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Challenges of Coal Transitions

A comparative study on the status quo and future prospects of coal mining and coal use in Indonesia, Colombia and Viet Nam

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Challenges of Coal Transitions

A comparative study on the status quo and future prospects of coal mining
and coal use in Indonesia, Colombia and Viet Nam

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Introduction to the project

This report is part of the “Implementation of Nationally Determined Contributions” (NDCs) project (FKZ 3716 4111 80), which considers NDC implementation in 10 countries: Colombia, Ethiopia, Georgia, Indonesia, Iran, Kenya, Marshall Islands, Morocco, Peru, and Viet Nam. This project places a special emphasis on identifying potential barriers to NDC implementation and mitigation potentials which could go beyond the current NDCs.

The country reports analyse the NDCs in terms of their robustness and coherence with other national or sectoral plans and targets, and put them into the context of additional mitigation potentials and other national circumstances. For countries where coal plays a critical role in consumption or national production, the analysis covers further details on this sector, including the economic relevance and local impacts of coal production or consumption. The content is based on available literature from research and public sector information on policies and institutions.

This report summarises the findings on coal given in the country reports of Colombia, Indonesia and Viet Nam. It has been augmented by a literature analysis on global coal trends and structural change in coal mining areas as well as very recent country specific publications which became available only after the finalisation of the three country reports.

The project was suggested and is financed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, supervised by the German Environment Agency and carried out by independent think tanks - NewClimate Institute and Wuppertal Institute. The country reports are a continuation of similar previous efforts (project numbers 3713 41 102, 3711 41 120, 360 16 022, 364 01 003 and 363 01 128) and aim to inform policy makers and the interested public about the implementation of NDCs in individual countries. The choice of countries is based on developing countries with which Germany works closely on climate change topics.

The country reports are scientific in nature, and all suggestions are derived by the authors from careful analysis, having in mind the individual backgrounds of countries. They aim to increase knowledge about implementation of mitigation potentials to meet the globally agreed goal of staying within a temperature increase of 1.5°C or well below 2°C above preindustrial levels, without intending to prescribe specific policies.

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List of abbreviations

ADB	Asian Development Bank
AVCT	Avoided Cost Tariff
BAPPENAS	Ministry of National Development Planning / National Development Planning Agency
BAU	Business as Usual
BMU	Bundesministerium für Umwelt, Naturschutz und Nukleare Sicherheit
BRT	Bus Rapid Transit
BUR	Biennial Update Report
CAT	Climate Action Tracker
CCNCT	Climate Change National Coordination Team
CCRC	Climate Change Research Centre
CDM	Clean Development Mechanism
CMP	Conference of Parties serving as the meeting of the Parties to the Kyoto Protocol
COP	Conference of the Parties
CPP	Coal Power Plant
CSP	Concentrated Solar Power
CTCC	Country Team on Climate Change
DMHCC	Department of Meteorology, Hydrology and Climate Change
DNA	Designated National Authority
ESMAP	Energy Sector Management Assistance Programme
EVN	Electricity Viet Nam
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FiT	Feed-in-Tariff
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoI	Government of Indonesia
HDI	Human Development Index
ICB	Inter-ministerial Coordination Board
ICCSR	Indonesia Climate Change Sectoral Roadmap
IEA	International Energy Agency

IKI	German International Climate Initiative
IMHEN	Viet Nam Institute of Meteorology, Hydrology and Climate Change
INCAS	Indonesian National Carbon Accounting System
IPCC	International Panel on Climate Change
IPPU	industrial processing and product use
ISPO	Indonesian Sustainable Palm Oil
ISPONRE	Institute of Strategy and Policy on Natural Resources and Environment
JBIC	Japan Bank for International Cooperation
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
KEN	National Energy Policy
ktoe	kilotonne of oil equivalent
kWh	Kilowatt hours
LCOE	Levelized Costs of Electricity Production
LGE	litres per gasoline equivalent
LNG	Liquid Natural Gas
LULUCF	Land Use, Land Use Change and Forestry
MARD	Ministry of Agriculture and Rural Development
MBI	Market Based Instruments
MOC	Ministry of Construction
MoE	Ministry of Environment
MOF	Ministry of Finance
MoEF	Ministry of Environment and Forestry
MoIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MPI	Ministry of Planning and Investment
MRV	Monitoring, Reporting and Verification
MtCO₂e	Mega tonnes carbon dioxide equivalent
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NCCC	National Committee on Climate Change
NCCS	National Climate Change Strategy
NDC	Nationally Determined Contribution
NDF	Nordic Development Fund

NGGS	National Green Growth Strategy
NTP-RCC	National Target Programme to Respond to Climate Change
OPEC	Organisation of Petroleum-Exporting Countries
PD	Project Development
PDP	Power development plan
PFES	Payment for Environmental Services
PLN	Perusahaan Listrik Negara (Indonesian state-owned electricity supplier)
PM	Particulate Matter
PV	photovoltaics
RAD-GRK	Provincial Action Plan for Greenhouse Gas Reduction
RAN-GRK	National Action Plan for Greenhouse Gas Reduction
RE	Renewable energy
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RES	Renewable Energy Sources
RIKEN	National Energy Conservation Master Plan
RPJMN	National Medium Term Development Plan
RUKN	General Plan for National Electricity Development
RUPTL	Electricity Supply Business Plan 2016-2025
SOE	State Owned Enterprise
SPPA	Standardized Power Purchase Agreement
UKP4	Delivery Unit for Development Monitoring and Oversight
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
USD	United States Dollar
VINACOMIN	Viet Nam National Coal – Mineral Industries Group
VND	Vietnamese Dong (currency)
VNEEP	Viet Nam Energy Efficiency and Conservation Program

1 Summary

More than 45% of all energy-related CO₂ emissions come from burning coal. If all of today's existing and planned coal-fired power plants were to be utilised until the end of their technical lifetime, they alone would eat up almost all of the available carbon budget to stay within the 1.5°C limit. Some 85% of current coal reserves would have to remain unused to limit warming to below 2°C. It is thus obvious that reducing CO₂ emissions from coal-fired energy production is one of the key challenges of climate mitigation. Reaching the Paris climate targets implies a reduction of global coal use in the short term, followed by a reduction of GHG emissions from coal use to zero by mid-century or shortly thereafter.

One side of the challenge relates to energy systems – how can coal be substituted with renewables and energy efficiency? For those countries that produce coal, there is another side to it: for many of them, coal mining has been a major factor in their national economy or at least an important source of income in the coal mining regions. For these countries the question is more than just: "What could a reliable zero carbon energy system look like?" Nor is it simply a matter of: "What is the cheapest solution?" (in fact energy efficiency and renewables are increasingly the cheapest solutions). An additional important question for coal producing countries is: "What happens to jobs and income in mining regions?"

Against this background we have taken a closer look at three coal producing countries: Indonesia, Colombia and Viet Nam. As different as these countries are, they share two common features: None of them is among the top 10 coal consuming countries in the world, but all three of them are or were in recent years among the top coal exporting countries. We believe that understanding the role of coal in these countries will help to develop global strategies how to reduce CO₂ emissions from coal in the short to mid-term.

► Colombia – the exporter

About 95% of Colombia's coal is exported. In 2015, Colombia delivered 81 Mt of steam coal to the global market, which makes the country the third largest exporter of steam coal globally (after Russia and Australia). The export value amounted to USD 5.3 billion. Coal is responsible for 14% of the country's export earnings (to compare: cars are responsible for 12% of Germany's exports). Domestically, coal only accounts for 9% of the country's electricity use - but plans exist to expand coal-fired power plants.

► Indonesia – the producer

Indonesia is the fifth largest coal producer globally. Including a high share of lower quality brown coal, Indonesia is the biggest coal exporter globally (in some years second to Australia). With an export value of more than USD 23 billion, coal is responsible for 10% of the country's export volume (palm oil is 9%). Thus, the coal industry is a key economic factor for the whole country. But recently the country's strategy towards coal has shifted: Plans are to use an increasing share of coal domestically. Between 2015 and 2025, Indonesia plans to build 80 GW of new coal-fired power plants. If these plans were implemented, Indonesia's GHG emissions from coal would rise from 220 MtCO₂ in 2015 to almost 500 MtCO₂ in 2030.

► Viet Nam – the self-supplier

The role of coal for Viet Nam has seen a massive shift in recent years. Between 1990 and 2007, coal production increased by a factor of nine. In 2007 Viet Nam exported more than 75% of its coal. Since then, production has stayed fairly constant, but consumption has increased so strongly that Viet Nam uses almost all of its coal domestically. Electricity demand is expected to rise from 140 billion kWh in 2015 to 570-630 billion kWh in 2030. The latest plans foresee this additional demand mainly being met through coal-fired power production, despite a call from Prime Minister Nguyen Tan Dung to build no more coal-fired power plants in January 2016. Coal is expected to generate over half of the electricity by 2030, up from 39% in 2014.

The transition pathway towards reaching the Paris climate agreement globally will fundamentally change the framework conditions in which the coal-based economies of these countries function to-day. We see three fields of action in which urgent actions and in some cases fundamental mind shifts are necessary:

Energy Policy

All three countries have plans to increase coal use for electricity generation and to build new coal-fired power plants. Part of the new coal capacity could be substituted by higher energy efficiency on the demand side and more renewable energy in the power supply. The options to do so are very different in each country. In fact, each country already has strategies in place to improve energy efficiency and build more renewable energy. Our recommendation would be to increase delivery on these targets in the short term: If it can be shown on the ground that higher energy efficiency and higher shares of renewables are not only possible but also economically viable, this may be an argument for ministries and utilities to revise their strategies towards coal. A key example for this approach is Indonesia: The country has ambitious renewable targets, but implementation is in question. In addition to that, plans for the extension of new coal-fired power plants seem to build on very high demand projections. Short-term success in energy efficiency and renewables would allow decreases in installation plans for coal-fired power plants in the mid-term.

Economic and Regional Development

If global coal markets go down – whether this is due to more ambitious climate actions of key importers or cost competitive alternatives from solar and wind power – coal exporters will face decreasing incomes. In Colombia and Indonesia, with coal contributing 10% or more to the countries' export value, coal is an important factor in the national economy as well as for government funding through taxes and royalties. In each of the three countries, more than 100.000 direct jobs and an additional (but difficult to quantify) number of indirect jobs rely on coal mining. On a regional level, the dependence is even higher: Many mining regions are quite rural and economically have very little to offer besides agriculture and (coal) mining.

Diversifying the economy of coal mining regions is a long-term process. Historic experiences from industrialised countries show that structural change processes take many decades. For example, coal mining in the Ruhr Valley in Germany started to decrease in 1957, but economic impacts of this decline are still visible today. Therefore it is very important to start thinking about the future of coal mining regions today. Colombia, Indonesia and Viet Nam have plans to increase mining activities or at least keep them at current levels. Nevertheless, strategies for a time beyond coal need to be designed and implemented today.

Concrete activities have to be tailor-made for the respective region. They may include better education, attracting alternative economic opportunities to coal mining regions and safeguarding local potentials, including a clean and safe environment. In our view, it is important that the national government assumes responsibility for coal mining regions early on as coal mining companies and those stakeholders profiting from mining often do not have an interest to prepare a region for a post-mining future.

Negative local impacts

Coal mining regions do not only benefit from coal mining (through jobs and revenues), but also suffer from negative local impacts like air pollution, land degradation as well as toxic and acid water. These negative environmental impacts cause health risks for both workers and local communities. Furthermore, they reduce the potential for other economic activities in the region (e.g. agriculture). Stringent legislation needs to be implemented and enforced to ensure that the external costs of coal are borne by coal consumers and not local communities. From a climate policy perspective, this is also important in order to increase the cost competitiveness of low-carbon alternatives.

One important issue is the environmental remediation after mine closure, which again is an important cornerstone for a long-term economic development of mining regions. Assuming that revenues from coal mining will decrease in the future, coal companies may find it difficult to cover very costly remediation activities, even in those countries where legislation would bind them to do so. Thus, it seems advisable to develop financing strategies for remediation, which are consistent with global low-carbon development trends.

Subsidies

In all three countries analysed, coal mining and sometimes also coal use have received high levels of direct and indirect subsidies. In the recent past, efforts have been made to reform and reduce these subsidies. Still, in Colombia the effective tax rate for the coal sector is, on average, only 66% of the nominal rate. In Indonesia, subsidies for electricity still amount to USD 4.4 billion in 2016. There, the potential for emission reductions through stringent subsidy reforms in the whole energy sector have been estimated to be 5 to 7% in the short-term and 9% with a 2030 time horizon.

Global knowledge for a just transition

This report has focused on challenges and developments in Colombia, Indonesia and Viet Nam. However, we believe that many coal producing countries around the world today face (or in the future will face) similar challenges. Many of these challenges are not new. Structural change due to mine closure is a phenomenon as old as mining. Only the reason has changed: In the past the driver has been mine depletion or changing economic frameworks. In the future, these drivers will be supplemented by climate policy. Irrespective of this difference, a great amount of knowledge exists on how to support structural change processes towards a socially just transition. Many good and bad examples exist around the world. To tap into this pool of knowledge, it is important to support knowledge exchange between countries and regions - but also between disciplines, sectors and policy departments: So far climate and energy policy experts have dealt very little with structural policy and regional development. But we believe that they will have to do so in the future.

2 Introduction

The starting point for our analysis is the fact that a reversal of the trend of global coal use is imminent: While coal use has been growing heavily in the last decades it is likely to peak and go down again in the near future. The drivers for this are increasingly ambitious climate targets and competition from renewables, which are already today cheaper than new coal-fired power plants in most cases (see chapter 3).

This has dramatic impacts on coal-rich countries, especially those, which are heavy exporters of coal. If global coal use is decreasing, an important source of income for the country is at stake. Beyond the negative impact on the national economy, the consequences can be even more severe for the very regions in which coal mining is located, because the relative importance of the coal industry is higher. Even in countries, for which coal mining contributes only marginally to the national economy (e.g. Germany), we witness fierce debates over the future of coal, because some specific (and often structurally weak) regions depend relatively strongly on coal in terms of jobs and tax revenues. These regions call – absolutely legitimately – for a “just transition”.

The question is: What are appropriate counter measures to compensate for, reduce or avoid economically negative aspects of reduced global demand for coal exports? How can coal-rich and especially coal exporting countries prepare themselves for a coal transition in order to avoid economic and social hardship?

One very obvious option is to postpone or slowdown the transition. Conserving the status quo may seem attractive for governments, coal companies and employees. And in fact, historic examples show that this has often been tried, e.g. by subsidising national coal mining, which was no longer competitive globally. Slowing down the transition helped to maintain social peace in coal mining regions – however, at the cost of very high government subsidies and reduced innovation.¹

For coal exporting countries, another option is to increase domestic use of coal and thereby compensate some of the economic losses due to shrinking global coal demand. This however, is not attractive from a climate policy perspective. And it may also not be favourable for the country as it may hinder necessary investments, innovation, and building up economically sustainable alternative industries.

A closer look at current challenges and future options of coal producing and especially coal exporting countries is needed to develop globally sound strategies for a low-carbon transition. In this report, we provide a comparative analysis of three countries which are not among the top coal consumers, but are (or were in the past) among the top coal exporters globally: Colombia, Indonesia and Viet Nam. We start with a brief review of the global perspectives on the future of coal (chapter 3). An overview of the situation of coal use and coal mining in the three countries is given in chapter 4. More detailed country profiles are provided in the annex. In chapter 5 we conduct a comparative analysis across the three countries and offer recommendations on how to support the transition away from coal. We hope that these recommendations can also be inspirational for other countries, not explicitly analysed in this study.

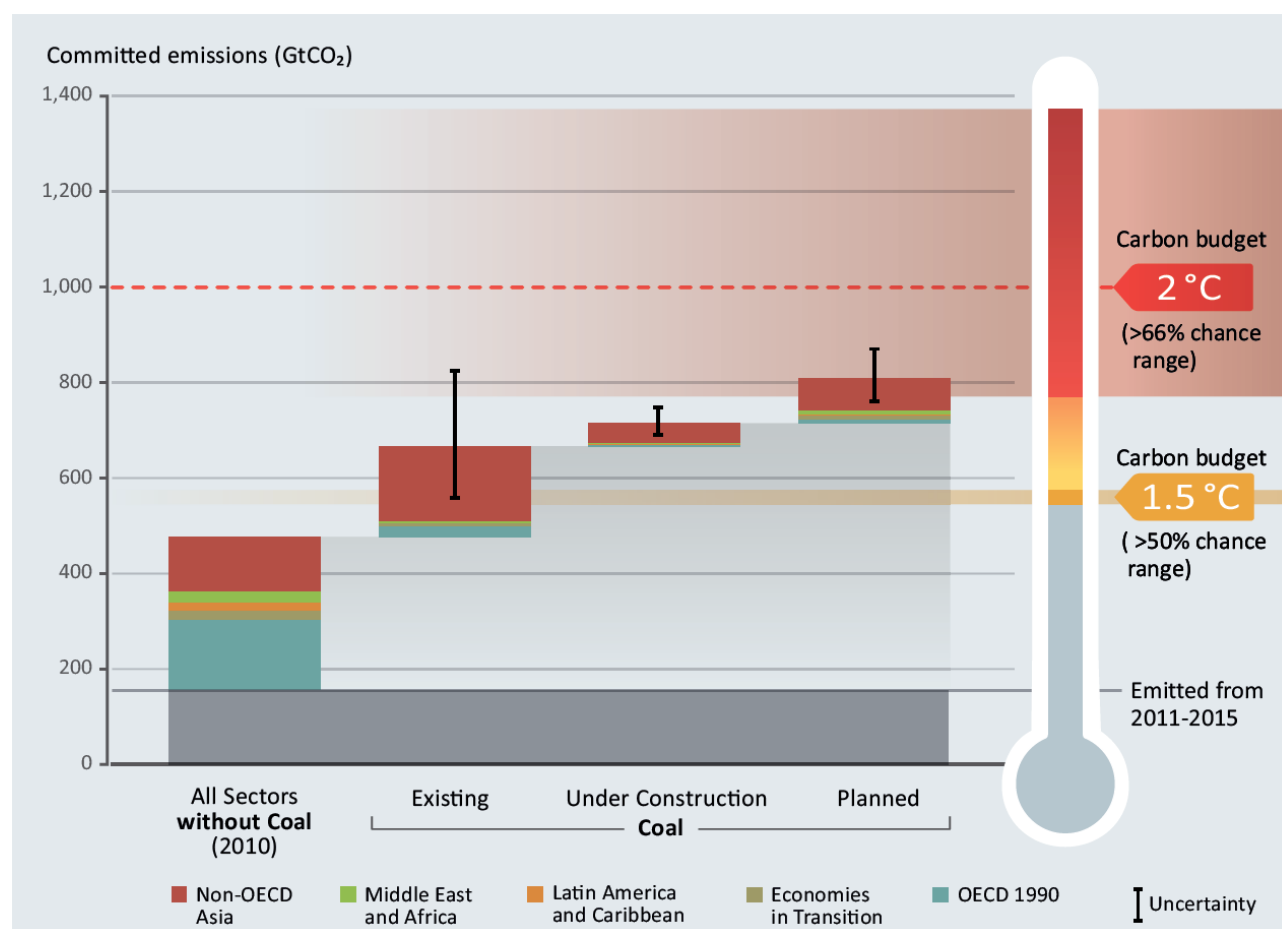
¹ In Germany coal mining peaked in 1957 with 750.000 direct jobs. All but 20.000 were lost due to mechanisation and competition from cheaper imported coal. Initially domestic coal was heavily subsidised - with approx. 300 billion € between 1950 and 2008. Over the decades structural policy had shifted more and more towards supporting the diversification of the economy and innovation in industry beyond the coal sector (Herpich et al. 2018)

3 A Global Perspective on the Future of Coal

3.1 Global Carbon Budget - Implications for the Use of Coal

In order to achieve the mitigation targets set in the Paris Agreement – to limit global warming to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C (UNFCCC 2015) – it is not only important to curb GHG emission trends quickly but also to reduce net emissions to zero in the long term. According to the IPCC scenario analysis, limiting global warming to 2°C is only likely if global net GHG emissions fall to zero before 2100 (IPCC 2014). To stay within the 1.5°C limit, global CO₂ emission would need to reach zero around 2050 (IPCC 2018a).

Figure 3.1: Committed emissions to the atmosphere from coal-fired power plants (existing, under construction and planned) and other economic sectors, by region.



Source: (UNEP 2017a)

The significance of emissions from coal-fired power plants for the global climate targets can be illustrated by using the concept of total available carbon budget. Although there is great uncertainty around the total remaining budget for a likely chance (at least 66%) of limiting warming to 1.5°C, a conservative estimate would be around 400 Gt CO₂ or less as of 2018. Similarly, for a 2°C warming limit approximately 1000 Gt CO₂ remain. (IPCC 2018a; MCC 2018). In Figure 3.1 a slightly higher remaining CO₂ budget is shown for 1.5°C, but this is because only an at least 50% probability range is used (meaning warming is just as likely to exceed 1.5°C). Regardless, the figure helps illustrate that a large part of this remaining budget would be consumed by remaining coal resources, if they are not kept in the ground. In 2015 coal-fired power plants alone emitted 14.5 Gt CO₂ and were thus responsible for 45 % of global energy related CO₂ emissions (IEA 2017a, 2018a). Assuming that all existing and planned coal-fired power plants would be in operation until the end of their technical lifetime, they

would collectively emit 234 Gt CO₂ (CoalSwarm et al. 2017). Under a conservative interpretation of the concept of available carbon budget, this alone would consume more than half of the remaining available carbon budget to stay within the 1.5°C limit. This is in line with estimates that approximately 85% of current coal reserves should not be burned if global warming is to be limited below 2° (McGlade and Ekins 2015).

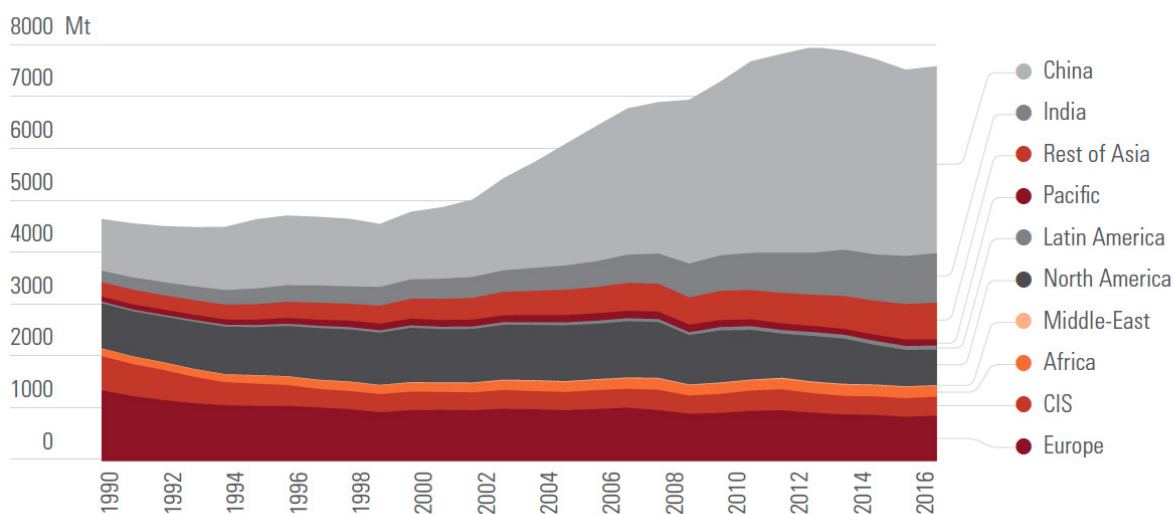
Against this background, the need to reduce GHG emissions from coal power is highlighted as one of the single most important mitigation actions in many climate scenarios. The 2 °C compatible "Sustainable Development Scenario" of the World Energy Outlook assumes a reduction of coal use from 3.755 Mtoe (in 2016) to 3.023 Mtoe in 2025 (IEA 2017b). To maintain the path to a maximum warming of 1.5°C it is deemed necessary to reduce coal related CO₂ emissions by 30% in 2025 (Kuramochi et al. 2018). The UNEP emission gap report states that global emissions from coal must be zero by mid-century to stay within the 2° limit (UNEP 2017b).

With respect to the question how climate mitigation will impact on the economy of coal producing countries, one important issue is whether reducing emission from coal directly implies reduced coal use or to which degree emission reductions could be achieved by carbon capture and storage (CCS). Ever since the IPCC's Special Report on carbon capture and storage (CCS) in 2005, there has been hope that CCS could in future make a substantial contribution to reducing CO₂ emissions from the power sector (IPCC 2005). However, 14 years later there are only two large-scale projects operational in the power sector (Global CCS Institute 2018). So a solid proof that the concept works not only as a technical theory but in terms of being technically, economically, and socially viable to be deployed at commercial scale is still missing. Barriers to technology diffusion are technology costs, lack of acceptance in some countries and storage limitations leading to a slow uptake of the technology (Gaede and Meadowcroft 2016). In consequence the various climate mitigation scenarios include very different shares of CCS (Bui et al. 2018). So on an optimistic note, CCS may help to reach climate targets quicker, beside its possible role to reduce emissions from industry and/or to achieve negative emissions through combining the combustion of bio-energy with CCS (BECCS). Quick advances in the development and employment of CCS technologies may to some degree increase the "burnable" amount of coal. However, the IPCC special report on 1.5°C states on this issue: *"the use of CCS would allow the electricity generation share of gas to be approximately 8% (3–11% interquartile range) of global electricity in 2050, while the use of coal shows a steep reduction in all pathways and would be reduced to close to 0% (0–2% interquartile range) of electricity (high confidence)"* (IPCC 2018b). In summary, our conclusion is that CCS will not constitute a major game changer for trends in global coal use which will be sketched in the next chapter.

3.2 Global Coal Trends

After more than a decade of high growth rates in global coal consumption, a reversal of the trend is imminent: consumption has peaked in 2014 and levelled-off since then. However, regional/national consumption patterns throughout the world show highly variable dynamics. While coal use has been declining in Europe, North America and Russia for many years, it has been growing in the rest of the world. This development, however, has been dominated by China, which in 2016 was responsible for almost 52% of global coal use (2788 Mtce out of global 5364 Mtce), but has displayed a slowing growth in recent years (IEA 2017c).

Figure 3.2: Global coal and lignite consumption (including thermal and metallurgical coal)

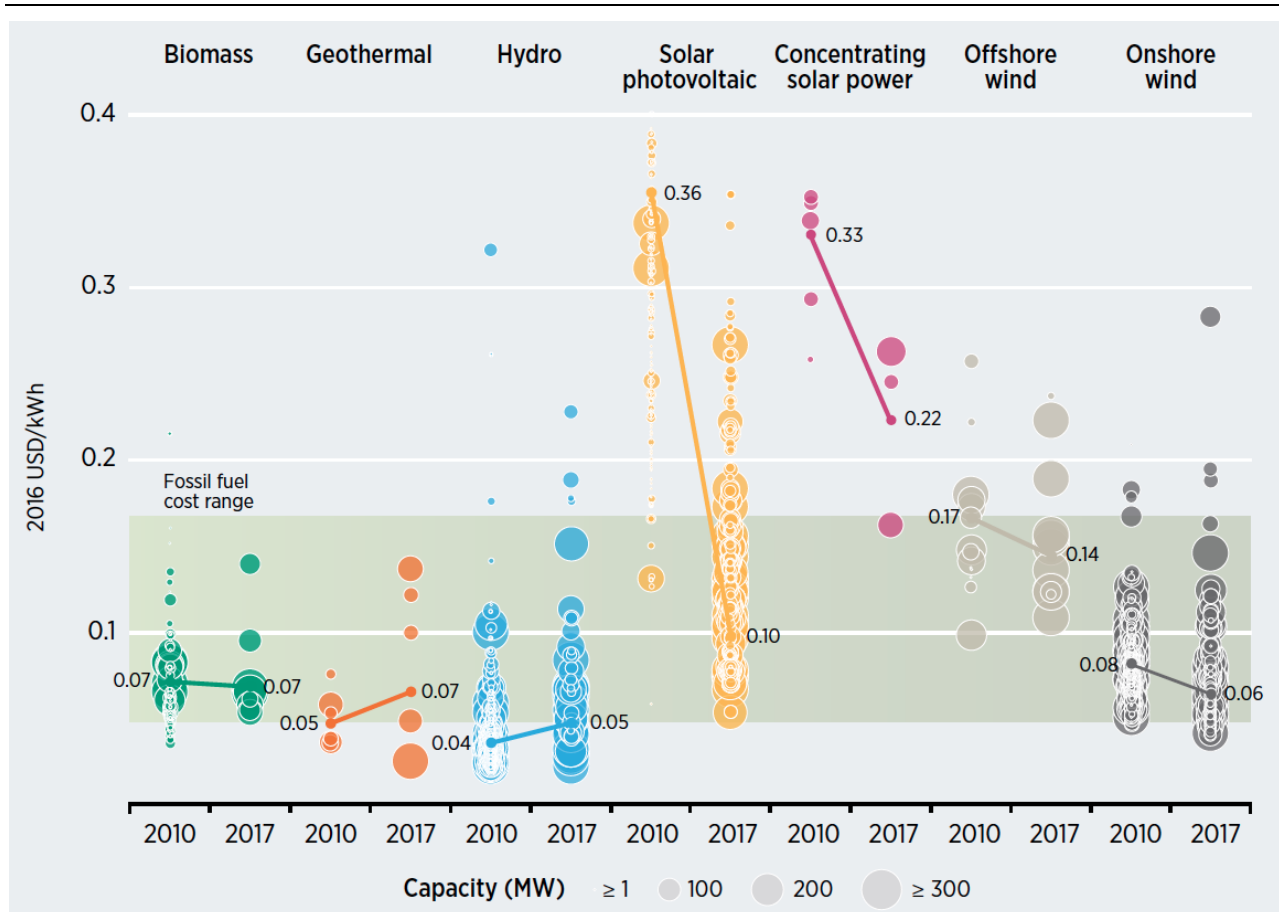


Source: (Sartor 2018)

The pipeline of coal-fired power plants in the planning phase or under construction has strongly decreased in recent years (CoalSwarm et al. 2017). In China and India alone, more than 100 projects have been put on hold (CoalSwarm et al. 2017). Global coal use forecasts in the International Energy Agency's World Energy Outlook have been lowered repeatedly since 2013 (Sartor 2018). This is largely due to changing energy policy frameworks, especially in China and India. Although drivers are manifold and include increasing concerns about local air pollution, in its NDC China sets the target to peak CO₂ emissions by 2030. However, the IEA and other studies assume that peak coal may have been reached in China today (Green and Stern 2017; IEA 2016a).

This trend is supported by the fact that costs for renewables, especially wind and solar have decreased dramatically over the last two decades. As shown in Figure 3.3, in more and more countries electricity from solar and wind is cost competitive with new coal-fired power plants (IRENA 2018). Even in Germany, a country with rather moderate wind and solar conditions, electricity costs for new onshore wind (4,0 - 8,2 €/kWh) and large-scale PV (3,7 - 6,8 €/kWh) are now comparable with new lignite power plants (4,6 - 8 €/kWh), and even undercut new hard coal power plants (6,3 - 9,9 €/kWh) in favourable sites (ISE 2018).

Figure 3.3: Global levelised cost of electricity from utility-scale renewable power generation technologies 2010 - 2017



Source: (IRENA 2018)

Note: The diameter of the circle represents the size of the project, with its centre the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE value for plants commissioned in each year. Real weighted average cost of capital is 7.5% for OECD countries and China and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.

Moreover, costs for renewables are expected to decrease further: according to Bloomberg New Energy Finance, by 2040 levelised cost of new electricity from solar PV is expected to drop another 66% and similarly from onshore wind by 47%. In conclusion wind and PV will produce electricity at lower cost than existing coal plants (Bloomberg New Energy Finance 2017). With expected cost reductions in batteries (IEA 2017b; IRENA 2017), system costs (dispatchable electricity) will close in on those of power from fossil fuels in the near future.

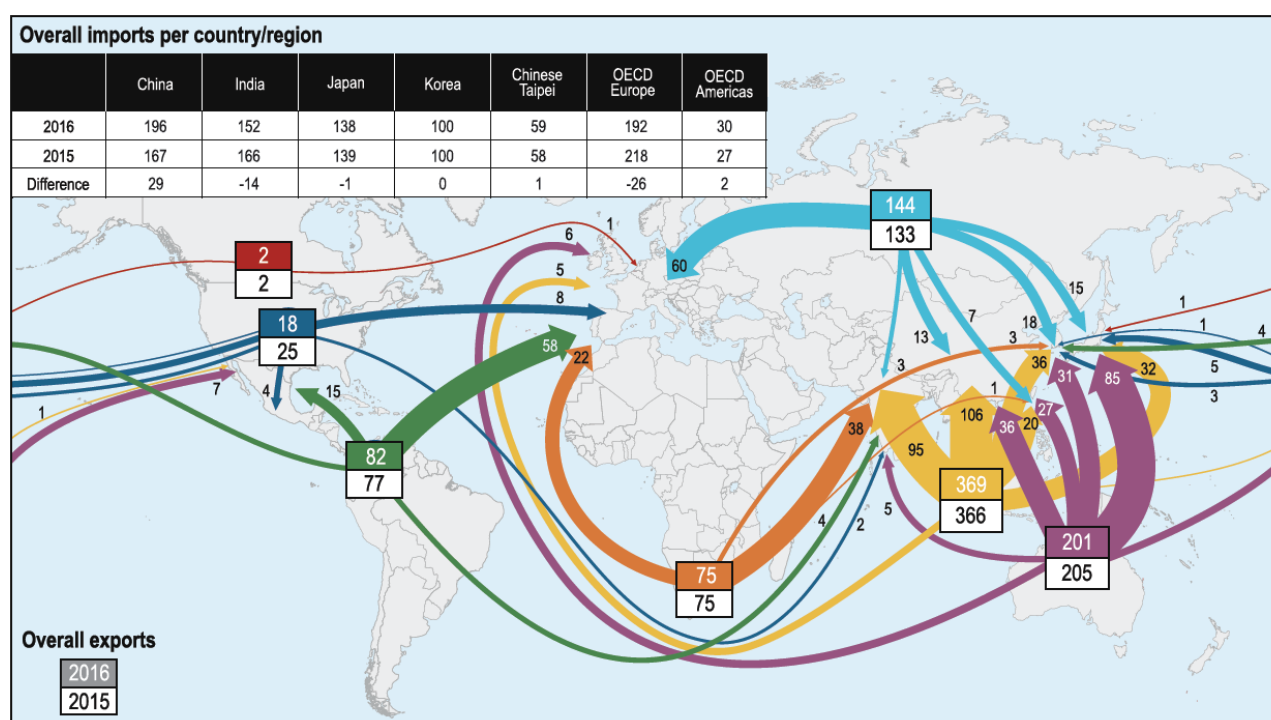
In conclusion, global coal use is likely to decrease in the future. Assuming that countries would only implement their planned policies ("New policies scenario" of the International Energy Agency's World Energy Outlook), then global coal consumption would stay about constant. However, any more stringent climate ambition would lead to a decrease in coal use. The IEA's Sustainable Development Scenario (with 50% probability of reaching 2°C at the lower end of the Paris targets) assumes a reduction of global coal use of approximately 50% in 2040 compared to 2016 - this is already including the employment of CCS (IEA 2017d). According to the IPCC Special Report on 1.5°C, limiting warming to 1.5°C means not only reducing coal use significantly, but phasing it out by 2050 (IPCC 2018b).

4 At a glance - Energy and Coal in Colombia, Indonesia and Viet Nam

Neither Colombia, nor Indonesia, nor Viet Nam are among the top 10 coal consumers of the world and only Indonesia is among the top producers. However, in terms of export volume Indonesia ranks second² and Colombia fourth (IEA 2017c). Viet Nam has come to be a net-importer of coal but a decade ago it also was among the top ten exporters (export volumes peaked at 32 Mt in 2007).

Key markets for coal from Colombia and Indonesia differ: While Colombian coal is mainly shipped to Europe, Indonesia exports its coal predominantly to Asian markets (see Figure 4.1). The other heavy weights in coal export are Australia, Russia and South Africa.

Figure 4.1: Most important flows of global thermal coal market 2016 (export volumes in Mt)



Source: (IEA 2017e); © OECD/IEA 2017; IEA Publishing. License: www.iea.org/t&c

In the following section we give a brief overview on the situation of coal mining and coal use in Colombia, Indonesia and Viet Nam. A more detailed country profile is provided in the Annex.

² Important to note: Australia was the world's biggest coal exporter in 2016 with 390 MT. However, approximately half of this coal is high quality "cooking coal" which is mainly used for industrial processes like steel making (often called "metallurgical coal"). In terms of so called steam coal or thermal coal, which is used for electricity generation, Australia is even second to Indonesia. (IEA 2017c)

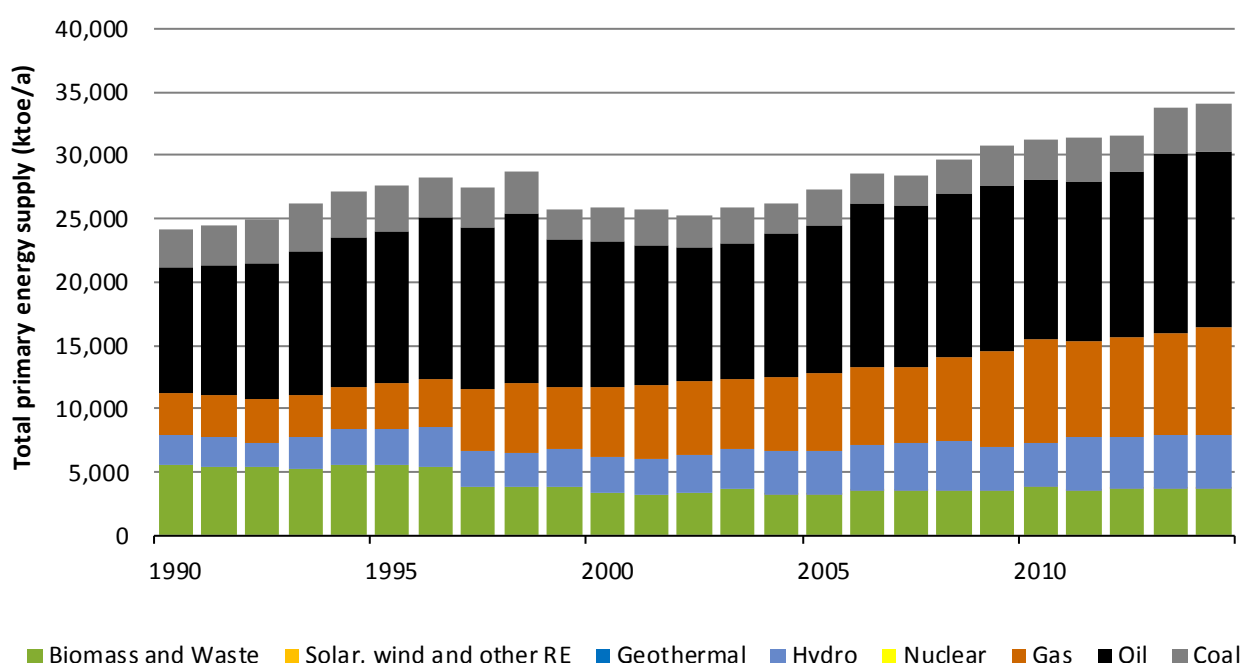
4.1 Colombia

Colombia is an energy-rich country, in particular with regards to coal, gas and hydropower. Fossil fuels have gained in importance (Figure 4.2) leading to a growth of CO₂ emissions from energy use by 50% between 1990 and 2015 (IEA 2018b). Colombia's electricity consumption has almost doubled over the last decade, with an annual growth rate of around three to four percent reaching 62 TWh in 2014 (IEA 2017f). Electricity is mainly generated by hydropower (71% in 2014; (IEA 2016b)).

To cope with the expected future growth in energy demand, decrease its dependence on hydropower (due to increasing and more severe droughts in the past) and boost exports, Colombia is concentrating on expanding its coal and gas fired electricity capacity. At the same time, the government plans to increase the share of grid-connected renewable capacity (other than hydropower, but including biomass) from 3.3 to 6.5% by 2020 (Briscoe et al. 2016).

Figure 4.2: Colombia's historical energy profile

Primary energy by energy carrier



Data sources: IEA (2016a)

Colombia is the eleventh largest coal producer in the world, with a production of around 90 Mt per year. The export share is around 95%, which makes Colombia the fourth largest coal exporter in the world (IEA 2016d)(Garcia et al. 2017). Colombia is estimated to have 5.041 Gt of probable coal reserves (IEA 2015a). The export value amounted to USD 5.3 billion, and coal is responsible for 14% of the country's export earnings (MIT 2017a). Thus, the coal industry is a key economic factor for the whole country, providing jobs for coal mining regions.

However, Colombia's coal export earnings have been decreasing since 2015 due to a drop in international coal demand. As a consequence, coal is increasingly being directed towards domestic use underpinning the plan to ramp up coal-fired power plants. By July 2017, an additional 550 MW in coal-fired power capacity had been announced and 250 MW are under construction (Global Coal Plant Tracker 2017).

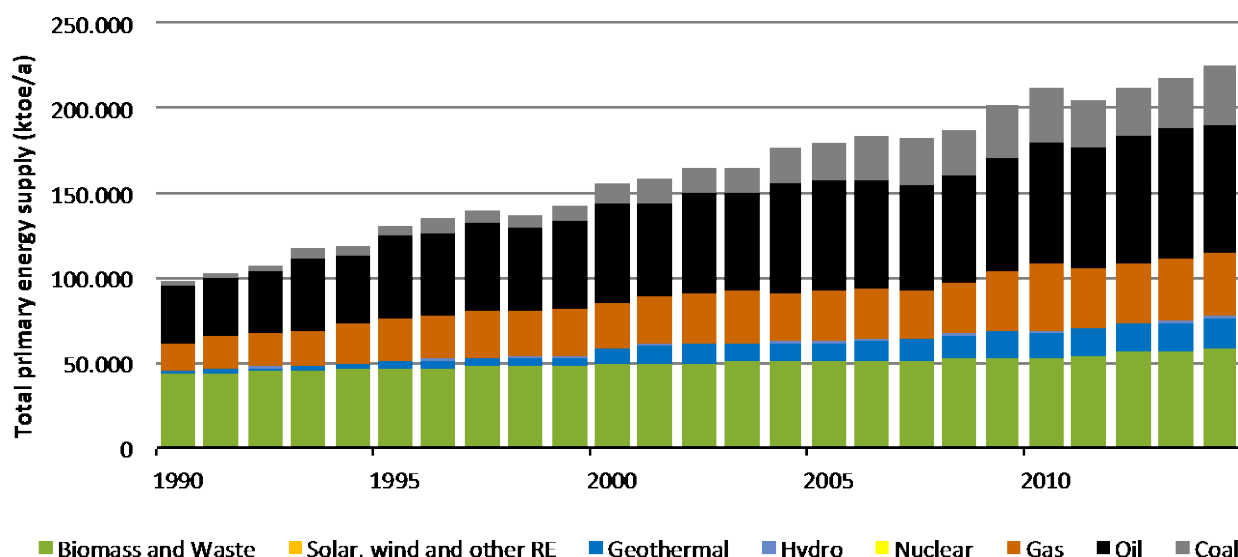
4.2 Indonesia

Fifteen years ago, Indonesia's energy demand was largely satisfied by domestic oil, biomass and gas. In recent years, growth rates of renewables have been much smaller than those for fossil fuel. Especially coal has risen in importance. In 2014 primary energy demand was mainly met by the use of oil (33 %), biomass and waste (26 %), natural gas (16 %), coal (16 %) and geothermal energy (8 %) (IEA 2016c).

Indonesia's electricity consumption has almost doubled over the last decade, reaching 230 TWh in 2014. Demand growth is largely linked to the country's economic growth and strongest in the commercial and residential sector as well as the increase of the country's electrification rate, which is planned to reach more than 97% in 2019 (DG Electricity 2016). To cope with the expected future demand growth, Indonesia plans to install more than 70 GW of new capacity until 2024, 60% of which would be by new coal-fired power plants. At the same time the government plans to reverse the trend for renewables and to increase their share to 23% renewable electricity in 2025, mainly from hydro and geothermal.

Figure 4.3: Energy profile of Indonesia

Primary energy by energy carrier



Data sources: (IEA 2016c).

Indonesia is the fifth largest coal producer in the world, with a production of 484 Mt per year. The export share is almost 85%, which makes Indonesia the biggest coal exporter in the world (in some years second to Australia). With an export value of more than USD 23 billion (MIT 2017b), coal is responsible for 10% of the country's export volume (palm oil is 9%). Thus, the coal industry is a key economic factor for the whole country, providing jobs and royalties for coal mining regions.

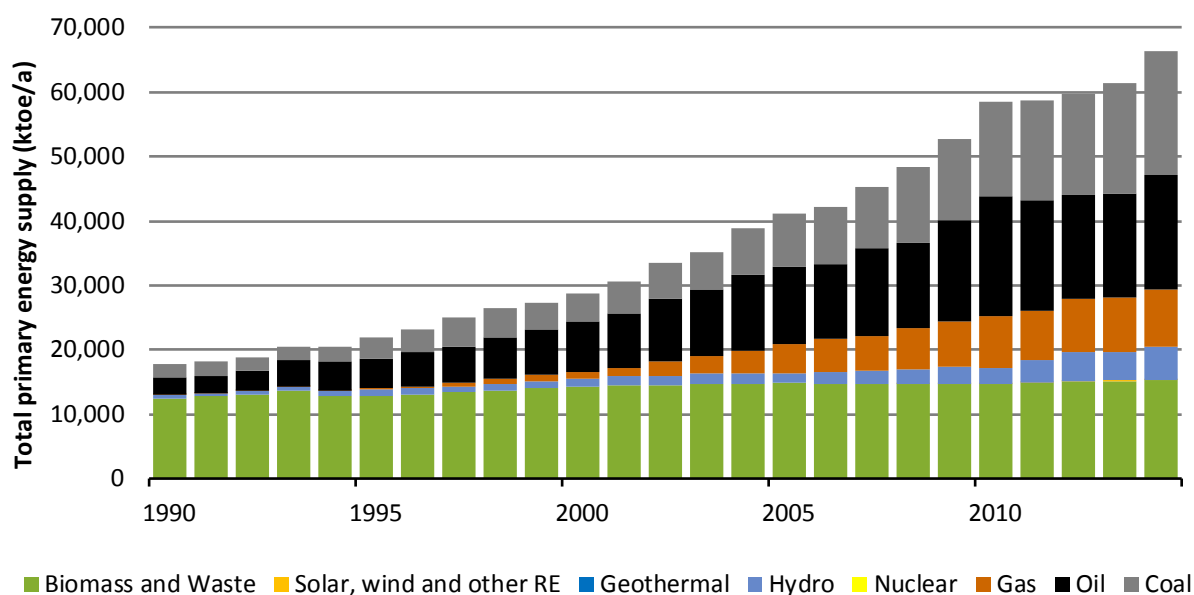
Exports of hard coal have gone to many Asian countries, while brown coal predominantly was exported to China. After steep growth rates over the last decades, coal exports have decreased in 2015. The reduced demand from countries like China, India and Japan falls in line with a change in the national energy strategy, which aims at a cap of coal production at 400 Mt per year. Coal is increasingly to be directed towards domestic use underpinning the plan to massively ramp up coal-fired power plants.

4.3 Viet Nam

Primary energy use is dominated by fossil fuels. Coal is the largest energy source with 29% of total supply, followed by oil (27%), biomass and waste (23%), and gas (13%). The traditional use of biomass and waste has remained constant since the early 1990s and growing demand has been largely met by fossil fuels and an increasing share of hydro. The share of other renewable energy is as yet negligible in primary energy (IEA 2016c) and constitutes only 3.7% of electricity generation with the bulk of electricity production almost equally distributed between coal, gas and hydro (GIZ 2016).

Figure 4.4: Energy profile of Viet Nam

Primary energy by energy carrier



Data sources: (IEA 2016c)

Viet Nam has substantial hard coal reserves as well as oil and gas. However, the demand in industry and for power generation is so high, that the country became a net importer of coal in 2015. Oil and gas reserves are also substantial and mainly located offshore.

Viet Nam has the 13th largest hard coal reserves globally, with an estimated 3,116 Mt (BGR 2014). Mining and power generation are in the hands of government-owned corporations, VINACOMIN and EVN. The economic importance of the coal sector as represented in the coal rent is fluctuating strongly and has decreased over the last years after a period of stronger influence, with the share of coal in GDP estimated at 0.16% for 2015, down from a peak value of 2.8% in 2008. For comparison: in Germany the respective share in 2015 was 0.013%, down from a peak value of 0.83% in 1982 (World Bank 2017). Demand increase has led to net imports since 2015 (EIA 2016).

5 Comparative Analysis and Recommendations

5.1 Coal Use and Energy Policy

Domestic coal use has doubled in the last decade in Indonesia and Colombia and more than tripled in Viet Nam. And all three countries have plans to increase coal use for domestic energy, specifically electricity supply. Despite the differences in the countries energy systems and consequently quite different shares of coal in the energy mix (see above), all three countries follow the strategy to increase domestic use of coal. In the details, however, there are big differences: Viet Nam has already transformed from an important exporter of coal (peak in 2007) to a net importer today. In contrast, Indonesia consumes only 20%, Colombia only 3% of its own coal production.

All three countries are rich in renewable potential and have large untapped energy efficiency potentials. Our analysis shows that a large share of the planned coal-fired power plants would not need to be built, if the countries were to intensify their efforts to reduce energy demand (growth) by more stringent energy efficiency measures and satisfy energy demand by a higher share of renewables, especially wind and solar, and in the case of Indonesia also geothermal energy. Given the recent dramatic cost reductions for most renewables, these alternatives in many cases would be cost-competitive or even cheaper than building new coal-fired power plants. Thus, one important step would be to re-assess cost structures of the national energy strategies and utility plans based on latest stage cost data for renewables. A very recent report estimates cost structures for future electricity supply options in Indonesia and Viet Nam, concluding that PV would become cheaper than new coal-fired power plants in 2021 in Indonesia and 2022 in Viet Nam. Competitiveness with existing coal plants is expected between 2027 (Viet Nam) and 2028 (Indonesia). Against this background utilities in the countries risk many billion USD of stranded value on coal-fired power plants in the near future (Carbon Tracker Initiative 2018).

Not to be mistaken, all three countries do have strategies to improve both energy efficiency and renewable energy use. However, in each country there is leeway for more ambitious action. Concrete measures differ from country to country. For example, Colombia currently has a low share of wind and solar, which could be increased fairly easily given the high share of hydro power (since hydro power could easily compensate fluctuating supply from other renewables). Indonesia has quite ambitious renewable energy targets. Here the challenge would be to quickly implement projects at a scale consistent with renewable targets. Achieving this could provide a basis to reconsider the massive ramp-up plans for new coal-fired power plants - which would be a pre-requisite to limit energy related CO₂ emissions.

Conclusion: short-term implementation of energy efficiency and renewables necessary

Viable options exist in all three countries to limit (growth of) domestic coal use in the short to mid-term. What is needed however are quick wins in the fields of energy efficiency and use of renewables – and political backing for a mid to long-term strategy. To receive this political support, it will in our view be decisive to develop strategies, which reduce the respective national and regional economic dependency on coal production.

5.2 Outlook on Global Coal Trade

Recent coal market assessments of the International Energy Agency show that both Colombia and Indonesia have highly competitive combined production and shipping costs of coal globally (IEA 2016e). Only coal from open pit mines in South Africa can compete. Coal from Australia and Russia is more expensive both in mining and shipping. However, coal cannot be used interchangeably for any global market, since coal-fired power plants are geared towards one specific quality of coal. Europe imports

rather high quality coal, while Asian countries also import relatively high shares of brown coal. For exporters, this means that they are limited to exporting their coal to other countries, if demand goes down.

For Colombia and Indonesia these trends and framework conditions result in different export perspectives (Oei and Mendelevitch 2018):

- ▶ Coal from Colombia is generally of higher quality and thus suitable for modern, high-efficient power plants. In consequence, 75% of Colombian coal goes to Europe - where coal consumption is most likely going to decrease in the coming decades.
- ▶ Coal exports from Indonesia contain high shares of lower quality coal and are aimed for respective power plants in India and South-East Asia. Countries in which coal consumption is currently still growing or peaking.

Generally, scenarios on the development of the global coal market strongly depend on assumptions of how quickly the world aligns on a pathway compatible with the Paris climate targets. Without assessing the details of the various scenarios, global coal demand is to peak before 2025 in 2° pathways. Assuming that the big coal consumers (including China and India) will prefer to use domestic coal over imported coal, this would very quickly lead to a reduced export markets for Indonesia and Colombia. Against the background that 10% of Indonesia's and even 14% of Colombia's export revenues stem from coal export (MIT 2017a); it is obvious that a reduction of coal exports would put a high challenge on the respective national economies.

Shrinking global coal markets will put economic pressure on Colombia and Indonesia

In conclusion Colombia is very likely to face a decrease in demand from its traditional costumers and may in future increasingly compete with Indonesia for the Asian coal market. Depending on how quickly the world aligns with a development compatible with the Paris Agreement, both countries may face a massively diminishing potential to export coal in future decades.

5.3 Economic and Regional Development

For the coal exporters Colombia and Indonesia, revenues from coal mining and export are important for their national economy and also government finance. For Indonesia, data was available for the mining sector as a whole (coal and other resources), which in 2014 amounted to 2.8 billion USD, around 10 % of total state revenues (EITI 2017). The Colombian governments received USD 510 million in taxes and royalties from coal companies in 2015 (Glencore 2017). However, critics claim that the royalty system has hampered the development and effective use of domestic industrial and human skills (Strambo and Velasco 2017).

Coal mining also provides many employment opportunities. In addition to the high number of direct jobs in coal mining (see Table 5-1), generally a large number indirect jobs in coal mining regions depend on mining activities. Importantly, the sector generates jobs for vulnerable populations in remote areas, and coal jobs are the main economic activity in some regions (Unidad de Planeación Minero Energética 2014). However, more detailed employment figures (including information on occupational health, income, skills, age etc.) would be needed to assess the impacts of energy transitions away from coal and to design measures for a socially just transition (Neefjes and Hoai 2017).

It is important to note that coal mining does not only bring positive developments to mining regions (see section on external costs and subsidies below), but it is a key factor for the respective national and regional economies.

Table 5-1: Employment in coal mining

Country	Number of Jobs	Source
Colombia	180,000 people directly employed in coal mining and 130,000 in mining services (2014)	(IEA 2015b)
Indonesia	202,000 direct jobs in mining in general (2013)	(Unidad de Planeación Minero Energética 2014)
Viet Nam	140,000 direct jobs in coal mining (2015)	(Neefjes and Hoai 2017)

Against the background of a likely decrease of global coal use in the future (as argued above), this strong dependency on coal is a risk for the national economies of coal exporting countries and for regional development in the mining regions. In our view it is advisable to start early to plan for the time beyond coal - even in countries, which currently do not plan for a phase-out of coal use and mining, which, in contrast, plan to increase coal use or mining. The reason is that restructuring an industry region is a very long-term process. Historic examples show that it can take several decades for former coal mining regions to establish alternative economies, especially if the transition is to be managed in a way to avoid massive job losses or even migration out of the region (Sartor 2018).

General analysis of "climate policy implications for fossil fuel-rich developing countries" show that diversification of the economy and the reduction of state investment in the fossil fuel industry should be key components to a climate proof economic development strategy (Manley et al. 2017). A wealth of experiences how to deal with structural change exists around the world. Currently, the European Commission is facilitating an exchange program for EU coal regions to prepare better for a climate policy driven coal phase out in Europe (EC 2018). The World Bank has for many years engaged in supporting mine closures around the world (World Bank 2018).

It would be advisable to use this knowledge to develop strategies for developing countries whose economies today strongly depend on coal mining and coal use. A few very recent publications already exist, which touch upon questions of a socially just transition away from coal in developing countries (Neefjes and Hoai 2017; SEI 2018), but they do not yet reach the level of detail, which would be necessary to design an economic development strategy beyond coal for the respective countries. It was not the objective of this study to analyse options how such a transition process could be designed specifically in any of the analysed countries, but from the above named experiences some general lessons can be derived:

- ▶ **Long-term transition planning:** Due to the very long lead times of structural change processes (many decades), it is important to proactively engage on an economic development strategy, with the objective to diversify the national and regional economy.
- ▶ **Policy coordination:** Fields of action are manifold and most of them lie outside the classical sphere of energy and climate policy. Thus an exchange of knowledge between and coordination among the different policy spheres and sectors is necessary.
- ▶ **Sustainable financing strategy:** Structural change requires high investment volumes. It is important to redirect public finance streams away from old industries into sectors with high future potential.
- ▶ **Strengthen the local innovation system:** The innovation system in mining regions often is either geared towards mining (e.g. strong focus on specialised engineering), or generally neglected (weak research and education in rural mining regions). This hinders a future oriented diversification of the regional economy. Historic examples show that coal mining companies often do not have an

interest in economic diversification as this would mean that they have to compete even more for land and workers with other branches.

- **Environmental standards for coal mining:** Low environmental standards for coal mines lead to high local pollution of soil and water, which reduces options for alternative economic activities in the region (including agriculture or tourism) in parallel to mining activities or after mine closure.

In our analysis of Colombia, Indonesia and Viet Nam we see very little activities (if at all), to prepare coal mining regions for a time beyond coal. This comes as no surprise, given the current situation in the countries, (coal production is still on the rise) above mentioned time spans and interests of incumbents. However, if economic alternatives to coal mining are not explored (regionally and nationally), this may negatively impact on the climate ambition of the countries if coal use prolonged or intensified to support domestic coal mines.

A proactive strategy for an economic development beyond coal needs to be developed timely

Against the background of a levelling-off of global coal demand, coal rich countries should reconsider their strategies of intensifying coal production in order to avoid a boom and bust cycle, the negative impacts of which would have to be borne by society at large. Due to the long lead times of structural changes process, immediate proactive development strategies for a time beyond coal seem advisable. Climate policy and development partnerships with coal-rich countries should thus not only be limited to collaboration and support in the field of alternative energy policy, but also entail collaborations to explore and develop alternative business models specifically in coal mining regions. Concrete activities have to be tailor-made for the respective region, but may include better education, attracting alternative branches to coal mining regions and safeguarding local potentials, including a clean and safe environment.

5.4 Negative local impacts of coal mining

Beyond CO₂ emissions, coal use and coal mining have heavy local environmental impacts. Coal burning is responsible for particle matter emissions and in consequence for respiratory diseases. In all three countries analysed, coal mining was responsible for severe environmental damages in mining regions. Toxic and acid pollutants into soil and water are a problem in most regions, which represent not only a health risk but also reduce the economic potential for agricultural use. In the analysed countries the environmental standards are either lower than in Europe or standards are not enforced. A high risk exists that negative impacts will prevail even long after mine closure and of mining companies to not cover or compensate for local damages. Considering that export opportunities for coal will decrease in the future the risk increases that mining companies may financially not be in a position to cover for land and environmental remediation after mine closure unless counter measures are taken today (e.g. national funds for remediation).

Specifically in Colombia, scientific studies and NGOs point to human right violations in coal mining regions (Misereor 2017; Niebank and Utlu 2017; PAX 2014). Claims exist that paramilitary violence in coal mining regions show links to the coal mining industry (PAX 2014).

Industrial buyers of coal are increasingly aware of negative local impact of coal mining and in response have formed an industry alliance "Bettercoal", which aims at improving conditions for workers and local communities all along the coal supply chain (Bettercoal 2017). However, their activities are challenged by NGOs not to have a sufficient impact e.g. on human rights violations in Colombia (Misereor 2017).

Reducing negative local impacts of coal mining

In the interest of long-term sustainable development of coal mining regions, negative local impacts of coal mining, like health risks for workers and local communities, environmental pollution or human right violations should be avoided. Stringent legislation needs to be implemented and enforced to ensure that the coal mining industry is covering long-term costs including land and environmental remediation after mine closure.

5.5 Subsidies

In all three countries analysed, coal mining and sometimes also coal use, have received high levels of direct and indirect subsidies. In the recent past, efforts have been made to reduce these subsidies. However, the situation is quite different in the three countries:

- ▶ **Colombia:** The coal export sector has traditionally received large support from the government. Tax discounts are common. In 2015, the mining sector received 23.4% of the total value of tax discounts provided to legal entities in Colombia, which reduced companies' income taxes by 11%. Between 2005 and 2010, tax breaks exceeded the amount of income taxes paid by mining companies. Even after the elimination of an expensive fiscal incentive in 2011, the effective tax rate for the coal sector was still, on average, only 66% of the nominal rate (Strambo and Velasco 2017). Direct support in form of fossil fuel subsidies however is very low (IEA 2016f), amounting to USD 268,000 (UPME 2016a).
- ▶ **Indonesia** has a long tradition of high subsidies on energy. In 2014 energy subsidies peaked at USD 26 billion per year, which equalled 4.5% of Indonesia's GDP (World Bank 2017b). Indonesia has a long history of attempts to reduce energy subsidies and the latest reform has brought down subsidies for fuels from 3% of GDP in 2014 to 1% of GDP in 2015, but for electricity still amount to USD 4.4 billion in 2016 (IISD 2016). The national electricity company Perusahaan Listrik Negara (PLN), which has the monopoly on transmission, distribution and retail of electricity is operating at a loss due to low electricity prices (The Australia Institute 2017). The potential for emission reductions through stringent subsidy reforms have been estimated to be 5 to 7% in the short-term and 9% with a 2030 time horizon (ADB 2015).
- ▶ Fossil fuel subsidies in **Viet Nam** as calculated by the IEA have decreased over the last years and reached an all-time low in 2015, with USD 211 million and an average subsidy rate of 1.1%. This represents only 0.1% of GDP and translates to USD 2.3 per person (IEA 2016g).

Reduce coal subsidies - and redirect investments in diversification of the economy

From a climate policy perspective it is important that the true cost of coal mining and use are visible to buyers of coal. Thus efforts to reduce subsidies on coal mining and use should be intensified. Coal mining countries should consider redirecting financial flows into other sectors of the economy, which are consistent with a low-carbon development and thus also promise a long-term economic benefit for the country.

6 Annex - In-depth analysis of coal perspectives in Colombia, Indonesia and Viet Nam

The analysis in this paper is mainly based on an in-depth analysis of NDC implementation in Colombia, Indonesia and Viet Nam. Full reports are available at:

<https://www.umweltbundesamt.de/en/topics/climate-energy/ten-country-reports-on-ambitious-climate-policy>.

The respective sections: "Assessment of the relevance and perspectives of coal use" for the three countries are included in this annex.

6.1 Colombia

Colombia is a country with large reserves of oil, gas and coal. Its coal reserves amount to 0.8% of global reserves, and they are the largest in Latin America (World Energy Council 2013). Colombia is the eleventh largest producer of coal and the fourth biggest exporter in the world. While domestic use of coal is only 3% of the coal production, it has rapidly increased in recent years.

Against this background, this chapter explores the role and perspectives of coal for Colombia: starting with an overview on the economic role of coal more broadly, and a detailed analysis of the country's position as a major coal exporter, we then analyse the historic and current domestic use of coal. In addition, we give an overview of local impacts of coal use and mining, followed by a brief analysis of the country's coal phase out potential.

6.1.1 The economic role of coal

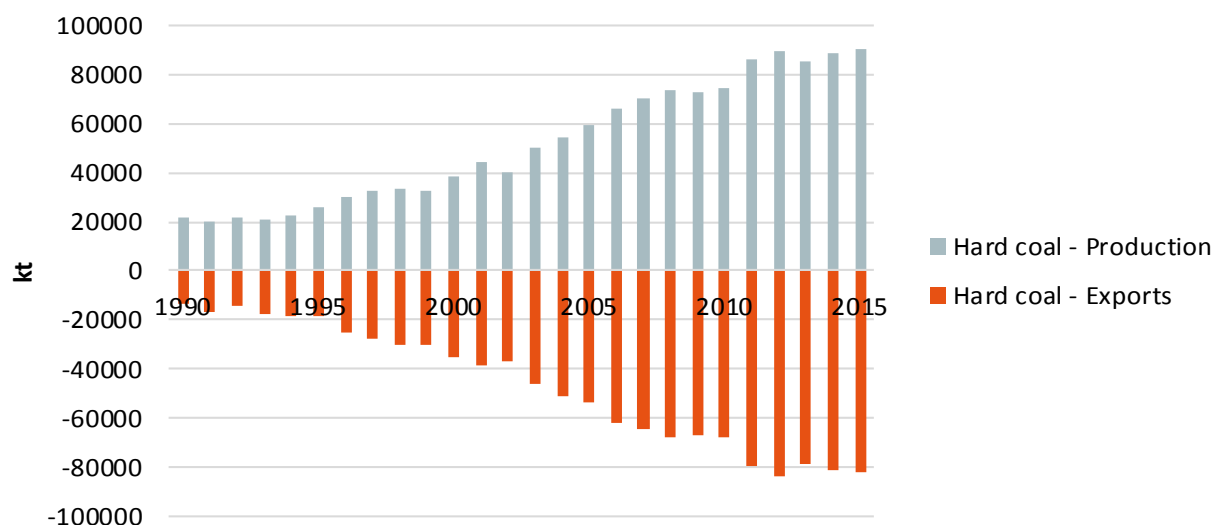
Coal production and coal trade

In Colombia, coal has been a pillar of the national economic development strategy, together with other parts of the mining and energy sectors. The country's National Development Plan (2014-18) has a focus on the extractive, including coal, sectors. Coal exploration was actively encouraged under President Uribe Velez (2002-2010), and has continued since then under President Santos (Strambo and Velasco 2017).

Coal production has significantly increased over the last years. Relatedly, coal mining for export has also soared in Colombia, with production having increased by 80% since 1999 (World Energy Council 2013).

In the past, Colombia has not produced as much as they intended to due to a mixture of decreasing global demand and low international prices of coal (Strambo and Velasco 2017). Nevertheless, production stood at a record high of 91 million tonnes in 2016. Around 95% of extracted coal is exported (Figure 6.1). Colombia is the world's fourth largest coal exporter and eleventh largest producer (IEA 2016d).

Figure 6.1: Coal extraction, import and export in Colombia (1990 - 2015)

Coal imports, exports and production

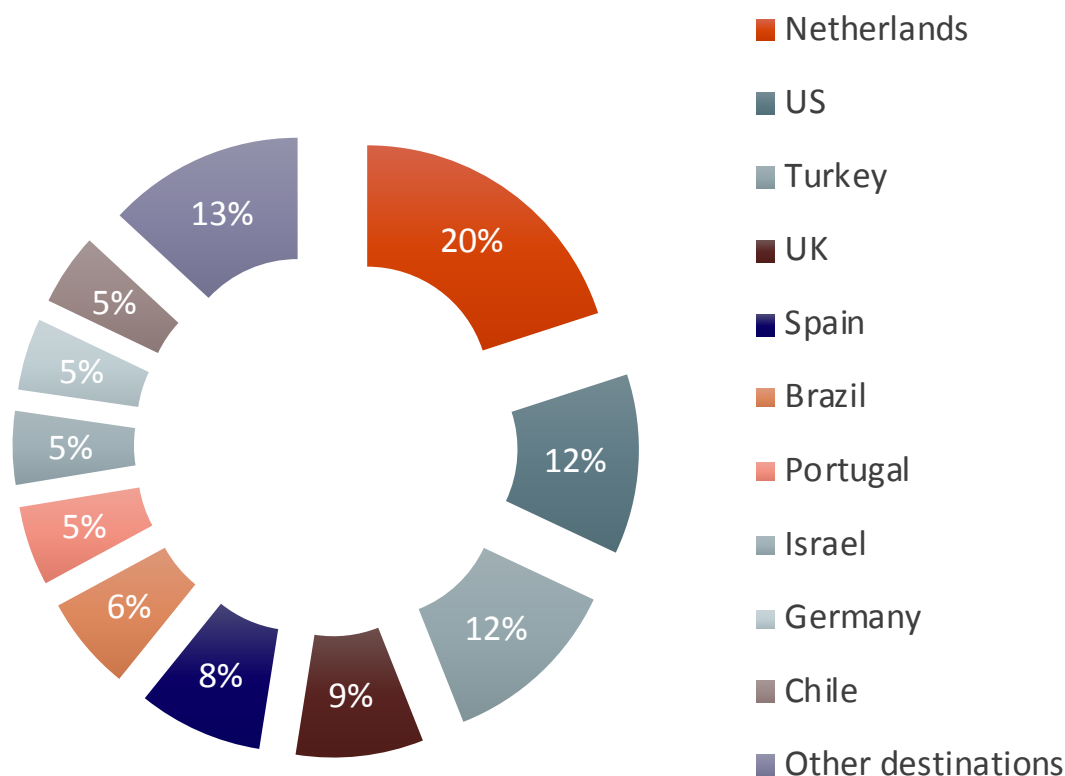
Data source: IEA World Energy Balances (2016)

Colombia is considered to be a low-cost producer whose coal is highly sought after due to its low sulphur content (World Energy Council 2013). Due to shorter distances compared to other geographies (such as Australia and much of Asia) with resulting lower freight costs and the high quality of its coal, Colombia exports most of it to European and American markets. Two-thirds of production is exported to Europe, and 20 percent to other countries in Latin America. In 2016, the largest importer of Colombian thermal coal was the Netherlands with 17.26 million tonnes (S&P Global Platts 2017). In 2015, Germany was the ninth largest importer of Colombian coal briquettes (MIT 2017a). However, this is an indirect import. In fact, Germany gets the Colombian coal through the Netherlands which exports 73% of Colombian coal to other countries, mostly Germany (87%) (Garcia et al. 2017)(MIT 2017a)(MIT 2017). Another twelve percent was directly exported to the United States, representing 73 percent of US coal imports (also see Figure 6.2) (Briscoe et al. 2016).

The recent widening of the Panama Canal will benefit Colombian coal exports in the future, further decreasing the distances that the country's coal has to travel to its main export markets in the EU and the US and therefore leading to decreasing shipping costs (PAO-YU OEI; ROMAN MENDELEVITCH 2016).

Figure 6.2: Colombian coal exports destinations in 2014

Hard coal



Data source: OEC - the Observatory of Economic Complexity(MIT 2017a)

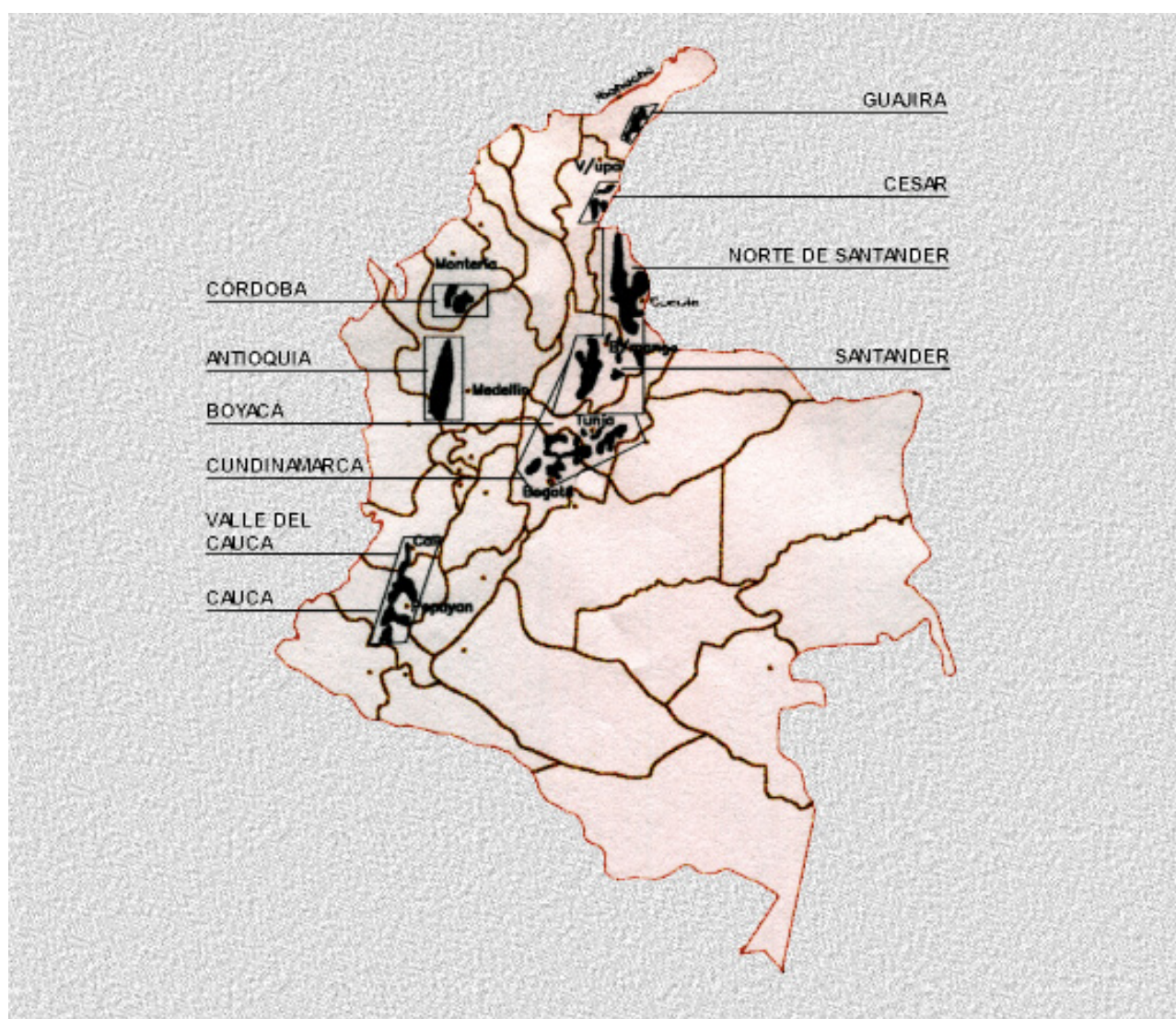
Geographic distribution of coal mining

90% of Colombia's coal is extracted from remote areas in the north and the west of the country, in particular the Guajira Peninsula and Cesar (Agencia Nacional de Minera 2014). The development of Colombian coal for export has centred in particular on the Cerrejón deposits, the country's biggest open pit coal mine, on the Guajira Peninsula (World Energy Council 2013). In 2015, more than 90% of coal exports came from mines in La Guajira and Cesar (UPME 2016a). More than 92% of coal extraction is done in open pit mines (Zárate and Vidal 2016).

At the same time, coal production strongly varies depending on the geographic location: On the one hand, coal produced in the north represents approximately 90% of Colombia's total production, and 99% of the production is exported. It is produced in large scale by multinational industries that in the past were repeatedly embroiled in controversies about their labour standards and environmental track record (The Guardian 2016). The Colombian state owns all coal reserves and unlike the oil sector, private, mostly large multinational companies operate coal mines under concession contracts with the state (World Energy Council 2013). The biggest coal companies include BHP-Billiton (Australian-British), Glencore (Anglo-Swiss) and Drummond (American).

The coal produced in the inner parts of the country, on the other hand, is mainly used for domestic consumption (30% is exported), has a medium to small production scale, is less pure and is made by medium and small producers, some of them informal (Salazar, Benavides, Cabrera, & Zapata, 2011).

Figure 6.3: Map of Colombian coal reserves



Data source: UPME (UPME 2017)

Relevance of coal for the Colombian economy

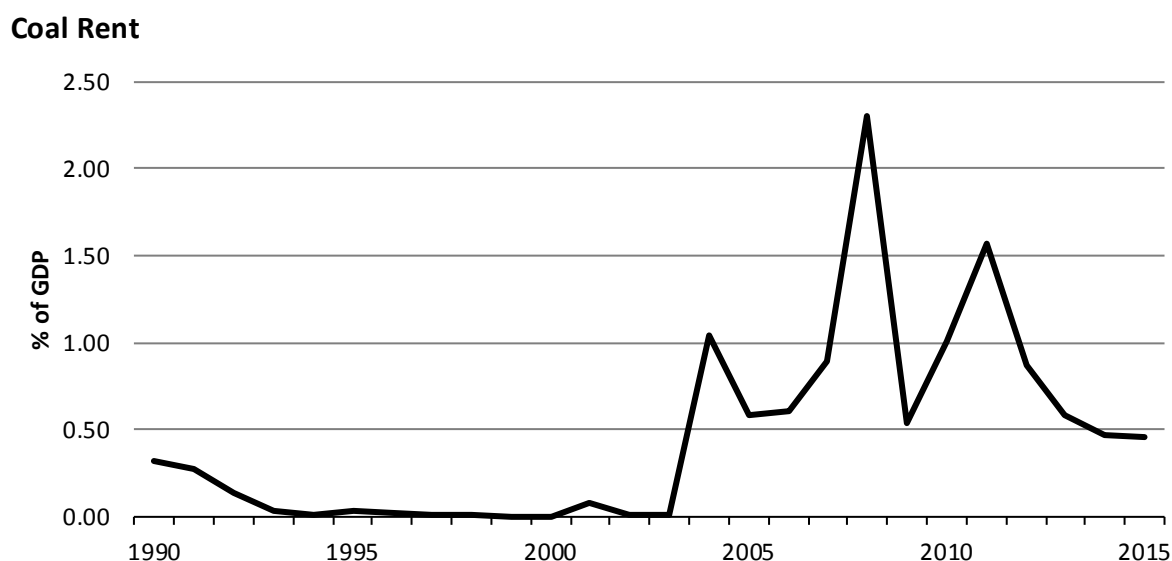
Coal plays an important role for Colombia's economy. In 2015, coal contributed to 1.3% of Colombia's GDP (Strambo and Velasco 2017). The export value amounted to USD 5.3 billion, and coal is responsible for 14% of the country's export earnings, after crude petroleum which accounted for 34% of earnings in 2015 (MIT 2017a). The sector is also a major recipient of foreign direct investment (FDI). The mining sector received USD 1.6 billion FDI in 2014 (30% of the country's total FDI) (UPME 2015). Thus, the coal industry is a key economic factor for the whole country, providing jobs and royalties for coal mining regions.

However, after steep growth rates for the last decades, coal export earnings have decreased significantly in 2015 (down from USD 7.6 billion in 2013/14) as export prices have fallen. Anthracite coal is down from USD 339/t to USD 195/t (-42%), coal briquettes down from USD 284 in 2012 to USD 123 in 2016 (-57%) and thermal coal down from USD 95/t to USD 50/t (-47%) (UPME 2016a). In addition, Colombia expects coal export earnings to further decrease due to a drop in international coal demand especially from its main export partners.

While coal is slowly becoming less attractive as an export commodity, it is increasingly being directed towards domestic use. This is underpinned by the plan to ramp up coal-fired power plants (see 6.1.2).

Coal rent. The relevance of coal's role for Colombia's economy can be expressed in terms of coal rent³: Even though coal rent values have decreased again, after peaks in 2008 and 2011 (Figure 6.4) coal rent in Colombia is still one of the highest in the world, at an average of 0.9% of GDP between 2005 and 2015. In comparison: coal rent values for South Africa, India, Australia are 1.33; 0.74; 0.559% of GDP in 2015 respectively (World Bank 2016).

Figure 6.4: Historic development of coal rent in Colombia, in % of GDP



Data source: ('World Bank Database, Coal rents (% of GDP)' 2016)

Employment. Coal, and the mining sector in general, also play a significant role as an employer in Colombia. Employment in the mining sector stood at 202,000 (4% of all jobs in Colombia) in 2013 (Unidad de Planeación Minero Energética 2014). Each job in the coal industry indirectly supports three to seven other jobs elsewhere (Agencia Nacional de Minería 2015) for example through off-site contractors, suppliers and subcontractors whose employment is attributable to business generated by the mining activities but also infrastructure investments (Columbia Center on Sustainable Investment 2016). Importantly, the sector generates jobs for vulnerable populations in remote areas, and coal jobs are the main economic activity in some regions (Unidad de Planeación Minero Energética 2014).

Royalties. Coal has brought Colombia large amounts of foreign currency. In 2015, the Colombian governments received USD 510 million in taxes and royalties from coal companies (Glencore 2017). However, royalties are not distributed equally. Critics claim that the royalty system has hampered the development and effective use of domestic industrial and human skills. As a result, Colombia has had limited opportunities to build the technological expertise in other industry sectors that is required to compete globally. The royalty distribution system was overhauled in 2012 in an attempt to boost the social benefits of royalties, but it is yet unclear whether the reforms have led to improved well-being (Strambo and Velasco 2017).

³ Coal rent is a revenue above the costs of resources' extraction; coal rent = value of hard & brown coal production at world prices minus their total costs of production.

Government support. The coal export sector has traditionally received large support from the government. Tax discounts are common. In 2015, the mining sector received 23.4% of the total value of tax discounts provided to legal entities in Colombia, which reduced companies' income taxes by 11%. Between 2005 and 2010, tax breaks exceeded the amount of income taxes paid by mining companies. Even after the elimination of an expensive fiscal incentive in 2011, the effective tax rate for the coal sector was still, on average, only 66% of the nominal rate (Strambo and Velasco 2017). Direct support in form of fossil fuel subsidies however is very low (IEA 2016f), amounting to USD 268,000 (UPME 2016a).

Future outlook on exported coal use

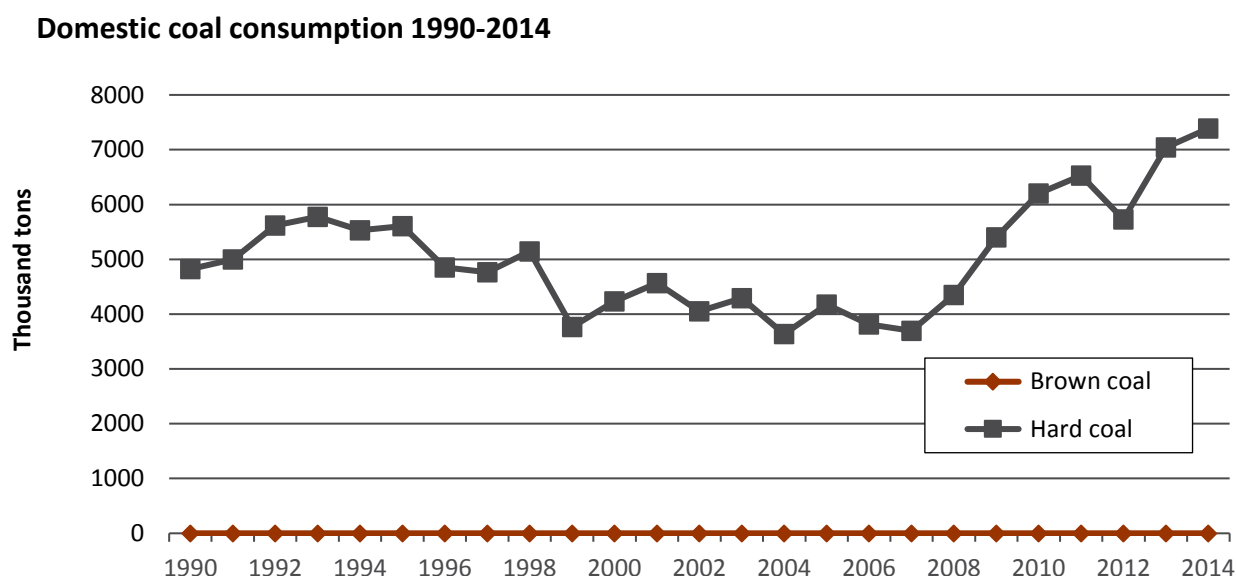
Despite estimated probable coal reserves of 5.041 Gt, with the majority of coal still in the ground, the future prospects for Colombia's coal exports are uncertain (IEA 2015a). The majority of Colombian coal is sold on international markets. A combination of reduced global demand and oversupply has reduced prices. At the same time, prices for renewable energy are expected to further come down, thereby likely further decreasing the demand for coal. In addition, and closely related, air pollution is increasingly becoming a key concern for countries. China and India are already revising their planned coal capacities downwards (Climate Action Tracker 2017) and the Paris Agreement might further contribute to decreasing global coal demand as countries aim to limit global temperature increase to well below 2°C. An example is the "Powering Past Coal Alliance", a group of governments, businesses and organisations that was created in November 2017 to take action to accelerate clean growth and climate protection through the rapid phase-out of coal (Powering Past Coal Alliance 2017). Three of Colombia's main coal exporters (Netherlands, UK, Portugal) are part of that Alliance, potentially further compromising the outlook for coal exports (Powering Past Coal Alliance 2017). In addition, the forecast of global coal prices by the World Bank is as low as 50-58 USD per tonne in 2020, making the coal business even more unprofitable (The Jakarta Post 2016).

At the same time, Colombia's dependence on export earnings from coal and coal products makes it unlikely that the country will substantially limit coal extraction and exports. On the contrary, the country intends to expand its coal production further, with a planned production target of 102.5 million tonnes in 2018 (Zárate and Vidal 2016).

6.1.2 Overview of domestic coal use

Colombia extracts and consumes almost exclusively hard coal, in particular thermal coal, but also some smaller amounts of metallurgical and anthracite coal (World Energy Council 2013). Domestic consumption of hard coal, while comparatively low, has grown significantly over the last decades, increasing from 4.8 million tonnes to 7.4 million tonnes in 2014 (Figure 6.5). Only three percent of the country's coal production is used domestically.

Figure 6.5: Colombia's domestic coal consumption 1990 - 2014



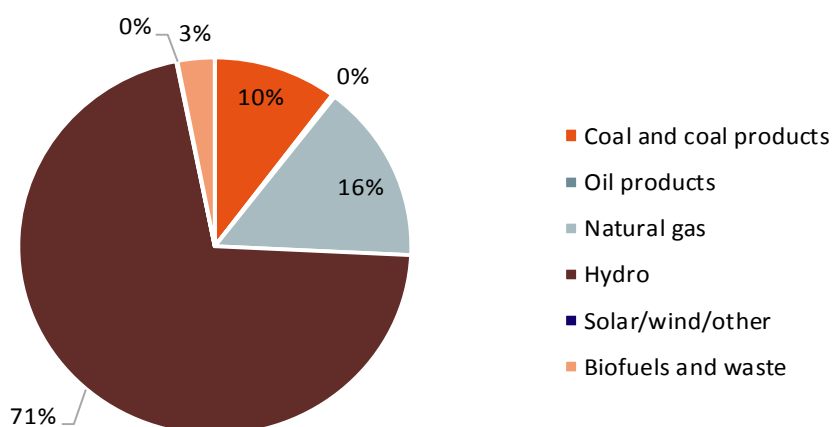
Data source: IEA World Energy Balances (2016)

The majority (35%) of Colombia's coal is used for power generation. While electricity is still largely generated by hydropower (Figure 6.6), coal-fired electricity capacity has been the fastest-growing technology in Colombia's electricity mix. One of the major reasons behind this increase in coal-fired electricity capacity is Colombia's objective to increase energy security. Colombia is highly dependent on hydropower for the country's electricity generation, however, due to increasingly severe and more frequent droughts this very dependence has become a challenge. In 2014, 10% or 7,100 Gwh of electricity were generated by coal and coal products (IEA 2016b).

Additionally, 32% of domestic coal is used for other transformation processes and 31% is used in industry (Figure 6.7). Iron and steel as well as non-metallic minerals are of particular relevance in this context.

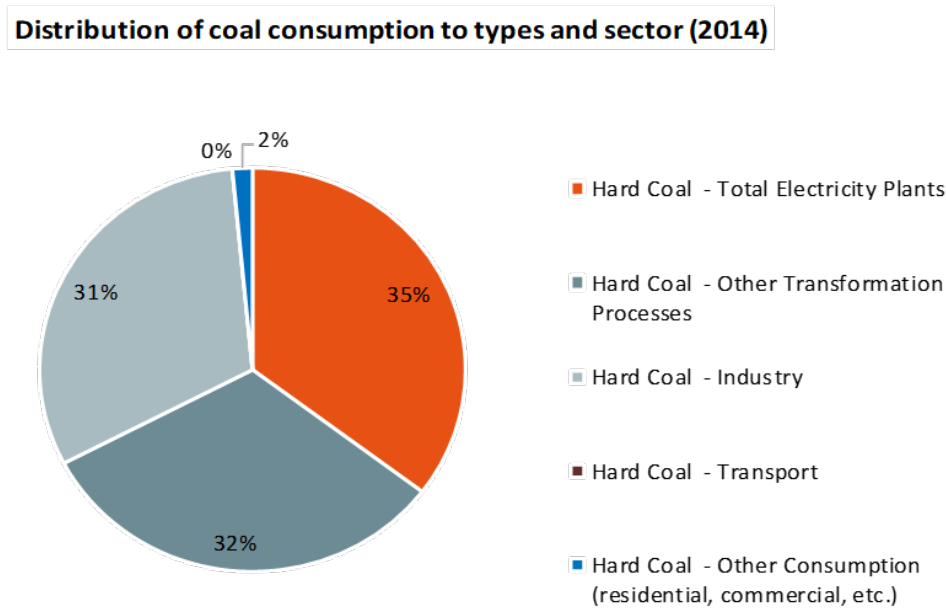
Figure 6.6: Colombia's fuel mix in electricity generation

Fuel mix in electricity generation (2014)



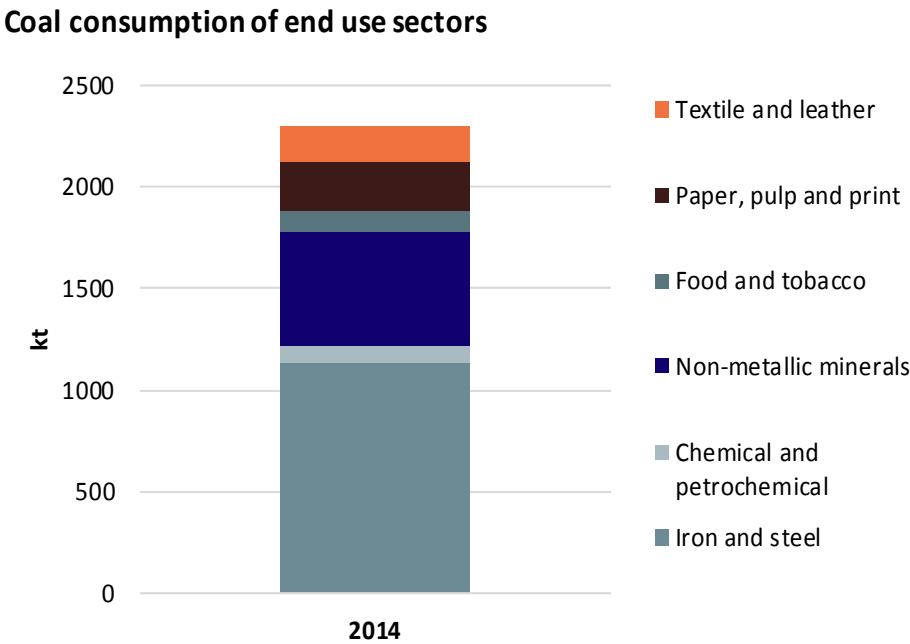
Data source: IEA World Energy Balances (2016)

Figure 6.7: Coal consumption by type of coal and shares of coal consumption by branch of industry



Data source: Ibid

Figure 6.8: Shares of coal consumption by branch of industry



Data source: Ibid

Future outlook on domestic coal use

With a view to meeting increasing electricity demand, increasing energy security and balancing decreasing profitability from coal exports (see 6.1.3), coal used for domestic electricity production has increased dramatically over the last years.

The country therefore intends to expand its coal production further, and make increasing use of coal on the domestic market to replace reliance on falling supplies of domestically produced oil and gas, as well as to further compensate for expected decreases in international coal demand and export revenues (Zárate and Vidal 2016). However, based on recent research comparing the price of renewables to the construction of new coal power plants (but not taking into account any necessary changes to the grid, for example), it seems questionable if this makes sense from an economic standpoint (Lazard 2017).

6.1.3 Local impact of coal use

Impact of power plants

The impact of power plants is largely influenced by mining governance. Mining governance in Colombia has, *de facto*, favoured the mining companies for decades. Environmental regulation was ineffectively implemented, and compliance poorly monitored, especially in the inner parts of the country. This is also due to the lack of resources by Colombian environmental agencies. Between 2010 and 2014, environmental protection agencies operated with the equivalent of 0.5% of the GDP, while the average for the Organisation for Economic Co-operation and Development (OECD) is 1.5–2% (Strambo and Velasco 2017).

Environmental impacts. Negative environmental impacts are mainly caused by open pit coal mining which affects surface and underground water. This is exacerbated by the fact that mining activities are largely concentrated in vulnerable, remote parts of the country with sensitive ecosystems (Rudas Lleras and Cabrera Leal 2015).

In addition, coal extraction has created massive amounts of waste, which in turn is impacting water resources and air quality. Air pollution is a major environmental challenge in mining regions where concentrations of particulate matter consistently exceed threshold levels set by the World Health Organisation (Ibid).

Moreover, an increasing coal production will also lead to increased GHG emissions from mining operations and also fugitive emissions from mines (existing and abandoned ones).

Human settlements. The coal industry has also led to the re-settlement of parts of the population, in particular small peasants, both voluntarily and forcefully (Strambo & Velasco 2017).

Health risks and accidents. Both coal extraction processes and its burning have highly negative impacts on local biodiversity, people's activities and health. Toxic dump water and coal dust increase the risk for numerous diseases: chemical elements and metals in mining pits' waters can cause skin diseases and skin cancer.

Coal dust in mining regions is linked to high rates of respiratory infections, in particular pneumoconiosis (Torres Rey et al. 2015). Mining accidents occur frequently due to poor safety standards and illegal operations. From 2012-15, 351 emergencies were recorded, in which 403 people died (UPME 2016b).

Conflict and tensions. There is growing criticism and opposition to coal mining in Colombia for environmental and socio-economic reasons, especially for coal extraction in the inner parts of the country. During the last seven years over 50 cases have been brought to the country's Constitutional Court on the issue of mining and the involvement of the local population. In many of the court rulings, it has overturned government legislation, allowing for greater participation and inclusion of the local population in mining related governance and projects (Strambo and Velasco 2017).

In 2017, the Constitutional Court authorised municipality councils to undertake referenda to ban mining activities in their territories. Since then, five municipalities have banned mining activities and another four municipalities have scheduled referenda to this end (Registraduría Nacional del Estado Civil 2017).

6.1.4 Conclusions on coal mining and use

A coal phase out is currently highly unlikely, as the analysis presented in the above sections shows. At this time, the coal debate is inextricably linked to the economic growth debate and there is no plan or goal to reduce its exportation or consumption for electricity generation.

Municipal referenda could limit the expansion of coal mining, especially in the inner parts of the country. However, due to the high level of informality of this type of production, it is likely that the ban will only affect the formal industries.

Environmental regulations could also reduce the use of coal in industrial activities to avoid stringent standards particularly in industries located in urban areas. In addition, if new gas reserves become available due off shore and fracking projects planned by Ecopetrol, Colombia's largest petroleum company, coal consumption in the industry sector could be replaced or be partially substituted by natural gas.

In the long term, it is also expected that the economy will become more orientated to technological and service activities and less dependent on the production of basic goods, with a reduction of coal consumption and exports.

At the same time, not reducing coal is likely to have a number of negative implications. These not only include negative environmental repercussions mentioned above, but importantly also mean that the government is not investing in the most cost-efficient energy technology to meet Colombia's growing energy demand but risks developing stranded assets.

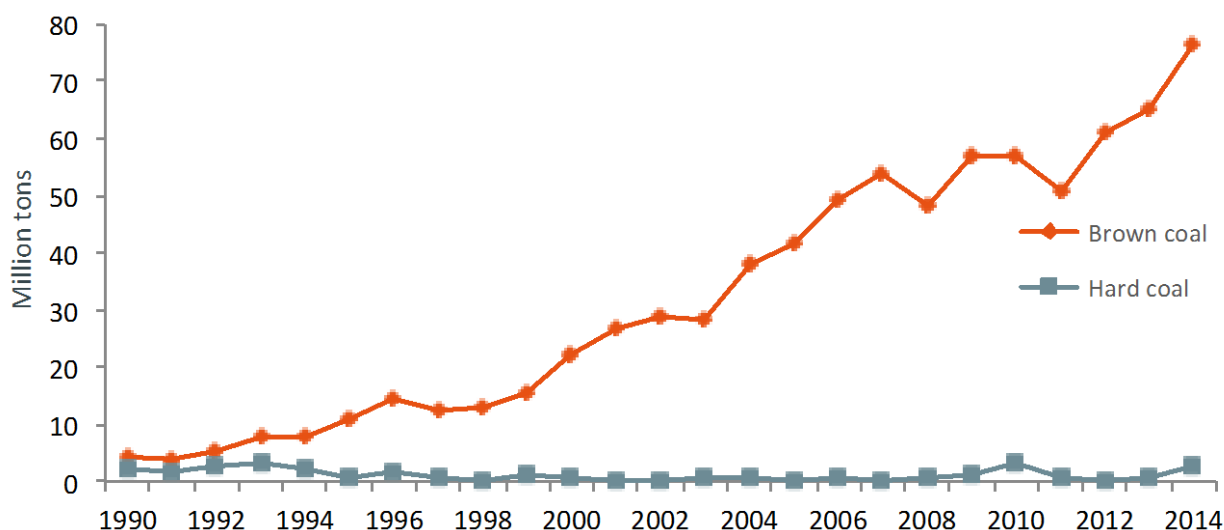
6.2 Indonesia

Indonesia is a fossil rich country with large reserves of oil, gas and coal. Its coal reserves are (only) 2.5% of global reserves⁴ (BGR 2016). But Indonesia is the fifth largest producer of coal and the biggest exporter in the world. Domestic use of coal has rapidly increased in recent years. Against this background, this chapter explores the role and perspectives of coal for Indonesia: starting with an overview on the historic domestic use of coal (6.2.1) and outlooks on future development of coal use (6.2.2). Then we analyse the economic role of coal more broadly, taking into account the country's position as a coal exporter (6.2.3). Finally we give an overview of local impacts of coal use and mining (6.2.4).

6.2.1 Overview of coal use - historic development and status quo of coal in Indonesia

Brown coal consumption has grown steeply within the last decades. Compared to 1990 it has increased by a factor of 18 to a total of 76 Mt/a in 2014 (Figure 6.9). Hard coal consumption plays a marginal role, fluctuating at levels at and below 1 Mt/a since the mid-1990s and has increased in recent years up to almost 3 Mt/a in 2014.

Figure 6.9: Domestic coal consumption 1990 - 2014

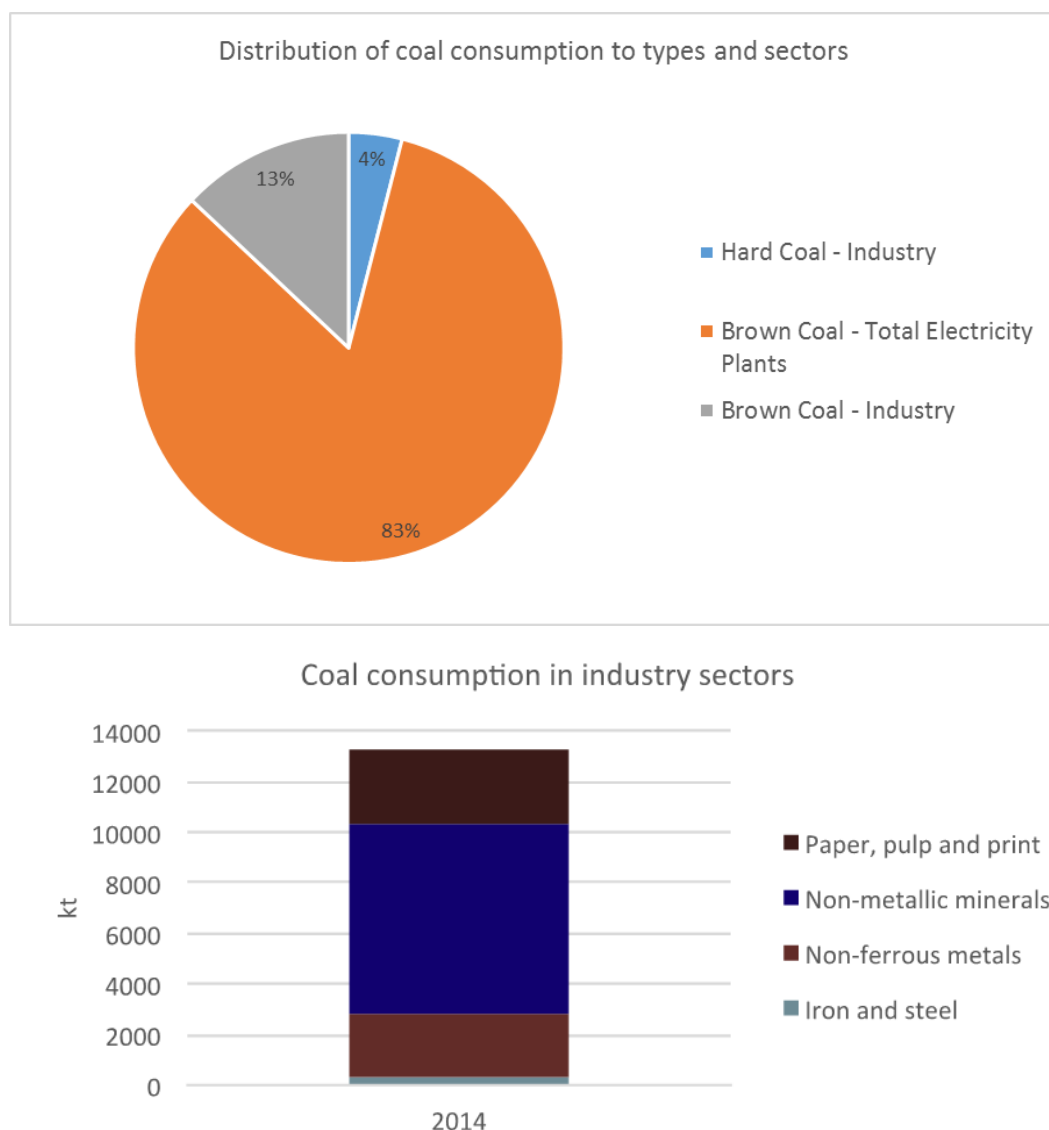


Data source: IEA (2016c)

The lion's share of Indonesia's coal use is brown coal used for power generation (83 % in 2014) (IEA 2016h). Additionally, in 2014, 10.4 Mt of brown coal was used in industry. Hard coal is used solely in industrial processes, in 2014 the amount was 2.8 Mt. The major part of coal for industry is used in cement production (12 Mt) (Figure 6.10).

⁴ Reserves refer to the amount of known or proven coal resources that can be recovered economically by using available technology. Thus coal reserve figures depend on the price of coal. Resources are defined as the amount of coal which is a) proven but not technically / economically recoverable; b) unproven, but geologically possible amounts of coal which could be discovered / extracted in the future (BGR 2016).

Figure 6.10: Coal consumption in Indonesia by type of coal in 2014 and shares of coal consumption by branch of industry

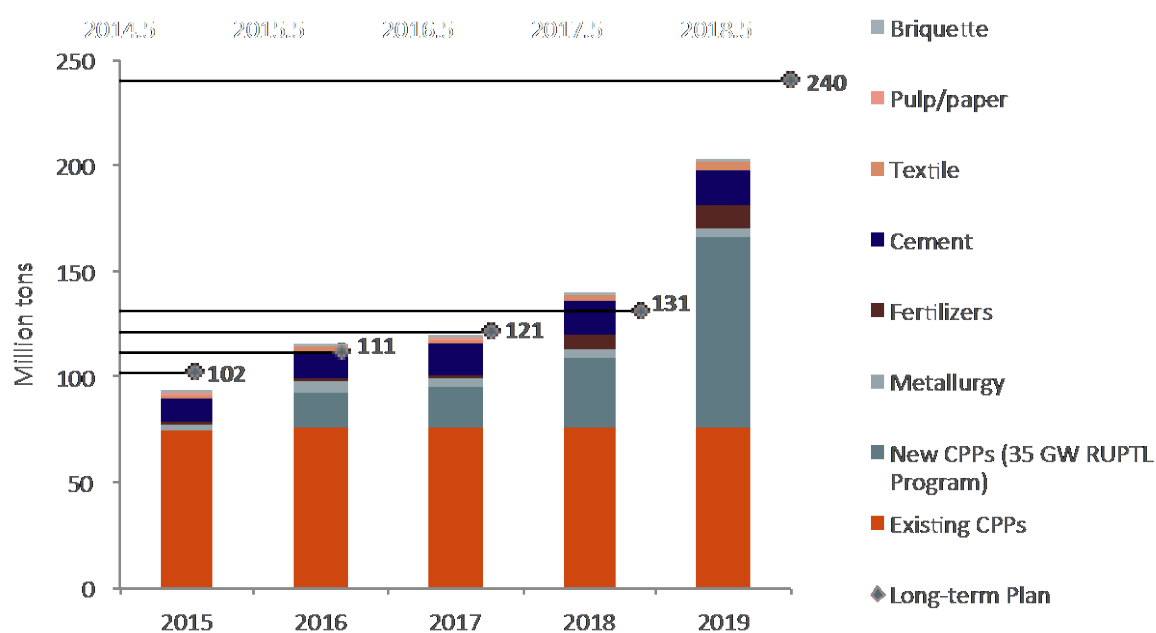


Data sources: IEA (2016c); Indonesian Coal Mining Association (estimated consumption) (2016)

6.2.2 Future outlook on coal use

Currently, there are 131 coal-fired power plants in Indonesia with an overall capacity of 27.4 GW (Global Plant Tracker 2017a, 2017b). Indonesia is planning to heavily build up generation capacities through coal, which will expand coal usage in the energy sector (Figure 6.12). A total of 125 additional plants are currently being planned (Global Plant Tracker 2017b), which corresponds to the electricity supply plans to provide 60% of additional 80 GW by. In combination with expected growth of coal use in industrial sectors like cement and fertilizer production, the Ministry of Energy and Mineral Resources (MEMR) assumes that coal consumption in Indonesia will more than double between 2015 and 2019 (Figure 6.11) (MEMR 2015).

Figure 6.11: Domestic coal consumption plans of Indonesian MEMR for the nearest years by branch



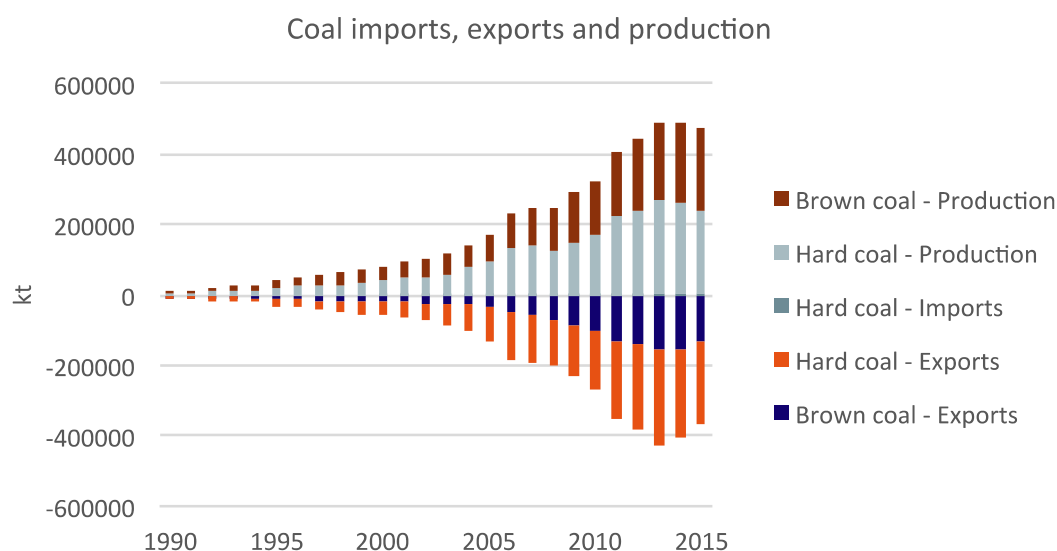
Data source: MEMR (2015)

6.2.3 The economic role of coal

6.2.3.1 Coal production and coal trade

Indonesia is the leading exporter of thermal coal (used for electricity generation) and has been taking turns with Australia of being the world's largest coal exporter altogether (IEA 2016e). 60% of the country's brown coal production and 99.9% of hard coal go into export. As Figure 6.12 shows, both export and production of hard and brown coal in Indonesia have grown strongly in the last decades. In 2013 coal production reached an all-time high of almost 490 Mt/a. Since then, both production and export have slightly decreased.

Figure 6.12: Coal extraction, import and export in Indonesia (1990 - 2015)

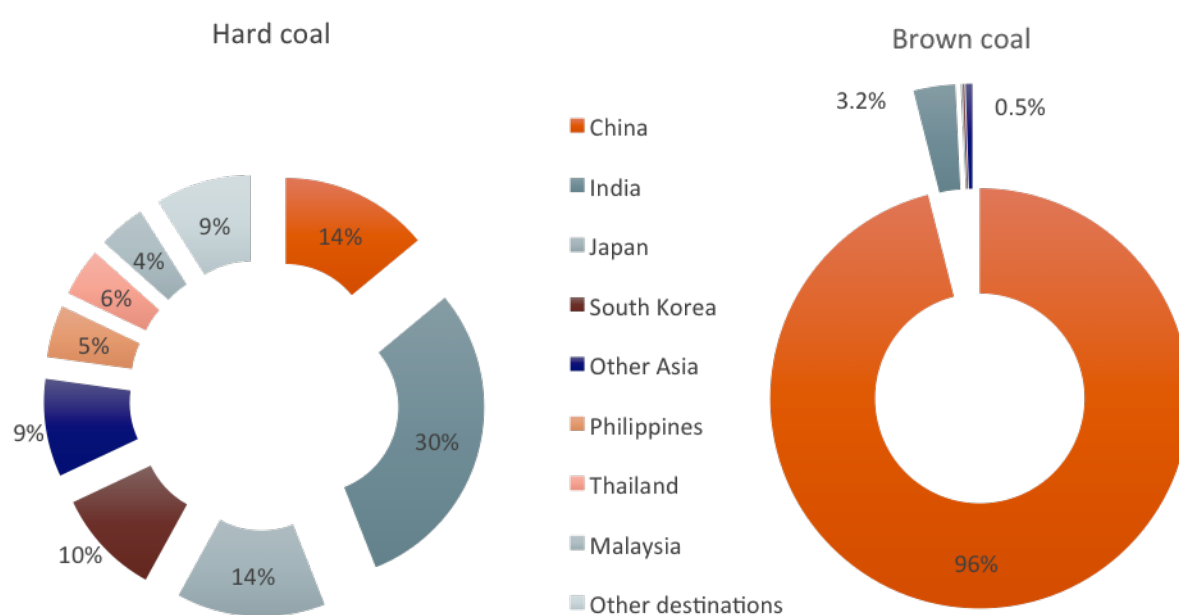


Data sources: IEA (2016c); MEMR (2016).

Indonesian brown coal exports almost exclusively goes to China, while hard coal exports are distributed among Japan, India, China and other Asian countries. Within the period from 2008 to 2014 Chinese demand for Indonesian coal has grown by 800% (IEA 2015b), while in 2015 it dropped by 30% (IEA 2016e). The levelling-off of Indonesia's coal production is generally linked to decreasing demand from most Asian countries (MEMR 2016) (ABC News 2016).

Indonesia's Ministry of Energy and Mineral Resources forecasts coal exports to level off at 470 million tons in 2017 (REUTERS 2017; World Finance 2016), which would be in line with expected higher demand from China in coming years (Mongabay 2017). However, the World Bank's forecast of global coal prices to be as low as 50-58 USD/Mt in 2020, could turn activities of young and middle-sized mining companies to be unprofitable (The Jakarta Post 2016), which may limit coal production in the mid-term.

Figure 6.13: Indonesian export destinations in 2014 by type of coal



Data source: OEC (2016)

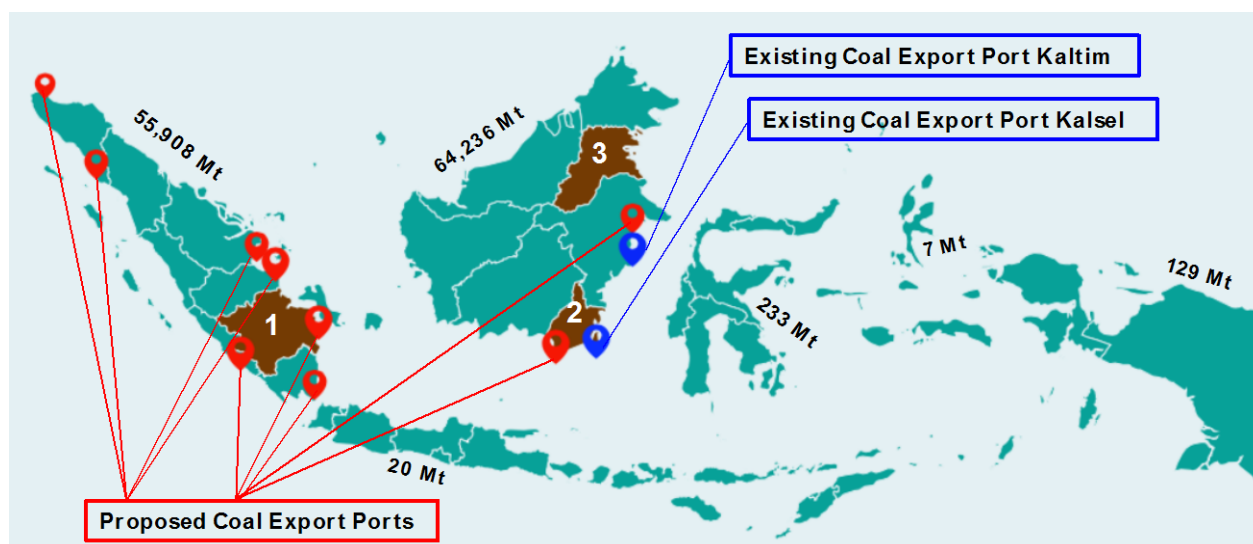
The current demand decrease falls in line with Indonesia's recent strategy to limit coal exports and increase domestic use (MEMR 2015). Even though some sources claim that Indonesia could seek to compensate export losses by using more coal domestically (The Australia Institute 2017), already in 2009 the Law on Mineral and Coal Mining introduced a minimum share (24.17%) of coal which had to be sold to the domestic market (IEA 2015b). This approach falls in line with Indonesia's high priority for energy security and reduction of import dependency (e.g. for oil). Lately the Indonesian president Joko Widodo announced that the country should quickly switch to raising added value from coal and other natural resources, rather than continuously selling them as raw materials (The Jakarta Post 2017).

6.2.3.2 Geographic distribution of coal mining

There are three major coal regions in Indonesia: two of them are on Kalimantan South (2) and East (3) and one in the South of Sumatra (1) Figure 6.14. Hard coal resources are 94 Gt (0.5% of global hard coal resources); brown coal resources are 33 Gt (0.7% of global resources) (BGR 2016). Indonesian coal is quite easily accessible as around 75% of all Indonesian coal reserves can be mined in open pits (IEA 2015b). Consequently the share of economically accessible reserves is higher: 2.4% of global hard coal reserves and 2.6% of global brown coal (BGR 2016). More than a half of Indonesian coal reserves

are of medium quality (4,700-5,700 kcal/kg), the rest has a caloric value of less than 4,700 kcal/kg (The Australia Institute 2017).

Figure 6.14: Three main coal pools of Indonesia; proposed and existing coal export ports and coal reserves (in Mt) by destination



Data sources: Indonesia-Investments (2016); KESDM (2014); MEMR (2015); built with "Pixel Map Generator"

6.2.3.3 Relevance of coal for the Indonesian economy

Indonesian coal is mined by a wide variety of companies both state- and private-owned, but the major amount of coal production is concentrated in the hands of 6-10 enterprises producing more than 50% of Indonesia's coal (ODI 2015). Most of the companies work only in Indonesia.

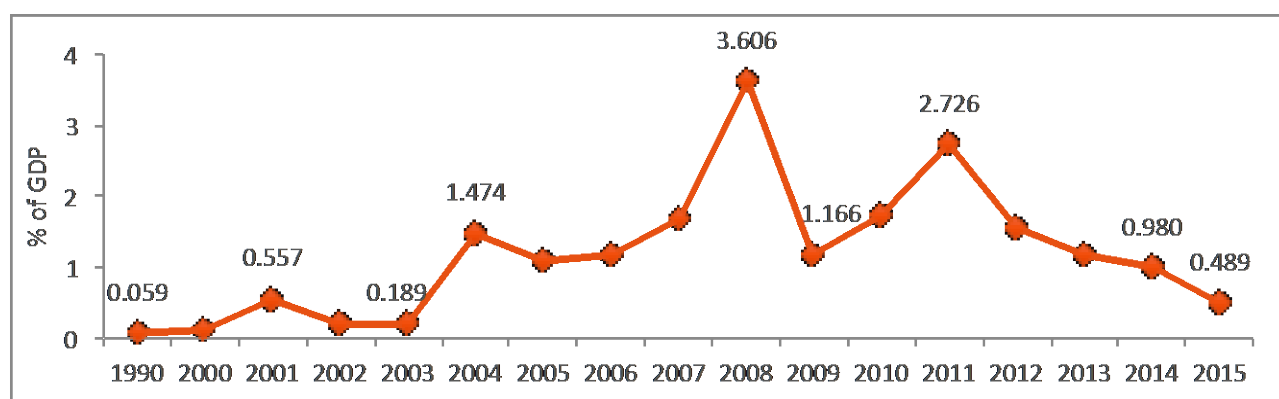
Coal rent. The relevance of coal's role for the Indonesia's economy can be expressed in terms of coal rent⁵: Even though coal rent values have decreased again, after peaks in 2008 and 2011 (Figure 6.15), coal rent in Indonesia is still one of the highest in the world, at an average of 1% of GDP between 2005 and 2015. In comparison: coal rent values for South Africa, India, Australia are 1.33; 0.74; 0.559 % of GDP in 2015 respectively (World Bank 2016).

Export share. Indonesia's economy shows a positive trade balance with a total export of 161 billion USD in 2015 (MIT 2017b). Coal, the single most important export item accounted for almost 10% of the country's export volume. To compare, palm oil accounted for around 7.6%, gas 5.9% and crude oil 3.7%.

Employment. Coal plays also a significant role as an employer in Indonesia. In 2015 about 1 million people were employed in coal-related sectors (REUTERS 2015). According to IEA assumptions, approximately 180,000 people were directly employed in coal mining and 130,000 in mining services (IEA 2015b). In line with the massive expansion of coal production between 2010 and 2014, employment in mining and quarrying grew by 2.7%, whereas employment in agriculture, forestry, hunting and fishery decreased by 1.6% in the same period (ADB 2016).

⁵ Coal rent is a revenue above the costs of resources' extraction; coal rent = value of hard & brown coal production at world prices minus their total costs of production.

Figure 6.15: Historic development of the coal rent in Indonesia, in % of GDP.



Data source: World Bank (2016)

Royalties. The Indonesian government collects royalties on coal mining. Data is available for the mining sector as a whole (coal and other resources), which in 2014 amounted to 2.8 billion USD, around 10 % of total state revenues (EITI 2017). However, illegal mining and non-payment of royalties are assumed to have led to income losses of several hundred million USD in the past (JATAM 2017). The Government of Indonesia planned to increase royalties up to 7 - 13.5 % (depending on quality of coal) for all types of companies (Oxford Business Group 2015). However, after the stagnation of production, the government decided to freeze its plan to increase coal royalties in order to support the coal mining sector and prevent potentially large job losses (REUTERS 2015).

6.2.4 Local impact of coal use

Both coal extraction processes and its burning have highly negative impacts on local biodiversity, people's activities and health.

6.2.4.1 Impact of power plants

Air pollutants, like particulate matter and ozone emitted by Indonesian coal-fired power plants are responsible for 7,100 premature deaths annually according to modelling undertaken by the Harvard University (Greenpeace 2015). Each GW of additional capacity in coal-fired power plants is estimated to cause approx. 600 premature deaths per year. The current expansion plans (see section 0) could thus be responsible for almost 30.000 additional premature deaths per year.

6.2.4.2 Impact of coal mining

Coal mining in Indonesia is also reported to have strong negative impacts mainly on the local environment and local communities. An early analysis concludes that many small-scale operations have lower environmental impact compared to large-scale coal mining (Fatah 2008). Although there is regulation governing environmental standards connected to mining, negative effects are quite dramatic in some regions. NGOs and media call for more transparency and public accountability of the issues, especially since it can be expected that negative impacts of coal mining occurs even long after mines are being closed (Greenpeace 2014).

Deforestation and land degradation. Most coal in Indonesia is mined in open pits, which is quite land intensive and leaves land degraded unless major efforts for re-cultivation are undertaken. Based on the total amount of mining concessions issued so far, 8.6 Mha corresponding to 7 to 9% of national forests are under threat to be deforested by coal mining only (Fern 2015).

Especially in East Kalimantan, where most of Indonesia's coal mines are located, negative effects through land degradation are being reported. One example is Samarinda, a regional capital of East Kalimantan, where the water runoff from the deforested slopes around the city increased the intensity

and frequency of floods after rainfalls (Mongabay 2014). In the same region mining concessions are in competition with agricultural uses of the respective lands, putting farmers under economic pressure (Yale E360 2015).

River and groundwater pollution: Coal mining is reported to have heavy negative effects through large amounts of acid mine drainage and toxic waste water containing e.g. sulfur, mercury, acid slarida, manganese, sulfuric acid and lead. A study by Greenpeace found that river pollution in South Kalimantan exceeded national environmental standards (Greenpeace 2014). Similar effects of coal mining with respect to river pollution and soil erosion as well as degradation were observed on South Sumatra (Sayoga Gautama 2012). In some cases water pollution from coal mining has directly affected the livelihoods of neighbouring communities by factually destroying rice plantations and killing fish in aquacultures (Mongabay 2014).

Health risks and accidents: Toxic dump water and coal dust increase the risk for numerous diseases: chemical elements and metals in mining pits' waters can cause skin diseases and skin cancer. Coal dust in mining regions is linked to high rates of respiratory infections (Mongabay 2014). Due to lack of protection in mining pits, individual cases of injuries and deaths have been reported, e.g. in Samarinda, where 22 children have perished since 2011 while swimming and playing in stagnant waters filling mining holes (Inside Indonesia 2016; WRM 2015).

6.2.5 Conclusions on coal mining and use

Indonesia is a coal-rich country and among the most important exporters of coal globally. Mining and export of coal have strongly increased over the last decades, but have levelled off in recent years. It can be expected that the domestic use of coal (mainly for electricity generation) will become more important in coming years. Thus any ambitious mitigation strategy for Indonesia must address coal mining and coal use.

From an economic perspective, coal mining is a key source of income for Indonesia, contributing 10% of the country's export share, providing several hundred thousand jobs and supplying the government directly with income through royalties. On the other hand, coal use has been subsidised in the past. And both mining and coal use cause heavy local environmental and health burdens to the Indonesian society.

To support national and international mitigation efforts, we see two key strategies relating to coal in Indonesia:

- ▶ If the plans for to-be-build coal-fired power plants were to be implemented, Indonesia would face a massive carbon lock-in for coming decades. Thus a national mitigation strategy must include a quick increase in energy efficiency and use of renewables for electricity generation in order to minimise the number of coal-fired power plants, which need to be built in order to satisfy the country's electricity demand.
- ▶ Indonesia's economy largely depends on coal mining. Assuming that global demand for coal would decrease (e.g. through efforts to decrease coal use and imports in countries like China and India) Indonesia would suffer economically. Thus, it is important to diversify the country's economic base and move away from the strong focus of coal exports, e.g. through an expansion of Indonesia's sustainable forestry products. Generally this is in line with the country's strategy to not only sell raw materials, but rather products with higher added value. However, if the coal mined was just used locally (instead of exported) this would not provide any climate benefit. Thus this strategy must go hand-in-hand with a decarbonisation of Indonesia's energy sector. In this case however, it is important to note that it would not only be mining companies who would suffer from reduced coal export and use. Also the regions in which coal mining happens today do benefit economically - and in the long-term could heavily lobby against reduced coal mining. Against this background we con-

sider it advisable to support the current coal mining regions to diversify their economic base, possibly in combination with raising the awareness of negative local impacts and the true costs of coal mining and use.

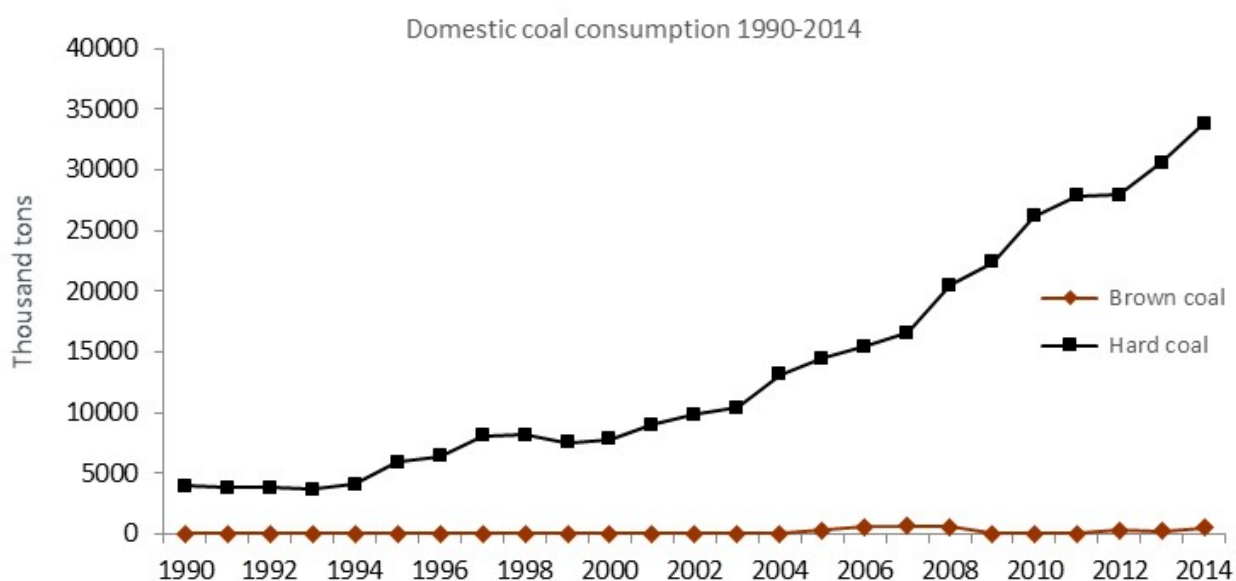
6.3 Viet Nam

Viet Nam has substantial coal resources, the 13th largest hard coal reserves globally, with an estimated 3,116 Mt (BGR 2014). Coal use is playing an increasing role in the energy mix and according to current planning this role is to increase further. This chapter explores the developments of the sector, its role in the economy and local impacts of mining and use in more detail.

6.3.1 Overview of coal use - historic development and status quo of coal

Coal consumption in Viet Nam has increased rapidly over the last 20 years. Brown coal plays no significant role, but the use of hard coal is more than 8 times that of 1990.

Figure 6.16: Domestic coal consumption 1990 - 2014



Data sources: (IEA 2016c)

In 2014, around half of the coal was used in the industry sector. A further 39% were used for power generation with the rest being utilized in residential and commercial sectors. Within industry the by far largest use sector is non-metallic minerals with 75% of total consumption within industry.

Figure 6.17: Coal use in 2014 by type and sector (share of consumption in tonnes of coal)

Distribution of coal consumption to types and sector

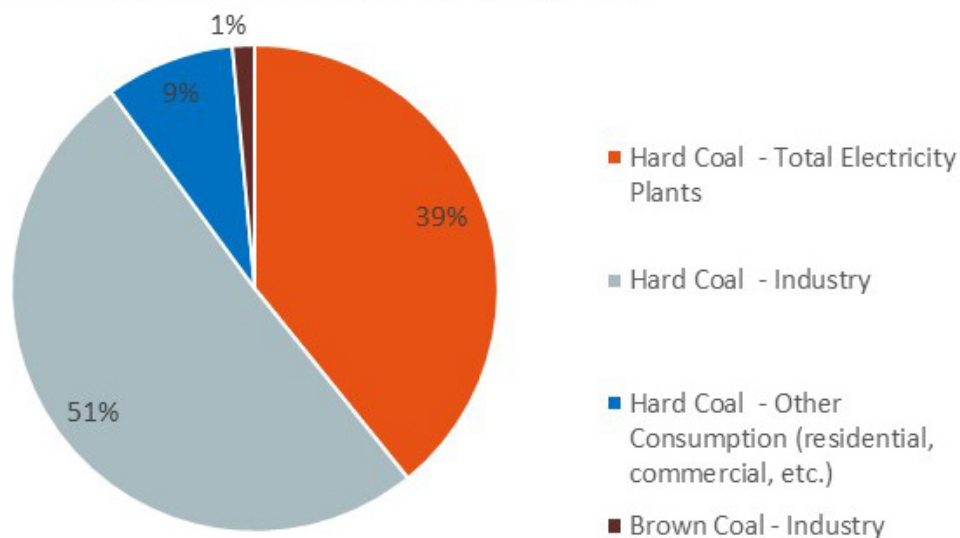
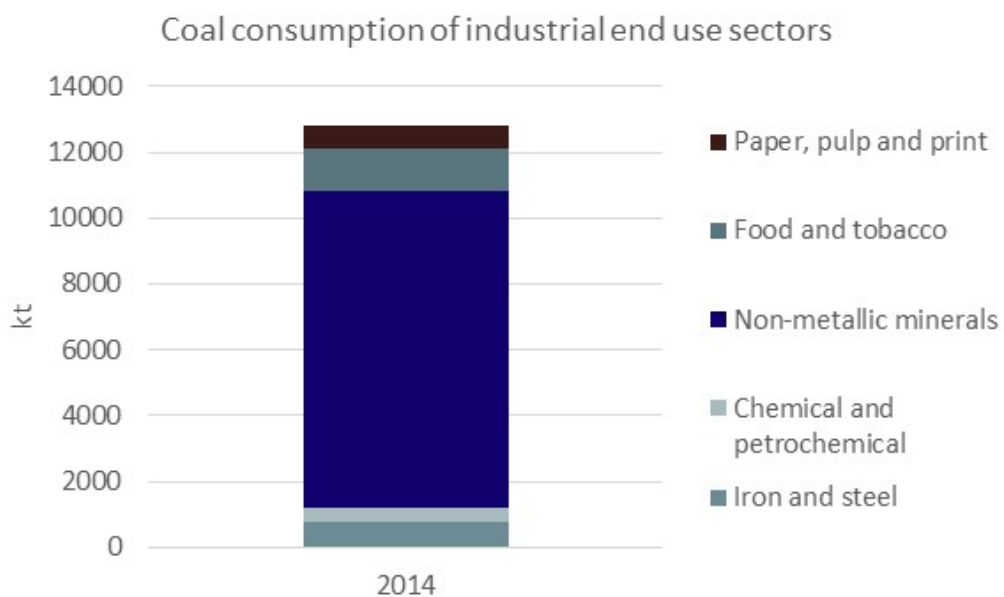


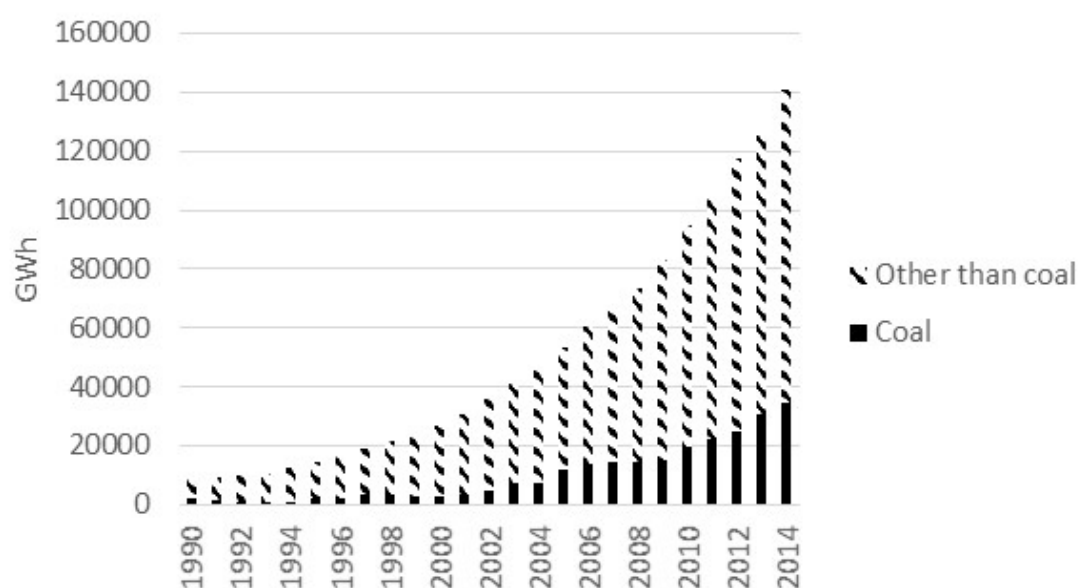
Figure 6.18: Coal use in 2014 by industrial end use (share of consumption in tonnes of coal)



Data sources: (IEA 2016c)

In power generation coal did not play any significant role until the early 2000s. Electricity generation from coal has doubled between 2007 and 2014 and increased 16 times compared to 1990.

Figure 6.19: Electricity generation from coal and non-coal



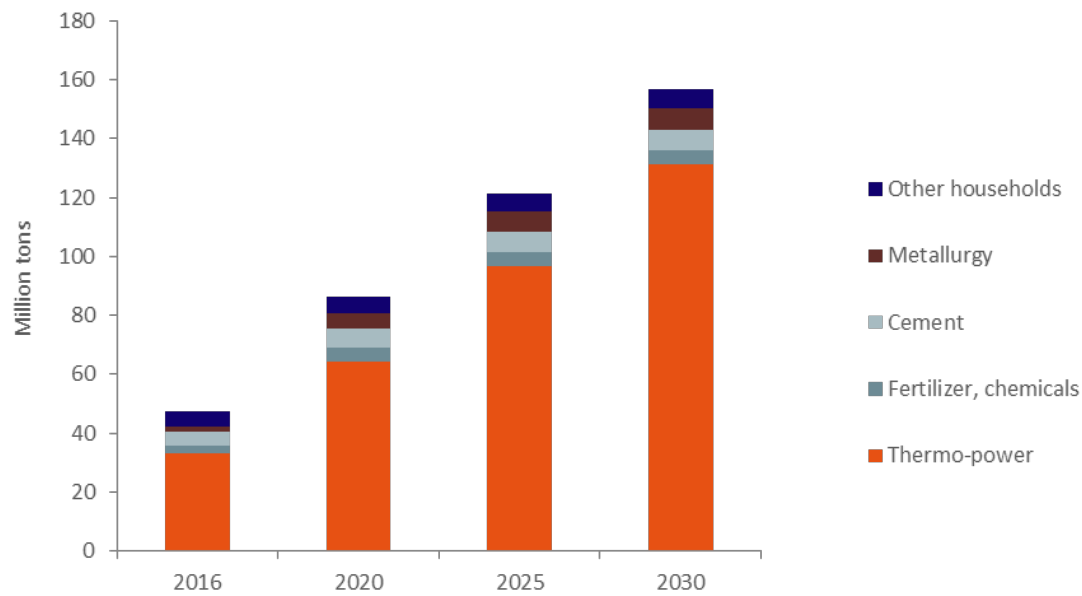
Data sources: (IEA 2016c)

6.3.2 Future outlook on coal use

Total coal consumption. According to the Master Plan of Coal Industry Development in Viet Nam by 2020, with perspective to 2030, which was adjusted in 2016, total coal output was planned at 41-44 million tons in 2016, 47-50 million tons (in 2020), 51-54 million tons (in 2025) and 55-57 million tons (in 2030) (Government of the Socialist Republic of Viet Nam 2016a). This constitutes a substantial downward revision compared to the previous version, where 75 million tons were expected to be extracted by 2030. This goes together with a drastic reduction in expected capital demand, which in the adjusted plan is only half the annual investment.

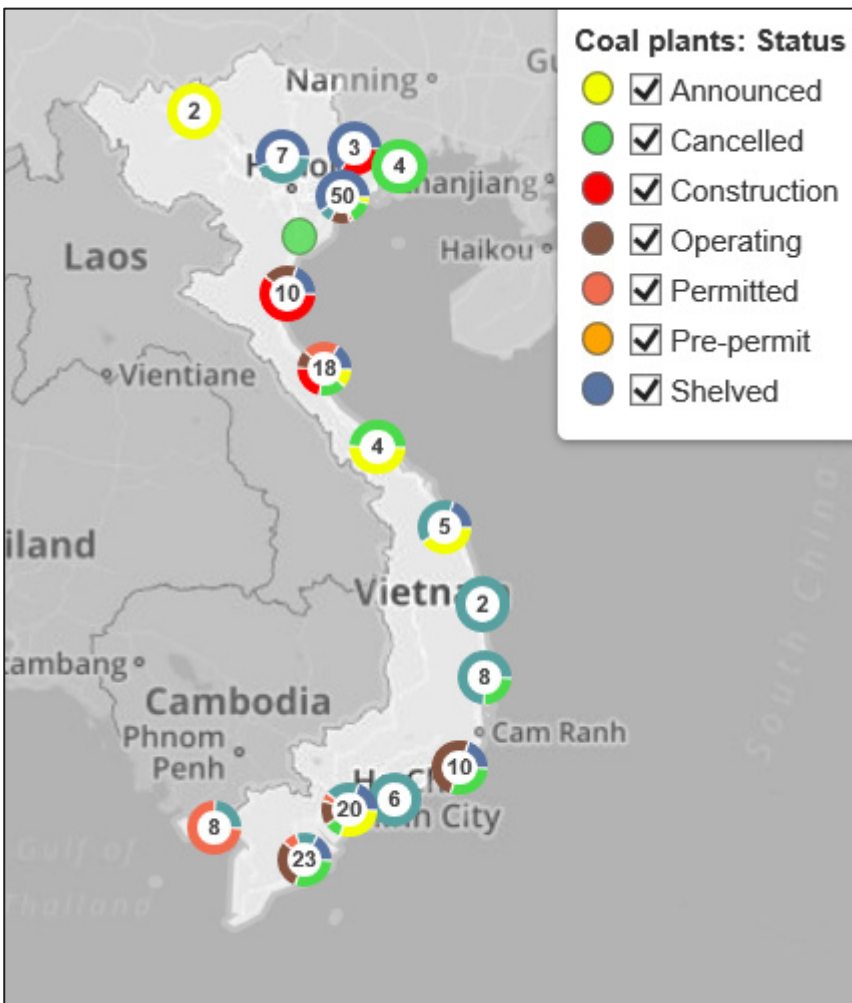
Despite this cut in expected output, overall coal consumption is planned to further increase, from 34 million tons in 2014 (IEA 2016c) to 156 million tons in 2030, with the vast majority of growth in the power sector (Government of the Socialist Republic of Viet Nam 2016a).

Figure 6.20: Coal consumption plans



Data sources: (Government of the Socialist Republic of Viet Nam 2016a)

Figure 6.21: Status of coal plants in Viet Nam



Source: (CoalSwarm 2017); Note: number is number of coal plants per region.

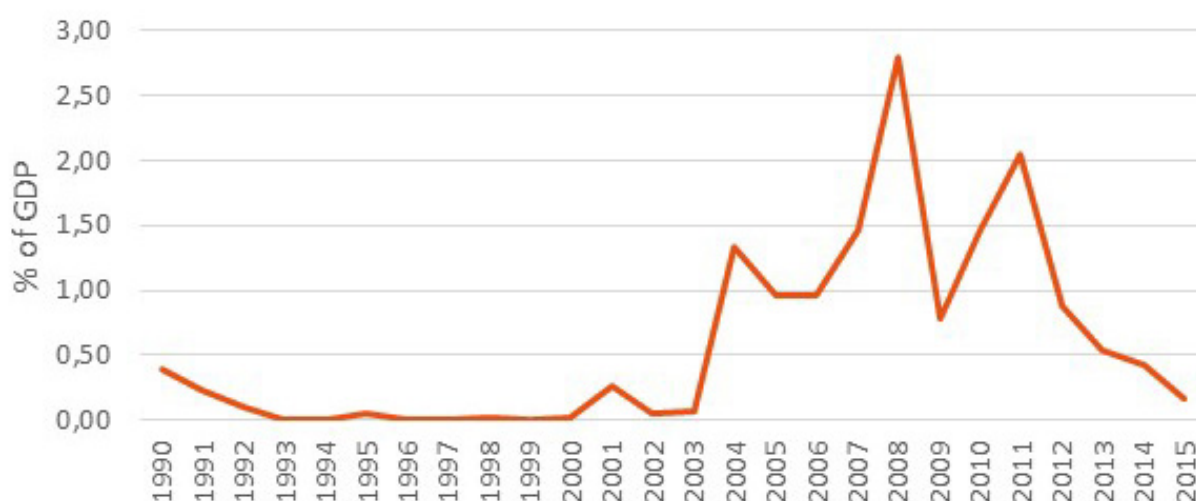
Coal-fired power generation. By 2020, total installed capacity of coal-fired power is expected to be 26,000 MW, producing around 131 billion kWh which accounts for 49.3% total electricity production and will consume about 63 million tons of coal. By 2030, total installed capacity of coal-fired power is planned to be 55,300 MW, producing 304 billion kWh which accounts for 53.2% total electricity production and will consume around 129 million tons of coal (Government of the Socialist Republic of Viet Nam 2016b).

54 new power plants were in different stages of planning and 34 were under construction in January 2017. They represent almost 30 GW of capacity in planning and 15 GW under construction, with almost 5 GW having become operational in 2016. Compared to previous years there is a decreasing trend in new planning, although construction has picked up from 2015 by 3 GW. At the same time more than 17 GW of capacity were shelved or cancelled, some of which were converted to gas-fired power generation, such as the Dung Quat power station (CoalSwarm 2017). Revised demand projections can be one explanation for this observation, but increased local resistance, growing environmental concerns and economic factors may also play a role, leading to a gradual re-thinking at the political level. In early 2016, the Prime Minister asked the sector to review development plans and build no more plants, but does not put a moratorium on new plants (Government of the Socialist Republic of Viet Nam 2016c).

6.3.3 The economic role of coal

Coal mining. The economic importance of the coal sector as represented in the coal rent (share of GDP generated in the sector) is fluctuating strongly and has decreased over the last years after a period of stronger influence, with the share of coal in GDP estimated at 0.16% for 2015, down from a peak value of 2.8% in 2008. For comparison: in Germany the respective share in 2015 was 0.013%, down from a peak value of 0.83% in 1982 (World Bank 2017).

Figure 6.22: Development of coal rent



Data sources: (World Bank 2017)

Coal extraction is run by the Viet Nam National Coal - Mineral Industries Group (VINACOMIN), a state-owned enterprise. In the period of 2011 - 2015, Vinacomin estimated total revenue of VND 527,878

billion (USD 23.5 billion⁶), up 15% compared to the Resolution of the first Party Congress. The total profit for the whole period was estimated at VND19,413 billion (USD 0.8 billion) (Vinacomin 2016).

The most recent update of the master plan for coal development estimates that Viet Nam has almost 2.3 billion tons of coal reserves and almost 47 billion tons of resources, most of which estimated or forecast (Government of the Socialist Republic of Viet Nam 2016a).

Table 6-1: Coal reserves by region in 1000 t

Region	Total	Reserve	Resources				
			Total	Proved	High possibility	Estimated	Forecasting
Dong Bac coal mines	6,287,077	2,218,617	4,068,460	109,452	394,958	1,585,050	1,979,000
Song Hong coal mines	42,010,804		42,010,804		524,871	954,588	40,531,345
Domestic coal mines	206,255	41,741	164,514	51,559	73,967	32,345	6,643
Local coal mines	37,434		37,434		10,238	8,240	18,956
Peat coal mines	336,382		336,382		133,419	106,611	96,352
Total	48,877,952	2,260,358	46,617,594	161,011	1,137,453	2,686,834	42,632,296

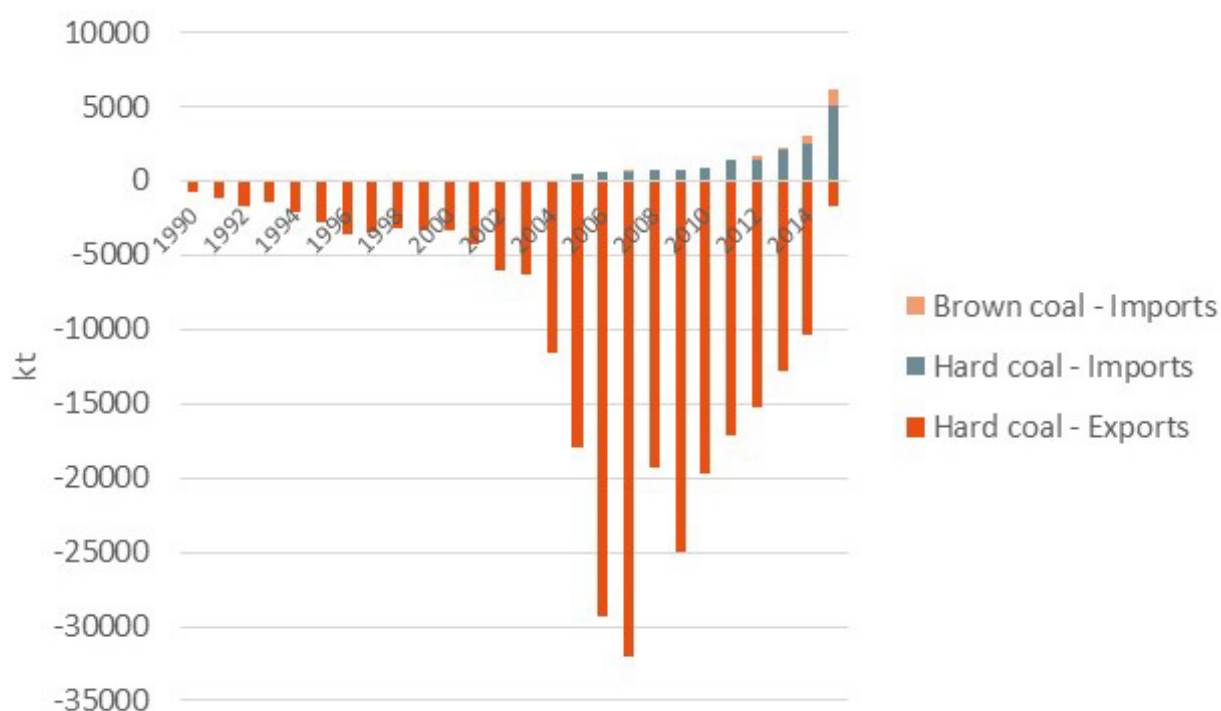
Data sources: (Government of the Socialist Republic of Viet Nam 2016a)

Trade. Viet Nam has a long history of coal exports, mainly hard coal. In 2005, it first started importing coal and imports have increased steadily while exports have decreased sharply since 2007. In 2015 Viet Nam became a net importer for the first time (IEA 2016c). The recent decline in coal exports is based on the Government's policy of restricting coal exports to ensure national energy security and domestic demand in the light of increased domestic demand. If the trend of increasing demand continues, coal imports could become a significant burden on national accounts, which is already characterized by a negative export/import balance (General Statistics Office of Viet Nam 2017).

The revised PDP 7 expects coal imports to rise to 129 million tons for power generation alone (Government of the Socialist Republic of Viet Nam 2016b). Assuming a cost of imported coal of 40 to 50 USD/t, this could amount to 5.1 – 6.4 billion USD/yr, equivalent to 2.7% - 3.4% of the current GDP.

⁶ Conversion using exchange rates from 1 June 2017, retrieved from www.oanda.com

Figure 6.23: Development of coal imports and exports



Data sources: (IEA 2016c)

Overall the importance of fuel exports (including coal, oil and gas) has decreased dramatically in importance from over 26% in total merchandise exports in 2000 to 6% by 2014, with manufactured products increasing in importance from 43% to 76% in the same period (World Bank 2017).

Employment. In 2015, around 238,000 people were employed in the ‘mining and quarrying’ sector in Viet Nam, representing 0.45% of the total workforce, of which coal only represents part. Likewise, the ‘electricity, gas, steam and air conditioning supply’ sector employed 0.25% of the workforce in 2015, with only a share of this being related to coal-fired power generation (General Statistics Office of Viet Nam 2017).

The construction of coal-fired power plants can contribute to local economies, as well as domestic equipment suppliers. The power plant construction requires skilled workers and engineers, therefore creating job positions with high wages (Ha-duong et al. 2016). With the scale of planned expansion (see Annex I), this could have visible impact on employment in the relevant sectors for the duration of construction.

Subsidies. Most fossil fuel subsidies are indirect and not recorded as actual fiscal transfers, making them particularly difficult to quantify. Support for fossil fuel consumption in Viet Nam comes in the form of various price controls and provisions to energy producers and distributors, the overwhelming majority of which are state owned enterprises (SOEs). These provisions include price controls, discounted or even free resources and infrastructure, preferential loans from state-owned banks, loan guarantees or bail out of loss-making units, and a variety of corporate tax breaks and concessions. Companies are also rarely made to incur the social and environmental costs that result from energy production.

Fossil fuel subsidies in Viet Nam as calculated by the IEA have decreased over the last years and reached an all-time low in 2015, with USD 211 million and an average subsidization rate of 1.1%. This represents only 0.1% of GDP and translates to USD 2.3 per person (IEA 2016g).

Table 6-2: Consumption subsidies for fossil fuels in Viet Nam (Real 2015 million USD)

Energy source	2013	2014	2015
Oil	16.7	-	-
Electricity	1 290.1	783.9	36.0
Natural gas	495.0	246.1	172.4
Coal	5.6	3.4	2.7
Total	1 807.4	1 033.3	211.0

Data sources: (IEA 2016g)

SOEs dominate energy markets, so as they are forced to lower their profits or make losses due to price caps and operational inefficiencies, they build up debt. The Government is foregoing revenue and eventually will need to cover losses. By the end of 2015, debt of Vinacomin was approximate VND 100,343 billion (USD 4.5 billion⁷) (Vinacomin 2016). In 2016, EVN had a debt of VND 475,357 billion (USD 21.2 billion) (EVN 2016).

6.3.4 Local impact of coal use

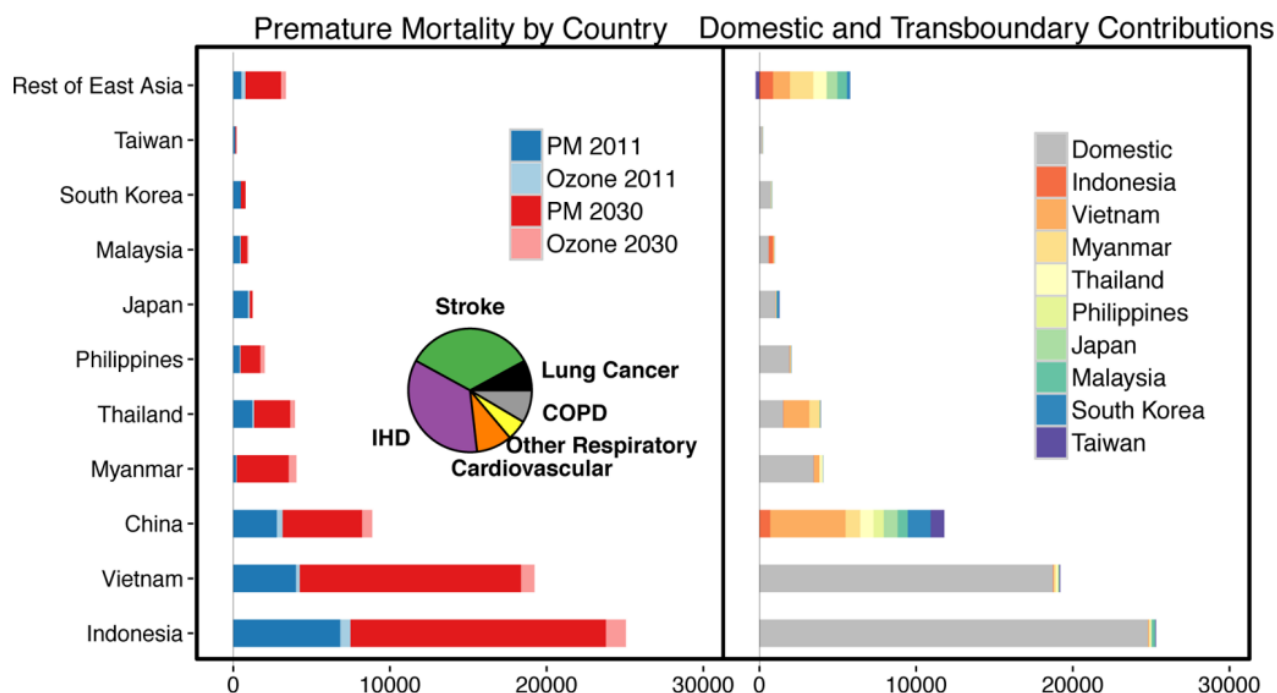
Air quality. Most coal power plants operating in Viet Nam as of 2016 are based on old technology (sub-critical power plants), and some lack emission control equipment. This leads to relatively high emissions at these plants.

Monitoring results from MONRE showed that in 100% of coal mining and processing facilities, concentrations of dust in the air exceeded the Vietnamese standard (QCVN06:2009/BTNMT) from 30 to 300 times (Ha-duong et al. 2016). According to QCVN06:2009, the maximum allowed dust concentration is 0.15mg/m³.

The Vietnamese standards on Ambient Air Quality (QCVN05:2013/BTNMT) set the national standards for particulate matter (PM). PM10 concentration is set at 50 µg/m³ (measured as an annual mean) and 150 µg/m³ (measured as a daily concentration). The standard for PM2.5 is 25 µg/m³ and 50 µg/m³, respectively. Figure 6.24 illustrates the estimated premature deaths related to particulate matter and ozone emissions from coal-fired power plants in Viet Nam and other South-East Asian countries (Kopplitz et al. 2017).

⁷ Conversion using exchange rates from 1 June 2017, retrieved from www.oanda.com

Figure 6.24: Coal-related mortality due to emissions in Southeast Asia

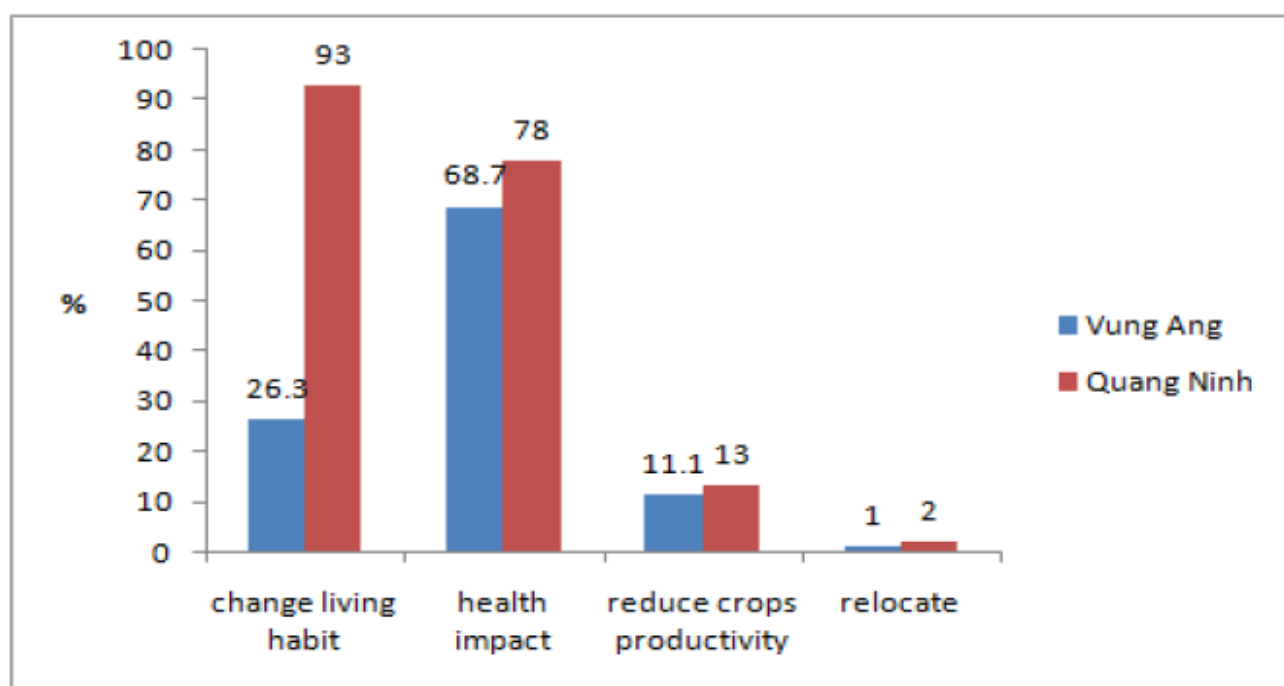


Source: (Koplit et al. 2017)

According to (Dinh-Hieu et al. 2012), the coal mines of Cam Pha, Uong Bi and Ha Long city had shown a high level of dust pollution. The largest sources of dust emission are the process of sorting coal and cost transport. Also, dust generated from active waste rock dumps or closed waste rock dumps which are not yet recultivated.

Air pollutants, especially dusts, produced from coal power plant operation (coal transportation to the plant, coal combustion, ash transportation and storage) is significantly affecting people's health and daily activities in the area around the plant sites (Ha-duong et al. 2016).

Figure 6.25: Impact of air pollution



Sources: (Ha-duong et al. 2016)

Worker safety and health. Spontaneous combustion of coal in the waste rock pile coal yards of some mines e.g Lang Cam, Phan Me (in Thai Nguyen province), Khe Bo (Nghe An province), Uong Bi and Southeast Company, has been recognized since the seventeenth century. The spontaneous combustion of coal has seriously impacted the environment, safety and occupational health of the miners.

Inspection in mining areas revealed that the noise intensity there could reach 97 – 106 dB. This noise exceeds the allowed value of 75 dB according to the Vietnamese standard TCVN 5949:1998 which results in many cases of occupational deaf among mining workers.

Water. A study on Lo Tri coal mine in Quang Ninh showed a high risk of streams around the coal mine being acid contaminated in the dry season (Le and Nguyen 2012). A recent survey of Quang Ninh coal power plant (Ha-duong et al. 2016) showed that water quality at the area receiving waste water of the cooling process has high temperature, ranging from 38.1°C to 38.9°C; this temperature is 7.9°C to 12.9°C higher compared to that of water source before entering the plant and 6.2°C – 16.1°C higher compared to that after exiting the plant as input of the cooling process⁸. The sudden increase of temperature of water will cause the temperature shock of living organisms in the ecosystem, increasing the living activities in water and the dissolved oxygen (DO) in water as well as the dissolution of toxic matters in water, resulting in an imbalanced ecosystem. Pollution is found to be higher in the rainy season and even areas further from the waste water discharge point and coastal areas are moderately affected. The survey of Mao Khe coal power plant in 2015 also revealed the same problem of thermal pollution at the point of discharge of cooling water to the Suoi Gao stream (CEWAREC 2015).

While there was only one mine with a mine water treatment station before 2009, VINACOMIN has been investing into further treatment stations. By 2012, there were 29 mine water treatment projects completed and operated in the Quang Ninh basin (Mien 2012).

⁸ For comparison: in Hamburg the allowed temperature difference induced through cooling water is 3°C (Projektgruppe Wärmelastplan Tideelbe 2008)

The ion concentrations of copper, lead, zinc, and iron in the wastewater of many mines are higher than the acceptable standards⁹. Zinc ion concentration in Lang Hich mine, for example, exceeded the acceptable standard by 1.4 to 3.39 times, the zinc and lead ion concentration in Cho Dien mine exceeded the acceptable standard of 1.4 - 3.6 and 1.9 - 6.93 times respectively (My 2010).

Soil. A study of rice paddy soil composition in Cam Pha, Quang Ninh province, showed the presence of cadmium, copper and lead at higher concentrations than calculated background concentrations (Martinez et al. 2013). Metals and metalloids in Cam Pha rice paddy soils, including Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Manganese (Mn), Nickel (Ni), lead (Pb) and Zinc (Zn), were found in concentrations ranging from 0.2 to 140 mg/kg, which were in close agreement with toxic metal contents in mine tailings and Coc Sau coal samples, suggesting mining operations as a major cause of paddy soil contamination. Solid waste is also one of the causes of changes in soil properties in the area. Coal mine wastes of Nui Beo contain high levels of Iron and Manganese to the flow through the soil surface will increase metal concentrations of iron, manganese in the soil.

Storage of coal ash is a major challenge, due to the large amount of coal ash generated by coal power plants in Viet Nam. According to the survey of the Japan Bank for International Cooperation (JBIC), 673,600 tonnes of coal ash is produced every year from just 5 EVN's coal power plants (with total capacity of 1 500 MW, which account for 10% of total installed capacity of all coal power plants in Viet Nam) in the Northern region. With an expected installed capacity of coal power plants of 55 300 MW by 2030, the amount of coal ash could be up to 25 million tonnes per year, requiring up to 22 000 ha of land for coal ash storage (Nga and Hoa 2015).

Local livelihoods. The most important impact to the livelihood of local people comes from land acquisition and resettlement. For example, due to the construction of Hai Phong Coal Power Plant, 53% of affected people became unemployed after their land was acquired. Of these, only 20% found new jobs or new ways of making a living such as opening small restaurants or entertaining services. Only a few got a job in Hai Phong Coal Power Plant.

Coal mining in Quang Ninh province impacted 750 ha of forest, caused the agriculture land to shrink by 79 ha compared to 1985 value, of which 30 ha lost was paddy field (Ha-duong et al. 2016). The coal mines do not have effective measures to restore the cultivation land, thus affect the agricultural activities of local farmers and reduce crops yield.

In Quang Ninh, illegal underground coal mining cause land sinking in the residential area. This phenomenon was threatening the stability of buildings in this area and affecting 80 households forcing them to relocate.

Coal-fired power plants located next to the sea are expected to affect aquaculture production and farming. Vung Ang Coal Power Plant discharge to Mui Dung Sea is, for example, seen as one of the reasons for decreasing fishery products and aquaculture. Nevertheless, more studies are needed to provide concrete evidences for this link.

Health. According to the National Environmental Report 2013 (Ministry of Natural Resources and Environment 2014), almost 50% of total cases of silicosis in Viet Nam are concentrated around the mining areas.

Health impact from coal power plant construction and operation is assessed through the survey (Ha-duong et al. 2016). Around Duyen Hai Coal Power Plant, 73% surveyed households said that their health care expenses have increased substantially since the plant construction started compared to previous years. 51% interviewed people live near Vung Ang Power Plant claimed that their physical

⁹ Compliant to QCVN 40:2011/BTNMT on wastewater quality of industrial facilities before discharging to the environment

and mental health is affected by water pollution. Some households even planned to relocate due to low water quality in the neighbourhood.

Respiratory diseases are the most common health problem in the area (69%), followed by eye diseases (32%), skin (26%) and digestive diseases (19%). Health care expenses of 45% survey households have increased in 2014 (when Vung Ang coal power plant was in construction). This number is 48% in case of Hai Phong coal power plant. In Ha Long city, where main coal mines are concentrated and Quang Ninh Coal Power Plant is located, health impact is a serious problem. One third of the interviewed households said that the frequency of hospitalization in 2014 was higher than previous years. 77% households have family members who have respiratory diseases, of which 44% households have members who diagnosed with chronic diseases.

A recent study (Kopplitz et al. 2017) estimated that the coal power plants operating in Viet Nam were responsible for 4,250 cases of premature death in 2011 due to exposure to airborne pollutant emissions and is projected to rise to 19,220 by 2030, if Viet Nam continues to develop coal power plants as planned in the current PDP.

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