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Synergies and Conflicts between Climate Protection and Adaptation Measures in Countries of Different Development Levels

Annexes

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Synergies and Conflicts between Climate Protection and Adaptation Measures in Countries of Different Development Levels

Annexes

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ADB:	Asian Development Bank
AFOLU:	Agriculture, Forestry and Land-Use
BAU:	Business as Usual
BID:	Inter-American Development Bank
BRICS:	Brazil, Russia, India, China and South Africa
CCFF:	Climate Change Financing Framework
CCS:	Carbon Capture and Storage
CGCM:	Coupled Global Circulation Models
CGMC	General Coordination on Global Climate Change
CGRE:	Climate-Resilient Green Economy
CICC:	Comisión Intersecretarial de Cambio Climático – Mexico
CIM:	Inter-ministerial Committee on Climate Change
CMIP3:	Coupled Model Inter-Comparison Project 3
CDM:	Clean Development Mechanism
CO_2:	Carbon Dioxide
COP:	Conference of the parties to the UN Framework Convention on Climate Change
CPR:	Conserve-Protect-Restore
CRF:	Common Reporting Format
DEA:	Department of Environmental Affairs – South Africa
DENR:	Department of Environment and Resources – Philippines
DNP:	National Department of Planning in Colombia
DRM:	Disaster Risk Management
ECDBC:	Colombian Strategy of Low Carbon Development
EPA:	Environmental Protection Authority – Ethiopia
EEP:	Energy and Environment Partnership
EPI:	Environmental Protection Index

FAO:	Food and Agriculture Organization
FAOSTAT:	The Statistics Division of FAO
GCM:	General Circulation Models
GDP:	Gross Domestic Product
GGGI:	Global Green Growth Institute
GHG:	Green House Gas
GIZ:	German International Cooperation Agency
GNI:	Gross National Income
CRGE:	Climate-Resilient Green Economy – Ethiopia
GTP:	Growth and Transformation Plan of Ethiopia
HDI:	Human Development Index
IACCC:	Inter Agency Committee on Climate Change – Philippines
IAM:	Integrated Assessment Model
IEA:	International Energy Agency
IF:	Integrating Framework
IMF:	International Monetary Fund
IPCC:	Intergovernmental Panel on Climate Change
IPRI:	International Property Rights Index
IRP:	Integrated Resource Plan
ITCZ:	Inter-tropical Convergence Zone
JPE:	UN Joint Program on Environment
LCDS:	Low Carbon Development Strategies
LDCs:	Least Developed Countries
LTMS:	Long-Term Mitigation Scenario
LULUCF:	Land Use, Land Use and Forestry
MoE:	Ministry of Environment
MWh:	Megawatt hour
MoCC:	Ministry of Climate Change - Pakistan

MRV:	Measurement, Reporting and Verification
MtCO2e:	Million Tons of Carbon Dioxide Equivalent
Mtoe:	Million Tons of Oil Equivalent
NAMAs:	Nationally Appropriate Mitigation Actions
NAPCC:	National Action Plan for Climate Change – India
NASA:	National Aeronautics and Space Administration
NAWASA:	National Water and Sewerage Authority of Grenada
NCs:	National Communications
NCCAP:	National Climate Change Action Plan – Kenya
NCCAP-P:	National Climate Change Action Plan – Philippines
NCCP:	National Climate Change Policy – Pakistan
NCCR:	National Climate Change Response
NCCRS:	National Climate Change Response Strategy – Kenya
NDB:	New Development Bank
NEMA:	National Environment Management Authority – Kenya
NHGGEI:	National Greenhouse Gases Emissions Inventory – Indonesia
NMSA:	National Meteorological Services Agency
NPCC:	National Plan on Climate Change
NREP:	National Renewable Energy Programme – Philippines
NSDP:	National Strategic Development Plan
NSDS:	National Sustainable Development Strategy – Pakistan
ODA:	Official Development Assistance
OECD:	Organisation for Economic Co-operation and Development
OPEC:	Organization of the Petroleum Exporting Countries
PAGASA:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PoA:	Programme of Activities
PMCCC:	Prime Minister's Council for Climate Change – India
PNMC:	National Policy on Climate Change

POSAF:	Forest Development Social and Environmental Program
PPP:	Purchasing Power Parity
PR:	Property Rights
RAN GRK:	National Action Plan to Reduce Greenhouse Emissions – Indonesia
RAN-API:	National Action Plan for Climate Change Adaptation – Indonesia
RCP:	Representative Concentration Pathways
REDD+:	Mitigation Measures related to "Reducing Emissions from Deforestation and Forest Degradation (REDD)" that also include conservation, sustainable forest management, and enhancement of forest carbon stocks, thus REDD+.
REIPPPP:	Renewable Energy Independent Power Producer Procurement Programme of South Africa
R&D:	Research and Development
SEMARNAT:	Ministry of Environment and Natural Resources – Mexico
SPCR:	Strategic Plan for Climate Resilience of Grenada
SRES:	Special Report on Emission Scenarios
SRM:	Sectoral Reduction Mechanism
TPES:	Total Primary Energy Supply
TC:	Transaction costs
tCO_2:	Tons of CO_2
UNDP:	United Nations Development Program
UNFCCC:	United Nations Framework Convention on Climate Change
UNEP:	United Nations Environmental Program
UN-REDD:	United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries.
WB:	World Bank
WBGU:	German Advisory Council on Global Change
WFB:	World Fact Book
WGI:	World Governance Indicators
WRI:	World Resource Institute

1. Appendix: Glossary

Adaptation: For the analysis of synergies, adaptation is defined as adjustments of country systems to resources availability and risks (Adger, Arnell, and Tompkins 2005). Adaptation aims to increase resources availability and to pool risks.

Adaptive Capacity: It is important to clarify the differences among three related concepts: adaptation, adaptive capacity and coping capacity. While adaptations are adjustments –i.e. actions, the adaptive capacity is the ability to adapt –i.e. an attribute. Adaptations are manifestations of the adaptive capacity (Barry Smit and Wandel 2006). According to the IPCC - AR5, the adaptive capacity is the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of climate change (Forster et al. 2014). On the other hand, the adaptive capacity depends on the coping capacity (Berman, Quinn, and Paavola 2012).

Coping Capacity is the ability of people, institutions, organizations and systems, using available skills, values, beliefs, resources and opportunities, to address, manage and overcome adverse conditions in the short to medium term (Forster et al. 2014). The adaptive capacity refers to structural adjustments producing changes in the coping capacity.

Country System: Any analysis requires the identification of a scale of analysis (Füssel 2007). In this report, the country is the system of analysis.

A country system is an ensemble of socially constructed elements interrelated. All the elements are developed from the transformation of natural, human and financial resources. Elements might be tangible or intangible. Tangible elements include resources, infrastructure, technologies, the productive structure of the economic activities, markets. Intangible elements include the structure of inequality of income distribution, the financial system, subject of development like education, health and food security, and all the institutions for the governance of resources. All the elements are interrelated. Such interrelations are given by the economic and social functions of these elements.

Mitigation refers to interventions to reduce the sources or enhance the sinks of greenhouse gases (Forster et al. 2014).

Synergies are 'the interaction of adaptation and mitigation so that their combined effect is greater than the sum of their effects if implemented separately' (Klein et al. 2007). With regard to the greater effect, (Swart and Raes 2007) analyses synergies in the context of 'a global strategy for controlling climate change that would simultaneously help to alleviate poverty and get us back on track to achieve the Millennium Development Goals'.

2. Appendix: Formalizing Climate Resilient Pathways

In this appendix the formal approach is presented. It offers a description of the interplay between growth, damages produced from impacts, and adaptation. The formalism includes the analysis of resilience, trade-offs and synergies.

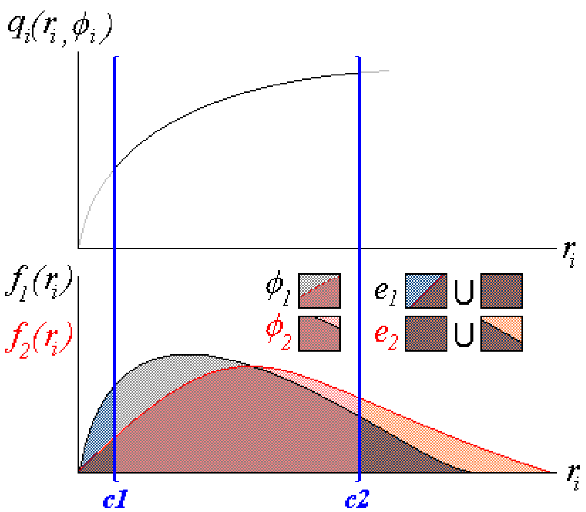
1.1 Mathematical Framework

Theoretical considerations are based on the formalization of the relations between growth, the reduction of the probability of uncertain events and adjustments of the socio-economic structure. The approach considers that the backbone of the country system is the productive structure, i.e. the set of n economic activities composing the economy of the country. Following the tradition in economics every economic activity q_j is presented by a production function. Production functions like Cobb-Douglas functions express productive factors in terms of technologies, labor and capital. Assume that production functions can be more generally explained by productivity factors q_N, q_H and q_S:

$$q_j = q_N(r_N,\phi_N)\cdot q_H(r_H,\phi_H)\cdot q_S(r_S,\phi_S), \qquad j=1,\ldots,n \qquad \text{eq. 1,}$$

where r_N, r_H and r_S represent the natural (N), human (H) and financial (S) resources, and ϕ_N, ϕ_H and ϕ_S are the corresponding coping ranges (cf. also appendices 3.3, 3.5ff), .

Figure 2-1: The coping ranges and their relationship with productivity factors.



The availability of each resource r_i for an economic activity is first given by a distribution function $f_i(r_i)$. The coping range is the share of the distribution between *c1* and *c2*, wherein an economic activity q_i can use the resource. The share e_i of the distribution out of the coping range accounts for all the uncertain events for which the activity cannot use the resource. If the distribution changes e.g. from f_1 to f_2, the coping range is reduced and the probability of uncertain events increases. Adjustments aim to broaden the coping range to reduce the probability e_i of uncertain events.

The coping range $\phi_i = \int_{c1}^{c2} f_i(r_i) dr_i$ is the window of each distribution density $f_i(r_i)$ in which the activity can use the resource. Observe that $f_i(r_i)$ is the distribution of the resource. Flows of resources within the coping range allow the activity to perform. However, the activity is exposed to uncertain events within e_i, i.e. the distribution outside the coping range (for example droughts, heavy rains and floods push agricultural activities out of the coping range, producing losses). Therefore, e_i determines the exposure of the activity to impacts, i.e. uncertain events producing *damages* and *losses*[1]. We call e_i the uncertainties associated to the use of the resource r_i. As the uncertainty e_i is associated to each resource, then it refers to uncertainties on natural resources when e_N, uncertainties on human resources when e_H, and uncertainties on financial resources when e_S. The coping range and the exposure are related as $\phi_i + e_i = 1$.

What determines a coping range for each resource? According to the approach, ϕ_i is determined by the conditions of the socioeconomic structure that create the *coping capacity* Ξ_i. It is evident that socioeconomic conditions determining the availability of natural resources are given by infrastructure and technologies. For example, a country with developed road infrastructure and dense road network creates better accessibility to natural resources. The productivity of human resources in economic activities is determined by nutrition levels, education (human capital), health status, and access to basic services, energy, and transport. Similarly, the availability of capital for economic activities is regulated by the conditions of the financial and the banking system, development of markets, income inequality. If these socioeconomic conditions are more developed then the coping capacity is higher (Adger et al. 2007). Therefore, the coping capacity Ξ_i on the resource r_i is a variable determining the coping range. In addition, according to Error! Reference ource not found. the coping range is also determined by the distribution e_i of uncertain events. Therefore, in our approach the coping ranges are functions of the share e_i of the distribution $f_i(r_i)$, and of the coping capacity Ξ_i:

$$\phi_i = \phi(e_i(r_i), \Xi_i(r_i)), \qquad \text{with } i: (N,H,S). \qquad \text{eq. 2}$$

We represent ϕ_i in terms of e_i as a convenient way to include $f_i(r_i)$. The use of $e_i(r_i)$ instead of $f_i(r_i)$ is favorable, because it allows addressing the reduction of uncertainties, i.e. created by GHG emissions.

Equation 2 formalizes the intuition that economic activities are affected by both, the fluctuations of resources flows, and the conditions of the socioeconomic structure wherein these activities are embedded. The mathematical form of Ξ_i and the analysis of its components is developed in appendix 3. By now we assume that Ξ_i represents a compact form of all the socioeconomic conditions that create the adaptive capacity in countries.

1.1.1 Model uncertainties:

Three types of uncertainties exist in climate change research: aleatoric, or uncertainties about the actual values of random variables ($e_i(r_i)$ in equation 2), epistemic uncertainties, and uncertainties

[1] Damages produced by impacts refer to structural changes on the adaptive capacity produced by impacts (e.g. a road is destroyed by a flood, or a beach is inundated by sea level rise). Losses refer to the opportunity costs of damages. A road damaged results in losses for those economic activities depending on this road for trade and resources inputs flows. Damages produce losses, but losses do not produce damages.

about the future trends of the country system. When a model is used to describe the temporal evolution of a system these three types of uncertainties are present. Uncertainties about the future are addressed by the development of scenarios. Epistemic uncertainties refer to our knowledge about the system under study. Model uncertainties include uncertainties about the actual value of parameters of models and epistemic uncertainties.

The approach being developed aims to reduce the epistemic uncertainties in the modeling of country systems. Observe that equation 2 aims to determine the range and distribution of events wherein economic activities keep operating. The parameters of production functions are given by ϕ_i. The accurate determination of ϕ_i requires both, knowledge of the distribution of $e_i(r_i)$, and also knowledge of the exact form and values of Ξ_i. Knowledge of Ξ_i allows mapping the socioeconomic conditions created by Ξ_i into the parameters of the production functions.

1.1.2 Growth, Damages and Adaptive Capacity

Let us now consider the implications of equations 1 and 2 for the analysis of growth, mitigation and adaptation. By introducing equation 2 into equation 1, the consequences of events or processes increasing the uncertainties e_i (e.g. climate change) *at a given time*[2] can be analyzed by appraising the total change in production functions Δq_j:

$$\Delta q_j = \sum_{i \neq k \neq l}^{N,H,S} q_k \cdot q_l \cdot \left(\frac{\partial q_i}{\partial r_i} dr_i + \frac{\partial q_i}{\partial \phi_i} \frac{\partial \phi_i}{\partial e_i} \frac{\partial e_i}{\partial r_i} dr_i + \frac{\partial q_i}{\partial \phi_i} \frac{\partial \phi_i}{\partial \Xi_i} \frac{\partial \Xi_i}{\partial r_i} dr_i \right) \qquad \text{with } i: (N,H,S)$$

eq. 3

Equation 3 depicts the relations between growth, damages from impacts and the adaptive capacity, at e.g. the present. Within the parenthesis, the first term is the coefficient of productivity $\partial q_i/\partial r_i$ times the inputs flows dr_i employed in production. Ceteris paribus (i.e. for fixed conditions for ϕ_i, e_i and Ξ_i), the marginal output growth from additional units of resources employed by q_j are given by the marginal contributions of each resource. However, e_i changes over time and the society is making adjustments in Ξ_i permanently.

The second term within the parenthesis accounts for changes in e_i at the time given. For $\partial e_i > 0$ this term represents the potential damages from events beyond the coping range increased by ∂e_i. When $\partial e_i < 0$ the second term represents the enhancement of the productive factor q_i resulting from the reduction of uncertainties. Uncertainties are reduced by e.g. mitigation of GHG emissions, the higher availability of skilled human capital or increased availability of financial resources.

The third term refers to adjustments of the socioeconomic structure that bring about the adaptive capacity $(\partial \Xi_i/\partial r_i)dr_i$. When $\partial \Xi_i > 0$ these adjustments produce co-benefits to activities. Examples of these positive adjustments include new road infrastructure facilitating trade, new technologies for communication, new laws and regulations making resources more accessible, new trade conditions creating incentives, better institutions to cope with risk, lower transaction costs, etc. Appendix 3 develops in detail the elements that create the coping and the adaptive capacity.

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[2] In this section we focus on the development of the formalism, without including the temporal analysis. Extending the temporal analysis requires adding the time variable as the independent variable of the resource r_i. However, important methodological gaps are still unresolved, as discussed in the remaining subsections. However, the formalism sets the basis for the temporal analysis.

1.2 Resilience

Resilience is defined as '*the persistence of relationships within a system and a measure of the ability of these systems to absorb changes of state variables, driving variables and parameters, and still persist* (Holling 1973). Equation 3 offers a suitable approach to evaluate resilience in human systems.

In equation 3 we disregard for a moment the output of marginal growth from the usage of more resources ($\partial q_i/\partial r_i dr_i$) and consider only the relationship between damages and adaptation, i.e. the second and the third terms. Let us further simplify the expressions by omitting the factors dr_i. If the damages are compensated by adjustments of the coping capacity, then $\Delta q_i = 0$. Under this condition the following expression determines the range of increased uncertainties de_i whose consequences can be compensated by changes in the coping capacity (i.e. the adaptive capacity $d\Xi_i$).

$$-\frac{\partial q_i}{\partial \phi_i}\frac{\partial \phi_i}{\partial e_i}de_i = \frac{\partial q_i}{\partial \phi_i}\frac{\partial \phi_i}{\partial \Xi_i}d\Xi_i \qquad \text{eq. 4}$$

We observe that the equation holds the persistence of relationships within the system because damages are compensated by the adaptive capacity. This is a measure of the ability of the system to absorb changes (de_i) of state variables (dr_i), driving variables (de_i) and parameters associated to Ξ_i, and still persist.

If both terms can be evaluated, the above equation serves to pose two complementary questions: what is the extreme event associated to the resource r_i that could be offset under the actual conditions of Ξ_i? Or alternatively: what is the required adjustment on Ξ_i to cope with a given extreme? If the above equation can be assessed, it provides an instrument to measure the resilience of q_i to fluctuations of r_i.

Methodological challenges have to be overcome to make equation 4 assessable. These challenges are about the existing gap between methods used to assess the impacts on activities from changes in distributions (the left side of the equality), and methods used to assess socioeconomic conditions (the right side of the equality). While methods to assess the impacts of changes in distributions are based on biophysical and economic models of variables evolving in time, methods to assess the socioeconomic conditions are based on indicators. These socioeconomic conditions include subjects like governance, inequality, access to basic services, property rights, etc., that cannot be directly associated to models. It is for that reason that the resilience of a productivity factor cannot be yet assessed from equation 4. However, the mathematical approach being introduced offers a way to tackle this challenge. Solving equation 2 will pave the path to assess resilience. One main goal of developing the description of country systems (cf. annex 3) is to specify the components that need to be considered for the assessment of Ξ_i.

1.3 Synergies and Climate Resilient Pathways

Sustainable growth, mitigation and adaptation are the three main subjects of synergies. Equation 3 states that the growth of q_j can follow three paths: increasing inputs, reducing resources uncertainties, and developing the adaptive capacity.

Climate-resilient pathways are development trajectories that combine adaptation and mitigation to realize the goal of sustainable development (Denton and Wilbanks 2014). In equation 3, climate resilient pathways are trajectories in which positive growth rates ($\frac{\partial q_i}{\partial r_i} dr_i > 0$) produce the reduction of uncertainties via mitigation $\frac{\partial q_i}{\partial \phi_i}\frac{\partial \phi_i}{\partial e_i}\frac{\partial e_i}{\partial r_i} dr_i > 0$, and the development of the socioeconomic structure $\frac{\partial q_i}{\partial \phi_i}\frac{\partial \phi_i}{\partial \Xi_i}\frac{\partial \Xi_i}{\partial r_i} dr_i > 0$. A description of how these processes are connected requires a description of the country system. This description is developed in appendix 3.

Equation 3 provides a setting to analyze trade-offs. As it was mentioned, trade-offs are situations where an economic activity produces damages to one resource. The economic benefit is depicted by the first term in equation 3, and the second term accounts for the changes in the distribution of the resources. Synergies are about the transformation of trade-offs into new situations where resources are enhanced (therefore the e_i is reduced) and economic activities are not affected. These changes are produced by adjustments of the socioeconomic structure. The country reports are all about the description of the consequences on resources from the actual trends in economic activities.

Observe that in equation 3 the correction of a trade-off affecting one resource r_i involves specific actions on the corresponding coping capacity Ξ_i. For example changes to correct deforestation are about changes in the accessibility to the resource, the use of technologies and knowledge for the proficient use of the resource, and changes in governance, i.e. institutions, organizations, laws and incentives that make effective the control of the resource. The same occurs with other resources: atmosphere, energy, water, land, etc. Correction of social trade-offs requires improvements in services, food security, education and health, jobs and better salaries, and good human governance. The correction of trade-offs affecting financial resources include decreasing income inequality, enhancing the banking sector and markets, and developing financial institutions, markets efficiency and property rights for the governance of financial resources.

The integrated analysis of environmental, social and economic trade-offs requires considering the interrelationships between resources. This is one main objective of the description of country systems developed in appendix 3.

1.3.1 Resilience and Synergies

The transformation of trade-offs into synergies can be formally represented as the maximization of resilience. Equation 3 provides the rationale for resilient growth.

From equation 3 we consider the second and the third terms in the parenthesis. Let us define the creation of resilience of the productivity factor q_i as the process that maximizes the equation:

$$\eta_{q_i} := \frac{\partial q_i}{\partial \phi_i}\frac{\partial \phi_i}{\partial e_i} de_i + \frac{\partial q_i}{\partial \phi_i}\frac{\partial \phi_i}{\partial \Xi_i} d\Xi_i \qquad \text{eq. 5}$$

The first term in equation 5 is negative, since $\frac{\partial \phi_i}{\partial e_i} = -1$ (as $\phi_i + e_i = 1$). Therefore, maximizing resilience implies minimizing de_i (when $de_i < 0$) and maximizing the adaptive capacity $d\Xi_i$, i.e. the construction of resilience requires transforming trade-offs into synergies.

1.3.2 The Evaluation of Climate Resilient Pathways

Equations (1-5) aim to provide a rigorous setting for the description, modeling and evaluation of climate resilient pathways. These equations are complemented by the formal description of country systems and the adaptive capacity (see appendix 3).

We can observe that equation 5 is specific to one resource. The analysis of climate resilient pathways requires the integrated analysis of equation 5, for each resource and for each activity. The integrated analysis of the transformation of trade-offs into synergies requires maximizing resilience. The evaluation of optimal resilient pathways can be tackled by applying methods from economics for the optimization of temporal processes. The evaluation follows the rationale of cost benefit analysis. Among alternative development trajectories, climate resilient pathways are those that develop the socioeconomic structure at a higher pace (maximizing the adaptive capacity) and reduce the uncertainties upon the resources. The application of economic methods to the maximization of resilience will inform the optimal growth rates and costs of such trajectories.

For the analysis of climate resilient pathways the identification of major niches for action is required for growth, development, adaptation and mitigation. In the current project we identified these niches. In the country reports we drew some conclusions about what institutional arrangements are required at the national and international level to transform trade-offs into synergies. The evaluation of the adaptive capacity in the country reports also provides an instrument to observe how countries are allocating their GDP.

3. Appendix: The Country System and the Adaptive Capacity

Appendix 2 introduced the mathematical foundations that support the analysis of synergies, in the context of climate resilient pathways. In that appendix the importance of describing country systems and establishing the relationships that create the adaptive capacity was argued. In this appendix we describe country systems and identify the relationship between the development of its components and the adaptive capacity. We formalize the notions of coping and adaptive capacities. The definition of the coping capacity is operationalized in terms of three factors: accessibility, proficiency and governance. This appendix discusses why such formalization is needed. In addition, the appendix introduces the indicators used to empirically assess the coping capacity, and provides statistical evidence to support the hypothesized relationships among factors.

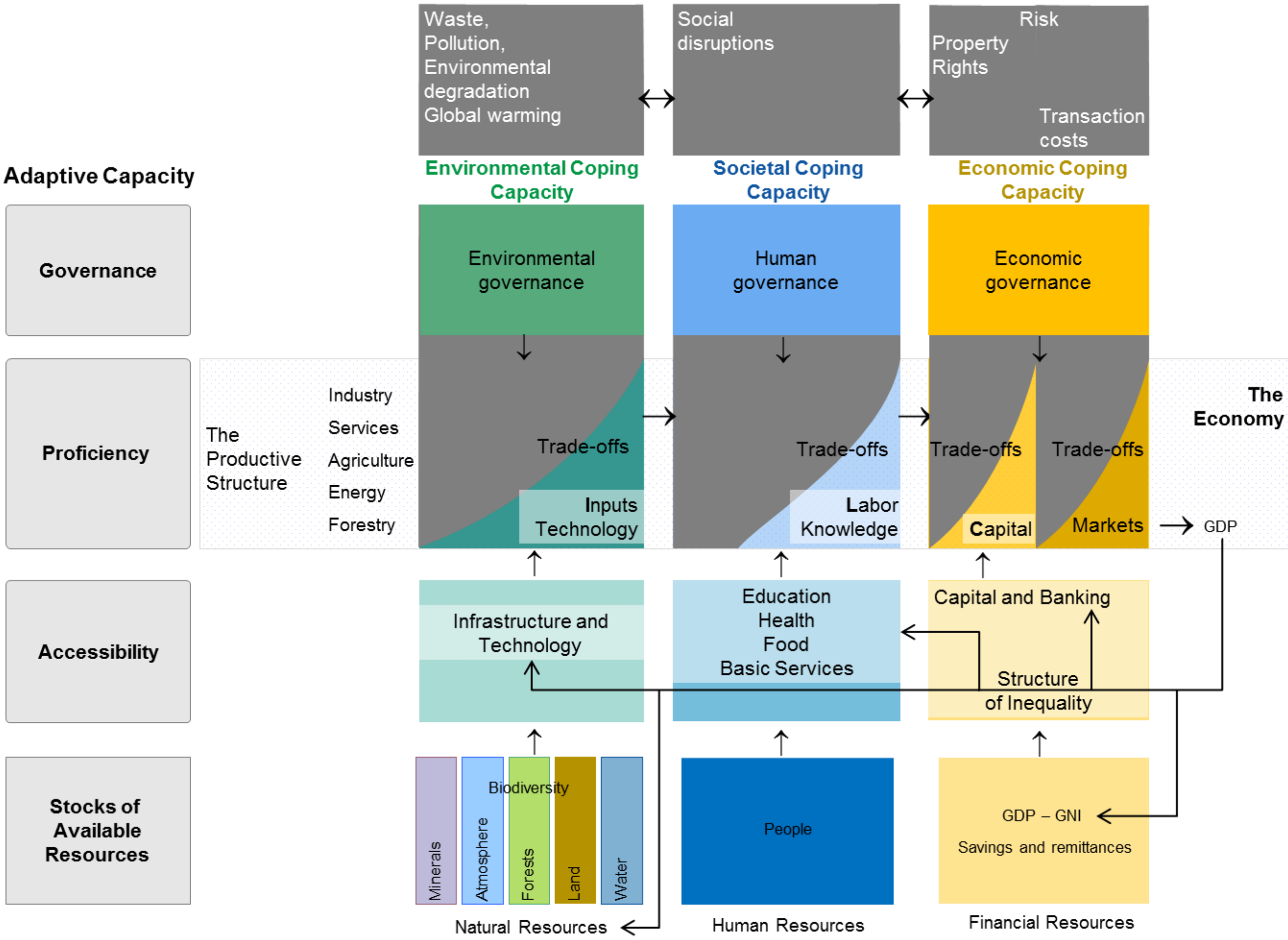
3.1 The Country System:

We use the term component to account for resources stocks, resources flows and structures composing any country system. The components of a country system were identified from the determinants of the adaptive capacity (Adger et al. 2007; Brooks et al., 2005b). They include: infrastructure and water supply (Moss et al., 2001), sanitation (Moss et al., 2001), technological development (Barry et al., 2002), human capital and governance institutions (Yohe and Tol 2002; Klein and Smith 2003; Brooks et al., 2005a; Næss et al. 2005; Tompkins 2005; Berkhout et al., 2006; Eriksen and Kelly 2007), social capital and networks (Yohe and Tol 2002; Adger 2003), economic and environmental capacity (Moss et al., 2001), food security and health (Moss et al., 2001; Brooks et al., 2005b), education and income (Adger et al. 2007), markets development (Moss et al., 2001; Skjeflo 2013), property rights (Adger and Kelly 1999) and other institutions (Adger 2001; Barnett 2001; Robledo et al., 2004; Sutherland et al. 2005; Ford et al., 2006; Engle 2011; Berman et al., 2012).

We describe country systems by identifying the relationships between resource flows and the components of country systems. These components are arranged to frame the flows of resources. Resources include natural, human and financial resources. Natural resources are composed by the atmosphere (air), water, forests, land, minerals and biodiversity. Human resources are defined as the people of the country. Financial resources refer to money stocks. Resources flow throughout the system. Resources are taken from their origin and allocated to productive activities where they are converted into goods and services. These new flows of transformed resources are further exchanged in markets where economic transactions produce financial flows. Goods and services are further consumed to enhance some components of the system. Financial flows produced and reproduced in markets are allocated as profit to firms, income to consumers–workers, and taxes to the government.

Some components of country systems are *structures*, i.e. modules of regularized interactions. A road provides regular conditions to transport. Similarly, a technology determines how a natural resource is used. In addition, rules, laws and institutions determine to what extent resources can be used, what the alternative uses of resources are, and how the outputs of the transformation of resources (in goods, money flows, waste, pollution and entropy) are allocated among the members and elements of the system. Therefore, country systems are composed by socioeconomic structures that contain the flows being transformed into goods, services and financial resources, but also waste and pollution flows. Let us consider the next figure for a representation of the country system.

Figure 3-1: The country system and its relation with the country's adaptive capacity.



Colored boxes at the right depict the components of country systems specified in the boxes texts. Countries use and transform natural, human and financial resources in economic activities. Arrows denote relationships between components of country systems, determined by the flows of resources within the structures composing country systems. Activities produce trade-offs: flows of goods and services producing economic growth (GDP) and wasted resources producing pollution, environmental degradation on natural resources, social disruptions on human resources, and economic losses from insecure property rights, financial risks and transaction costs. Grey forms refer to the wasted part of resources. Governance structures aim to increase the usable part of the resource and reduce the wasted part, i.e. transform trade-offs into synergies. In natural resources, this waste occurs in all activities and comprises all the resources (for that reason the grey zone starts with the first resources and covers all the activities). For human resources, trade-offs are produced by economic activities (unemployment, bad working conditions, etc.), and by deficient social conditions related to basic services, food, health or education. For that reason the grey zone starts even before the use of human resources in activities. In financial resources trade-offs are produced both at the production side and in markets. The adaptive capacity is a property of the development of the components of country systems.

Figure 3-1 associates the components of the country system with three factors of adaptive capacity: accessibility, proficiency and governance. Before introducing the formal representation of the relationships between these factors, it is worth discussing the methodological gaps that challenge the formal treatment of the adaptive capacity.

3.2 Challenges Posed to the Description and the Assessment of the Adaptive and the Coping Capacity

The study of the coping and the adaptive capacity is still challenged by conceptual and methodological issues hindering the description and the assessment.

Conceptual issues: A first obstacle is the fact that adaptability and capacity are not adequately defined (Hinkel 2011). The TAR-IPCC defines adaptive capacity as 'the potential or capability of a system to adapt to (to alter to better suit) climate stimuli or their effects or impacts' (Smit et al. 2001). Notice that adaptive capacity is defined in terms of a capability. A similar shortcoming is found in the definition of adaptability, i.e. a synonym of adaptive capacity: 'the ability, competency, or capacity of a system to adapt to (to alter to better suit) climate stimuli (essentially synonymous to adaptive capacity)' (Smit et al. 2001). Despite the shortcomings these definitions show that the adaptive capacity is a function of the capability, i.e. the coping capacity. Another challenge arises around the formal description of the coping and the adaptive capacity. The adaptive capacity emerges from the relationships among its determinants (Moss et al., 2001; Willems and Baumert 2003; Adger et al. 2007). Previous frameworks developed to assess the coping and the adaptive capacity of countries have accounted for the elements that determine the adaptive capacity (Yohe and Tol 2002; Brooks et al, 2005b; Smit and Wandel 2006; Füssel 2007; Pahl-Wostl 2009; Engle 2011). However, these approaches do not present the relationships among the determinants.

Besides the above mentioned unresolved issues the assessment of the coping and the adaptive capacity is further challenged by the disparity of methods used to assess different elements, since resources flows and structures determining the capacity are not measured under common metrics.

Many elements of the adaptive and the coping capacity are structures, e.g. social capital (Adger 2003), health (Brooks et al., 2005b), human governance, food security, education, public services or the institutions for risk pooling. The assessment of these structures is complex. Health for example, cannot be measured as 'the quantity of health'. More than a variable, health is determined by the relationships among many different elements, e.g. number of doctors, illiteracy (Kabir 2008), health infrastructure, availability of medicines, health institutions, access to health services, practices in hospitals, etc. These structures cannot be measured as resources flows, impacts or GDP flows are measured, but instead they are assessed with indicators (Eriksen and Kelly 2007). Indicators evaluate the development of some attributes of incumbency, e.g. number of doctors per 1000 people, investments in health or life expectancy. Indicators are like windows that allow observing some but not all the attributes of the element. The identification of indicators may follow different approaches, based on criteria like transparency and justification (Füssel 2007).

Other elements or even attributes determining the adaptive capacity are flows, e.g. GDP, financial flows for the health system. Flows are described and measured from models. For example, GDP accounts for the market value of the summed output of production functions. These functions describe how much input flows (natural resources, labor and capital) are used in economic activities.

The integrated assessment of flows and structures is challenged by uncertainties of different nature. Epistemic uncertainties in the assessment of structures refer to the comprehensiveness of the indexes used. Composite indices (e.g. the EPI index, the GEF index, the IPRI index) are elaborated from weights determined by experts. The uncertainties of events also exist, i.e. a drought or a flood may or may not occur. But such events will fall within the knowable range and distribution of one variable. Another source of epistemic uncertainty refers to relationships between structures and flows. The description of country systems aims to reduce these epistemic uncertainties.

3.3 The Coping Capacity

The description of the coping capacity takes the elements composing the country system as inputs, i.e. the determinants of the coping capacity (Adger et al. 2007). We argue that the coping capacity is about the development of these elements. For example, higher human governance contributes to a higher coping capacity. However, as discussed above, the formal description of the coping capacity requires identifying the relationships among the determinants. Our formal representation of the coping capacity aims to establish the relationships among the determinants.

We have followed a deductive approach, i.e. we develop a hypothesis of the relationships among the elements of the coping capacity and then design a strategy to test it. According to (Eriksen and Kelly 2007) the deductive approach to selecting indicators involves identifying a set of relationships on the basis of theory, and selecting indicators on the basis of these relationships. We hypothesize which relations determine the coping and the adaptive capacity, and offer statistical evidence.

In order to operationalize the definition, we consider that the adaptive capacity is determined by three factors: the accessibility to the resource, the specialized and diversified use of the resource in economic activities (the proficiency), and the governance of the resource. We hypothesize that these factors relate as:

$$\Xi_i\left(r_i\right) := \kappa_i \circ \pi_i \circ \psi_i\left(r_i\right), \quad i: (N,H,S). \quad \text{eq. 1}$$

The symbol $\circ$ represents a composition of functions. The letter at the right of $\circ$ is a function that also plays as dependent variable of the function at the left of the symbol. We assume that the functions representing the factors π and κ increase monotonically[3]. Therefore, it is hypothesized that the capacity factors coevolve. In equation 1, r_N refers to natural, r_H to human, and r_S to financial resources.

r_N = {water, forests, arable land, biodiversity, atmosphere, minerals}

r_H= {people},

r_S= {financial resources}.

In equation 1 $\psi_i(r_i)$ accounts for the accessibility to the r_i resource, $\pi_i(\psi_i(r_i))$ for the proficiency in the use of the resource, and $\kappa_i(\pi_i(\psi_i(r_i)))$ for the governance. The coping capacity Ksi $\Xi_i(r_i)$ upon the resource therefore depends on the development κ_i and π_i and ψ_i.

3.4 Capacity Factors

3.4.1 Accessibility

Capacity starts with the creation of accessibility to resources. Accessibility creates coping capacity because it reduces the costs, the time and the uncertainties of the acquisition of the resource. A new

[3] For example, if $\psi_1 \leq \psi_2$, then $\pi(\psi_1) \leq \pi(\psi_2)$

dam or a new water reservoir reduces costs, time and the uncertainty on water resources for electricity generation or agriculture. The same applies to other resources. Since every resource is different, the determinants of accessibility differ. The accessibility to natural resources is given by infrastructure and technology. Roads provide access to land, forests and landscapes, and eventually to mineral resources. Wind mills provide accessibility to air for energy production, or solar panels provide access to light resources. Access to water for agriculture and industry is provided by irrigation systems and aqueducts.

The accessibility to human resources refers to basic conditions that make the human resource suitable for economic activities. These conditions are about food security, health, education, and services: housing, energy, transport, water and sanitation (the subjects of the Millennium Development Goals). According to the IPCC-AR4 report (Parry et al. 2007), efforts to cope with the impacts of climate change and attempts to promote sustainable development share common goals and determinants including: access to resources (including information and technology), equity in the distribution of resources, stocks of human and social capital, access to risk-sharing mechanisms and abilities of decision-support mechanisms to cope with uncertainty.

The accessibility to financial resources refers to the conditions of structures and flows that make financial resources available. It is determined by income (GDP), the development of the banking system, the development of capital, and the structure of income inequality.

3.4.2 Proficiency

The proficiency of economic activities in the use of resources π_i is determined by the effective use of the resource. It shows the level of development of the potential of the resource and the specialization reached in the treatment of resources. The proficiency reflects the degree of technological, human and economic development that creates valuable applications of resources. However, proficiency is also related to the production of waste, pollution and entropy, human conflicts and economic inefficiencies. Therefore, the trade-off is also determined by the proficiency developed. Changes on proficiency reduce the share of resource wasted and increase its added value. The proficiency may be evaluated under two criteria: specialization reached in the use of the resource, and the diversity of usages. Therefore, an economy develops its proficiency if it specializes and diversifies.

3.4.3 Governance

Trade-offs created in the use of resources lead to uncertainties on the availability of the resource. Governance is the factor of capacity that aims to work out the trade-offs and to reduce the uncertainties on the resources. Trade-offs are reduced by developing the proficient usage of the resource. This is done via policies, incentives and limits to e.g. pollution. Uncertainties on resources are reduced by regularizing interactions and protecting the resource. Interactions are regularized with enforceable rules. Environmental governance is about institutions that steer innovation, reduce the waste of natural resources and protect these resources. Institutions for human governance aim to reduce social conflicts and develop human capital. This is done with public policies, the provision of basic services, human development, and measures to secure food supply and food consumption. The economic governance is about the institutionalized mechanisms for securing property rights, reducing transaction costs and pooling risk (e.g. financial markets). Institutions for economic governance aim to control the sources of risk, e.g. inflation, speculation, prices volatility.

3.5 The Adaptive Capacity

The coping and the adaptive capacity are related but not identical (cf. glossary). While the coping capacity reflects the ability to cope with impacts from available resources and structures, the adaptive capacity is the ability to change the coping capacity. This relationship can be formulated as:

$$\Delta\Xi_i = \frac{\partial \Xi_i}{\partial r_i} dr_i , \quad i: (N,H,S). \qquad \text{eq. 2}$$

According to equation 2 the adaptive capacity $\Delta\Xi_i$ is the change of the coping capacity Ξ_i. Equation 2 states that resources are needed to transform the coping capacity. A rigorous assessment of the adaptive capacity requires a measure of the coping capacity and a measure of the change rate of the coping capacity per unit of resource used to change it. Accordingly, the assessment of the adaptive capacity will require knowledge about the effectiveness of the transformation of resources into structures.

3.6 The Three Capacities

Notice that every component of country systems (Figure 3-1) plays a role for adaptive capacity (accessibility, proficiency or governance) and is associated to a specific resource. Therefore, country systems can be seen as composed of environmental coping capacity Ξ_N, societal coping capacity Ξ_H and economic coping capacity Ξ_S:

$$\Xi = \begin{Bmatrix} \Xi_N = \{\psi_N, \pi_N, \kappa_N\} \\ \Xi_H = \{\psi_H, \pi_H, \kappa_H\} \\ \Xi_S = \{\psi_S, \pi_S, \kappa_S\} \end{Bmatrix} \qquad \text{eq. 3}$$

3.6.1 Environmental Coping Capacity Ξ_N

The term was presented in Moss et al. (2001). The environmental regime is responsible for efficient use of resources and the reduction of uncertainties on natural resources. Let us consider the case of water: The coping capacity $\Xi(r_{water})$ is about the combined relationships among the accessibility to the resource, the specialized and diversified uses of water and water governance. It is also responsible for the control of water pollution, water waste and increased uncertainties on water availability. The accessibility to water resources is given by irrigation systems, aqueducts and sewage systems. The proficiency in the use of water resources is determined by the usages of water resources, including human consumption and economic activities. Water governance in turn represents the institutions, regulations, laws, government bodies, policies and plans that reduce these uncertainties, waste and pollution. A similar reasoning applies to other natural resources: forests, land, biodiversity, air or mineral resources.

3.6.2 Societal Coping Capacity Ξ_H

The societal coping capacity refers to conditions shaping living standards, knowledge usable in economic activities and human governance. Conditions shaping living standards refer to four elements: food security, health, education and services. Elements considered in basic services include energy, transport, water supply and water sanitation. Access to these services supports the development of human capital. Labor productivity would be high if a society enjoys high standards on these elements (cf. section 1.7 in this appendix). Proficiency of human resources refers to knowledge. The governance of human resources aims to reduce social conflict and uncertainties. It is responsible for institutions, policies, laws and organisms that enhance human conditions, promote employment (the proficient use of labor) and reduce social conflicts and human exposures (Fine 1999).

3.6.3 Economic Coping Capacity Ξ_S

The term was also presented in (Moss et al., 2001). A country has different sources of financial resources: income, loans, international cooperation, remittances or savings. Yet, the accessibility to financial resources is determined by the structures: capital assets, the banking system and GDP. The accessibility to these stocks is determined by the structure of income inequality in the country. The proficiency in the use of financial resources is given by the development of markets in the country which can be measured through the level of diversification of markets and specialization of economic activities. The use of financial resources in economic interactions produces uncertainties, i.e. potential losses. The sources of potential losses are the structure of property rights (PR), transaction costs (TC) and financial risks. The governance of financial resources is about institutions, laws, policies and organizations securing PR, reducing TC and pooling risks –financial markets.

3.7 Assessment

The framework developed to assess the coping capacity takes indicators (Eriksen and Kelly 2007) of the determinants of adaptive capacity. Each indicator evaluates an attribute related to the coping capacity. We did not try to condense the information of these indicators into e.g. one index. The main reason was large sensitivity of indicators of flows (e.g. GDP), compared to the low sensitivity of conditions associated to structures (e.g. % population with access to sanitation). A country may decide to invest large GDP shares in education today, but the outcome of these investments might take decades to appear. The tool elaborated to assess the coping capacity just presents the stage of development of the elements of the capacity, including resources, flows and structures.

3.7.1 Environmental Coping Capacity Ξ_N

Resources:

The coping capacity on natural resources depends on the availability of resources (Adger et al. 2007). Natural resources include water, land, forests, biodiversity, air, minerals and solar light. The indicators to assess available natural resources included forests area per capita (World Bank 2015), fresh water per capita (World Bank 2015), arable land per capita (World Bank 2015), and the GEF benefits index for biodiversity (World Bank 2015). The GEF is a composite index of relative biodiversity potential for each country based on the species represented, their threat status, and the diversity of habitat types.

Accessibility:

The evaluation of accessibility to natural resources is incomplete. In principle it should include indicators assessing the accessibility to each resource. We did not find adequate indicators to assess some resources, namely biodiversity and mining. We assessed the accessibility to natural resources with only three indicators: roads density, percentage of irrigated land (World Bank 2015) and total investments on infrastructure, represented in the index of gross fixed capital formation of the (World Bank 2015):

$$\hat{\psi}_N = \left\{ \hat{x}_{Roads}, \hat{x}_{Irrigated\ land}, \hat{x}_{Investments\ in\ gross\ fixed\ capital\ formation} \right\}$$

The stage of irrigated land does not necessarily indicate more coping capacity. Irrigation is only needed in countries who deal with water scarcity. Other indicators about the capacity to create access to water resources would include the installed capacity of water resources. The accessibility to improved water supply and sanitation is also related to the accessibility to water. But this indicator was used for the assessment of social conditions, i.e. access to services for human resources.

Proficiency:

Consistent with our affirmation that proficiency is best represented by an indicator demonstrating the productivity of the resource, or the value added to the resource through human process, we have selected three indicators: the GDP per land used in agriculture (World Bank 2015), the GDP per volume of water used (World Bank 2015), and the GDP per energy used (World Bank 2015):

$$\hat{\pi}_N = \left\{ \hat{x}_{Water\ productivity}, \hat{x}_{Land\ productivity}, \hat{x}_{Energy\ productivity} \right\}$$

Governance:

The Environmental Performance Index was used as a proxy of environmental governance in general. The EPI also accounts for human health issues. The environmental part of the EPI index is about the protection of ecosystems (Yale University 2014). We only took the environmental part as indicator. As the EPI's methodology shows, the environmental part of the index reflects the performance of the country on the protection of the resources of interest for environmental governance: ecosystems, land us, water, forests and air.

$$\hat{\kappa}_N = \left\{ \hat{x}_{\kappa_N} = EPI_{environmental} \right\}$$

3.7.2 Societal Coping Capacity Ξ_H

Resources:

The people of the country constitute the resources. In the framework we report the total population of the last available year (World Bank 2015).

Accessibility:

The accessibility to human resources is given by the conditions that enhance the human potential for the specialized and diversified use in economic activities. The elements considered were food security, health, education, transportation (mobility), energy, water and sanitation.

With regard to food security, health and education, we considered three indicators for each element. We selected indicator looking at three aspects: financial flows invested in the element, an additional attribute related to capacity, and the outcome.

Food security: An adequately nurtured population is more resilient to shocks, e.g. climate change impacts. For the assessment of food security, three indicators were used: the domestic food price level index (FAO 2015), the average dietary energy supply (FAO 2015), and the average dietary energy supply adequacy (FAO 2015). The food price ratio serves to proxy the relative price of food for the population. It indicates the share of income by households spent on food. The evaluation of food supply was the second aspect evaluated. We used the average dietary energy supply (FAO 2015). It serves to proxy the availability of food in the market. Yet this index does not inform about distributional issues. To account for food distribution, we considered the average dietary energy supply adequacy as final outcome of food security (FAO 2015). The indicator of food adequacy serves also to proxy the quality of food consumed. The relative situation of food security in the country would be better if the domestic food price level index was low, the average dietary energy supply was high, and the average dietary energy supply adequacy was high. In the vulnerability assessment for each country (not in the assessment of the coping capacity) we considered the variability of food supply and the volatility of food price.

Health: The capacity of the population to cope with the consequences of climate change is also determined by their health status. Healthy communities are more resilient to shocks and impacts (Brooks et al. 2005). In the area of health, we first consider the total health expenditures as % of GDP per capita (World Bank 2015), because it offers a proxy of the relative flows of money invested in health. Then, we looked at the number of doctors per 1000 people (World Bank 2015), because it offers a proxy of human resources working on health. The number of physicians has been shown to correlate with life expectancy at least in developing countries (Kabir 2008) Lastly, we considered life expectancy (World Bank 2015) as an indicator for human health (Brooks et al., 2005).

Education is an important determinant of adaptive capacity (Brooks et al., 2005; Wamsler et al., 2012). For the assessment of education, three indicators were used: the public expenditure on education as % of GDP (World Bank 2015), the Pupil/teacher ratio in primary school (World Bank 2015), and the labor force with tertiary education (World Bank 2015). As with food security and health, the public expenditure on education as % of GDP is a proxy of the financial resources used to foster education. The second indicator is a proxy of the human resources used in education. It is also a proxy of education quality. The third indicator is a proxy of the outcome, i.e. knowledge.

Education, health and nutrition are related. Literacy correlates with life expectancy (Kabir 2008). It is noteworthy that education and health are also variables of the Human Development Index, widely used as indicator of the adaptive capacity (Füssel 2007).

The selection of indicators assessing access to basic services followed a different approach. For transport we used the number of vehicles per 1,000 people (World Bank 2015). For electricity we considered the percentage of population with access to electricity (World Bank 2015). Access to fresh water was assessed by the percentage of population with access to improved water resources (World Bank 2015). In a similar manner, we used the percentage of population with access to sanitation services as an indicator for sanitation (World Bank 2015).

A more detailed assessment of accessibility to basic services should have considered other elements i.e. technologies, human resources and management. With regard to energy, water and sanitation, we could have proceeded similarly. For simplicity in services we just looked at the outcomes. The indicators selected offer a good compromise between the appraisal of accessibility and the amount of information. In summary, the accessibility to knowledge in human resources was measured by the following indicators:

$$\widehat{\psi}_H = \begin{Bmatrix} \widehat{\psi}_{Food} = \left\{\widehat{x}_{Food\ price\ index}, \widehat{x}_{Food\sup}, \widehat{x}_{Food\ adequacy}\right\}, \widehat{\psi}_{Health} = \left\{\widehat{x}_{Health\ \exp per\ cap}, \widehat{x}_{Doctors\ per\ 1000\ people}, \widehat{x}_{Life\ \exp}\right\}, \\ \widehat{\psi}_{Edu} = \left\{\widehat{x}_{Public\ \exp edu}, \widehat{x}_{Pupil-teacher\ ratio}, \widehat{x}_{Labor\ force\ with\ tertiary\ edu}\right\}, \widehat{\psi}_{Transport} = \left\{\widehat{x}_{Number\ vehicles\ per\ 1000\ people}\right\}, \\ \widehat{\psi}_{Sanit} = \left\{\widehat{x}_{\%\ Pop\ with\ access\ to\ sanitation\ serv}\right\}, \widehat{\psi}_{Energy} = \left\{\widehat{x}_{\%\ Pop\ with\ access\ to\ electricity}\right\}, \widehat{\psi}_{Water} = \left\{\widehat{x}_{\%\ pop\ with\ access\ to\ water\ serv}\right\} \end{Bmatrix}$$

It should be noticed that we did not use the Human Development Index to account for social conditions. The HDI has gained notoriety as outperforming indicator of adaptive capacity (Füssel 2007). But the indicators used to assess accessibility to human resources used two out of three components of the HDI: life expectancy and education. The third component of the HDI (income per capita) is used but in the assessment of accessibility to financial resources. A more elaborated version of the HDI could aggregate information about food security, health, education, and services.

Proficiency:

The proficiency of economic activities in the use of human resources is given by the efficiency within the productive structure and by the diversity of uses of knowledge. The efficiency determines the share of the resources that create value and the share wasted. Therefore, the social trade-off is also determined by the proficiency developed. For indicating π_H we considered labor productivity as basic indicator in terms of GDP per worker hours. Social capital (Adger 2003) should have been included as an important element of knowledge. Indeed, Fukuyama provides a suitable definition of social capital related to productivity (Fukuyama 1995). But we did not find a suitable indicator that reflects the additional benefits of social capital in productivity.

$$\widehat{\pi}_H = \left\{\widehat{x}_{Labor\ productivity}\right\}$$

Governance:

The governance of human affairs refers to participation, empowerment, good government (Downing et al., 1996). The governance system on human resources is built upon government and other institutions where people participate and decide the rules of the social game. Our indicator of κ_H is an aggregate of the six Worldwide Governance Indicators (World Bank 2015):

$$\widehat{\kappa}_H = \left\{\widehat{x}_{Human\ gov} = \frac{1}{6}\sum_{i=1}^{6}\widehat{x}^{i}_{\kappa_H}\right\} \text{ with}$$

$$\widehat{x}^1_{\kappa_H} = voice\_and\_accountability, \widehat{x}^2_{\kappa_H} = political\_stability$$
$$\widehat{x}^3_{\kappa_H} = government\_effectiveness, \widehat{x}^4_{\kappa_H} = rule\_of\_law,$$
$$\widehat{x}^5_{\kappa_H} = regulatory\_quality, \widehat{x}^6_{\kappa_H} = control\_of\_corruption$$

3.7.3 Economic Coping Capacity Ξ_S

Resources:

The coping capacity of financial resources depends on their availability (Adger et al. 2007). The indicators used to assess availability of financial resources include gross savings as percentage of GDP (World Bank 2015), the remittances as percentage of GDP (World Bank 2015), and the development assistance per capita as percentage of GDP (World Bank 2015).

Accessibility:

Four components determine the accessibility to financial resources, but only three were assessed: access to financial resources from the financial system, the GINI index of income inequality, and the GNI per capita. We should have reported the creation of capital (wealth), but it was not possible to find reliable and complete information. The provision of domestic credit as percentage of GDP helped us to indicate the performance of the financial system in the provision of loans (World Bank 2015). We used the opposite of the GINI index $\hat{x}_{non\ inequality} = (100 - GINI)/100$ to account for the opposite to income inequality. We included the GNI per capita to provide information about net income available. Therefore, the measured accessibility to financial resources includes the following indicators:

$$\hat{\psi}_S = \{\hat{x}_{Non\ inequality} = 100 - GINI, \hat{x}_{Provision\ domestic\ credit\ by\ financial\ sector}, \hat{x}_{GNI\ capita}\}$$

Proficiency:

The proficient use of financial resources is to large extent related to the development of markets. In order to appraise the specialization and the diversification of the economy, we used three indicators: the exports of goods and services as percentage of GDP (World Bank 2015), the high technology exports as percentage of manufactured exports (World Bank 2015), and the total GDP (in constant 2005 US$).

$$\hat{\pi}_S = \{\hat{x}_{Exports\ of\ goods\ and\ services(\%GDP)}, \hat{x}_{High\ technology\ exports\ (\%\ of\ manuf\ exp)}, \hat{x}_{Total\ GDP}\}$$

Governance:

The governance of financial resources is about the institutionalized mechanisms for securing property rights, reducing transaction costs and pooling risk. The structure of entitlements i.e. property rights are relevant for the vulnerability to climate change (Kelly and Adger 2000). The governance of property rights is in charge of the institutions that enforce land tenure systems and rights on property. Effective institutions reduce uncertainties on property. We used the International Property Rights Index of IPRI (Property Rights Alliance 2014) to assess property rights . Transaction costs refer to the costs involved in market exchange. These include the costs of discovering market prices and the costs of writing and enforcing contracts (OECD 1993). They may include the costs of information, but also the costs of deficient infrastructure or high labor costs. For the assessment of transaction cost we used the indicator of ease doing business, which evaluates the environment facilitating development of business (World Bank 2015). Financial risk also creates vulnerability. The volatility of prices, inflation and high variability of market signals create vulnerability. Countries develop their financial institutions to pool risk. For the assessment of risk it was used the Country Risk Rating (Euromoney 2014), which evaluates structural, political and economic risk.

$$\hat{\kappa}_H = \{\hat{x}_{PR} = IPRI, \hat{x}_{Risk} = Country\ Risk, \hat{x}_{TC} = Ease\ Doing\ Business\}$$

3.8 Statistical Evidence

Equation 1 hypothesized the coevolution of capacity factors: accessibility coevolves with proficiency and governance. For each resource we analyzed the coevolution of factors in two steps, first the coevolution of accessibility with proficiency, and then the coevolution of proficiency with governance. The Pearson's coefficient correlation was used to analyze the correlation.

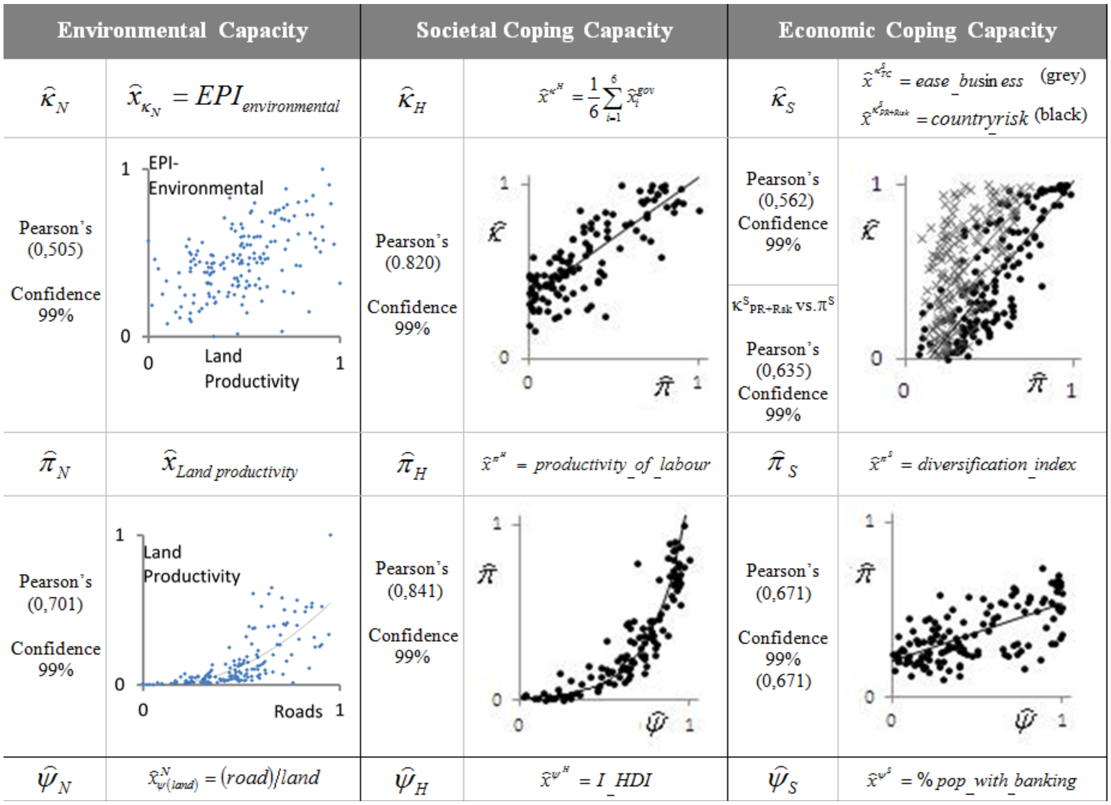
Ξ_N: We assessed the coevolution of accessibility and proficiency in natural resources by correlating the density of roads with land productivity. To assess the relationship between proficiency and governance, land productivity was correlated with the environmental part of the EPI.

Ξ_H: A rigorous assessment of the coevolution of ψ_H and π_H should have combined the indicators used to assess $\hat{\psi}_H$ and labor productivity (used to assess $\hat{\pi}_H$). We did not follow this approach due to the disparate sensitivities of indicators of flows (highly variable) and indicators of structures. Instead, the inequality adjusted Human Development Index (I_HDI) was used as representative indicator of the overall outcome of the elements of accessibility ψ_H. The I_HDI was taken as a proxy for ψ_H as it includes the outcomes of education and health used in the evaluation of $\hat{\psi}_H$. Moreover, the I_HDI correct the biases caused by income inequality. Our approach simplifies the work but evidently increases the uncertainties associated to the not included information. In order to assess the relationship between proficiency and governance, labor productivity was correlated with the averaged indicators of Human Governance of the World Bank.

Ξ_S: To assess the relationship between accessibility and proficiency, we correlated the percentage of population with access to banking with the diversification index. In addition, to assess the relationship between proficiency and governance, we correlated the diversification index with two indexes: the ease doing business (TC), and the country risk index (Risk + PR). As was the case in the field of human capacity, these correlations provide an incomplete evaluation. The percentage of population with a bank account provides an initial proxy for access to financial resources. But a better appraisal requires more indicators and more sound statistical tests. Moreover, the diversification index was not considered in the tool as such. However, the diversification index is adequate to measure the diversification of the economy[4]. Figure 3-2 presents the statistical evidence.

[4] The diversification index signals whether the structure of exports or imports by product of a given country or group of countries differ from the structure of product of the world. This index that ranges from 0 to 1 reveals the extent of the differences between the structure of trade of the country or country group and the world average. The index value closer to 1 indicates a bigger difference from the world average (UNCTAD 2013).

Figure 3-2: Statistical evidence of the coevolution of governance, proficiency and accessibility factors of capacity.



The high confidence levels of the Pearson's correlation coefficients suggest the existence of a coevolution between the elements associated to capacity factors.

4. Annex: The Assessment of Mitigation Measures

4.1 Methodology

This chapter focuses on ten countries covered in this study: namely Brazil, Cambodia, Ethiopia, India, Indonesia, Kenya, Nicaragua, Pakistan, Peru and South Africa. The chapter appraises the mitigation capacity and potential, compile country-wide mitigation strategies, and present the individual measures to reduce emissions.

In a first step we try to classify the given country in terms of its mitigation capacity and potential. Our evaluation is based on literature research and a list of indicators. Additionally, we include net energy imports, displaying a country's dependency on foreign energy sources and therefore on world market prices and supply. This enables us to identify the country's condition in terms of energy security. In regard of the societal capacity the report highlights the status quo on research and development, indicated by the number of technicians and Research and Development (R&D) expenditure. In addition, the Worldwide Governance Indicator for government effectiveness helps us to assess a government's capabilities and effectiveness, mostly in terms of implementing legislations[5]. The environmental capacity compiles score and ranking in the Environmental Performance Index, a useful tool to estimate a country's environmental performance. Moreover, the shares of renewable energy sources in a country's total primary energy supply (TPES) and domestic electricity production offer information about to what extent a country is able to provide low-carbon energy. Our definition of mitigation capacity emphasizes the energy sector. By reason of this, the short time-frame and mitigation capacity only constituting one part of our assessment, we don't review and incorporate the current scientific discourse about "mitigative capacity" in our study. Furthermore is the energy sector crucial in terms of mitigation, being responsible for more than two thirds of all global emissions and its thus expected to play a major role in our search. Nonetheless, to compensate for the shortcomings of our assessment, we integrate a qualitative appreciation of the countries' capacity and potential derived from literature as well as other indicators in our work. In some cases, comprehensive studies related to mitigation potential have already been elaborated.

After assessing the mitigation capacity and potential, we compile available information on the country's overarching mitigation strategies. This includes the national approach towards climate change, the institutional setup, its position towards the United Nations Framework Convention on Climate Change (UNFCCC) and national emission reduction targets. If available, we have a look at the National Communications, although they are most often outdated and therefore inaccurate. The assessment of effectiveness and ambition is based on literature research as well as our own appreciation. In the next step we give examples for existing small-scale projects with reference to type, annual emission reduction numbers and co-benefits. This is to provide examples and contribute to our assessment of effectiveness. Projects from the Clean Development Mechanism (CDM) under the Kyoto Protocol often provide good information on individual measures including

[5] The officially used definition of the cluster government effectiveness is: "capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies." (Kaufmann, Kraay, and Mastruzzi 2010)

quantified emission reductions and co-benefits. We hence included CDM projects to give examples for mitigation opportunities.

Finally, the case studies' conclusions aim to integrate the country's mitigation capacity, potential and action in order to evaluate the presented country-wide and small-scale mitigation measures in terms of ambition, responsibility, efficiency and deficits. In the end, we conclude this work package by combining all individual case studies and point out identified trends, more and less effective measures and try to group the investigated countries.

4.2 Brazil

Table 4-1: Indicators of emissions in Brazil

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	2,439.95 $MtCO_{2e}$ (Rank 3 of 186)	2,136.21 $MtCO_{2e}$ (Rank 5 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	13.11 tCO_{2e} (Rank 35 of 186)	10.94 tCO_{2e} (Rank 49 of 186)

4.2.1 Assessment of Mitigation Capacity and Potential

Being an emerging economy, Brazil is crucial for global efforts towards mitigating climate change. It has been experiencing high GDP growth rates of 3.7% from 2000-2012 (World Bank 2014a). It continues to be in the top 10 of the largest economies and has a large population of almost 200 million people. Up to now Brazil was responsible for about 4.5 per cent of worldwide GHG emissions (WRI 2014) and ongoing economic and population growth could potentially boost this. Striking about Brazil is its peculiar emissions composition for an emerging economy: Land use and forestry account for nearly half of all emissions, agriculture for 30 and energy for only 18 per cent. If Land Use, Land-Use Change and Forestry (LULUCF) is excluded, totals drop by almost 1,000 $MtCO_{2e}$ to 1,162.62 $MtCO_{2e}$ (*CAIT 2.0* 2014). Reduced deforestation rates in recent years, especially in the Amazon, are responsible for lower numbers in 2010 than in 2005.

Future economic growth could potentially lead to more energy-demand and a more carbon-intensive economy. In 2011, Brazil already needed net energy imports as high as 28.61 Mtoe (mostly refined oil and coal) with an 11% share of Brazil's total primary energy supply (270 Mtoe) (IEA 2014). This included 35,886GWh net electricity imports, a 6% share of the domestic supply.

Brazil's net development assistance received amounted to US$ 826 million (US$ 4.2 per capita, close to 0% of GNI) and mitigation related aid of US$ 604 million in 2011 (US$ 3.07 per capita) (OECD 2014; World Bank 2014a). In addition, Brazil has made significant use of the CDMs, attracting international assistance through 323 CDM projects (as of March 2014) (UNFCCC 2014). According to the Inter-American Development Bank, the country is above all very successful in raising foreign investment for low-carbon energy projects, with amounts from 2006-2012 as high as US$ 82 billion

(McKinsey and Company 2009). According to the same source, the clean energy business is well-developed (McKinsey and Company 2009). The 11% Total Primary Energy Supply (TPES) share from energy imports reveals possible energy security concerns.

In 2010, 657 out of a million people were technicians (1,418 in the EU 2005-2010) and 1.16% of the GDP was used for Research and Development in 2009 (2.1% in the EU 2005-2010) (World Bank 2014b). The World Governance Indicators credit an average government effectiveness of 50.24 per cent out of 100 (World Bank 2014b). In 2014 the Environmental Performance Index (EPI) ranks Brazil 77th out of 178 countries (EPI 2014). Together with the World Government Indicator for government effectiveness, this can be used as a sign for an average capacity to implement climate change policies. Nonetheless, the Inter-American Development Bank attributes Brazil a good performance, ranking it 2nd out of 26 Latin American and Caribbean countries in the category 'enabling framework' for renewable energy and low carbon policies and regulation (Inter-American Development Bank 2013).

High shares of renewables in energy (43%) and electricity mix (87%) contribute to Brazil's fairly good environmental capacity. Brazil's river watershed network offers great potential for hydropower. Although already three quarters of electricity generation is based on this source, the Brazilian government estimates that only 36% of all hydropower potential has been utilized (UNFCCC 2010). Apart from hydropower, the country does not produce any solar or geothermal power and only insignificant amounts of wind electricity in 2011. However, scaling up of renewable energy capacities based on biomass, wind, solar, tidal and geothermal is intended (UNFCCC 2010). The country already produces big amounts of biofuels but at the same time is the 11th largest crude oil producer in the world and possesses significant oil reserves, most of them offshore (EIA 2014). 98.7% of the population were connected to the electricity grid in 2010 (World Bank 2014a). Remaining deficits are the still low GDP per capita compared to industrialised countries, energy security concerns in the future and lack of governance effectiveness.

4.2.2 Overview of Country-Wide Mitigation Strategies

There are a couple of bodies responsible for climate policies in Brazil (Fekete, Mersmann, and Vieweg 2013): the General Coordination on Global Climate Change (CGMC) as part of the Ministry of Science, Technology and Innovation provides the technical expertise, e.g. it develops the National Communications. The Inter-ministerial Commission on Global Climate Change (CIMGC) is the Designated National Authority for the CDM and coordinates government and the respective ministries' actions towards climate change. Additionally, the Inter-ministerial Committee on Climate Change (CIM) was established to oversee the National Plan on Climate Change (NPCC). Furthermore, the National Fund on Climate Change (FNMC) and the Amazon Fund has been set up to finance climate change action.

The flagship climate legislation is the National Policy on Climate Change (PNMC), adopted in 2009, and its implementation, the National Plan on Climate Change (NPCC) and respective sector plans. It defines the country's low carbon strategy and constitutes simultaneously the voluntary emission reduction targets submitted to the Copenhagen Accord of the UNFCCC as Brazil's 'Nationally Appropriate Mitigation Actions' (NAMAs) (see Table 1-2) (Nachmany, Frankhauser, et al. 2014). While the Copenhagen pledge is conditional to the provision of adequate financial and technological support, the identical national legislations do not mention any preconditions. The PNMC sets the target of 36.1-38.9% emission reductions in 2020 compared to a BAU scenario of

2,704-3,236 $MtCO_{2e}$ in 2020 (Hare et al. 2014). It tackles the most obvious potential through reductions in the LULUCF sector as well as in agriculture and energy and would lead to total GHG emissions of 1,977 to 2,068 $MtCO_{2e}$ in 2020 (Hare et al. 2014), which could be in line with the target of an emission cap of under 2 $GtCO_{2e}$/yr and a reduction of 5.8 per cent compared to 2005 numbers (Fekete, Mersmann, and Vieweg 2013). The PNMC uses several sector plans for implementation such as the 'Action Plan to Prevent and Control Deforestation in the Legal Amazon', which aims for a 80% reduction of annual deforestation rates in 2020 compared to 1996-2005 or the Forest Code to establish 'Permanent Protected Areas' and for controlling deforestation (Nachmany, Frankhauser, et al. 2014; Hare et al. 2014).

Brazil submitted the Initial National Communication to the UNFCCC in 2004 and the second one in 2010. It's part of the BASIC group and argues strongly for the historic responsibility of Annex I countries for climate change. It makes extensive use of the Clean Development Mechanism under the Kyoto Protocol and the concurrent Programme of Activities (PoA). To date, there exist 323 registered CDM projects and eight PoAs (UNFCCC 2014a). Because of the big potential in the LULUCF sector for using REDD+, a national REDD+ strategy is currently under development and will be launched in the near future (Nachmany, Frankhauser, et al. 2014). As mentioned before, the calculation of BAU emissions is extremely difficult to estimate and therefore an assessment of effectiveness and ambition of Brazil's mitigation strategy is challenging. Brazil clearly possesses a comprehensive framework of legislation and activities to mitigation. It tackles the sectors with most mitigation potential, namely the LULUCF and agriculture sectors and especially the implementation of forest protection is regarded as good (Fekete, Mersmann, and Vieweg 2013). However, gaps in implementation of reforestation and agricultural measures remain (Fekete, Mersmann, and Vieweg 2013). Current policies are likely to overachieve the pledges made and will therefore lead to reduced overall emissions in 2020. The Climate Action Tracker evaluates Brazil's actions as medium, on the brink of sufficient. Accordingly, the country will easily meet the pledges made (Hare et al. 2014).

Because of wide ranges of BAU scenarios, ambition of emission reductions might be regarded as poor, because no significant reductions would be made in comparison to the low-end BAU scenarios (Fekete et al. 2013). However, Brazil is a Non-Annex I country under the UNFCCC and is legally not committed to reduce emissions. Hence, Brazil's embracing mitigation strategies display a growing commitment to meet important low carbon actions as one of the up and coming countries in the world and consequent essential contributions to the global climate. The Climate Change Performance Index, evaluating climate protection performance of 58 countries responsible for 90% of worldwide emissions, nonetheless ranks Brazil 36th and thus indicating a rather poor climate action, mostly due to low scores in development of emissions and climate policy (Bals, Burck, and Merten 2013).

Table 4-2: Brazil's NAMAs

NAMA	Range of estimated reduction in $MtCO_{2e}$/year in 2020
Reduction in deforestation in the Amazon	564
Reduction in Cerrado deforestation	104
Restoration of grazing land	83-104
Integrated crop-livestock system	18-22
No-till farming	16-20
Biological nitrogen fixation	16-20
Energy efficiency	12-15
Increase in use of biofuels	48-60
Increase in energy supply from hydroelectric power plants	79-99
Alternative energy sources	26-33
Iron and steel - replacing coal from deforestation with coal from planted forests	8-10

NAMAs submitted to the UNFCCC (and simultaneously the National Policy on Climate Change) (UNFCCC 2013)

4.2.3 Examples of Individual Mitigation Measures

While the NPCC and its included sector plans serve as the overarching flagship legislation, the country has embraced several other more specific measures on key sectors. Examples for such sector-wise legislations are the Low Carbon Emission Agriculture Programme to integrate farming, livestock and forestry aiming for a sustainable development and the Forest Code which, amongst other action, establishes a Rural Environmental Register to efficiently track deforestation and defines compulsory forest reserves for all properties with native vegetation (Nachmany, Frankhauser, et al. 2014). Furthermore, as mentioned above, Brazil is host to many CDM projects. Of all 269 CDM projects reviewed in the Climatescope 2013, 57% were related to power generation, 24% to methane, 14% to waste management and 1% to forestry (McKinsey and Company 2009).

Table 4-3: Mitigation action Brazil - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Forest Code (Nachmany, Frankhauser, et al. 2014)	Afforestation and reforestation, forest protection	Compulsory forest reserve for all properties with native vegetation, prosecution of illegal logging, reforestation of degraded areas and recording of respective areas in the Rural Environmental Register	not quantifiable	Enhanced biodiversity and ecosystem, prevention of soil erosion, improved water recharge, improved local environment, agroforestry	-
Caixa Econômica Federal Solid Waste Management and Carbon Finance Project (since 2012), Programme of Activities (PoA) under the UNFCCC (UNFCCC 2014a)	Renewable energy, waste handling and disposal	Capture and burn/use methane generated by the decay of organic waste from landfill	794,672	Energy production, distribution and security, reduced fuelwood demand, improved local environment	Spain
Jirau Hydro Power Plant (since 2013), CDM	Renewable energy	3,750 MW Hydro-Power Plant	6,180,620	Energy production and security, job creation, technology transfer	-
Lagoa de Touros Wind Power Plants CDM Project Activity (since 2012), CDM	Renewable Energy	Seven wind power plants with 177.8 MW total capacity	263,793	Energy production and security, job creation, technology transfer	Switzerland

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
AES Tietê Afforestation/Reforestation Project in the State of São Paulo, Brazil (since 2000), CDM	Afforestation and reforestation	Reforestation of 13,939 hectares of riparian forests near ten hydropower stations	157,635	Enhanced biodiversity and ecosystem, prevention of soil erosion, improved water recharge, improved local environment, agroforestry	Canada, Italy, Luxembourg, France, Japan, Spain
AWMS GHG Mitigation Project BR05-B-03 (since 2005), CDM	Waste handling and disposal, renewable energy,	Animal Waste Management System, digester with capture and combustion of biogas	182,079	Improved local environment, job creation, energy production, distribution and security	-

4.2.4 Conclusion

Both emission profile and mitigation potential of Brazil are very unusual for an emerging economy and different to most other countries assessed in this study. Globally, energy is the main driver of and accounts for about two thirds of all emissions (WRI 2014). Due to extensive use of hydropower and biofuels, energy accounts only for a small share of Brazil's emissions. The biggest emitters by far are the LULUCF and agricultural sector. Therefore Brazilian climate change policies address the most potent mitigation measures identified by literature, especially reducing deforestation, re- and afforestation but also agriculture and energy. Being a fast growing emerging economy and possessing remarkable fossil fuel reserves, the economy could become more carbon intensive, even though existing strategies try to reduce overall emissions and provide for a potential low-carbon pathway. One exemplary trade-off to mention is the needed agrarian land for the cultivation of biofuel-plants and forest protection on the other hand. Brazil already exhibits fairly high mitigation capacities and projected economic growth will probably foster these capabilities in the future.

Despite being a non-Annex I country without commitments under the UNFCCC, the government aims for significant reductions through their NAMAs and an emission cap of 2 $GtCO_{2e}$, which first of all is commendable. These reductions, however, are based on highly uncertain BAU scenarios (mostly because of doubtful reforestation numbers) and therefore cannot simply be regarded as ambitious. Summing it up, Brazil can be attributed an average performance in terms of climate change mitigation, having a comprehensive policy framework and comparably clean energy mix.

Big potential still lies in the forestry and agriculture sector and future economic growth might collide with a feasible low-carbon pathway.

Figure 4-1: Share of total primary energy supply, Brazil, 2011

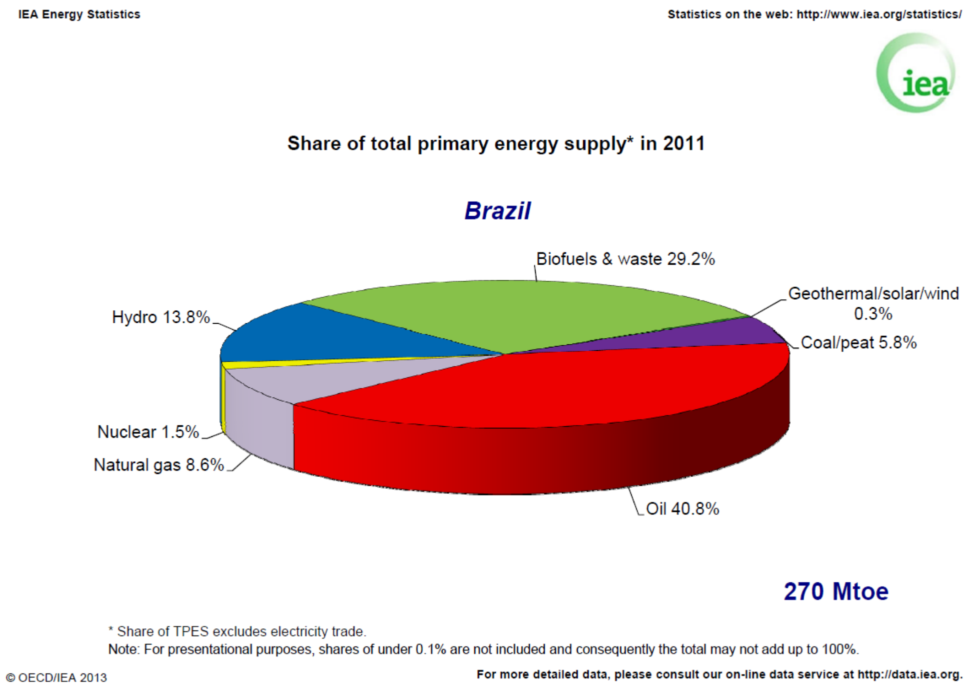
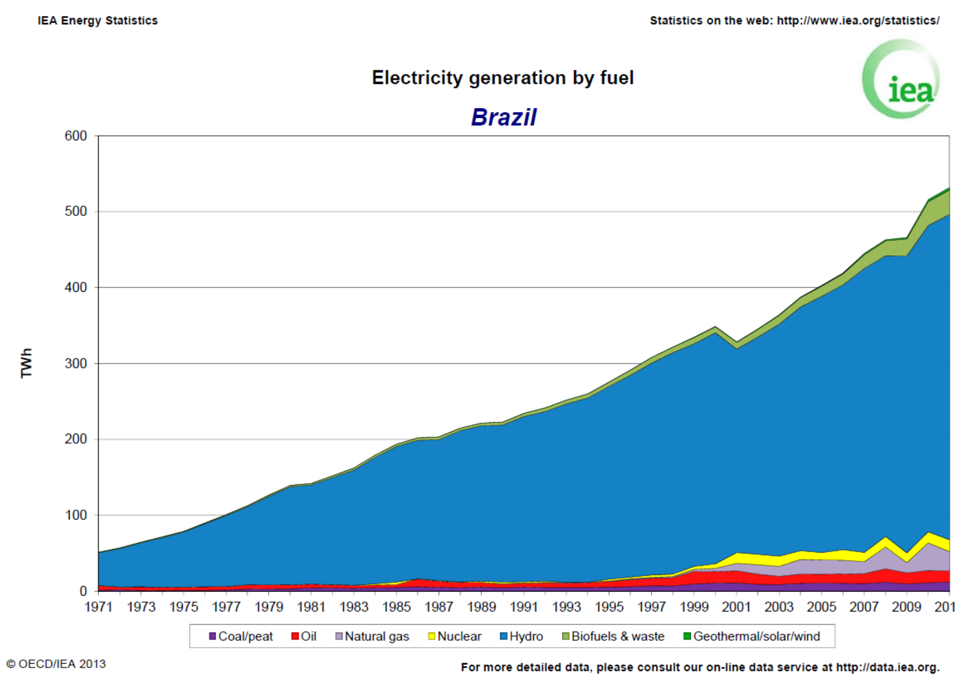


Figure 4-2: Electricity generation by fuel, Brazil



4.3 Cambodia

Table 4-4: Indicators of emissions in Cambodia

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	51.33 Mt CO_{2e} (Rank 84 of 186)	47.50 Mt CO_{2e} (Rank 91 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	3.84 t CO_{2e} (Rank 126 of 186)	3.31 t CO_{2e} (Rank 131 of 186)

4.3.1 Assessment of Mitigation Capacity and Potential

Total and per capita emissions are both very low. Because of its poor industrial development and 80 per cent of the population living in rural areas, Cambodia's GHG emissions mostly derive from LULUCF as well as agriculture, which in 2011 accounted for about 45 and 41 per cent respectively (WRI 2011). Emissions and removals estimates from the LULUCF sector, like in other countries, remain difficult to appreciate due to forest's significance as carbon sinks. Cambodian forests cover approx. 59% total land area and it experiences high ongoing deforestation rates of around 1,2% per annum from 2005-2010 which explains the high portion of emissions in the LULUCF sector (FAO 2010). If LULUCF is excluded, total GHG emissions are significantly lower (26.01 $MtCO_{2e}$ in 2012, reduction by 45%) (WRI 2014)

Cambodia's low economic capacity is the most obvious barrier for its ability to reduce GHG emissions since many mitigation measures require initial financing. Somehow trying to compensate for low GDP and GDP per capita, international assistance is provided through official development aid (ODA) of US$ 800 million (US$ 54.24 per capita, 6.5% of GNI), but only US$ 14 million mitigation related aid (US$ 0.95 per capita). In addition, Cambodia is sometimes regarded as a CDM leader amongst the least developed countries (LDCs), with 10 registered projects since 2006 as of February 2014 (Kamal 2013).

The government clearly lacks effectiveness (22.01 out of 100% in the Worldwide Governance Indicators) which could impede the effective implementation of climate change legislation (World Bank 2014a).

Oil, gas and coal reserves have been discovered in Cambodia, but are not being exploited yet (Ellis et al. 2013). All used fossil fuels are imported with amounts as high as 1.57 Mtoe (almost one third of 5.3 Mtoe total primary energy supply) in 2011, and oil products virtually accounting for all of them (IEA 2014). Oil is responsible for more than one quarter of Cambodia's total energy supply (excluding electricity trade) and for 90 per cent of all domestic electricity generation in 2011. With respect to electricity supply, Cambodia is highly dependent on imports - in 2011, 1644 GWh were imported from Vietnam, Thailand and Laos and only 1053 GWh were produced domestically (IEA 2014). However, a hydro-power plant currently under construction (e.g. the Kamchay Hydropower Station operating since late 2011) aims for a decrease of dependency on imported fossil fuels and electricity as well as a better diversification of power sources. Furthermore, its purpose is to solve the country's wide electricity supply shortages and contribute to the national targets for 100% grid connection of villages in 2020 and 70% of households in 2030 (Kingdom of Cambodia 2012). In 2010, only 31.1% of the population were connected to the grid, while electricity prices remain exceptionally high compared to neighbouring countries (Mohammed, Wang, and Kawaguchi 2013; World Bank 2014b).

In recent years, the government has introduced several environmental legislations and frameworks which could enhance Cambodia's environmental capacity. Nonetheless, the EPI ranks Cambodia as 145th out of 178 and is therefore attributing weak environmental governance. Because of the high importance of rural lifestyles and therefore widespread use of fuel wood, the country's current energy mix is comparably clean (73% renewables in TPES in 2011) (Kamal 2013). In the electricity production, renewables only play a minor role (6% in 2011), even though the build-up of hydro-power plants could change this in the future (Kamal 2013). The existing literature on mitigation potentials mainly focuses on energy and related emissions. Because of this lack of research and the expected increase in energy production and consumption due to increased development, it seems appropriate to focus on mitigation potential related to this sector. Official Cambodian scenarios estimate a reduction potential of 573 to 7,094 $ktCO_{2e}$ in 2050 compared to a baseline scenario if all preconditions are provided (private sector investment, donor financing and government policy development) (Kamal 2013). Possible mitigation options include energy efficiency, hydro and solar power, gasification and cogeneration, electric vehicles, efficient cook stoves, biogas digesters and ceramic filters. Cambodia has great potential for hydro power generation due to the Mekong River Network and could make use of its tropical location by using solar power. However, currently only small-scale projects of solar PV systems to individual households exist (Kamal 2013).

Energy-related emissions only accounted for about 12 per cent of Cambodia's emissions in 2011 and obviously big potential lies in the agriculture and LULUCF sector. According to the Cambodian Ministry of Environment, emissions from agriculture could be reduced by 32,521 $ktCO_{2e}$ until 2050. This would include mitigation options such as improved livestock management (enteric fermentation and manure management such as biogas), rice cultivation, soil and crop management (ADB 2013). Regarding the LULUCF sector, emission reductions of 20,545 $ktCO_{2e}$ could be provided through enhancing sinks through forest protection and management (including REDD+), afforestation and reforestation or agroforestry.[6]

Cambodia's mitigation capacity can be regarded as low. Few total and per capita emissions are outweighed by poor governance and societal development and missing economic assets. General assistance per capita is noticeable high, but does not compensate for domestic deficits and mitigation activities do not really benefit at present. Nonetheless, does the country possess significant mitigation potential, mostly reducing energy-related emissions in the future while pursuing a low-carbon pathway. Furthermore, big potential obviously lies in the LULUCF and agricultural sectors. Forest protection remains a big issue for the country and small-scale actions in agriculture would not only lead to less GHG emitted but also provide for significant co-benefits and sustainable development.

[6] In contrary to the data collected by the WRI, the Cambodian MoE estimates the LULUCF sector as a net sink. This shortcoming seems to lie in the problematic estimations of sinks and classifications for emissions relating to LULUCF.

4.3.2 Overview of Country-Wide Mitigation Strategies

Cambodia has integrated climate-change policies in several country-wide frameworks. In 2006, the National Climate Change Committee was established, chaired by the Minister of Environment (MoE) and consisting of several ministries' representatives and the Prime Minister, serving as an umbrella for all climate change related strategies, policies, legal instruments and plans (Thou 2012). Responsible for mitigation is the Climate Change Department under the Ministry of Environment. The MoE also serves as the Designated National Authority for the CDMs.

Climate Change has been included in the National Strategic Development Plans (most recently the NSDP 2014-2018) and particular roadmaps have been developed, namely the recently published Cambodia Climate Change Strategic Plan 2014-2023 and the Cambodia Climate Change Action Plan to support the implementation of actions in the different sectors and ministries. A National Green Growth Map has been adopted in 2010, focusing on sustainable development and including adaptation as well as mitigation and was followed by the National Policy on Green Growth (2013) and the National Strategic Plan on Green Growth 2013-2030. In November 2013, the 3rd National Forum on Climate Change was held during which the construction of a Climate Change Financing Framework (CCFF) to secure sources for adaptation and mitigation was announced.

The Initial NC to the UNFCCC was delivered in 2002 and Cambodia's Second NC is currently under development. Likewise, the development of a National Inventory System is underway and a taskforce was assigned to work out a REDD+ Roadmap, the development of strategies, a monitoring system, reference levels and safeguard systems, to be implemented until 2014. This is in line with the high priority the government puts on Cambodian forests through the establishment of protected areas (26% of all land mass) and the target for 60% forest cover in 2015 (Kingdom of Cambodia 2012). It remains to be seen to what extent the government is able to halt deforestation and effectively preserve and restore the domestic forests. Mitigation is also partly addressed in the Cambodia Climate Change Alliance under the UNDP, in order to support Cambodia in his efforts towards Climate Change. A feasibility study for a Nationally Appropriate Mitigation Action (NAMA) under the UNFCCC for a Bio-digester program is currently being done with help of Japan. Accordingly, the country has reported that it would address the importance of deforestation through a pilot project within the framework of REDD since 2009 (Kingdom of Cambodia 2013).

An ongoing study conducted by the Cambodian MoE and Japanese experts has been working out a "Low Carbon Development Strategy for Cambodia toward 2050" (Mao 2013). It developed four policy sectors for low carbon growth: Green Environment (including forest, waste and agriculture management); Harmonization of Green Economy, Society, and Culture (transport, energy and tourism management); Blue Economy (Green merchant marine and sustainable coastal zone management); Eco-Village (Low Carbon infrastructure development, green building design and construction).

Overall, adaptation has been the main focus of climate change strategies in Cambodia. In recent years, however, mitigation has been included and is currently carried out in practice through pilot projects, the CDM and voluntary carbon markets or bilateral action such as the Energy and Environment Partnership with the Mekong Region (EEP). In terms of overall emission reduction aims, Cambodia is very reluctant and does not provide any quantification, pointing to its status as a LDC.

4.3.3 Examples of Individual Mitigation Measures

In Table 4-5, we listed five individual mitigation measures conducted in Cambodia. An example for a voluntarily funded project is the EEP, with small scale-projects related to renewable energies and energy efficiency. The National Biodigester Programme is selling Carbon Credits on the voluntary carbon market and can be regarded as very much successful with a lot of co-benefits (Ellis et al. 2013). However, only 20% of the costs are provided by the selling of the carbon credits. Under the CDM, there are currently ten registered project as of February 2014 with combined emission reductions of 2,021,187 tCO_2/yr (UNFCCC 2014a): four of them, and the most recent ones, are hydro power projects with high emission reductions, although there have been concerns about environmental degradations by the construction of this electricity production. Four projects are related to biogas and energy, one to biomass and energy and one to waste avoidance and energy use of waste.

Table 4-5: Mitigation action Cambodia - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Energy and Environment Partnership with the Mekong Region (EEP) eight projects in 2009-2012, evaluation of projects for second phase 2014-20?? (Käkönen et al. 2013)	Renewable Energy, Energy Efficiency	Improving energy-access in the Mekong region and emission reductions through projects, studies, demonstrations, promotion, training	not quantifiable	Energy production, distribution and security, awareness-raising, technology transfer, cost-savings, improved local environment	Finland, Nordic Development Fund
National Biodigester Programme, (since 2006), voluntary carbon market (Gold Standard)	Renewable Energy	Funding and supporting for building of biogas plants in rural households for lighting, cooking and heating; over 20,000 installed 2006-2013	154.687 (May 2009 - December 2012) (National Biodigester Programme 2014)	Improved local environment, job creation, fertilisers as by-product, reduced fuelwood demand, energy production, distribution and security	Netherlands

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Kamchay Hydroelectric BOT Project (since late 2011), CDM	Renewable Energy	Hydropower station	281.348 (UNFCCC 2014a)	Energy production and security	Netherlands
Stung Tatay Hydroelectric Project (since late 2013), CDM	Renewable Energy	Hydropower station	701.199	Energy production and security	Sweden
Biogas Project at MH Bio-Ethanol Distillery, Cambodia (since 2008), CDM	Waste handling and disposal, Renewable Energy	Using Agricultural Waste (methane) for Biogas	58.146	Energy production, distribution and security, technology transfer, job creation, improved local environment, reduced fuelwood demand	-

4.3.4 Conclusion

At present, Cambodia still is a least developed country, with livelihoods to a high degree depending on agriculture and rural live patterns. Accordingly, GHG emissions derive to a great extent from agriculture and LULUCF. Mitigation in both sectors is tackled through various individual measures, such as biogas projects or forest protection, and included in official sustainable development policies. As it can be expected, future growth, urbanisation and therefore higher energy demand and production will lead to higher overall emissions, particularly in the energy sector. Being extremely dependent on energy imports, scaling up of energy supply has been a main focus of Cambodia in recent years and renewable energy sources and energy efficiency seem to provide both big mitigation potential and simultaneous co-benefits such as economic growth and energy security. This is reflected by various country-wide strategies and frameworks like the National Green Growth Roadmap, and also in individual measures, such as the most recent construction of multiple hydro-power plants. The scaling up of domestic energy supply will likely reduce the exceptionally high energy prices and increase energy access and thereby benefit economy growth.

Cambodia is regarded as highly vulnerable to the effects of climate change and therefore focuses mainly on adaptation rather than mitigation. The latter happens mostly through embedding low carbon strategies in future development pathways. Furthermore, Cambodia makes use of international assistance, e.g. the CDM, to gain support for projects which aim for development and mitigation. Yet, still questions remain about the government's ability to implement policies related to climate change. Future use of REDD+ could be a key factor in its mitigation activities.

Summing it up, Cambodia possesses limited capacities for mitigation, mostly due to its low development, but also offers some mitigation potential. While currently most potential lies in the Agriculture, Forestry and Land-Use (AFOLU) sector, especially in the preservation of Cambodia's valuable forests, also many opportunities are provided by the energy sector which is expected to grow substantially in the next years. The government already engages climate change mitigation through framework policies, agenda-setting, some individual measures and forest management, but is well-advised to implement more concrete legislations and use the window of opportunity to set the trajectory for a low carbon development pathway. Further international assistance may be needed for this.

Figure 4-3: Share of total primary energy supply, Cambodia, 2011

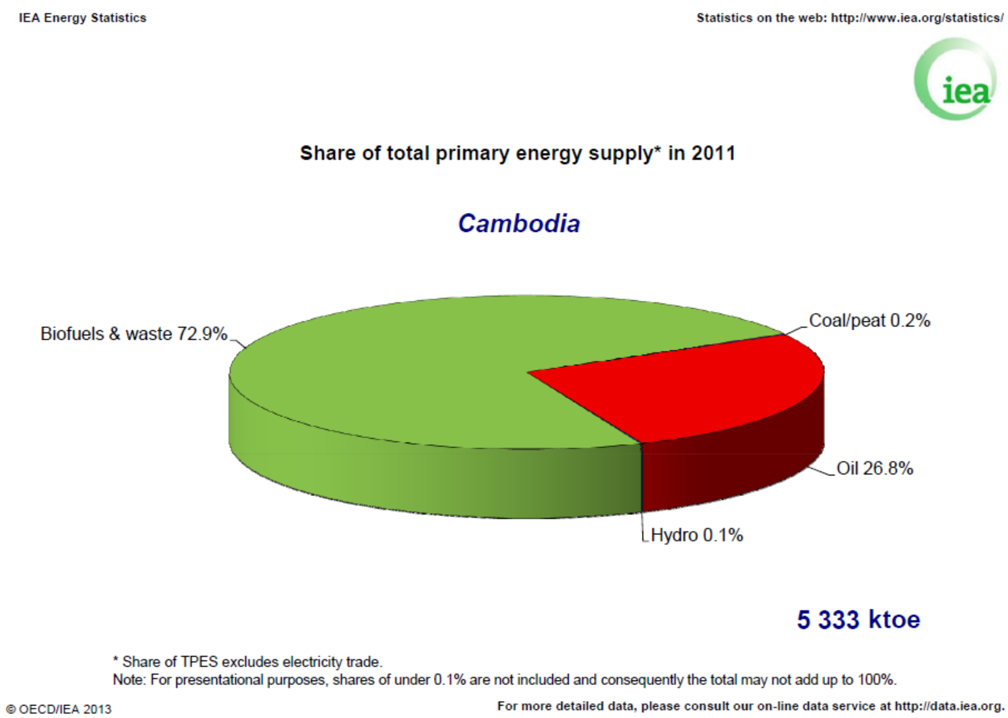
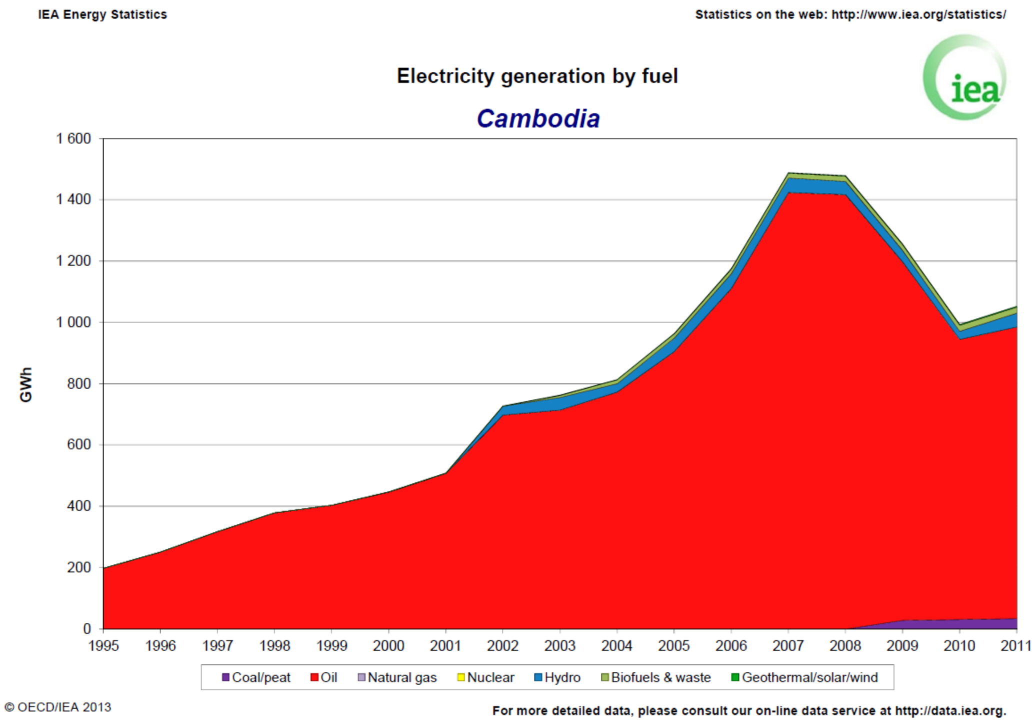


Figure 4-4: Electricity generation by fuel, Cambodia



4.4 Ethiopia

Table 4-6: Indicators of emissions in Ethiopia

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	109.93 Mt CO_{2e} (Rank 55 of 186)	131.99 MtCO_{2e} (Rank 51 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	1.44 tCO_{2e} (Rank 166 of 186)	1.52 tCO_{2e} (Rank 162 of 186)

4.4.1 Assessment of Mitigation Capacity and Potential

In Ethiopia the main sources of energy are still found in the traditional energy sources (UNDP 2014a). This is characterized by a heavy reliance on biomass fuels – in 2001 93% of the total primary energy supply was generated by biofuels and waste (WRI 2011). Agriculture is by far the most important sector of Ethiopia. Examples for mitigation measures are promotion of mixed-crop livestock farming, manure-management system facilities, improved nutrition through strategic supplementation and improving the productivity through improved genetic characteristics.

Ethiopia has got energy potential measuring up to 30-50 billion cubic metres of natural gas, more than 1000 MW of geothermal power and several hundred million tons of coal and oil shale so far discovered (Mariuam 1992). The energy consumption pattern in Ethiopia is characterized by heavy reliance on biomass fuels, which sums up to a share of 93% on total primary energy supply, mainly on account of the household sector. Some economic sectors like transport are fully dependent on modern energy sources, mainly petroleum. Petroleum is wholly imported and consumed about 30% of entire export earnings in 2001 (IEA 2014). In 2011, Ethiopia needed net imports of 2.32Mtoe (only oil products) with a 7% share of the country's total primary energy supply (34,06Mtoe) (IEA 2014). Only 23% of the entire population had access to electricity in 2010 (World Bank 2014a).

Possible mitigation strategies proposed in the NCs of Ethiopia are side management in the household sector like improved stoves and, on the supply side management, improved charcoal kilns; furthermore the substitution of Photo Voltaic lanterns for kerosene lighting (UNFCCC 2001). Lacks in finance abilities as well as the very low HDI rating are the most obvious reasons for Ethiopia's struggle to develop mitigation strategies.

This is partly met by international financial assistance. For 2011, the OECD estimated the international assistance having climate change mitigation as principal or significant objective to approx. US$ 61.1 million (US$ 0.68 per capita) and the World Bank estimated net official development assistance and official aid (ODA) in 2011 of US$ 3,6 billion (US$ 40 per capita or 11.1% of GNI) (OECD 2014; World Bank 2014a). As apparent, only a minor part of ODA is invested in mitigation related aid on account of Ethiopia's condition as least developed country. Because of Ethiopia's low industrial development – only 13% of the GDP arouse from the industrial sector – the total and per capita GHG emissions are with a total share of 131.99 $MtCO_{2e}$ in 2012 (WRI 2014) in global comparison still very low. But due to the socio-economic development and population growth emissions are most likely going to rise in the future. Ethiopia's GHG emissions mostly derive from agriculture (72%) followed by the energy sector (17%).

In terms of Ethiopia's environmental capacity, it has to be noted that the country is ranked as one of the world's leading countries in hydro potential with a gross of 650 tWh/yr. Out of these, 25% could be exploited for power production, although only around 1% of the total hydro-power potential has been utilised so far (*CESEN-ANSALDO/FINMECCANICA Group* 1986).

An increased exploitation of Ethiopia's hydro, solar, wind, biomass and geothermal resources could further contribute to GHG emission reduction (UNFCCC 2001). Particularly current water resources and Ethiopian topography indicate an overall potential of more than 30,000 megawatts in economically viable hydropower generation capacity (World Bank Group, EACC, 2010). The approach of the current Growth and Transformation Planning 2011-2015 (GTP) of Ethiopia focuses on "the development of water and wind energy options to fulfil the energy demand of the country," with targets for hydropower of 6,000 to 8,000 MW in additional generation capacity (World Bank Group, EACC, 2010).

The LULUCF sector accounts after agriculture and energy for the third highest amount of GHG emissions (9.29 $MtCO_{2e}$ in 2009) (WRI 2011). The Ethiopian Forestry Action Plan Report estimated the disappearing of forest and woody vegetation at a rate of 150,000 to 200,000 ha annually. With it, the rich biodiversity of Ethiopia is threatened. Proposed areas of mitigation in the Land-use change and Forestry sector are initiating reforestation and afforestation projects, rehabilitation of degraded forest and protection of the existing forest from deforestation (UNFCCC 2001). A mitigation option in the planning process is the afforestation of 21.000ha to notably increase the carbon pool and reduce emissions of other greenhouse gases such as methane.

In recent years, the government has introduced several environmental legislations and frameworks. Nonetheless, in 2014 the EPI ranked Ethiopia as 131st out of 178 and is therefore also attributing a weak ambition of the government to tackle climate change. This is particularly due to an estimated low performance in water and sanitations, water resources and air quality (EPI 2015). The World Bank attributes 40 out of 100% government effectiveness, which indicates a weak governmental effectiveness to implement climate change related policies.

4.4.2 Overview of Country-Wide Mitigation Strategies

Ethiopia has at present nine laws dealing with climate change legislation with a main focus on institutions and administrative arrangements (Nachmany, Frankhauser, et al. 2014). Several GHG reduction aims are planned or implemented on a country-wide level. The Environmental Protection Authority (EPA), an institution in-charge of environmental issues in general, was established at the federal level in 1994. Also the Environmental Policy of Ethiopia, an umbrella policy which is composed of 10 sectoral and 10 cross-sectoral environmental policies, was formulated in 1994. Among the 10 sectoral environmental policies, one of them deals with Climate Change and Air Pollution. In this context, the National Meteorological Services Agency (NMSA) is mandated to deal with these issues, the implementation of Climate Change and Air Pollution issues falls under its responsibility (UNFCCC 2001). The initial and up to date only National Communication to the UNFCCC has been delivered in 2001.

In 2011, at COP-16, Ethiopia, Norway and the UK established a strategic partnership to promote collaboration on international climate change policy. Most importantly, in September 2011 the government finalised its "Climate-Resilient Green Economy" (CRGE) strategy. This is the first of its kind in Africa, and was established under the leadership of the Prime Minister's Office, the Environmental Protection Authority and the Ethiopian Development Research Institute (Nachmany, Frankhauser, et al. 2014). In the process of developing the CRGE strategy, the Ethiopian Government, aided by the Global Green Growth Institute, unveiled a Climate Resilience strategy for agriculture as well as a Sectoral Reduction Mechanism (SRM) Framework, which outlines the mechanism for implementation of the CRGE (GGGI 2011). The Strategy addresses both climate change adaptation and mitigation objectives and will gradually be fully integrated into the GTP of Ethiopia to create a green national economic growth plan (GGGI 2011). The very ambitious GTP states the objective of transforming Ethiopia in a mid-income country by 2025 based on carbon-neutral growth (Environmental Protection Authority Ethiopia 2011). This leap will require increasing agricultural productivity, strengthening the industrial base, and fostering export growth. The current per capita GDP has to increase to US$ 1,000, which is the lower threshold of middle-income status. To meet the aim of a green economy, 150 initiatives have been identified and 60 prioritised based on their local relevance, feasibility and significant potential for emission reduction. If all the emission reduction initiatives that have been identified were fully implemented, Ethiopia would limit emissions to current levels in absolute terms and reduce per capita emissions from 1.8 to 1.1 tCO_{2e} while achieving middle-income status before 2025 (CIF 2012a). The plan covers the six sectors of energy, REDD, agriculture, building/green city, transport and industry, supporting TC/STCs. The project also puts emphasis on knowledge transfer and capacity building of local stakeholders.

Formulated in the Green Growth Strategy of Ethiopia's Growth and Transformation Plan, the most powerful initiative to reach its ambitious aim is the use of more efficient stoves to reduce the burning of fuel wood for cooking. According to the Environmental Protection Authority of Ethiopia, this action has the potential to reduce forestry-related emissions by a rate of 50 $MtCO_{2e}$ emissions a year in 2030. In agriculture, higher livestock productivity has the potential to reduce 45 $MtCO_{2e}$ emissions a year in 2030. In the industry sector, the highest potentials for reducing emissions have been identified in modernising cement production to achieve higher efficiency and in generating electric power from renewable sources (mostly hydro power) (EPA 2011). Through the CRGE Initiative the country expects to be able to attract additional investment to Ethiopia. The country aims to leverage up to US$500 million of additional investment a year by 2025 (GGGI 2013). To implement the CRGE, SRMs will be used. Its purpose is to reduce emissions and vulnerability and build a climate-resilient green economy with zero-net growth in carbon emissions by 2025. A framework of the SRM is currently under revision (Nachmany, Frankhauser, et al. 2014).

Ethiopia is also active in the area of REDD: One of the world's largest afforestation and reforestation programmes is being processed. One of the projects – in the Great Rift Valley – is Africa's first large-scale CDM project in forestry . The development of a CDM for fuel-efficient stoves is in progress, as well as studies to devise a similar mechanism to support the reduction of emissions from livestock (CIF 2012b).

4.4.3 Examples of Individual Mitigation Measures

The CRGE strategy can be seen as the biggest and most effective mitigation strategy in the country, which comprises numerous small-scale projects and individual measures. Up to date, there are only few CDMs registered in Ethiopia, with the Humbo Ethiopia Assisted Natural Regeneration Project as Africa's first large-scale CDM.

Table 4-7: Mitigation action Ethiopia - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Green Power of more efficient stoves, proposed in the Green Growth Plan 2011 (EPA 2011)	Energy Efficiency	Deploy of 9 million more efficient stoves by 2015	50,000	-cost-savings -reduced fuel wood demand -lower overall energy consumption and energy security	Government of Ethiopia, seeking support for financing

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Interurban electric rail (NAMA), proposed 2012 (NAMA database 2014)	Renewable Energy	Replacing 50% of the transportation of road cargo by electric rail through eight routes connecting the main economic hubs. - Rail transport will be powered by renewable electricity, hydropower	-	-Technology transfer -pollution reduction -Energy security	Seeking support for implementation
Grand Ethiopian Renaissance Dam (GERD), start of construction 2011 (Schwartz 2013)	Renewable Energy	Hydro Dam, largest hydroelectric power plant in Africa - Flood control, will produce 15,86 GWh/yr hydropower	10,600 (estimated by Ministry of Water & Energy, Ethiopia)	-Energy production and security -job creation -pollution reduction	Ethiopian Electric Power Corporation (EEPCo), Ethiopia
Humbo Ethiopia Assisted Natural Regeneration Project (CDM) 2006-2036	Afforestation and reforestation	Large-scale afforestation and regeneration of native forest, enhancement of GHG removals by sinks	29,343 (UNFCCC 2014)	-Enhanced ecosystems and biodiversity -agroforestry -job creation -Prevention of soil erosion and improved water recharge -improved local environment	Spain, France, Japan, Canada, Italy, Luxembourg/ BioCarbon Fund (BioCF)

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Methane Capture and Flaring from Addis Ababa Repi open dump fill, (CDM), 2013-2023	Waste handling and disposal	Capturing Methane and Flaring from open dump fill	96,884	-improved local environment -technology transfer	n/a

4.4.4 Conclusion

Ethiopia's situation is very special in comparison with the other case studies; with a 94% share of renewable energy in the energy mix, its ambitious aim to become carbon neutral by 2025 is not as unrealistic as it sounds. But the low amount of fossil fuels in the energy mix is mainly due to the country's low stage of development and the power demand is expected to grow enormously in the future. This is – amongst others – shown by only 26.6% of the population with access to electricity in 2012 (World Bank 2014a). Also, the major part of GHG emissions still derives from the agriculture sector, which is also expected to change vastly due to growing GDP and development. The very ambitious GTP states the objective of transforming Ethiopia in a mid-income country by 2025 based on carbon-neutral growth (Environmental Protection Authority Ethiopia 2011). This leap will require increasing agricultural productivity, strengthening the industrial base, and fostering export growth. The current per capita GDP has to increase to around US$ 1,000, which is the lower threshold of middle-income status.

Ethiopia is still one of the least developed countries in the world, with comparing low GHG emissions (Rank 162 of 186 in 2012). On account of this high vulnerability to the threats of climate change and its lacking financial capacities, it has a strong focus on adaptation measures. But mitigation measures like CDMs are exceedingly in planning. Although the country has abundant energy resources, especially in hydro power, it is not yet able to utilise them up to their potential (UNFCCC 2001). An increased exploitation of the country's hydro, solar, wind, biomass and geothermal resources could not only further contribute to GHG emission reduction, but also help the economic development.

Our analysis indicates that the main focus for mitigation measures in Ethiopia is a combined path linking climate change action with its development agenda; the GTP and the CRGE Strategy already point in this direction. They describe a model of development that integrates key aspects of economic performance, such as poverty reduction, job creation, and social inclusion, with those of environmental performance, such as mitigation of climate change and biodiversity loss as well as ensuring access to clean water and energy. If the ambitious plans are successful, this transformative approach will provide a clear example of green economic transformation, not only in Africa but across the world. By promoting a green economy, Ethiopia aims do decouple growth from natural resource consumption and GHG emissions (Nachmany, Frankhauser, et al. 2014).

Experts evaluate the Ethiopian climate change relating policies as comparatively well-designed and supported by a strong political will with government backing, but implementation problems also appeared, mainly due to lacks of finance (Nachmany, Frankhauser, et al. 2014). To reach the ambitious aims successfully, further international assistance is highly needed.

Figure 4-5: Share of total primary energy supply, Ethiopia, 2011

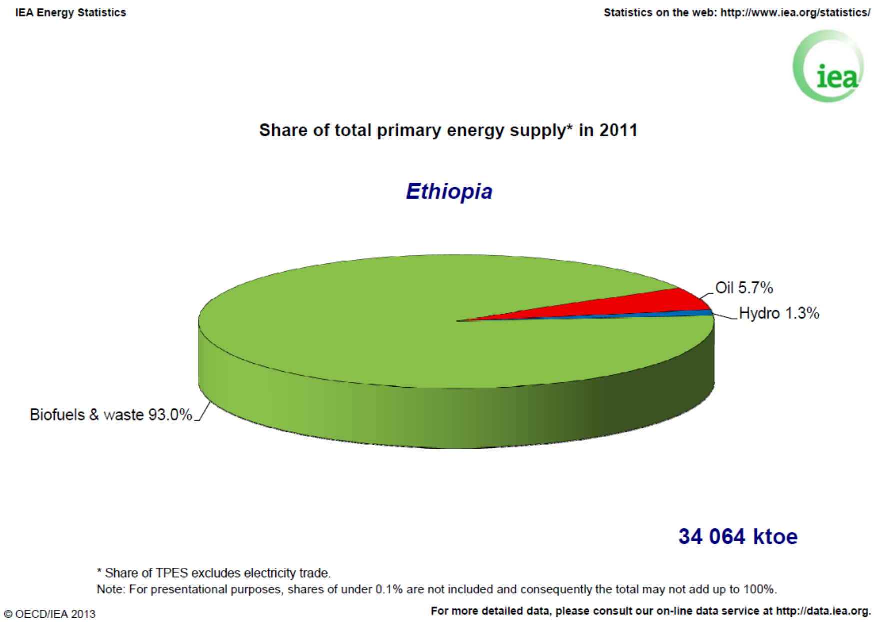
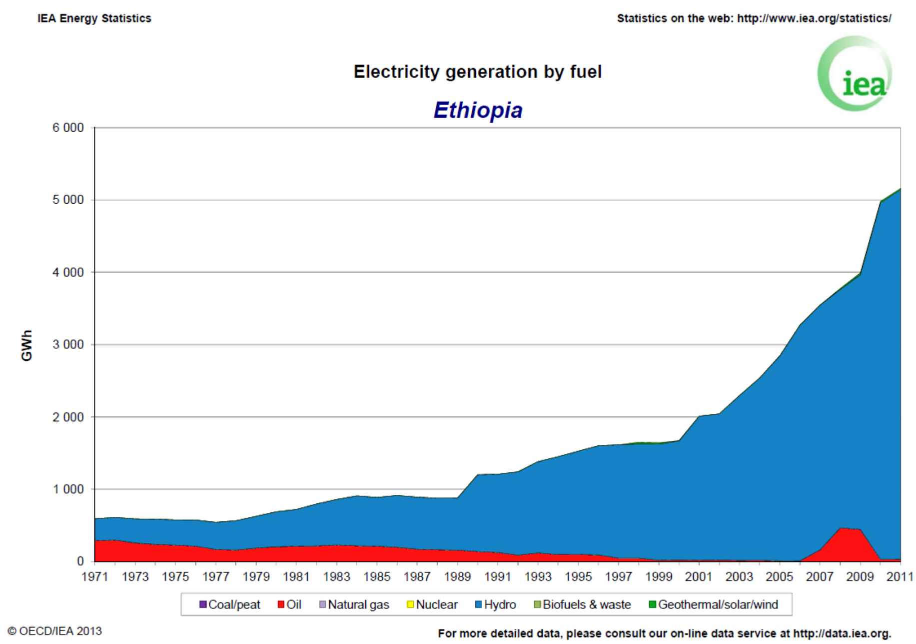


Figure 4-6: Electricity generation by fuel, Ethiopia



4.5 India

Table 4-8: Indicators of emissions in India

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	1,783.58 $MtCO_{2e}$ (Rank 5 of 186)	2,304.39 $MtCO_{2e}$ (Rank 4 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	1.58 tCO_{2e} (Rank 162 of 186)	1.58 tCO_{2e} (Rank 157 of 186)

4.5.1 Assessment of Mitigation Capacity and Potential

Due to its strong development needs, India receives significant foreign assistance, adding to its economic capacity. The World Bank estimated net official development assistance and official aid in 2011 of US$ 3.2 billion (US$ 2.64 per capita) and the OECD calculated the international assistance having climate change mitigation as a principal or significant objective at US$ 2.9 billion (US$ 2.34 per capita) (World Bank 2014b; OECD 2014). As of March 2014, India has also hosted 1480 registered CDM projects. Hence, India accounts for nearly 20 per cent of all CDM projects, second only to China (3743, ~50%). Energy security is a significant issue: the country is highly dependent on imports, with 28% (213 Mtoe) of its energy supply based on traded energy sources (mostly crude oil). Additionally, it suffers from frequent electricity shortages and blackouts; the grid-system is often over-stretched and not able to meet electricity demand. India's total energy supply is mostly fossil-fuelled, as is its electricity generation, both mainly supplied by coal and oil. Renewable energy sources are currently being scaled up, but accounted for only 17 per cent of total electricity production in 2011 (hydro 12%, biofuels 3% and wind 2%) (IEA 2014). In 2010, 75 per cent of the population had electricity access (World Bank 2014b).

Lacking societal capacity is displayed by only 93 technicians out of one million people in 2005 (1,418 in the Euro area 2005-2010) and 0.76% of the GDP spent on R&D in 2007 (2.1% average 2005-2010 in the Euro area). The World Bank attributes 47 out of 100% in the category of government effectiveness which is below the global average (World Bank 2014a). In 2014 the EPI ranked India 155th out of 178 countries indicating poor governmental ability to implement environmental policies (EPI 2014). India's environmental capacity also comprises the 27% of the TPES and 17% of the domestic electricity production based on renewable energy sources in 2011. While this might not be regarded as low for the given development status, India has immense potential countries for solar power generation and offers opportunities for large-scale wind power as well (Goswami 2013). Moreover, hydro, biomass and geothermal potential is available. These endowments are presently not being exploited at a large scale. A crucial benefit could be the load removal of the grid-system and less distribution losses by installing distributed energy from local solar and wind energy (Goswami 2013).

Facing the challenges of severe long-term impacts of climate change (droughts, floods and desertification), India finds itself in a constant challenge of maintaining and increasing short- and long-term economic growth through sustainable low-carbon development (Nelson 2013).

4.5.2 Overview of Country-Wide Mitigation Strategies

India has introduced several pieces of climate change related legislation. Most noteworthy is probably the overarching National Action Plan on Climate Change (NAPCC) of 2008 which consists of eight specific "National Missions" such as the former National Solar Mission (now 'Jawaharlal Nehru National Solar Mission') or the National Mission for Enhanced Energy Efficiency (Prime Minister's Council on Climate Change 2008). The Indian federal states simultaneously, and often quite ambitiously, develop their State Action Plans for implementation. The Expert Group on Low Carbon Strategy for Inclusive Growth is working on a comprehensive low-carbon framework and its recommendations, laid out in its interim report in 2011, have been incorporated in the 12th Five-Year Plan (Nachmany et al. 2013).

Most responsible for climate change policies are the Ministry of Environment and Forests in charge of all environmental and forest topics and the Prime Minister's Council for Climate Change (PMCCC). It consists of stakeholders from government, industry and civil society and serves as the high-level meeting point of all relevant ministries and other experts (Fekete, Mersmann, and Vieweg 2013). The PMCCC is furthermore responsible for the NAPCC, its revision and updates.

In the UNFCCC negotiations, India has often pointed towards the developed nations' historic responsibility and per capita emissions as an important indicator for countries' performance. With China, Brazil and South Africa, it forms the BASIC group. The Initial National Communication was handed in in 2004 and the second one in 2012. In the 2009 Copenhagen conference, India pledged to reduce its GDP's emission intensity by 20-25% by 2020 (excluding agriculture) compared to 2005 levels, constituting an official NAMA but explicitly voluntary and without legally binding character (Kingdom of Cambodia 2013). The government projects overall emissions of 3,500-4,000 $MtCO_{2e}$ if the target is pursued, which is also in the range of BAU estimations in the literature (Planning Commission Government of India 2011; Climate Action Tracker 2014). The NAPCC additionally aims for an electricity production share of renewable energy sources of 15% by 2020 and expanding forest cover from 23% to 33% (Nelson 2013; Nachmany et al.2013). The future use of REDD+ is being pursued by a technical group and a coordinating agency (Ministry of Environment and Forests, Government of India 2010).

Besides insufficient monetary assets, several other barriers impede mitigation actions. Knowledge and acceptance of new technologies is insufficient and the decentralized institutional setup of federal and state authorities sometimes makes decision-making drawn-out and difficult (Fekete, Mersmann, and Vieweg 2013). On the other hand, this allows individual states to go beyond the federal mitigation targets and act more ambitiously.

Some independent institutions and experts rank India's climate change policies positively overall (Fekete, Mersmann, and Vieweg 2013). The country is sometimes regarded as relatively ambitious when compared to other nations' performances, especially if one takes into account the low per capita emissions (Fekete, Mersmann, and Vieweg 2013). On the other hand, India is ranked 30th out of 58 countries and rated moderate in the Climate Change Performance Index, mostly because of its development of emissions and lack of energy efficiency (Bals, Burck, and Merten 2013).

Despite the stated ambition to mitigate GHG emissions, India's pledges do not differ substantially from BAU-scenarios. Given the vast challenges India will face in the future (society-wide development, energy supply and security, climate change adaptation), further action seems appropriate and international support for India's climate change policies might be necessary to make use of its big mitigation potential.

4.5.3 1.2.3 Examples of Individual Mitigation Measures

Some of the National Missions in the NAPCC comprise quantified targets such as the Jawaharlal Nehru National Solar Mission. Other small-scale legislations cover issues such as afforestation, promotion of bio-diesel and ethanol (20% blending requirement of biofuels in 2017), public transportation and incentives for renewables, especially for solar and wind power (e.g. feed-in tariffs and renewable purchase obligations). Furthermore, a levy of 50 Rs (˜ US$ 1) per ton of produced and imported coal was introduced to benefit the National Clean Energy Fund financing research, innovative projects in clean energy technologies and environmental remedial programmes (Nachmany et al. 2013).

Table 4-9: Mitigation action India - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Perform, Achieve and Trade Mechanism under the National Mission on Enhanced Energy Efficiency (Ministry of Environment and Forests, Government of India 2010)	Energy efficiency	Market-based mechanism, 4-5% energy consumption reduction of largest industrial and power facilities (covers >50% of all fossil fuel use in India)	25,000,000 by 2014/15	Cost-savings, load removal of the grid, lower overall energy consumption and energy security	
Jawaharlal Nehru National Solar Mission	Renewable energy	20,000 MW of solar power in 2022 (including 2,000 MW off-grid)	not quantifiable	Energy production, distribution and security, job creation, technology transfer, pollution reduction	

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Green India Mission (2010-2020)	Afforestation and reforestation	Afforestation/eco-restoration of 20 million ha	43,000,000	Enhanced biodiversity and ecosystem, agroforestry and improved livelihoods, prevention of soil erosion, improved water recharge, improved local environment	
Natural Gas based Combined Cycle Power Plant, GPPC at, Gujarat (since 2014), CDM (UNFCCC 2014)	Non-renewable energy	702.86 MW Natural Gas Electricity Plant, replacement of coal	1,076,688	Energy production and security, job creation, pollution reduction	
Jangi 91.8 MW wind farm in Gujarat (since 2012), CDM	Renewable energy	51 wind turbines à 1.8 MW	254,527	Energy production and security, technology transfer, job creation	

4.5.4 Conclusion

Our analysis clearly suggests that the energy sector exhibits the highest mitigation potential in India. Already being responsible for three quarters of emissions, massive future build-up of energy capacities could result in continuing use of fossil fuels which stem the lion's share of the country's current energy mix. However, the country's circumstances provide for immense opportunities in utilizing renewable energy sources, particularly solar and wind power. The ongoing poverty of many Indian people will require significant economic growth powered by rising energy production and energy security. The government is trying to make use of the domestic opportunities and is implementing climate change mitigation and adaptation into its development agenda, displayed by the setup of the NAPCC and incorporating low-carbon policies into its Five-Year Plans. Most noteworthy are the incentives for renewable energy, particularly solar power, but also other targets such as afforestation or biofuel blending requirements.

Despite low per capita emissions, the government seems to recognize the significance of reducing total GHG emissions and cash in on the substantial co-benefits of low-carbon development including reduced dependency on energy imports, increased health, biodiversity and sustainable livelihoods. Nonetheless, the country's official NAMA to the UNFCCC (reducing emissions intensity of 20-25%) is regarded as in range of BAU scenarios and therefore comparatively unambitious. This might be due to India's position that the developed countries are historically responsible for climate change and that only voluntary action is necessary for developing countries. Overall, India's mitigation policies can be rated acceptable, especially if one looks at the strong development needs and low per capita emissions. A significant potential in favour of a low-carbon pathway is evident and might be ambitiously utilized by India. In this context, a more coherent strategy on the federal level would be helpful. Barriers such as lack of economic capacity could be addressed through international assistance or by improving governmental structures (Fekete et al., 2013)).

Figure 4-7: Share of total primary energy supply, India, 2011

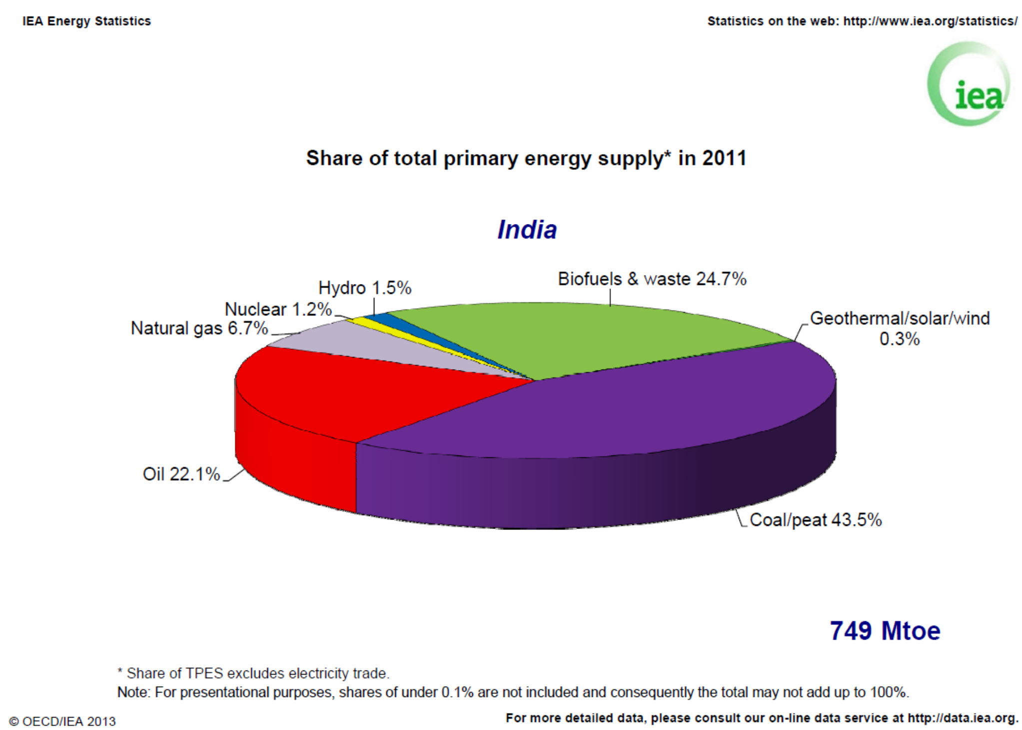
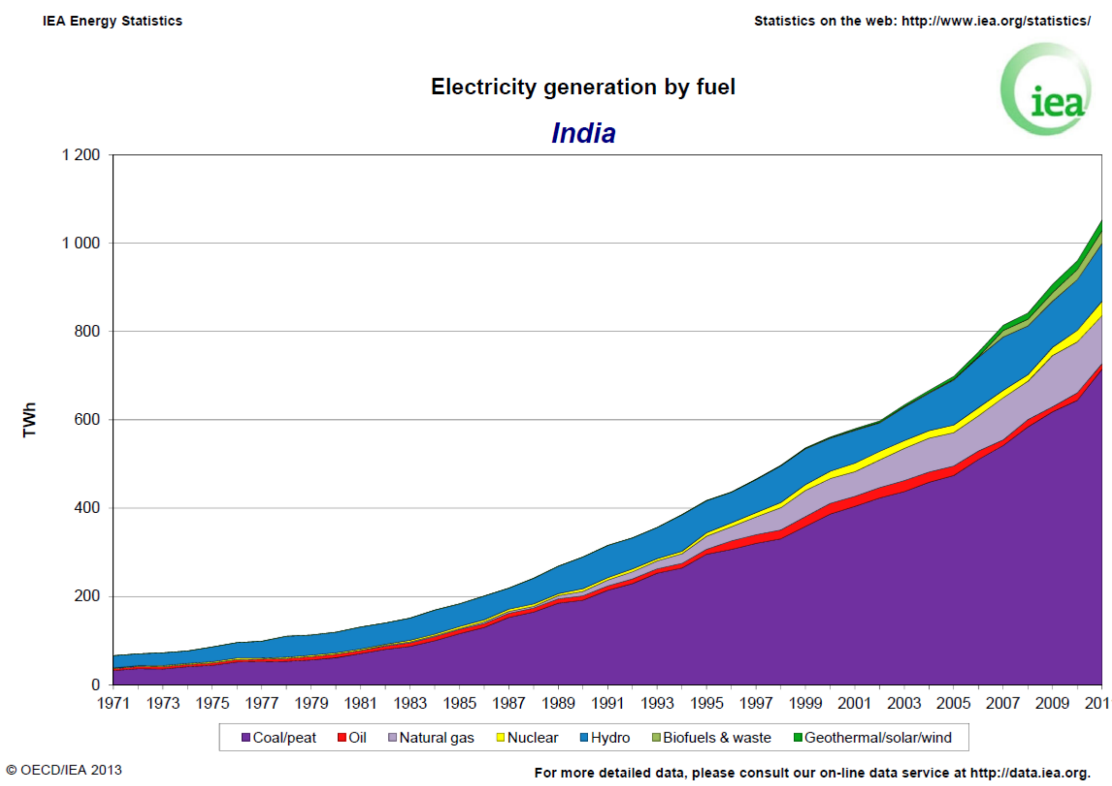


Figure 4-8: Electricity generation by fuel, India



4.6 Indonesia

Table 4-10: Indicators of emissions in Indonesia

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	890.61 $MtCO_{2e}$ (Rank 8 of 186)	1,170.02 $MtCO_{2e}$ (Rank 7 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	3.97 tCO_{2e} (Rank 123 of 186)	4.86 tCO_{2e} (Rank 105 of 186)

4.6.1 Assessment of Mitigation Capacity and Potential

Since the Asian Financial Crisis in 1997/8 the role of sectors other than oil and gas has become much more important to Indonesian economy, especially agriculture has continued to play an important roleMainly on account of Indonesia's abundant coal and peat resources, the country had an export surplus measuring up to -184,8 Mtoe net imports (IEA 2014). This indicates a very positive independence of imports, meaning energy security.

Indonesia’s annual GHG emissions including LULUCF accounted for 890,61 $MtCO_{2e}$ in 2005 (WRI 2014). This amount already measured up to approximately 4.5% of global GHG emissions (Rank 8 of 186 in 2005). These numbers are especially alarming since Indonesia’s share of global emissions is significantly higher than its share of real global GDP – which was just 0.6% in 2005. By far the largest share of Indonesia’s GHG emissions derive from peat land activities and LULUCF. Due to the economic growth emissions from fossil-fuels based energy are also growing rapidly and give rise to a growing concern on the future (Ministry of Finance 2012). Agricultural carbon emissions accounted for 21.5% of the total in 2009 and are mostly other GHGs than carbon dioxide, like methane and nitrogen oxide. Such emissions come from three major sources: water management practices for rice crops, artificial fertilizer application, and the burning of crop residues. Main mitigation strategies in this sector are the improvement of water management and nutrition in rice farming and the restoration of degraded land. In the power sector, emissions are expected to grow seventh fold up to 2030: On account of the rapid economic development, growing electrification in rural areas (planned: From 60% in 2010 to 100% in 2020) and the expected growing demand for power (Ministry of Finance 2012).

In terms of Indonesia’s environmental capacity, the country comprises the third largest area of rainforest in the world; in terms of biodiversity, it is one of the world's richest and contains a significant part of the planet’s tropical deep peat – therefore its forests are also on global view of highest importance (UN-REDD 2014). Indonesia has one of the highest deforestation and forest degradation rates, from 1990-2005 nearly 28 million ha disappeared. These rates are accountable for approximately 80% of its GHG emissions, mainly due to forest loss. About half derive from carbon-rich peat lands. Hence most activities aimed at the reduction of GHG emissions have to focus on LULUCF (Nachmany et al. 2013). Emission reduction activities in the areas of aforestation and reforestation, sustainable forest management and the prevention of forest fires especially in peat lands are most auspicious.

On the energy supply side, Indonesia has ambitious plans in expanding its renewable energy sources, out of which hydro-electricity plants offer the largest emission abatement opportunities. Indonesia also contains a significant share of the world’s known conventional geothermal resources. The country’s commitment to renewable energy is centred on geothermal power and biofuels, the country’s geothermal power plant capacity increased already by 317 MW in 2007-2008. But as the Ministry of Forestry reports, some 80% of geothermal sources are in conservation forests, so exploitation of these resources could lead to further deforestation and degradation. Additionally, solar power and biomass power plants offer further abatement opportunities (Nachmany, Frankhauser, et al. 2014).

Regarding the societal capacity, the vast lack in capacity is displayed by only 0.08% of the GDP spent on R&D in 2008 (2.1% average 2005-2010 in the Euro area) (World Bank 2014a). The EPI ranks Indonesia on 112th place (out of 178 countries), mainly on account of poor values in forests, water resources and agriculture (EPI 2015). The World Bank attributes 46% out of 100% government effectiveness out of worldwide governance indicators, which can be seen as comparably poor. 73% of the population had access to electricity in 2010 (World Bank 2014b).

4.6.2 Overview of Country-Wide Mitigation Strategies

Indonesia presented its First NC under the UNFCCC in 1999, which included a First National Greenhouse Gases Emissions Inventory (NHGGEI). The second NC followed in 2011 (UNFCCC 2014a).

At present, Indonesia has a total of 27 laws adopted concerning climate change legislation, which is the same number as the EU announced. Out of these, the main focus is on Energy supply, LULUCF and REDD+ as well as institutions/ administrative arrangements (Nachmany, Frankhauser, et al. 2014).

In 2007 the Environment Ministry launched the Action Plan to Respond to Climate Change. Indonesia launched its "National Action Plan – Addressing Climate Change" when it hosted the COP13 in Bali in 2007. It is still the most important climate change related legislation, covering 70 projects, e.g. in forestry and peat land, agriculture, energy and transportation, industry and waste management. Its main aims are to diversify the energy mix, enhancing energy efficiency, promoting renewable energies, DRR, improving climate resilience and improving the water efficiency (Nachmany et al. 2014). To coordinate climate change related activities within Indonesia, the National Council on Climate Change (DNPI) was founded in 2008.

To further increase its climate change efforts, Indonesia launched the Indonesia Climate Change Trust Fund in 2009 under the interim trusteeship of the UNDP. The fund is supposed to serve as a focal point for the attraction, management and mobilization of funding to support the government's efforts to move forward on low carbon development and adapt to the impacts of climate change (ALM 2014). In 2010, the planning agency BAPPENAS launched the country's Climate Change Sectoral Roadmap (Nachmany, Frankhauser, et al. 2014).

There is also a presidential decree on the National Action Plan to Reduce Greenhouse Emissions (RAN GRK), signed in 2011. This is intended as a framework document to plan NAMAs. In the RAN GRK, the Indonesian Government has committed to make a 26% cut in the GHG emissions by 2020 compared to projections of BAU scenario (Nachmany et al. 2014). With a range of mitigation strategies, Indonesia aims to achieve an optimal energy mix by 2020. This is meant to be achieved through an increase of geothermal and biofuel energy, intensification of biomass, nuclear, hydro, solar, and wind power and a reduction of oil, gas and coal at the same time (Nachmany et al. 2014). Also in 2010, Indonesia signed a REDD+ partnership with Norway, in which Norway contributed US$ 1 billion towards REDD+ readiness programme.

Actions on renewables are pursued rather through executive action than a legislative approach. The government has passed a series of regulations in recent years including a Presidential Instruction on Biofuel Development in 2006 and a Ministerial Regulation that sets out plans for a greater role for biodiesel and ethanol-blend fuel in transportation (Nachmany et al. 2014).

4.6.3 Examples of Individual Mitigation Measures

There are currently 150 CDM projects registered for Indonesia with approx. 10 million CERs (certified emission reduction, 2014) (UNFCCC 2014a). Out of these projects, 80 deal with waste handling and disposal, 79 deal with energy industries and few others with agriculture, manufacturing, chemical and metal industries (UNFCCC 2014). There are also 10 PoAs registered in Indonesia. Furthermore, already three NAMAs are in progress, while two feasibility studies for NAMAs are worked on (NAMA Registry 2014). Indonesia is also undertaking several REDD+ activities 2009-2012 and carried out phase one of the UN-REDD programme (UN-REDD 2014).

Table 4-11: Mitigation action Indonesia - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Biofuel decree issued by the MoE in 2008	Renewable Energy	Establishes mandatory use rules in the transportation, industrial, commercial and power generation sectors -minimum biodiesel use set at 20% in 2025 in all sectors	Not quantified	-technology transfer -pollution reduction	-
Power generation using biogas from state-owned palm oil mills, (2012-2040), PoA	Renewable Energy; Waste Handling and Disposal	Collecting biogas (methane) from existing lagoons at state-owned palm oil mills, with a view to using it for generating electric power and distribute it to the local grid.	18,372	-Energy production -pollution reduction -technology transfer -improved local environment -job creation	Japan

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Methane Capture and Combustion from Swine Manure Treatment Project at PT Indotirta Suaka Bulan Farm in Indonesia (since 2006), CDM	Waste Handling and Disposal	Large scale project, collection and combustion of methane from the manure treatment system of Indonesia's largest pig farm by installing anaerobic digesters	166,000	-improved local environment -job creation -technology transfer	Japan; Mitsui & Co., LTD.; Chubu Electric Power Co., Inc
Emission reductions through partial substitution of fossil fuel with alternative fuels in the 2 cement plants of PT Holcim Indonesia Tbk (since 2008), CDM	Renewable Energy	Partial replacement of coal in the kiln system by alternative fuels like biomass (palm kern shell, rice husk, saw dust, etc.) and potentially a smaller quantity of sorted waste (rubbers, plastics, paper, etc.).	516,706	-pollution reduction -technology transfer	Switzerland

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
PT Navigat Organic Energy Indonesia Integrated Solid Waste Management (GALFAD) Project in Bali, Indonesia (2007-2014), CDM	Waste Handling and Disposal	Treatment and recovering energy from municipal solid waste through construction and operation of a GALDFAD (Gasification, Landfill gas and Anaerobic Digestion) plant	123,423	-energy production -improved local environment -technology transfer	Japan
Bundled Landfill Gas Recovery Project in Indonesia (2013-2022), CDM	Waste Handling and Disposal	Capture and utilizing landfill gas (LFG) generated at landfills - can serve as CERs under CDM mechanism	74,338	-improved local environment -job creation -technology transfer	Netherlands

4.6.4 Conclusion

Indonesia is characterized by both high levels of GHG emissions – counting amongst the ten major emitters in the world – as well as being strongly affected by the negative impacts of climate change. And its emissions are expected to grow by more than 60% up to 2030 (UNFCCC 2011a). Approximately 80% of Indonesia's GHG emissions result from deforestation and forests degradation, and about half of these from carbon-rich peat lands. So, any attempt to reduce Indonesia's carbon emissions must focus on LULUCF. Reforestation is a potential activity under the 'plus' of REDD+, and also under the Kyoto Protocol's Clean Development Mechanism and another regulation outlines procedures (Nachmany, Frankhauser, et al. 2014).

In response to the challenges to reduce these GHG emissions, a lot of work has already been done, with the National Action Plan as a major step towards climate change relating policy frameworks. In comparison to other Non-Annex I countries, Indonesia has one of the more developed national policy frameworks on climate change and can thus be classified as a middle league player in terms of its climate change mitigation related actions. The pledge to reduce emissions by 26% below BAU unilaterally and 41% with sufficient international support up to 2020 is very ambitious and aims to create an optimal energy mix by then. This translates into an increase of biofuels and geothermal energy, enhancement of biomass, nuclear, hydro, solar, and wind and the usage of liquified coal. At the same time the country targets to reduce oil, gas, and coal as a source of energy respectively out of the energy mix (Nachmany et al. 2014).

In conclusion, despite the country's active legislative response, enforcement and land tenure issues continue to be central challenges when it comes to action on deforestation, the country's main source of emission. Experts criticize the legislations as rather neutral due to a lack of coordination with relevant ministries, a lack of common low-carbon transport vision and as leaving out important other causes for GHG emissions (Nachmany et al. 2014). With current policies in place it will likely not achieve the targeted pledge; however the uncertainty of LULUCF emissions makes an evaluation difficult (Hare et al. 2014).

Figure 4-9: Share of total primary energy supply, Indonesia, 2011

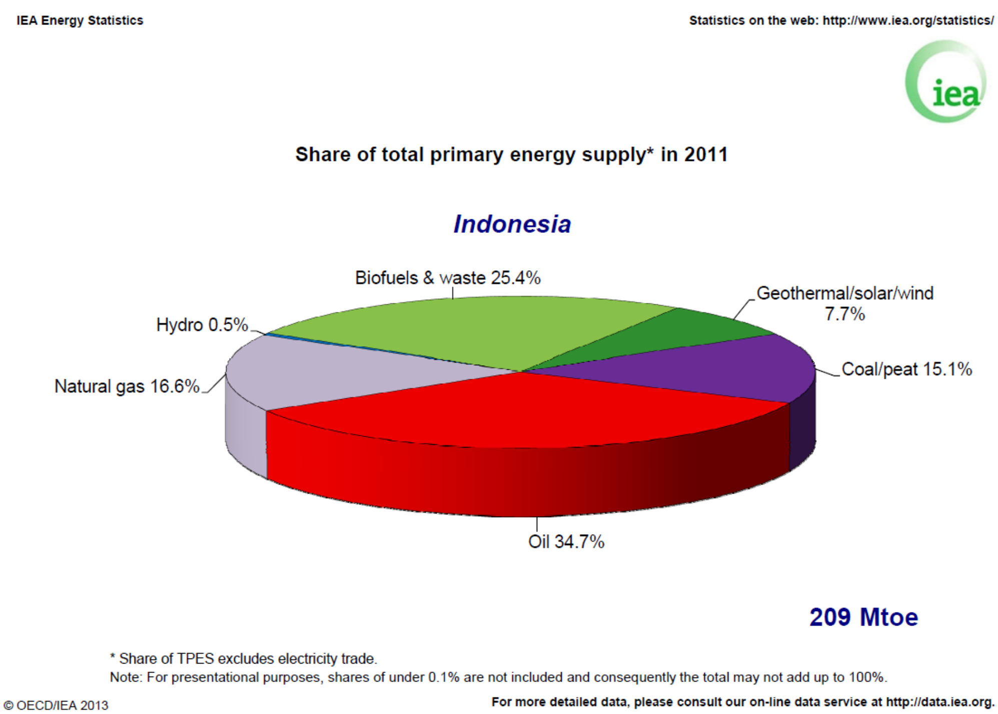
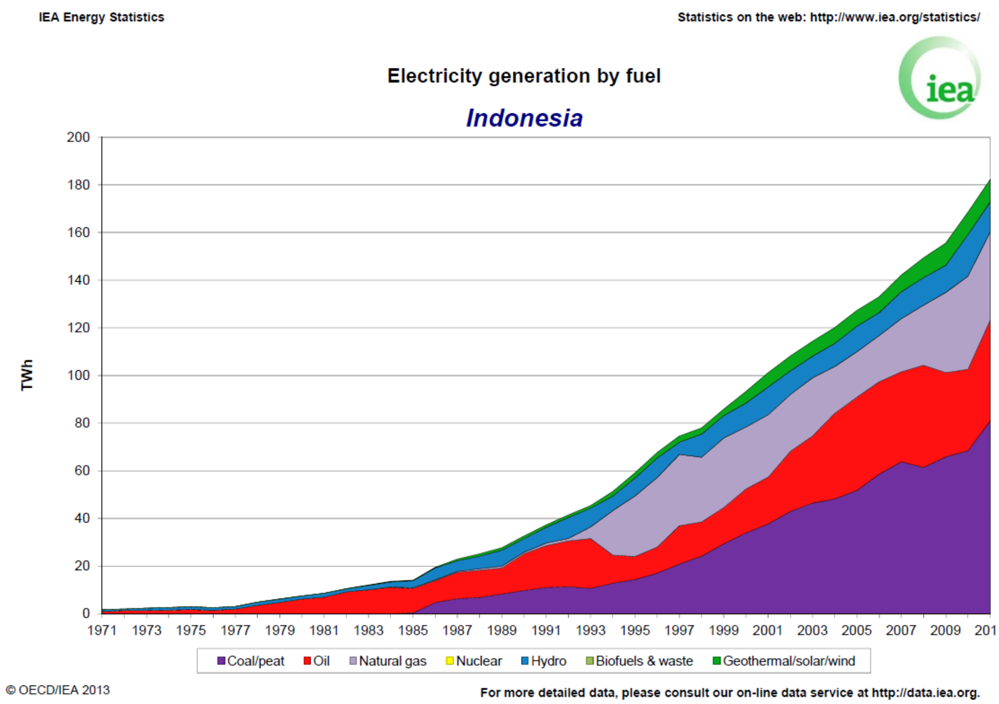


Figure 4-10: Electricity generation by fuel, Indonesia



4.7 Kenya

Table 4-12: Indicators of emissions in Kenya

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	44.99 $MtCO_{2e}$ (Rank 92 of 186)	51.97 $MtCO_{2e}$(Rank 87 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	1.26 tCO_{2e} (Rank 175 of 186)	1.27 tCO_{2e} (Rank 174 of 186)

4.7.1 Assessment of Mitigation Capacity and Potential

Its per capita GHG emissions are one of the lowest worldwide and did not show significant rise in recent years. In terms of composition, agriculture accounts for about half of all emissions, energy for one third and LULUCF for ten per cent.

The provision of international assistance related to climate change can be regarded as good in comparison to other countries: amounts of about US$ 2.3 billion are likely to add up for the timeframe 2005-2015 (OECD 2014). Official aid activities targeting mitigation as principal or significant tracked by the OECD were around US$ 300 million in 2011 (US$ 7.36 per capita) (OECD 2014). Overall, ODA with amounts of US$ 2.5 billion was provided (US$ 59.11 per capita). Plus, there are seventeen registered CDM projects and eighteen PoA under the UNFCCC taking place in Kenya. No fossil fuels are being extracted domestically yet (although just recently, sources of oil, coal and natural gas have been discovered), and imports as high as 4.7Mtoe in 2011 of oil, oil products, coal and peat were needed, which accounted for about one fifth of the total primary energy supply in 2011 (UNFCCC 2014b; IEA 2014). Due to expected growth in energy needs, energy security is to constitute a crucial point in the country's development pathway.

The lack of societal capacity is indicated by expenditures for R&D of only 0.42% of its GDP and 63 technicians per million people in 2007 (2.1% average GDP share and 1,418 technicians per million people in the Euro area 2005-2010The World Governance Indicators credit a government effectiveness of only 35.41 per cent out of 100..

A fairly clean current energy mix (~80% renewables) is strengthening Kenya's environmental capacity, as is its electricity mix (67%) (IEA 2014). The latter is mostly based on renewable energy sources such as hydropower (~44% of total domestic electricity supply in 2011), geothermal electricity (19%), biofuels (4%) and wind (0.2%), while oil products account for about 33% of all domestic electricity production (IEA 2014). In 2014 the EPI ranked Kenya on 140th place (out of 178 countries), which raises questions of the ability to implement concrete climate change legislation (EPI 2014). The country's endowments provide further big potential for renewable energy, especially for geothermal but also wind and hydro-based power generation (Government of Kenya 2013). In August 2013, the government launched the '5000+ MW in 40 Months Initiative, which includes the build-up of 3,000 MW coal and natural gas as well as 1,500 MW of geothermal capacity (UNFCCC 2014b).

4.7.2 Overview of Country-Wide Mitigation Strategies

In 2010, the National Climate Change Response Strategy (NCCRS) was launched as the first official approach and setting the stage for country-wide climate change understanding and action (Government of Kenya 2010). In 2013, the cabinet approved the NCCAP 2013-2017, serving as the operationalization of the NCCRS by identifying specific measures towards adaptation and mitigation, with six sectors explicitly mentioning the reduction of GHG emissions: energy, transport, industry, agriculture, forestry and waste management.

Both NCCRS and NCCAP aim to accompany the national development agenda set out in its "Kenya Vision 2030" to become a "newly-industrialising middle-income country providing a high quality life to all citizens by the year 2030" through establishment of a low-carbon climate resilient development pathway (Government of the Republic of Kenya 2008). Despite its high vulnerability and low emissions, Kenya seeks to integrate both adaptation and mitigation actions under the NCCAP and explicitly wants to express 'its commitment and leadership in the effort to combat climate change' (Government of Kenya 2013). Nonetheless, the country's first priority is clearly to reduce vulnerability and enhance resilience.

Besides NCCRS and NCCAP, Kenya has introduced several legislations relating mitigation, which include the stimulation and promotion of renewable energy sources, forest management and agriculture (Nachmany, Frankhauser, et al. 2014). In line with both frameworks, a comprehensive Climate Change Policy is being worked out to provide the basis for future legislations. Responsible for the coordination of climate change action is the Ministry of Environment and Mineral Resources. It comprises several departments and institutions such as the National Climate Change Secretariat for the development and implementation and the designated authority for the Clean Development Mechanism (CDM) is the National Environment Management Authority (NEMA). Additionally, a National Climate Change Council has been set up to provide guidance and oversight for the government.

Kenya submitted its Initial National Communication to the UNFCCC in 2002. As stipulated in its constitution, it aims for a ten per cent tree cover of all land area (Government of Kenya 2013). The use of the REDD+ mechanism is intended, a strategy is currently being developed. In terms of quantified targets, it just handed in its first NAMA to the NAMA registry: 820MW of new geothermal capacity is to be installed until 2017, resulting in 3.77 $MtCO_{2e}$ emission reductions per year (UNFCCC 2014b). Overall, Kenya provides quantified GHG reduction potential in its NCCAP and lists the required financial assets of about $US 16 to 21 billion to implement these. In order to mobilise required financing by public, private and international sources, the development of a Climate Fund is intended.

Overall, Kenya's top priority in terms of climate change strategies remains adaptation. NCCRS and NCCAP, however, also constitute important frameworks for mitigation. The country clearly tries to link adaptation and mitigation with the Kenya Vision 2030 for a low-carbon climate resilient development pathway.

4.7.3 Examples of Individual Mitigation Measures

Most actions towards reducing emissions are conducted through their integration in the general development agenda. includes the recently published official NAMA and several CDM projects. The country is host to seventeen registered CDM projects with a total emission reduction of 3,143,599 tCO_2e/year. Four projects deal with geothermal energy generation, four with wind energy, three with reforestation, two with hydro power and one each with biomass, biofuel, biogas and energy efficiency. Furthermore, there are eighteen Programmes of Activities under the UNFCCC. In eight of them, Kenya is the only host party, and in ten it takes part with other countries. The eight PoAs only addressing Kenya provide for 266,754t CO_2e/year - three are related to biomass, two to solar power and one each to biogas, hydro power and renewables in general. Quantitatively, geothermal and wind energy projects provide the biggest emission reductions.

Table 4-13: Mitigation action Kenya - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
NAMA for accelerated geothermal electricity development in Kenya (UNFCCC 2014b)	Renewable energy	Installing of 820 MW of directly supported geothermal energy as part of the "5000+ MW in 40 months initiative" by the government	3,770,000 (by 2020)	Energy production and security, technology transfer, job creation	-
Olkaria I Units 4&5 Geothermal Project (from 2014), CDM (UNFCCC 2014a)	Renewable energy	Geothermal energy plant	635,049	Energy production and security, technology transfer, job creation	-
Olkaria IV Geothermal Project (from 2014), CDM	Renewable energy	Geothermal energy plant	651,349	Energy production and security, technology transfer, job creation	-
Kipeto Wind Energy Project (from 2014), CDM	Renewable energy	Wind energy plant	254,125	Energy production and security, technology transfer, job creation	-
Karan Biofuel CDM project – Bioresidues briquettes supply for industrial steam production in Kenya (since 2012), CDM	Renewable Energy	Biofuels, production of renewable briquettes from agricultural residues	43,699	Energy production and security	United Kingdom

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
SimGas Biogas Programme of Activities (since 2011), PoA	Waste handling and disposal, renewable energy	Agriculture and biogas, installation of biogas systems with stoves using manure and organic waste, methane recovery	45,156	Reduced fuelwood demand, improved local environment, job creation	Netherlands

4.7.4 Conclusion

Kenya has clearly linked climate change action with its development agenda. It is striking that the country underlines the possibility of integrating adaptation and mitigation in future development. The overarching target of becoming a middle-income country laid out by the "Kenya Vision 2030" goes along with a low carbon development pathway emphasized in NCCRS and NCCAP. Although Kenya's focus lies on adaptation to climate change consequences, mitigation measures are carried out through the intention for a low carbon development, and through several CDM and PoA projects.

At present, agriculture accounts for the biggest share of emissions and provides for further reduction potential which is addressed through several CDM projects and PoAs and mentioned in the NCCAP. The country's electricity mix already comprises a high share of renewable energy sources. Due to the current lack of people's electricity access and the estimated rise in demand in the next years, large potential lies in the future use of renewable energy instead of fossil fuels. The Kenyan government clearly tries to scale up capacities, connect people to the grid and make use of the country's endowments of clean energy sources, indicated by a number of recently registered CDM projects and their first NAMA. However, the country also tries to increase energy capacities by pursuing construction of fossil fuel based electricity and this could be encouraged by recent discoveries of domestic oil, natural gas and coal. The NCCAP identified most mitigation potential in the forestry sector. At the moment, this is addressed by the national target of 10 per cent tree cover of all land area and related domestic actions and a couple of CDM projects. In this context, the use of REDD+ could promote forest management.

Overall, with a view to its mitigation capacities and while having one of the lowest per capita emissions worldwide, Kenya can be regarded as quite ambitious in terms of GHG reduction measures. In recent years, it has sought to integrate climate change into their policies and greater plan of development. Especially renewable energy sources offer great potential for emission reductions with additional co-benefits of energy security, lower energy prices and higher electricity supply. Kenya therefore tries to explicitly follow a low carbon climate resilient development pathway. Specific actions towards mitigation at present are limited and to a greater extent intended through future development. International support is likely needed for Kenya to strongly follow this path and make the aspired progress. Still, questions remain if the government will be able to strictly implement certain policies due to limited capabilities and development pressures.

Figure 4-11: Share of total primary energy supply, Kenya, 2011

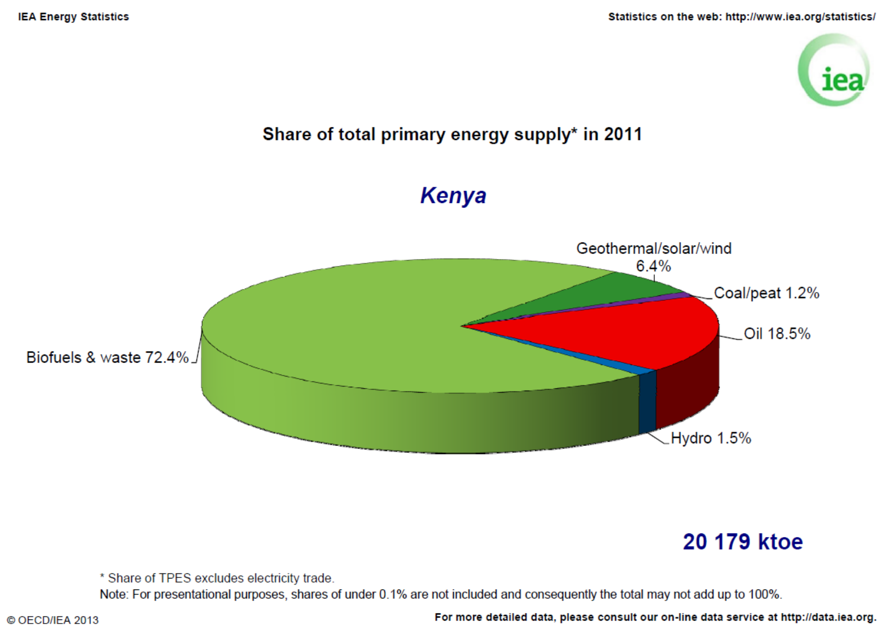
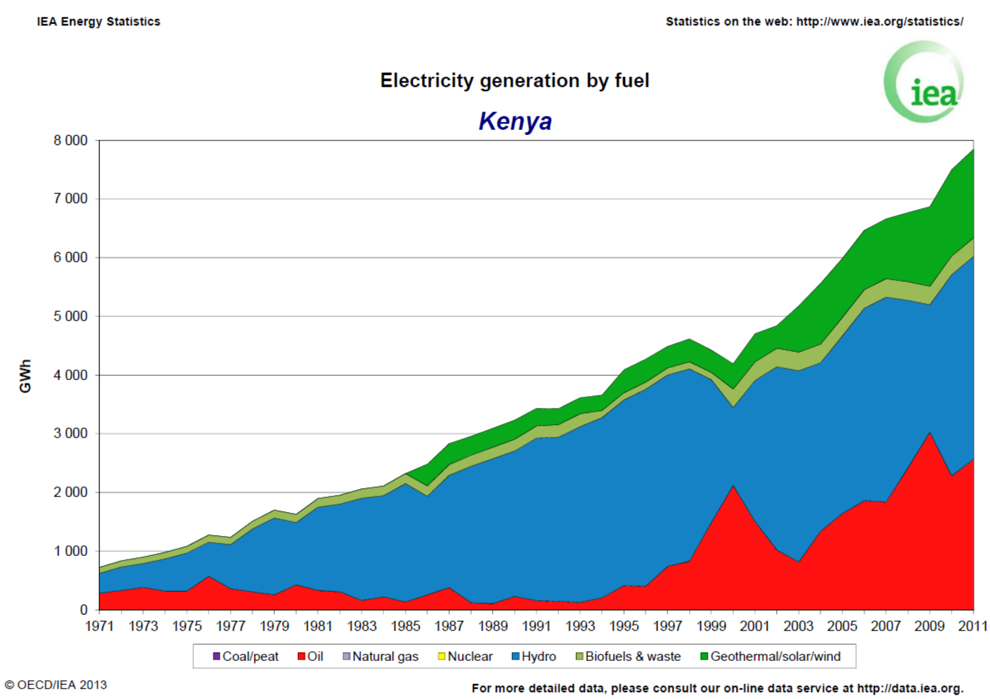


Figure 4-12: Electricity generation by fuel, Kenya



4.8 Nicaragua

Table 4-14: Indicators of emissions in Nicaragua

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	45.35 $MtCO_{2e}$ (Rank 91 of 186)	46.19 $MtCO_{2e}$ (Rank 93 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	8.31 tCO_{2e} (Rank 70 of 186)	7.93 tCO_{2e} (Rank 71 of 186)

4.8.1 Assessment of Mitigation Capacity and Potential

Most GHG are emitted in the LULUCF sector (˜63%), followed by agriculture (24%) and energy (11%). The most striking cause for emissions is the high deforestation rate of 1.5-2% per year and 31% overall from 1990-2010 (Food and Agriculture Organization of the United Nations 2010; UNDP 2014). If LULUCF related emissions are excluded, totals drop to 17.44 Mt CO_2e in 2010, a reduction of 62% (WRI 2014).

Yet the strong international development assistance of almost US$ 700 million (US$ 117.69 per capita) and US$ 48 million (US$ 8.21 per capita) of aid targeting mitigation, the highest number of all countries reviewed, is encouraging. In recent years the government has embarked strongly on a strategy towards renewable energy sources and successfully attracted international financing on renewable energy projects (US$1.5bn since 2006) (Inter-American Development Bank 2013). Furthermore, there are presently 11 registered CDM projects and several PoAs in Nicaragua. The country does not possess any identified domestic fossil fuels and imports are responsible for about half of its total primary energy supply (1.58 Mtoe of crude oil and oil products) (CONSORCIO MULTICONSULT 2011). In terms of energy security, it is therefore highly dependent on international oil supply and respective prices.

Having a small population, societal capacity can be regarded as low, also indicated by a very poor government effectiveness of only 20.57 out of 100, assessed by the Worldwide Governance Indicators, the lowest number of all countries reviewed in this study (World Bank 2014a). Provision of food, health, education and services is also well below average. In terms of domestic low-carbon business, expertise and know-how, the country clearly lacks capacities (Inter-American Development Bank 2013).

The country's environmental capacity can be displayed by an average rank 90 in the EPI and renewable energy sources' shares of 50% of TPES and 37% of domestic electricity production (EPI 2015). The potential for renewable energies in Nicaragua, however, is regarded as excellent due to possible utilization of geothermal, hydroelectric, wind, solar and biomass energy. PRONicaragua, the official investment agency of Nicaragua, estimates a potential of about 4,500 MW in the renewable energy sector (PRONicaragua 2012). The World Bank estimates even larger numbers up to 5,800 MW (World Bank 2013b) In this regard, the Inter-American Development Bank credits Nicaragua excellent climate fund-raising (Inter-American Development Bank2013). With electricity prices comparably high, there seem to be great incentives for establishing clean energy. In 2010, 72.1 per cent of the total population had access to the electricity grid (World Bank 2014a).

Poor domestic economic and societal assets diminish Nicaragua's overall mitigation capacity. Thanks to its low development status, implementing measures solely targeting mitigation might be challenging. Despite that, the country seems capable of attracting international financing and because of remarkable opportunities in the forestry sector and using green energy, mitigation potential can be regarded as high.

4.8.2 Overview of Country-Wide Mitigation Strategies

Nicaragua is very vulnerable to climate change impacts. Hence, the main focus of climate change related policies lies on adaptation which is also emphasized in its second National Communication to the UNFCCC (MARENA 2011a). Nonetheless, a number of voluntary mitigation measures are listed, mostly focussing on projects in the agriculture and forest sector. The measures include training, awareness-raising and pilot projects for sustainable activities. The National Environmental Strategy and Climate Action Plan 2010-2015 likewise targets for reducing vulnerability but also mentions concurrent mitigation effects, for instance in the National Strategy for Avoided Deforestation and Forest Degradation with linking to REDD+ (MARENA 2011b). Overall responsible for climate change topics is the Ministry of Environment and Natural Resources, in particular the Climate Change Directorate. Nicaragua argues for the developed countries contribution to climate change and therefore does not formulate any binding GHG emission reduction targets and hasn't officially communicated any NAMAs yet (MARENA 2011a).

The most noteworthy mitigation policy would be the aim for a 94% renewable energy share in 2017 which is regarded as being very ambitious ((Inter-American Development Bank 2013). The Inter-American Development Bank in their Climatescope 2013 study rank Nicaragua third out of twenty six countries in Central and South America. This was due to high scores in the categories "Enabling Framework" and "Clean Energy Investment & Climate Financing" (Inter-American Development Bank 2013). In recent years, the government has focused strongly on improving electricity access through renewable resources, aiming to bring down electricity prices and to become more independent from imported fossil fuels. In 2010, the National Program for Sustainable Electrification and Renewable Energy was introduced (Inter-American Development Bank 2012). The country was also remarkably successful in developing micro-credits for small-scale renewable energy projects and attracting large-scale credits from foreign investors and donors. On the other hand, the study credits Nicaragua only an average score in the "Greenhouse Gas Management Activities" category due to the lack of immediate mitigation-policies and great unused potential in the forest sector (Inter-American Development Bank 2013).

4.8.3 Examples of Individual Mitigation Measures

There are currently eleven registered CDM projects Nicaragua with a combined emission reduction of 999,059 tCO_2/year (UNFCCC 2014a). Four projects are related to wind power, two to hydropower, one to biomass and energy, one to geothermal energy, two to waste management, and one to reforestation. Additionally, there are five PoAs under the CDM which Nicaragua participates in (together with other host countries). Quantitatively, most productions are provided by wind power projects with three of them reducing emissions of more than 100,000 tCO_2/year. The Vinasse

Anaerobic Treatment Project also provides big potential while other projects such as the Southern Nicaragua CDM Reforestation Project and the Biogas Programme Nicaragua only possess limited individual reduction potential.

Table 4-15: Mitigation action Nicaragua - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Biogas Programme Nicaragua (since December 2011), PoA under the UNFCCC	Renewable energy, waste handling and disposal	Agriculture, Energy - biodigesters to be installed in households and small dairy farms	10,014	Energy production, distribution and security, fertilisers as by-product, reduced fuel wood, improved local environment,	Netherlands
EOLO Wind Power Project (since 2012), CDM	Renewable energy	44MW renewable energy production	110,054	Energy production and security, technology transfer, job creation	-
Amayo 40 MW Wind Power Project (since 2009), CDM	Renewable energy	39.9MW renewable energy production	120,811	Energy production and security, technology transfer, job creation	United Kingdom
Vinasse Anaerobic Treatment Project - Compana Licorera del Nicaragua, S.A. (CLNSA) (credited 2003-2013), CDM	Waste handling and disposal, renewable energy	Wastewater treatment and energy-use of methane from alcohol-production	119,847	Improved local environment, energy production, distribution and security	Brazil, Japan, Switzerland, United Kingdom

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Southern Nicaragua CDM Reforestation Project (since 2003), CDM	Afforestation and reforestation	Afforestation and reforestation of 813 ha former pasture land	7,915	Job creation, agroforestry, enhanced biodiversity and ecosystem, prevention of soil erosion, improved local environments	Canada, Italy, Luxembourg, France, Japan, Spain

4.8.4 Conclusion

Given its high deforestation rates, obviously most of Nicaragua's current emissions derive from the LULUCF sector. The government clearly has not made significant progress in stopping the loss of forest, although it has introduced a National Strategy for Avoided Deforestation and Forest Degradation with linking to REDD+. To what extent it will halt deforestation and how REDD+ will contribute, the future will show. There is clearly room for improvement in this area. In terms of emissions from the energy sector, which are usually growing fast when pursuing carbon-based development, Nicaragua has made significant progress in recent years to diversify its energy mix on renewable energy sources, which provide great potential in Nicaragua. The aim for a share 94% renewable energy in 2017 is very ambitious and commendable. The country could therefore become a role model for low-carbon development in the energy sector. Yet, mitigation in other areas is not engaged in large-scale since adaptation gets the most attention with regard to climate change action. Still being one of the least developed countries covered in this study, Nicaragua needs to scale up its capacities to fully exploit its mitigation potential and obtain the benefits low-carbon development.

Figure 4-13: Share of total primary energy supply, Nicaragua, 2011

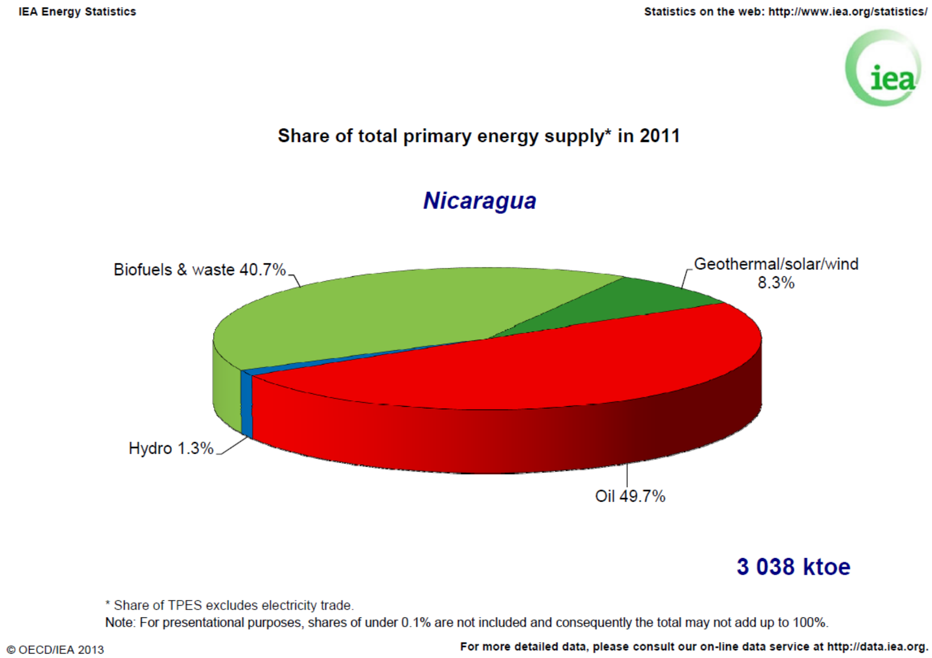
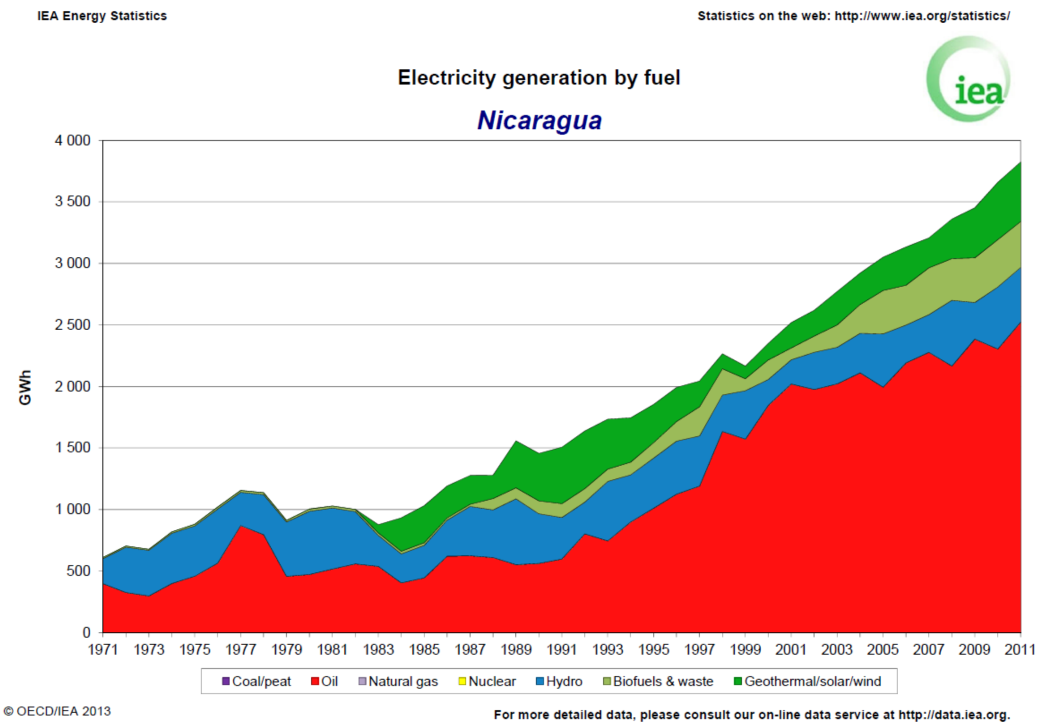


Figure 4-14: Electricity generation by fuel, Nicaragua



4.9 Pakistan

Table 4-16: Indicators of emissions in Pakistan

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	281.02 $MtCO_{2e}$ (Rank 29 of 186)	333.35 $MtCO_{2e}$ (Rank 28 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	1.78 tCO_{2e} (Rank 160 of 186)	1.93 tCO_{2e} (Rank 156 of 186)

4.9.1 Assessment of Mitigation Capacity and Potential

With a GDP growth of 6.1% in 2013 (compared to a South Asian GDP growth of 4.6%), a significant growth of emissions in the near future is expected, particularly in the energy and transport sectors as Pakistan develops further (World Bank 2014a). Pakistan already needed net energy imports of 19.82 Mtoe in 2011, mainly on account of crude oil, oil products and coal. The net imports measure up to a 23% share of the country's total primary energy supply (84.84 Mtoe) (IEA 2014). This indicates a further improvable energy security.

To meet the needs of Pakistan's lack of financial capacity and development, the World Bank estimated net ODA of US$ 3.5 billion (US$ 20 per capita) in 2011 (World Bank 2014a). The OECD calculated international assistance having climate change mitigation as principal or significant objective of US$ 23.1 million (US$ 0.13 per capita) (OECD 2014). As shown, only a minor part of ODA received by Pakistan is related to climate change mitigation. Pakistan's GHG emissions per capita are with 1.93 tCO_{2e} in 2010 (ranking 156^{th} of 186), still very low: out of the total emissions, 48% derive from the energy sector and 38% from agriculture and livestock. Minor amounts derived from LULUCF, industrial processes and waste (NCCP 2011). Since the energy sector is the largest source of GHG emissions, most promising mitigation options are seen in this sector, primarily through increasing the share of renewable energy in the electricity mix. Further mitigation actions start with an integration of climate change and energy policy objectives. One focus is on energy efficiency requirements in building codes and long-term transport planning (NCCP 2011).

Emissions deriving from agriculture were mainly methane and nitrous oxide and originated particularly from the four sub-sectors enteric fermentation in cattle, rice cultivation, release of N2O from soils through fertilizers and manure management. Hence possible mitigation actions should set in here (NCCP 2011).

Pakistan's forestry and other land-use sector contributed only to estimated 6% in 2009, but considerable mitigation potential exists in the sector through carbon sequestration via afforestation and reforestation measures as well as preventing deforestation (NCCP 2011). The forestry sector is in focus of Pakistan's Vision 2030 document (see part 3 below). As an example, the Forestry Policy sets out to restore existing forests in addition to reforesting some deforested and degraded areas with a strong focus on watershed reforestation (Nachmany et al. 2014).

Primary energy supplies in Pakistan comprised of biofuels and waste (35%), natural gas (32), oil (24%), coal/ peat (5%), hydro and nuclear electricity in 2011 (National Communication 2003). This measured up to a 37% share of renewable energy in the electricity mix – mainly deriving from biofuels and waste (National Communication 2003) . Due to commissioning of a number of fuel oil based power plants in the 1990s the relative share of oil had been increasing in these years. But on account of recent policies with a focus on economic as well as environmental friendly considerations, the percentage shares of natural gas and oil have reversed in the last years (UNFCCC 2003).

The World Bank estimates governmental effectiveness to implement climate change abatement related policies of only 23 out of 100 percent, which is very alarming (World Bank 2014b). The lack in capacity is further displayed by 64 technicians in Research and Development per million people in 2010 (1,418 in the Euro area 2005-2010) and 0.33% of the GDP spent on R&D expenditure in 2012 (2.1% average 2005-2010 in the Euro area) (World Bank 2014a).

4.9.2 Overview of Country-Wide Mitigation Strategies

Pakistan is a party of the UNFCCC since 1994 and of the Kyoto Protocol since 2004. In 2006, a National Operational Strategy for CDMs was established, to enable Pakistan to take part in the project approval process. Up to date, over 60 CDMs are registered in Pakistan (UNFCCC 2014a). The National Sustainable Development Strategy (NSDS) of Pakistan was formulated in 2010, to show "Pakistan's pathway to a sustainable and resilient future". Additionally, the National Forest Policy was also set in force to address the sustainable use of the country's natural resources. Furthermore, the Alternative Energy Development Board Act and the Pakistan Council of Renewable Energy Technologies Act, both in the energy sector, were enacted in 2010. In addition, the Pakistan Energy Efficiency and Conservation Act was enacted in 2011. In 2012, the federal level Ministry of National Disaster Management was renamed as the Ministry of Climate Change (NCCP 2011).

The most important policy drafted by the Pakistani Planning commission's Task Force on Climate Change is the National Climate Change Policy (NCCP) of 2012, funded by the UN Joint Program on Environment (JPE). The Policy provides a comprehensive framework for the National Action Plan, which is designed to implement the Policy for national efforts on adaptation and mitigation. Its goals are envisioned in the Planning Commission's Vision 2030 document (Nachmany et al. 2014). The main focus of this document is adaptation on account of Pakistan's high vulnerability to the impacts of climate change. Nonetheless, mitigation measures for the sectors of energy efficiency and conservation, transport, forestry, industry, agriculture, livestock and town planning are also part of the Policy. As an example, the Forestry Policy has set itself the ambitious goal to double the total forest cover by 2030. After the NCCP is adopted, institutional arrangements provide for an Action Plan to implement it. To ensure effective implementation and to oversee the progress, Climate Change Policy Implementation Committees are established at the federal and provincial levels. The Provincial Committees will be the key actors in the implementation of the proposed climate change agenda (Nachmany et al. 2014).

Summing up, Pakistan has currently a total of seven climate change related policies in place. Five of them directly address mitigation aspects while the remaining two have a broader climate change scope, taking up some mitigation as well as adaptation issues. The main focus is on addressing institutions and administrative arrangements, while pricing carbon is not covered yet by any of the legislations.

4.9.3 Examples of Individual Mitigation Measures

Up to date, 37 CDMs are registered in Pakistan, which comprise mainly projects concerning the energy industry and in the manufacturing industry. Also, three PoAs are registered under the UNFCCC. Furthermore, two NAMAs are recorded in the NAMA database, one in solid waste management through waste water methane capturing and the other in energy efficiency in the building industry through energy efficient lightning (UNFCCC 2014b).

Table 4-17: Mitigation action Pakistan - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Forestry Policy, part of the NSDS, (2010)	Afforestation and Reforestation	Doubling the existing forest cover by 2030 -restoration of degraded mangrove forests -sustainable forest management -expanding protected areas	Not quantified	-enhanced ecosystems and biodiversity -job creation -prevention of soil erosion and improved water recharges -improved local environment	-
National CFL Project, (2012-2019) PoA	Energy efficiency	Replacement of 30 million incandescent lamps (ICL) with energy efficient compact fluorescent lamps (CFL) in the domestic sector.	550,134	-cost-savings -lower overall energy consumption	Under the Asian Development Bank (ADB) investment programme

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Solar PV in Pakistan (PoA), 2012-2019	Renewable Energy	Development a series of autonomous Photovoltaic solar power plants in different regions	32,070	-Energy production and security -pollution reduction -job creation	
Hydropower Project in Azad Jammu and Kashmir, (CDM), 2012-2019	Renewable Energy	Large-scale project, Run-off-the-river hydropower scheme with a capacity of 84 MW	218,988	-Energy production and security -technology transfer -job creation -pollution reduction	Germany
Community-based renewable energy development, (CDM), 2009-2016	Renewable Energy	Micro- and mini hydropower projects (MHP) for community energy needs	87,477	-pollution reduction -Energy production and security	Canada, Netherlands, Italy, Denmark, Finland, Sweden Luxembourg, Switzerland, Austria, Germany Belgium, Japan Norway, Spain

4.9.4 Conclusion

Since 2010, Pakistan has stepped up its effort to claim its due share of support from global sources, particularly from those available through the United Nations. For example, at the September 2010 General Assembly of the UN, Pakistan's Foreign Minister remarked, "Climate change, with all its severity and unpredictability, has become a reality for 170 million Pakistanis. The present situation in Pakistan reconfirms our extreme vulnerability to the adverse impacts of climate change" (ALM 2014).

The most important policy regarding climate change mitigation is the NCCP. The main focus within it lies on energy efficiency, renewable energy production, disaster preparedness, capacity building and technology transfer, e.g. for adaptation measures. In the forest sector the country targets at the substitution of firewood and an active prevention of encroachment on remaining forest lands through regulations on grazing, also by the ambitious plan of doubling its forest cover by 2030 (Nachmany, Frankhauser, et al. 2014).

On overall view, Pakistan has put in place several policies that aim principally at energy efficiency measures as well as at the promotion of renewable energy production. Also the LULUCF sector is addressed in most of them, e.g. through the National Forest Policy. But the legislative coverage on other sectors, like the waste sector, manufacturing industries as well as construction is rather scarce and these have only received very limited attention (Nachmany et al. 2014).

Pakistan has several further options for mitigation readiness, for example updating the GHG inventory, establishing sector emission baselines, carrying out studies of renewable energy resources, building capacity at national and provincial levels and designing specific NAMA proposals (CDKN 2013).

Figure 4-15: Share of total primary energy supply, Pakistan, 2011

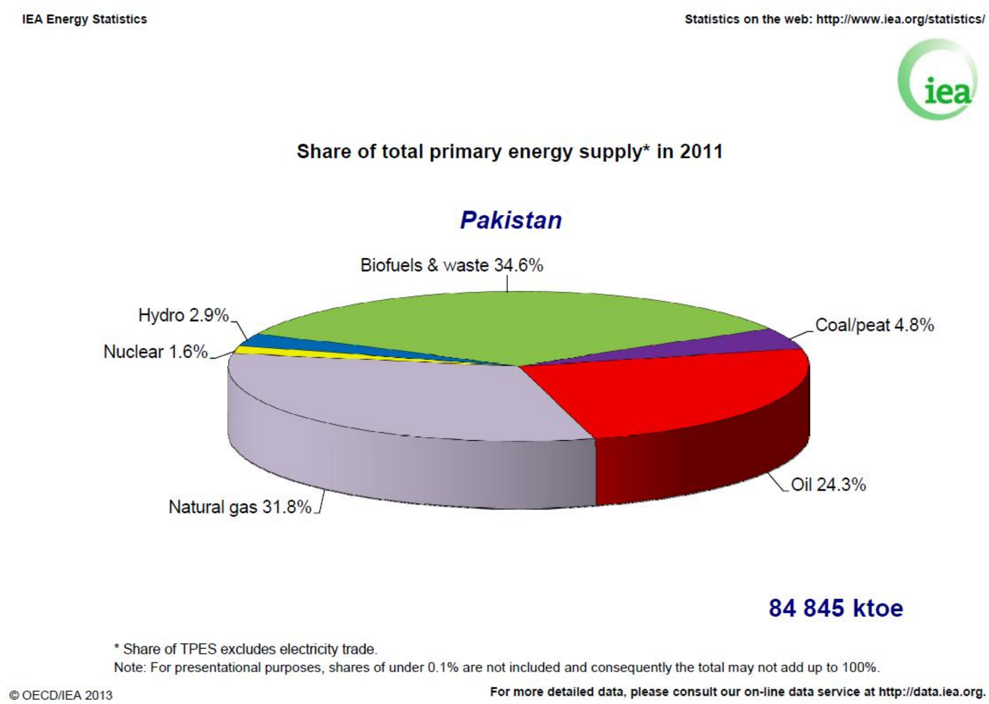
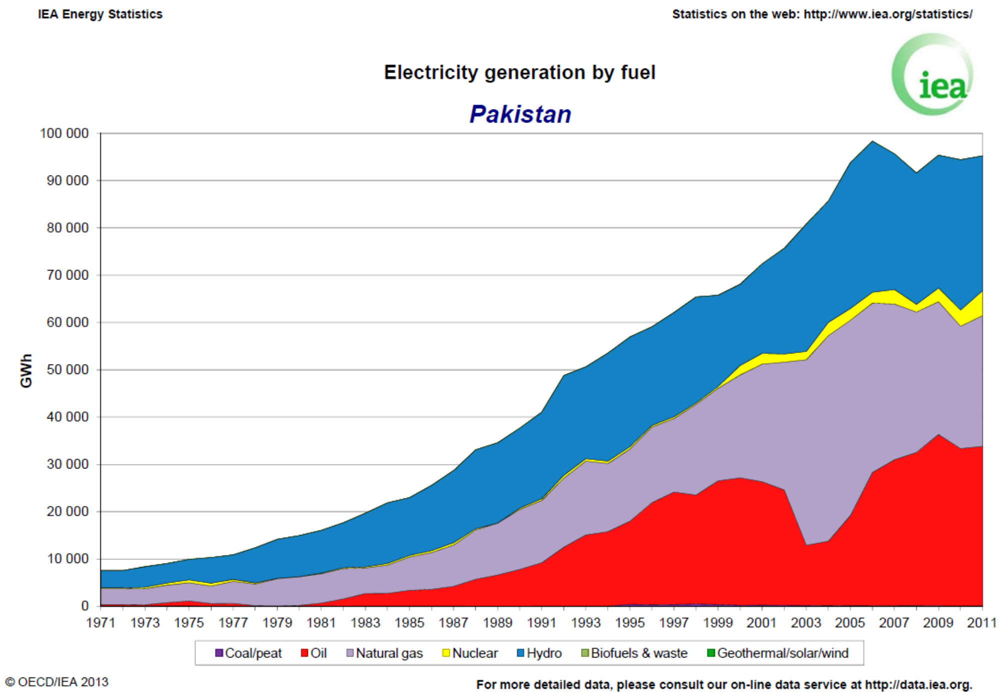


Figure 4-16: Electricity generation by fuel, Pakistan



4.10 The Philippines

Table 4-18: Indicators of emissions in Philippines

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	118.39 $MtCO_{2e}$ (Rank 52 of 186)	131.45 $MtCO_{2e}$ (Rank 52 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	1.38 tCO_{2e} (Rank 168 of 186)	1.41 tCO_{2e} (Rank 166 of 186)

4.10.1 Assessment of Mitigation Capacity and Potential

The Philippines as an archipelago country are highly vulnerable to the threats of climate change, especially since a major part of its population lives in coastal areas. According to the World Risk Report 2011 of the United Nations University Institute for Environment and Human Security, the Philippines are the third most endangered country by climate change impacts (UNU-EHS 2011). Simultaneously, a high rate of population growth, land use patterns, poor economic conditions and others all serve to create a growing energy demand which today still translates into growing GHG emissions (UNFCCC National Communications 2000). With a population of over 99 million, the

Philippines are the 12th most populous country in the world. Some further 12 million Filipinos live overseas, comprising one of the world's largest and most influential diasporas.

Agriculture is still seen as 'the country's economic lifeline' and caused 12% of total GHG emissions in 2012 (UNFCCC National Communications 2000).

The Philippines' total energy supply is 60% fossil-fuel based (IEA 2014); fossil fuels also make up the largest share of electricity generation. Both are mainly provided by coal/ peat, natural gas and oil (IEA 2014). Renewable energy sources accounted for 40% of total electricity production in 2011 (geothermal/ solar/ wind 21%, biofuels 17% and hydro 2%) (IEA 2014). Imported coal and crude oil provide more than half of the country's energy supply.

The Philippines import energy fuels of 18.56Mtoe, mostly in the form of crude oil and oil products (IEA 2014). This comprises 46% of the total percentage of energy supply (40.45Mtoe). Therefore the Philippines are comparably dependent on net imports and energy security is an issue. In 2010, 83 percent of the population had electricity access (World Bank 2014a). Current investments in the enhancement of renewable energy sources will also help to reduce the country's dependence on imported fossil fuels (World Bank 2010). Regarding international assistance, the OECD calculated the international assistance having climate change mitigation as its principal or significant objective at US$ 19.56 million (US$ 0.2 per capita) and the World Bank estimated overall net ODA in 2010 at US$ 531.19 million (US$ 6 per capita) (World Bank 2014a; OECD 2014).

The country has estimated reserves of about 400 million barrels of oil and 4.5 trillion standard feet of natural gas. Additional potential reserves of geothermal energy are conservatively estimated at 4,000 MW. Renewable energy resources are mainly hydro and geothermal; further minor potential exists for in wind, solar and biomass. To achieve higher energy self-sufficiency, increasing the use of alternative fuels such as biodiesel, ethanol, compressed natural gas, and auto gas is supported by the government (UNFCCC National Communications 2000).

While the energy sector is with over 50% by far the largest emitter of GHG emissions, agriculture contributes mainly with CH_4 and N_2O rather than CO_2, mostly from rice cultivation, domestic livestock and agricultural soils (UNFCCC National Communications 2000). The Asian Development Bank estimates total potential mitigation options in the energy sector at 157 $MtCO_2$, out of which 68 $MtCO_2$ could be implemented at a negative cost (ADB 2009). GHG emissions from the industry sector, which are the third highest emission rates after energy and agriculture, are largely based on the production and transformation of raw materials (ADB 2009).

There were only 11 technicians for every one million people in 2007 (1,418 in the Euro area 2005-2010) and only 0.11% of GDP was spent on R&D in 2007 (2.1% average 2005-2010 in the Euro area), indicating a very poor proficiency (World Bank 2014a). In 2014 the Philippines was ranked as 114th out of 178 in the EPI, mainly due to the country's partly unsustainable performance in agriculture, water resources and climate and energy policy (EPI 2014). The World Bank attributes 58 out of 100% government effectiveness (World Bank 2014b). That hints to a further improvable governance ability to implement and enforce environmental and climate change policies.

4.10.2 Overview of Country-Wide Mitigation Strategies

Since the early 1990s, the Philippines have taken various steps related to climate change and sustainable development. The Inter Agency Committee on Climate Change (IACCC) under the

Environmental Management Bureau of the Department of Environment and Resources (DENR) was already founded in 1991 and serves as the national coordination and implementation mechanism of commitments towards the UNFCCC. The Clean Air Act of 1999 included a part especially on GHG emissions and called for the preparation of a national plan on GHGs (Nachmany et al. 2014).

The Philippines ratified the UNFCCC in 1994 and the Kyoto Protocol in 2003. The country submitted its first national communication to the UNFCCC in 2000, which included a national inventory of anthropogenic emissions by sources and removals by sinks of GHGs (updated to 1994), and a description of steps taken or planned to be implemented. The second communication to the UNFCCC is currently being prepared (Nachmany, Frankhauser, et al. 2014).

In 2007, a presidential task force on climate change was created in order to meet the needs for a strategic plan. In 2010, a National Framework Strategy was initiated which has been translated into an NCCAP. This prioritizes food security, water sufficiency, ecological and environmental stability, human security, climate-smart industries and services, sustainable energy and knowledge plus capacity development as the strategic direction for 2011 to 2028. The Climate Change Act emphasized the important frontline role of local governments and mandated them to draft Local Climate Change Action Plans (Climate Change Comission Philippines 2011).

Since the energy sector is the main contributor to the country's GHG emissions (over 53%), the main focus of the Climate Change Action Plan also lies on energy: on the supply side, the Biofuels Act of 2006 guarantees a minimum percentage of biofuels and biodiesel included in the fuel mix (Nachmany et al. 2014). On the demand side, the Department of Energy has declared in the National Renewable Energy Programme (NREP) that it aims to save 50.9 $MtCO_{2e}$ by employing various energy efficiency and alternative programs in 2005-2014. Furthermore, the government has set itself the key target to double renewable energy capacity (to 9,000 MW) in the next 20 years. Additionally, efficiency as well as conservation programmes on energy are in place and a low carbon transportation pathway is being pursued. This is also being followed by the Natural Vehicle Program for Public Transport (NVPPT), initiated in 2002 by the Department of Energy. It builds on the mandatory use of biofuels in the fuel mix (Nachmany et al. 2014).

REDD+ is also seen as an important mechanism to reduce GHG emissions. In 2009, a national workshop on REDD+ was held by several NGOs, which formed the CoDe REDD2 Philippines. Also, a national REDD+ strategy has been formulated and integrated into the National Climate Change Action Plan. In 2012, the House of Representatives approved the "Sustainable Management of Forest Act 2011", which provides for a sustainable management of forests as well as for mitigation of climate change risks and reduction of poverty in forest areas (Nachmany et al. 2014).

4.10.3 Examples of Individual Mitigation Measures

Up to date, more than 50 CDMs have been registered by the Philippines with 11 large, and 43 small scale projects. Additionally, several Conserve-Protect-Restore (CPR) projects are in progress, as well as five PoAs, mainly supporting the ambitious National Renewable energy Programme, REDD+ activities, NAMAs in solid waste management (founded by the GIZ), organic farming capacity development and programmes towards environmentally sustainable transport.

Table 4-19: Mitigation action Philippines - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
NREP, part of the NCCP	Energy efficiency; Renewable energy	-Doubling renewable energy share by 2030 -saving 50.9 million tCO_{2e} by employing various energy efficiency and alternative fuel programmes for 2005–2014.	Not quantified	-cost-savings -lower overall energy consumption and energy security -pollution reduction	-
Development of a number of greenfield renewable energy projects that feed into local grids, (2009-2019), PoA	Renewable Energy	Large-scale project, grid-connected electricity generation from various renewable sources	53,543	-pollution reduction -energy production, distribution and security -technology transfer -job creation -load removal of the grid	Sweden
Wastewater treatment using a Thermophilic Anaerobic Digester at an ethanol plant in the Philippines (2008-2015), CDM	Waste Handling and Disposal	Forced methane extraction from organic waste-water treatment plants for grid-connected electricity supply	95,896	-improved local environment -job creation -technology transfer	Japan

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Secondary catalytic reduction of N2O emissions at ONPI nitric acid plant in Bacong (2010-2017), CDM	Waste Handling and Disposal	Catalytic reduction of N2O inside the ammonia burner of nitric acid plants	39,203	-improved local environment -technology transfer	Australia
Biogas to Energy Project (2011-2021), CDM	Renewable Energy	Methane recovery in animal manure management systems	43,839	-Energy Production and distribution -pollution reduction	Japan

With information from (UNFCCC 2014)

4.10.4 Conclusion

The country has already implemented seven policies related to climate change mitigation, out of which four address mitigation matters, one adaptation and two are broader legislations that address both issues. The main focus among these is on the sector of institutions and administrative arrangements, while carbon pricing is not addressed in any of them (Nachmany, Frankhauser, et al. 2014). The NCCAP with the ambitious target of doubling renewable energy capacity in the next 20 years is one major step and comprises a number of significant aims. Furthermore, the country has energy efficiency and conservation programmes in place and pursues a low carbon transportation pathway (Nachmany et al. 2014). However, experts also criticize an inadequate convergence in policy planning and coordination across national government agencies (Nachmany, Frankhauser, et al. 2014).

Among the main problems of the Philippines in terms of mitigation action is the affordability of the technologies needed, e.g. utilization of renewables in power production. Regarding this, interventions in terms of overcoming market barriers for the widespread use of renewables need to be undertaken. Moreover, it would be very useful to agree upon a single mitigation strategy, comprising all the steps and strategies necessary. To this end, the various GHG abatement efforts being proposed and contemplated under the various sectoral plans should be integrated.

The Asian Development Bank calculated that - compared to a BAU scenario - the country would have a fairly large CO_2 reduction potential at a relatively low cost. A number of net negative cost options exist in the power, industry, transport, and residential and commercial sectors, with total potential of 68 $MtCO_2$ (amounting to 37% of the BAU emissions) in 2020 (ADB 2009). A further increase in renewable energy production could also help in terms of energy security, since currently 46% of the country's energy is being imported (IEA 2014).

Figure 4-17: Share of total primary energy supply, Philippines, 2011

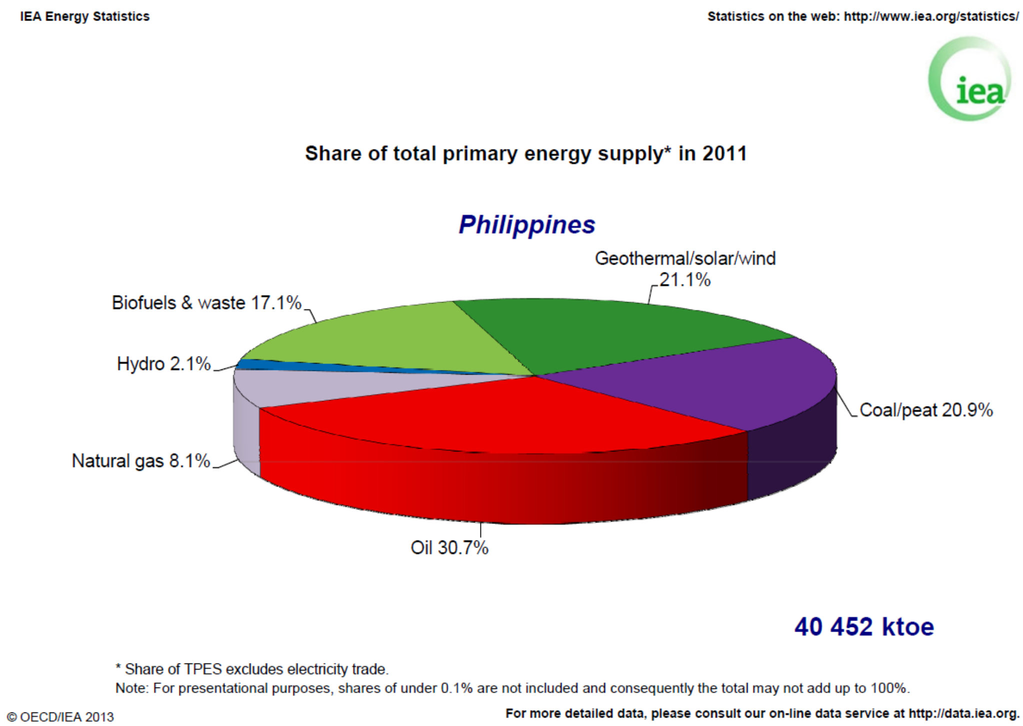
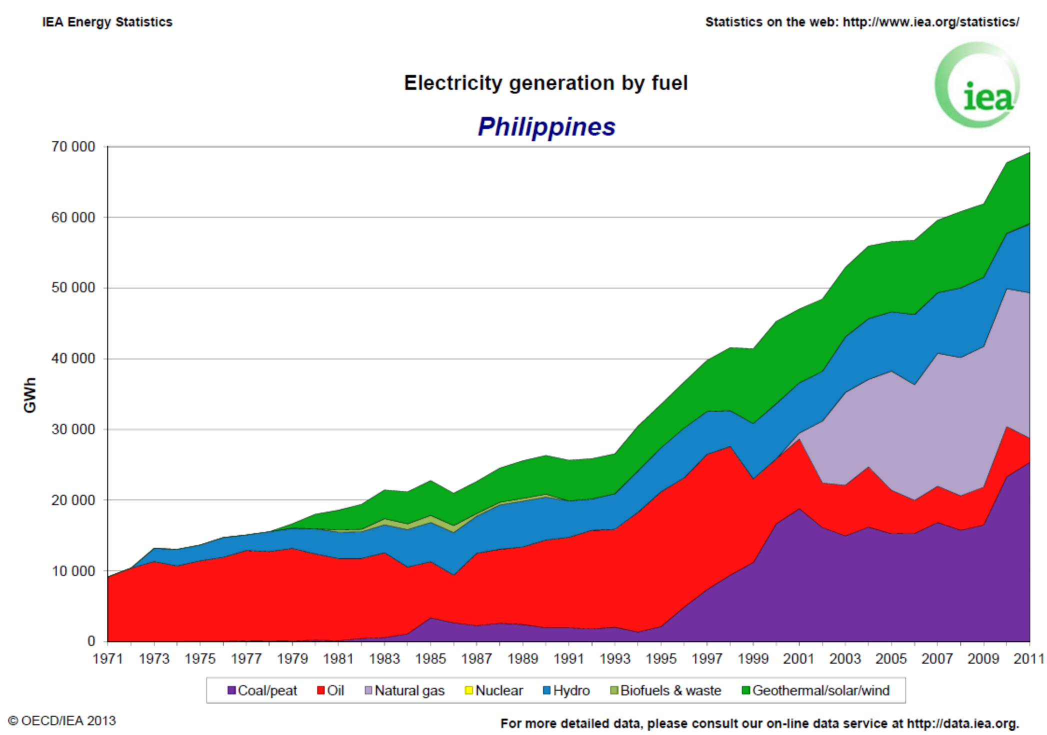


Figure 4-18: Electricity generation by fuel, Philippines



4.11 South Africa

Table 4-20: Indicators of emissions in South Africa

	2005	2010
Total Greenhouse Gas Emissions, including Land-Use, Land-Use Change and Forestry (LULUCF) (WRI 2014)	491.44 $MtCO_{2e}$ (Rank 18 of 186)	559.65 $MtCO_{2e}$ (Rank 15 of 186)
Greenhouse Gas Emissions per Capita, including LULUCF	10.41 tCO_{2e} (Rank 52 of 186)	11.2 tCO_{2e} (Rank 46 of 186)

4.11.1 Assessment of Mitigation Capacity and Potential

South Africa accounts for about 30% of total primary energy consumption on the entire continent. Its energy sector is critical to its economy, as the country relies heavily on its large-scale, energy-intensive coal mining industry. South Africa has limited proved reserves of oil and natural gas and uses its large coal deposits to meet most of its energy needs, particularly in the electricity sector. Most of the oil consumed in the country, used mainly in the transportation sector, is imported from Middle Eastern and West African producers in the Organization of the Petroleum Exporting Countries (OPEC) and is locally refined (IEA 2014). Import products in the energy sector are mainly crude oil and oil products, but South Africa had an overall energy export surplus of 17,31Mtoe in 2011 (IEA 2014). Energy consumption in the industrial and construction sectors relies largely on electricity which is produced with high carbon content by the use of domestic coal (EIA 2014). Regarding international assistance, the OECD calculated the international assistance having climate change mitigation as principal or significant objective at US$ 108.24 million (US$ 2.3 per capita) and the World Bank estimated net ODA in 2011 of US$ 1.398 billion (US$ 28 per capita) (OECD 2014; World Bank 2014a).

South Africa is the largest GHG emitter on the African continent, with emissions having risen from 350 $MtCO_{2e}$/yr in 1990 by more than 50% to 559.7 Mt CO_2e/yr in 2012 (World Bank 2014a). In global comparison it ranks at number 15 in terms of its total GHG emissions. Also its per capita emissions, ranking 46th out of 186, are very high (see Table 4-20). In total, 82.5% of all GHG emissions derive from the energy sector, out of which 75% are due to coal use (Fekete et al. 2013). Energy generation from fuel combustion is the country's single largest emission source. Therefore most mitigation strategies are located in this sector. Within a 2020 time horizon emission growth mainly stems from growth in industry and the increased electrification and electricity use of households. From a longer-term perspective, transport will also contribute significantly to emission growth (Fekete et al. 2013).

On account of renewable energy, fuel wood is currently the most widely used form in South Africa, with more than one third of the population relying on it for their energy needs (National Communications 2011). Commercially viable renewable energy capacity is not yet well developed or exploited relative to fossil and nuclear sources, but there is a growing national focus on renewable energy sources (National Communications 2011). Theoretical renewable energy potential in South

Africa is vast, with about 280 TW of solar energy. Wind energy resources of South Africa are estimated by the South African Wind Energy Association to exceed 30 GW, though only 700 MW were utilized in 2013. About 2% of South Africa’s current energy mix is provided by hydroelectric and pumped storage schemes (National Communications 2011).

South Africa’s societal capacity can be analyzed with a number of indicators. 122 technicians out of one million people in 2008 (1,418 in the Euro area 2005-2010) and 0.87% of the GDP spent on R&D in 2008 (2.1% average 2005-2010 in the Euro area) (World Bank 2014b). The World Bank attributes 65 out of 100% government effectiveness (World Bank 2014b). This hints to a further improvable governance ability to implement and enforce environmental and climate change policies.

4.11.2 Overview of Country-Wide Mitigation Strategies

Only four pieces of legislation directly concerning climate change have been adopted in South Africa, which is rather poor in international comparison. South Africa has almost exclusively dealt with climate change through policies, strategies and regulations rather than legislation. Through these measures South Africa is showing its commitment to tackling climate change, particularly in developing market-based mitigation mechanisms and promoting renewable energy and energy efficiency. Legislation on this issue has been rather scarce until a proposal on carbon tax has been introduced in 2012 (Nachmany, Frankhauser, et al. 2014).

South Africa has so far published two NCs, in 1998 and 2011, including data of three national GHG inventories (for the years 1990, 1994 and 2000). The Ministry heading the country's approach to climate change is the Ministry of Water and Environmental Affairs, with the Department of Environmental Affairs (DEA) as the main responsible entity (Fekete, Mersmann, and Vieweg 2013). The National Climate Change Response Strategy developed in 2004 was the first direct recognition of the need for action on climate change. In 2006 the cabinet commissioned the Long-Term Mitigation Scenario (LTMS) study, aiming to produce a sound scientific analysis from which the government could derive a long-term climate policy. The LTMS also includes a series of policy recommendations which will be at the core of South Africa’s climate change legislation (Department of Environment Affairs and Tourism South Africa 2007).

In 2008, the vision strategic direction and framework for climate policy was announced; it sets a framework for a long-term net zero-carbon electricity sector and establishes general guidelines for tackling climate change: inter alia it includes introducing a carbon tax, renewable energy feed-in tariffs, a carbon capture and storage system, energy efficiency and transportation, only to name some (Nachmany, Frankhauser, et al. 2014). South Africa has made a conditional pledge to reduce its GHG emissions below the BAU emission development by approximately 34% by 2020 (and 42% by 2025). The target was proposed during the Copenhagen negotiations and submitted to the UNFCCC Secretariat in 2010. This is adopted in the flagship policy of South Africa, the National Climate Change Response White Paper (NCCR) of 2011. The NCCR addresses both mitigation and adaptation and provides planning goals for the short- (5 years), medium- (20 years), and long-term (up to 2050). Based on this, South Africa’s emissions should peak between 2020 and 2025, plateau for approximately a decade and then decline in absolute terms thereafter. This characterizes a peak-plateau-decline trajectory (Hare et al. 2014). The NCCR reiterates that the emission reduction pledge is conditional on international support. The strategy contains a number of general measures and activities that serve to reach the country’s reduction goal. In particular, the NCCR calls for the development of carbon budgets for each sector (Fekete, Mersmann, and Vieweg 2013).

In regard to short-term actions, the NCCR proposes so-called Flagship Programmes that should show immediate results in various sectors, such as water protection and demand management, transport, waste management, energy efficiency in the industry sector as well as one on transportation that promotes lower carbon mobility in five larger and ten smaller cities. Further, there is a policy on promoting a transport modal shift (road to rail, private to public transport) and to alternative vehicles (e.g. electric and hybrid vehicles). However, the ambitious NCCR has the character of a general White Paper and still needs to be underpinned by strong legislation (Fekete et al. 2013).

The South African Department of Energy has taken up GHG mitigation in its mission, aiming to have 30% clean energy by 2025. In the Integrated Resource Plan (IRP), which is the key governmental document for power generation planning in South Africa, reducing carbon emissions has been labelled as a key constraint for energy planning (Fekete et al. 2013).

4.11.3 Examples of Individual Mitigation Measures

Since the major part of South Africa's GHG emissions derive from the energy sector, most mitigation measures are also related to energy. Fifty-eight CDMs are registered in South Africa. Out of these, 38 deal with measures in energy industries, 12 with manufacturing industries and 8 with waste handling and disposal.

The country does not currently have any programmes in place that are explicitly targeted at GHG mitigation in the forestry or agriculture sectors. A maximum mitigation potential of 18 $MtCO_{2e}$/yr in 2020 was identified in these sectors. The introduction of a REDD+ Strategy (currently in process) may therefore lead to significant emissions reductions (Fekete et al. 2013a).

Table 4-21: Mitigation action South Africa - individual level

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Introduction of a carbon tax, starts 2015 covering direct GHG emissions from stationary sources resulting from fuel combustion, gasification and industrial processes (Fekete et al. 2013)	Non-renewable energy	Coal tax; Tax rate set at US$ 12/tCO_2e, increasing by 10% each year up to 2019 - sets price incentives to invest more strongly in low-carbon technologies	Not quantified	-pollution reduction	n/a

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Industrial Energy Improvement Project; (since 2010), design of policies and regulations for implementation and monitoring of industrial energy efficiency (Fekete et al. 2013)	Energy efficiency	10% reduction of energy demand of the 138 largest electricity consumers (40% of total energy demand), and 7% by the next-largest 40 000 - reducing energy consumption by at least 23 000 GWh per year	22,000	-cost-savings -lower overall energy consumption and energy security	Switzerland; Great Britain
South African renewables Initiative (SARI), launched at COP17 (NAMA in implementation phase) (Fekete et al. 2013)	Renewable energy	-mobilise international and national support for accelerated renewables deployment -development of the renewables sector	Not quantified; if fully implemented, relative saving of up to 1.2 billion tonnes on CO_2e in total	-energy production and security -technology transfer -pollution reduction	Launched as collaborate programme with Denmark, Germany, Norway, and the United Kingdom
Renewable Energy Independent Power Producers Procurement Programme (REBIB), since 2011	Renewable energy	Renewable Energy support policy; competitive procurement process for Independent Power Producers (IPP)	n/a 1,415 MW of renewable energy in the first round up to 2012	-energy production, distribution and security -technology transfer -job creation -pollution reduction	Project funding for solar tower by the European Investment Bank

Mitigation measure	Type	Description	Annual emission reduction tCO_{2e}/year	Potential co-benefits	Project participants /sponsoring body
Catalytic reduction of N^2O inside the ammonia burner of nitric acid plants (CDM), 2007-2014	Waste handling and disposal	Large-scale project; chemical industry N_2O reduction	960,322	-technology transfer -improved local environment -job creation	Great Britain; Switzerland; Germany

4.11.4 Conclusion

Historically, South Africa's emissions have steadily increased, reaching rank 15 in global comparison in 2012. Its economy relies heavily on mining and heavy industry. Energy consumption in the industrial and buildings sectors relies largely on electricity as an energy source, which is produced with high carbon intensity using domestic coal. Only a minor part, 11% of total primary energy supply, currently derives from renewable energy sources (Hare et al. 2014).

South Africa has put in place a large variety of strategies, policies and measures to mitigate climate change, addressing most of the country's mitigation potential. The country's pledge during the Copenhagen negotiations 2010 to undertake mitigation actions resulting in a deviation below the baseline emissions of 34% by 2020 and 40% by 2025 is very promising.

Out of the existing efforts, the NCCR is certainly at the forefront, but considering the country's high energy intensity, especially for electricity, strategies such as the Integrated Resource Plan play a similarly important role for South Africa's future low-carbon development(Fekete, Mersmann, and Vieweg 2013). A point of criticism is that the policies fall short of their potential. In the energy sector critics highlight that the government is still giving prominence to coal fired power stations. There also exists significant room for improvement and ambition in the transportation and manufacturing sectors (Nachmany, Frankhauser, et al. 2014). The design of the carbon tax sends a positive signal as it cuts across most sectors and has a large potential to lead to low carbon development in the medium term if is adopted as timely as currently envisaged. For shorter term benefits in climate protection, the flagship programmes laid out in the NCCR should be implemented. These projects can showcase the country's ambitions and may serve to attract international funding that is necessary to fulfil South Africa's mitigation goal inscribed as a NAMA under the UNFCCC (Fekete et al. 2013).

In conclusion, South Africa has a tremendous mid to long-term mitigation potential at moderate cost. However, meeting the country's 2020 target will require strong short-term action. South Africa will have to address all available mitigation options simultaneously, including more costly options. A large short-term mitigation potential exists specifically in the fields of energy efficiency, renewable energy, waste and land-use change. Immediate action is required to ensure its full deployment – not only to meet the countries 2020 target, but also to facilitate a cost-effective long-term mitigation pathway (Fekete et al. 2013). South Africa's current performance is rather medium; while its stated intentions (particularly in regard to its international pledges) are ambitious and well-designed, implemented policies have so far had little effect on the emission trend (Hare et al. 2014).

Figure 4-19: Share of total primary energy supply, South Africa, 2011

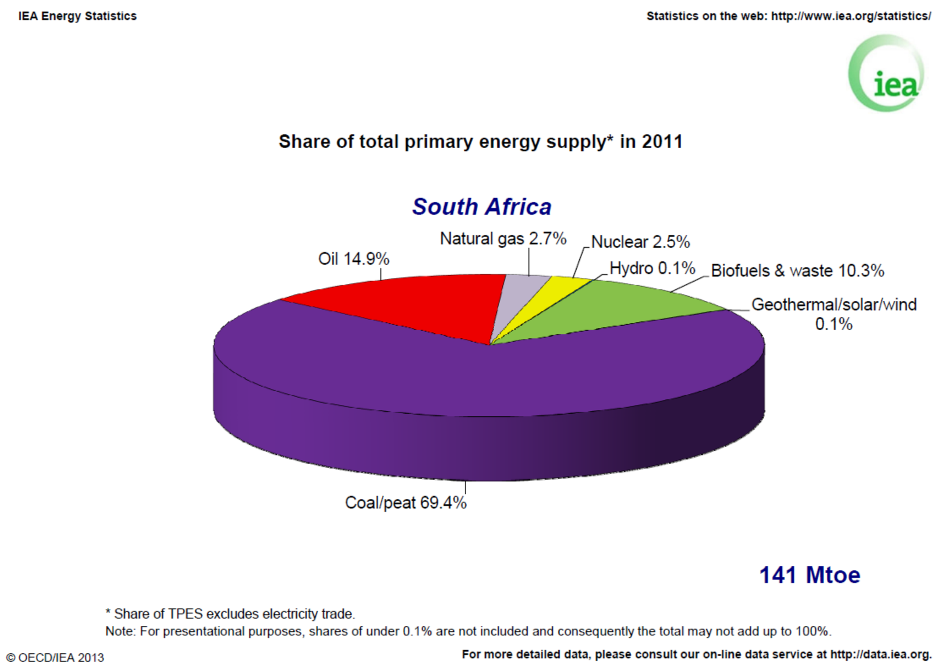
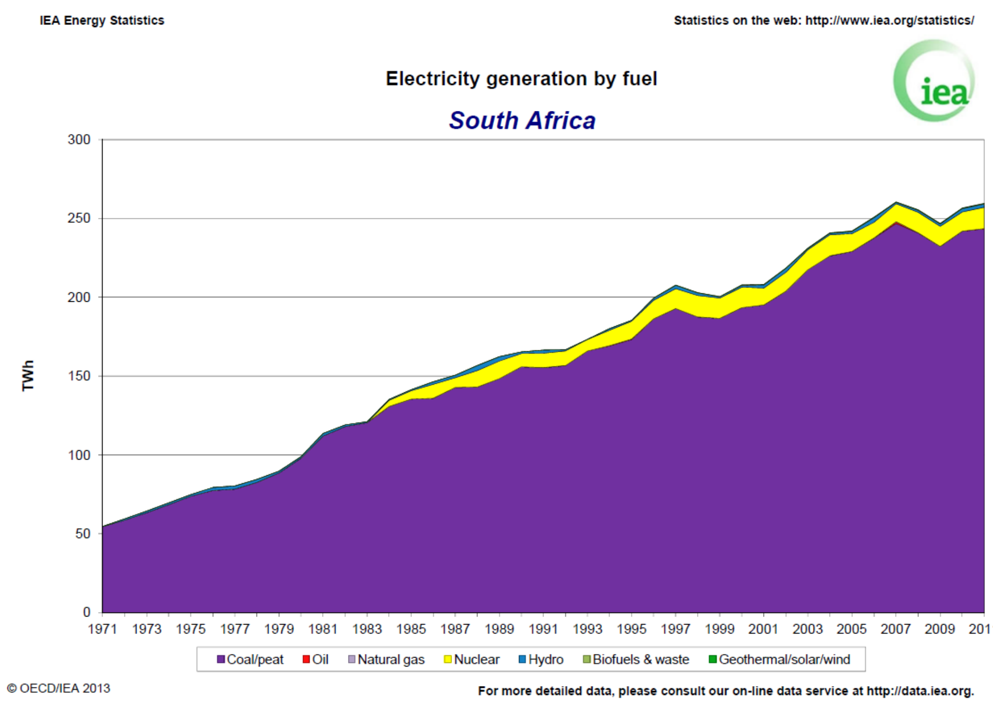


Figure 4-20: Electricity generation by fuel, South Africa



4.12 Conclusion

In our country studies we identified several trends. All analyzed countries have more or less strictly integrated climate change mitigation into their national policies and developed a respective institutional setup, especially in recent years. These policies are generally integrated into the countries' greater development plans. This leads us to the conclusion that the importance of climate change is generally acknowledged and mitigation is regarded as a key factor for global politics. The ambition, however, generally depends on to what degree mitigation measures are in line with the general development plans and how co-benefits of emission reduction measures contribute to the countries' progress.

Our analyses confirm the assumption that energy plays the major role in both emissions and development plans. Energy is seen as one of the main drivers for economic growth and therefore developing countries see the provision and scaling up of capacities in this sector as a centrepiece in their development pathways. In this regard, least developed countries like Kenya, Cambodia or Ethiopia, with a currently low energy consumption and poor electricity access for the population have a peculiar advantage over industrialized and emerging economies: because construction of capacities for energy production would demand large-scale investments no matter if based on fossil fuels or renewable energy sources, they might strongly focus on the latter and simultaneously strengthen their energy security, cash in on other co-benefits and get less dependent on imports and respective prices. Furthermore, international assistance is likely to support such projects and compensate for possible additional costs compared to carbon-based energy production. Examples are already carried out projects under the CDM. The possibility for a leapfrog lies in front of many of the analyzed countries, which could skip the carbon intensive development path of most western countries in favour of a sustainable development pathway. Many countries are at such crossroads and have to take a decision how to provide for growing energy needs.

Table 4-22: Grouping of assessed countries

Development status and capacity	
High	Brazil, South Africa
Medium	Nicaragua, India, Indonesia, Philippines
Low	Cambodia, Ethiopia, Kenya, Pakistan
Total emissions / significance for global climate change	
High (<500 Mt CO_2e)	Brazil, India, Indonesia, South Africa
Medium (100-500 Mt CO_2e)	Ethiopia, Pakistan, Philippines
Low (<100 Mt CO_2e)	Cambodia, Kenya, Nicaragua
Emissions per capita	
High (>10 t CO_2e)	Brazil, South Africa
Medium (5-10 t CO_2e)	Nicaragua
Low (<5 t CO_2e)	Cambodia, Ethiopia, Kenya, India, Indonesia, Pakistan, Philippines
Ambition of mitigation measures	
Good	Ethiopia, Kenya, Nicaragua

Development status and capacity	
Average	Brazil, Cambodia, India, Indonesia, Nicaragua, Pakistan, Philippines
Poor	South Africa
Effectiveness of mitigation measures	
Good	Brazil, India, Indonesia, Philippines
Average	Ethiopia, Kenya, Nicaragua, Pakistan, South Africa
Poor	Cambodia

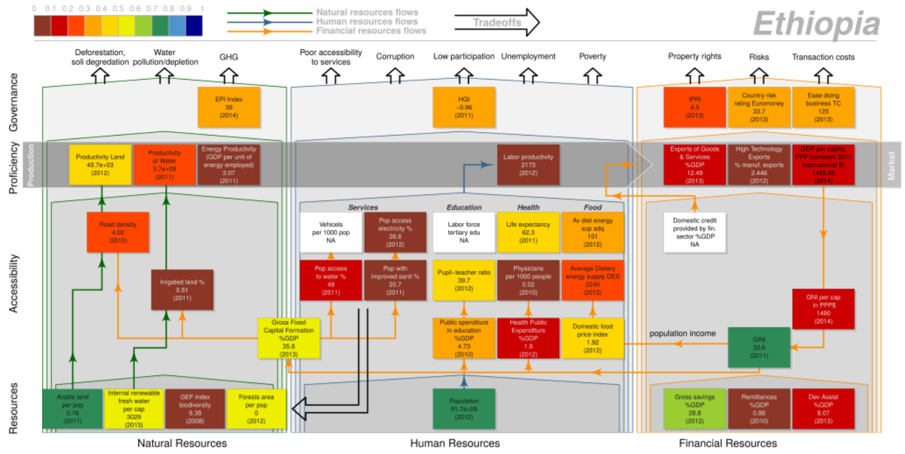
Countries whose emissions derive largely from LULUCF (namely Brazil, Cambodia, Nicaragua and Indonesia) possess their highest potential for GHG emission reduction in this sector, for example through REDD+ mechanisms. As part of these activities, monitoring systems that allow for credible measurement, reporting and verification (MRV) are among the most critical elements for the successful implementation. On account of weak governmental effectiveness or lacking financial capacity, international assistance, economically as well as trainings and implementation aid, is a key factor for success.

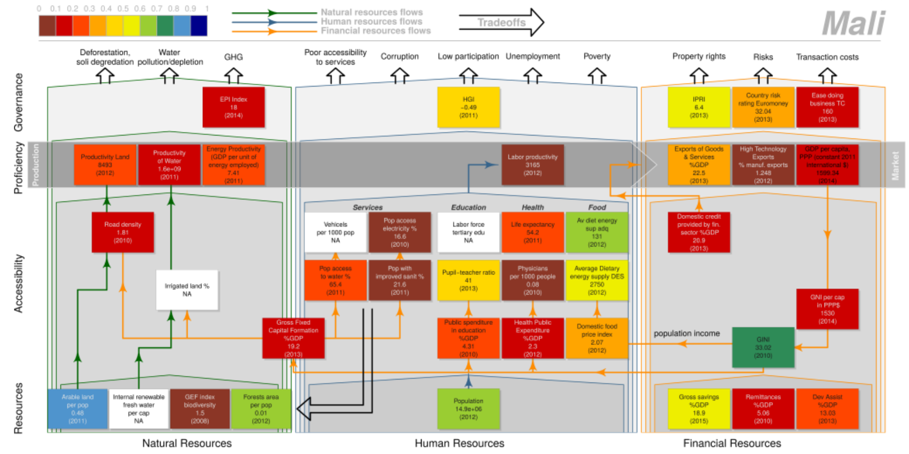
Small-scale actions with noteworthy co-benefits could also help to reduce current emissions, especially in the least developed countries. As an example, more efficient cook stoves are able to reduce emissions significantly in countries like Ethiopia, whose total primary energy supply still derives to the vast majority from biofuels and waste. Actions like agroforestry or energy efficiency appliances may account quantitatively for lower reduction amounts than large-scale investments in renewables, but are not less important if implemented thoroughly.

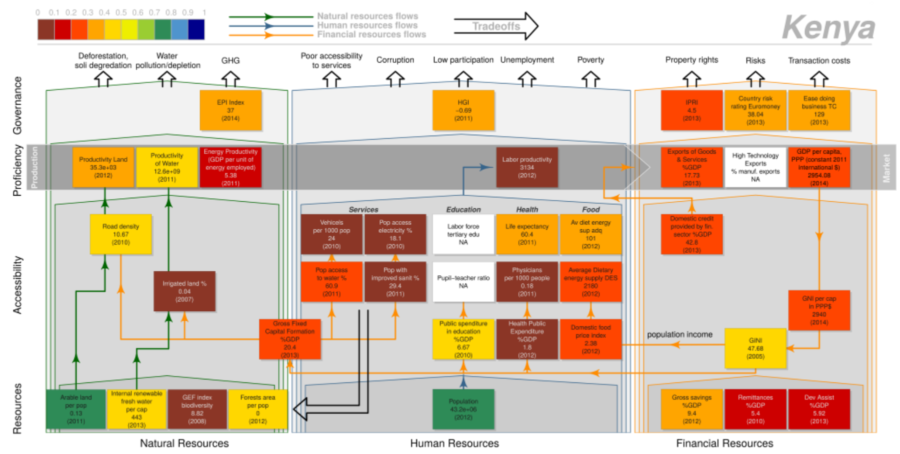
In we tried to divide the countries into several groups in terms of capacity, total emissions and emissions per capita, which helps to assess the ambition and effectiveness of mitigation measures.

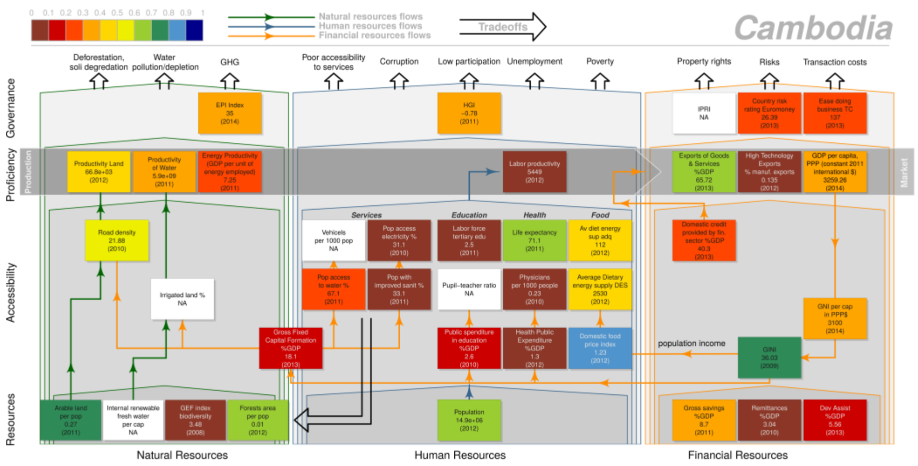
Appendix 5: The Assessment of the Adaptive Capacity of the 16 Countries Studied

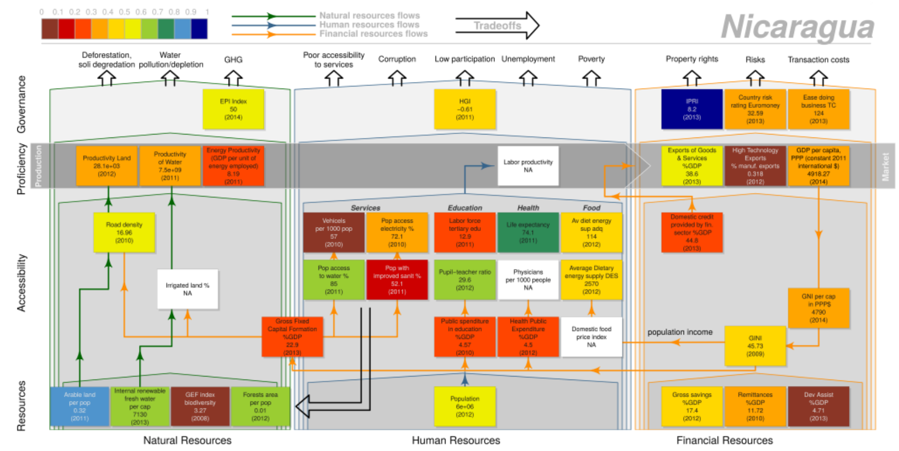
The figures were arranged according to the GNI per capita, i.e. from lowest to highest. Rankings of brown and red colored indicators are appear overproportional in countries with lower income per capita. The frequency of brown and red colors decrease as GNI per capita grows. Green and blue colored cells are more frequently found in countries with higher GNI per capita. This provides an evidence of the co-evolution of growth and adaptive capacity. Higher developed countries show a better developed governance sector. This supports the assumption that growth is needed for higher governance, hence for adaptive capacity.

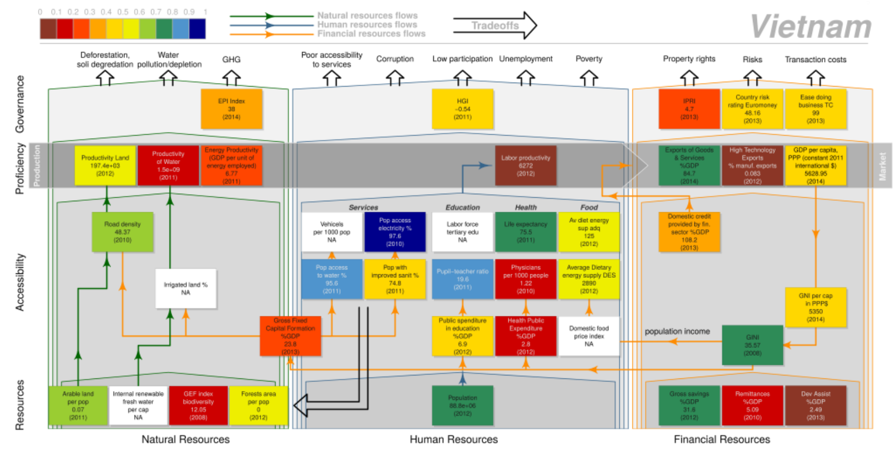


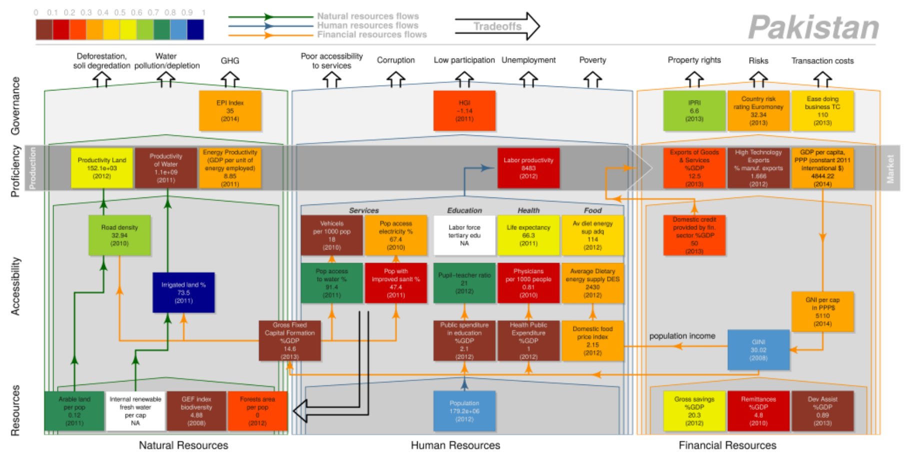


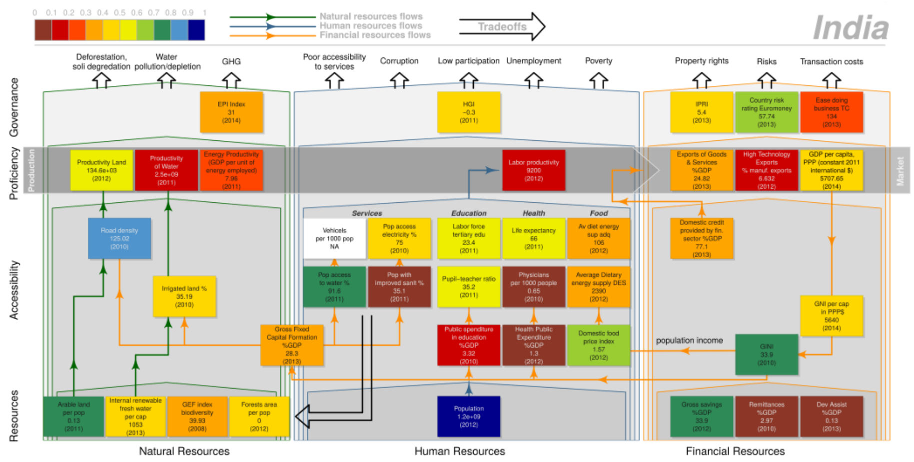


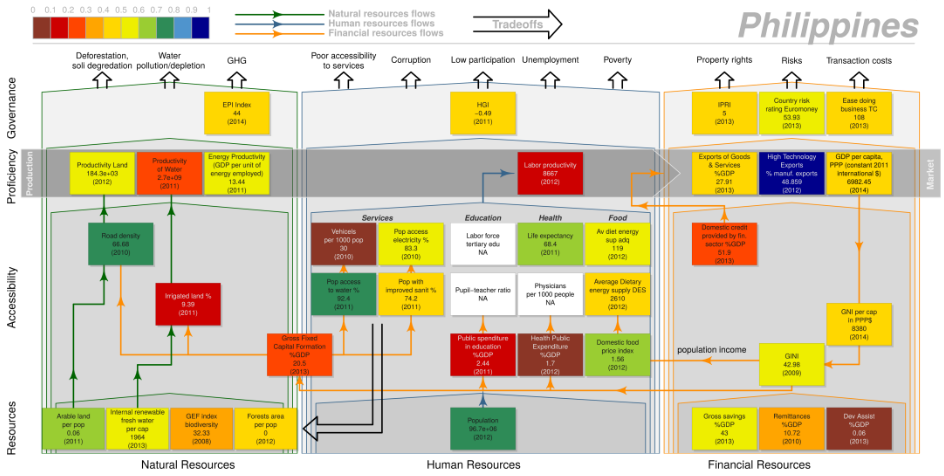








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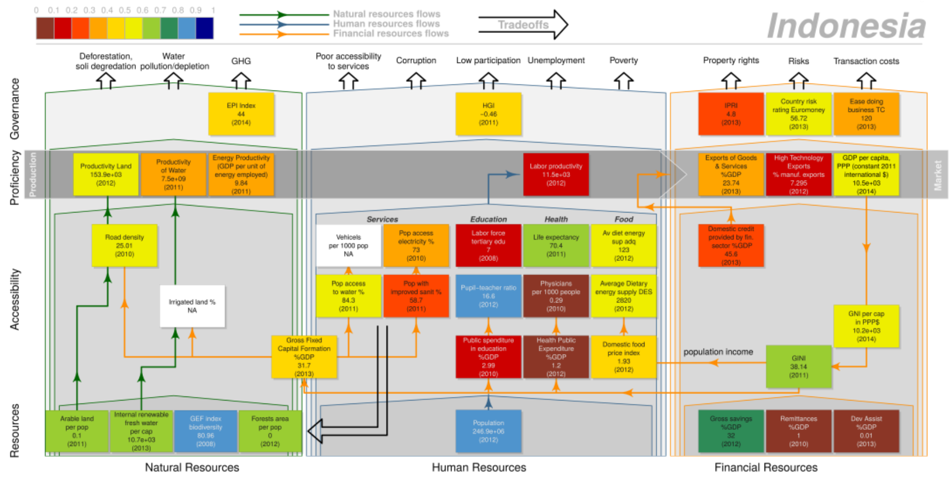
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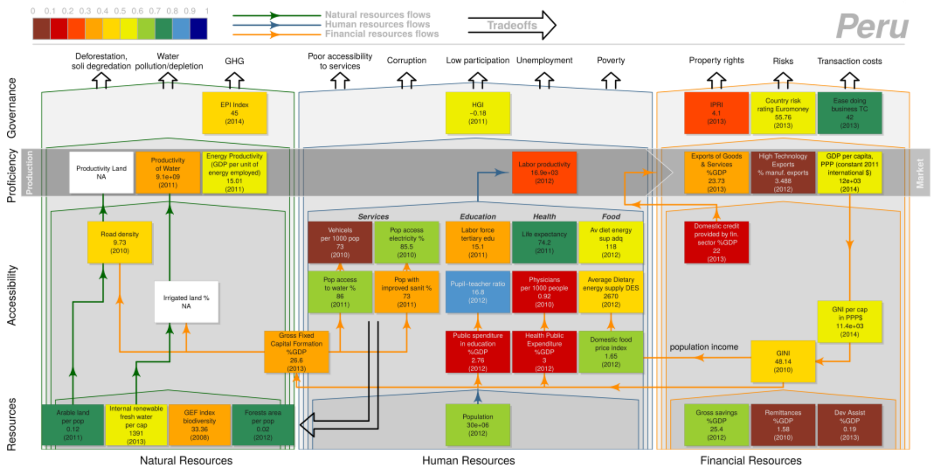
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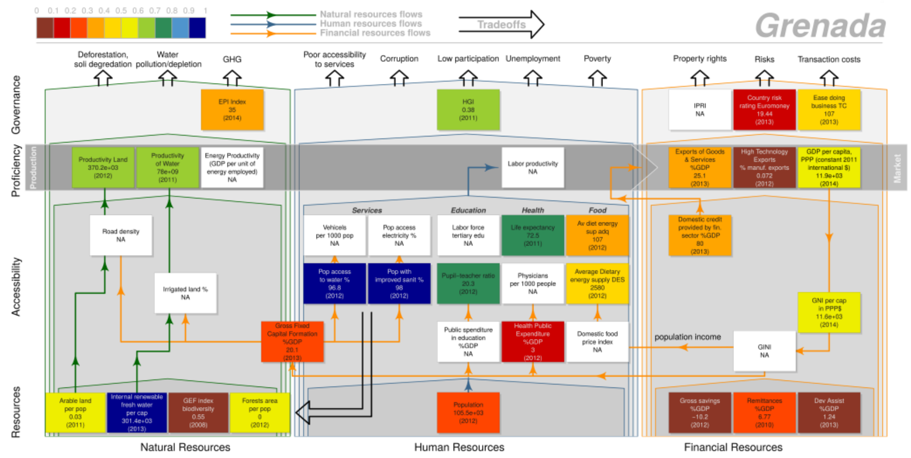
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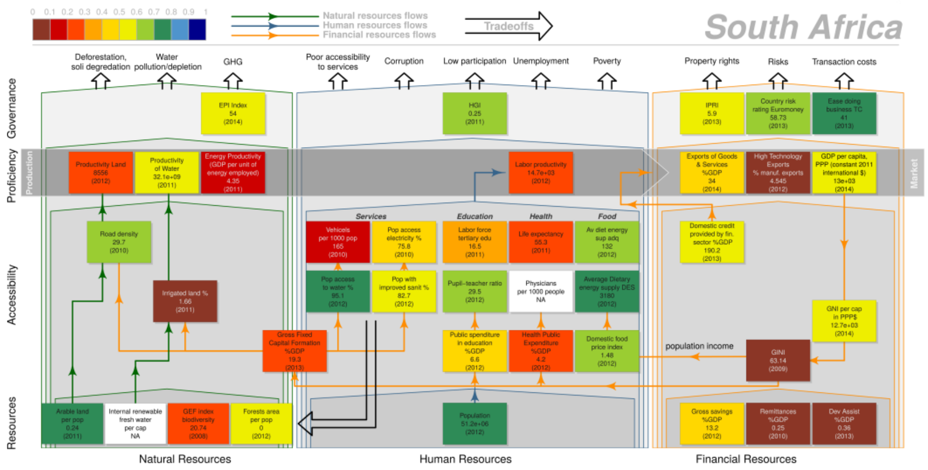
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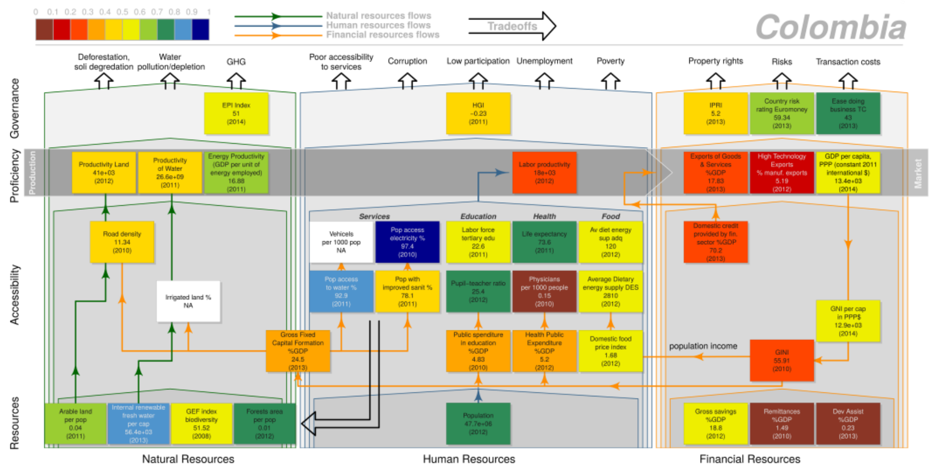
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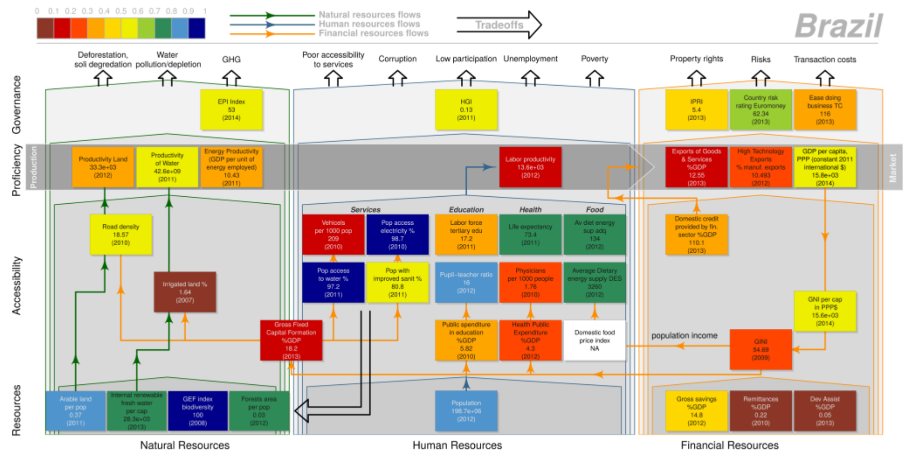
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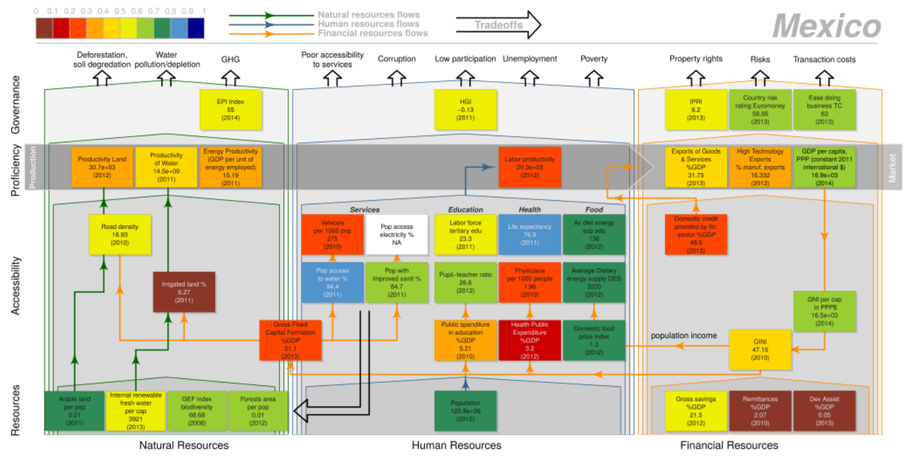
Mexico
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