Turkey’s Renewable Power

Alternative Power Supply Scenarios for Turkey
WWF-Turkey
WWF-Turkey is the national office of the World Wide Fund for Nature (WWF); one of the world’s oldest and foremost independent nature conservation organizations. WWF-Turkey’s history goes as far back as 1975, when its parent organization, Doğal Hayat Koruma Derneği (DHKD) was founded. With over five million supporters worldwide and an active presence in more than 100 countries, the mission of WWF is “to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature. WWF-Turkey focuses its work on two main areas: nature conservation and the reduction of ecological footprint.

For more information, please visit www.wwf.org.tr adresini ziyaret edebilirsiniz.

BNEF (BLOOMBERG NEW ENERGY FINANCE)
Bloomberg New Energy Finance (BNEF) provides unique analysis, tools and data for decision makers driving change in the energy system. With unrivalled depth and breadth, we help clients stay on top of developments across the energy spectrum from our comprehensive web-based platform. BNEF has 200 staff based in London, New York, Beijing, Cape Town, Hong Kong, Munich, New Delhi, San Francisco, São Paulo, Singapore, Sydney, Tokyo, Washington D.C., and Zurich. BNEF products fit your daily workflow, streamline your research, sharpen your strategy and keep you informed. BNEF’s sectoral products provide financial, economic and policy analysis, as well as news and the world’s most comprehensive database of assets, investments, companies and equipment in the clean energy space. BNEF’s regional products provide a comprehensive view on the transformation of the energy system by region.

New Energy Finance Limited was acquired by Bloomberg L.P. in December 2009, and its services and products are now owned and distributed by Bloomberg Finance L.P., except that Bloomberg L.P. and its subsidiaries (BLP) distribute these products in Argentina, Bermuda, China, India, Japan, and Korea.

For more information on Bloomberg New Energy Finance:, visit http://about.bnef.com

Authors (Part 1: WWF-Turkey’s Policy Recommendations)
Mustafa Özgür Berke (WWF-Turkey)

Authors (Part 2: BNEF Analysis)
Michael Wilshire (Bloomberg New Energy Finance)
Janis Hoberg (Bloomberg New Energy Finance)
Itamar Orlandi (Bloomberg New Energy Finance)
Harry Boyle (Bloomberg New Energy Finance)

Contributors
Ceren Ayas (European Climate Foundation)
Tolga Baştak (WWF-Turkey)
Dr. Sedat Kalem (WWF-Turkey)
Eren Atak (WWF-Turkey)
Funda Gacal (WWF-Turkey)
Öykü Şenlen (WWF-Turkey)

Editors
Berivan Dural (WWF-Turkey)
Angus McCrone (Bloomberg New Energy Finance)

Design
Tasarmhane Tanıtım Ltd. Şti.

Press
Ofset Yapım ve

This report was made possible by the generous support of European Climate Foundation.

The contents of this document cannot be reproduced without prior permission of WWF-Turkey
© Texts and graphics: Bloomberg New Energy Finance and WWF-Turkey 2014
All rights reserved.

WWF-Turkey
Büyük Postane cad. No:19 Garanti Han Kat:5
Bahçekapı 34420 - İstanbul

Front cover photo: © Fatih Ünlü / Getty Images Turkey

ISBN: 978-605-9903-01-1
TURKEY’S RENEWABLE POWER

Alternative Power Supply Scenarios for Turkey 🐼
Contents

Foreword 5

PART I 7
CLIMATE CHANGE AND ENERGY POLICIES 9
WWF’s HIGHLIGHTS OF THE BNEF ANALYSIS 10
GREENHOUSE GAS EMISSIONS 15
RECOMMENDATIONS FOR CLEAN AND LOW-COST POWER GENERATION IN TURKEY 17
2. Put More Realistic and Ambitious Targets for Renewables 21
3. Improve Support Schemes for Renewable Energy Technologies 23
4. Phase out Fossil Fuel Subsidies / Start with Coal 25
6. Renewable Energy Should Be an Integral Part of Industrial Policies 29
7. Implement Effective Mechanisms in Order to Meet Energy Efficiency Targets 31
8. Implement Robust Environmental Impact Assessment Processes in Thermal Power Plants 33
9. We Are Running out of Time. Now is the Time to Act. 35

RENEWABLE ENERGY AND NATURE CONSERVATION 36
Hydropower 36
Wind Energy 37
Solar Energy 37

PART 2: BNEF ANALYSIS (BNEF FULL REPORT) 39
BY 2030, TURKEY CAN MEET ALMOST 50% OF ITS POWER DEMAND FROM RENEWABLE ENERGY SOURCES
With one of the most dynamic energy markets in the world, Turkey is at a critical crossroads. Decisions to be made today on how the ever increasing energy and power demand is going to be met - together with their economic, environmental and social implications - will shape the next 30 years.

We all agree on the ultimate goal of Turkey’s energy policies: To ensure energy supply security. In other words, we aspire to meet the power demand that is rising in parallel to Turkey’s economic growth, while we reduce the country’s dependence on fuel imports. The general opinion dictates that the only option before Turkey in its efforts to achieve these goals is to prioritize coal - both domestically extracted and imported -, ignoring the risks it poses in terms of climate change, public health and even labor safety.

The critical question for WWF-Turkey is as follows: Is it possible to ensure both environmental sustainability and a cleaner, cost-comparable energy mix, while progressing towards the goal of sufficient and secure energy provision? We know that an affirmative answer will be a game-changer.

In this study, we sought answers to these questions through the analysis commissioned to Bloomberg New Energy Finance (BNEF) and funded by the European Climate Foundation (ECF). The scenario analysis, which is based on informed assumptions on costs and capacity factors of renewable energy technologies and expected progress in energy efficiency, states the following:

**By 2030, Turkey can meet almost 50% of its power demand from renewable energy resources; mainly solar, wind and hydropower. A renewables-based energy strategy could be cost-comparable to a coal-based strategy. Moreover, a renewables-based strategy could allow Turkey to anchor its GHG emissions from power generation slightly above current levels and limit the pressure on its foreign trade balance.**

The Electricity Market Law aims at sufficient, high-quality, uninterrupted, cost-efficient and environmentally friendly supply of power to consumers. With its findings that point to these targets, we hope that our analysis will serve as a useful reference tool for policymakers.

Uğur Bayar
Chairman of the Board of Directors
WWF-Turkey
PART I
IN ORDER TO STAY BELOW 2°C GLOBAL WARMING, 2/3 OF ALL PROVEN FOSSIL FUEL RESERVES MUST BE LEFT UNDERGROUND
CLIMATE CHANGE AND ENERGY POLICIES

5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) concluded that it is extremely likely that human influence has been the dominant cause of the observed warming. IPCC further underlined that two thirds of GHG emissions since the industrial revolution have resulted from fossil fuel combustion and cement production1.

Coal accounts for 29% of global primary energy demand. On the other hand, due to its high carbon content per unit of energy released, it is responsible for 44% of global CO₂ emissions2.

Climate scientists contend that, in order to have a fair chance to avoid devastating impacts of climate change, the rise in average temperatures compared to pre-industrial levels should be limited to 2°C. However, Earth’s temperature has already increased 0.9°C since 1900. Should emissions continue to increase at this rate, the rise in global average temperatures is expected to be 4°C in 20603, and 6°C by the end of the century4.

IPCC urges swift and significant emission cuts as well as structural changes in the global energy sector to meet the 2°C target. Accordingly, the share of low-carbon energy supply should exceed 90% by 2050. The International Energy Agency (IEA) asserts that two thirds of global fossil fuel reserves should be left underground in order to be able to limit temperature increase to 2°C5.

The IEA concludes that unless a structural transition towards clean energy and low-carbon technologies is initiated by 2017, today’s dependency on fossil fuel infrastructure will render it much harder and costly to meet energy security and climate targets of tomorrow6.

Climate scientists and energy experts agree on this simple fact: In order to avoid the devastating impacts of climate change, scaling up the share of renewables in both primary energy and power demand should be the top-priority policy option.

---

3 “Turn Down The Heat: Why a 4°C World Must be Avoided”, World Bank, 2012
5 IEA, World Energy Outlook 2012
Turkey’s energy market is going through a rapid change. Over the last decade, power demand has grown by 70%; this is a trend that is expected to continue. Turkish government is compelled to make critical decisions: on the one hand it has to meet the power demand, on the other it has to minimize dependency on energy imports. Turkey’s current energy strategy and policies aim to utilize primarily coal, secondarily nuclear and finally renewable energy sources.

WWF-Turkey commissioned Bloomberg New Energy Finance (BNEF) to provide an analysis on alternative scenarios through which Turkey can meet its power demand until 2030. BNEF has provided three alternative scenarios and analyzed the impacts of each scenario on capital expenditures, O&M costs (including fuel) as well as Turkey’s overall balance of trade and GHG emissions:

(i) **Official Plan**: This scenario depicts the official targets for increase in power demand, the installed capacity targets for coal, nuclear and renewable energy sources for 2023, as well as the official power demand and electricity mix projections for year 2030.

(ii) **Business-as-Usual (BAU) Scenario**: This scenario makes mainstream projections on how power demand and supply will evolve in Turkey by 2030 on the basis of the current conditions of the electricity market and sector, existing policy outlook and capacity pipeline.

(iii) **Renewables Development Pathway (RDP) Scenario**: The projections under this scenario are based on the assumption that by 2030, wind and solar will take on the dominant role, which is now played by natural gas and will be played by coal in the future by virtue of existing policies.

The main findings of the analysis are as follows:

**Power Demand**

According to the official projections, energy demand in 2030 will reach 620 TWh - nearly 2.5 times today’s level. According to BNEF estimates, the increase in power demand will be limited to 93%. Under the BAU Scenario, power demand will reach 462 TWh by 2030, 25% less than official projections.

The RDP scenario, meanwhile, indicates that the rate of increase in power demand will be 0.15 percentage points lower than the BAU scenario, thanks to enhanced energy efficiency. These relatively lower expectations are based on the view that, as in other European economies, economic growth and increased welfare will lead to a decline in the rate of increase of power demand in Turkey.
Capacity Additions

In order to meet the rising power demand, installed capacity in Turkey will increase across all scenarios. By 2030, installed capacity is projected to increase by 56GW in the BAU scenario and 71 GW in the RDP scenario. According to Official Plans, installed capacity is expected to increase by 101GW.

Under the BAU scenario, by 2030, some 19GW of additional coal power capacity will come online. RDP scenario, on the other hand, projects that additional coal power capacity will be around 3.3GW, while 60GW of additional renewables capacity will be installed.

Power Generation Mix

In accordance with the priorities set by Turkey’s energy supply security strategy, all three scenarios estimate a reduction in the share of natural gas in power generation.

Under the Official Plan and the BAU scenario, the government’s “dash for coal” plan, which involves exploitation of all domestic coal resources and development of new coal fields, is expected to significantly increase the share of coal in power generation. However, according to the RDP scenario, Turkey can meet 47% of its power demand from renewable energy technologies. Under the RDP scenario, the share of hydropower in power generation is projected to decrease from 26% to 21%, while the total share of solar and wind power is estimated to increase to 26% from its current level of 3%.
26% SHARE OF WIND, SOLAR AND GEOTHERMAL ENERGY IN TURKEY’S ELECTRICITY MIX IN 2030, UNDER THE RDP SCENARIO

Cost Analysis

In the “Official Plan” scenario, in order to meet high power demand, both capital expenditures and fuel expenditures are projected to be quite high. The BAU and the RDP scenarios, on the other hand, converge on similar – and lower – levels for total costs.

The BAU scenario has the lowest capital expenditure of the three scenarios. While the overall costs of the RDP scenario are higher in the short run, as new capacity is financed and built, the lower fuel costs, which accompany a more ambitious renewables strategy, result in both scenarios reaching similar levels of total costs by the end of the 2014-30 period. Projections indicate that cumulative fuel expenditures in the RDP scenario would be 18 billion US dollars lower than the BAU scenario from today until 2030 (in nominal terms).
BNEF analysis points out that the estimated decline in the levelized cost of energy (LCOE) pertaining to solar and wind power technologies is the driving force behind the long-term cost effectiveness of the RDP scenario.

According to BNEF figures, the LCOE for an onshore wind project in Turkey is currently around $120/MWh. By 2030, it is estimated that the LCOE of a similar project should fall into the $60 to $80 per MWh range, on average below the current $73-116 per MWh LCOE for coal.

In a similar vein, it is projected that the LCOE for a ground-mounted solar project will decrease from $150/MWh to $85-120/MWh by 2030.

Figure 4: Levelized cost of electricity for various technologies in Europe, Turkey and globally, 2014 ($ / MWh)

Source: Bloomberg New Energy Finance

Note: Some developers of solar and wind projects in Turkey have LCOEs at the low end of this range, while hard coal and lignite LCOEs could equally be at the high end of our range. BNEF has however elected to continue using an internal methodology for all these technologies, which it has built and refined in the last decade.

BNEF analysis indicates that, in the medium to long term, the levelized costs of power generation from solar and wind power – excluding social, environmental and societal externalities – may become comparable to the costs of fossil fuels in Turkey.
TURKEY COULD STABILIZE GHG EMISSIONS FROM THE POWER SECTOR WITHIN THE NEXT FIVE YEARS
GREENHOUSE GAS EMISSIONS

Currently, annual GHG emissions of Turkey from the power sector stand around 110 million tons CO₂ equivalent (MtCO₂e). Under BNEF’s BAU scenario, it is expected that the upward trend since 1990 will continue and the GHG emissions from the power sector will almost double to over 200 million tons per annum by 2030, as a result of intensifying coal consumption.

BNEF analysis indicates that, under a renewables-based strategy, power sector emissions will continue to rise slowly in the next five years, but will remain constant from that time onwards at around 120 MtCO₂e. The difference between two alternative scenarios corresponds to one fifth of Turkey’s current total emissions per annum.

When the projected stabilization of emissions is combined with the results of the cost analysis, an alternative path for Turkey becomes visible: **Turkey could stabilize GHG emissions from the power sector in the next five years.** The expected decline in the costs of wind and solar technologies means that such an alternative can be achieved at a comparable cost to coal oriented policies.

![Figure 5: Annual power sector CO2e emissions, 2000-30 (Million tons of CO2 equivalent)](image)

**Turkey’s Emissions**

From 1990 till 2012, Turkey’s GHG emissions rose by 133%. Within the same period, emissions from public electricity and heat production increased by 286%. Carbon intensity of Turkey’s power generation is above OECD and EU averages. In other words, Turkey emits more CO₂ per kWh electricity generated.
RECOMMENDATIONS
Bloomberg New Energy Finance’s analysis indicates that by 2030, Turkey could meet almost half of its power demand from renewable energy sources. An energy strategy designed towards this target could be cost comparable to coal-dependent strategies. In addition, the analysis points out that by employing a renewables-oriented strategy, it is possible to stabilize power sector emissions at levels slightly higher than the current levels.

BNEF analysis shows that deployment of renewable energy can help halt the increase in natural gas imports, while an increase in the share of domestically manufactured renewable energy technologies might have a positive impact on the balance of trade. When various externalities are factored in, the cost difference between the renewable energy and its coal-dependent alternatives become more apparent in favor of renewables. In the event that a carbon price and more stringent emissions criteria for power plants are instituted as a consequence of Turkey’s prospective EU membership or of international climate negotiations, Renewables Development Scenario could turn out to be more cost-effective.

WWF-Turkey’s policy recommendations for a transformation that shall serve both economic and ecological sustainability are as follows:

TURKEY’S RENEWABLE ENERGY TARGET FOR 2030 SHOULD BE 50%

Energy security may be defined as resilience to disruptions in energy supply. In Turkey, supply security discussions focus mostly on the availability of energy resources. Turkey’s import dependency in primary energy stands at 75%. 98.6% of the country’s natural gas, 93% of oil and 92% of hard coal consumption is derived from imports. This puts Turkey in a vulnerable position in the face of price fluctuations and probable supply disruptions in the import of fossil fuels due to political, logistical or other reasons.

For Turkey, achieving the twin goals of satisfying increasing power demand and reducing fuel import dependency is crucial to sustaining economic growth without increasing dependence on natural gas imports. “Energy imports” is the item that has the most negative impact on the current account deficit of Turkey, and the share of the power sector in energy imports is around 40%. According to BNEF analysis, should a renewables-oriented path be adopted, it is possible to reduce cumulative fuel expenses by $US 18 billion compared to the BAU scenario between 2014 and 2030.

According to the Ministry of Energy and Natural Resources, Turkey’s installed capacity potential for hydropower, wind and geothermal are 36 GW, 48 GW and 2 GW, respectively. The country’s solar energy potential is calculated as 380 billion kWh of electricity per annum, while its biomass potential is 1.3 billion kWh of electricity per annum.

Renewable energy could be the main building block for Turkey to maintain supply security in power generation. Turkey is a resource-rich country in renewable energy resources and the costs associated to renewable energy technologies are gradually decreasing. Seizing this opportunity and supporting it with sound targets and policy tools could render it possible for Turkey to limit the increasing use of imported coal and natural gas in power generation.

---

98.6% of Turkey’s natural gas, 93% of oil and 92% of hard coal consumption is derived from imports.

---

7 Energy Market Regulatory Authority of the Republic of Turkey, 2013, Natural Gas Market Sector Report
2. Put More Realistic and Ambitious Targets for Renewables

In 2013, renewables accounted for 29% of Turkey’s power generation. The target for 2023 is to increase the share of renewables in power generation to 30%. Toward this end, Turkey intends to utilize all technically and economically feasible hydropower capacity (around 36GW) and reach 20GW wind, 3GW solar and 600MW geothermal installed capacity.

The Bloomberg New Energy Finance analysis indicates that by 2030, Turkey could generate 47% of its power from renewables. For achieving this target, installed capacity of wind and solar power should be substantially increased. BNEF envisions that by 2030, installed capacity of solar power and wind power could reach 24GW and 27 GW, respectively.

Energy policies in Turkey should focus on the concurrent enhancement of renewables. "50% renewables in power generation by 2030" should be the new minimum target. This shall serve as a powerful message to investors, encouraging them to allocate required funds for investments in renewable energy technologies, particularly wind and solar.

Wind

Despite arguably low FiTs (feed in tariff), wind power capacity in Turkey has been displaying a steady growth for the last 9 years. Since 2009, annual wind capacity additions amounted to around 500MW, as a result of which, total installed capacity has exceeded 3,000MW. However, given the current rate of development, 20GW (20,000 MW) installed capacity target in 2023 seems out of reach. According to BNEF’s Renewables Development Pathway (RDP) Scenario, total wind capacity may rise to 14 GW in 2023 and 27GW in 2030.

Solar

Given the solar energy potential of the country, Turkey’s targets for solar power are considerably unambitious. Solar installed capacity target for 2023 is only 3GW – by comparison Germany has 32GW and Italy has 16GW online. According to BNEF, relatively lower levels of FiTs for solar power in Turkey may partly explain this difference. However, there are also various regulations that hold back the development of solar energy.

The first round of license applications for power generation from solar energy was finalized in July 2013. While a cap of 600MW was set for solar power licenses, 496 applications -which amounted to a total of 7,873MW installed capacity- were filed. It should be underlined that as of September 2014, 675 MW of unlicensed solar power generation applications have received positive evaluation from the regulatory authorities10. In a similar fashion with wind power, as a result of the decrease in the costs of solar generation, solar power is expected to scale up not thanks to the government incentives, but despite them.

---

3. Improve Support Schemes for Renewable Energy Technologies

The designated strategy of Turkey to ensure supply security in electricity is based on fossil fuels. BNEF analysis demonstrates that in the long run, a policy path that increases the share of renewables is cost-comparable with a strategy based on fossil fuels.

Turkey’s supply security strategy and power market legislation need to be revised in a way that will reflect this trend and prioritize renewable energy. FiT regimes for especially wind and solar power need to be improved by introducing higher prices and/or longer terms. These changes should provide a more favorable environment for investors and help secure finance for renewable energy projects.

**Feed-in Tariffs**

Turkey’s Renewable Energy Resources Support Mechanism (YEKDEM) was devised as a key tool to support the use of renewable energy sources in power generation. The feed-in tariffs stipulated by this mechanism only cover a period of 10 years\(^\text{11}\). This is shorter than the 15-year period implemented in many EU member states.

It should be noted that the FiTs for wind and geothermal power are also lower than those granted to the Russian contractor for the nuclear power plant project in Akkuyu, Mersin.

\[^\text{11}\text{http://www.enerji.gov.tr/mevzuat/5346/5346_Sayilii_Yenilenebilir_Enerji_Kaynaklarinin_Elektrik_Enerjisi_Uretimi_Amacli_Kullanimina_Iliskin_Kanun.pdf}\]

<table>
<thead>
<tr>
<th>Technology</th>
<th>Purchase Guarantee</th>
<th>Domestic Component Price Incentives</th>
<th>Maximum Limit for Incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroelectric power plant</td>
<td>7,3</td>
<td>2,3</td>
<td>9,6</td>
</tr>
<tr>
<td>Wind energy power plant</td>
<td>7,3</td>
<td>3,7</td>
<td>11</td>
</tr>
<tr>
<td>Photovoltaic power plant (PV)</td>
<td>13,3</td>
<td>6,7</td>
<td>20</td>
</tr>
<tr>
<td>Concentrated Solar Power Plant (CSP)</td>
<td>13,3</td>
<td>9,2</td>
<td>22,5</td>
</tr>
<tr>
<td>Biomass power plant (landfill gas included)</td>
<td>13,3</td>
<td>5,6</td>
<td>18,9</td>
</tr>
<tr>
<td>Geothermal power plant</td>
<td>10,5</td>
<td>2,7</td>
<td>13,2</td>
</tr>
</tbody>
</table>

Table 1: Renewable Energy Feed-in Tariffs in Turkey (US $ cent/kWh)
IN TERMS OF PER CAPITA NEW COAL FIRED INSTALLED POWER CAPACITY, TURKEY RANKS SECOND, AHEAD OF CHINA AND INDIA
4. Phase out Fossil Fuel Subsidies / Start with Coal

The Ministry of Energy and Natural Resources in Turkey is prioritizing coal-related objectives. Turkey has tremendous lignite reserves, estimated at approximately 14.1 billion tons. In the last nine years, some 5.8 billion tons were discovered after a five-fold increase in prospecting work. The Ministry announced 2012 as the “Year of Coal”, while action towards implementation gained momentum in 2013. The government is currently developing policies to support a series of coal and lignite projects that will utilize domestic resources. There are 55 coal-fired power plant projects in the pipeline, with a total installed capacity of 50,000MW. Turkey ranks 4th in terms of new installed coal power capacity following China, India, and Russia, while in terms of per capita new installed power capacity, it ranks second.

In Turkey, substantial subsidies are available for coal mining and coal based power generation. Investments in these fields are offered “Region 5” incentives, which is the second highest subsidy level under the new Investment Incentives Program that was introduced in 2012. Projects enjoy VAT and customs duties exemption, tax reductions, support for national insurance contribution of employer and land allocation.

According to International Monetary Fund (IMF) data, Turkey’s coal subsidies amounted to 1.9% of government revenues and to 0.66 % of its GDP in 2011\textsuperscript{12}.

Phasing out these subsidies could constitute the first step in revealing the actual costs of fossil fuels. By allocating these funds to low-cost energy efficiency and renewable energy projects, it may be possible to ensure both energy supply security and environmental sustainability.

Phase-out of fossil fuel subsidies is an item that was previously agreed at G-20 summits held by the largest 20 economies of the world. Turkey, the world’s 17\textsuperscript{th} largest economy, will be hosting the G-20 Summit in 2015. This provides Turkey with the chance to place fossil fuel subsidies high on the summit agenda and assume the role of a global pioneer on the issue.

\textsuperscript{12} IMF, Energy Subsidy Reform: Lessons and Implications.

In 2013, international financial institutions such as the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB) and the World Bank, as well as a number of export credit agencies, decided to impose stringent criteria on – or completely abandon – the provision of finance for coal-fired power plants.

Despite various obstacles that appeared in the last few years, the prospect of Turkey’s EU membership is still on the agenda. There is a strong chance that international climate negotiations under the UNFCCC framework may result in a new climate agreement that will be binding for the post-2020 period and put Turkey in a position to assume more responsibility.

As a consequence of these processes, Turkey may have to adopt policy tools such as carbon tax and emission standards, which may render some fossil fuel assets “stranded” and add to the country’s economic burden.

BNEF analysis suggests that, should renewables-oriented policies be adopted, the costs of complying with the EU Emission Trading Scheme and the Industrial Emissions Directive may be cut by one-third. In other words, in the event that environmental externalities are partly reflected in costs, a renewables-oriented power supply strategy may enable Turkey to save 13 billion US dollars in the period between 2020 and 2030.

Therefore, the transition towards renewable energy should start now, and priorities for finance decisions should be set accordingly.

![Figure 6: Net scenario costs of compliance with EU ETS and IED in post-2020 period ($bn)](image-url)
RENEWABLE ENERGY TECHNOLOGIES OUTPERFORM FOSSIL FUELS AND NUCLEAR ENERGY IN EMPLOYMENT CREATION PER UNIT OF POWER GENERATION
6. Renewable Energy Should Be an Integral Part of Industrial Policies

In countries such as Germany, Denmark and China, renewable energy technologies are not merely a tool for energy supply security, but also an integral part of industrial policies. As a result of this approach, these countries have witnessed improvements in manufacturing, export and employment pertaining to renewable energy technologies in parallel with the increasing use of renewable energy.

Turkey spends almost as much on natural gas imports (an estimated $8-10bn) as the value of the foreign investment it attracts ($10bn in 2013). The BNEF analysis asserts that it is possible to limit the increase in natural gas imports through coal-oriented policies. However, a projected increase in the use of hard coal in coal-fired power plants points out to a further increase in fossil fuel imports: as of today, Turkey meets 92% of its hard coal demand through imports.

BNEF analysis indicates that meeting the increasing power demand with renewables instead of coal could have a positive impact on Turkey’s balance of trade. It further underscores that this positive effect can be achieved only if a major portion of the additional installed capacity investments for renewables are provided by domestic manufacturers.

Multiplier effect created by macroeconomic parameters such as employment, export and GDP could reinforce this advantage. According to the “Green Jobs Report” published by the International Labour Organization (ILO) in 2008, per installed capacity, solar and wind generate more jobs than coal or natural gas. World Bank also suggests that, in employment creation per unit of power generated, renewable energy technologies perform much better than fossil fuels and nuclear energy.

The additional incentives provided by Turkey’s Renewable Energy Resources Support Mechanism (YEKDEM) for the use of domestic content in renewable energy projects signify a positive step in this respect. This step should be transformed into a strategic priority. Manufacturing renewable energy technologies and equipment should be integrated into Turkey’s industrial policy.

---

7. Implement Effective Mechanisms in Order to Meet Energy Efficiency Targets

According to the BNEF analysis, power demand in 2030 is projected to be 25% lower than official projections. The level of power demand has significant impact on capacity additions, capital and fuel expenditures and greenhouse gas emissions associated with power generation.

Even the conservative estimates in the BNEF analysis indicate that it is possible to limit the growth in power demand through energy efficiency measures. If Turkey can meet its 2023 target of reducing its energy intensity by 20%, this would mean a big step towards a more efficient use of the electricity it generates.

The International Energy Agency states that the most cost-effective way to resist fluctuations in energy prices is through energy efficiency. Under its 2020 climate and energy package, The European Union aims to achieve a 20% increase in energy efficiency. For 2030, the target is an increase of “at least 27%” in energy efficiency. Developing countries are also undertaking successful policies and practices in energy efficiency. As mentioned in the BNEF analysis, Brazil, despite the increases in its national income, has managed to stabilize its per capita electricity consumption, thanks partly to the energy efficiency measures it has been implementing since 2000.

The cleanest and the cheapest energy is the energy that is not consumed. In order to meet its ambitious energy efficiency and intensity targets, Turkey needs to unwaveringly implement necessary measures at the sectoral level, without any delays or opt-outs. As in the case of Brazil, allocation of a certain portion of their revenues to energy efficiency projects by utilities might yield positive results in Turkey.

---

20% MEETING THE 2023 TARGET OF REDUCING ENERGY INTENSITY BY 20% WOULD BE A SIGNIFICANT STRIDE FOR TURKEY

---

"IEA World Energy Outlook 2013, page 297."
8. Implement Robust Environmental Impact Assessment Processes in Thermal Power Plants

The Electricity Market Law No.6446, which entered into force in 2013, provided exemption from environmental legislation until 2018 to those power generation assets that are owned by EÜAŞ or are in the privatization process. This clause was revoked by the Constitutional Court in May 2014.

No thermal power plant should be exempt from environmental legislation. The impacts on ecosystems, biodiversity, public health and other factors should be thoroughly assessed, and decisions regarding thermal power plant projects should be taken accordingly. In order to complement this process, tools such as carbon pricing mechanisms and GHG emission standards need to be employed and the process of harmonization with the EU's acquis in relevant areas needs to be accelerated.
34 TURKEY'S RENEWABLE POWER

Alternative Power Supply Scenarios for Turkey
9. We Are Running out of Time. Now is the Time to Act.

The economic life span of a coal power plant is around 30-40 years. The decisions made today could lock-in the Turkish economy and society to a high carbon, high cost, fossil fuel dominated future toward the middle of the century. In light of their decreasing costs and environmental, social and economic advantages, renewable energy sources should be given priority in the electricity supply security strategy of Turkey. Fossil fuel projects, on the other hand, need to be phased out.
Renewable energy sources offer a unique opportunity to achieve the transformation needed to ensure energy supply security and effective climate change mitigation. However, like all energy projects, renewable energy projects also have some negative environmental impacts. Environmental and social risks arising from the implementation of renewable energy projects, especially hydroelectric power plants, are well known by most stakeholders. In order to eliminate the risks, these projects should follow strict environmental criteria from the planning stage to the operation stage and be subject to strategic environmental impact assessment processes.

Necessary measures to avoid, mitigate and compensate negative environmental and social impacts of renewable energy projects should be taken. In this respect, social and environmental impact assessment processes should be implemented diligently.

**Hydropower**

Hydropower currently accounts for 16% of global power generation. It generates 80% of the total electricity production from renewables. Hydroelectric dams can generate uninterrupted power, and pumped hydropower plants can provide energy storage. Despite these advantages, hydroelectric power plants, no matter what size or type, have serious environmental and social drawbacks.

WWF-Turkey advocates that during hydropower generation, the health of rivers and biodiversity should be protected and sustainability of ecosystem services that rivers provide should be maintained. In this respect, internationally accepted sustainability principles such as Hydropower Sustainability Assessment Protocol (HSAP), should be given consideration. In addition, a set of requirements should be met in hydropower development processes:

- Conservation of legally protected areas and species or those that have scientific conservation priority should be ensured. Dams should not be constructed on rivers that are good representatives of free-flowing rivers bearing their natural structures.
- Credible information should be made publicly available to demonstrate that a dam is the best available option, and that the best possible locations, designs and operating rules have been chosen.
- The benefits of the planned dam should be acknowledged by all stakeholders, including downstream communities.
- Environmental and socio-economic risks and impacts emanating from the project should be avoided or minimized.
**Wind Energy**

While the global wind power installed capacity has increased eight-fold over the last decade, wind power capacity in Turkey has increased from 20MW to 3,000MW. A target of 20,000MW of installed wind capacity in 2023 has been set. In terms of carbon lifecycle emissions (cradle to grave), wind power is 40 times cleaner than natural gas and 80 times cleaner than coal. Wind will play a key role in power generation in the rest of the 21st century.

On the other hand, environmental and social impacts of wind power plants are also becoming a topical issue. The “environmental” value of wind energy projects are being questioned because of aesthetic concerns about wind turbines and landscape, noise pollution, impacts on wildlife – birds in particular – on agriculture and other types of land use.

It should be emphasized that the environmental impacts of wind power can be considered to be negligible when compared to those of other alternatives such as fossil fuels and nuclear energy. Various policy tools and measures are available to prevent, mitigate and compensate for environmental and social impacts of wind power development projects:

- Wind power plants should undergo appropriate planning and siting processes in order to minimize their negative impacts on ecosystems as well as local communities.
- Wind power plants should be included in strategic environmental impact assessment processes. If necessary, “no-go” areas should be identified by taking into account relevant environmental and socio-economic criteria.
- EIA processes should be transparent, and all stakeholders should be involved. Measures, identified for mitigation and compensation of environmental and social impacts should be implemented.

**Solar Energy**

Solar energy installed capacity appeared in the Turkish Electricity Transmission Company’s statistics only in 2014. By the end of July 2014, installed solar capacity of Turkey was 14MW. The official target for 2023, on the other hand, stands at 3,000MW.

The most important environmental concern regarding the proliferation of solar power is the potential impact on land use – in particular on valuable agricultural land.

The Solar PV Atlas report that was published by WWF in 2013 illustrates that PV technology, when well-planned, does not conflict with conservation goals. According to the Solar Atlas, in theory, a total of 790 km² of solar panels would generate enough electricity to meet Turkey’s current total power demand. 790 km² is equal to 0.1% of Turkey’s total surface area or the total lake area of Atatürk Dam.

In the foreseeable future, Turkey will not be meeting its power demand solely from solar energy. Even in a 100% renewable energy system, other sources such as wind, geothermal, hydropower and biomass will have significant shares. It just needs to be underlined that nature conservation and renewable energy development can coexist and develop in parallel, without undermining each other.

As the global climate change takes its toll on people and the environment, the importance of properly-sited renewable power plants that meet the criteria of sustainability becomes even more apparent.
TURKEY'S RENEWABLE POWER

Alternative Power Supply Scenarios for Turkey
PART 2

BLOOMBERG NEW ENERGY FINANCE ANALYSIS
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Turkish power capacity by type, 2000-2013</td>
</tr>
<tr>
<td>2</td>
<td>Turkish power generation by type, 2000-2013</td>
</tr>
<tr>
<td>3</td>
<td>Coal-fired power plants in Turkey</td>
</tr>
<tr>
<td>4</td>
<td>&quot;Official Plan&quot; scenario projected capacity in Turkey, 2014-2030 (GW)</td>
</tr>
<tr>
<td>5</td>
<td>&quot;Official Plan&quot; scenario projected power generation in Turkey, 2014-2030 (TWh)</td>
</tr>
<tr>
<td>6</td>
<td>Turkish power demand, 1996-2030 (TWh / Year)</td>
</tr>
<tr>
<td>7</td>
<td>European economies annual power demand and GDP per capita (1990-2012)</td>
</tr>
<tr>
<td>8</td>
<td>Developing world economies annual power demand and GDP per capita (1990-2012)</td>
</tr>
<tr>
<td>9</td>
<td>Turkish GDP power intensity, 1990-2020 (GWh / Real TRY bn)</td>
</tr>
<tr>
<td>10</td>
<td>Turkish electricity consumption shares by sector, 1990-2013 (%)</td>
</tr>
<tr>
<td>11</td>
<td>Energy intensity vs. per capita consumption for select countries (2011)</td>
</tr>
<tr>
<td>12</td>
<td>Actual vs. projected Turkish power demand (TWh / Year)</td>
</tr>
<tr>
<td>13</td>
<td>BAU scenario installed capacity in Turkey, 2014-2030 (GW)</td>
</tr>
<tr>
<td>14</td>
<td>BAU scenario power generation in Turkey, 2014-2030 (TWh)</td>
</tr>
<tr>
<td>15</td>
<td>Historical electricity transmission and distribution losses (%) in Turkey, 1970-2012</td>
</tr>
<tr>
<td>16</td>
<td>RDP scenario installed capacity in Turkey, 2014-2030 (GW)</td>
</tr>
<tr>
<td>17</td>
<td>RDP scenario power generation in Turkey, 2014-2030 (TWh)</td>
</tr>
<tr>
<td>18</td>
<td>Scenario power generation projections, 2014-2030 (TWh)</td>
</tr>
<tr>
<td>19</td>
<td>Official plan capacity additions (GW)</td>
</tr>
<tr>
<td>20</td>
<td>BAU scenario capacity additions (GW)</td>
</tr>
<tr>
<td>21</td>
<td>RDP scenario capacity additions (GW)</td>
</tr>
<tr>
<td>22</td>
<td>Annual power generation, 2014-30 (TWh)</td>
</tr>
<tr>
<td>23</td>
<td>Power generation technology mix, 2023</td>
</tr>
<tr>
<td>24</td>
<td>Power generation technology mix, 2030</td>
</tr>
<tr>
<td>25</td>
<td>Power generation scenario comparison, 2023</td>
</tr>
<tr>
<td>26</td>
<td>Power generation scenario comparison, 2030</td>
</tr>
<tr>
<td>27</td>
<td>Levelised cost of electricity for various technologies in Europe, Turkey and globally, 2014 ($ / MWh)</td>
</tr>
<tr>
<td>28</td>
<td>European solar PV LCOE range, 2013-30 ($ / MWh)</td>
</tr>
<tr>
<td>29</td>
<td>European onshore wind LCOE range, 2013-30 ($ / MWh)</td>
</tr>
<tr>
<td>30</td>
<td>BNEF Turkish fuel price assumptions</td>
</tr>
<tr>
<td>31</td>
<td>Official plan capital expenditure, 2014-30 ($bn)</td>
</tr>
<tr>
<td>32</td>
<td>BAU scenario capital expenditure, 2014-30 ($bn)</td>
</tr>
<tr>
<td>33</td>
<td>RDP scenario capital expenditure, 2014-30 ($bn)</td>
</tr>
<tr>
<td>34</td>
<td>Capital expenditure comparison, 2014-30 ($bn)</td>
</tr>
<tr>
<td>35</td>
<td>Fuel expenditure comparison, 2014-30 ($bn)</td>
</tr>
<tr>
<td>36</td>
<td>Annual sum of capital and operating expenditure (including fuel use) 2014-30 ($bn)</td>
</tr>
<tr>
<td>37</td>
<td>Cumulative sum of capital and operating expenditure (including fuel use) 2014-30 ($bn)</td>
</tr>
<tr>
<td>38</td>
<td>BAU versus RDP scenario trade balance impacts, 2014-30 ($bn nominal)</td>
</tr>
<tr>
<td>39</td>
<td>Annual power sector CO2e emissions, 2000-2030 (Million tonnes)</td>
</tr>
<tr>
<td>40</td>
<td>Net scenario costs when including post-2020 EU compliance ($bn)</td>
</tr>
</tbody>
</table>
TABLE OF TABLES

Table 1: Scenario top-level results comparison .......................................................... 3
Table 2: Turkish government 2023 energy targets ....................................................... 7
Table 3: Turkish “10th Development Plan” targets for 2018 ........................................ 7
Table 4: Domestic coal supply market shares (2011) ............................................... 8
Table 5: Concluded coal tenders through the Royalty Tender Mechanism .................. 9
Table 6: Renewable energy production incentives ($ cents / kWh) .............................. 10
Table 7: Turkey energy sector policies and targets summary table (GW) .................. 11
Table 8: Turkey’s transmission and distribution capacity ......................................... 11
Table 9: Opportunities for energy storage applications ............................................. 12
Table 10: “Official Plan” installed capacity in Turkey, 2000-2030 (MW) ....................... 14
Table 11: Official Plan and BAU scenario installed capacity projections, 2023/2030 (MW) 25
Table 12: Official Plan, BAU and RDP scenario installed capacity projections, 2023 and 2030 (MW) .......................................................... 30
Table 13: Key capital expenditure assumptions, $m / MW (2014) ............................ 30
Table 14: Overview of fixed O&M assumptions, 2014 ($ / MW / Year) ...................... 31
Table 15: Total discounted cost assessment over 2014-2030 ($bn) .......................... 34
Table 16: Overview of key input metrics and variables ............................................. 42
Table 17: Turkey coal plant pipeline analysis, 2014 ................................................ 44
SECTION 1. EXECUTIVE SUMMARY

Turkey’s energy market is at a crossroads. Demand for electricity grew by 70% in the last decade, and it is a trend that is expected to continue. The government is being forced to make some critical decisions about how it delivers electricity today and in the long term – while minimising the costs to the economy and environment.

There are two imperatives underlying the government’s energy plans – firstly to satisfy rising electricity demand and secondly to decrease its fuel import dependency. Succeeding in both will be crucial to sustaining Turkey’s economic growth without increasing its dependence on natural gas imports. Current plans strive for greater use of domestic resources such as coal, a modest increase in renewables capacity and a reduction in its dependence on natural gas imports amid continued strong growth in total electricity consumption. Bloomberg New Energy Finance examines these plans, and their likely consequences, and then outlines two independent scenarios for the future of the Turkish electricity system. Both scenarios envisage Turkish electricity demand growth slowing as the nation becomes richer, a well-observed pattern in comparable nations. In the first scenario, the demand growth is met mainly by coal-fuelled power plants. In the second projection we asked whether Turkey could achieve the same benefits with a focus on renewables instead of fossil fuels. This study was commissioned by WWF-Turkey and funded by the European Climate Foundation (ECF).

TURKEY’S POWER SYSTEM TODAY

At present, Turkey spends almost as much on natural gas imports as it attracts foreign direct investment – an estimated $8-10bn versus $10bn each year. The Turkish government is keen to stem these high gas import costs, and it has recently unfurled its “dash-for-coal” plan. To this end, it is also encouraging power plant construction by subsidising asset capital expenditure and operating costs. Turkey has been equally diligent in finding and mining its considerable lignite reserves, which are close to 14.1bn tonnes. Some 45% of these lignite reserves alone come from the Asfin-Elbistan field, which already houses two power plants with a combined installed capacity of close to 2.8GW. And, perhaps more importantly, since 2000 the government has made significant moves towards both liberalising and privatising its power sector. In the last decade it has begun selling certain coal assets. The government likewise has ambitious wind and hydro plans for 2023 while defending its modest solar targets by suggesting they will protect a transitional electricity market.

OFFICIAL PLANS

In the Official Plan, which represents the government position, annual power demand is projected to grow at 5.25% each year for the next decade and a half. It sees – or hopes – that the natural gas share of electricity generation will fall from 41% to 18% by 2030 as coal, nuclear, hydro and renewables all start to contribute more substantially. We believe both ambitions are more wishful-thinking than plausible projections. The government has a track record of overestimating future power demand, and our analysis indicates that it is on course to do so again with its current plans. Furthermore, we think it is unlikely that many of the capacity targets for nuclear, wind and other technologies will be met on time.

BNEF’S BUSINESS-AS-USUAL (BAU) SCENARIO

In our BAU scenario, we attempt to create a more plausible projection of how Turkey’s electricity sector could evolve, if the government continues in its ambition of replacing natural gas imports with domestic coal. We project power demand will be about 25% lower than foreseen by the government during the next decade. We benchmark this conclusion against comparable
economies, like Brazil and Poland which have also seen declining demand growth rates as they grew wealthier. In fact, the data from 2013 suggest Turkish electricity demand growth is already beginning to slow. Examples from Brazil and Germany also highlight the potential of energy efficiency measures, which could further slow demand growth. Brazil, for instance, has managed to stabilise its electricity consumption per capita in recent years, partly by requiring its utilities to invest 0.5% of their annual revenue in energy efficiency improvements.

The forecasts for future capacity installations similarly reflect what we consider realistic assumptions in line with the spirit of the current government plan. We project that natural gas capacity will not grow by more than 3.3GW before 2030, in accordance with the government plans. We project that around 50% of the target for wind installations will be met by 2023, with 10.3GW, rather than 20GW of total installed capacity. We are also bearish about the prospects of its three nuclear sites. Given concrete has not even begun being poured at its first four-reactor site, in the Mersin province, we think it is unlikely Turkey will be able to meet its ambition to source 10% of its electricity demand from nuclear by 2025. We anticipate the first reactor at this site will come online around 2022, with one of the remaining three reactors coming online every year after. If Turkey develops as this scenario projects, the nation will substantially boost the share of coal and lignite in its generation mix while keeping natural gas import costs from rising. It will also roughly double its carbon emissions from an estimated 110m tonnes in 2014 to 205m in 2030 according to our estimates – about the equivalent of adding a third of Germany’s annual power sector emissions.

**BNEF’S RENEWABLES DEVELOPMENT PATHWAY (RDP)**

This scenario is underpinned by many of the same assumptions as our BAU scenario. The critical difference is that we assume more renewable capacity can and will displace the government’s ambitious new-build plans for hard coal and lignite capacity. We therefore model the Turkish power sector under an assumption that no further coal capacity will come online after 2022, once plants currently under construction or in advanced planning stages are delivered. Despite its heavy reliance on variable renewable generation, we found that enough dispatchable back-up capacity will be available to comply with the government’s requirements. In the spirit of this more environmentally ambitious scenario, we have also assumed that Turkey will introduce energy efficiency measures that slightly reduce power demand growth by 0.15% per annum, when compared to our BAU projection. This scenario would keep both carbon emissions and natural gas imports relatively stable, while boosting the investments required in new capacity.

**SCENARIO COMPARISONS**

A comparison of some of the main results from this scenario analysis is shown in the table below.

- **Power demand projections:** In the Official Plan, power generation hits almost 440TWh by 2023 and then climbs to over 600TWh by 2030. Electricity generation is more modest in both our BAU and RDP scenarios, hitting around 370TWh in 2023 and 450TWh by 2030. This, in our view more realistic outlook, substantially reduces the need for additional generation capacity.

- **New capacity build:** In the Official Plan 101GW are added before 2030, in the BAU scenario 56GW come online and in the RDP 71GW are installed over the next decade and a half. Most of the 15GW difference between the BAU and the RDP scenarios is due to the lower utilisation rates of wind and solar capacity.

- **Greenhouse gas emissions:** We estimate they would stabilise at around 120m tonnes per year, or just above current levels, if Turkey develops in line with the conditions laid out in the
RDP scenario. By relying on coal for its future capacity additions, Turkish emissions would almost double in the next 15 years.

**SCENARIO COST COMPARISON**

Our modelling indicates that displacing Turkey’s investment in domestic fossil fuels, as highlighted in the BAU scenario, with a larger renewables spend will not come at a substantial premium when considering the entire timeframe. Generally speaking, this finding is driven by the expectation that wind and solar equipment costs will drop sharply in the future. Fossil fuel technologies are unlikely to see a similar trend.

**Table 1: Scenario top-level results comparison**

<table>
<thead>
<tr>
<th>Key variable</th>
<th>Official Plan</th>
<th>BAU</th>
<th>RDP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2023</td>
<td>2030</td>
<td>2023</td>
</tr>
<tr>
<td>Total installed capacity (GW)</td>
<td>121</td>
<td>165</td>
<td>98</td>
</tr>
<tr>
<td>Natural gas share (%)</td>
<td>16</td>
<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Hard coal and lignite share (%)</td>
<td>27</td>
<td>27</td>
<td>30</td>
</tr>
<tr>
<td>Renewables share, incl. hydro (%)</td>
<td>39</td>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>Scenario emissions (MtCO2)</td>
<td>150</td>
<td>213</td>
<td>157</td>
</tr>
<tr>
<td>Cost of fuel expenditures ($bn nominal)</td>
<td>9</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Bloomberg New Energy Finance

Our total scenario costs account for three elements – capital expenditure, generation costs and fuel. By 2030 the cumulative costs amount to $400bn in the BAU scenario and $406bn in the RDP scenario while in the Official Plan the total has ballooned to $530bn (all in nominal terms). Some of detailed assumptions and findings on the costs of Turkey’s future power system read as follows:

- **Levelised cost of energy (LCOE):** We project the current LCOE levelised cost of electricity for an onshore wind project in Turkey equates to around $120 per MWh. But by 2030 such a project’s LCOE should fall into the $60 to $80 per MWh range, compared with $80-105 per MWh for coal and $73-116 per MWh for lignite. The story for a hypothetical ground-mounted solar project is similar: its LCOE today is approximately $150 per MWh, but we project this figure will fall to between $85 and $120 per MWh by 2030.

- **Capital expenditure:** We estimate that the Official Plan would require capital investments into new power plants worth around $240bn (nominal) between 2014 and 2030. With a more realistic projection of power demand, fewer of those plants will be needed. As a result, we project that the market for new power plants will be worth $122bn (nominal) over the same period in our BAU scenario. This figure would rise to $148bn if Turkey choses to replace its reliance on coal with renewables, as laid out in the RDP scenario.

- **Fuel burn costs:** The Official Plan will probably lead to a significant drop in Turkey’s expenditure on natural gas imports – but only until the middle of the next decade, in part due to its ambitious nuclear plans. In our two alternative scenarios, we are more sceptical about the extent to which Turkey will become less dependent on gas imports, if not about the trend. Most of the beneficial impact on the trade balance of adding either coal or renewable capacity will come in the form of avoiding a further increase in the import costs, which we project to remain relatively stable (in nominal terms). The increased use of both domestic and imported coal in the BAU scenario (compared with the RDP scenario) will however increase the variable costs of Turkey’s power generation to a similar extent as the additional capacity investments in renewables.
FROM SCENARIOS TO REALITY

In the immediate term, too many barriers exist to advance aggressively towards higher reliance on renewables. The Turkish electricity grid requires investment to deal with the supply variability created by a flood of new renewable projects, the Turkish government is putting a break on solar installations, the electricity market is not completely liberalised, the tenor of feed-in tariffs is comparatively short and administrative grid connection complexities abound. These are however only near-term barriers. As renewable long-run marginal costs – for which LCOEs are a good proxy – fall subsidies will become less important while innovative developers will find ways around the administrative and permitting complexities. Our analysis indicates that the conventional wisdom, claiming that renewables are not cost-competitive, may not hold in the next decade. In the medium to long term, Turkey may therefore achieve many of the benefits it expects to gain from increased coal power generation also from a strategy that puts renewables at the centre. This will not just be welcome news to environmentalists but also to the Turkish government and economists.
SECTION 2. BACKGROUND

Bloomberg New Energy Finance conducted an analysis of the Turkish power market and formulated a view on some alternative plausible scenarios. This study was commissioned by WWF-Turkey and funded by the European Climate Foundation (ECF). This section provides some background on the Turkish energy sector, the power market policy landscape and industry development plans.

2.1. TURKEY’S POWER SECTOR TODAY

In 2013, Turkey generated about 44% of its electricity from gas, 25% from coal and lignite, and 24% from hydro. It is thus heavily reliant on imported gas, much of which comes from Russia. The government expects electricity demand to almost double between 2013 and 2023.

The government has enacted policy to build greater power capacity and improve energy efficiency so as to become less dependent on gas imports – shifting its energy mix to favour both domestically-sourced and imported coal. It plans likewise to have two nuclear plants commissioned between 2020 and 2022, with a third under construction. Renewable generation is expected to grow in line with its current share, with most of that growth satisfied by new-build onshore wind capacity.

In 2013 Turkey generated 239TWh of power – almost 70% more than just a decade previously and 315% more than 1990 levels. The nation has grown in just under 25 years from being a power consumer roughly equivalent to Belgium to one the size of Spain. Because power consumption and wealth per capita are still below the levels of western European nations, Turkey could conceivably continue to show this rapid power demand growth in the coming years.

One important aspect to this growth has been a shift in fuel mix. Approximately 70% of Turkey’s 2013 generation was supplied by coal and gas power plants, up from about 47% in 1993. As a result, fuel imports have risen. Almost half of the power generation in Turkey last year was produced with imported natural gas. The government is keen to redress this balance in the coming years.

Turkey’s power market is currently heavily reliant on natural gas imports.

Figure 1: Turkish power capacity by type, 2000-2013

Figure 2: Turkish power generation by type, 2000-2013

Source: Turkish Electricity Transmission Company (TEIAS), Bloomberg New Energy Finance
LIBERALISATION, REGULATION AND MARKET STRUCTURE

One of the top priorities of the Turkish Energy Ministry is to improve the efficiency of the country’s power market and thus make it more attractive to private investors. It has set about reducing the public ownership shares of power assets and liberalising the power market to expedite the transition. It is hoped this will lead to an attractive environment for investors, and will ensure a cost-effective and secure power supply for consumers\(^1\).

The privatisation model being pursued by the government, currently based on bilateral agreements, is serving to increase the number of companies active in the sector – both in terms of wholesale and retail electricity sales. Such agreements are made between suppliers and eligible consumers, which have sufficiently high demand to buy from the wholesale market.

In advance of this privatisation wave, all state-owned power generation assets were first transferred to the ownership of the newly formed Electricity Generation Company, or EÜAŞ. By the end of 2013 EÜAŞ held 23.8GW of installed capacity, or 37% of the national total. It annually generates approximately 80TWh, or 33.4% of the total\(^2\). A fully liberalised transmission grid should make it easier for renewable projects to integrate into Turkey’s current power market. However, the requisite adequate policy, to support a renewables industry, must be first put in place.

In a fully liberalised market like the UK, capacity is simply brought online based on the lowest short-run costs. In Turkey, a collection of prior agreements, between the government and power suppliers, ensure that certain plants come into service despite not being the lowest cost at that instant. This serves to distort power prices and adversely affect the profitability of other plants.

POLICY AND REGULATORY ENVIRONMENT

In the middle of its long-term strategic move to liberalise its power markets, it seems unlikely that the Turkish government will reverse the privatisation process in the coming years. It hopes to have a competitive electricity market by 2016. The most recent strategy announcements have put a clear focus on energy security, independence and competition, and indicate that the government will continue carefully shaping the new market structure with additional policy.

There are signs that the government is relaxing its control over electricity distribution – even if such moves are not yet all-encompassing. As part of its privatisation push, the government reined in the authority of the Turkish Electricity Distribution Company (TEDC) while giving private distribution companies the right to obtain licences from the Turkish Energy Market Regulatory Authority (EMRA).

Small-scale consumers cannot yet choose an electricity provider. Instead, they get allocated a default provider from a specific region, while retail tariffs are regulated by EMRA. The threshold for total electricity spend to be able to choose a supplier was recently reduced to TRY 133 ($63) a month, which suggests both that less state control is being exerted and that a more competitive retail market is evolving. In the future more and more consumers will be able to choose their supplier. Larger consumers can negotiate their own terms with a supplier of their choice and are not subject to the national tariffs.


\(^2\) TEİAŞ (Turkey Electricity Transmission Company)
2.2. DEVELOPMENT PLANS

The government’s energy strategy aims to meet the twin objectives of satisfying demand and decreasing import dependency – under its primary objective of energy security. It has released a number of energy strategy papers that outline its targets for the country’s power system. Table 2 addresses these stated goals.

Table 2: Turkish government 2023 energy targets

<table>
<thead>
<tr>
<th>Variable</th>
<th>Target</th>
<th>BNEF Take</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy intensity</td>
<td>20% reduction compared to 2011</td>
<td>This is an ambitious target, in the absence of any new measures. Drawing on IMF data and our own power demand forecasts, we estimate that Turkish electricity consumption per unit of GDP will increase by about 8% before 2019 when compared to 2011.</td>
</tr>
<tr>
<td>Installed power capacity</td>
<td>Increase to 110GW with annual generation at 440TWh (by 2023)</td>
<td>In adhering to our more conservative power demand forecasts, we estimate power generation capacity will only reach 98GW by 2023; while power generation will climb to approximately 373TWh in our business-as-usual scenario.</td>
</tr>
<tr>
<td>Nuclear plants</td>
<td>Commission two plants with a total capacity of 10GW: begin building a third</td>
<td>We expect only one nuclear plant will be online by 2023, as the planning is progressing at a staccato pace. Experience indicates it can take 15 years to build up the required institutional capacity and knowledge. Furthermore, none of the three sites have begun “pouring concrete”.</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>Increase the share of renewable energy in power generation to 30% (incl. hydro)</td>
<td>With a current total generation share of about 29%, of which 85% is large hydro, we believe this target will be met. However, in the policy landscape of our BAU scenario, we estimate the share will not increase substantially, principally because the target to commission 20GW of wind power will be missed.</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Decrease the share of natural gas in power generation to 30% from the current 44%</td>
<td>We think this is plausible, as nuclear power will displace gas capacity from 2020 onwards, although we estimate a slightly higher natural gas share of 32% for 2023.</td>
</tr>
</tbody>
</table>

Source: Turkish Government / Bloomberg New Energy Finance

The Turkish government aims to reduce natural gas generation share from 41% to 30% by 2023.

The 10th Development Plan (2014-2018) forms the foundations of all policy decisions made by the Turkish government. Table 3 addresses its key tenets relating to the energy sector while our comments draw on internal modelling and analysis, external interviews and trajectories of historical patterns.

Table 3: Turkish “10th Development Plan” targets for 2018

<table>
<thead>
<tr>
<th>Variable</th>
<th>Target</th>
<th>BNEF take</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP / capita</td>
<td>GDP per capita to increase from $10,500 in 2012 to $16,000 in 2018</td>
<td>This equates to a 7.2% annual growth rate, which is considerably higher than the projection of 3.9% average annual growth over 2014-18 projected by the IMF (in purchasing power parity terms) that we use in our analysis.</td>
</tr>
<tr>
<td>Installed power capacity</td>
<td>Increase installed energy generation capacity from 58GW to 78GW</td>
<td>This government projection is more achievable than the long-term target of 110GW by 2023. It is also more in line with our power demand growth forecast. In our business-as-usual (BAU) scenario, starting from a 2012 base of 57GW, we project 82GW will be online by 2018.</td>
</tr>
<tr>
<td>Total factor productivity</td>
<td>Total factor productivity to grow from -0.8 (2013) to 1.9 (2018)</td>
<td>The target for this metric, which measures growth independent of capital and labour inputs (i.e. technological progress), appears ambitious in our view– especially in light of the recent drop into negative figures.</td>
</tr>
</tbody>
</table>

Source: Turkey Ministry of Development, Bloomberg New Energy Finance

“DASH FOR COAL” PLAN

With 22% of the Turkey’s installed capacity and 25% of its annual power generation, the Turkish coal sector currently contributes far less to electricity generation than the gas sector. But it is likely
to become the fastest-growing part of the Turkish power market in the coming decade. And to underscore this momentum, 2012 was declared the “year of coal” by the Turkish energy ministry. The Turkish government is currently advancing policy to support the development of coal and lignite projects that can be fed cheaply with domestic resources. Turkish banks are prioritising getting domestic coal projects financed. International institutions, like the World Bank and EBRD, are likewise continuing to support the government’s energy policies due to its almost-complete power market liberalization. However, these institutions do not support the government’s plans for coal plants expansion.

The Turkish coal industry is currently seeing the benefits of large-scale public investment – an incentive scheme serves to subsidise both plant capital expenditure and operating costs for domestic coal exploitation.

Turkey has tremendous lignite reserves, estimated at approximately 14.1bn tonnes. In the last nine years, some 5.8bn tonnes were discovered after a five-fold increase in prospecting work. Domestic coal resources are still largely supplied by public institutions (see Table 4). However, the government says that roughly 35% of the coal production reported by state-owned enterprises was in fact mined by private companies, under sub-contracts.

Table 4: Domestic coal supply market shares (2011)

<table>
<thead>
<tr>
<th></th>
<th>Turkish Coal Enterprises (TKI)</th>
<th>Electricity Generation Company (EUAS)</th>
<th>Turkish Hard Coal Enterprises (TTK)</th>
<th>Remainder (All Private)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic coal share</td>
<td>43.96%</td>
<td>41.59%</td>
<td>2.09%</td>
<td>12.36%</td>
</tr>
</tbody>
</table>

The government is prioritising the exploitation of these coal resources. It hopes that the dash-for-coal plan will strengthen regional development, reduce the foreign trade deficit and secure long-term energy resources. The government suggests that greater public support will lead to lower consumer electricity costs, usher in further employment opportunities and increase value added in the country. It is emotive and controversial rhetoric. Courtesy of the royalty tender mechanism, the state-owned Turkish Coal Enterprise has opened 11 coal fields with a total generation potential of 3.1GW. As of November 2013, the government indicates there were seven successful tenders for small-scale lignite fields resulting from the mechanism, as below.

---


6 Turkey Ministry of Energy and Natural Resources
Table 5: Concluded coal tenders through the Royalty Tender Mechanism

<table>
<thead>
<tr>
<th>Location</th>
<th>Power Plant Capacity (MW)</th>
<th>Coal Field Reserves (Million Tonne)</th>
<th>Company</th>
<th>Tender (Kurus / kWh)</th>
<th>Tender ($ cents / kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tufanbeyli / Adana</td>
<td>600</td>
<td>323</td>
<td>Teyo Group</td>
<td>2.57</td>
<td>1.21</td>
</tr>
<tr>
<td>Soma-Deniş / Manisa</td>
<td>450</td>
<td>150</td>
<td>Kolin İnşaat</td>
<td>4.69</td>
<td>2.20</td>
</tr>
<tr>
<td>Keles-Davutlar / Bursa</td>
<td>270</td>
<td>55</td>
<td>Çeliker İnşaat</td>
<td>5.61</td>
<td>2.64</td>
</tr>
<tr>
<td>Domanıç / Kütahya</td>
<td>300</td>
<td>114</td>
<td>Çeliker İnşaat</td>
<td>5.03</td>
<td>2.36</td>
</tr>
<tr>
<td>Yeniköy / Muğla</td>
<td>420</td>
<td>50-60</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Karabalıkg Kızılıova /Bingöl</td>
<td>150</td>
<td>89</td>
<td>Aska</td>
<td>3.2</td>
<td>1.50</td>
</tr>
<tr>
<td>Çan / Çanakkale</td>
<td>210</td>
<td>45</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Investment Support and Promotion Agency of Turkey
Notes: power plants are built next to coal fields

In addition, the Afsin-Elbistan coal field, which holds up to 45% of Turkey’s lignite reserves and is currently owned by the Turkish Electricity Generation Company (EUAS), can now be legally privatised. In May 2014, the Turkish energy minister announced that the government is in talks with China regarding the development of the $10bn to $12bn field. The same talks have covered the construction of 8GW of coal-fired power plant in the locality. Furthermore, EUAS is privatising six lignite sites in its portfolio with a combined capacity of 2.6GW. Figure 3 shows the status of various coal plants in Turkey according to our projects pipeline.

**Figure 3: Coal-fired power plants in Turkey**

Source: Esri, Bloomberg New Energy Finance, ECF, Bloomberg (BMAP), Sourcewatch

---

RENEWABLES

The government expects to have 30% of its power supply from renewables by 2023, a share that it wants to meet with new wind and hydro capacity. Hydro power currently accounts for over 90% of installed renewable capacity. Despite low feed-in-tariffs (FITs), Turkey’s wind market has expanded at a modest pace in recent years⁸.

The targets for new-build solar and geothermal capacity are low, especially when taking into account the considerable potential of both resources in Turkey. The 2023 target for solar is only 3GW – by comparison Germany today has 30GW online. This may be explained by the fact that Turkish solar FITs are below those of countries such as Germany, the Philippines and Greece. The government says it wants to limit solar development to protect its newly-privatised power market⁹. This policy is not in line with most other countries that see the benefits of a cheap and diversified mix of technologies and are therefore pushing greater solar PV deployment.

Law No. 6094, which came into effective on 8 January 2011, amended a preceding law on the deployment of renewable resources (No. 5346). The law guarantees prices from electricity sales for renewables certificate holders. But, significantly, prices are only guaranteed for the first ten years. This is a shorter time span than most EU-28 feed-in-tariff regimes, which typically last 15 years. Bidding in the first Turkish solar PV auction closed in July 2013. The total amount of applicant capacity almost touched 9GW, but a cap of 600MW ensured that only just under 7% of the applicants will receive FIT support.

Table 6: Renewable energy production incentives ($ cents / kWh)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Guaranteed price</th>
<th>Domestic production support</th>
<th>Maximum incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro power</td>
<td>7.3</td>
<td>2.3</td>
<td>9.6</td>
</tr>
<tr>
<td>Wind</td>
<td>7.3</td>
<td>3.7</td>
<td>11</td>
</tr>
<tr>
<td>Solar PV</td>
<td>13.3</td>
<td>6.7</td>
<td>20</td>
</tr>
<tr>
<td>Concentrated solar</td>
<td>13.3</td>
<td>9.2</td>
<td>22.5</td>
</tr>
<tr>
<td>Biomass (including landfill gas)</td>
<td>13.3</td>
<td>5.6</td>
<td>18.9</td>
</tr>
<tr>
<td>Geothermal</td>
<td>10.5</td>
<td>2.7</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Source: Amendment to Law No. 6094

The government is likely to set stringent back-up requirements for renewables. An excess of 50% dispatchable conventional capacity is expected to be required to support each MW of solar and wind capacity – essentially for 1GW of variable renewables, there must be 0.5GW of excess coal, gas, hydro or nuclear capacity.

Hydro power is a relatively clean and non-variable technology that has been in use, on an industrial scale, since the 19th century. In Turkey, hydro power plants currently provide about a quarter of the total electricity generated, and it has more than 22GW of installed capacity. According to the government’s project pipeline, another 4GW are expected to come online between now and 2016, which will help the government push towards its 2023 target of 36GW. The government believes that 433TWh of hydropower generation are theoretically possible, 216TWh are technically achievable and 140TWh are economically feasible¹⁰. Most of the new

---

⁸ Since 2007, the wind sector has grown 15-fold and total installed capacity is now 2.8GW, with a pipeline of 7GW.


hydro capacity is expected to be small-scale installations – located in northeastern Anatolia. Pumped hydro-electric power, which involves shifting water between two reservoirs at different altitudes, is a mature and low-cost means of energy storage. It provides about 99% of energy storage worldwide. With capital expenditure costs of between $1.5m and $3.5m per MW, it is cheaper than most of today’s other commercial energy storage technologies – for example lithium-ion batteries. The technology is demand-responsive and it can be used to smooth out supply variations, and thus help integrate variable renewable energy sources.

As discussed above, the government requires 50% dispatchable back-up capacity to support each MW of solar and wind. At the moment, the country’s existing hydro facilities have limited pumped storage capacity. However, preliminary analysis has been conducted on 16 hydro plants that have a total capacity of 14GW. Furthermore, two proposals for pumped storage facilities (3.2GW) are in the conceptual design stage. Such improvements are likely to boost grid resilience as renewables penetration increases.

**POWER TARGETS OVERVIEW**

**Table 7: Turkey energy sector policies and targets summary table (GW)**

<table>
<thead>
<tr>
<th>Sector</th>
<th>2013 Capacity</th>
<th>2023 Target capacity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal and lignite</td>
<td>12.4</td>
<td>~ 25</td>
<td>Domestic sources heavily prioritised</td>
</tr>
<tr>
<td>Gas</td>
<td>20.3</td>
<td>~ 25</td>
<td>Government seeks to lower import dependency</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
<td>10</td>
<td>One 4.8GW plant is in the late planning and permitting stage</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>22.3</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>2.8</td>
<td>20</td>
<td>Onshore wind capacity is not currently being added at a fast enough rate to meet the 2023 target</td>
</tr>
<tr>
<td>Solar</td>
<td>0.02</td>
<td>3</td>
<td>An annual build cap of 600MW is currently in place; the 2023 target of 3GW is not ambitious considering available resource and it is likely it will be exceeded before 2020. This will be driven by economics as solar module prices continue falling.</td>
</tr>
</tbody>
</table>

Source: Turkey Electricity Transmission Company (TEIAS), Bloomberg New Energy Finance

**TRANSMISSION AND NETWORK CAPACITY**

The Turkish transmission network is a state-owned monopoly administered by the Turkish Electricity Transmission Company (TETC), founded in 2001. There are no plans to privatise the transmission system. But the government is encouraging private firms to participate in grid infrastructure development, implementation and automation projects and service offerings.

**Table 8: Turkey’s transmission and distribution capacity**

<table>
<thead>
<tr>
<th>Primary voltage level</th>
<th>380kV</th>
<th>220kV</th>
<th>154kV</th>
<th>66kV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission lines (km)</td>
<td>16,344</td>
<td>85</td>
<td>33,481</td>
<td>509</td>
<td>50,418</td>
</tr>
<tr>
<td>Underground cables (km)</td>
<td>43</td>
<td>0</td>
<td>214</td>
<td>3.2</td>
<td>260</td>
</tr>
<tr>
<td>Transformers (Number)</td>
<td>222</td>
<td>0</td>
<td>1,153</td>
<td>50</td>
<td>1425</td>
</tr>
<tr>
<td>Transformers (MVA capacity)</td>
<td>43,795</td>
<td>0</td>
<td>68,458</td>
<td>593</td>
<td>112,846</td>
</tr>
</tbody>
</table>

Source: Turkish Electricity Transmission Company

There is a total of 50,418km of transmission lines and 259km of underground cables, according to 2012 data. Overall transmission line capacity grew 1.7% annually between 2008 and 2012. Underground cable capacity is growing by around 10% each year, after the first 380kV and 66kV underground cables were installed only in 2007. Aside from the development of the national
transmission system, the government is also pushing towards greater international grid integration. The integration process with ENTSO-E is in its final testing stages, and the government expects to sign a long-term contract later this year. It hopes there will be technical, economic and environmental benefits from the connection. Turkey already has interconnections to Azerbaijan, Georgia, Iran, Iraq and Syria. International integration brings flexibility to the grid, and this could be a positive driver for renewables penetration. The ambition is to establish Turkey as an energy bridge that connects Western customers with suppliers from the East. It is also expected that progress will continue being made on Turkey’s section of the southern gas corridor. The Interconnector Turkey-Greece-Italy (ITGI) and the Trans-Anatolian pipeline represent two infrastructure projects that could transform the region into an energy hub moving gas from Azerbaijan, Iraq and Iran to Western Europe11.

ENERGY STORAGE

Utility-scale energy storage could play an important role in terms of helping Turkey integrate its renewable capacity and efficiently upgrade its power grid. Applications include price arbitrage, frequency regulation, renewable energy integration, both transmission and distribution investment deferral, voltage compensation and congestion relief (see Table 9).

Table 9: Opportunities for energy storage applications

<table>
<thead>
<tr>
<th>Application group</th>
<th>Application</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market-level applications</td>
<td>Frequency regulation</td>
<td>This is the provision or absorption of short bursts of power to maintain the balance of supply and demand hence the frequency of power. This is often procured by the system operator.</td>
</tr>
<tr>
<td></td>
<td>Other ancillary services</td>
<td>This involves the provision of power, real or reactive, to the system, often procured by system operators. Reserves and frequency regulation are covered in other applications, examples of other ancillary services include reactive power.</td>
</tr>
<tr>
<td></td>
<td>Price arbitrage</td>
<td>This involves buying electricity in the power market when prices are low, store it and then sell it when prices are higher.</td>
</tr>
<tr>
<td>System-level applications</td>
<td>Renewables integration</td>
<td>This involves being connected to renewable assets and manages the output of the assets so that they have a less negative impact on the operations of the grid.</td>
</tr>
<tr>
<td>Transmission-level applications</td>
<td>Investment deferral</td>
<td>Here modular energy storage system is used to meet the incremental increase in transmission capacity requirement instead of a much more expensive upgrade to the transmission line itself.</td>
</tr>
<tr>
<td></td>
<td>Reduction of transmission access charges</td>
<td>Energy storage system is used to reduce the peak load, thus reducing the transmission access charges that need to be paid by the load to access the transmission system.</td>
</tr>
<tr>
<td></td>
<td>Reduction of transmission congestion charges</td>
<td>Energy storage system is used to reduce the peak load, thus reducing the congestion charges that need to be paid by the load in congested areas.</td>
</tr>
<tr>
<td></td>
<td>Voltage compensation</td>
<td>Energy storage system with the right electronics can provide reactive power to the transmission system in similar ways to a capacitor or STATCOM.</td>
</tr>
<tr>
<td>Distribution-level applications</td>
<td>Investment deferral</td>
<td>Modular energy storage system is used to meet the incremental increase in distribution capacity requirement instead of a more expensive upgrade to the distribution line itself.</td>
</tr>
<tr>
<td></td>
<td>Reduction of distribution access charges</td>
<td>Energy storage system is used to reduce the peak load, thus reducing the distribution access charges that need to be paid by the load to access the distribution system.</td>
</tr>
<tr>
<td></td>
<td>Voltage compensation</td>
<td>Energy storage system with the right electronics can provide reactive power to the distribution system in similar ways to a capacitor bank.</td>
</tr>
</tbody>
</table>

Turkey currently relies on the obligatory provision of various grid services (mandated or directly by the state-owned grid operators) and this is limiting storage demand. Regulatory changes will be required to allow storage to play a role. By contrast, South Korea recently announced that it was switching from mandatory provision of frequency regulation to a storage market of 500MW by 2017; and in Chile generators are allowed to use energy storage to provide frequency regulation to the grid instead of using their generation capacity.

SECTION 3. OFFICIAL PLAN

In the previous section, we outlined the current state of the Turkish power market, while sketching out the government’s broader policy and development plans. In this section, we build a demand and generation capacity forecast – based on Turkey’s official energy plans. This section will also serve as a comparator for two alternative scenarios in Section 4 and Section 5.

3.1. SUMMARY

- The government believes there will be significant growth in power demand in the next two decades, with current levels almost doubling by 2023.
- It plans to match growing demand with the ambitious construction of new coal, hydro and onshore wind capacity.
- It hopes no additional natural gas capacity will come online as it attempts to improve trade balances and lower fuel import dependency.

![Figure 4: “Official Plan” scenario projected capacity in Turkey, 2014-2030 (GW)](source: TEIAS / Bloomberg New Energy Finance)

3.2. METHODOLOGY

POWER DEMAND

The Turkish government publishes regular medium- to long-term forecasts on power demand. In its most recent estimate, it suggests power demand will grow at 5.25% each year until 2030. Total power generation should consequently rise from 239TWh in 2013 to 440TWh by 2023 – and 619TWh by 2030. We adhere to these power demand scenarios in the “Official Plan” scenario.

POWER GENERATION CAPACITY

To formulate the power generation and capacity plans from this government vision, we simply use the targets for 2023 and 2030 and linearly interpolate between 2014 and 2022, and 2024 and 2029. The data points for 2023 and 2030 merge two different official sources (the General Directorate of Energy Affairs and the Turkish Ministry of Energy) and, generally, they align well...
but there is a small divergence after 2023 because different government bodies use contrasting numbers (see Figure 4)\(^\text{12}\).

### 3.3.  CAPACITY AND GENERATION FORECAST

**Figure 5:** "Official Plan" scenario projected power generation in Turkey, 2014-2030 (TWh)

![Power Generation Graph](image)

Source: TEIAS, Bloomberg New Energy Finance

Table 10 summarises anticipated power generation capacity for specific years before 2030 when taking into account government targets for 2023 and 2030.

**Table 10:** "Official Plan" installed capacity in Turkey, 2000-2030 (MW)

<table>
<thead>
<tr>
<th>Technology</th>
<th>2014</th>
<th>2018</th>
<th>2023</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard coal</td>
<td>5,005</td>
<td>6,672</td>
<td>8,755</td>
<td>12,257</td>
</tr>
<tr>
<td>Lignite</td>
<td>9,208</td>
<td>12,380</td>
<td>16,245</td>
<td>22,743</td>
</tr>
<tr>
<td>Oil</td>
<td>737</td>
<td>854</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Natural gas</td>
<td>24,672</td>
<td>24,818</td>
<td>25,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
<td>0</td>
<td>9,600</td>
<td>12,000</td>
</tr>
<tr>
<td>Hydro</td>
<td>23,660</td>
<td>29,145</td>
<td>36,000</td>
<td>36,000</td>
</tr>
<tr>
<td>Geothermal</td>
<td>340</td>
<td>456</td>
<td>600</td>
<td>1,000</td>
</tr>
<tr>
<td>Wind</td>
<td>4,484</td>
<td>11,380</td>
<td>20,000</td>
<td>38,000</td>
</tr>
<tr>
<td>Solar</td>
<td>318</td>
<td>1,510</td>
<td>3,000</td>
<td>16,000</td>
</tr>
<tr>
<td>Biomass</td>
<td>153</td>
<td>530</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>68,658</td>
<td>87,743</td>
<td>121,200</td>
<td>165,000</td>
</tr>
</tbody>
</table>

Source: TEIAS, GDEA and Bloomberg New Energy Finance  
Note: figures in purple indicate official government targets, not BNEF projections; Total figures might not add up due to rounding.

---

SECTION 4. BUSINESS-AS-USUAL SCENARIO

In this section, we will lay out the methodology and assumptions that drive our business-as-usual scenario – particularly in terms of power demand growth and capacity additions.

4.1. SUMMARY

POWER DEMAND

- Drawing on our internal power demand modelling, which is based on GDP per capita development, we conclude that the Turkish government forecast significantly overestimates future power demand.
- Our own projections suggest that power demand will reach 373TWh by 2023 and 462TWh by 2030. These forecasts assume per-capita power demand growth will flatten as the country develops. The government also has a stated ambition of growing the service sector of its economy. The trajectory of Turkish power demand indicates it will converge with more developed Western Europe markets in the coming decade.

POWER GENERATION CAPACITY

- In our BAU scenario, natural gas becomes less important to Turkey’s energy mix: its market share of total power generation will slide to 32% by 2023 from 44% in 2013.
- The government’s dash-for-coal plan will boost hard coal and lignite-fired plants; these two resources will together provide 35% towards Turkey’s 2030 power generation – up from the current 26% share. We assume that capacity factors for all technologies but natural gas will remain at historical average rates.
- The share of renewables when excluding hydro, as a proportion of total generation, will increase from 4% in 2013 to 14% in 2030, with wind alone contributing 10%. In assessing the government plans, and particularly wind and solar, it is worth pointing out that in most other countries solar and wind installed capacity are more in balance.
- There will be sufficient thermal, hydro and nuclear capacity to provide the back-up capacity required by the government energy plans and to meet expected peak demand.

4.2. POWER DEMAND

Starting with the government plan, and using data on the growth of European economies in Europe, Bloomberg New Energy Finance concludes that the demand growth rate will be lower than the government forecast. We have assembled a set of parameters that form the basis of our BAU scenario assumptions, and further details can be found in the Appendix. We estimate that Turkish power consumption will climb by 47% in the coming decade to 373TWh per annum. We assume electricity demand per capita will follow a similar path to other European nations at different levels of personal wealth. Despite the outlook of continuing demand expansion, the percentage growth rate is likely to slow before 2030 (see Figure 6). The reasons for this are outlined in the next section.
Our power demand forecast puts Turkey on a trajectory with other developed European economies.

WHY THE PAST IS NOT ALWAYS A GOOD GUIDE TO THE FUTURE

Population growth should slow

A total of 76.5m people lived in Turkey in 2013, 9.7m more than a decade ago. By 2023, the total is expected to grow by 7.8m, because as countries get richer populations tend to grow more slowly. Between now and 2035, the number of residents is likely to increase at a compound annual growth rate (CAGR) of 0.8% — well below the 1.4% rate observed between 1990 and 2013 — according to data from the Turkish Statistical Institute.

Figure 7: European economies annual power demand and GDP per capita (1990-2012)

Annual consumption (MWh / Capita)


Notes: the GDP per capita data uses 2005 euros and is purchasing power adjusted
Electricity consumption per capita should flatten

Global historical trends show that a rapidly industrialising country requires steep rises in energy consumption for each incremental unit of GDP per capita. However, as countries become wealthier and the industrialisation process slows, each euro of additional GDP correlates with a smaller increase in energy consumption. This finding is consistent with the observation that as countries get richer, a greater proportion of its GDP growth tends to come from the service sector, which is less energy-intensive than industrial sectors.

Turkey is currently in the bottom left hand corner of Figure 7, when compared to European nations. The country saw very rapid and steep increases in electricity use at the end of the 20th century, even though power intensity (as in power consumption per unit of GDP per capita) remained below similar countries like Poland. Further sharp increases would however make Turkey an outlier. It is therefore more likely that Turkey will follow the same trend as Poland, Spain and Portugal with its energy consumption flattening as it becomes richer. The early signs of slowing energy growth are, in fact, already becoming evident.

Figure 8 shows how Turkey compares to other developing economies. It falls well within its peer group – with the exception of Brazil which enacted a successful energy efficiency programme in 2000.

Figure 8: Developing world economies annual power demand and GDP per capita (1990-2012)

Notes: GDP per capita data uses 2005 EUR rates and is purchasing power adjusted

Figure 9 shows that the ratio of power consumption to GDP has flattened in recent years, with even a slight decline in 2013. Part of this trend is attributable to the falling share of heavy industry in total electricity demand (see Figure 10). This has stabilised at between 45% and 47% – from about 62% in 1990. And this is not because industrial demand has declined in absolute terms, but rather that other sectors have grown disproportionately. Our demand forecasts take account of the shifting trajectory of the economy, assuming an optimistic growth forecast that follows other European nations.
The Turkish economy is relatively energy-intensive per unit of GDP, when compared to most of its European peers (see Figure 11). This is perhaps because its service sector constitutes 64% of its GDP, which is close to the world average but lower than in most developed nations. In the group of displayed countries, it belongs to those with the lowest energy consumption per capita—an indicator of energy access levels in parallel with economic development—and lower energy intensity of GDP. Developed economies are increasingly aspiring towards increasing each unit of GDP growth at a lower rate of energy consumption.

Figure 11: Energy intensity vs. per capita consumption for select countries (2011)

Source: US Energy Information Administration (EIA)

How does the BAU scenario compare?

Our long-term power demand projections for Turkey fall well below even the most conservative estimates of the Turkish government; it projects that generation will be 34% higher by 2030 than our BAU forecast. Precedent suggests that the Turkish government systematically overestimates...
growth – as it has done in all projections since 1990 (see Figure 12). 2012 estimates by the
Turkish Energy Market Regulatory Authority (EMRA) have already exceeded the actual 2013
figures. Independent analysts seem to agree with our projections. In December 2013 utility
association Eurelectric forecast that Turkey would consume around 340TWh in 2020 – almost
identical to our projection and about 40TWh below the government reference case. 13

Figure 12: Actual vs. projected Turkish power demand (TWh / Year)

Source: Bloomberg New Energy Finance, Turkey Energy Market Regulatory Authority

4.3. CAPACITY AND GENERATION FORECAST

Given the current policy outlook and capacity pipeline, our business-as-usual (BAU) scenario
represents a plausible projection for the development of the Turkish power sector in the next two
decades. We have highlighted some of the key points and rationale behind our BAU capacity
projections:

- **Coal:** We think 19GW of new coal and lignite capacity will come online before 2030, based on
  a probability-weighted analysis of the extensive government coal pipeline (see Appendix C).

- **Natural gas:** As the government is aiming to reduce its dependency on imported gas, we
  assume that only gas plants currently in the government’s plans, which amount to around
  3.3GW, will be commissioned in the coming years.

- **Hydro:** We used the short-term government pipeline to assume 5GW of new hydro capacity
  will come online before 2022 – with no additions in the remainder of the next decade.

- **Nuclear:** We assume one plant, with a capacity of 4.8GW from four reactors, will be fully
  commissioned by 2025 (we expect the first reactor (1.2GW) will come online in 2022). Once in
  operation, this facility will be a key component of baseload generation, as nuclear is relatively
  cheap to run and hard to ramp up or down.

- **Solar and wind:** We project that, under current policy, the government will overshoot its
target to build 3GW of solar by 2023 (5.5GW). The expansion of its onshore wind sector will
however be slower. In our BAU scenario we project it will reach only 10.3GW in 2023 – about
half the government target of 20GW. But from 2018 onwards, we assume the country will add
800MW of wind and 650MW of solar per year until 2030.

---

• **Back-up capacity:** In line with the government’s requirements, variable renewable capacity, like solar and wind, should have sufficient back-up. We assume that coal, lignite, oil, natural gas and nuclear plants will amply provide this cover. We assume all existing gas plants will remain operational as back-up.

**Figure 13:** BAU scenario installed capacity in Turkey, 2014-2030 (GW)

Source: Turkey Energy Market Regulatory Authority (EMRA), Bloomberg New Energy Finance

Our BAU scenario assumes a strong growth in hard coal and lignite capacity.

**Figure 14** shows our forecast for past and projected power generation in Turkey under our BAU scenario conditions. The additional nuclear capacity will displace gas generation after 2022. We believe this will lead to very low annual usage – or load factors – at gas plants, and potential closures. The driver behind this trend is the higher marginal cost of gas plants, which require costly fuel, unlike the newly-built nuclear plant which can generate power at a low cost once built.

**Figure 14:** BAU scenario power generation in Turkey, 2014-2030 (TWh)

Source: Turkey Energy Market Regulatory Authority (EMRA), Bloomberg New Energy Finance
### Table 11: Official Plan and BAU scenario installed capacity projections, 2023/2030 (MW)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Official Plan</th>
<th></th>
<th>BAU Scenario</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2023</td>
<td>2030</td>
<td>2023</td>
<td>2030</td>
</tr>
<tr>
<td>Hard coal</td>
<td>8,755</td>
<td>12,257</td>
<td>12,108</td>
<td>19,318</td>
</tr>
<tr>
<td>Lignite</td>
<td>16,245</td>
<td>22,743</td>
<td>10,478</td>
<td>13,059</td>
</tr>
<tr>
<td>Oil</td>
<td>1,000</td>
<td>1,000</td>
<td>818</td>
<td>818</td>
</tr>
<tr>
<td>Natural gas</td>
<td>25,000</td>
<td>25,000</td>
<td>27,920</td>
<td>27,920</td>
</tr>
<tr>
<td>Nuclear</td>
<td>9,600</td>
<td>12,000</td>
<td>2,400</td>
<td>4,800</td>
</tr>
<tr>
<td>Hydro</td>
<td>36,000</td>
<td>36,000</td>
<td>27,434</td>
<td>27,434</td>
</tr>
<tr>
<td>Geothermal</td>
<td>600</td>
<td>1,000</td>
<td>703</td>
<td>703</td>
</tr>
<tr>
<td>Wind</td>
<td>20,000</td>
<td>38,000</td>
<td>10,302</td>
<td>15,902</td>
</tr>
<tr>
<td>Solar</td>
<td>3,000</td>
<td>16,000</td>
<td>5,500</td>
<td>10,050</td>
</tr>
<tr>
<td>Biomass</td>
<td>1,000</td>
<td>1,000</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>121,200</strong></td>
<td><strong>165,000</strong></td>
<td><strong>97,759</strong></td>
<td><strong>120,100</strong></td>
</tr>
</tbody>
</table>

*Source: Turkey Energy Market Regulatory Authority (EMRA), Bloomberg New Energy Finance; Note: Total figures might not end up due to rounding.*
SECTION 5. RENEWABLES DEVELOPMENT PATHWAY

In this section, we build on the analysis from the business-as-usual (BAU) scenario to create an alternative path that has a focus on renewable energy development. This means that Turkey would meet most of the expected growth in power demand in the next decade from renewable sources, mainly wind and solar, instead of the coal plants currently being considered.

5.1. SUMMARY

The following four points represent some important observations from this scenario:

- Power demand will be slightly lower when compared to the BAU scenario. We believe there is potential for efficiency improvements in the economy, triggered by both public sector policy and private sector investment in new technology.
- Any net additional demand will not come from GHG-intensive coal-fired power plants, but from a more aggressive build-out of renewable technologies – particularly wind, solar and hydro.
- By 2030, we project that renewables will amount to 26% of Turkey’s power supply, excluding hydro. Hydro’s share of total generation will be 21%.
- Gas will make up 26%, coal and lignite 18% and nuclear 8%, according to our projections. Even in the light of these increases in variable generation and the strict back-up regulations, there will be sufficient installed capacity to support expected peak demand.

5.2. POWER DEMAND

Power demand in the RDP scenario draws on our forecast from the BAU scenario. Again we assume there will be lower demand than outlined in the official plan and that there will be end-user efficiency improvements. This scenario also projects slightly faster efficiency gains. In the RDP scenario we project there will be annual incremental efficiency gains of 0.15% of annual power demand, which will effectively serve to slow demand growth. As a result, generation amounts to 367GWh in 2023 or about 6TWh lower than forecast in the BAU scenario. We align these efficiency gains to our assessment of EU-28 member state efforts, which envisage significantly less demand growth than Turkey. Consequently, the absolute impact on Turkish power demand is relatively small. We believe these efficiency improvements will be driven by two critical factors – government legislation and technology investment in energy efficiency. The following case studies illustrate some comparable impacts on power demand development in other countries.

CASE STUDY: GERMANY

Germany is a prime example of a country that managed to align GDP growth with its transition towards having a cleaner and more productive energy economy. In the 20 years between 1991 and 2011, its GDP grew by 31%, while power consumption per capita grew by only half that amount. In the decade since 2001, its power consumption has stabilised at around 6.3MWh per capita. The main drivers were not only concrete policy targets on energy intensity – like the 2005 coalition agreement, which aimed to double energy productivity by 2020 compared to 1990 – but

also its prescient recognition that the international competitiveness of German industry would rest on resource efficiency.

CASE STUDY: BRAZIL

Our analysis suggests Brazilian power consumption stood at approximately 2.43 MWh per capita in 2011, close to our 2.51 MWh per capita estimate for Turkey in the same year. By way of context, in 2000 the Brazilian government passed a law to drive forward its energy efficiency programme. It required utilities to use 0.5% of their annual revenues to work on end-user energy efficiency, which equated to $248m in 2011. However, our analysis reveals that while the cost of the programme – effectively $0.06 per kWh – was expensive, it did lower demand by an average of 3.9 TWh per year between 2008 and 2012, equivalent to 0.8% of net electricity consumption from 2011. In the latest policy development, electricity distributors will have to provide smart meters to all new customers and also, if requested, to existing residential users as of 1 January 2014. Brazil is at a similar stage of economic development to Turkey, and it has shown that with progressive energy targets and legislation it can impact energy efficiency and arrest demand growth.

ENERGY EFFICIENCY IN TURKEY

The above case studies give a flavour of how power demand and energy intensity have developed in recent years in other nations, thanks to progressive policy and shifting investment patterns. They likewise point a path forward for the Turkish government and economy. The modernisation of inefficient transmission lines and aging grid connections should generally also lead to efficiency improvements and lower demand. However, in Turkey’s case, the network and distribution losses of around 15% largely relate to economic losses – unbilled electricity consumption – and not physical losses. Reducing such economic losses would not therefore result in less generation demand. The above figure shows historical transmission and distribution losses and net supply to the grid of the Turkish power market.

Figure 15: Historical electricity transmission and distribution losses (%) in Turkey, 1970-2012

Source: Turkish Electricity Transmission Company (TEIAS)  Note: “transmission losses” represent a percentage of net electricity supply; “distribution losses” represent a percentage of net electricity supply; “in-plant losses” represent a percentage of gross generation; and “net supply” equates to gross generation less direct consumption plus imports; Net supply = (Gross generation) – (In-Plant losses) + (Imports)

15 BNEF research note “Efficiency in Brazil: Tantalisingly out of reach” (11 December 2012)
In terms of potential new legislation, Turkey’s 10th Development Plan draws attention to the importance of transitioning towards Turkey developing a more information-based and less energy-intensive economy. Improving energy efficiency is one of 25 transformation points outlined in the plan. This underscores the likelihood that new policy will be implemented beyond what is assumed in the BAU scenario. The Energy Efficiency Law (No. 5627), passed in 2007, outlines some principles and procedures designed to promote energy efficiency measures across all sectors of the economy. It does not set quantitative targets, but it does introduce regulation aimed at expanding energy efficiency activity. Two such changes require the appointment of energy managers and the monitoring and reporting of relevant information at a corporate and public sector level. The law also puts in place a subsidy system for energy efficiency projects – for up to 20% of the cost – that have a payback period of five years or less and cost no more than TRY 500,000 ($237,000).

Figure 16: RDP scenario installed capacity in Turkey, 2014-2030 (GW)

Source: Bloomberg New Energy Finance

5.3. RDP FORECAST HIGHLIGHTS

There are four key points worth drawing attention to from our RDP scenario:

- In the RDP scenario, we assume only coal-fired power plants that have either secured finance or are under construction will come online before 2030 (around 3.3GW).

- The resulting gap in generation is then entirely met by a mix of renewable capacity additions – wind (55%), solar (30%) and hydropower plants (15%).

- Oil, nuclear, geothermal and biomass capacity additions are equal to those in the BAU.

- Capacity factors and the use of natural gas power plants are assumed to be equal to the BAU scenario.
Figure 17: RDP scenario power generation in Turkey, 2014-2030 (TWh)

Table 12: Official Plan, BAU and RDP scenario installed capacity projections, 2023 and 2030 (MW)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Official Plan</th>
<th>BAU Scenario</th>
<th>RDP Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2023</td>
<td>2030</td>
<td>2023</td>
</tr>
<tr>
<td>Hard coal</td>
<td>8,755</td>
<td>12,257</td>
<td>12,108</td>
</tr>
<tr>
<td>Lignite</td>
<td>16,245</td>
<td>22,743</td>
<td>13,059</td>
</tr>
<tr>
<td>Oil</td>
<td>1,000</td>
<td>1,000</td>
<td>818</td>
</tr>
<tr>
<td>Natural gas</td>
<td>25,000</td>
<td>25,000</td>
<td>27,920</td>
</tr>
<tr>
<td>Nuclear</td>
<td>9,600</td>
<td>12,000</td>
<td>4,800</td>
</tr>
<tr>
<td>Hydro</td>
<td>36,000</td>
<td>36,000</td>
<td>27,434</td>
</tr>
<tr>
<td>Geothermal</td>
<td>600</td>
<td>1,000</td>
<td>703</td>
</tr>
<tr>
<td>Wind</td>
<td>20,000</td>
<td>38,000</td>
<td>15,902</td>
</tr>
<tr>
<td>Solar</td>
<td>3,000</td>
<td>16,000</td>
<td>10,050</td>
</tr>
<tr>
<td>Biomass</td>
<td>1,000</td>
<td>1,000</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>121,200</td>
<td>165,000</td>
<td>97,759</td>
</tr>
</tbody>
</table>

Source: TEIAS, Bloomberg New Energy Finance; Note: Total figures might not end up due to rounding.

The above table compares the projected generation capacities, on a technology basis, for specified years between the official plan and our two scenarios.
SECTION 6. SCENARIOS COMPARISON

Sections 3, 4 and 5 laid out the details behind three possible outcomes for the Turkish power market in the next two decades. We now compare these three scenarios in terms of power demand, new capacity and generation. The section highlights the opportunities for renewable technologies to replace fossil-fuel generation.

6.1. POWER DEMAND

Our Turkish power demand forecast projects significantly less growth than the government estimates. We believe that as GDP grows, the power consumption per capita data will follow a similar line to other Western European countries, effectively slowing the current pace of demand growth. The RDP scenario assumes energy efficiency improvements will be made at a similar level to European targets – resulting in less demand than in the BAU scenario. Figure 18 compares the different power demand forecasts.

Figure 18: Scenario power generation projections, 2014-2030 (TWh)

![Graph showing scenario power generation projections](source)

The high government demand forecast significantly influences projected capacity additions. The BAU and RDP demand forecasts diverge only slightly, on the other hand. It is worth noting that the assumed efficiency gains of 0.15% in the RDP scenario are offset by the sizeable increase in absolute demand.

6.2. CAPACITY ADDITIONS

The BAU and RDP scenarios require new capacity of 56GW and 72GW respectively by 2030, in addition to what exists today. Current government plans would require 101GW of new build. It should be noted that the government plan assumes there will be much higher demand (see Figure 22), which increases the importance of adding new capacity.
6.3. GENERATION MIX

Due to the differences in capacity additions and utilisation rates, our two scenarios also result in differing generation mixes. Figure 23, Figure 24, Figure 25 and Figure 26 all project different visions of how power generation could unfold up to 2030.

- The share of natural gas generation will decline in all three scenarios, in line with the government aim. This could dent the profitability of such assets, even if their role as back-up generators during peak times is growing.
- Under the current policy conditions, echoed in the official plan and BAU scenario, coal will win a greater share of the generational mix as the government looks to promote domestic resources by pushing the development of new coal fields.
- Renewables, and onshore wind in particular, will take a larger share of the generation mix. In the short term, however, the official wind target seems too ambitious given the current pipeline and the uncertainty surrounding the short life of the current feed-in-tariffs.
Similarly, we consider the nuclear plans unrealistic, given that not a single plant is under construction at this point. We think the official nuclear plans will struggle to meet both their projected commissioning dates and full potential. We believe the first Rosatom plant could get commissioned between 2020 and 2022, despite currently being behind its initial projected timeline.

Figure 23: Power generation technology mix, 2023

Figure 24: Power generation technology mix, 2030

Figure 25: Power generation scenario comparison, 2023

Figure 26: Power generation scenario comparison, 2030

Source: Bloomberg New Energy Finance. Note: Renewables figures include hydro
SECTION 7. SCENARIO COST ANALYSIS

In the following section we lift the lid on the various cost factors driving our BAU and RDP scenario projections. Using analysis on the levelised cost of electricity (LCOEs), we assess the different cost components to deduce the all-in costs of the official plan and our BAU and renewables development pathway scenarios.

7.1. LEVELISED COST OF ELECTRICITY

LCOEs are useful means of comparing the electricity generation costs of different technologies and then tracking how these costs change over time. They represent the total revenue producers must receive, either from the government or other customers like utilities, to achieve a zero net present value (NPV) for their project – when assuming an appropriate return to its equity and debt investors.

We used various Bloomberg New Energy Finance models to calculate and forecast Turkey-specific LCOEs for solar, wind, hard coal and lignite. For the other technologies in Turkey’s power generation mix, we used our current global or European estimates. This section explains some of the details behind our underlying assumptions for the LCOEs. (BNEF clients can find a more detailed overview of global LCOE estimates here.)

LCOES

When aligning various cost assumptions, Figure 27 shows our indicative LCOE ranges.

Figure 27: Levelised cost of electricity for various technologies in Europe, Turkey and globally, 2014 ($ / MWh)

Across Europe, the LCOEs of solar and wind plants are expected to continue declining in the coming two decades (see Figure 28 and Figure 29). This projection draws on our knowledge of project pipelines, policy targets and an analysis of the learning curves for various technologies. Where policy does not exist beyond 2020, new-build capacity will be determined by local supply-
demand economics. Demand for new generation assets will be met by a range of technologies, but they will be heavily weighted towards those with the lowest lifetime costs on a levelised basis. To capture the uncertainty when looking beyond 15 years, we have flexed technology, operating and finance costs around our central view. Over our modelled time horizon, we project that both utility-scale solar and onshore wind will be increasingly competitive in Turkey without subsidies.

**Figure 28: European solar PV LCOE range, 2013-30 ($ / MWh)**

**Figure 29: European onshore wind LCOE range, 2013-30 ($ / MWh)**

**CAPITAL EXPENDITURE**

Capital expenditure (capex) for a power plant is made up of development, balance of plant and equipment costs. Such costs are incurred during the development and construction phase of the project. Table 13 gives an overview of our capex assumptions. It is worth noting that for the lignite, solar and onshore wind capex assumptions we only use a central estimate. The LCOE variability of these three technologies results from either fuel source differences or plant location, which will influence utilisation rates.

**Table 13: Key capital expenditure assumptions, $m / MW (2014)**

<table>
<thead>
<tr>
<th>Technology</th>
<th>CAPEX Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Hard coal (Turkey-specific)</td>
<td>1.31</td>
</tr>
<tr>
<td>Lignite (Turkey-specific)</td>
<td>1.61</td>
</tr>
<tr>
<td>Natural gas (CCGT)</td>
<td>0.93</td>
</tr>
<tr>
<td>Nuclear</td>
<td>4.17</td>
</tr>
<tr>
<td>Hydro (large)</td>
<td>1.58</td>
</tr>
<tr>
<td>Geothermal (flash plant)</td>
<td>1.68</td>
</tr>
<tr>
<td>Wind (Turkey-specific)</td>
<td>2.07</td>
</tr>
<tr>
<td>Solar (Turkey-specific)</td>
<td>1.57</td>
</tr>
<tr>
<td>Biomass (incineration)</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Source: Bloomberg New Energy Finance
OPERATING COSTS

FIXED AND VARIABLE OPERATING AND MAINTENANCE COSTS

Fixed operating and maintenance (O&M) costs include components like plant maintenance and labour. We use global inflation-adjusted estimates, which are outlined in Table 14.

Variable operating and maintenance costs increase according to how much electricity is generated. They typically include input costs other than fuel and indirect or internal electricity consumption. For hard coal (and lignite) and onshore wind, we assume variable O&M costs are $5.74 and $6 per MWh respectively. The variable O&M costs of the other applicable technologies are negligible and we have therefore excluded them from our analysis.

Table 14: Overview of fixed O&M assumptions, 2014 ($ / MW / Year)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Fixed O&amp;M cost ($ / MW / Yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard coal and lignite</td>
<td>40,565</td>
</tr>
<tr>
<td>Natural gas (CCGT)</td>
<td>7,210</td>
</tr>
<tr>
<td>Nuclear</td>
<td>122,880</td>
</tr>
<tr>
<td>Hydro (large)</td>
<td>31,000</td>
</tr>
<tr>
<td>Geothermal (flash plant)</td>
<td>15,000</td>
</tr>
<tr>
<td>Wind (new turbines)</td>
<td>24,000</td>
</tr>
<tr>
<td>Solar (PV)</td>
<td>30,000</td>
</tr>
<tr>
<td>Biomass (incineration)</td>
<td>81,620</td>
</tr>
</tbody>
</table>

Source: Bloomberg New Energy Finance

FUEL COSTS

Fuel costs constitute a major component of the LCOEs of fossil fuel-fired power plants. Consequently, our assumptions on underlying fuel prices play a fundamental role in deducing each technology’s LCOE.

- **Gas:** We assume Turkish natural gas prices will follow a similar trajectory to that of the UK national balancing point (NBP) – consistent with our internal forecasts. We believe UK prices will drop between 2017 and 2020, as LNG imports from the US increase supply and exert downward pricing pressure across the continent. In deriving the absolute price in Turkey, we believe there will be a premium of $1.09 per Mmbtu over UK prices, which reflects the fact there will be less supply flexibility and a larger share of oil-linked contracts. The premium was based on the volume-weighted import price drawn from data from the Oxford Institute of Energy Studies.

- **Hard coal:** We use a hard coal price of $81 per tonne in 2014 and forward curves as per October 2014, reflecting the prices traded in the European benchmark contract. Front-year prices for ARA delivery have fallen significantly in the last year, and now stand well below the five-year average of $99 per tonne. This highlights the inherent risks of forecasting commodity prices. We have chosen a coal price for our analysis that we believe is a realistic assumption for investment decisions, significantly below the five-year average but above the latest spot price.

---

• *Lignite:* we derive our lignite prices again from Yildirim figures. They amount to $20 per tonne for domestically-sourced lignite. We believe the price for this fuel will be more stable because there is less international lignite trade and it is usually locally sourced. We assume the costs will stay constant in real terms.

• *Nuclear:* we assume nuclear fuel costs, in real terms, will also remain constant up to 2030.

**Figure 30: BNEF Turkish fuel price assumptions**

<table>
<thead>
<tr>
<th>Year</th>
<th>Hard coal (y1)</th>
<th>Lignite (y1)</th>
<th>Natural gas (y2)</th>
<th>Nuclear (y2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2027</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2029</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Bloomberg New Energy Finance  Note: *y1 and y2 represent the left and right y-axes*

**FINANCE ASSUMPTIONS**

Our Turkey-specific LCOEs for select technologies come from an internal project finance model. Various assumptions concerning how the theoretical project is financed must be made, and we detail the key features below:

• **Debt-to-equity ratio:** power plants are financed through a mixture of debt and equity. In the Turkey-specific LCOEs, we assume the debt share is between 65 and 75% depending on the commissioning year and technology.

• **Hurdle rate:** The hurdle rate represents the required rate of return for equity investors in the power plant project. It varies between technologies due to differences in maturity and risk perception. In our Turkey-specific LCOEs, we assume a constant hurdle rate of 11% for onshore wind and 13% for solar PV. There is a downside potential for the LCOEs of renewable technologies, as it can be expected that hurdle rates will decline with maturing technologies.

• **Debt costs:** In the debt financing component, we use interest rates drawing from USD swap rates. Each swap rate is technology specific, for instance the rate is longer-dated for onshore wind projects than solar projects. The time horizon depends on the terms of loan tenor for each technology, adjusting the spread to account for debt funding during construction and operation. The debt spread in the Turkey-specific LCOEs ranges between 300 and 500 basis points.

---

7.2. SCENARIO COSTS COMPARISON

Based on the assumptions laid out above, Figure 31, Figure 32, Figure 33 and Figure 34 compare the required capital expenditure (capex) resulting from the Official Plan and the BAU and RDP scenarios.

Figure 31: Official plan capital expenditure, 2014-30 ($bn)

Figure 32: BAU scenario capital expenditure, 2014-30 ($bn)

Figure 33: RDP scenario capital expenditure, 2014-30 ($bn)

Figure 34: Capital expenditure comparison, 2014-30 ($bn)

Source: Bloomberg New Energy Finance. Note: the Official Plan assumes a higher generation level in line with government demand forecast. All figures are presented in nominal terms assuming a 2% inflation rate (in USD denomination).

Figure 35 compares the annual fuel costs of the Official Plan and the two alternative scenarios. In the former, it is striking how the government’s aggressive build-out plans for hydro, nuclear and wind limit its annual fuel bill spend.

Figure 35: Fuel expenditure comparison, 2014-30 ($bn)

Source: Bloomberg New Energy Finance.
TOTAL SCENARIO COSTS

Figure 36 and Figure 37 show the sum of the estimated annual and cumulative costs for capital expenditure, operating costs and fuel use.

Figure 36: Annual sum of capital and operating expenditure (including fuel use) 2014-30 ($bn)

![Figure 36](image)

Figure 37: Cumulative sum of capital and operating expenditure (including fuel use) 2014-30 ($bn)

![Figure 37](image)

Source: Bloomberg New Energy Finance, Note: Discounted to 2014 values at 8%

As generation costs will change significantly over the period we are considering, a discounted cash flow analysis gives a more accurate perspective on each scenario’s costs. Table 15 shows the net present value of these generation costs at three different discount rates.

Table 15: Total discounted cost assessment over 2014-2030 ($bn)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4%</td>
</tr>
<tr>
<td>Official plan</td>
<td>369</td>
</tr>
<tr>
<td>Business-as-usual</td>
<td>280</td>
</tr>
<tr>
<td>Renewables development pathway</td>
<td>285</td>
</tr>
</tbody>
</table>

Source: Bloomberg New Energy Finance, Note: these are the discounted total costs for each scenario (2014-2030) including capex, opex and fuel use. Costs of energy efficiency improvements are not estimated.

CONCLUSIONS

• The BAU scenario will require the least capital expenditure – due to the higher capacity factors of the coal fleet that we anticipate will provide future power, compared with those of the renewable alternatives.
However, fuel costs in the BAU are substantially higher than in the RDP scenario, which ultimately serves to put them both at a similar level by 2030.

While the overall costs of the RDP scenario are higher in the short run, as new capacity is financed and built, the lower fuel costs that accompany a more ambitious renewables strategy result in a slightly lower total spend in the middle to late years.

The future decline in the solar and onshore wind LCOEs drive the long-term cost efficiency of the RDP scenario.

As the official plan assumes a significantly stronger power demand, its power generation costs are naturally higher.

**TRADE BALANCE IMPACTS**

**Gas imports**

One of the main drivers behind the Turkey government’s ambitions to shift its fuel mix away from natural gas is the heavy toll that such imports have on its trade balance. The majority of its natural gas demand comes from imports. We estimate Turkey will spend between $8 and $10bn importing natural gas to support its grid-connected electricity generation in 2014 – or just below the $10.2bn of foreign direct investment the nation attracted in 2013. This figure would remain relatively stable in both our scenarios, in nominal terms, because our scenarios indicate that investment in either new coal or renewable capacity is unlikely to reduce the absolute level of natural gas use – even if its proportional share declines sharply.

The main impact of the BAU and RDP scenarios on Turkey’s trade balance, will therefore be in stabilising its gas import costs. However, the alternative of limiting gas expenditure will also require imports of either hard coal or renewable energy systems, if they are not manufactured domestically.

**Hard coal imports**

In our BAU scenario, most of the growth in tomorrow’s electricity demand is met by new lignite and hard coal power plants. It is likely that these lignite resources will come from domestic production but, based on its recent history, Turkey would have to continue importing around 80% of hard coal. In the BAU scenario, the annual spend on hard coal could rise from an estimated nominal figure of $1bn in 2014 to $4bn by 2030, as hard coal generation more than triples. For our calculations in Figure 38 we assume that 50% of the capital expenditure on hard coal will flow out of Turkey. In contrast, the RDP scenario would keep the annual spend on hard coal below the nominal $1.5bn level – even by 2030.


Imports of renewable technologies

The RDP scenario will save fuel costs, but it will likewise boost spending on capital expenditure in installing new capacity. Our analysis suggests that capital expenditure in the RDP scenario will exceed spending in the BAU scenario by $0.75bn (nominal) on average each year, as renewables require more installed capacity due to lower load factors. The impact on the trade balance of this greater expenditure will rest on what renewable power equipment can be sourced domestically. We assume 50% of this capital expenditure will flow out of the country with the remainder being supplied by local manufacturers.

In the next 15 years, any additional capital expenditure on renewable technologies would then total $13bn, around the same as the cumulative savings on coal imports of $12bn (nominal). Replacing coal generation with renewables could thus have a positive impact on Turkey’s trade balance – but only if a significant share of the envisaged renewable capacity investment can be produced domestically. Our analysis however suggests that Turkey will only start to see the full effects of these savings in the latter half of the next decade. We also illustrate the results if 100% of the capital spent on renewable capacity is imported. Turkey currently has the capacity domestically to manufacture 410MW of solar equipment each year, according to Bloomberg New Energy Finance data. In our RDP scenario, it will need to add 1.9GW of solar capacity each year between 2021 and 2030. Significant additional investment in manufacturing capacity would be required, to ensure the maximum local job creation from this programme and to ensure that this scenario benefits Turkey’s balance of trade in the long run. Given the scale of the opportunity in the Turkish market, international manufacturers would be likely to show interest in setting up factories. The government policy of offering higher feed-in-tariffs for locally-sourced equipment has already proved successful. For instance, German manufacturer Nordex, in June 2014, confirmed that the wind turbine towers and rotor blades it plans to deliver to its Turkish clients will be made domestically.21

INVESTMENT IN TRANSMISSION INFRASTRUCTURE

We anticipate that our Renewables Development Pathway scenario will necessitate additional investment in the Turkish grid and transmission network – but some of this investment will be required across all three scenarios. It is commonly held that the Turkish grid can accommodate another 2GW of variable renewables capacity before major infrastructure investment becomes very necessary. Data on the state of the Turkish grid system, and on expected investment

requirements, are not publicly available. A detailed assessment is therefore required, beyond the scope of this analysis and our scenarios. However, drawing on loosely comparable circumstances in Europe, we project that Turkey will have to invest heavily in its grid infrastructure to cope not only with rising power demand but also grid-connected renewables integration. We have not included cost estimates for improvements in transmission and distribution networks in any scenario. The type and level of investment will largely depend on the state and complexity of the existing power system, how electricity consumption grows over time and the distance between new power plants and the main demand centres. Investment costs also differ considerably, depending on which technologies are deployed. For instance, when assuming that 29GW of offshore wind capacity will be installed in Europe, we believe EUR 28bn of transmission investment will be required – of which EUR 21bn will go towards new projects. Our analysis also suggests over EUR 60bn will be invested in onshore transmission lines by 2023.

The costs of offshore and onshore interconnectors differ widely, and are primarily dependent on the type of current – direct or alternating. Across Europe the anticipated average costs range from EUR 159m for an AC onshore interconnector to EUR 895m for a DC offshore one. As an alternative example, at the distribution level, we estimate Germany will need 135,000km of new lines and retrofits at an estimated cost of between EUR 15bn and EUR 27bn.

EMISSIONS

One of the clear advantages of the RDP scenario is that it almost entirely prevents the projected rise in Turkey’s greenhouse gas emissions from the power sector. As Figure 39 illustrates, emissions in the RDP scenario remain broadly constant from 2020 onwards: in the other two scenarios, they continue increasing rapidly during the next decade, reaching more than 200m tonnes per annum by 2030. By way of comparison, this volume equates to just under two-thirds of German power sector emissions in 2013.

Figure 39: Annual power sector CO2e emissions, 2000-2030 (Million tonnes)

![Figure 39: Annual power sector CO2e emissions, 2000-2030 (Million tonnes)](image)

Source: Bloomberg New Energy Finance, IEA

**POST-2020 EU COMPLIANCE COSTS**

With the possibility of Turkey joining the European Union, we have also assessed the potential costs to comply with the major environmental policies affecting the EU power sector. We therefore modelled the potential cost of Turkey complying with the European Emissions Trading Scheme (EU ETS) and the Industrial Emissions Directive (IED) from 2020 onwards.

**CARBON COSTS**

As a proxy for potential carbon pricing in Turkey, we applied our forecast price for European Union Allowances (EUAs) from July 2014. We only included the projected emissions from 2020 to 2030, as we do not expect a carbon pricing mechanism can come into play in Turkey in the next six years. Net carbon costs vary across the different scenarios and applied discount rates, and fall into a range of $21bn to $50bn. Our EUA price forecast considers the near-term impact of the recently passed...
backloading proposal, which temporarily withdraws permits from the markets in order to reduce supply. We project a bullish market from 2021 in response to a tightening of the EU ETS cap, reflecting the 2030 targets. Our detailed price forecast runs until 2024, and after that we assume prices will increase in line with 2% inflation.

**INDUSTRIAL EMISSIONS DIRECTIVE (IED)**

The IED will come into effect on 1 January 2016 and it regulates how many sulphur dioxide, nitrogen oxide, dust and heavy metals emissions are churned out of power plants over 50MW in size. We accounted for three abatement technologies:

- Dry scrubbers for flue gas desulphurisation
- Selective catalytic reduction for NOx abatement
- Electrostatic precipitator for dust abatement

All three abatement technologies will result in higher capex and operating costs for each coal-fired power plant subject to the regulation. We assume that by 2020 all Turkey’s existing coal plants would be retrofitted with one of these three technologies. All new plants commissioned after 2020 must obviously also meet the regulation’s requirements.

**TOTAL COMPLIANCE COST**

We estimate that in the RDP scenario, Turkey could save $14bn between 2020 and 2030 on EU regulation compliance costs (in 2014 terms) because fewer coal plants will need to meet IED compliance and leaner carbon requirements.

**Figure 40: Net scenario costs when including post-2020 EU compliance ($bn)**

Note: BNEF clients have access to an in-depth analysis of IED compliance costs here: all costs discounted at 8%.
APPENDICES

Appendix A: METHODOLOGY OVERVIEW

Figure 41: Methodology overview

Appendix B: ADDITIONAL BACKGROUND

POWER MARKET STRUCTURE

Turkey’s distribution networks began being privatised in 1989, but early cases were fraught with costly legal complexities. In response, the government developed two specific schemes, the “build-operate-transfer” and “build-operate” models: neither has served to completely eliminate the legal wrangles.22

The most significant regulatory shift came in 2001 with the adoption of the Electricity Market Law No. 4628. This set in motion reforms similar to those seen in the late 1970s in the UK, with a renewed focus on liberalisation and privatisation to facilitate the restructuring of the power sector. The stated objective of the law was to provide consumers with affordable, uninterrupted, high-quality and environmentally-friendly electricity via a competitive market. This objective also forms the basis of the New Energy Market Law No. 6446, which was enacted in 2013 and brought

novelties to the licence requirements and regulations, market operation, total market share and some exemptions from environmental requirements.

With these legislative developments, the ministry’s objective continues to be privatising state-owned power plants, with the exception of a few strategic hydroelectric dams with a total capacity of 7.5GW.

REGULATORY ENVIRONMENT

There are signs that the government is relaxing its control over electricity distribution – even if such moves are not yet all-encompassing. As part of its privatisation push, the government reined in the authority of the Turkish Electricity Distribution Company (TEDC) while giving private distribution companies the right to obtain licences from EMRA.

With these licences, said companies can formalise connection and system utilisation agreements with users of the distribution facilities\textsuperscript{23}. They also facilitate the construction and operation of new distribution facilities under 36kV – provided they are in line with EMRA’s country-wide investment plans. But the government has not relinquished all its influence: TEDC owns all the country’s distribution facilities while TETC continues to play a major role in the construction of the country’s power distribution systems.

“DASH FOR COAL” PLAN

Turkey’s investment incentives programme includes: tax deductions; VAT and custom duties exemptions; interest and insurance financial support; preferable land and site allocation; and investment contributions. The extent of the government’s investment contribution varies between geographical regions in Turkey, ranging from 25% in western Turkey to 60% for projects in the eastern part of the country\textsuperscript{24}.

To boost coal exploitation, the state-run Turkish Coal Enterprise (TKI) has started privatising existing coal fields by offering long-term contracts to investors. In 2012 it introduced a royalty tender mechanism to spur private investment further. It includes a royalty fee for the generated electricity, linked to the consumer price index. Private investors can also now get access to the operating rights of certain coal fields – as long as they build a plant within the framework of the royalty model.

TRANSMISSION AND NETWORK CAPACITY

As of 2012, the country has 1,425 transformers with a total installed capacity of 112,846MVA. Between 2008 and 2012, transformer capacity grew at an annual rate of 6.6% according to the available TETC data. Further investment in the transmission network is now expected – especially in loop lines and new compressor stations to increase gas dispatch capacity.


ENERGY STORAGE

Developers are continuing overwhelmingly to select lithium-ion for their projects – an occasional project deploys flow batteries or flywheels. We expect this to continue in the short- to medium-term for a number of reasons:

- **Technology risk**: There is more operational data from already-commissioned projects and other industries for lithium-ion. This increased certainty reinforces the technology’s advantage, at least in the short-term.

- **Company risk**: Lithium-ion battery manufacturing is dominated by a few large diversified conglomerates, notably LG Chem, Panasonic and Samsung SDI. They offer more warranty security than other smaller technology developers. GE’s sodium nickel chloride battery is a notable exception though.

Figure 42 shows BNEF’s global forecast for battery pack costs and projected annual production until 2030. The expected decline in costs suggests energy storage will play a greater role in tomorrow’s global power markets, including in Turkey.

### Figure 42: BNEF battery pack costs and production forecast (2010-2030)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total pack cost ($/kWh)</th>
<th>Annual production (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>$800/kWh</td>
<td></td>
</tr>
<tr>
<td>H1 2012</td>
<td>$689/kWh</td>
<td></td>
</tr>
<tr>
<td>H2 2013</td>
<td>$599/kWh</td>
<td></td>
</tr>
<tr>
<td>H2 2014</td>
<td>$540/kWh</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Bloomberg New Energy Finance*

In general, energy storage economics are dependent on the system’s application and specific location. There is thus no single threshold that must be met for the system to be cost-effective. It is likely that the projected cost decreases will make battery storage a more attractive option in offsetting renewables variability in the long run. Ultimately this will counteract the demand for back-up capacity, increasing the role of energy storage in Turkey.

TURKEY’S ENERGY EFFICIENCY PLANS

The Energy Efficiency Coordination Board oversees the administration of the law, which includes regulation on minimum energy efficiency requirements and penalties for non-compliance. The energy efficiency investment support programme, launched by the General Directorate for Renewable Energy in 2009, further demonstrates the government’s commitment to support the sector.

---


The government likewise said it will make a strategic move towards fostering value-adding technology companies, which operate higher up the supply chain, in addition to its privatisation drive. It can therefore be expected that public and private investment in energy smart, energy-efficient and generally superior technology will increase in the next decade from virtually nothing today. Our database indicates there are 10 related efficiency projects that have recently been announced or have secured finance; they range from smart grid and metering to electric vehicle (EV) charging infrastructure developments.

The modernisation of its transmission line network and its aging grid connections should also lead to efficiency improvements and lower demand. Turkey’s network and distribution losses of around 15% tend to be economic, from unbilled electricity consumption, and not physical losses. Reducing such losses would thus not lead to less net generation demand.

**Appendix C: METRICS OVERVIEW**

**Table 16: Overview of key input metrics and variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation</th>
<th>Metric</th>
<th>Time frame</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>N / A</td>
<td>$ (2005)</td>
<td>1995-2014</td>
<td>Eurostat</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>GDP / population</td>
<td>$ GDP &amp; Population</td>
<td>1995-2014</td>
<td>Derived from total GDP and population</td>
</tr>
<tr>
<td>GDP growth rate forecast</td>
<td>N / A</td>
<td>%</td>
<td>2014-2030</td>
<td>IMF and OECD</td>
</tr>
<tr>
<td>Annual power consumption</td>
<td>N / A</td>
<td>MWh / Annum</td>
<td>1995-2013</td>
<td>Turkish Bureau of Statistics (Turkstat)</td>
</tr>
<tr>
<td>Annual power demand per capita</td>
<td>Total electricity demand / population</td>
<td>MWh / capita</td>
<td>1995-2013</td>
<td>Derived from total electricity demand and population</td>
</tr>
<tr>
<td>Energy intensity</td>
<td>Total energy consumption / total GDP</td>
<td>BTU / $ GDP (2005)</td>
<td>2011</td>
<td>US Energy Information Administration</td>
</tr>
<tr>
<td>Gross power generation</td>
<td>N / A</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
<tr>
<td>Internal consumption</td>
<td>N / A</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
<tr>
<td>Net power generation</td>
<td>Gross generation - internal consumption</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
<tr>
<td>Power imports</td>
<td>N / A</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
<tr>
<td>Network power supply</td>
<td>Net generation + imports</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
<tr>
<td>Transmission losses</td>
<td>N / A</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
<tr>
<td>Distribution losses</td>
<td>N / A</td>
<td>MWh</td>
<td>1984-2013</td>
<td>Turkish Electricity Transmission Company</td>
</tr>
</tbody>
</table>

Source: Bloomberg New Energy Finance
Appendix D: POWER DEMAND METHODOLOGY

The power demand projections for Turkey were calculated based on regression analysis of GDP per capita and power demand per capita in 26 European nations. This is the same methodology that Bloomberg New Energy Finance uses in its coverage of European power markets.

As Turkey is a complex and rapidly-changing country, it is particularly challenging to forecast such a nation’s power consumption 20 years ahead. Our forecast could be too low or too high, for reasons outlined below:

WHAT COULD INCREASE OUR FORECAST?

- **Generation for export:** our demand figures refer to generation for domestic consumption and are derived from per capita consumption. If Turkey starts to export significant amounts of electricity, the need for domestic generation will obviously increase. At the moment the import-export balance is negligible in relation to total generation.
- **De-industrialisation moving more slowly:** the effect of slower power demand growth at higher wealth levels seen in Europe is at least partially driven by a shift in manufacturing to cheaper locations, including Turkey. Turkey may not be able to shift industrial production offshore in a similar fashion as it develops, keeping its industry sector larger and power demand higher than the projection based on a regression of European trends implies.

WHAT COULD LOWER OUR FORECAST?

- **Greater energy efficiency:** the impact of energy efficiency measures is notoriously difficult to forecast. Energy efficiency measures could be rolled out at a much larger scale than our BAU scenario assumes. Stable power consumption in some European countries over the past few years may be an indicator that such measures could be more impactful than anticipated.
- **2013’s decline trend continues:** power demand in Turkey slightly declined in 2013, and the power intensity of a unit of GDP has been relatively stable since 2008. Our forecasts reflect that fact that we think power demand will continue to grow and that the decline in total consumption in 2013 was an outlier rather than a new trend.

Appendix E: COAL FORECAST METHODOLOGY

The Turkish government’s “Dash-for-Coal” plan will arguably be the most market-changing development of the next two decades. It is worth therefore outlining our methodology concerning coal capacity additions in our BAU and RDP scenarios.

In our BAU scenario, we used probability-weightings to build a coal plant pipeline out until 2030. We used a combination of the following three sources, in order of importance:

- Bloomberg data (BMAP)
- Cross-checked and supplemented with data from the EMRA
- SourceWatch (data on proposed and existing coal plants)

Based on talks with our colleagues at WWF and ECF Turkey, we applied probability weightings to each plant due online as dependent on its current status. Table 17 summarises the results of this approach:
Table 17: Turkey coal plant pipeline analysis, 2014

<table>
<thead>
<tr>
<th>Status</th>
<th>Number of plants</th>
<th>Total capacity (MW)</th>
<th>Hard coal capacity (MW)</th>
<th>Lignite capacity (MW)</th>
<th>Asphaltilite capacity (MW)</th>
<th>Probability weighting (%)</th>
<th>Time frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financing Secured / Under Construction</td>
<td>6</td>
<td>4,136</td>
<td>2,604</td>
<td>1,532</td>
<td>0</td>
<td>80%</td>
<td>2015-2020</td>
</tr>
<tr>
<td>Permits Obtained</td>
<td>3</td>
<td>2,592</td>
<td>2,316</td>
<td>0</td>
<td>276</td>
<td>70%</td>
<td>2016-2020</td>
</tr>
<tr>
<td>Application</td>
<td>15</td>
<td>12,689</td>
<td>12,689</td>
<td>0</td>
<td>0</td>
<td>40%</td>
<td>2018-2030</td>
</tr>
<tr>
<td>Planned / Announced</td>
<td>31</td>
<td>30,252</td>
<td>19,052</td>
<td>11,062</td>
<td>138</td>
<td>30%</td>
<td>2022-2030</td>
</tr>
<tr>
<td>Cancelled</td>
<td>8</td>
<td>5,610</td>
<td>2,364</td>
<td>3,246</td>
<td>0</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>63</td>
<td>55,278</td>
<td>39,024</td>
<td>15,840</td>
<td>413</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

Source: ECF, Sourcewatch, Bloomberg New Energy Finance and Bloomberg (BMAP). Total figures might not add up due to rounding.

For some of the coal plants above the data represents the expected commission year. However, for the majority of these projects, we distributed their capacity additions equally over the indicated time frame. This approach yields 10GW of installed capacity across the coal, lignite and asphaltilite sectors before 2030.

In our RDP scenario, we assume that only plants that fall into the status of “financing secured / under construction” come online between 2014 and 2020 – we apply an 80% probability weight to these plants, like in BAU scenario. Under this methodology, total coal capacity additions before 2030 amount to 3.3GW.

Figure 43: Annual coal capacity additions in BAU scenario (GW)

Figure 44: Annual coal capacity additions in RDP scenario (GW)

Source: Bloomberg New Energy Finance

Appendix F: POWER MARKET LIBERALISATION

Since the turn of the century the Turkish government has embarked on a sustained liberalisation and privatisation campaign in its energy sector. In the last 13 years, it has passed seven new laws updating regulations on its natural gas, nuclear, renewables and energy efficiency sectors. At the same time, it drove liberalisation by splitting up and privatising state-owned enterprises and engaging the European Union in regards to its link with ENTSO-E. The government hopes to have a fully competitive power market by 2016. The chart below illustrates the major milestones of the liberalisation process:
Appendix G: SENSITIVITIES

Bloomberg New Energy Finance estimates that the total capacity build and generation costs to Turkey until 2030 of both options – business-as-usual and Renewables Development Pathway – would be around $190-210bn (in current terms, discounted at 8%). This would include the upfront capital cost of building new capacity, and also the cost of running the fleet of plants, including the bill for fuel feedstock. This excludes potentially required investments in grid improvements.

As is always the case with such an ambitious long-term analysis of two complex scenarios, this conclusion depends on a number of assumptions and expectations. Below we have discussed and examined several of our assumptions to validate the robustness of our conclusion. We believe that the finding of comparable costs for the BAU and the RDP scenario is robust, notwithstanding the fact that both scenarios would expose Turkey to risks, be it from commodity prices or unexpected changes in the rate of decline of renewables costs.

**Capacity factors:** In our analysis we have assumed that the capacity factors of both conventional and renewables will remain in line with historical averages observed in Turkey. However, it is possible that the market liberalisation efforts will boost the utilisation of coal and lignite plants from their historical, relatively low levels. If the capacity factor for the coal and lignite fleet was to increase to 78% from 2016 onwards, this would result in total estimated costs of the BAU scenario of $193bn, compared to $204bn in the RDP scenario. This would also reduce gas dependency.

**Coal or lignite:** We have applied an equal probability-weighting to the coal and the lignite project pipelines. We think this is a reasonable assumption as the project-level pipeline for hard coal projects is much larger than for lignite. However, if lignite was prioritised, this could reduce the costs of the BAU scenario and give it a more positive impact on Turkey’s balance of trade. A lignite-heavy approach would however increase Turkey’s emissions and local pollution beyond that expected in the BAU scenario, further increasing the potential compliance costs in case of EU accession.
**Associated costs:** We have said in the report that the RDP scenario would possibly involve Turkey making improvements to the grid above and beyond what would be required under the BAU scenario. This would involve extra costs, although the addition of intelligence to the grid would also have other benefits in terms of efficiency and reducing waste. The RDP scenario would also involve extra investment on energy efficiency. This is not quantified in the report either. It is possible that, on a net basis to 2030, the cost of this efficiency investment could be outweighed by the money saved.

**Repowering:** The analysis in the report does not take into account the potential for repowering wind, solar and hydro-electric projects with more up-to-date and efficient technology between now and 2030. It is possible that this could reduce the cost of the RDP scenario by enabling Turkey to generate the same amount of electricity with fewer investment dollars.

**Generating costs after 2030:** The report does not cover the ongoing generation costs after 2030 of fossil-fuel and renewable power capacity installed before that date. These costs would be expected to be lower in the case of the wind, solar and hydro installations, since their feedstock is free and maintenance costs relatively light, than in the case of coal or gas plants, which have relatively high ongoing feedstock costs.
# ABOUT US

## Subscription details

sales.bnef@bloomberg.net

## Contact details

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Wilshire</td>
<td><a href="mailto:mwilshire1@bloomberg.net">mwilshire1@bloomberg.net</a></td>
<td>+44 20 3216 4643</td>
</tr>
<tr>
<td>Director of Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angus McCrone</td>
<td><a href="mailto:amccrone1@bloomberg.net">amccrone1@bloomberg.net</a></td>
<td>+44 20 3216 4795</td>
</tr>
<tr>
<td>Chief Editor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felix Leworthy</td>
<td><a href="mailto:fleworthy@bloomberg.net">fleworthy@bloomberg.net</a></td>
<td>+44 20 3216 4233</td>
</tr>
<tr>
<td>Manager, Business Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Janis Hoberg</td>
<td><a href="mailto:jhoberg@bloomberg.net">jhoberg@bloomberg.net</a></td>
<td>+44 20 3525 8303</td>
</tr>
<tr>
<td>Analyst, Applied Research and Policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luke Mills</td>
<td><a href="mailto:lmills9@bloomberg.net">lmills9@bloomberg.net</a></td>
<td>+44 20 3525 8135</td>
</tr>
<tr>
<td>Associate, Clean Energy Economics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Itamar Orlandi</td>
<td><a href="mailto:iorlandi@bloomberg.net">iorlandi@bloomberg.net</a></td>
<td>+44 20 3525 8349</td>
</tr>
<tr>
<td>Associate, European Power and Carbon</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Copyright

© Bloomberg Finance L.P. 2015. This publication is the copyright of Bloomberg New Energy Finance. No portion of this document may be photocopied, reproduced, scanned into an electronic system or transmitted, forwarded or distributed in any way without prior consent of Bloomberg New Energy Finance.
Disclaimer

This service is derived from selected public sources. Bloomberg Finance L.P. and its affiliates, in providing the service, believe that the information it uses comes from reliable sources, but do not guarantee the accuracy or completeness of this information, which is subject to change without notice, and nothing in this document shall be construed as such a guarantee. The statements in this service reflect the current judgment of the authors of the relevant articles or features, and do not necessarily reflect the opinion of Bloomberg Finance L.P., Bloomberg L.P. or any of their affiliates (“Bloomberg”). Bloomberg disclaims any liability arising from use of this document and/or its contents, and this service. Nothing herein shall constitute or be construed as an offering of financial instruments or as investment advice or recommendations by Bloomberg of an investment or other strategy (e.g., whether or not to “buy”, “sell”, or “hold” an investment). The information available through this service is not based on consideration of a subscriber’s individual circumstances and should not be considered as information sufficient upon which to base an investment decision. BLOOMBERG, BLOOMBERG PROFESSIONAL, BLOOMBERG MARKETS, BLOOMBERG NEWS, BLOOMBERG ANYWHERE, BLOOMBERG TRADEBOOK, BLOOMBERG BONDTRADER, BLOOMBERG TELEVISION, BLOOMBERG RADIO, BLOOMBERG PRESS, BLOOMBERG.COM, BLOOMBERG NEW ENERGY FINANCE and NEW ENERGY FINANCE are trademarks and service marks of Bloomberg Finance L.P. or its subsidiaries.

This service is provided by Bloomberg Finance L.P. and its affiliates. The data contained within this document, its contents and/or this service do not express an opinion on the future or projected value of any financial instrument and are not research recommendations (i.e., recommendations as to whether or not to “buy”, “sell”, “hold”, or to enter or not to enter into any other transaction involving any specific interest) or a recommendation as to an investment or other strategy. No aspect of this service is based on the consideration of a customer’s individual circumstances. You should determine on your own whether you agree with the content of this document and any other data provided through this service. Employees involved in this service may hold positions in the companies covered by this service.
TURKEY’S RENEWABLE POWER

By 2030, Turkey can meet almost 50% of its power demand from renewable energy sources.

According to BNEF analysis, power demand in 2030 will be 25% lower than official projections.

Total share of wind, solar and geothermal energy in electricity mix could increase from 4% to 26% by 2030.

Turkey could stabilize GHG emissions from the power sector in the next five years.

In order to stay below 2°C global warming, 2/3 of all proven fossil fuel reserves must be left underground.

Why are we here

The mission of WWF Turkey is “to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature” by protecting the world’s biological diversity, ensuring that the use of renewable natural resources is sustainable, promoting the reduction of pollution and wasteful consumption.

www.wwf.org.tr