (GWh)	1295.4	386.5
Number of customers	431,432.0	90,989.0
National electricity access rate (%)	31.4	9.3
Electricity average price (US$/kWh)	0.1205	
Electricity consumption per capita (kWh/capita)	132.5	35

Source: GNESD 2004: 20.

Over the last years, electricity consumption has grown by approximately 6% annually, even higher rates are expected for the near future (GTZ 2004c). However, between 2000 and 2002 there was a slight decline. In 2002, about 1.5 TWh were generated (IEA 2004a). Due to limited and outdated capacity, electricity demand is not covered by domestic generation. In total, there were about 440 MW installed generating capacity in 2002, including a share of the Manantanali power plant in Mali. Of these, 138 MW were thermal plants, 99 MW diesel and 92 MW gas turbine power plants as well as one private-owned gas-steam power plant with 51 MW capacity (GTZ 2004c). Because of the electricity imports from Mali (one third of the total electricity demand) and the imports of oil for the diesel power stations, the import dependency in the electricity sector is very high. Since 1990, electricity prices have annually increased by 3% (GTZ 2004c; GNESD 2004).

CO_2 emissions from the burning of fossil fuels have almost doubled since 1990, up to 3.7 Mt in 2002. The main emitters are a group of sectors that are not specified (“other”), transport and the manufacturing industry (IEA 2004a).

Renewable Energies: Status Quo, Targets and Potential[109]

Regarding the *hydropower* potential, there are different estimates ranging from 700 MW (with an annual electricity generation of 4,250 GWh) to 1,400 MW (see Table 10.6). The climatic conditions, characterised by a long dry season and precipitation between 800 and 1,500 mm/year during the rainy season, offer only a limited potential (Risø 2001). According to figures from the project partner ENDA-TM, there are 322 MW of hydropower capacity with an annual generation of 1,360 GWh (1999) *(see table 6.2)*. In addition, Senegal participates in the Manantali hydro power plant in Mali. According to GTZ, near this site another 200 MW plant (800 GWh per year) is in preparation (GTZ 2004c; Small Hydro 2005).

Table 10.6: Figures on Hydropower in Senegal (1999)

Potentiel MW	Capacité installée MW	Production GWh
1.400	322	1.360

Source: http://www.iepf.org/recherche/resultat.asp?p=/docs/profils2001doc/SENEGAL.pdf

The potential in *wind energy* seems to be relatively limited and is concentrated primarily near the coast between Dakar and St. Louis. The average wind speed ranges from 3.7 to 6.1 m/s (GTZ 2004c). The interior of the country only has wind speeds of 2-3 m/s (InWent 2004). According to calculations of the GTZ, wind energy can be exploited profitably on sites with at least 5.3 m/s, depending on financial aspects such as loan conditions (GTZ 2004c). A comprehensive scientific assessment of wind energy potential does not exist. At present, there are no wind power plants with grid connection. However, the Ministry for Mining, Energy and Water plans to develop a 10 MW wind power park in the coastal area. Explorations of a Canadian company regarding the development of a 50 MW park are currently not being pursued any further.

GTZ (2004c) estimates the number of wind-powered water pumps to be about 200. There is also one project supported by French development cooperation and the EU and carried out by a Senegalese-Mauritanian NGO (Alizés).

[109] It needs to be added that most of the literature does not differentiate between the different types of potential, see chapter 2.3.

There does not seem to be a comprehensive assessment of the energetic potential of *biomass* yet. More than 50% of Senegal's energy consumption comes from the "traditional" use of fuel wood and charcoal. This intensive use puts an enormous pressure on the remaining forest resources, approximately 80,000 ha of forest are lost each year. Other resources that could be used are 52 mio. m^2 of turf and an unspecified amount of municipal waste (GTZ 2004c). Also, the residues from cash-crop production – primarily peanuts and sugar cane – bear energetic potential that could partly be used for power generation. GTZ mentions two companies of the agroindustry that presently fire 40 MW of installed capacity with these residues, but mainly for their own use. Deepchand estimates the potential of co-generation based on bagasse to be 60-90 GWh per year (Deepchand 2004). The residues from peanut production of about 200,000 t could suffice for firing 220 MW capacity (WEC 2002). There is also an unspecified number of small biogas plants supplying households with electricity.

There is a significant solar energy potential in Senegal. With sometimes more than 3,000 hours of sunshine and an average insulation of 5 kWh/m^2, annual radiation is estimated to be 2,000 kWh/m^2 (Edjekumhene 2003: 32, GTZ 2004c). The northern regions around Dakar show even higher figures.

The radiation map produced by DLR for the Mediterranean region assumes a technical electricity generation potential of 200 to 300 $GWh/km^2/a$ from *solar thermal power* generation (see Figure 2.2).

In the area of *photovoltaics*, so far about 1 MWp have been installed, primarily as solar home systems (SHS) in rural electrification (about 1,500 systems; Risø 2001). GTZ has been one of the most active project developers to disseminate SHS. Other projects for rural electrification are being planned. According to one study by the Japan International Cooperation Agency, the total amount needed to reach a 100% electrification rate was estimated to be 83,000 SHS. The budget plans of the Senegalese Agency for Rural Electrification (ASER) also pay attention to SHS: 20% of the entire budget are to be spent for PV in the years to come (GTZ 2004c). In the train of this development, about 20 small companies and NGOs distributing SHS have emerged (Risø 2000). Risø (2000) highlights that there is a lively decentralised network of small companies for distribution and maintenance (Risø 2000). The Spanish company Atersa also carries out SHS projects (GTZ 2004c). A further increase in PV installations is expected, PV power production is estimated to grow from 15 GWh in 2000 to 41 GWh in 2005 and 160 GWh in 2015 (Risø 2001).

There was no data on the present state in *solar thermal* applications. However, in the late 1980s there was one factory (SINAES) that produced more than 1000 units for solar water heating (Risø 2000).

According to the International Geothermal Union, *geothermal* energy is neither used for power generation nor directly for heating purposes. There is no information on the potential (GTZ 2004c).

Renewable Energies in Energy Policy

When analysing the latest energy policy documents, the intensified use of renewable energies seems to gain increased priority, primarily in the context of poverty reduction. This increased attention was articulated in the strategy paper on energy policy from April 2003 as well as the "National Strategy for Renewable Energy Development for Poverty Alleviation" that were contributed to the International Action Programme of the renewables 2004 conference (IAP 2004). The share of renewables is to increase to 15% in 2025, rural electrification from 8% to 60%. ASER is primarily responsible for achieving these targets. For this purpose, the country has been divided into 18 concessional areas to foster a successive extension through tenders. The outcome of current plans to privatise the state-owned major power supplier SENELEC will also be of relevance. So far, several attempts at privatisation have failed. In addition, it might be of importance that non-state actors from Senegal are engaged in other initiatives of the International Action Programme, for example in the "Bio-Diesel Initiative Substitution of Oil Products in Transportation and Household Fuels" or in the programme „World Energy Council's Centres of Excellence for Sustainable Energy (CESE) in Egypt and Senegal" (GTZ 2004a). Furthermore, Senegal joined several relevant Type II partnerships established during the World Summit on Sustainable Development, e.g. the "EU Initiative Energy for Poverty Eradication and Sustainable Development".

Conclusions

Senegal's electricity supply is characterised by an increasing but still low electrification rate, old-fashioned and insufficient power generation capacity as well as a high dependence on imports of fossil fuels. Wind energy potential worth mentioning are limited to the coastal area and hydroenergy potential is also limited. The extension of the use of solar energy for which there is a huge potential has in recent years primarily taken place through solar home systems in the rural areas. Although the extended use of renewables has gained increasing political attention, it is hampered by the relatively low economic power and limited financial resources of the country

Preliminary Study on the Clean Development Mechanism (CDM)

Emission Indicators	
CO_2 emissions (in Mt, 2002) (IEA sectoral approach) - in %, change since 1990	3.71 75
CO_2 emissions per capita (in t, 2002)	0.37
CO_2/TPES (t CO_2 per TJ) - in %, change since 1990	27.76 22.4
Total GHG emissions (in Mt CO_2e, 1990)	3.8
Total GHG emissions (in Mt CO_2e, 2000)	5.2
Annual growth rate (in %)	3.1
Total growth 1990-2000 (in %)	36.2

Source: IEA 2004a; WRI 2005.

Milestones of Senegalese Climate Policy	Date
▪ Ratification of UNFCCC	17 October 1994
▪ Ratification of Kyoto-Protocol	20 July 2001
▪ First national communication	1. December 1997
▪ Establishment of CDM-DNA	Early 2005

Source: http://unfccc.int; Thomas 2005.

The CDM in the Context of Senegal's Environmental and Development Policies

Senegal's environment and development policies are very much determined by the conditions imposed by international financing institutions, namely the World Bank and the International Monetary Fund (Sonoka et al. 2003).

The country is exemplary with regard to ratifying and complying with international treaties (e.g. on combating desertification, biodiversity, the ozone layer and climate change) and actively participates in regional and international projects (e.g. NEPAD; African Carbon Finance). In each case the government develops a plan of national implementation of the treaty. However, the treaties are not implemented in an integrated manner and there is no interministerial cooperation (Sonoka et al. 2003). This external orientation and the single-track implementation of international initiatives has so far prevented the development of domestic indicators of sustainable development. Thus, criteria for aspects of sustainable development within the CDM so far remain underdeveloped (Thomas 2005).

Africa in general and especially West Africa in particular do not offer promising conditions for the implementation of the CDM. With only 4% of global CO_2 emissions, there are not many options for reducing greenhouse gas emissions. The often unstable political circumstances combined with a weak infrastructure discourage foreign investors, only 3% of global *Foreign Direct Investment* flow into Africa (Ramakrishna et al. 2003). South Africa is the most active country regarding the CDM and has in the past received most support in CDM capacity building (Silayan 2005). Nevertheless, Senegal recently established a DNA, acting under the *Direction de l'Environnement et des Etablissements Classées (DEEC)*. The structure of the DNA and the decision-making processes on CDM in Senegal are still unclear, though. Our project partner could not give us definite information.

Capacity Building

Before implementing CDM projects in Senegal, the instrument needs to be communicated to the government, population and the companies in the country and implementation capacity needs to be strengthened. At the moment, awareness is very limited (Thomas 2005). In the past, a couple of workshops on climate change have been offered, inter alia by the World Bank and the Danish government, but not on the CDM in particular (Thomas 2005).

According to our partner in Senegal, Jean-Phillippe Thomas (ENDA), the World Bank conducted a study on the CDM in Senegal. However, the results have not been published so far. Moreover, there was an attempt to appraise the CDM potential in

Senegal, Uganda and Zambia which, however, outlines the barriers to CDM implementation in rather vague terms only (European Commission 2000).

Senegal signed a Memorandum of Understanding with the World Bank, which resulted in a grant of US-$ 491,000 (Point Carbon 2005c). The money is to be spent on the establishment of the DNA as well as for the development of *public-private partnerships* in the Senegal.

Project Portfolio

According to information from our partner in Senegal, the government presented six Project Idea Notes (PIN) for future CDM projects during the Carbon Expo in Cologne in May 2005: three in the field of waste, two on energy efficiency and one project in the field of renewable energies, namely a wind power project. More detailed information, e.g. on the CO_2 reductions expected, the approval procedure and the size of the projects, could not be obtained. Apparently, four of these six projects were initiated by foreigners (Thomas 2005). According to the GTZ, there is also a landfill project being developed that would generate 500,000 CERs per year. However, at the moment the project is still looking for investors (GTZ 2005).

Conclusions

Senegal could be described as a kind of model student in following the conditions of international financing institutions and in signing global treaties. This has the consequence that internal policies are to a significant extent being shaped by foreign institutions. To be able act as an independent and self-confident partner in the CDM, Senegal needs to become aware of its national interests and define priorities for sustainable development which are designed in a comprehensive manner and independently from foreign interests. In order to achieve this goal, the instrument CDM needs to be discussed more intensively in the country and the institutional framework must be strengthened.

Annex 15: Country Selection

The basis for the selection of two countries for the second project phase was the following list of criteria agreed by the Federal Environment Ministry, the Federal Environment Agency, and the Wuppertal Institute:

1. Renewable energy potential
2. Institutional framework for CDM projects
3. Role of renewable energies in national development, energy and climate policy
4. Regional influence
5. General investment climate
6. Importance for EU energy supply
7. Foreign direct investment potential for German companies
8. Information basis

These criteria were evaluated by the Wuppertal Institute on a five-tiered scale (--, -, 0, +, ++). The country selection was furthermore based on a written recommendation by the GTZ (see Annex 16) and a discussion in the project advisory board. The final selection was done in a two-step process.

First, the totality of criteria was considered (see Table 10.7). Several criteria such as the renewable energy potential, the institutional framework for CDM projects and the information basis were considered to be particularly important. The relatively negative evaluation of Senegal is particularly striking. This is not least due to the fact that Senegal as one of the *Least Developed Countries* has a different status of economic development and its size is also significantly lower than that of the other countries. Since in absolute terms the CDM potential of Senegal is significantly lower than that of the other countries, it was not selected for the second project phase. The evaluation of the remaining countries yielded comparable results as regards central criteria such as the renewable energy potential and the institutional framework for CDM projects.

Table 10.7: Country Evaluation Criteria

	Egypt	Morocco	Senegal	Thailand
Renewable Energy Potential	++	++	+	+
Institutional Framework for CDM Projects - DNA Structure/ Procedures - Project Portfolio	 + +	 ++ ++	 - -	 + +
Role of renewable energies in national development, energy and climate policy	+	++	+	++
Regional Influence	++	+	+	++
General Investment Climate	0/+	+	- -	0/+
Importance for EU Energy Supply	0/+	++	- -	-
Foreign Direct Investment Potential for German Companies	+	++	-	+
Information Basis	+	+	0	-

The second step of the country selection therefore discussed potential combinations of countries. The central argument for including Thailand in the second project phase was to cover two regions. Moreover, it has a significant regional influence, which is why it has been selected as "anchor country" of German development cooperation activities. Secondly, Egypt was selected. The key argument was that there seemed to be a higher need for a detailed analysis of potential and barriers. In contrast to the oil and gas producer Egypt, renewable energies have already been given a high priority in Morocco, due to the country's high dependence on energy imports. The additional value of such an analysis for this country would therefore probably be more limited.

Annex 16: Vorschlag der GTZ für die Länderauswahl

Die folgenden Aussagen wurden einerseits aus den uns vorliegenden Unterlagen des Forschungsvorhabens und andererseits unseren GTZ internen Betrachtungen hergeleitet.

Dabei ist folgendes Ranking für die vertiefenden Länderstudien entstanden:

1. Thailand
2. Marokko
3. Ägypten
4. Senegal

Grundsätzlich halten wir jedoch die vertiefte Betrachtung aller genannten Länder grundsätzlich für denkbar. Im folgenden Begründen wir unsere Prioritäten

Thailand

Neben einem afrikanischen Land sollte auch Thailand als asiatisches Land in dem Forschungsvorhaben behandelt werden.

Thailand bietet u. E. gute Voraussetzungen, um dort CDM-Projekte zu entwickeln, die vornehmlich erneuerbare Energien nutzen und sich auf Energieeffizienz-Maßnahmen stützen. Thailand war zwar bisher nicht der Vorreiter in Asien beim CDM, weil – wie dargestellt – im Länderpapier die politische Diskussion um die Nutzung des CDM kontrovers diskutiert wurde. Nun ist aber eine DNA etabliert, die auch über Regelungen verfügt, wie CDM-Projekte genehmigt werden sollen. Wie dieses Genehmigungsverfahren in der Praxis läuft muss noch erprobt werden. Thailand ist sich bewusst, dass es beim CDM hinterher hinkt, daher wird erwartet, dass die nationalen Genehmigungen relativ zügig erfolgen.

Die deutsche EZ ist nicht mehr im Energiebereich tätig, aber über die Beratung der Agroindustrie, im Kooperationsschwerpunkt „Wirtschaftsreform und Aufbau der Marktwirtschaft“ mit dem Energiesektor verbunden. Es geht dabei vornehmlich um die Stärkung der Wettbewerbsfähigkeit und Ökoeffizienz von Klein- und Mittelunternehmen. Dabei wird wiederum auch beachtet, dass der CDM gewisse

Chancen bietet, neue Technologien einzusetzen, um die Energieproduktivität in der Agroindustrie zu erhöhen.

In diesem Kontext ist auch das CDM-Projekt einzuordnen, das die GTZ zur Zeit mit einem Unternehmen der thailändischen Palmölindustrie plant, um die Emissionen der GTZ-Zentrale zu neutralisieren. Hierdurch besteht bei der GTZ ein gutes Know-how darüber, welchen Herausforderungen die Vorbereitung und Umsetzung von CDM-Projekten man in Thailand begegnet.

In diesem Zusammenhang und über die bestehenden TZ-Vorhaben wurde ein guter Kontakt zur thailändischen DNA aufgebaut. So möchte die DNA beispielsweise das Kompensationsprojekt der GTZ als eines der ersten in den nationalen Genehmigungsprozess einspeisen; dies dürfte im September 2005 erfolgen.

Die Deutsche Botschaft in Thailand hat sich über den Wirtschaftsattaché und durch den Kreis von Wirtschaftsvertretern, der sich regelmäßig trifft, mit dem CDM-Thema beschäftigt und hat versucht auszuloten, welche Optionen für die deutsche Industrie in Thailand bestehen. Insofern haben auch die deutschen Wirtschaftsvertreter in Thailand einen guten Kenntnisstand über den CDM. Außerhalb Bangkoks besteht ein kleines Konferenz- und Informationszentrum, in dem auch verschiedene erneuerbare Energietechnologien präsentiert werden. Mit der Unterstützung von öffentlichen Geldern wird dieses Zentrum von einem Vertreter der deutschen Privatwirtschaft gemanagt.

Zusammenfassend würden wir aus den o. g. Gründen deshalb empfehlen, Thailand als eines der Länder für das Forschungsvorhaben auszuwählen.

Marokko

Marokko erscheint im Maghreb/Maschrek im Vergleich zu Ägypten interessanter aufgrund der Darstellung der Länderstudien einerseits (siehe insbesondere Fazit) als auch der Tatsache, das die deutsche EZ dort mit einem Umweltprogramm im TZ-Bereich vertreten ist sowie die KfW im Bereich erneuerbare Energie aktiv ist. Das GTZ Projektbüro ist auf dem gleichen Flur wie die DNA im Umweltministerium angesiedelt, so das gute Arbeitskontakte bestehen. Interessant erscheint uns auch die etablierte Zusammenarbeit des GTZ Umweltprogramms mit der deutschen Wirtschaft in Zusammenarbeit mit der AHK. GTZ hat gemeinsam mit der AHK die EnviroMaroc, die Umweltmesse mit begleitendem Fachkongress in 2004 erstmalig veranstaltet. Es ist voraussichtlich Ende 2006 geplant, die „EnviroMaroc" wieder durchzuführen. (Infos zur EnviroMarco von 2004 siehe http://www.dihkcasa.org/enviro_maroc.html). Die Ergebnisse der zu vertiefenden Studie könnten dort ggf. einer breiteren Öffentlichkeit vorgestellt werden in Verbindung mit Vertretern der Deutschen Wirtschaft, die sich in Marokko engagieren möchte.

Ägypten

In Ägypten ist die GTZ vor allem in Wasser- und Abfallsektor vertreten, nicht im Bereich Energie- und Umweltpolitik. Daher sind wir nicht sehr engem Kontakt mit der EEAA, der nationalen Umweltbehörde. Es besteht ein KMU Programm, dass eine Komponente zum Thema Umweltdienstleistungen für erneuerbare Energien und Umwelttechnologien beginnen wollte, jedoch derzeit, nicht zuletzt aus Budgetgründen, nicht aktiv werden konnte. Weiterhin haben wir den Eindruck dass Ägypten auch mittelfristig an der starken Subvention der Energie für die lokale Bevölkerung festhalten wird und die Erschließung der eigenen Gasvorkommen gegenüber dem strategischen Ausbau von erneuerbaren Energie vorziehen wird. Falls Ägypten aufgrund anderer Argumente dennoch von Interesse ist, kann hierzu ggf. noch die Einschätzung der KfW eingeholt werden, die dort einen Windpark finanziert.

Senegal

Die eingehendere Betrachtung von Senegal in einer vertiefenden Länderstudie, erscheint uns, obgleich seiner ausstrahlenden Wirkung auf die westafrikanischen Länder, aufgrund des vergleichsweise geringen Potentials für THG-Minderung bzw. erneuerbare Energien weniger attraktiv. Die in vielen Bereichen bestehenden korrupten Strukturen verglichen mit den anderen Ländern, stellen eine weitere Barriere dar.