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Subsidies to Coal and Renewable Energy in Turkey

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March 2015

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GSI REPORT

Published by the International Institute for Sustainable Development.

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About GSI

GSI is an initiative of the International Institute for Sustainable Development (IISD). GSI is headquartered in Geneva, Switzerland and works with partners located around the world. Its principal funders have included the governments of Denmark, the Netherlands, New Zealand, Norway, Sweden and the United Kingdom. The William and Flora Hewlett Foundation have also contributed to funding GSI research and communications activities.

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Acknowledgments

The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD) wishes to thank the European Climate Foundation (ECF) for their generous support to the project and the following peer reviewers who kindly dedicated their time to providing comments and suggestions:

Arzu Akçura Değer and Zeki Kurtçu (Deloitte, Istanbul); İzzet Arı and Arzu Önsal (Ministry of Development); Yıldız Arıkan (Istanbul Kemerburgaz University and TRAEE); Ahmet Atıl Aşıcı (Istanbul Technical University); Ceren Ayas (European Climate Foundation, ECF); Baran Bozoğlu (The Union of Chambers of Turkish Engineers and Architects, TMMOB); İbrahim Çiftçi (Greenpeace); Deniz Gümüşel (Health and Environment Alliance, HEAL); Clemens Hoffmann (Bilkent University); Gürkan Kumbaroğlu, (Bogazici University and Turkish Association for Energy Economics, TRAEE); Heike Mainhardt (Oil Change International, OCI); Bengisu Özenç (The Economic Policy Research Foundation of Turkey, TEPAV); Mustafa Özgür Berke (World Wildlife Fund, WWF); Necdet Pamir (Bilkent University and Energy Commission of the Republican People's Party, CHP); Nejat Tamzok (Turkish Coal Enterprises, TKI); Ethemcan Turhan (Istanbul Policy Centre, IPC); Sinan Ülgen and Gökşin Bavbek, (Centre for Economics and Foreign Policy Studies, EDAM); Erinç Yeldan (Bilkent University).

Peer reviewers' feedback greatly improved the publication. Any mistakes remain the responsibility of the authors.

Executive Summary

The electricity system in Turkey faces three challenges. First, demand for electricity is growing as economic growth brings increased energy usage. Second, as the electricity supply expands to keep pace with demand there is the need to ensure that electricity prices remain affordable. Third, as energy and electricity are at the heart of modern economies, energy security is critical for the electricity sector. To balance the competing demands of demand growth, affordability and energy security, policy must seek to create a framework that promotes technologies and projects that meet these needs and deliver sustainable development.

To meet these challenges, current policies in Turkey propose to increase the supply of electricity through a considerable investment in coal-fired generation. Generation from coal has economic, social and environmental costs. This paper presents an overview of the cost of promoting investment in coal in the form of subsidies. It also considers the external costs of coal use (including environmental and health costs). This paper seeks, where possible, to quantify the costs of subsidies and external costs so that the impact of these policies can be understood. By way of comparison, the costs are presented alongside analysis of the costs and impacts of solar and wind energy.

Fossil-fuel subsidies are generally considered to have negative economic consequences. They are often costly, causing government budgets to be reduced in other areas, increase wasteful consumption and distorted markets. Despite these disadvantages, governments use subsidies to support vulnerable groups, promote economic development and promote energy security. However, subsidies frequently fail to meet their intended objectives.

This study finds that there are significant subsidies to coal in Turkey and presents a preliminary estimate for these of between US$0.01–0.02 per kilowatt hour (kWh). The total subsidy to the coal industry that it has been possible to quantify is approximately US$730 million in 2013. This figure includes direct transfers to the hard coal industry, subsidies to exploration of coal resources, rehabilitation of power stations and coal aid to poor families. Further subsidies were identified but not quantified. If included, the unquantified investment guarantees and exemptions from customs charges, VAT, social security, land allocation and below market interest rates would raise the estimate significantly. Quantification of these measures would help to shed further light on the true costs of coal subsidies.

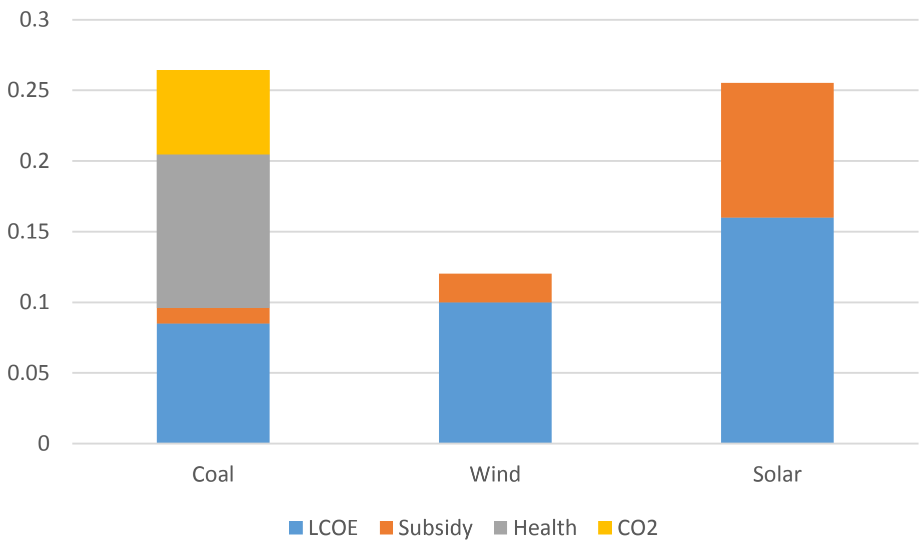

FIGURE 1. FULLY BUILT-UP COSTS ASSOCIATED WITH GENERATION FROM COAL, SOLAR PHOTOVOLTAIC (PV) AND ONSHORE WIND (US$ PER KWH), 2013 COSTS

Source: Authors' calculations.

Furthermore, when externalities are included in a consideration of the costs of energy, this study finds that electricity generation from wind and solar is already cheaper than generation from coal (See Figure 1) and the costs of renewables are expected to fall significantly over the next 15 years.

Quantifiable subsidies to coal in 2013 make up around 0.1 per cent of Turkey's nominal GDP, which may not appear significant. However, the continuation of these subsidies, together with new incentives and guarantees, locks the country in to a set of technical, institutional and legal structures dependent on coal and impedes renewable energy development. It is recommended that Turkey phase out fossil-fuel subsidies. Where the reduction in subsidies will have adverse impacts (such as a fall in employment in coal-related industries) mitigation strategies should be developed. The true cost of coal, including the social and environmental impacts, should be built into energy sector decision making processes. There is the potential for a much larger role for renewable energy in Turkey's energy mix in the future. Finally, the assumption that domestic coal production will provide energy security should be reconsidered.

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Introduction

This report is divided into four sections. Section 1 provides a summary of the Turkish energy system. Section 2 describes the electricity sector subsidy policies that have been identified in Turkey and presents estimates for their magnitude where these are available. It then goes on to address externalities of coal use. Section 3 explores the role of subsidies in the energy systems considering the situation in 2013–2014 and projecting to 2030. The section also discusses the three challenges described above and considers the overall costs, including the levelized cost of energy, subsidies and externalities. Section 4 makes a series of policy recommendations based on the findings of the study.

1.0 The Turkish Energy Situation

In the past three decades, the Turkish energy sector has evolved dramatically, and continues to do so as economic growth and social development drive demand for energy services. In the early 1980s, the government began to reform the petroleum sector, and by 2005 privatization of state-run enterprises, price reform, and establishment of a competitive energy market were complete. Reform of the electricity sector, although set in motion in the 1980s, did not progress significantly until 2001 when a comprehensive reform package was passed, enabling privatization, unbundling, and price reform (International Monetary Fund [IMF], 2013). This package established a "new and radically different" legal framework for the design of electricity markets and set up an independent Energy Market Regulatory Authority (EMRA) (Atiyas & Dutz, 2005). The IMF (2013) reports deep changes in the electricity market with the fragmentation of state-owned enterprises into different entities (generation, transmission, distribution, wholesale and retail supply). Furthermore, a competitive wholesale electricity market was put in place in 2006.

Despite these steps in the privatization of the electricity market, electricity prices remained state-controlled. Between 2002 and 2007, electricity prices remained constant although demand was rising and the prices of inputs were increasing significantly. This situation led to a lack of funding for investment in the sector and for maintenance of infrastructures. Furthermore, low electricity tariffs encouraged demand further. In 2008, the government set up a "cost-based pricing mechanism" for state-owned enterprises in the energy sector aiming to reach full cost recovery. The mechanism allowed for a transition period during which retail electricity tariffs were progressively adjusted every three months towards full cost reflection (Acar, Challe, Christopoulos, & Christo, 2014).

Turkey also took steps towards restructuring the coal sector (Turkish Hard Coal Enterprise, or TTK) within the context of the 9th Development Plan. Considering the continued losses of the TTK, the program initiated in 2009 aims at more productive and rentable production of hard coal under the conditions of international competitiveness (Turkish Court of Accounts, 2011). The Undersecretariat of Treasury is responsible for the process in collaboration with the Ministry of Energy and Natural Resources, Ministry of Development, TTK and other relevant institutions.

Today, Turkey faces the challenge of meeting rapidly growing demand for energy, while ensuring affordability and security of supply. This has led the country to develop a strategy focusing on developing domestic coal resources, such that growth in coal-fired power generation is expected to be highest of all Organisation for Economic Co-operation and Development (OECD) countries, and only fourth globally (International Energy Agency [IEA], 2012). By contrast, the strategy also acknowledges the importance of environmental protection and emissions reduction, and foresees a much larger role for renewable energy in the energy future.

The following sections set the background for the analysis, describing in detail the energy demand and supply situation, the current and future role of coal and renewable energy, and the relationship between the two.

1.1 Energy Demand and Supply

Turkey's economic and social development has led to a massive increase in its energy demand over the last decade, a trend that is set to continue in coming years. Total primary energy supply grew by over 50 per cent between 2000 and 2012, while electricity consumption grew by over 100 per cent in the same period (IEA, 2014a). Looking forward, electricity demand is projected to increase at an annual rate of between 6 and 7 per cent through to 2020 (Turkish Electricity Transmission Company [TEIAS], 2013), with capacity expected to increase from 64 gigawatts (GW) in 2014 to up to 120 GW in 2023. However, some studies and experts have questioned the rate of demand growth, claiming overly optimistic assumptions for economic growth have led to an unrealistically high estimate.[1]

In 2012, total primary energy supply comprised mainly fossil fuels (90 per cent), with gas accounting for 32 per cent, coal for 30 per cent and oil for 27 per cent. Renewable energy sources accounted for the remaining 10 per cent, with hydroelectricity (4 per cent) and biofuels (3 per cent) being the primary sources (IEA, 2014a). This generation mix, coupled with limited domestic resources of fossil fuels, means that Turkey imports the majority of its energy supply. Figures from the IEA show that in 2012, net imports accounted for almost 75 per cent of energy supplied, with 93 per cent of total oil demand and 99 per cent of total gas demand being imported, primarily from Iran and Russia (IEA, 2014a). In addition, while Turkey has domestic reserves of coal and lignite, current production is not sufficient to meet demand, with imports accounting for 55 per cent of supply in 2012. This import dependency exerts a heavy toll on Turkey's balance of payments, with energy imports accounting for US$56 billion, or almost a quarter of the total import bill in 2012 (Macit, 2014).

Supporting the expected level of growth in demand is in itself a challenge, requiring significant investment in generation capacity and energy infrastructure, as well as continuation of the energy market reform initiated in the 2000s (IEA, 2013). However, Turkey is also grappling with the challenges of ensuring a cost-competitive energy supply for its population and industrial sector, ensuring energy security, and realizing emissions-reduction needs (Ministry of Energy and Natural Resources, 2010). Although the country does not spell out strong ambitions to cope with climate change and has not yet set a target for decreased emissions, these priorities are addressed in the Institutional Strategic Plan (2010–2014) of the Ministry of Energy and Natural Resources of Turkey. This plan identifies strategic aims in the areas of energy supply security, regional and global effectiveness in the field of energy, environment, and natural resources. For instance, the country aims at decreasing the speed of growth in GHG emissions stemming from the energy sector after 2014. Measures to increase the security of supply include giving priority to domestic resources (namely coal), by increasing the share of both nuclear and renewable generation in the energy mix. Similarly, the strategic aim in relation to natural resources focuses on the role that mining plays in the development of the economy. Together, these factors mean that Turkey faces a tricky balancing act with respect to the future development of its generation mix and the policy tools used to support this.

1.2 Coal in Turkey

Reflecting a desire to reduce import dependency and improve energy security, the strategic direction for Turkey's energy sector focuses heavily on expansion of coal-fired power generation utilizing domestic resources. Estimated proven reserves of coal are around 13.9 billion tonnes, with the majority of these reserves (13.4 billion tonnes) being low-quality lignite, located throughout the country (See Figure 2). The remaining proven reserves (0.4 billion tonnes) are higher-quality hard coal, found mainly in the Zonguldak basin in northwest Turkey. Since 2005, significant efforts

[1] According to BNEF (2014, p. 14), it is more likely that Turkey will follow similar trends with Poland, Portugal and Spain in its electricity consumption, i.e., as the country becomes richer, energy demand is expected to flatten. The report highlights that the early signs of slowing energy demand growth are already evident.

have been made to exploit existing reserves and explore new deposits, and recent years have seen an additional 6 billion tonnes of coal resources added (IEA Clean Coal Centre, 2014). This was mainly due to government-sponsored exploration campaigns undertaken by the General Directorate of Mineral Research and Exploration (MTA) and the Turkish Coal Operations Authority (TKI). The government-funded exploration program has increased Turkey's coal reserves by over 50 percent since 2005 opening up 5.8 billion tonnes of new coal to be mined (OCI, 2014).

FIGURE 2: LIGNITE RESERVES IN TURKEY

Source: General Directorate of Mineral Research and Exploration (2012).

In 2013, coal-fired power generation accounted for around 12.5 GW or 20 per cent of total generation capacity in Turkey, and for 64 terawatt-hours (TWh) or 26 per cent of total generation (see Figure 3). While lignite accounts for almost two thirds of total coal-fired capacity (8.2 GW), it accounts for just under half of generation (30.2 TWh), reflecting the lower heating value of lignite compared to hard coal. The majority of hard-coal power stations use imported coal, while the fuel needs of lignite power stations are met from domestic sources. In 2013 and 2014, the top five import countries for coal were the United States., Ukraine, Canada, Australia and Russian Federation (Turkstat, 2015).

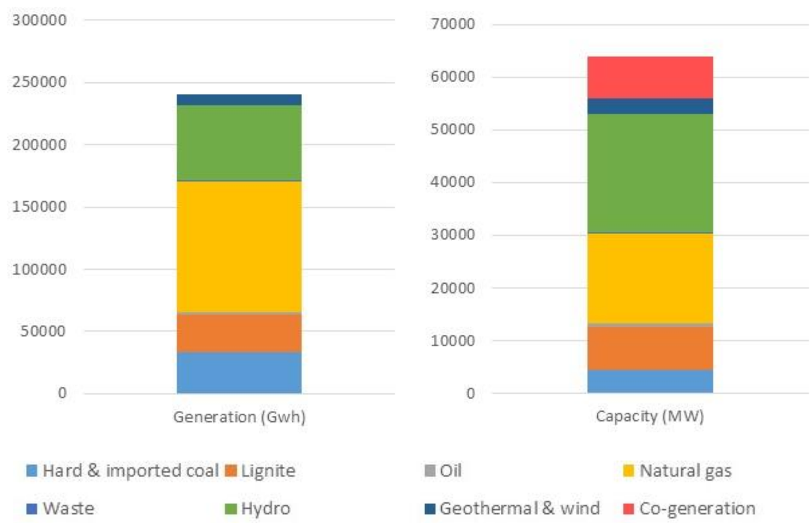

FIGURE 3: INSTALLED CAPACITY AND ELECTRICITY GENERATION BY SOURCE, 2013

Source: Generation data from Demircan (2013); capacity data from BNEF (2014).

By 2030, total electricity generation is expected to increase from 240 TWh to over 600 TWh. The share of coal will grow from approximately 27 per cent to around 32 per cent of total generation: given the increase in total generation, this seemingly modest percentage rise represents a three-fold increase in coal-fired generation, to almost 200 TWh (see Figure 4). This increase in generation will be met by a three-fold increase in installed capacity to almost 35 GW, comprising both lignite and hard-coal fired plants. Of this, approximately 35 per cent will be met by hard-coal capacity and the remaining 65 per cent by lignite capacity—given Turkey's limited reserves, it is likely that the majority of hard coal will need to be imported and thus reliance on overseas sources of supply will not be entirely cut.

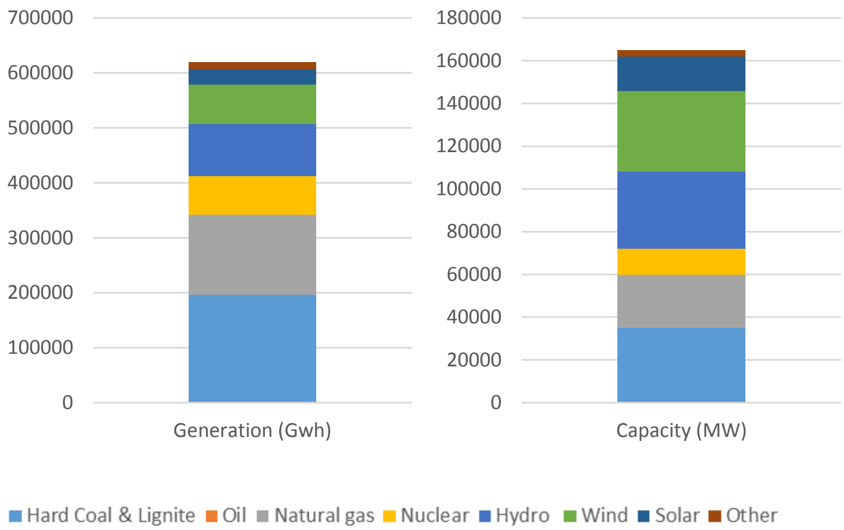

FIGURE 4: INSTALLED CAPACITY AND ELECTRICITY GENERATION BY SOURCE, 2030

Source: Generation data from Demircan (2013); capacity data from BNEF (2014).

The fact that domestic coal production is mainly lignite and many of the plants operate on hard coal means that domestic coal production is not compatible with the energy security targets. Increasing dependence on imported coal will not only worsen current account deficits but also deadlock the country's energy security efforts.

Another issue to discuss is in which specific areas and for which aims coal is being utilized in the country. Most of the hard coal and lignite supply (both domestic and imported) is used in the energy sector. According to the energy balance tables, around 7 million tonnes of oil equivalent (TOE) hard coal and 9 million TOE of lignite were utilized by power stations in 2013. Sectoral use of hard coal corresponds to 6.4 million TOE, 2.9 million of which is comprised of industrial consumption whereas 3.5 million TOE is consumed by housing and services sectors. The cement sector is the only industry with outstanding amounts of coal consumption, exploiting a level of 1.6 million TOE of hard coal and 0.9 million TOE of lignite in 2013. Iron and steel, textiles, chemical and petrochemical industry and ceramic industries are also large consumers of coal. These figures reveal the economic priorities of the country, which leans on the most polluting sectors. If these sectors continue to be considered engines of economic growth, dependence on coal (specifically for these industries) will further jeopardize the balance of payments at the expense of unsustainable growth in ecological and economic terms.

BOX 1. SAFETY IN THE TURKISH MINING SECTOR

In 2014, the Turkish mining sector recorded two major incidents: the Soma accident (May 2014) which resulted in over 300 deaths and the Ermenek accident (October 2014) which resulted in 18 deaths. Both accidents brought further into question the already poor safety record in the sector (see Table 1 for data from earlier years). Even prior to the recent accidents, analysis by Turkish Economy Policies Research Foundation (TEPAV) showed that Turkey recorded more deaths per millions of tonnes mined (7.22 in 2008) than either China (1.27) or the United States (0.02) (Today's Zaman, 2014).

Nine months before the Soma mining disaster, the Minister of Energy and Natural Resources visited the mines in the region, praised the Soma Holding company for "prioritizing workers' safety at its facilities," and described the mine as an "exemplary one" in his speech during the opening ceremony of another mine in Soma. His words on July 9, 2013 are quoted below ("Turkish energy minister praises," 2014):

> "We saw [at the mine] that as we spend money on safety-related systems, my worker brothers' efficiency rises... We need to make sure our workers are free from concerns."

TABLE 1. EMPLOYMENT INJURIES, OCCUPATIONAL DISEASES, PERMANENT INCAPACITY AND DEATH IN THE COAL AND LIGNITE MINING SECTOR (2007–2012)

YEAR	NUMBER OF EMPLOYMENT INJURIES	NUMBER OF OCCUPATIONAL DISEASES	NUMBER OF PERMANENT INCAPACITY	NUMBER OF DEATH CASES
2007	6.293	996	427	38
2008	5.728	328	221	30
2009	8.193	201	92	3
2010	8.150	92	94	92
2011	9.217	170	104	58
2012	8.828	231	122	20

Source: Employment Injury and Occupational Diseases Statistics, Social Security Institution

Regulations in Turkey, however, are on a par with those found elsewhere in the world, suggesting that implementation rather than existence of regulation remains the problem. Commentary by TEPAV suggests two reason for this: the first being that growth in the sector has been too rapid to ensure that miners are well trained, and the second that management of mines simply neglect to follow the regulations (Sak, 2014).

In particular, the tragedy at Soma called into question the means by which the private sector has achieved a reduction in production costs. In 2012, the director of the mine noted that private sector practices had led to a fall in the cost of production from between US$130 and US$140 per tonne of coal to US$23.80. Subsequent reports questioned the safety practices at the mine, and suggested that safety measures had been compromised in pursuit of profit (Kotsev, 2014).

1.3 Renewable Energy in Turkey

To date, exploitation of renewable energy resources in Turkey has been restricted to hydropower plants (approximately 20 GW of capacity in 2012) and some recently constructed wind generation projects (approximately 2 GW of capacity in 2012). Since 2000, generation from hydro sources has almost doubled to reach 58 GWh in 2012 and generation from other renewable sources has increased exponentially from a very low base to reach over 7 GWh in 2012.

However, renewable energy remains a largely untapped resource in Turkey. Table 2 shows the technical potential for renewable energy in Turkey. The country has the highest potential for geothermal energy in Europe, and one of the highest potentials for wind energy and solar photovoltaic (PV), and useful resources of biomass and small hydro power.

TABLE 2. TECHNICAL POTENTIAL OF RENEWABLE ENERGY IN TURKEY (IN MEGAWATTS [MW])

GEOTHERMAL	BIOMASS	SOLAR PV	WIND	SMALL HYDRO
31,500	16,000	3,871,500	114,000	6,800

Source: Geothermal data from Baris & Kucukali (2012); all other data from UNDP (2014).

Exploiting these resources is part of government plans for the energy sector. By 2030, renewable energy is expected to account for a third of electricity generation, compared to under 30 per cent in 2012. Further, the split between renewable technologies is expected to be more broad-based, with the relative share of hydro decreasing and that of wind and solar increasing (see Figures 3 and 4). The government aims at reaching 20,000 MW of installed wind capacity, 3,000 MW of installed solar power capacity and the full utilization of its hydro potential by 2023.

While there is clearly very significant technical potential for renewable generation, as shown in Table 2, there are a number of barriers to attaining it. Developers of renewable energy projects must navigate the licensing and permitting systems which can pose both technical and political barriers to projects. In addition, projects must establish a connection to the electricity grid and a power purchase agreement (PPA) to be able to sell their output. Anecdotal reports suggest that the regulatory system and availability of PPAs currently pose a significant barrier to renewable energy projects. These barriers may not prevent project development but may increase the "soft" costs of project development. These costs render the Levelized Cost of Generating Electricity (LCOE) from renewable energy more expensive than in countries with comparable levels of renewable resources.

1.4 Comparing Coal and Renewable Energy

The Turkish government has emphasized the importance of energy security in its strategy for the sector. Coal, renewable energy, and to some extent nuclear power, are prioritized with the aim of reducing reliance on imports of natural gas and oil. However, the ambitions for renewable energy remain limited in comparison with the ambitions for coal—while the strategy is strongly focused on exploiting domestic reserves of coal, the ambitions for renewable resources are more limited. Most notably, the role of solar and of geothermal energy sources is expected to be far below the technical potential implied by the resource available.

It should be noted that renewable energy generation capacity is not necessarily a direct replacement for fossil-fuelled generation capacity. There are several reasons for this discrepancy. First, as fossil generation capacity is not reliant on the availability of natural resources, such as wind or solar radiation, coal can be dispatched as required. As a result, load factors for thermal generators tend to be significantly higher than renewable generators. Second, the geographical distribution of renewable energy resources means that wind and solar power may be available but transmission may be limited by the capacity of the electricity grid. This may limit the ability of renewable resources to meet local demand. Due to these reasons a greater renewable energy generation capacity may be needed to replace an equivalent quantity of fossil-fuelled capacity.

The remainder of the report will look at whether the adapted strategy will indeed ensure energy security, and how it will affect the provision of cost-competitive energy and the provision of clean energy—in other words, Turkey's energy "trilemma." In answering these questions, we are particularly concerned with the subsidies granted by the government to coal and renewable energy sources. Such subsidies, as described below, alter the development of the energy market through changing relative prices. In turn, this affects the likely attainment of Turkey's energy goals.

2.0 Identifying Subsidies in Turkey

2.1 Defining Subsidies

In broad terms, a subsidy is frequently defined as "any government action that lowers the cost of energy production, raises the revenues of energy producers, or lowers the price paid by energy consumers" (World Economic Forum [WEF], 2009). More specifically, subsidies can be considered to fall within one of four main categories: income and price support, government revenue foregone, provision of goods and services below market value, and direct and indirect transfer of funds and liabilities. Definitions of subsidies generally overlook underpricing of social and environmental externalities such as health-related costs associated with fossil-fuel use. However, since these represent a cost to society that the parties liable are not required to pay, there is an argument for considering them in the definition or for at least taking account of them otherwise.

Governments typically subsidize energy for a range of reasons: to support the more vulnerable sections of society and ensuring their access to energy, stimulating economic development in certain regions or the economy as a whole, or to promote energy security. However, regardless of intentions, subsidies frequently evolve into costly mechanisms that fail to meet their original objectives and that have other adverse consequences. Among these consequences, fossil-fuel subsidies impede the deployment of renewable energy sources and the development of a sustainable energy system by altering relative investment and generation costs (Bridle & Kitson, in press).

2.2 Energy Subsidies in Turkey

There is an increasing body of work on the incidence and level of subsidies to fossil-fuel energy in Turkey (see OECD [2013], Makhijani [2014], Oil Change International [OCI] [2014], Acar, Challe, Christopoulos, & Christo [2014] for some examples). Following the reform of the petroleum and electricity sectors in the 1990s and 2000s, it is now generally considered that the majority of fossil-fuel subsidies are granted to the coal sector. However, there are a range of non-quantifiable subsidies that also confer a significant financial and non-financial benefit on the sector, identified and described below. In addition, Turkey has also recently begun to subsidize renewable energy, providing a feed-in tariff and some additional support measures to developers, as described below.

2.2.1 Subsidies to Coal

Government support to the coal industry is aimed at supporting continued development of indigenous reserves and utilization of these reserves to meet increasing domestic and industrial demand, and thus economic growth. In addition, the continued operation of coal mining operations supports 55,500 jobs per year, including in some of the country's more remote and less-developed regions. According to the figures estimated by TKI and TTK, around 18,500 are employed in the hard coal sector whereas 37,500 are employed in the lignite sector.[2]

Table 3 sets out the subsidies payable to the coal industry in the period 2009 to 2013, as granted by the Turkish government.[3] Subsidies are quantified and disaggregated as far as possible but in many cases the data available does not allow this level of analysis. For example, the government grants packages of incentive measures to both the lignite and hard coal mining industries, but there is no financial data available on the value of these packages. Similarly, exploration subsidies refer to coal, gas and oil subsidies, not just coal alone, making it difficult to identify the funds allocated to coal alone.

[2] See TKI (2013) and TTK (2013). According to the annual statistics of TTK (2013), around 11,000 people are employed in the establishments of Armutcuk, Amasra, Uzulmez, Karadon and Kozlu and the Head Office of TTK.
[3] For data on subsidies provided by international and bilateral institutions see OCI (2014).

2.2.2 Producer Subsidies to Coal

In terms of quantifiable subsidies, the most important measure supporting coal is the **financial assistance given to the hard-coal industry** in the form of transfer payments from the Turkish Treasury. These transfers are mainly used to subsidize imports of hard coal—domestic resources supply less than a tenth of total demand and the costs of this supply is much in excess of international prices (OCI, 2014). Table 3 displays the extent of these transfers from 2009 to 2013. The amount of these transfers varies in the range of US$260–US$300 million per year. Other subsidies quantified in the table include:

- **R&D expenditure**: The government supports the fossil-fuel sector with R&D expenditures. Among various fuels, coal receives the highest expenditures. IEA reports that 2.6 million TL was spent on coal R&D by the government in 2009. (No data was available after this year.)
- **Rehabilitation Support**: As part of the privatization process, the Turkish government funded the rehabilitation of hard coal mines and coal power stations.
- **Government support for exploration**: Ministry of Energy and Natural Resources (MENR) Strategic Plan 2010-2014 (MENR, 2010, p. 41) documents the coal, oil and gas exploration budgets of the MENR from 2010 to 2014 as displayed in the table. The budgets varied between 35 million and 51 million TL (Turkish lira, approximately US$23 million to US$34 million) in the plan period.
- **Government expenditure on coal-fired power stations**: Planned budgetary expenditure for new coal power plants was calculated as 28 million TL (~US$15 million) for 2013 and estimated to be around 31 million TL (~US$14 million) for 2014. These include the new domestic coal thermal plants of 3,500 MW to be completed by the end of 2013 (MENR, 2010).

There are a number of other subsidies that are difficult to quantify since no data is publicly available. First, the Treasury has provided **investment guarantees**[4] to coal power plants up to 15-20 years of operation life (e.g. Cayirhan and Iskenderun thermal plants).

Second, **guaranteed price and purchase of** electricity for certain periods of time are offered to projects including lignite-fired power generation investments. Turkey's long-term power purchase agreement framework and auction system guarantees revenues to new power-generation investments. This is critical for large power projects to receive financing. The long-term power purchase model and auction system are set up to provide beneficial treatment to power generation projects with long lead times, such as coal power plants (OCI, 2014). The power plants based on Build-Operate-Transfer and Build-Own-Operate models are engaged in long-term power purchase agreements for the sale of electricity to the public trading company.

More substantially, coal projects are subsidized under the **New Investment Incentive System**, which was introduced in April 2012. This comprises four schemes: (1) General Investment Incentive Scheme (2) Regional Investment Incentive Scheme (3) Large Scale Investment Incentive Scheme (4) Strategic Investment Incentive Scheme. Coal exploration, production and investments in coal-fired power plants are subsidized within the Regional Investment Incentive Scheme and included as "priority investments" receiving elevated investment incentives. This program categorizes Turkish regions and cities with respect to their development levels and aims at supporting the relevant industries in line with the potentials of the cities. In general, the scheme offers subsidies in the form of Customs Duty Exemption, VAT Exemption, Tax Reduction, Social Security Premium Support (Employer's Share), Land Allocation and Interest Support, with the terms and rates of support depending on the region (Regions 1 to 6, with Region 6 attracting the highest levels of support).

[4] Investment guarantees include a broad range of guarantees and insurance products that mitigate investment risks.

These subsidies are complemented by explicit or defacto **exemptions from environmental regulation**. There are several reported examples of weak environmental regulations or a failure to enforce the existing regulations and standards. The poor implementation of environmental impact assessments (EIAs) is one such example that could be considered a subsidy. CEE Bankwatch Network (2013) revealed that EIAs for the planned coal-fired plants are incomplete. According to the Ministry of Environment and Urbanization statistics, the EIA reports of more than 40 coal-fired power plants and related facilities were approved between 1999 and January 30, 2015 and there was no coal project whose EIA was disapproved. Besides, coal power plants below the calorific power of 300 MWt (Megawatt thermal) are not subject to EIA. If the capacity of a non-assessable plant is increased to an assessable level (due to a capacity increase or enlargement), it is not compulsory to prepare an EIA report. The EIA legislation was amended in November 2014[5] under the pretext of harmonization with that of the EU; however, it did not turn out to be in line with European objectives in the end. One of the amendments brought together the exemption of the facilities from EIA during the process of dismantling after the plants shut down.

Another exemption from regulation has been offered to coal power plants that are in the process of privatization by the Electricity Market Law (No. 6446). According to a provisional article (no: 8) in the law, these plants are allotted a grace period for compliance to environmental requirements until the end of 2018, with a possible extension to 2021. This implies that the heavily polluting coal-fired power plants (such as Afşin-Elbistan plants in Kahramanmaraş) are legally allowed to cause environment damage for some more years. Undoubtedly, such an exception decreases the production costs of these plants, and thus, can be deemed a subsidy.

BOX 2: COAL PROJECTS IN THE NEW INVESTMENT INCENTIVE SCHEME

Under the Regional Investment Scheme, certain *priority investments* benefit from the levels of support set for Region 5, even if the investments are made in other Regions 1, 2, 3, 4. Among these priority investments are "mining investments" and "electric production investments which uses IV-b group mines as defined in the Mining Law as input." IV-b group mines include peat, leonardite, lignite, hard coal, and anthracite. The amount of minimum fixed investment is defined separately for each sector and each region, the lowest amount being 500,000 TL (US$202,500) for Region 5.

Accordingly, these projects receive VAT and customs duty exemptions, income tax reductions, up to 10 years of support for social security premiums, land allocation, and interest support. The Ministry of Economy (2012) defines each measure as follows: investment machinery and equipment imported and/or locally provided within the scope of the incentive certificate will be exempted from VAT and customs duty set in the Import Regime Decree. Reduced income or corporate tax rates will be imposed on the investor's income under the incentive scheme according to the characteristic of the investment until the amount calculated on the basis of government's contribution rate, determined by the same scheme and corresponding to a certain percentage of the fixed investment amount is reached. The contribution rate to investment refers to the rate of the fixed investment subject to tax deduction, whereas tax deduction refers to the rate of income or corporate tax to be reduced until the contribution rate is reached. The amount of the security premium corresponding to the employer's share on legal minimum wage, paid by the investor, is covered by the Ministry of Economy. In order for an investor to benefit from this support, the project should be concluded and a completion visa should be granted. A certain portion of total investment amount is set as a cap for this support measure. For Region 5, the ceiling is 35 per cent. Government land will be allocated for investments with incentive certificates under the Regional Incentive Scheme in accordance with the rules and principles defined by the Ministry of Finance, depending on the availability of such land in the provinces where investments are made. Finally, interest rate support will be available for investment loans, borrowed to finance the investment, with a maturity of at least one year for regional investments (Region 3, 4, 5 and 6). The Ministry will cover a specific portion of the interest/profit share of the loans that do not exceed 70 per cent of the fixed investment amount registered on the certificate for a specific period which would not exceed five years.

[5] Official Gazette No: 29186, Date: 25.11.2014

BOX 2: COAL PROJECTS IN THE NEW INVESTMENT INCENTIVE SCHEME (CONTINUED)

Ascertaining the value of this support is dependent upon adopting a case-by-case approach, depending upon the specific characteristics of the project. Further research on the value of these packages is necessary, and therefore values have not been estimated or included in Table 3.

However, to set some dimensions for the benefit provided, some simple calculations can be considered based on capacity additions for lignite-fired power and using investment costs for recently announced projects. For example, the investment costs for the Konya Karapınar power station are estimated at US$10 billion for 5,000 MW, or at US$2 million per MW (Investment Support and Promotion Agency, 2014). Additional lignite capacity between 2012 and 2030 is projected at approximately 14,500 MW—if all this capacity benefits from the scheme, and 40 per cent of investment costs are covered (assuming that the investment started before December 31, 2014), then the total subsidy would be in the region of US$11.6 billion just for power generation and not accounting for mining projects.

2.2.3 Consumer Subsidies to Coal

The only type of coal subsidy to consumers in Turkey is the distribution of coal to poor families, accounting for over 2 million households since it was initiated. The program executed by the Ministry of Family and Social Policies, Social Assistance Services has been implemented since 2003. The coal supplied by the Turkish Hard Coal Enterprises (TKI) is sent to poor families at a minimum amount of 500 kilograms per household. The Turkish Court of Accounts reports the amount of transfers from the Treasury to TTK, TKI and EUAS arising from the distribution of coal to poor families. The value of the aid was around 600 million TL (US$243,052,746) in 2009 and reached a level of more than 700 million TL (US$283,561,537) in 2013.

2.2.4 Total Coal Subsidy Estimation

The total subsidy to coal mining and coal power generation is calculated by summing all subsidies identified in Table 3, for which data is available. The assumptions to estimate the average subsidy amount are as follows: In the low case scenario, only 50 per cent of exploration subsidy is attributable to coal and 50 per cent of expenditure on new coal-fired power stations is assumed to be a subsidy, while in the high case all of the exploration subsidy is attributable to coal, and it is assumed that all of the expenditure on new coal-fired power stations is a subsidy. It is assumed that all domestically mined coal is used in power generation, and thus the subsidy per kWh of generation is calculated by taking total generation in 2013 from coal, and dividing the total subsidy by total power generation.

Based on 2013 data, this gives a per-kWh subsidy of approximately US$0.01 per kWh, which increases to US$0.02 per kWh when subsidies to consumers (in the form of coal aid) are included. In total, around US$730 million accrued to the coal sector in the form of subsidies in 2013. It is noteworthy that these numbers provide an underestimate of the total subsidy, as they do not include subsidies related to investment guarantees, the regional incentive scheme, or any of the other subsidies identified, which are expected to be significant. The extent of the regional investment incentives provided to the coal sector outlined in Box 2 mirrors this significance. The estimate presented here is significantly higher than IEA (2009) which identified subsidies to hard coal enterprises of US$398 million; it is considered to be higher than OECD (2013) which identified numerous subsidies but provided limited quantitative subsidy estimates; slightly higher than the OCI (2014) figure for 2013, which finds US$560 million, and is not directly comparable with the IMF (2013), which includes externalities as well and does not provide the composition of the total subsidy. Looking forward, and based on the continued role of hard coal in the generation mix, plans for exploiting domestic reserves of coal, and continued development of coal-fired power stations, subsidies can be expected to increase in the near to mid-term.

TABLE 3. SUBSIDIES APPLICABLE TO THE COAL SECTOR IN TURKEY

COAL SUBSIDIES		2009	2010	2011	2012	2013	UNIT	SOURCE
Support to Producers (Mining & Electricity Generation)	Investment Incentives to Lignite Mining*	1	N.A.	3	9	7	No. of incentive documents	Ministry of Economy
	Investment Incentives to Hard Coal Mining*	N.A.	N.A.	N.A.	1	2	No. of incentive documents	Ministry of Economy
	Government R&D Expenditures on Coal	1.68	N.A.	N.A.	N.A.	N.A.	million US$	IEA
	Exploration Subsidies**		23.11	22.89	23.41	24.36	million US$	MENR
	Rehabilitation during privatization - hard coal	23.00	19.00	N.A.	N.A.	N.A.	million US$	OCI
	Aid to the Hard Coal Industry (Direct Transfers from the Treasury)	264.42	302.98	286.68	258.18	298.47	million US$	IEA, Undersecretariat of the Treasury
	Rehabilitation during privatization—power stations	N.A.	2.00	2.00	2.00	2.00	million US$	OCI
	Expenditures for New Coal Power Plants***	N.A.	13.86	13.73	14.05	14.62	million US$	MENR
	Unquantified Subsidies	1. Investment, Price, and Purchase Guarantees to Coal Power Plants 2. Subsidies provided under the New Investment Incentive Scheme in the form of exemptions from customs charges, VAT, social security, allocation of land and below market interest rates 3. Exemptions from environmental regulation including temporary exemptions for existing coal plants and permissive EIA procedures						Undersecretariat of the Treasury, and others
Support to Consumers	Coal Aid to Poor Families	356.4	295.6	390.4	413.2	392.3	million US$	Undersecretariat of the Treasury

Notes:

** Coal exploration, production and investments in coal-fired power plants are subsidized within the Regional Investment Incentive Scheme, which offers subsidies in the form of Customs Duty Exemption, VAT Exemption, Tax Reduction, Social Security Premium Support (Employer's Share), Land Allocation and Interest Support.*

*** The numbers include estimated coal, oil and gas exploration budgets of the MENR from 2010 to 2014 as recorded in the Ministry of Energy and Natural Resources Strategic Plan 2010–2014.*

**** The numbers represent planned budgetary expenditures for coal power plants for 2010– 2014 as stated in Target 1.2: New domestic coal thermal plants of 3,500 MW will be completed by the end of 2013 (MENR, 2010). The amount of subsidy within these budgets is not known.*

2.2.5 Subsidies to Renewable Energy

In 2001, Turkey enacted its Electricity Market Law (Law No. 4628) which introduced two measures relating to renewable energy: first, it reduced costs related to licensing by cutting costs associated with obtaining the license and annual fees, and second, it obliged the Turkish Electricity Transmission Company (TEIAS) to give priority status for renewables facilities' systems connection. Turkey enacted its first law specific to renewable energy in May 2005 (Law No. 5346), providing feed-in tariffs (FITs) for electricity generated from renewable energy sources at the rate of EUR225/ MWh for 10 years (Republic of Turkey, 2005).[6] Given the relatively low rate and limited duration in comparison to other countries, investors either chose not to invest or sold their output on the spot market.[7] In 2010,

[6] Feed-in tariffs (FIT) are fixed cash-per-kWh payments determined by an administrative body and generally available for eligible energy producers.

[7] The FIT scheme in Turkey is not competitive compared to most EU countries' FiTs, which are typically provided for 15 years.

an amendment was introduced that differentiated the tariff payable by technology type and introduced a premium payment, payable over the first five years of operation, dependent on using locally manufactured technologies in the project (Republic of Turkey, 2010). Table 4 shows the standard tariff applied and the maximum tariff that is realizable dependent on local content.

TABLE 4. FEED-IN TARIFF FOR RENEWABLE ENERGY (US CENT/KWH)

	PRICE	DOMESTIC MANUFACTURING ADDITION	MAXIMUM INCENTIVE
Hydroelectric	7.3	2.3	9.6
Wind	7.3	3.7	11
Geothermal	10.5	2.7	13.2
Biomass	13.3	5.6	18.9
Solar photovoltaic (Solar PV)	13.3	6.7	20
Concentrated solar power (CSP)	13.3	9.2	22.5

Source: Republic of Turkey (2010).

Turkey's 2023 solar target is 3 GW, which is considered to be low considering its abundant natural resources. The solar FITs displayed in Table 4 are below those of Germany, Philippines, and Greece, exemplifying Turkey's relative lack of ambition for solar development. The FIT lifespan of only 10 years is shorter than most other EU solar FITs of 15 years. The first Turkish solar PV auction, which involved 9 GW of applicants, closed in July 2013 but it was capped at 600 MW, which implied that fewer than 7 per cent of the bidders would take advantage of the FIT scheme (BNEF, 2014). As of the end of 2013, 136 facilities had applied for the feed-in tariff, representing a total capacity of almost 3 GW. Of this capacity, 1.2 GW was in the wind sector, 1.2 GW in the solar sector, and the remainder split between geothermal and biomass (Gozen, 2014).

In addition, renewable energy investments are subsidized within the General Investment Incentive Scheme, which grants the projects VAT exemption, customs duty exemption, and income tax withholding support provided that the investment is made in Region 6. Other financial and non-financial support measures for the development of renewable energy projects and subsequent operation have been granted, covering the licensing process, land appropriation, and purchase of electricity (see Table 5).

TABLE 5. SUBSIDIES APPLICABLE TO RENEWABLE ENERGY IN TURKEY

TYPE OF SUBSIDY	PROJECT DEVELOPMENT	OPERATION
Income and price support		Feed-in tariff payable for 10 years Guaranteed purchase of electricity
Government revenue foregone		VAT exemption Customs duty exemption
Provision of goods and services below market value	Priority for system connection Enabled access to government land Facilities <1 MW exempt from licensing Licensing cost set at 1% of value	No licensing fees paid in first eight years 85% discount on land use and rent fees Forestation and Erosion control fees not payable in first 10 years

Source: Authors' compilation based on Kucukali & Baris (2011).

The effective subsidy provided by the feed-in tariff is equal to the difference between the market price for electricity and the value of the feed-in tariff. In the absence of subsidy policies, renewable generators would be able to sell their output on the wholesale power market. The price they achieve depends on the market price at the point when power is generated. FITs provide a degree of certainty for generators in the form of a fixed price for all output. These payments constitute a subsidy if the FIT is higher than the wholesale price. This subsidy is readily quantifiable, as FITs can be compared with wholesale prices. In addition, the certainty of the tariff provides a further benefit by reducing the revenue risk due to wholesale price risk.

Due to the difficulty of quantifying many of these subsidies, the following analysis is based on the difference between the FIT paid to renewable energy producers and the average Day Ahead Market (DAM) price, with the high case being taken as the basic tariff plus local content bonus, the low case being taken as the basic tariff only, and the central case used in the following analysis being the mid-point between the high and low cases. As in the case of coal subsidies, where a direct quantification cannot be given, this other support provided is excluded from the analysis. The average DAM prices are given by TEIAS (2014) as 156.3 TL (US$71.1)/MWh in the period from December 2011 to January 2014.

For wind power, the value of the FIT without domestic manufacturing (US$0.073 per kWh) is close to the average DAM price (US$0.071 per kWh). This indicates that for wind power the financial advantages from the FIT are likely to be small, particularly in years when wholesale prices are higher than average. This assertion is confirmed by considering the proportion of wind projects that opt out of the FIT scheme (Table 6). Renewable energy projects in Turkey have the option to opt in or out of the FIT scheme in each year. Table 6 shows that due to the low level of the effective subsidy for wind power, most projects do not choose to register under the scheme.

TABLE 6. PROPORTION OF WIND ENERGY PROJECTS REGISTERING FOR FEED-IN TARIFF SCHEMES

	INSTALLED WIND CAPACITY IN FIT SCHEMES (MWE) (compiled from EMRA databases: http://www.epdk.gov.tr/index.php/elektrik-piyasasi/yekdem)	**TOTAL WIND CAPACITY IN THE BEGINNING OF THE YEAR** (MWe) (Source: MENR)	**FIT UTILIZATION RATE**
2012	655.4	1728	38%
2013	111.46	2,260.6	5%
2014	824.5	2,759.6	30%

2.3 Externalities

In addition to the costs to the government (and thus to the taxpayer) described above, extracting and burning coal has other external costs that place economic, social or environmental burdens on society. Primarily, coal has significant external costs in the form of local environmental pollution, and the associated impacts on the environment and public health, and on emissions of greenhouse gases, which fuel climate change at a global level. In addition, the presence of smog from coal combustion is reported to have a negative economic impact on tourism and real estate prices. These costs are not captured by the market, but are borne by society as a whole and thus represent a very real burden. While the range of such costs is significant, the following focuses on the costs associated with emissions of carbon dioxide and the health costs arising from emissions of other air pollutants.

Carbon dioxide emissions: The cost of climate change effects associated with carbon dioxide emissions is hard to ascertain due to uncertainty as to the relationship between emissions and damage and the cost associated with these damages. Prices realized in carbon markets such as the EU Emissions Trading System (EU ETS) or the Western

Climate Initiative (WCI) can be used as proxy values, but these vary depending on market factors and understate the true costs.[8]

The EU ETS in particular has received much criticism as prices have crashed to close to zero several times since the inception of the scheme, and the permit price has failed to reflect the marginal cost of emissions abatement. There is little agreement on the reasons why EU ETS price has not functioned to provide a consistent carbon price. Three possible reasons include: the effects of the economic crisis in Europe; the overlapping of climate policies, e.g., the interaction of emissions trading and renewable energy policies; and the influx of Certified Emissions Reductions and Emission Reduction Units from outside Europe (Koch, Fuss, Grosjean, & Edenhofer, 2014). Regardless of the reasons, it is clear that the EU ETS has not performed well. Because of these problems the carbon price from the EU ETS is not considered to be a good proxy for the true cost of carbon. It is therefore necessary to consider alternative prices for carbon.

A number of studies have attempted to develop a more indicative view of the true cost of carbon dioxide emissions, and these generally suggest a much higher value, depending on the assumptions used. For example, the social cost of carbon calculated by the U.S. government in 2013 estimated 2015 values of US$11, US$37 and US$57 per tonne depending on discount rate (United States Government, 2013), but these are still well below values calculated elsewhere. Using the same modelling approach, but varying the assumptions on damage functions and the associated economic costs, Ackerman & Stanton (2011) calculate a 2010 social cost of between US$28 and US$893 per tonne.

Total emissions associated with power generation from lignite and coal is estimated by assuming certain emissions factors (1062 kg of carbon dioxide per MWh for lignite and 833 kg of carbon dioxide per MWh for bituminous coal).[9] These factors are applied to generation from lignite (estimated at 35.3 TWh in 2012) and coal (estimated at 32.6 TWh in 2012). This gives total emissions of 64.7 million tonnes from coal and lignite use in power stations in 2012. Assuming a low, mid and high value of US$25, US$50 and US$100 per tonne of emissions results in a total value of carbon dioxide emissions of US$1.6 billion, US$3.2 billion and US$6.5 billion. Given that these calculations refer only to the emissions associated with burning coal, rather than the entire value chain, the estimates are expected to be understated.

Despite the challenges of implementing successful mechanisms, emissions trading has the potential to be a key component in climate policy as it offers a mechanism to embed the costs of one specific externality into energy costs. In Turkey, regulations governing monitoring, reporting and verification of emissions will soon take effect and require emissions to be reported in April 2016. Further in the future, Turkey may eventually establish a national emissions trading system suggested in the National Climate Change Action Plan (NCCAP).

Health Costs[10]: Emissions of sulphur dioxide, particulate matter and nitrogen oxides are implicated in cardiovascular, respiratory and nervous system diseases and deaths. Setting aside ethical arguments, attributing values to these effects is extremely complex because it involves making assumptions as to the characteristics of each power station, the surrounding physical environment, and the local population. However, a number of studies have attempted this, including ExternE in the European Union, and the National Research Council in the United States.

[8] For example, the EU ETS has been trading at around EUR5 per tonne since the end of 2012, while the reserve price on the most recent WCI auction was US$11.34 per tonne.

[9] Emissions factors from Berghmans & Alberola (2013). Generation data from TEIAS.

[10] See HEAL (2013) for further discussion of health effects. See Burtraw & Krupnik (2012) for discussion of the methodological challenges involved in estimating health costs.

A study by the Health and Environmental Alliance (HEAL) looking at Turkey estimated the health-related costs associated with coal-fired power generation as lying between EUR2.45 billion and EUR6.69 billion, dependent on how mortality is expressed (HEAL, 2013). Focusing only on three main air pollutants (SO2, NOx and PM2.5), these assessments exclude the health effects of emissions on water and neurological damage related to the release of mercury; hence they provide an underestimated value in both cases. There are three parts to the methodology followed. First, emissions from coal- and lignite-fired power generation are quantified. Second, human exposure to pollutants is assessed. Third, economic valuation of these damages to human health is performed using both the value of a life year (VOLY) and the value of statistical life (VSL) techniques.[11] Based on the higher figure, and assuming 2009 generation, the health costs per kWh of electricity generated from coal was calculated at EUR0.123/kWh, compared to an average of EUR0.062 for the EU27 plus Turkey, Croatia and Serbia. These estimates do not include the health impacts associated with the full life cycle of coal (mining, transportation, waste disposal), and the true costs can therefore expected to be higher.[12]

2.4 Summary

Although there is an increasing body of work on subsidies to coal mining and coal-fired power generation in Turkey, quantifying these subsidies remains challenging. This reflects the lack of transparency in relation to many of the incentives granted and difficulties in assigning a numerical value to those subsidies identified, issues compounded by the existence of bilateral deals between a producer and the government. As an example, although the royalty tendering scheme is highly beneficial to an operator in that it grants access to land and resources, it is difficult to place a monetary value on this benefit. However, even based on the partial data available, it is evident that subsidies to coal mining and generation are significant and give the coal sector a financial benefit.

The coal-fired power sector also benefits from the underpricing of externalities, both in relation to health and environmental damages. While quantification of health costs is a developing area of research, work to date indicates that even assuming a limited range of impacts, the costs associated with coal-fired power generation alone (i.e., not including mining) are significant. Similarly, while quantification of the environmental impacts associated with coal mining and power generation are known to be significant, assessing and quantifying is an ongoing area of research. However, even restricting analysis to carbon dioxide impacts and making conservative assumptions as to the financial value, coal-fired power generation has a significant adverse impact.

As for coal, there are a range of subsidies granted to renewable energy. From an economic standpoint, these subsidies can be fully justified in that they support infant industries during the early stages of their development and deployment, and that they go some way to compensating for the fact that external costs associated with thermal power generation are not captured by the market. However, the priority given to renewable energy sources remains lower than that given to coal subsidies—for example, unlike coal investments, renewable energy is not included on the priority list (investment region 5) for higher subsidies.

[11] Needless to say, both techniques have some limititations since a true "valuation of a human life" is extremely hard to assess. Besides, valuing human life in monetary terms has been subject to criticisms by many scholars.

[12] Epstein et al. (2010) examine the full life-cycle cost of coal in the United States and estimate external costs in the region of US$180/MWh.

BOX 3: JOBS IN THE TURKISH MINING SECTOR

According to the figures estimated by TKI and TTK, around 18,500 workers are directly employed in the hard coal sector whereas 37,500 are directly employed in the lignite sector—these numbers exclude subcontractors, who have made up a larger proportion of employment since privatization.[13] Although this number accounts for a small proportion of total employment, in many areas (including Soma), mining is the main source of employment. For these communities, continued operation of mines is vital for the economy and reform of subsidies in the sector is likely to be politically unpopular insofar as it threatens viability.

However, the quality of the jobs is increasingly under question, with safety breaches and accidents leading communities to question the sustainability of current operations (see Box 1 on mining safety). Unfortunately, employment in the coal sector cannot be considered "quality employment." Labour conditions, such as precariousness of employment, low wages, lack of unionization and insecurity in the coal industry add another social cost to the public. Historically, coal miners played an active role in demonstrating against poor conditions and violation of labour rights. Mitchell (2009) notes that coal miners in the United States went on strike more frequently than the workers in all major industries such as tobacco manufacturing between 1881 and 1905. The duration of these strikes was longer than that of others both in the U.S. and Europe. A similar pattern was observable in Turkey in the end of the 1980s through to the beginning of the 1990s. However, unionization in the sector has remained quite limited recently, which hinders the mobilization of the labour force to lobby for more humane and democratic circumstances.

Furthermore, the increasing involvement of foreign investors in the sector has led to an increase in employment of foreign nationals, again causing questions to be asked of the local benefits arising from the industry. In particular, recent reports have focused on the number of Chinese miners employed in the industry, at lower wages than those of Turkish workers (Kayalar, 2012), which has not been even noticed in the Turkish media.

Considering these, the value of job creation in the renewable energy industry is comparable to that in the coal-fired energy industry.

[13] See TKI (2013) and TTK (2013). According to the annual statistics of TTK (2013), around 11,000 people are employed in the establishments of Armutcuk, Amasra, Uzulmez, Karadon and Kozlu and the Head Office of TTK.

3.0 Meeting Turkey's Energy Goals: The role of subsidies

Based on the preceding discussion, the following analysis looks at the three aspects of Turkey's energy trilemma: securing energy supplies, ensuring cost-competitive energy, and minimizing environmental impact, and asks to what extent energy policy and, particularly, subsidies granted to the energy sector, help to realize these goals.

3.1 Cost-Competitive Energy

A widely cited advantage of coal-fired power generation is its lower cost in comparison to other power generation techniques. The characteristics of different electricity generators make direct comparison difficult. The cost of electricity generation includes the cost of project development, technology costs, civil works, balance of plant costs, operation and the purchase of fuel and other inputs. Some of these costs are one-offs, some are ongoing costs that are fixed over time, and some are subject to international commodity prices. Costs vary according to the national context including the available resources and policy related costs such as carbon pricing (World Energy Council [WEC], 2013). Reflecting this, costs for each generation source will vary by country and by region within that country.[14]

To allow a simple comparison between diverse energy types, it is helpful to discount all costs and revenues to a common reference year to find an indicative value for the overall cost per unit of generation. This value is known as the Levelized Cost of Energy (LCOE). LCOE analysis must be treated with some caution. It can be tempting to conclude that the market would deliver the generation technology with the lowest LCOE, but in practice the market may favour low capital costs over the lowest lifetime energy costs. In addition the analysis requires assumptions and projections for key variables that can affect the accuracy of the analysis. Nevertheless, this report will use LCOE to compare between technologies due to the simplicity of this measure.

The LCOE of coal is highly dependent on its commodity price, and also upon the specific type of generation technology employed, both of which are country-specific factors. Research from the IEA (2014b) estimates a global LCOE of between US$0.05 and US$0.09/kWh for new coal-fired generation. BNEF has calculated LCOEs for Turkey of between approximately US$0.08 and US$0.1/ kWh for hard coal and between approximately US$0.07 and US$0.2/ kWh for lignite (BNEF, 2014). The same report projects that LCOE for coal will be US$0.075 in 2030.

The LCOE of renewable energy technologies is critically dependent upon the natural resources available in the region under consideration. More so than fossil-fuel-based generation technologies, the LCOE of renewable energy technologies is expected to decline rapidly over time as deployment widens and technology advances. In the case of the more mature technologies this decline in costs is now well advanced, and in some regions these technologies are close to grid parity with fossil-fuel technologies (see IEA [2014b] for further discussion).

The LCOE of renewable energy projects is particularly sensitive to capital costs, since they tend to be higher than operating costs. For mature technologies, capital costs today provide a reasonable indication of capital costs in the future. For developing technologies, where the impacts of technological developments are expected to be significant, future costs of technology are estimated by considering the trajectory of historical prices. This process is very sensitive to the assumptions made for learning effects. Solar PV is generally considered to be still in a learning phase, and wind energy is considered to be more mature though some further learning effects are expected.

Analysis by the IEA suggests an approximate LCOE in 2014 of between US$0.06 and US$0.13/kWh for onshore wind and between US$0.13 and US$0.22/kWh for utility-scale solar PV (IEA, 2014b).[15] BNEF estimates costs specifically

[14] The LCOE data cited in this section is approximate, including some variables that have been estimated from data available in graphs and figures.

[15] Also see IRENA (2012), EIA (2014), Lazard (2014) and EPIA (2014) for further discussion of the LCOE for various technologies. IRENA suggests a LCOE for onshore wind of between US$0.06 and US$0.14/kWh in Europe, in line with the numbers used here.

for Turkey in 2014 at between US$0.1 and US$0.12 for wind and between US$0.14 and US$0.18 for solar PV. IRENA also provides estimates for LCOE based on real project costs on completed projects in 2013 and 2014 (IRENA, 2015). For wind projects, the LCOE in Eurasia is estimated to be US$0.07 kWh. For utility-scale solar PV projects, IRENA finds an average LCOE of around US$0.28 per kWh. Interestingly, this cost is the highest average regional cost anywhere in the world, more than double the cost in China and North America, perhaps due to high costs of project management, permitting and balance of plant.[16]

Projecting out to 2030, no figures are available for Turkey but estimates are available for Europe from BNEF and for regions with high irradiation from Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE, 2013). BNEF estimates LCOEs for wind power in 2030 at between approximately US$0.05 and US$0.07/kWh for onshore wind and between US$0.08 and US$0.15 for solar PV (BNEF, 2014). Fraunhofer ISE estimates that the LCOE for wind power in Germany in 2030 will be EUR0.04 to EUR0.1/kWh (US$0.045 to US$0.12/kWh), while the LCOE for solar PV is estimated to be between EUR0.045 to EUR0.075/kWh (US$0.05 to US$0.08/ kWh).

The estimates for wind power show relatively good agreement but there are significant differences in the estimates for solar PV, perhaps due to the difference in assumptions around solar irradiation. For the purposes of analysis, this report will assume LCOE for solar PV of US$0.08/kWh in 2030, though this figure should be viewed in the context of differing estimates.

Comparison of LCOE: Based on 2014 estimates and at the lower end of the range, the LCOE costs of new coal and onshore wind are similar. Solar PV is not yet competitive with the new coal, but approaches competitiveness by 2030 at the lower end of the range.

However, as identified above, the LCOE of energy is just one part of the costs associated with each energy source. A full analysis of costs also includes the subsidies granted by the government to an energy source, the health costs associated with extraction of energy sources and generation, and the costs associated with carbon dioxide and other emissions. Using the per-kWh costs identified in the preceding section, Figure 5 demonstrates the final costs associated with each generation technology, including LCOE, health costs, carbon dioxide costs and subsidies granted.[17] This analysis shows that even based upon incomplete data on subsidies, health costs, and pollution, and making conservative assumptions about the cost of carbon dioxide, coal generation is more expensive than wind power and solar PV.

[16] Balance of Plant refers to ancillary equipment and infrastructure needed in addition to the primary technology to complete a project
[17] The central point of the range is used for each cost category.

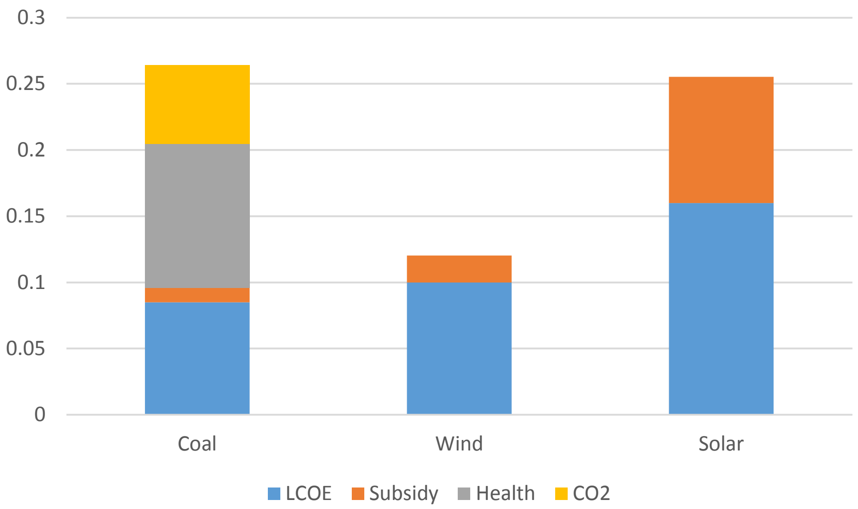

FIGURE 5. FULLY BUILT-UP COSTS ASSOCIATED WITH GENERATION FROM COAL, SOLAR PV AND ONSHORE WIND (US$ PER KWH), 2013 COSTS

Source: Authors' calculations based on the referred studies.

Furthermore, in developing coal-fired power, it is necessary to consider that the LCOE of renewable technologies and the associated need to grant subsidies are likely to fall in the near to medium terms as technologies advance, further damaging the case for coal. Figure 6 shows one potential scenario for 2030, based on the assumptions on LCOE for wind and solar PV outlined above, and assuming that the subsidy to wind will be cut to 25 per cent of current levels and the subsidy to solar will be cut to 50 per cent of current levels. The LCOE for coal falls slightly to the bottom end of the 2013 range, but it is assumed that all other costs are as in 2013, although given the increasing costs of extracting more technically complex reserves of coal and the projected future build of coal facilities, the subsidy estimate may be an understatement. Based on these assumptions, wind is cost competitive with coal even before health and carbon dioxide costs are taken into account while solar is competitive once health and carbon dioxide costs are included. However, by committing to coal-fired power, there is a risk that the ability to take advantage of these falling costs will be compromised.

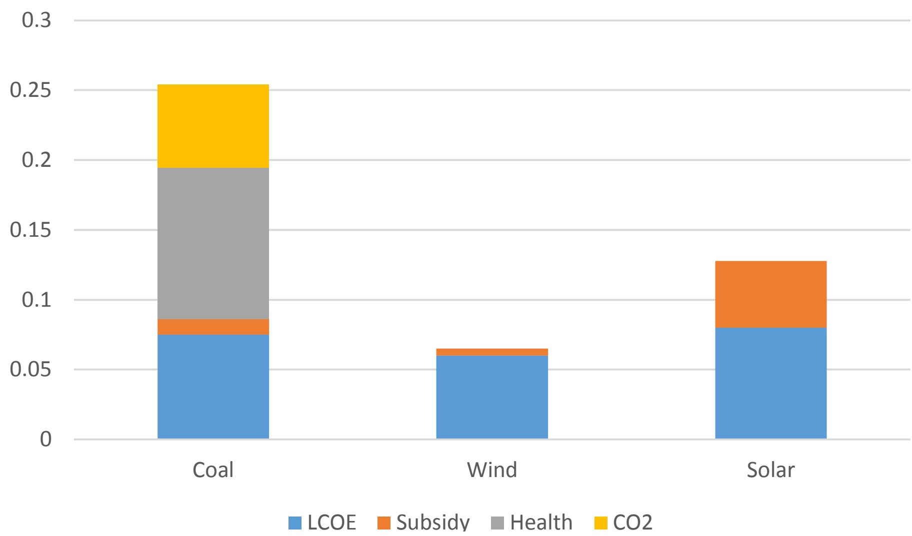

FIGURE 6. FULLY BUILT-UP COSTS ASSOCIATED WITH GENERATION FROM COAL, SOLAR PV AND ONSHORE WIND (US$ PER KWH), 2030

Source: Authors' calculations based on the referred studies.

3.2 Energy Security

For both coal and renewable energy, it is assumed that because the associated generation resource is domestically located, exploiting this resource will have benefits in terms of energy security, with associated financial and physical benefits. Conversely, gas, which is sourced from overseas, is assumed to be more liable to interruption analysis and have balance of payments consequences for the country. This assumption is, however, dependent upon a number of caveats, and in analyzing energy security, the broader energy system needs also to be considered.

In terms of coal, the primary question is whether reserves of domestic coal can meet projected demand for electricity. A rough assumption regarding the characteristics of reserves, expected demand, and generation technologies suggests that the currently identified reserves of lignite are sufficient to support power demand from lignite out to 2050—after this date new reserves additions will be necessary.[18] However, this analysis depends on being able to extract all identified reserves at a cost that is cheaper than imported sources, and there have already been questions as to the economic viability of reserves in some projects (see CEE Bankwatch Network [2013]) for a discussion of the Amasra project).

However, the question of energy security extends more widely than location of generation source. A related security-related factor is the volatility of primary energy source prices in world markets. Figure 7 demonstrates coal and oil prices in the last few decades. In 2013, coal prices remained highest in Asia, including Japan, and lowest in the United States. Being dependent on coal, oil and gas imports makes Turkey prone to uncertainties in terms of its energy sources. For instance, considering the context of falling oil prices recently, it is expected that this will reduce the cost of energy imports in the short term; however, this may cause problems due to instability in neighbouring countries with economies that are dependent on oil in the longer term. Hence volatility of prices reduces energy security.

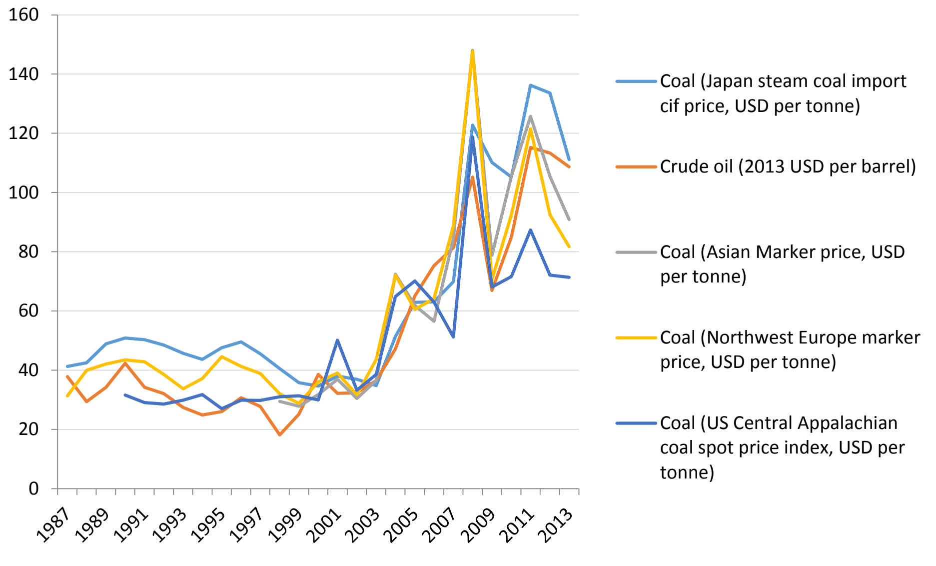

FIGURE 7. COAL AND CRUDE OIL PRICES

Source: BP Statistical Review of World Energy (June 2014).

[18] We assume a heating value of 8665 kj/kg of lignite, a boiler efficiency of 80 per cent and a steam cycle efficiency of 37 per cent. In terms of power demand, we assume that growth between 2014 and 2030 is linear, and in line with achieving 197 TWh of generation in 2030. After 2030, we assume a 2.5 per cent growth rate. Based on these assumptions, lignite reserves required to meet power demand are estimated at 10.1 billion tonnes out to 2050 and 15.3 billion tonnes out to 2060, while current reserves are 13.7 billion tonnes.

Energy security also encompasses questions of cost, source of technology and expertise in the power generation sector, and financing. Where costs of domestic production are higher than the cost of imports, the financial security of the system is compromised. This is particularly relevant for the case of hard coal in Turkey—domestic reserves are typically difficult and expensive to extract, and are only likely to supply a small proportion of required demand and only on the basis of significant subsidies being granted. Imports of hard coal are set to continue and, thus, exposure to overseas sources of supply and prices will continue (see BNEF [2014] for some further analysis of scenarios). In addition, continuing to maintain inefficient lignite operations also compromises the financial and operational integrity of the sector, and this will be even more the case in the future if relative costs increase. In terms of expertise and financing, the government also needs to consider the extent to which it is willing to rely on external funds and labour, and how this compromises security of jobs and local capacity to direct energy supply. For example, Afşin-Elbistan and Konya Karapınar coal mines and power plants are funded by foreign investors (Nayir, 2014).

More broadly speaking, energy security also depends on the reliability of the electricity supply network and its ability to deliver power. The greatest risk of committing to a coal-fired electricity system, and granting subsidies to this system, is that this approach locks Turkey in to a set of technical, institutional and legal structures that will endure past the point that domestic reserves are exploited. This restricts the ability of the country to adapt to an increased international focus on externalities and the decline in costs of renewable generation. Significant development of renewable energy depends upon addressing a different set of issues related to balancing and system reliability—addressing these issues can be compromised by continued support given to coal generation, and thus impair the future sustainability of the electricity system. Specifically, granting subsidies and encouraging the development of the coal sector not only entrenches coal in the energy mix, but also reduces funds available to support the development of renewable energy deployment. There is also some doubt over the ability of domestic coal resources to meet national needs in the longer term.

3.3 Environmental Goals

Without doubt, the continued expansion of coal-fired power generation in Turkey will come at the expense of the environment. Notably, continued burning of coal will increase emissions of carbon dioxide, as well as emissions of particulates, sulphur dioxides, nitrogen oxides, heavy metals and persistent organic pollutants (POPs). In addition, mining operations and power generation have impacts on water availability and quality, lead to contamination of land, and can contribute to biodiversity loss. Reports estimate that if government plans for coal-fired power generation materialize, then total annual emissions from new plants will be almost 150 per cent higher than carbon dioxide emissions from the energy sector today, and 71 per cent higher than total annual emissions in Turkey (CEE Bankwatch Network, 2013).

Turkey's climate change policies are set out in the National Climate Change Strategy (2010–2020) and the National Climate Change Action Plan (2011–2023). The former identifies actions against climate-related outcomes and sets carbon intensity reduction targets and an emissions reductions target for carbon dioxide from the energy sector (-7 per cent on 1990 levels by 2020). However, while Turkey is a signatory to the Kyoto Protocol, it remains the only OECD country without a national greenhouse gas emissions target, and which has not made a commitment to GHG emissions reductions by 2020. It needs to be pushed to take a clear and strong position as well as to put forward a target at COP21 in Paris, 2015.

There is real potential for Turkey to realize economic growth without compromising environmental ambitions. While emissions per unit of GDP are currently low compared to peers, they are increasing at a very rapid rate, and are projected to continue to do so (World Bank, 2013). This suggests that Turkey has not yet decoupled rising energy use and economic growth, and that there is potential to introduce measures to realize this decoupling such that growth occurs without a corresponding rise in emissions. In particular, the government has put in place legislation and strategies to encourage energy efficiency and has set a 20 per cent primary energy intensity reduction target for 2023 compared with the 2008 level. Adoption of new technologies (e.g., renewable energy) and industrial processes (e.g., use of alternative fuels in the cement sector) also helps to achieve decoupling. However, for as long as Turkey continues to subsidize the production and the use of coal, the incentive for these practices and technologies will be weakened.

In many respects, this is a wasted opportunity for Turkey—there is currently an opportunity to seize leadership in the areas of green growth and renewable energy, and Turkey is well positioned to capitalize on this opportunity. In doing so, it would be in a strong position to learn from other nations that have pursued economic growth with little regard for the environmental damage (e.g., China, where neglect of environmental issues in energy policy has led to economic and social costs and where current policy is focused on correcting this imbalance). It would also be in a position to capitalize on the benefits associated with environmental leadership, such as development of industry and pollution reductions (e.g., Denmark).

3.4 Summary

The estimates for subsidies to coal in Turkey remain highly unreliable due to the difficulties in estimating some of the more qualitative elements (e.g., the incentive packages) and the existence of bilateral deals between governments and operators. Further examination of these subsidies would be helpful in bringing further data to the debate on coal subsidies in Turkey, and in illuminating the true costs of coal-fired electricity in the country. In the meantime, and based on the analysis outlined above, it is clear that subsidies to coal mines and power stations, along with neglect of external costs, means that coal-fired power appears artificially cheap in comparison to renewable energy. Over the longer term, as the costs associated with renewable energy fall and the need for subsidies correspondingly declines, renewable energy is likely to attain a cost advantage over coal, based on LCOE alone. However, taking advantage of these lower costs will be hindered if actions are not taken now to promote renewable energy development.

While domestic coal offers the appearance of energy security, it does this at the expense of other aspects of security. Most notably, Turkey has been assessed as being highly vulnerable to the effects of climate change, and emissions of other pollutants will also compromise environmental integrity. On the financial front, subsidies represent a drain on the government budget, and compromise the ability to develop renewable energy and the associated structures necessary for its widespread implementation. Over the longer term, Turkey cannot secure its energy supply on the basis of domestic coal, but by emphasizing this in current policy, it sets itself on an institutional and technical track that is orientated towards coal, and thus opens the possibility of an import-dependent future.

Finally, an emphasis upon coal is incompatible with climate-friendly development. Continuing to subsidize coal entrenches it in the economic structure, stifles the development of renewable energy, and reduces fiscal space available to support other technologies and mitigation actions.

4.0 Recommendations

Turkey has a real opportunity to realize the development of a climate-friendly and secure energy system, and to develop an economy based on sustainable principles. Increasingly, countries across the world, recognizing the true cost of coal, are implementing policies and initiatives to reduce coal use. Most recently, the United States and China announced an ambitious and joint initiative to cut emissions, which will be dependent upon reducing the use of coal (IISD, 2014). Facing a choice in its energy generation mix, and indeed its development pathway, Turkey has the chance to join those countries that are leading the way in clean development rather than risk committing to a technology that will be obsolete in the medium term.

In the near term, there are a number of steps that can be taken to ensure that the goals of energy security, cost-competitive energy, and clean energy supplies are met:

Fossil-fuel subsidies need to be phased out: Although renewable energy is becoming cheaper due to subsidies and learning-by-doing, it is still struggling to compete against fossil fuels. This is exacerbated by fossil-fuel subsidies that distort market signals making renewable energy relatively more costly—thus reducing incentives for investment in renewable energy and hindering its development. In addition, fossil-fuel subsidies crowd out public support for the development of clean energy.

As a member of the G-20, Turkey has committed to phasing out inefficient fossil-fuel subsidies that encourage wasteful consumption over the medium term. This commitment attains particular acuity in 2015 since Turkey will be hosting the 10th meeting of the G-20 heads of government in 2015. Holding the presidency in 2015 offers an opportunity to reaffirm and take actions so as to realize this commitment.

Address employment aspects of reform: Coal mining is, in many areas, the only local employment option, and any actions that could lead to a loss of jobs are likely to be resisted. The likely impacts of reform measures will need to be assessed and compensation packages put in place to ensure that these effects are appropriately mitigated.

Real cost of coal should be considered: Relatedly, policy measures need to address the real cost of coal, particularly with respect to carbon dioxide emissions and health impacts. Turkey has made steps in addressing carbon pricing by participating in the World Bank's partnership for Market Readiness Initiative (PMR), which looks to establish carbon-pricing mechanisms. In terms of health, neglect of these costs can lead to social discontent, and higher long-term costs to address these impacts.

Further renewable energy policies, based on addressing challenges: The rate of growth in electricity demand, coupled with a strong renewable energy resources, means that Turkey is well-placed to attract investment into the renewable energy sector, and thereby realize its ambitions for the sector. While the current policy environment is a good base for further stimulating investment, further measures are necessary, including addressing:

- The lack of expertise and know-how about renewable energy among energy sector decision makers at the levels of government, industry and local consulting services.
- Energy market issues, including distorted energy policies (e.g., subsidies for fossil fuels, energy tariffs not covering costs, lack of synchronization between various environmental support programs and the very frequent crowding out of potential support by excessive national subsidies), and inadequate and non-transparent legal, regulatory and institutional frameworks, all of which lead to uncertainties in the heat and power industry and to a bias in favour of fossil fuels.
- High transaction costs due to the typically small size of renewable energy projects compared to the large fossil-fuel-based projects.

Explore other means of energy security: Domestic coal offers the illusion of security based on the idea that if resources are located within the country, then they are secure. However, this is dependent upon the ability to extract identified reserves at a cost-competitive price and to attract the investment necessary to develop power stations to use this coal. It also comes at the cost of other aspects of security—both energy-related and financial. There are a range of other measures that could be considered to improve energy security, including diversifying the source of current energy supplies, enhancing energy efficiency programs, and improving operation of the grid so as to reduce losses. Turkey is in a unique position to accomplish this, based on its geographical position, and upon its indigenous renewable energy

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