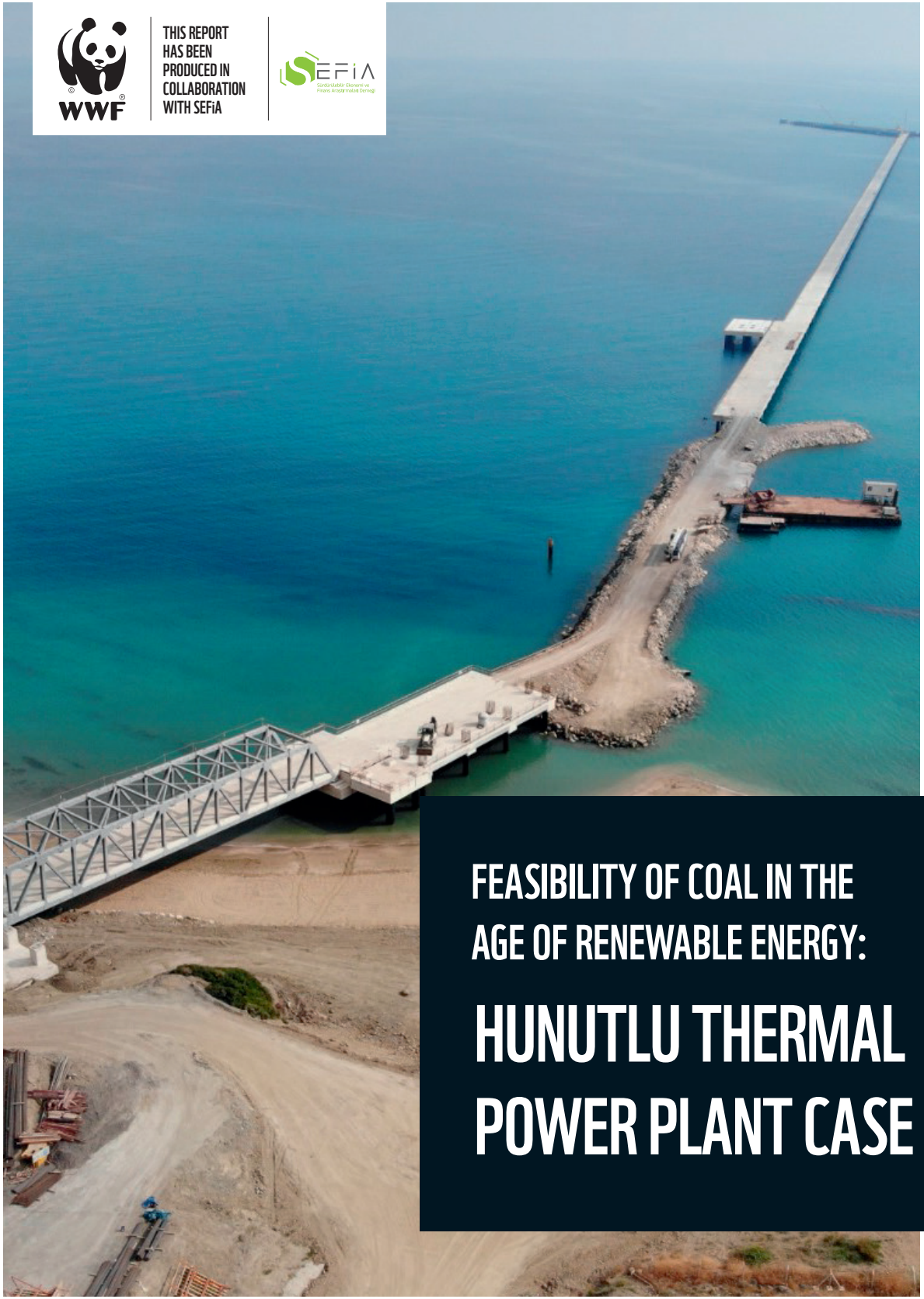
THIS REPORT HAS BEEN PRODUCED IN COLLABORATION WITH SEFiA



FEASIBILITY OF COAL IN THE AGE OF RENEWABLE ENERGY:

HUNUTLU THERMAL POWER PLANT CASE

WWF

WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries. WWF's mission 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 conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

Sustainable Economics and Finance Association (SEFiA)

SEFiA, is a research oriented environmental NGO based in Ankara, Turkey. SEFiA focuses on energy transition, climate change and low-carbon development discussion from the lens of economics and financial analysis. SEFiA works in close ties with the environmental NGO sphere, by addressing their research needs through academic integrity. While its main domain of research is Turkey, SEFiA also seeks opportunities for building alliances with international peers to enhance the knowledge base.

Acknowledgment

We would like to thank Orhan Aytaç from the Chamber of Mechanical Engineers - Energy Working Group, Özlem Katısöz from the Climate Action Network -Europe and Mustafa Özgür Berke from the European Climate Foundation for providing valuable opinions, insights and comments during the preparation of this report.

Translation: Esin Aslan Gürbüz

Design and infographics by: Cihan Uyanık

Press: PrintWorld Matbaa San. Tic. A.Ş.

Bengisu Özenç
Sustainable Economy and Finance Research Association (SEFiA)
Founding Director

Feasibility of Coal in the Age of Renewable Energy: HUNUTLU THERMAL POWER PLANT CASE

As the global COVID-19 pandemic has once again shown, we are living in a period of "triple crisis"[1] in broad areas of development, finance and the environment. Economic crises that have now become permanent are combined with the climate crisis, against which the necessary prevention steps yet to be taken, and together, they mostly affect the segments of the society that are most vulnerable in the face of these crises.

While efforts are made to respond to these crises with in-system improvements, the need for a transformation that will change trends is also often emphasized. The strongest resistance to transformation is a result of the urge to protect the status-quo. However, studies show that when the possible externalities of current policy paths are considered, using the resources mobilized to exit the crisis to build a sustainable and more resistant system against new shocks in the future will bear less costly results for all parts of the society. [2]

This study briefly discusses the trends in energy transformation, which is one of the basic components of a more sustainable and resistant system design, and elaborates specifically on the political and financial pressure on coal investments. The study also provides an analysis of the ongoing Hunutlu Thermal Power Plant, which has been designed to complement Turkey's installed coal capacity, to draw attention to the problems that may arise in relation with the financial feasibility of a coal-fired power plant in light of current and anticipated market developments.

1 For more information and articles on "Triple Crisis", please see the website created by Jayati Gosh and Kevin P. Gallagher.
2 Johnson, O., Shawoo, Z, Talebian, S., Kemp-Benedict, E. and Lindblom, A. (2020). Shaping a Sustainable and Low-carbon Recovery that Spurs Industry Transition. Background brief. Leadership Group for Industry Transition.

WHAT DOES ENERGY TRANSITION MEAN FOR COAL?

In the specific context of energy sector, "transition to clean energy" is a process which functions in parallel with rapid technology improvement and downward price dynamics that accompany energy policies. Improvements in the levelized cost of energy on the utility scale over the last 11 years (2009-2020) indicate a cost decline of 90% in solar PV systems and 70% in wind energy (Figure1)[3]. On the contrary, the cost of coal-fired thermal power plants has increased by 1% during the same period. Calculations show that the average levelized costs of electricity of new solar and wind investments are lower than the marginal costs of coal-fired thermal power plants that are in operation.

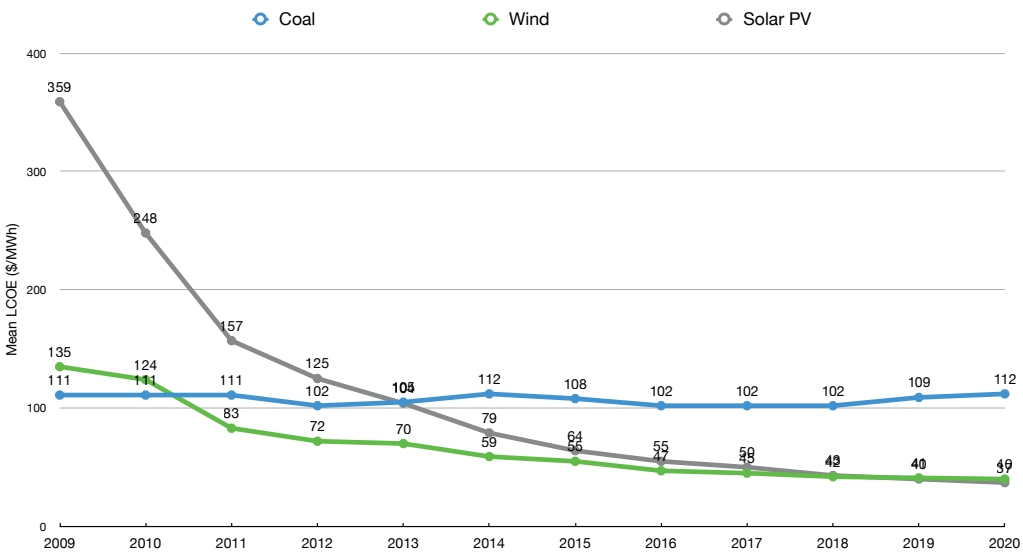


Figure 1: *Levelized cost of electricity comparison based on utility scale generation (2009-2019)*

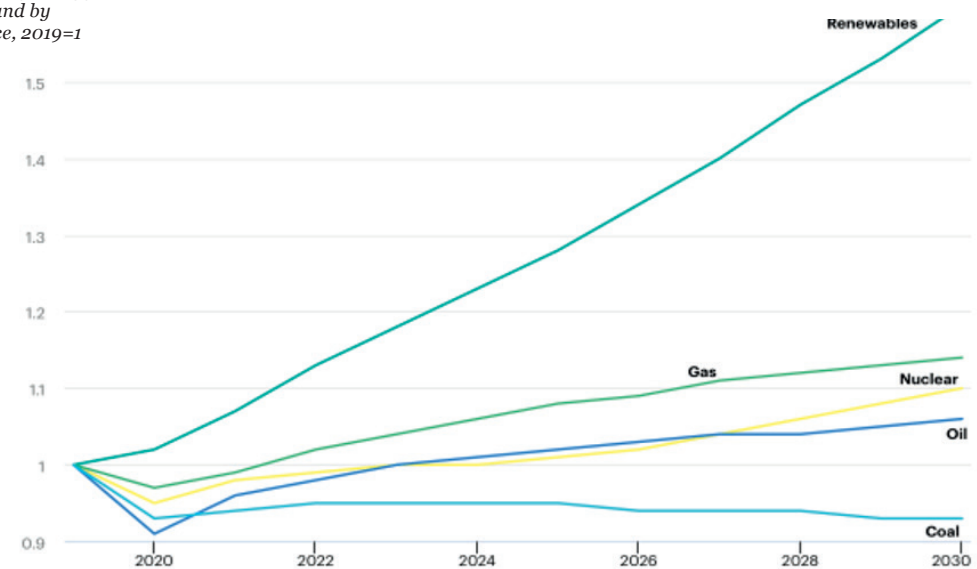
With these developments in prices, the demand for coal, which has been on an upward trend since the beginning of the 2000s, has decreased since 2015 and this downward trend is assessed to become permanent with the effect of COVID-19. The International Energy Agency (IEA) estimates that the decline in electricity demand and industrial activity in 2020 could lead to a 5% drop in energy demand and a 7% drop in coal demand.[4] In the years that follow, the demand for coal remains below the pre-crisis level, even under the business as usual (BAU) scenario. It is estimated that the share of coal in global electricity generation, which was 37% in 2019, will decrease to 28% in 2030 under the BAU scenario, and to 15% under a "Sustainable Development Scenario" in line with the Paris Agreement targets. By 2040, it is predicted that the share of coal in the energy mix will fall below 20% for the first time since the Industrial Revolution.

3 Lazard's levelized cost of energy analysis – Version 13.0
4 World Energy Outlook 2020, IEA

Long term projections suggest that the share of renewable energy within total energy mix will increase every year while the share of coal will decrease. For example, the IEA's forecasts for 2040 recorded a 43% rise in solar energy in just two years (2018-2020), while coal estimates fell about 25%. [5]

When we look at the change in primary energy demand in 2019-2020 due to COVID-19 pandemic, the upward trend in energy technologies took place only in renewable energy (Figure2). Albeit limited, this upward trend puts renewable

Figure 2: *Primary energy demand by source, 2019=1*



energy on a different path for the future compared to other energy technologies.

Countries' coal phase-out policies, the rising share of renewable energy as well as the rising competitive power of natural gas play a major role in the downward revision of coal capacity. It is reported that by 2025, 275 GW of coal capacity will be phased out. This is equal to 13% of the coal capacity in 2019.

According to the calculations of the International Energy Agency, 1,715 GW of fossil fuel capacity needs to be phased out before the end of its economic life by 2060, under a scenario in line with the Paris Agreement objective to keep the global temperature increase to "well below 2oC". 1,330 GW of this capacity will be from coal-fired thermal power plants.[6] When the predictions under this scenario, which aims at reaching net-zero emissions by 2060 are evaluated in the light of EU's plan to achieve net-zero emissions by 2050 under EU's European

5 World Energy Outlook 2020 and World Energy Outlook 2018, IEA
6 Energy Technology Perspectives 2017, IEA

Green Deal announced in December 2019, an earlier phase out of coal fired power plant capacity may be expected.

As these scenarios and recent developments show, carbon-intensive investments, especially coal-fired thermal power plants, are likely to become stranded assets[7] in the future, in face of possible legal regulations. The risk of stranding increases for coal investments also because of the increasing competitiveness of renewable energy and natural gas investments, as stated above. In the light of these developments, it is estimated that investments totaling 638 billion USD made on 499 GW of new coal-fired power plants, which are already under construction or planned, may all become stranded. [8]

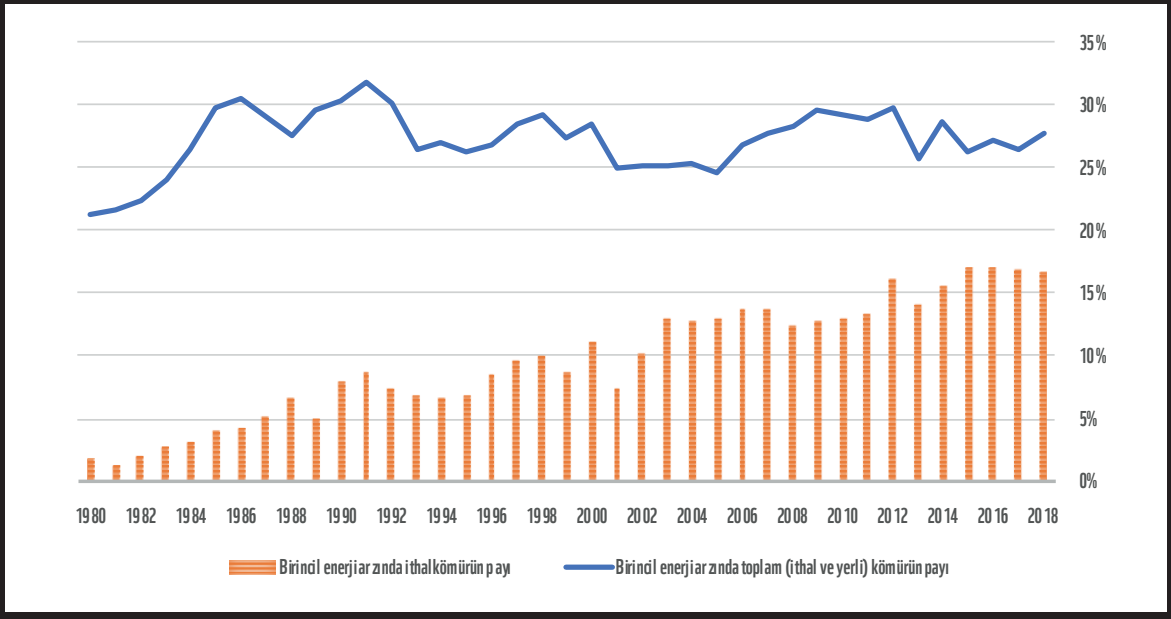
As the governments announce their coal phase-out plans, the trend across the financial world to exit coal is also gaining momentum. In 2020, 56 global banks, insurance companies, pension funds and asset managers revised their existing coal phase-out plans or announced new exit plans. [9] 143 globally significant[10] financial institutions, including 20 global asset managers and 123 banks and insurance/reinsurance companies pledged to exit coal altogether or limit their investments. This trend complicates the financing conditions of coal investments in Turkey as well as in the world.

7 Stranded assets are investments that fail to offer sustainable financial returns and thus suffer from premature write-downs due to different causes including technological transformation and changes in government regulations and/or market conditions.
8 https://carbontracker.org/coal-developers-risk-600-billion-as-renewables-outcompete-worldwide/
9 https://ieefa.org/ieefa-why-2020-is-turning-out-be-a-pivotal-year-for-fossil-fuel-exits/
10 In the study conducted by the Institute of Energy Economics and Financial Analysis (IEEFA), asset managers are included in this classification if they have across their portfolio assets with a coal exit plan of at least 50 billion USD and, banks, insurance and reinsurance companies are included if their total assets exceed USD 10 billion. https://ieefa.org/finance-exiting-coal/

COAL'S PLACE IN TURKEY'S ENERGY OUTLOOK

Subsidized as a domestic resource in Turkey, coal was also covered in the National Energy and Minerals Policy of 2017 and supported through steps taken towards "developing domestic and renewable energy resources". In this context, a total of 24.8 billion TL worth of government support was provided to fossil fuels in 2019.[11] Although the reason behind this support was to increase the share of domestic coal within the total primary energy supply, the share of imported coal increased from 2% in 1980 to 17% in 2018, while share of total coal remained stable at 25-30%, while (Figure3). Thus, the share of imported coal in the total coal supply increased from 10% to 60%.

Figure3: *Share of coal and imported coal in Turkey's primary energy supply (1980-2018)*



In terms of electricity supply, the share of coal in the total installed capacity of 91.2 GW in 2019 was 21% with 19.5 GW. [12] As reported in the 2019-2023 Strategic Plan of the Ministry of Energy and Natural Resources, the installed capacity of domestic coal for electricity generation is planned to be increased from 10 GW at the beginning of the plan period to 14.6 GW until 2023, the end

11 Figures compiled by the author from the Tax Expenditures Report of the Ministry of Treasury and Finance (2018) and the Ateş and Acar study of 2019 (Ates, L. Acar and S. 2019). Informing the Legislative Process to Achieve a Solid Renewable Energy Tax Incentive Policy", presented at the 112th Annual Conference on Taxation, National Tax Association (NTA), 21–23 November 2019, Tampa, Florida.)
12 Turkey Electricity Generation-Transmission Statistics, 2019, TEIAS

A FINANCIAL ANALYSIS BASED ON HUNUTLU THERMAL POWER PLANT

According to the Energy Market Regulatory Board's (EMRA) data on licenses, currently there are 28 coal-fired thermal power plants operating in Turkey (excluding autoproducers and smaller power plants with a capacity of less than 50 MW). 9 thermal power plants are under construction. In order to evaluate the financial feasibility of an imported coal-fired thermal power plant in the light of the trends given above, the Hunutlu Thermal Power Plant in Yumurtalık, Adana, which is known to be under construction, was taken as a case study. The plant is noteworthy in terms of being China's largest ever direct investment in Turkey and its use of imported coal-based ultra-super critical technology.

Hunutlu Thermal Power Plant project is developed and executed by EMBA Electricity Generation Co. Inc., a joint venture between Chinese Shanghai Electric Power and CPI Power Engineering. The project received electricity generation license in 2015. In 2016, the project was granted VAT exemption for the fixed investment amount of 3.5 billion TL and customs tax exemption for the machinery and equipment imports amounting to 768 million USD. [13]

Although China gives priority to renewable energy in its domestic investments, it continues to invest in imported coal-fired thermal power plants in 27 countries. It is reported that 102 GW of the 399 GW of coal capacity under construction outside of China is financed by China through investments in coal mines, power plants, ports and other necessary infrastructure projects.[14] This is because China encourages its state-owned enterprises (SOEs) to pursue foreign investments in order to compensate their losses in the domestic market due to their lack of competitiveness against the private sector investing in renewable energy.[15] While Chinese SOEs use the Belt and Road Initiative (BRI) to invest in coal-fired thermal power plants that can become operational within the short term, just like in the case of Hunutlu project, Turkey aims to be included in the BRI with such investments and to get its share from other critical infrastructure investments, such as ports, that will shape global trade.

According to the information obtained from different sources, the power plant, which will have a capacity of 1,320 MW upon completion, will have an investment cost between 1.7 billion USD[16] and 2.1 billion USD[17,18] . It is worth

13 List of investment incentive certificates issued from 1.05.2016 to 30.05.2016 https://www.resmigazete.gov.tr/eskiler/2016/06/20160625-11.pdf
14 https://ieefa.org/ieefa-china-lender-of-last-resort-for-coal-plants/
15 Tan, F. (2011), Change in China's Foreign Investments following Low Carbon Economy
16 https://www.haberturk.com/cinliler-adana-da-17-milyar-dolara-emba-hunutlu-termik-santral-in-sa-edecek-1687029-ekonomi
17 https://asia.nikkei.com/Editor-s-Picks/Interview/Turkish-sovereign-wealth-fund-courts-China-s-Belt-and-Road
18 http://www.cukurovabarisgazetesi.net/haber/cinden-2-milyar-100-milyon-dolarlik-enerji-yatirmi-20561.html

questioning whether an investment of this scale is financially sustainable in light of the above-mentioned trends in coal.

The power plant has been designed to use imported-coal and fuel constitutes a major part of the variable costs. For the import price of coal, ICE Rotterdam coal futures prices[19] can be taken as a benchmark. Prices have changed between 38.45 USD/ton and 57.70 USD/ton over the last 52 weeks, based on closing prices, and have not exceeded 70 USD since March 2019. The additional financial liability[20] of 15 USD/ton imposed by Turkey in 2016 on imported coal that will be used in electricity production was revised in the same year. According to the new regulation [21], if the import price of coal is less than 70 US$/ton the state charges the difference as import duty. When the international import prices and the additional financial liability imposed by Turkey on imported coal are taken into consideration, the fuel cost for an imported coal-fired power plant will be 70US$/ton.

The transportation cost to be included in the total fuel cost was taken as 6 USD. This cost includes transporting coal from the Port of Rotterdam to Turkey, unloading it and transferring it to the power plant.[22] This price is expected to increase by 20-40% compared to 2020, due to the regulations by the International Maritime Organization (IMO) about reducing the sulfur level in fuels. Although in the long-term there is the possibility that new regulations may impose additional costs on transportation, these costs were not taken into account in the feasibility studies. Therefore, when the international transportation costs and transfer costs from the port to the plant are included, the total cost of coal, which we assumed as 70 USD$/ton, increases to approximately 76 USD$/ton.

Calorific value of the resource plays an important role in converting coal into electricity. In our calculation, 6,000 kcal/kg[23] was taken as a basis, which is the theoretical net calorific value of imported coal. A reference was made to this value in the Hunutlu Thermal Power Plant's Environmental Impact Assessment (EIA) Report, which stated that the calorific value of the coal to be used in the power plant will be in the range of 6,000 kcal/kg to 6,400 kcal/kg. Based on this assumption, the cost of generating electricity from coal brought to the plant at a cost of 76 US$/ton would be 10,89 US$ per MWh, if 100% efficiency is assumed. When calculating the marginal fuel cost of the plant, boiler and plant efficiency should also be taken into account. Hunutlu Thermal Power Plant's gross efficiency is reported as 43.84% in its EIA Report.[24] Building on this number, considering also the own electricity consumption of the plant, the net

19 https://tr.investing.com/commodities/rotterdam-coal-futures -- https://www.quandl.com/data/CHRIS/ICE_ATW1-Rotterdam-Coal-Futures-Continuous-Contract-1-ATW1-Front-Month
20 https://www.resmigazete.gov.tr/eskiler/2016/08/20160802-4.pdf
21 https://www.resmigazete.gov.tr/eskiler/2016/10/20161003-5.pdf
22 This calculation took the cost of transportation from Colombia, the country where Turkey imports the most (43%) coal by weight, as a benchmark. In 2018, the cost of transporting coal from Colombia to Europe was reported as 8.75 US$/ton. This cost is included in the price of coal that Turkey buys from the Rotterdam Stock Exchange and has been adapted for the distance between Rotterdam and Hunutlu. https://www.hellenicshippingnews.com/coal-freight-rates-face-20-40-hike-from-2020-woodmac/
23 https://www.globalcoal.com/coaltrading/financialcoaltrading.cfm
24 https://docplayer.biz.tr/3540456-Hunutlu-entegre-termik-santrali-2x-600-mw-e-616-mw-m-1-332-8-mw-t-kul-depolama-sahasi-ve-iskele-projesi.html

efficiency is calculated as 40% the highest. Assuming that Hunutlu will run at 40% efficiency on average, the marginal fuel cost of the plant will be 27.23 USD per MWh. When other components within variable costs such as maintenance, waste disposal and TEİAŞ fees are also considered[25] , the total cost reaches 31.23 USD/MWh.

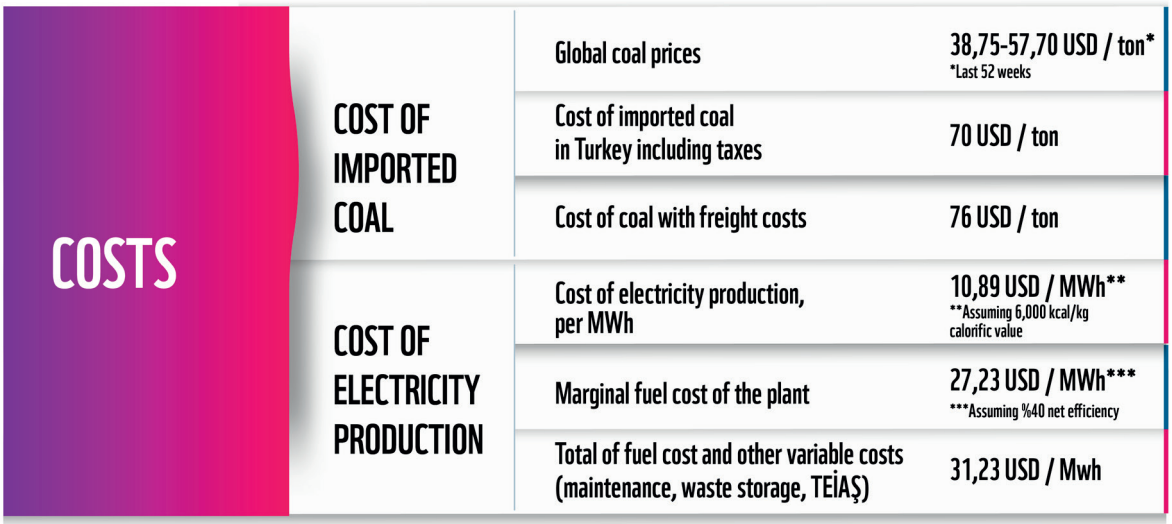


Table 1:
Calculation of total variable costs for Hunutlu power plant

Breakdown of the total variable costs for a thermal power plant using imported coal and Chinese equipment, like Hunutlu, is given above in detail. Based on the assumption[26] that the average electricity price will be 50 US $/MWh through the years in which plant is operational, the gross revenue per MWh will be 18.77 USD. It is reported that Hunutlu will be generating between 9.9 billion kWh [27] and 11.5 billion kWh[28] of electricity per year, after it becomes operational. The estimate of 11.5 billion kWh does not seem realistic as it is only possible if the power plant operates at full capacity 8,712 hours per year (8,760 hours). Therefore, in the analysis, 9.9 billion kWh production, which corresponds to 7,500 hours of full capacity per year, was taken into account in accordance with its EIA report. In this case, the annual gross revenue to be generated by the plant will be around 186 million USD.

In order to reach the net revenue figures, the fixed costs of the power plant including labor, rent and administrative expenses should also be included in this calculation, which is based only on variable costs and electricity prices. The fixed operating cost estimate for Hunutlu over the licensed 1,320 MW capacity totals

25 Maintenance and waste storage cost is assumed to be 2US$/MWh and the costs arising from TEİAŞ deal is assumed to be 2US$/MWh.
26 For the electricity price estimation, the average of market clearing prices (excluding the Carbon Cost Scenario) calculated by APLUS Enerji for SHURA at 2020 constant prices for alternative scenarios until 2030 have been taken as a basis.
27 https://www.enerjiatlasi.com/komur/hunutlu-termik-santrali.html
28 http://www.cukurovabarisgazetesi.net/haber/cinden-2-milyar-100-milyon-dolarlik-enerji-yatirimi-20561.html

between 22 million USD[29] and 40 million USD [30].

Table 2:
Calculation of net profit for Hunutlu power plant

The net present value (NPV) was calculated based on an annual revenue ranging between 146 million USD and 164 million USD, which resulted from the cost and revenue calculations made with average fixed prices of 2020. [31] Taking the 30-year economic life of the power plant into account, calculations reveal that the plant will not be paying back the capital cost of 2.1 billion USD[32] (excluding borrowing costs) throughout its operational life (Table1). In simple terms, under high capital cost assumptions, the net revenue of Hunutlu Thermal Power Plant from electricity generation does not cover the costs pertaining to the 4-year construction period and 30-year economic life of the plant.

The situation is not much different under lower investment cost scenarios. When the investment cost of 1.7 billion USD as reported in different sources is taken as a basis, the pay-back period is calculated to be 26 years after being operational. Considering the construction period of 4 years, total repayment period is 30 years. Although the investment cost in question is at the level of standard thermal power plant costs[33] , it is at an acceptable level considering the below-market costs of Chinese investments.

Despite the fact that 6,000kcal/kg is widely accepted as the average calorific value for imported coal in the literature, under the scenario where the calorific

29 The fixed operating cost of USD 22 million was calculated over the number of employees stated in the plant's EIA report, assuming an average monthly net income of 5,000 TL per employee. In the calculation, the fixed operating cost calculation methodology utilized by the International Energy Agency for an ultra-supercritical thermal power plant was followed.
30 In this calculation, the cost assumptions of Turkey's Optimum Energy Generation Capacity Towards 2030" (SHURA, 2020) report is used, as it is employed in their levelized cost of electricity calculations for different energy technologies. According to the report, the fixed operating cost per MW for an imported coal-based thermal power plant is assumed to be 30,000 USD.
31 An average discount rate of 8.5% and inflation rate of 2% was used to calculate the net present value.
32 IEA calculations show that the capital cost for a 650 MW ultra-supercritical thermal power plant stands at US 2.3 billion USD. Considering the 1,320 MW capacity of Hunutlu Thermal Power Plant, the cost will be much higher. However in this study, the figures referred to in available sources as capital cost of the power plant have been taken into account.
33 The section in the SHURA 2020 report on levelized cost of energy by source assumes that the investment cost of an imported coal-based thermal power plant is 1.1 million USD per MW. Accordingly, the total investment value for the Hunutlu Thermal Power Plant of 1,320 MW capacity would be 1.5 billion USD.

value of the coal to be used in the power plant is set at the upper limit (6,400 kcal/kg) indicated in Hunutlu's EIA report, a positive net present value can only be achieved with a high electricity price and low investment cost. The highest value is reached under the assumption of a fixed investment cost

				CALORIFIC VALUE			
				6.000 kcal/kg		6.400 kcal/kg	
				ELECTRICITY PRICE			
				45 Dolar/ MWh	50 Dolar / MWh	45 Dolar / MWh	50 Dolar / MWh
INVESTMENT	1,7 Billion Dolar	FIXED OPERATING COST	22 Million Dolar	-362 Million Dolar	102 Million Dolar (Breaks even at 26th year of operation)	-204 Million Dolar	260 Billion Dolar (Breaks even at 21th year of operation)
			40 Million Dolar	-530 Million Dolar	-67 Million Dolar	-372 Million Dolar	91 Billion Dolar (Breaks even at 26th year of operation)
	2,1 Billion Dolar		22 Million Dolar	-698 Million Dolar	-235 Million Dolar	-541 Million Dolar	-77 Billion Dolar
			40 Million Dolar	-867 Million Dolar	-404 Million Dolar	-709 Million Dolar	-246 Billion Dolar

Table 3:
Net present value calculation for 4 years of construction and 30 years of operating life, based on alternative calorific value, electricity price, project investment value and fixed operating cost assumptions.

of 22 million USD, and the plant pays back the investment after 21 years following its operationalization. The net present value of the cash flow of the plant during the 4-year construction and 30-year operating period is 260 million USD under the best scenario. Although a payback period of 21 years corresponds to an average value for thermal power plants, it should be noted that it can only take place under a high revenue, low cost scenario.

According to these calculations which have been made under the assumption that the current market trends will remain unchanged and that no strict measures will be taken or an excessive shock will be experienced during the economic life of the plant, the Hunutlu Thermal Power Plant is not a financially feasible investment for the investor companies and financing institutions. As history repeats itself, this situation will get worse if market conditions develop against coal.

CONCLUSION

This study summarizes the forecasts related to the future of coal within the global energy transformation dynamics, and provides an evaluation on Turkey's coal investments in light of these forecasts. Constructing new coal-fired power plants is obviously a serious question mark given the increasing amount of considerations on coal phase out scenarios as well as the developments in the energy market and technologies. The puzzle may be solved by analyzing the financial feasibility of new power plant investments which are expected to become stranded not only due to climate change concerns but also due to the change in the direction of global financial flows. Chinese origin Hunutlu Thermal Power Plant, which is under construction in Turkey has therefore been discussed as a case study.

The net present value calculations show that, under the capital cost scenario which corresponds to the ultra-super critical coal burning technology, the plant is not able to pay back its capital cost for 30 years, even under the assumption of high energy prices. It may however, under low cost-high revenue scenarios, come to a point where it will pay off the capital investment but this break-even point only occurs 21 years after the plant starts operating. Considering the construction period, this amounts 25 years, at best. In the scenario where the fixed operating costs match the power plant technology, break-even point cannot be reached before year 28 of its operation.

It would therefore be appropriate to question the political economy of the Hunutlu Thermal Power Plant, which is being built as China's largest ever direct investment in Turkey, despite its critical condition in terms of the financial return of the investment.

FEASIBILITY OF COAL IN THE AGE OF RENEWABLE ENERGY

%1

In the last 11 years, levelized energy costs have decreased by 90% for solar and 70% for wind, while there is an increase of 1% for coal.

143

As of 2020, 143 global banks, insurance companies, pension funds and asset managers have coal phase-out plans.

26 years

Even in the lowest cost, highest income scenario, Hunutlu Power Plant will start generating positive returns only 26 years after starting operation.

24,8 billion TL

Turkey has provided 24.8 billion Turkish Liras as direct public support to fossil fuels in 2019.

WWF

Working to sustain the natural world for the benefit of people and wildlife.

together possible™

Bizi Twitter'da takip edin: @wwf_turkiye
Bizi Instagram'da takip edin: @wwf_turkiye
Bizi Facebook'ta takip edin: @wwfturkiye