Danish Energy Agency

EMBASSY OF DENMARK

MOIT

EREA Electricity & Renewable Energy Authority

Fuel Price Projections for Viet Nam

Background report to Viet Nam Energy Outlook Report 2021

2021

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1 Executive summary

This report is part of the Danish Energy Agency's (DEA) Energy Partnership Programme between Vietnam and Denmark (DEPP). Within this framework, the report responds to the task of delivering fuel price projections, which is itself part of the engagement outcome "Capacity Development for long-range energy sector planning with the Electricity and Renewable Energy Agency of Vietnam (EREA)".

The report presents both international and domestic fuel price projections for Vietnam, and describes the methodology employed to obtain these. The projections are to be used as inputs to the long-term energy sector modelling of the DEPP programme activities. Table 1 summarises the central price projections for fuels, which are priced internationally, and are then imported into Vietnam. There are a series of domestic price add-ons that are added on top of these prices.

CIF prices Main scenario	2020	2025	2030	2035	2040	2045	2050
Oil ($2019/barrel)	41.5	55.4	76.0	81.0	85.0	85.0	85.0
Coal ($2019/tonne)	68.8	71.0	73.9	72.9	71.9	71.9	71.9
Natural gas ($2019/MBtu)	8.2	6.7	8.9	8.9	9.0	9.0	9.0

Table 1.1: Summary of the central projections for imported fuel prices. Note: the prices shown on the table are cost, insurance and freight (CIF) prices, i.e., prices that account for the expenses borne by a seller to cover costs when the commodity is in transit to its destination.

Similarly, table 2 summarises the central price projections for domestic fuels in Vietnam:

Prices at plant ($2019/GJ) Main scenario		2020	2025	2030	2035	2040	2045	2050
Oil products	Diesel oil	11.29	11.87	12.53	12.68	12.79	12.79	12.79
	Kerosene	12.61	13.26	14.02	14.18	14.29	14.29	14.29
	Jet fuel	11.55	12.22	12.99	13.14	13.27	13.27	13.27
	Gasoline	15.94	16.78	17.75	17.95	18.10	18.10	18.10
	Fuel oil	6.45	6.77	7.14	7.21	7.28	7.28	7.28
Coal	Imported coal	3.48	3.48	3.58	3.48	3.37	3.37	3.26
	Domestic coal 4b5	3.37	3.48	3.69	3.69	3.69	3.69	3.58
	Domestic coal 6	3.26	3.26	3.58	3.48	3.48	3.48	3.48
	Domestic coal 7	3.05	3.16	3.37	3.37	3.37	3.26	3.26
Domestic natural gas	South East	7.93	9.95	11.30	11.60	11.40	11.40	11.40
	South West	7.58	9.86	11.76	11.76	11.86	11.86	11.86
	Central	9.03	9.03	9.03	9.03	9.03	9.03	9.03
LNG	South East	11.22	9.56	12.15	12.24	12.44	12.54	12.65
	South West	11.69	10.11	12.80	12.96	13.27	13.49	13.72

Table 1.2: Summary of the central projections for domestic prices

To contextualize the chosen methodology, the report also compares the International Energy Agency's (IEA's) and World Bank's (WB's) long-term fuel price prognoses. Further, the report suggests price projections to be used for oil, coal, Liquefied Natural Gas (LNG) and biomass for the period 2020 – 2050.

Excluding the introduction, the report consists of seven chapters, which are summarized in what follows.

Price and methodology overview

The purpose of this chapter is to review the price projections produced by the IEA and the WB (sub-sections 3.1 and 3.2) and to present an overview of the methodological approach to price projections in the present report (sub-section 3.3).

IEA's WEO

Regarding the IEA's price projections, each November the organization publishes its annual World Energy Outlook (WEO), which is a comprehensive report providing in-depth scenario analysis of the energy sector. Based on the World Energy Model (WEM), the WEO puts forward three main scenarios (IEA, 2020b):

• Stated Policies Scenario (SPS) - This scenario attempts to paint a future picture of the energy sector based on the current policy ambitions. It therefore incorporates both currently implemented policies and measures around the

world, but also the anticipated effects of announced policies and measures, which would for example include National Determined Contributions (NDC) under the Paris Agreement. This scenario assumes that the COVID-19 pandemic is gradually brought under control in 2021 and that the economy returns to pre-crisis levels in 2021.

• Sustainable Development Scenario (SDS) – This scenario, which made its debut in the 2017 WEO, "outlines an integrated approach to achieving internationally agreed objectives on climate change, air quality and universal access to modern energy" and "puts the energy system on track to achieve sustainable energy objectives in full". Regarding public health issues, this scenario has the same assumptions as the SPS (IEA, 2017, 2020b).

• Delayed Recovery Scenario (DRS) – The scenario is a reaction to the COVID-19 pandemic and assumes that more prolonged outbreaks of COVID-19 prompt continued periodic confinements and other restrictive measures by governments. As a result, "the global economy returns to its pre-crisis size only in 2023, and the pandemic ushers in a decade with the lowest rate of energy demand growth since the 1930s" (IEA, 2020b). In addition to a deeper near-term recession, the long-term growth potential of the global economy is significantly impaired. The scenario puts many aspects of global energy into slow motion, holding back energy demand and CO_2 emissions compared with the SPS but also slowing many of the structural changes in the energy sector that are essential for clean energy transitions. There is systematic underinvestment in new, cleaner energy technologies and over-reliance on existing capital stock. Inequalities in the global economy and in the energy sector worsen and recent progress towards universal access to energy is slowed or goes into reverse as the incomes of the poorest are hit and funding for access programmes is squeezed.

The three fossil fuels considered (crude oil, coal and natural gas) are forecasted to have the highest price in the SPS, followed by the DRS, and the lowest prices in the SDS. This is due to the assumed climate policy initiatives in each of the scenarios, with the SPS scenario having the least ambitious climate change mitigation policies in place, and the SDS having the highest. With more aggressive climate change mitigation policies in place, it is assumed that demand for fossil fuels will fall, and thereby the price will fall.

The World Bank's Commodity Markets Outlook

The latest World Bank's energy commodity price projections are presented in a report entitled 'Commodity Markets Outlook' from October of 2020, which

includes analyses, historical prices, short-term and long-term price forecasts for a broad range of over 40 commodities within energy, agriculture, fertilizers, metals, minerals and precious metals (World Bank, 2020). In the near term (until 2025), the prices are given for each year and then for 2030.

For the present report on fuel price projections, we focus on the WB projections for natural gas, coal and crude oil. Instead of using the real prices produced by the World Bank, and for consistency purposes with other fuels in the report, it was chosen to use the WB's nominal prices and apply a standard inflation indexation to arrive at prices in 2019 USD for use in further analysis.

With respect to natural gas, the World Bank forecasts anticipate a slight fall in Japanese import prices and increases in US and European prices relative to today. However, fossil fuel prices were historically quite low in 2020 as the market has experienced dramatic price declines due to the COVID-19 pandemic. For crude oil, the World Bank forecasts a price increase of over 45% in 2030 relative to 2020, while the forecasted price fall for coal is somewhat constant with a drop of 10% in 2030 relative to 2020. All price projection trends are quite flat from 2020 to 2025 with little variation in changes from year to year.

Ea's usage of fuel price projections

For its long-term fossil fuel price projections, Ea takes point of departure in the above-described scenarios from IEA's WEO. For most of Ea's analytical work, it is necessary to have one main set of fuel prices, and these fuel prices must reflect what Ea deems to be the *most likely* scenario going forward. The fuel prices in Ea's main scenario are therefore *not* meant to reflect a frozen policy, nor a business-as-usual future, but instead an *anticipated development* future.

To arrive at prices that both reflect consumption points and capture short-term price fluctuations and volatility, Ea has developed a method that builds on the IEA prices comprising two main steps:

- Converging to the IEA projections with Forward/Future contract prices in the short- to medium-term to better express the current market expectations.
- Estimating price add-ons to transform the IEA prices into consumer prices over the course of the projection period.

Convergence approach

The convergence approach involves utilising the latest forward/futures prices for each energy commodity and "converging" these prices towards the future applicable WEO scenario prices. For each commodity, forward and futures

prices were chosen according to the relevance of the contract that they reflect, taking both geography and similarity with Vietnamese conditions into consideration. For crude oil, the forward price for Platts Dubai crude oil supplied by CME Group (2020) was utilized. For coal, it was decided to use the forward price for Newcastle coal (Australia). For LNG, the Japan Korea Marker (JKM) by Platts was chosen.

During the initial timeframe, the future/forward prices receive a 100% weighting in the estimated price, and this percentage gradually falls to zero when the WEO scenario becomes the sole driver of the price forecast. It is chosen to use the forward prices directly up till 2023, mix between forward and WEO prices up to 2030 and rely only on WEO prices from 2030 onwards.

At-consumption prices

To arrive at "at-consumption" prices, the difference between wholesale and CIF prices is found either via a bottom-up approach where each component of the price spread is estimated, or by applying a historical price spread between the two. "At consumption" prices here refer to the price paid by the end user of the fuel at the place where it will be used. The selection of approach is dependent on availability of information for each commodity. To ensure consistency and a transparent, straightforward approach, the add-ons are quantified based on simple historic averages (unless otherwise specified, for instance, in the case of refinery spreads for petroleum products). The only modification applied is with respect to the length of the historic period used in estimation of the averages.

IEA and World Bank fuel price comparisons

Before adopting the previously described methodology in 2019, the Vietnamese fuel price projections utilized by MOIT were based on information from the World Bank. Because this was the previously preferred source in MOIT's work, this chapter identifies the differences in fuel price projections between the IEA's WEO and the WB's Commodity Markets Outlook. The comparison allows substantiating the chosen source for long-term projections.

Comparison challenges

In some respects, the fuel price projections from the IEA's WEO and the WB's Commodity Markets Outlook are not directly comparable. For some fuels, the prices represent different geographic regions, with the WB having fewer regional prices for coal and natural gas than in the IEA's WEO. Furthermore, the WB produces annual price forecasts up to 2025, along with the year 2030. In contrast, the IEA's first forecast figures are for 2025, and they continue for 5-

year intervals until 2040. The fuel price projections after 2040 are kept constant until 2050. In the figures and analysis below, the comparison assumes linear development between data points.

When comparing the World Bank's and IEA's crude oil and coal prices, it appears to be the case that the World Bank's forecasts are more focused on short-term prices (there are data points from each year from 2020 to 2025, and then in 2030), whereas the IEA's first forecast data points are in 2025 and 2030, with IEA also estimating price forecasts for the years 2035 and 2040.

Crude oil price comparison

The World Bank's crude oil price forecast arrives in between the IEA's DRS and SD forecasts for 2030. However, in 2025 the World Bank prices are lower.

Coal price comparison

When reviewing the IEA's and World Bank's forecasted prices for coal (Figure 7 and Figure 8), the IEA's WEO price for Japan looks to be the most comparable to the Australian price from World Bank based on historical prices (before 2020). In 2030, the World Bank projection for Australia is 28 USD lower than the IEA's SPS for Japan, and 15 USD lower than the SDS. There may be some geographical influence on the price, e.g., in terms of transportation costs, but in general it may be concluded that World Bank projects much lower coal prices than IEA does.

Natural gas price comparison

For natural gas, the World Bank's and IEA's price forecasts for the DRS are the most similar. However, there are some significant differences, especially for the European price in 2025. The SDS projects much lower prices than World Bank and SPS has higher prices. The relevant source for the Vietnamese fuel price projections is the price for Japan which is an import price for LNG. Here, the IEA and World Bank forecasts are very similar when looking at the SPS and DRS. Only the SDS arrives at a lower forecast in 2025 and 2030. This provides a robust base for the LNG projection when two sources arrive at very similar forecasts.

Comparison of historic IEA price projections

This chapter compares the different fuel price projections from previous IEA WEO publications going back to 1994, including crude oil, natural gas and coal. When reviewing price forecasts, it is relevant to investigate how the same price forecasts have developed over time, and how prices at the time of the forecast impacted the price predictions.

IEA price projections may be highly influenced by market prices at the time of the prognosis

After a systematic comparison of prognoses, it became evident that market prices at the time have historically affected long-term projections significantly. While it is often reasonable to base decision on latest available information, the fuel price projections of IEA may have suffered from a possible bias, in which long-term projections are highly correlated with current market prices, i.e., prices at the time of the prognosis.

Prognoses for imported fuels

This chapter outlines the conclusions for the chosen methodology for long-term fuel price projections for Vietnam, and presents the resulting prognoses, from applying the methodology described in chapter 3.

Since the methodology for the Vietnamese fuel price projections utilizes forward prices in the short to medium term, the importance of having good and reliable sources for fuel prices beyond the medium term becomes important. Normally, forward prices are not even available for more than 3-5 years into the future. Furthermore, the more volatile nature of the forward price markets in comparison to equilibrium model projections, does not make them suitable for long-term projections.

Based on the abovementioned aspects, it is still recommended to utilise the World Energy Outlook scenario prices as inputs for developing price forecasts for imported oil, coal and LNG in Vietnam, with the IEA Stated Policies Scenario (the IEA's central scenario) as the main scenario. The WEO provides projections further into the future and the well-documented assumptions and methodology in the WEO and the WEM, together with the renowned and well-known reputation of IEA makes for a good foundation for the fuel price projections on the medium and long term. The methodology for fuel price projections converges into WEO prices in 2030 and use WEO prices also in 2035 and 2040. These price levels are then assumed to be constant towards 2050.

Crude oil price prognosis

For crude oil, the forward price for Platts Dubai crude oil supplied by CME Group (2020) was used as a short-term price projection, which then converges with the IEA's WEO projections in the long run. In the period up to 2024, the resulting price projection relies on the Platts Dubai price, and then gradually relies 100% on the IEA long-term price forecasts, until the price projection is the IEA WEO price from 2030 onwards. Both price quotes (IEA WEO and Platts Dubai) represent delivered prices that are deemed to be representative of CIF Vietnam prices.

Coal price prognosis

For coal, it was decided to use the forward price for Newcastle coal (Australia) in the short-term, as it is highly correlated with Indonesia's benchmark HBA price, for which there are no future/forward contracts. The Newcastle coal price, for which there are projections, was then adjusted with the historic average difference of 2,6 USD/tonne to arrive at a forward price for Indonesian coal.

The second step involved the conversion of Indonesian prices to CIF (Cost Insurance and Freight) Vietnam prices. To this end, a transportation cost from Indonesia to Vietnam, was obtained from the comparison of the historical import price gathered from the Vietnamese Customs Authority and the historical Indonesia's benchmark HBA price.

After these steps, the convergence approach between short-term prices (Newcastle) to long-term prices (IEA's WEO price for Japanese coal imports) was applied.

LNG price prognosis

In Asia, there are essentially two main price markers: the Japan Korea Marker (JKM) by Platts and the Argus Northeast Asia (ANEA) marker. Given that the shipping distances from Australia to Japan are very similar to those between Australia and Vietnam, it is assumed that Japanese LNG import prices can serve as a good proxy for Vietnamese import prices.

Regarding projections, there are both IEA long-term forecasts for LNG delivered to Japan as well as the publicly available prices for the JKM contract, covering the period up to 2026. Using the convergence price methodology already described, LNG price projections were constructed.

Alternative LNG price scenario

An alternative LNG price scenario was constructed, based on one of the oldest oil-indexed LNG contracts, for LNG import to Japan. Specifically, the 1973 SPA between Pertamina (from Indonesia) and the so-called Western Buyers in Japan was used (Finizio et al., 2020):

$$LNG\ price = 0.1485 \times Crude\ Oil\ benchmark + 0.60$$

The slope of the formula (0,1485) reflects the extent to which the change in the price of the indexed crude oil is passed through to the buyer on an energy equivalent basis. The constant, which in this case is set to 0,6 reflects the cost of delivering the LNG to its destination. The most commonly used price index for crude oil in LNG contracts in the Asia Pacific region is the Japan Customs-

cleared Crude (JCC), often called the Japanese Crude Cocktail. However, for Vietnam, it was chosen to use the crude oil price for Vietnam described in Chapter 6, using the SPS scenario as the benchmark for oil index pricing. Following the same methodology as with the other fuel price projections, the oil-indexed scenario converges from forward prices for LNG in 2024 to the long-term prices in 2030 found by the oil indexing formula described above.

Ability to import LNG and coal

Regarding LNG import sources, Vietnam expects to obtain supplies from Qatar, Australia and the USA, which are the three biggest producers globally. However, the country's ability to secure imports will depend on its relative position relative to other LNG consumers in Asia. China, Japan and Korea are all among the largest consumers of LNG in the world, a fact that could challenge Vietnam's ability to obtain LNG. With a longer-term perspective, the country expects to diversify its import sources from Russia, Turkmenistan and Iran (MOIT & IoE, 2021).

Implications for LNG price projections

Given that Vietnam is a relatively small player in a region characterized by the concentration of big LNG consumers, price formation for this fuel in the region is likely to be more sensitive to the demand of larger countries in the region, like Japan, China, and Korea, than to Vietnam's LNG demand.

As the price spike of Asian LNG prices in January 2021 reveals, there may be structural issues in the market, which could make it likely that a similar episode happens again (Fulwood, 2021; S&P Global, 2021). As Vietnam enters the LNG market, it is important for the country, not only to secure sufficient supplies, but also to agree on supply contracts that safeguard it from potential volatility in the market. A number of options exist in this respect: oil indexation, spot purchases, and a variety of hub-linked pricing options, such as the Japanese LNG cocktail or the Japanese Korea Marker (TLG, 2018).

Regarding coal import sources, Indonesia, Australia, South Africa and Russia appear to be in the position to provide the necessary supplies to Vietnam. Given geographical considerations, reserves and infrastructure, Indonesia and Australia seem to be in relatively better conditions than Russia and South Africa to provide coal supplies to Vietnam.

Implications for coal price projections

Given the relatively limited geographical sources from which coal can be obtained, as well as the competition faced by Vietnam against other consumption centres in Asia (e.g., India), it is possible that coal import prices to Vietnam experience spikes in the future.

Although demand for coal was weak in 2020, due to among other things the COVID pandemic, coal prices received a boost because of increased imports from Vietnam. It is worth noting that the increase (in prices and in imports) took place at a time when there was a de facto import ban on Australian coal by China. Now that the ban has been lifted, price might experience further increases (Argus Media, 2021a, 2021b).

Historical Vietnamese fuel prices

Petroleum products

For petroleum products, the government sets "base prices" as price ceilings. The formula to calculate ceilings for consumer price includes various taxes and fees, including: import duties, special consumption taxes on gasoline and E5, a stabilization fund fee, an environmental protection tax and VAT. These taxes and fees are where the Government can exercise discretion to adjust petroleum product selling prices. This figure shows the domestica average retail prices for petroleum products in Vietnam.

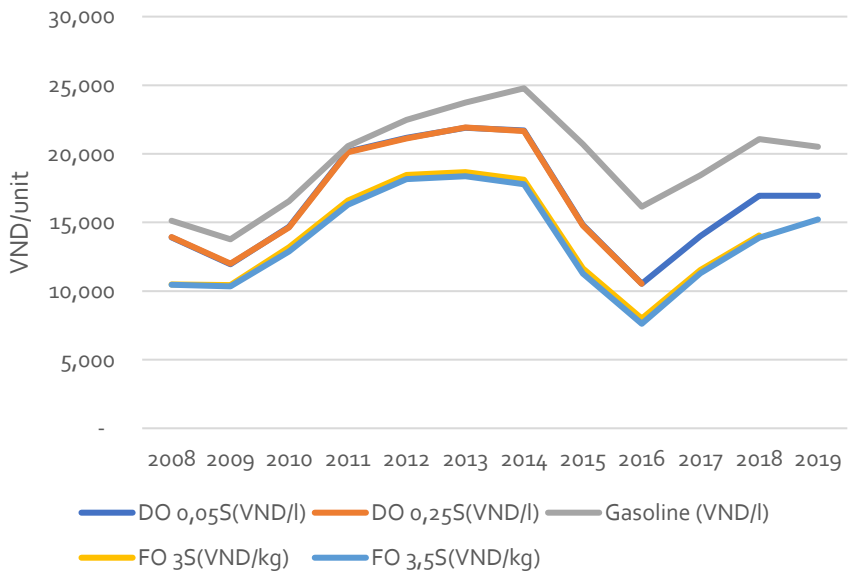

Figure 1: Domestic average retail prices for petroleum products. DO 0,05S means diesel oil with sulphur content less than 50 part per million (ppm).

Natural gas

In recent years, the decline in gas fields at the end of the exploitation period with low price was offset by the gas fields that have just come into operation which have large reserves and high price. Wellhead prices can be set based on bilateral negotiations, Government pricing regulation or indexation to fuel oil

price. Pipeline and distribution costs vary much by natural gas field. Wellhead prices for future gas are forecasted to be much higher than the existing ones. Future gas price may be determined via “pass-through” mechanism in relation to electricity buyback rate of gas-fired power plants. Past trends of natural in the East (NSC+CL) and the West (PM3) of the South are as below:

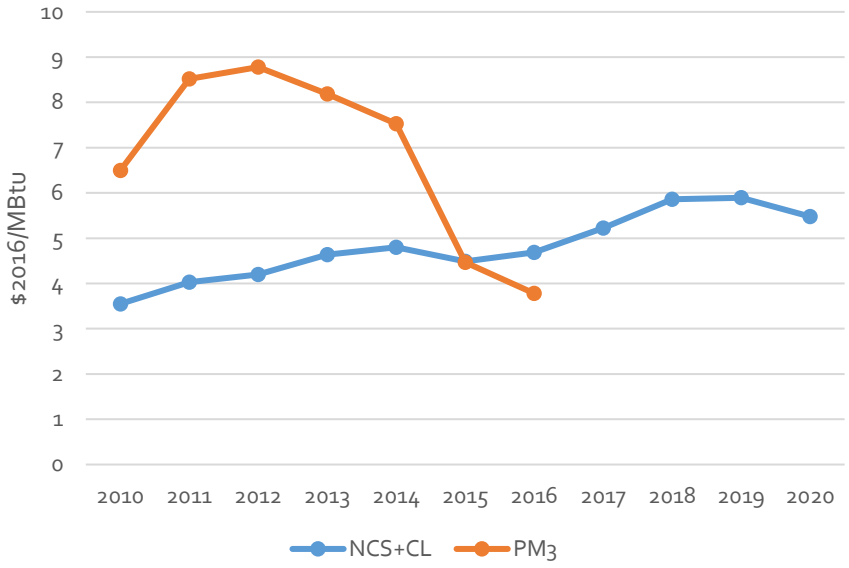

Figure 2: Historical gas prices by field

Coal

Vietnamese coal prices have also been regulated by the Government, and historically domestic coal prices (shown in Figure 33) were kept artificially low. Coal prices for power plants were 60% in 2012 and ~25% in 2013 lower as compared to coal prices for other users. From 2014, the subsidies were removed from coal prices for power plants.

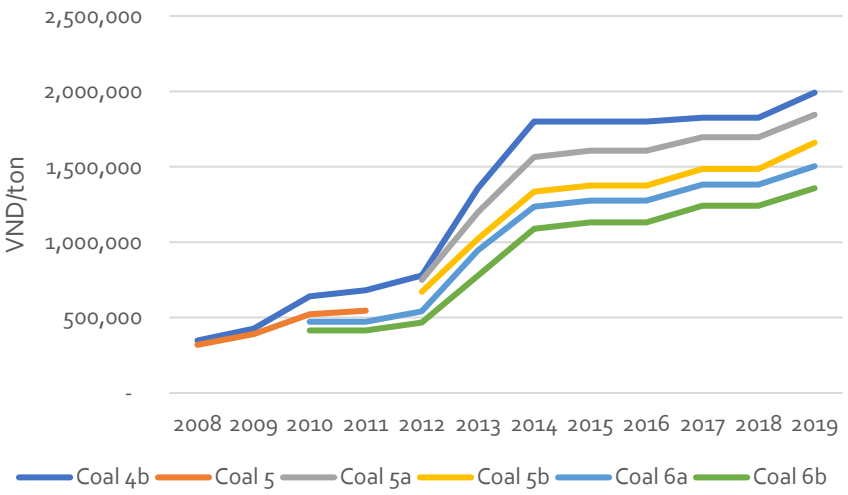

Figure 3: Average domestic coal prices by main coal type

The current coal price scheme is comprised of the following:

- Coal prices are subjected to natural resource, environmental protection and export taxes;
- The frequency for adjusting coal prices is still low, with a late response to world coal price for keeping stable prices for domestic users;
- Government regulates export tax and/or export quota to limit coal export for meeting domestic demands sufficiently.

Prognoses for domestic fuels

Oil price

Base prices for domestic oil products are adjusted for every 15-day based on world oil prices. Therefore, domestic oil prices are highly correlated with world crude oil prices. Domestic CIF oil prices are forecasted based on the growth rate of projected world crude oil price.

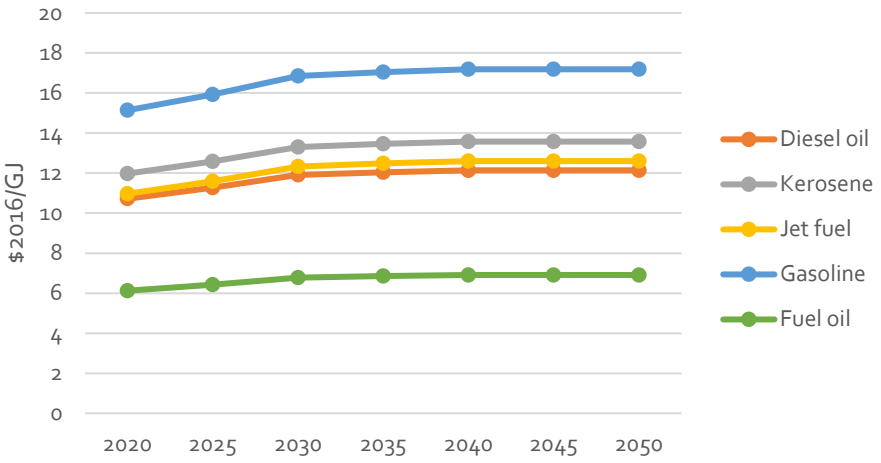

Figure 4: Domestic oil product prices in Stated Policies scenario.

Coal price

Due to the increased trend of domestic production cost, domestic coal production may be lower than planned in case of world coal price decrease due to climate change policies. Domestic coal prices are forecasted higher imported coal after 2030.

	2020	2025	2030	2035	2040	2045	2050
Imported coal (SPS)	3.3	3.3	3.4	3.3	3.2	3.2	3.1
Domestic coal 4b5	3.2	3.3	3.5	3.5	3.5	3.5	3.4
Domestic coal 6	3.1	3.1	3.4	3.3	3.3	3.3	3.3
Domestic coal 7	2.9	3.0	3.2	3.2	3.2	3.1	3.1

Table 1.3: Summary of domestic coal price prognoses ($2016/GJ). Source: authors' calculations.

Gas price

Due to high natural gas price from Block B, imported LNG can compete with domestic natural gas from 2020-2025. After 2025, the price of domestic gas in the South West must be adjusted to compete with imported LNG. The gas price in the region may be set by LNG price from 2025 onwards.

Year	Domestic natural gas			LNG South East	LNG South West
	South East	South West	Central	SPS	SPS
2020	7.53	7.2	8.57	10.65	11.10
2025	9.45	9.36	8.57	9.08	9.60
2030	10.73	11.17	8.57	11.54	12.15
2035	11.01	11.17	8.57	11.62	12.31
2040	10.82	11.26	8.57	11.81	12.60
2045	10.82	11.26	8.57	11.91	12.81
2050	10.82	11.26	8.57	12.01	13.03

Table 1.4: Projection results for natural gas and imported LNG. Source: Authors' calculations.

2 Introduction

This report is part of the Danish Energy Agency's (DEA) Energy Partnership Programme between Vietnam and Denmark (DEPP). Within this framework, the report responds to the task of delivering fuel price projections, which is itself part of the engagement outcome "Capacity Development for long-range energy sector planning with Electricity and Renewable Energy Agency of Vietnam (EREA)".

It is expected that the capacity engagement will result in Vietnam's enhanced capacity to deliver long-range planning of the energy sector that translates into policy development which facilitates renewable energy integration, the usage of energy efficiency technologies, as cost-effective measures to meet Vietnamese Nationally Determined Contribution (NDCs) which simultaneously ensure the country's security of supply.

The activities within the task include model-based analyses about the possible long-term development of the Vietnamese energy sector, where the Balmorel and TIMES models compute least-cost development, including optimal investments in new power generation capacity. In this respect, this is a continuation of earlier work, included the results presented in Vietnam's Energy Outlook Report 2019 (MOIT and DEA, 2019).

Least-cost development of the energy system is heavily dependent on assumptions regarding a series of aspects such as:

- Energy demand prognoses (analysed in a separate report)
- Future technology costs for generation (a technology catalogue is being developed for Vietnam based on similar analyses from Indonesia and Denmark).
- Future fuel prices (this report)

Short-term fuel prices have historically shown large variations, and this has also been reflected in considerable variations in long-term prognoses. Whenever high spot or short-term prices, long-term fuel price projections have also been high. While it is impossible to accurately predict future fuel prices, the purpose of this report is to suggest a consistent method to produce fuel price projections, and to understand their related uncertainty.

In Denmark, the Danish Energy Agency bases its expectations about future fuel prices on analyses from the International Energy Agency (IEA): mostly the

World Energy Outlook (WEO), (IEA, 2020b). In Vietnam, estimates of future fuel prices have previously been based on analyses from the World Bank (WB): mostly the Commodity Markets Outlook (World Bank, 2020).

In the earlier edition of the present report (published in June 2019) a new methodology was developed using relevant forward prices for short-term fuel price projections, i.e., prices for the following 1-5 years, which converged into IEA's price projections contained in the WEO, going towards 2050. The work was presented in the report entitled "Fuel price projections" from June 2019 (EREA & DEA, 2019). After careful consideration and review of the previously proposed methodology, it was chosen to continue using it for the present report.

The purpose of this report is to describe the methodology for the estimation of international and domestic fuel prices relevant for Vietnam, which are to be used as inputs to the long-term energy sector modelling of the DEPP programme activities. To contextualize the chosen methodology, the report also compares the IEA and WB fuel price prognoses for long term fuel price projections. Further, the report discusses the applied methods and suggests prices to be used for oil, coal, LNG and biomass for the period 2020 – 2050.

Note that the present report is an update of the report by EREA & DEA (2019). with improvements and review of methodology, relevant sources, and new information for fuel price projections for Vietnam. Finally, the report also investigates Vietnam's future ability to import coal and LNG to Vietnam.

3 Price and methodology overview

Fuels are traded in increasingly competitive international markets. Many of them, like crude oil (see Figure 1) and coal are global commodities, whose price is set in markets across continents. Others, like natural gas, have traditionally had a more regional (yet international character), e.g., the European Gas market. However, technological innovations, such Liquefied Natural Gas (LNG), are gradually making of gas a decidedly global market.

Figure 5. Historical brent oil prices in nominal USD/barrel (Economics Trading, 2021).

The purpose of this chapter is to review the price projections produced by the IEA and the WB (sub-sections 3.1 and 3.2) and to present an overview of the methodological approach to be followed in the present report (sub-section 3.3).

3.1 IEA's WEO

Methodology

Each November the IEA publishes its annual World Energy Outlook (WEO), which is a comprehensive report providing an in-depth scenario analysis of the energy sector. The present report is based on the latest publication of the WEO of 2020 (IEA, 2020b). The main tool used in the development of the WEO scenario projections is the World Energy Model (WEM), which according to the extensive publicly available background documentation, is a "large-scale simulation model designed to replicate how energy markets function and is used to generate detailed sector-by-sector and region-by-region projections"(IEA, 2020a).

The WEM operates under the assumptions of long-term equilibrium, that is to say: a state of the economy where the general price level is fully reflecting and adjusted to the existing set-up of the main price drivers and market factors (as opposed to short-term equilibrium or cyclicality where the price level might not be fully adjusted to the current situation in the market due to different short-term market factors and distortions/fluctuations).

The WEO traditionally has three primary scenarios and several alternative scenarios. The three main scenarios in the WEO 2020 are (IEA, 2020b):

- *Stated Policies Scenario* (SPS) - This scenario attempts to paint a future picture of the energy sector based on the current policy ambitions. It therefore incorporates both currently implemented policies and measures around the world, but also the *anticipated effects* of announced policies and measures, which would for example include National Determined Contributions (NDC) under the Paris Agreement. This scenario assumes that the COVID-19 pandemic is gradually brought under control in 2021 and that the economy returns to pre-crisis levels in 2021.
- *Sustainable Development Scenario* (SDS) – This scenario, which made its debut in the 2017 WEO, "outlines an integrated approach to achieving internationally agreed objectives on climate change, air quality and universal access to modern energy" and "puts the energy system on track to achieve sustainable energy objectives in full". Regarding public health issues, this scenario has the same assumptions as the SPS (IEA, 2017, 2020b).
- *Delayed Recovery Scenario* (DRS) – The scenario is a reaction to the COVID-19 pandemic and assumes that more prolonged outbreaks of COVID-19 prompt continued periodic confinements and other restrictive measures by governments. As a result, "the global economy returns to its pre-crisis size only in 2023, and the pandemic ushers in a decade with the lowest rate of energy demand growth since the 1930s" (IEA, 2020b). In addition to a deeper near-term recession, the long-term growth potential of the global economy is significantly impaired. The scenario puts many aspects of global energy into slow motion, holding back energy demand and CO2 emissions compared with the SPS but also slowing many of the structural changes in the energy sector that are essential for clean energy transitions. There is systematic underinvestment in new, cleaner energy technologies and over-reliance on existing capital stock. Inequalities in the global economy

and in the energy sector worsen and recent progress towards universal access to energy is slowed or goes into reverse as the incomes of the poorest are hit and funding for access programmes is squeezed.

Two of the three main scenarios from the most recent WEO (2020 version) described above have been renamed or changed in comparison to previous publications. The scenario previously named *New Policies* is now called the *SPS* and the earlier-named *Current Policies*[1] scenario has been replaced by the DRS.

All the WEO scenario projections operate under the assumption of long-term equilibrium subject to fundamental supply and demand dynamics, i.e., effects of short-term market volatility and fluctuations are not a part of the price pathways of the scenarios. As in any modelling framework, the World Energy Model simplifies reality, and the assumptions made have an impact on the results. The validity of the long-term price projections set forth in the WEO scenarios are subject to the realisation of the assumptions and dynamics (e.g., assumption of long-term equilibrium) underlying each scenario. This is common practice in scenario development, where certain assumptions normally depict a plausible trajectory for the future with the scenarios then describing the effects of these assumptions.

Price forecasts

The WEO provides fuel price forecasts for several regions in the world. For natural gas and coal, separate price forecasts are provided for the United States, the European Union, China, and Japan. The 2020 WEO price forecasts for international oil, European coal and European natural gas are displayed in Figure 2.

[1] Current Policies Scenario is defined as a scenario that only factors in the impacts of policies and measures that were in place, and therefore does not incorporate the influence of any new potential legislation or policies. The IEA states that this scenario can be seen as a "cautious assessment of where momentum from existing policies might lead the energy sector in the absence of any other impetus from government".

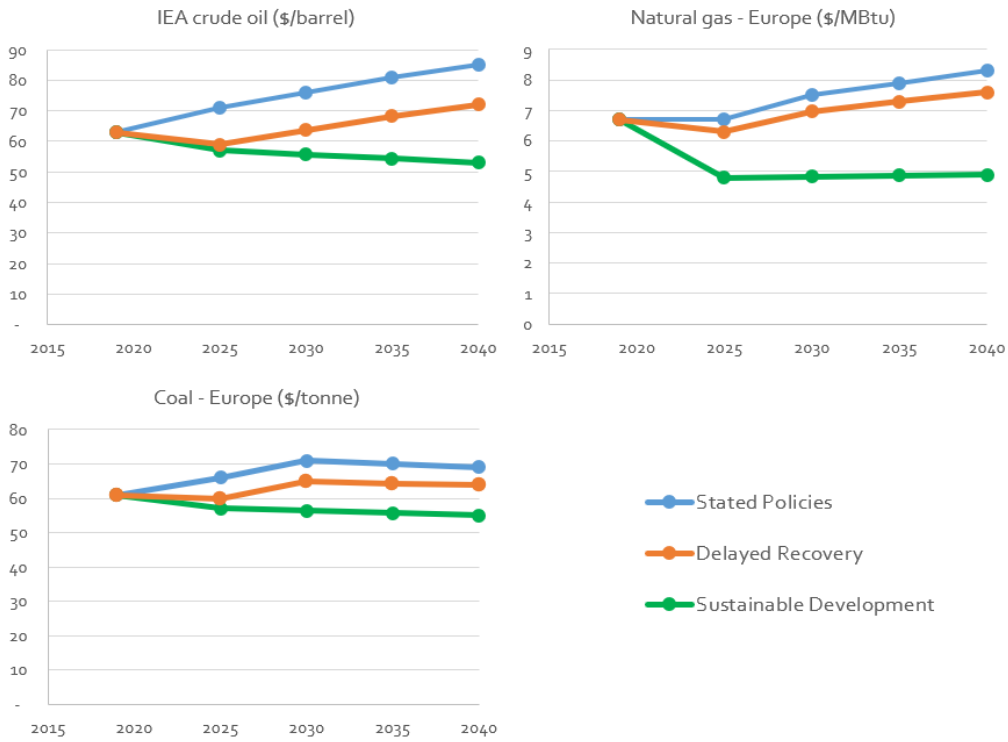

Figure 6: Fossils fuel prices from the IEA's 2020 version of the World Energy Outlook. All values are in 2019 USD (IEA, 2020, a). Dots represent years with data points.

Specifically, in relation to Figure 2:

- The IEA crude oil price is a weighted average import price among IEA member countries.
- The European steam coal price reflects import prices at European hubs.
- The European gas price reflects a balance of pipeline and LNG imports.

As can be seen in Figure 2, all three fossil fuels are forecasted to have the highest price in the SPS, followed by the DRS, and the lowest prices in the SDS. This is due to the assumed climate policy initiatives in each of the scenarios, with the SPS scenario having the least ambitious climate change mitigation policies in place, and the SDS having the highest. With more aggressive climate change mitigation policies in place, it is assumed that demand for fossil fuels will fall, and thereby the price will fall. Note, that the DRS and SDS scenarios only provides data points for 2025 and 2040.[2]

[2] Ea has been in contact with IEA staff, who has confirmed that the years between 2025 and 2040 the DRS will follow the trend of the SPS, whereas the SD will follow a linear interpolation.

3.2 WB's commodity price forecasts

Methodology

The latest World Bank energy commodity price projections are presented in a report entitled 'Commodity Markets Outlook' from October of 2020, which includes analyses, historical prices, short-term and long-term price forecasts for a broad range of over 40 commodities within energy, agriculture, fertilizers, metals, minerals and precious metals (World Bank, 2020). In the near term (until 2025), the prices are given for each year and then for 2030.

The World Bank has prepared commodity price forecasts since 1994, with up to four publications per year, which are freely available on their website (World Bank, 2021).

Price forecasts

The World Bank price forecasts for five energy products in nominal and constant US dollars are displayed in Figure 7 below.

TABLE A.2 Commodity prices forecasts in nominal U.S. dollars

Commodity	Unit	2018	2019	Forecasts 2020	2021	2022	2023	2024	2025	2030
Energy										
Coal, Australia	$/mt	107.0	77.9	57.2	57.8	58.0	58.3	58.5	58.8	60.0
Crude oil, avg	$/bbl	68.3	61.4	41.0	44.0	50.0	52.1	54.4	56.7	70.0
Natural gas, Europe	$/mmbtu	7.7	4.8	2.8	4.0	4.3	4.5	4.8	5.1	7.0
Natural gas, U.S.	$/mmbtu	3.1	2.6	1.9	2.6	2.7	2.9	3.0	3.1	4.0
Liquefied natural gas, Japan	$/mmbtu	10.7	10.6	8.6	8.6	8.6	8.6	8.6	8.6	8.5

TABLE A.3 Commodity prices forecasts in constant U.S. dollars (2010=100)

Commodity	Unit	2018	2019	Forecasts 2020	2021	2022	2023	2024	2025	2030
Energy										
Coal, Australia	$/mt	105.2	78.3	57.8	57.5	56.8	56.0	55.3	54.5	50.6
Crude oil, avg	$/bbl	67.2	61.7	41.4	43.8	48.9	50.1	51.4	52.6	59.0
Natural gas, Europe	$/mmbtu	7.5	4.8	2.8	4.0	4.2	4.4	4.6	4.8	5.9
Natural gas, U.S.	$/mmbtu	3.1	2.6	1.9	2.6	2.7	2.8	2.8	2.9	3.4
Liquefied natural gas, Japan	$/mmbtu	10.5	10.6	8.7	8.6	8.4	8.2	8.1	7.9	7.2

Figure 7: World Bank energy commodity price forecasts. Upper table in nominal US dollars, lower table in constant US dollars (2010). Source: (World Bank, 2020). Note that the World Bank's constant prices are deflated by a Manufacturers Unit Value (MUV).

The World Bank utilises a Manufacturers Unit Value (MUV) index to arrive at real prices (lower portion of Figure 7). This differs from standard inflation indexation, where the MUV is the unit index in US dollar terms of manufactures exported from 15 countries as opposed to standard inflation indexing. It was chosen to use the WB's nominal prices (the upper portion of Figure 2) and apply a standard inflation indexation to arrive at prices in 2019 USD for use in further analysis. This is done to be consistent in the use of inflation rates across all nominal price sources for the work on fuel price projections. The inflation rates used are based on the consumer price index. The consumer price index is a measure of change in the price level of a preselected market basket of consumer goods and services purchased by households calculated as an average of U.S. cities. This forecast of U.S. inflation was prepared by the International Monetary Fund (Statista, 2021).

The Australian coal price in Figure 7 is a FOB[3] price, while the oil price is an average of Brent, Dubai Fateh, and WTI prices (Table 1). With respect to natural gas, the European price is an average import price, the US price is a Henry Hub spot price, and Japanese price is the LNG import price. Table 1 below provides more fuel-specific details.

Commodity	Specifications
Coal (Australia)	Thermal, fob. piers, Newcastle/Port Kembla, 6,700 kcal/kg, 90 days forward delivery.
Crude oil, avg.	Average price of Brent (38° API), Dubai Fateh (32° API), and West Texas Intermediate (WTI, 40° API). Equally weighed.
Natural gas, Europe	Average import border price with a component of spot price, including UK.
Natural gas, US	Spot price at Henry Hub, Louisiana.
Natural gas, Japan	LNG, import price, cif[4]; recent two months' averages are estimates.

Table 2.1: World Bank energy commodity specifications (World Bank, 2020).

The resulting prices for all 3 fuels (coal, crude oil and natural gas) are displayed in Figure 4 and Figure 5 below.

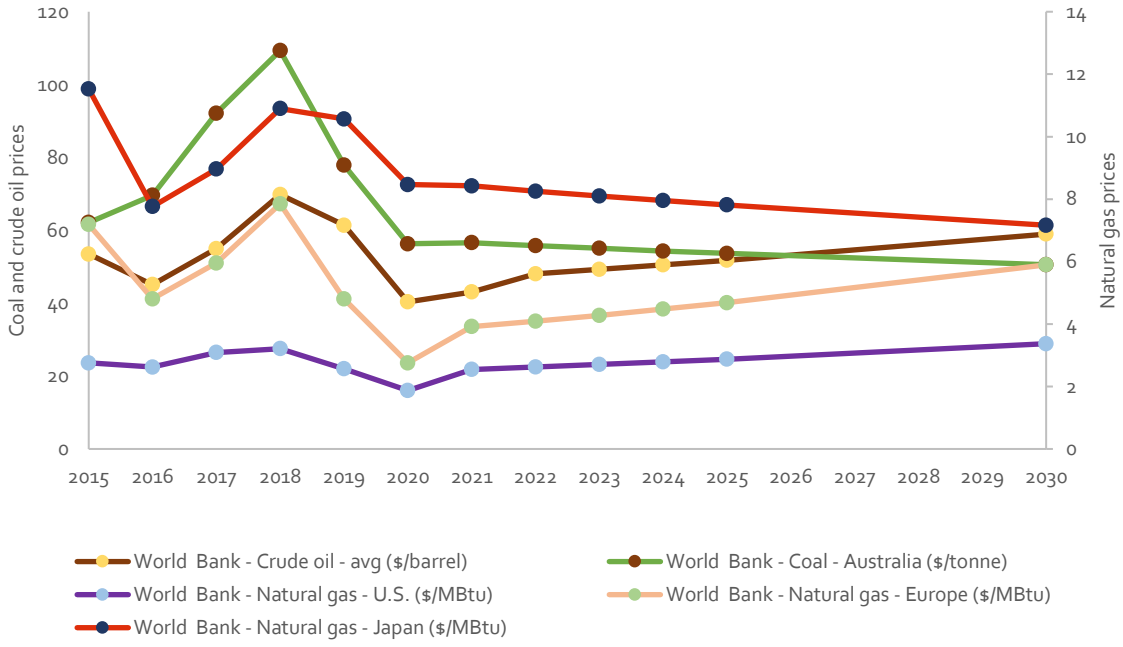

Figure 8: Fossil fuel price forecasts in 2019 USD based on World Bank forecast prices ($/trade units). Note that natural gas is on the right axis. Dots represent years with data points. Years before 2020 are historical prices.

[3] FOB: free on board, simply stated, is the price of the commodity once it has been loaded on a ship.
[4] CIF: Cost Insurance and Freight, simply stated, the price of a commodity on a ship (prior to offloading) on arrival in a harbour.

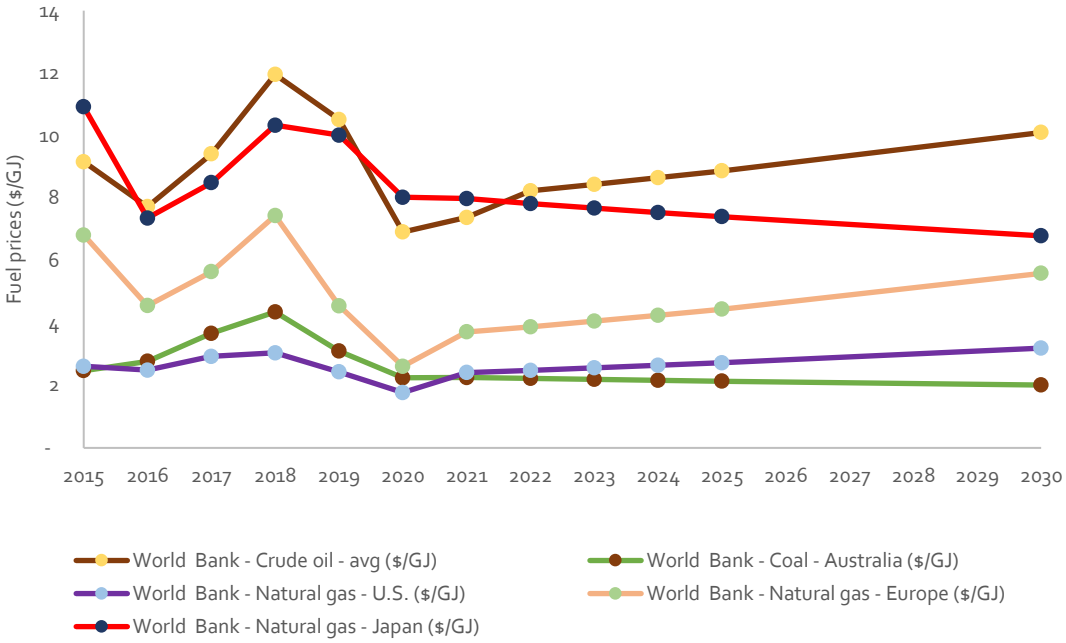

Figure 9: Fossil fuel price forecasts in 2019 USD/GJ based on World Bank forecast prices. Dots represent years with data points. Years before 2020 are historical prices.

With respect to natural gas, the World Bank forecasts anticipate a slight fall in Japanese import prices and increases in US and European prices relative to today. However, fossil fuel prices were historical quite low in 2020 as the market has experienced dramatic price declines due to the COVID-19 pandemic. For oil, the World Bank forecasts a price increase of over 45% in 2030 relative to 2020, while the forecasted price fall for coal is somewhat constant with a drop of 10% in 2030 relative to 2020. All price projection trends are quite flat from 2020 to 2025 with little variation in changes from year to year.

3.3 Methodology overview

This sub-section presents a methodological overview of the price projection methodology employed in this report. Note that this was initially proposed in the report by EREA & DEA (2019).

In essence, this sub-section describes how Ea Energy Analyses arrives at "at-consumption" prices using price add-ons. This methodology is directly implementable in a Vietnamese context.

Ea Energy Analyses' utilisation of IEA prices

For its long-term fossil fuel price projections, Ea takes point of departure in the above-described scenarios from IEA's WEO. For most of Ea's analysis

work, it is necessary to have one main set of fuel prices, and these fuel prices must reflect what Ea deems to be the *most likely* scenario going forward. The fuel prices in Ea's main scenario are therefore *not* meant to reflect a frozen policy, nor business as usual future, but instead an *anticipated development* future.

Core scenario selection

For several years, Ea utilised the central scenario out of IEA's WEO scenarios, i.e., the New Policies Scenario (now SPS) but starting with the 2015 edition of IEA's WEO, Ea shifted over to using the 450 PPM scenario (which is similar to the present-day SDS). This was done because at the time, it was assessed that the fossil fuel price predictions arising from the New Policies Scenario were simply too high relative to what Ea deemed the *most likely* scenario.

For example, in the 2015 WEO, the price forecast for coal in 2040 was roughly 110 USD/tonne in the New Policies Scenario vs. the 2017 WEO which had a 2040 price of roughly 80 USD/tonne (see Figure 13). In addition, Ea assessed that the IEA consistently underestimates both the cost reductions and rollout of renewable technologies, which points to a future more in line with the SDS. The costs of renewables have decreased drastically in recent years, as demonstrated by record low renewable energy auction prices in Mexico, as well as low prices in Dubai, Peru, Chile, Abu Dhabi, and Saudi Arabia (IRENA, 2018).

At the same time, several countries that until recently had plans for massive investments in coal have begun to cut back drastically on these plans. A prominent example includes India, where the coal-fired pre-construction project pipeline is rapidly shrinking with 46GW of cancellations in the last twelve months as of March 2020, adding to over 600 GW of cancellations this past decade (IEEFA, 2020). Taking all these elements into consideration, Ea considered the SDS to be the most likely of the three. However, it should be noted that Ea's shift away from the New Policies scenario came at a time when the New Policies price forecasts for natural gas and coal where considerably higher than those from the 2020 WEO (see Figure 12 and Figure 13 in chapter 5). Therefore, relative to when the WEO 2015 edition was released, Ea is more inclined today to use the SPS as the main scenario. Also, the SPS is widely considered to be the main scenario of the WEO. It follows that, it would be advisable for governmental institutions to use the SPS as the main scenario.
While it is impossible to predict the future, the main scenario should be the best guess for the developments of the future. Alternative scenarios would then be different (but normally plausible) paths of the future which provide

context to the main scenario by demonstration the effects of e.g., fuel prices when other paths than the best guess would be realised going forward.

To arrive at prices that both reflect consumption points and capture short-term price fluctuations and volatility, Ea has developed a method that builds on the IEA prices comprising two main steps:

- Converging to the IEA projections with Forward/Future contract prices in the short- to medium-term to better express the current market expectations.
- Estimating price add-ons to transform the IEA prices into consumer prices over the course of the projection period.

Methodology and rationale for price convergence

Due to the market volatility of energy prices and the time lag between the date of the IEA finalising its fuel price inputs and when the WEO is published, as well as the moment when Ea undertakes its fuel price projections for use in analysis, market prices may have changed (particularly for short-term deliveries).

It is therefore reasonable to apply the WEO price projections in the medium to long-term based on fundamental supply and demand dynamics (subject to the realisation of the assumptions regarding these dynamics in the respective scenarios). In the short to medium term, on the other hand, it is reasonable to assume that price projections based on the best available actual market information would be more representative (thereby likely incorporating the price effects of short-term market distortions and/or cyclicality).

This gives rise to a need for a simple and transparent methodology for combining the long-term energy price projections from the last IEA publication with the most recent market view provided by forward prices. There is no single robust scientific method for doing so, thus a pragmatic and transparent approach which generates conceivable outcomes was developed. This approach involves utilising the latest forward/futures prices for each energy commodity and converging these prices towards the future applicable WEO scenario prices. During the initial timeframe, the future/forward prices receive a 100% weighting in the estimated price, and this percentage gradually falls to zero when the WEO scenario becomes the sole driver of the price forecast. It is chosen to use the forward prices directly up till 2023 where the prices then converge to WEO prices in 2030.

This methodology was adapted as the basis for the Vietnamese fuel price projections back in 2019 by EREA & DEA (2019), and used in the Energy Outlook Reports carried out by MOIT and DEA since then.

Methodology for fuel price "add-on"

Since the "at-consumption" prices need to be linked directly to the international derived price forecasts, the methodology employed to determine prices is based on an evaluation of the historical linkages and comparative levels between wholesale and IEA-based prices which are CIF prices.[5] In addition, the price add-ons for each fuel must cover the entire spread between prices at consumption and IEA-based prices. This includes all real costs, as well as trade margins in the supply chain where they occur.

While some of these can be substantiated individually, others – particularly trade margins – arise from the difference in price levels: wholesale vs. retail prices. For this reason, the most important sources of information used to derive the total add-ons are observed prices along the supply chain. The difference in price levels along the supply chain are referred to as "price spreads".

The difference between wholesale and CIF prices is either found via a bottom-up approach where each component of the price spread is estimated, or by applying a historical price spread between the two. The selection of approach is dependent on availability of information for each commodity. The overall methodology of arriving at "at-consumption" prices in Vietnam will be these same but for each fuel type the exact calculations could differ due to differences in available information.

In order to ensure consistency and a transparent, straightforward approach, the add-ons are quantified based on simple historic averages (unless otherwise specified, for instance, in the case of refinery spreads for petroleum products). The only modification applied is with respect to the length of the historic period used in estimation of the averages.

[5] CIF are cost, insurance and freight prices of commodities traded internationally.

4 IEA and World Bank fuel price comparisons

Before adopting the previously described methodology in 2019, the Vietnamese fuel price projections utilized by MOIT were based on information from the World Bank. Because this was the previously preferred source in MOIT's work, this chapter identifies the differences in fuel price projections between the IEA's WEO and the WB's Commodity Markets Outlook. The comparison allows substantiating the chosen source for long-term projections.

In some respects, the fuel price projections from the IEA's WEO and the WB's Commodity Markets Outlook are not directly comparable. For some fuels, the prices represent different geographic regions, with the WB having fewer regional prices for coal and natural gas than in the IEA's WEO. Furthermore, the WB produces annual price forecast figures up to 2025, along with the year 2030. In contrast, the IEA's first forecast figures are for 2025, and they continue for 5-year intervals until 2040. In the figures and analysis below, the comparison assumes linear development between data points.

4.1 Oil

The following charts are not constructed with the convergence methodology described in chapter 3 but are instead direct price points from each publication with a straight linear interpolation between price points.
Figure 6 below displays the IEA's WEO crude oil price forecasts for crude oil in the SPS, DRS and SD scenarios, and the World Bank's crude oil price forecast (all prices are in 2019 USD).

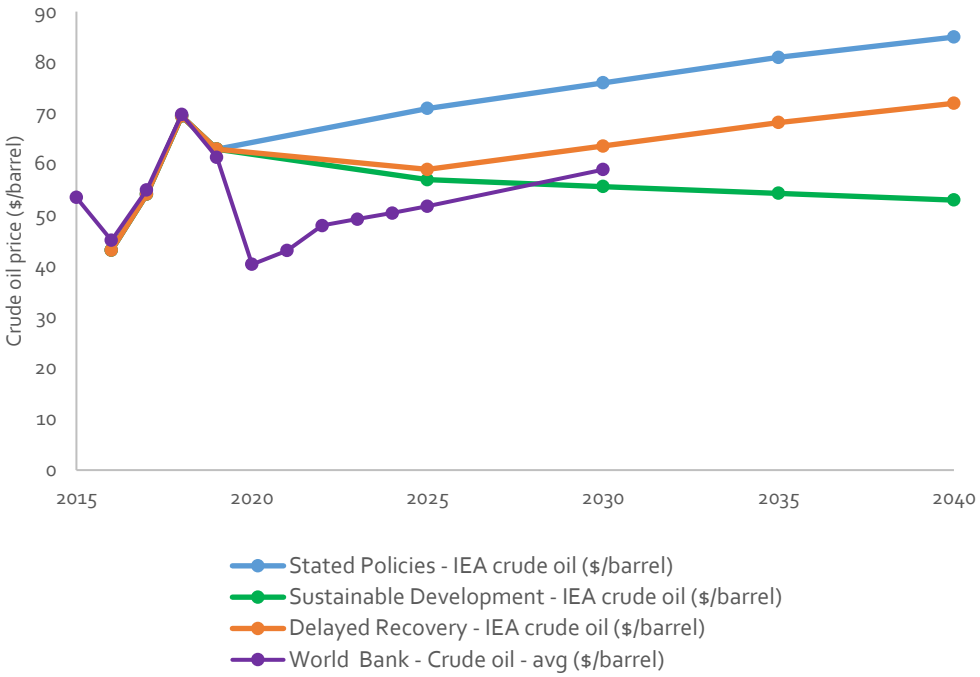

Figure 10: WEO crude oil price forecasts for IEA in the Stated Policies, Delayed Recovery and Sustainable Development scenarios, and the World Bank's crude oil price forecast. All prices are in 2019 USD. Dots represent years with data points.

The IEA crude oil is a weighted average import price amongst IEA member countries, while the World Bank oil price is an average of Brent, Dubai Fateh, and WTI prices. As such, it is important to note that the two forecasts are not 100% directly comparable but given the global nature of oil as a traded product, they are likely to be quite comparable.

The World Bank oil price forecast arrives in between the IEA's DRS and SD forecasts for 2030. However, in 2025 the World Bank prices are lower. Two factors should be noted here. Firstly, IEA starts their work and locks in their assumptions on fuel price projections much earlier than the World Bank, which means that World Bank will have more recent information about the current market conditions under the COVID-19 pandemic. Since oil prices dropped dramatically in 2020, it follows that World Bank projections in the shorter term are lower than the IEA's. Secondly, as shown in Figure 6, the data points of WEO from their historical year 2019 to the projections in 2025 are drawn as a straight line. For years between 2019 and 2025, this line should in no way be considered a good forecast for the years. Chapter 5 describes how to project fuel prices for these years using forward prices and the convergence methodology. In the SPS the price is 71 $2019/barrel in 2025 which is

approximately an increase of 70% compared to the historical price in 2020. However, compared to earlier projections from earlier editions of the IEA's WEO, this is not a high price where some of these projections exceeding 130 $/barrel, see Figure 12.

4.2 Coal

When reviewing the IEA's and World Bank's forecasted prices for coal (Figure 7 and Figure 8), the IEA's WEO price for Japan looks to be the most comparable to the Australian price from World Bank based on historical prices (before 2020). The price for Japan from the IEA is an import price and Japan receives it's majority of coal from Australia (EIA, 2019), 61% of all imports in 2018 it follows that these prices are highly comparable. In 2030, the World Bank projection for Australia is 28 USD lower than the SPS for Japan and 15 USD lower than the SDS. There may be some geographical influence on the price, e.g., in terms of transportation costs, but in general it may be concluded that World Bank projects much lower prices than IEA does. To provide additional context to this statement, the average price of the last 10 years was around 85$/tonne. In the World Bank's Commodity Markets Outlook from (World Bank, 2021), the reasoning behind the low coal prices is explained by the influence of the COVID-19 pandemic causing slow coal consumption recovery combined with green transition plans from the world governments. This should be comparable to the DRS from IEA, but the World Bank still arrives at lower prices in both medium and longer term.

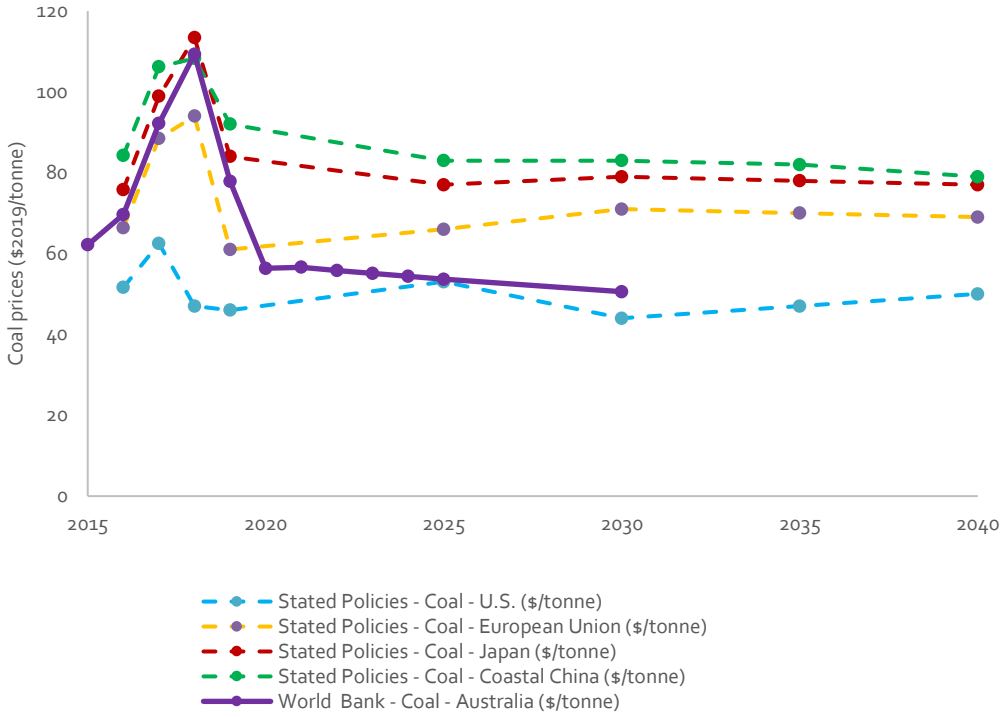

Figure 11: WEO coal price forecasts for various regions in the Stated Policies scenario, and the World Bank's Australian price forecast. All prices are in 2019 USD per tonne. Dots represent years with data points.

When comparing the World Bank's and IEA's crude oil and coal prices, it appears to be the case that the World Bank's forecasts are more focused on short-term prices (there are data points from each year from 2020 to 2025, and then in 2030), whereas the IEA's first forecast data points are in 2025 and 2030, with IEA also estimating price forecasts for the years 2035 and 2040.

One conclusion from this could be that the World Bank price forecasts would be more effective at capturing the short-term price developments. However, if focussing on Australian coal prices, they averaged roughly 60 USD/tonne in 2020, and around 86 USD/tonne thus far in March 2021, which is significantly higher than reflected in the World Bank prices for 2021 (Index Mundi, 2021). This could suggest that World Bank's projections could perhaps be biased by the very low prices at the time of publication. It is however still very early in 2021 and prices must be expected to be more volatile during the uncertainties of the COVID-19 pandemic.

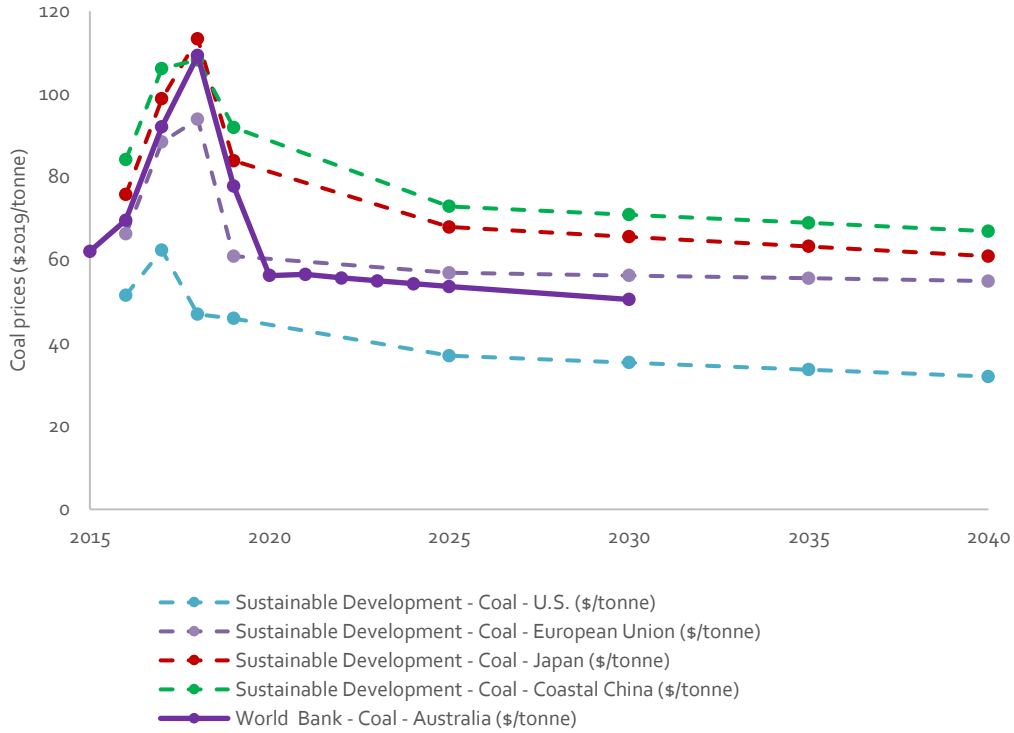

Figure 12: WEO coal price forecasts for various regions in the Sustainable development scenario, and the World Bank's Australian price forecast. All prices are in 2019 USD per tonne. Dots represent years with data points.

4.3 Natural gas

For natural gas, the World Bank's and IEA's price forecasts for the DRS are the most similar. However, there are some significant differences, especially for the European price in 2025. The SDS projects much lower prices than World Bank and SPS has higher prices. The relevant source for the Vietnamese fuel price projections is the price for Japan which is an import price for LNG. Here, the IEA and World Bank forecasts are very similar when looking at the SPS and DRS. Only the SDS arrives at a lower forecast in 2025 and 2030. This provides a robust base for the LNG projection when two sources arrive at very similar forecasts.

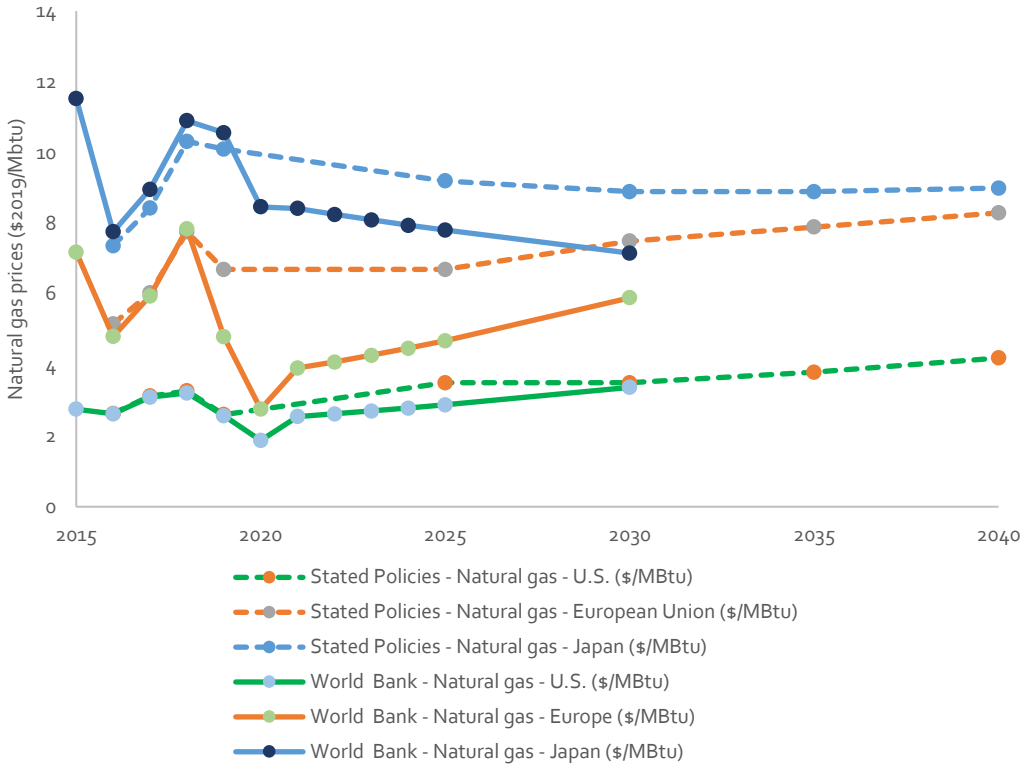

Figure 13: WEO natural gas price forecasts for various regions in the Stated Policies scenario, and the World Bank price forecasts for the same regions. All prices are in 2019 USD per MBtu. Dots represent years with data points.

In all of Figure 9, Figure 10 and Figure 11 the natural gas prices are weighted averages expressed on a gross calorific-value basis. The US gas price reflects the wholesale price prevailing on the domestic market. The EU gas prices reflects a balance of pipeline and LNG imports, while the Japan gas price is solely LNG imports (LNG prices used are those at the customs border, prior to regasification).

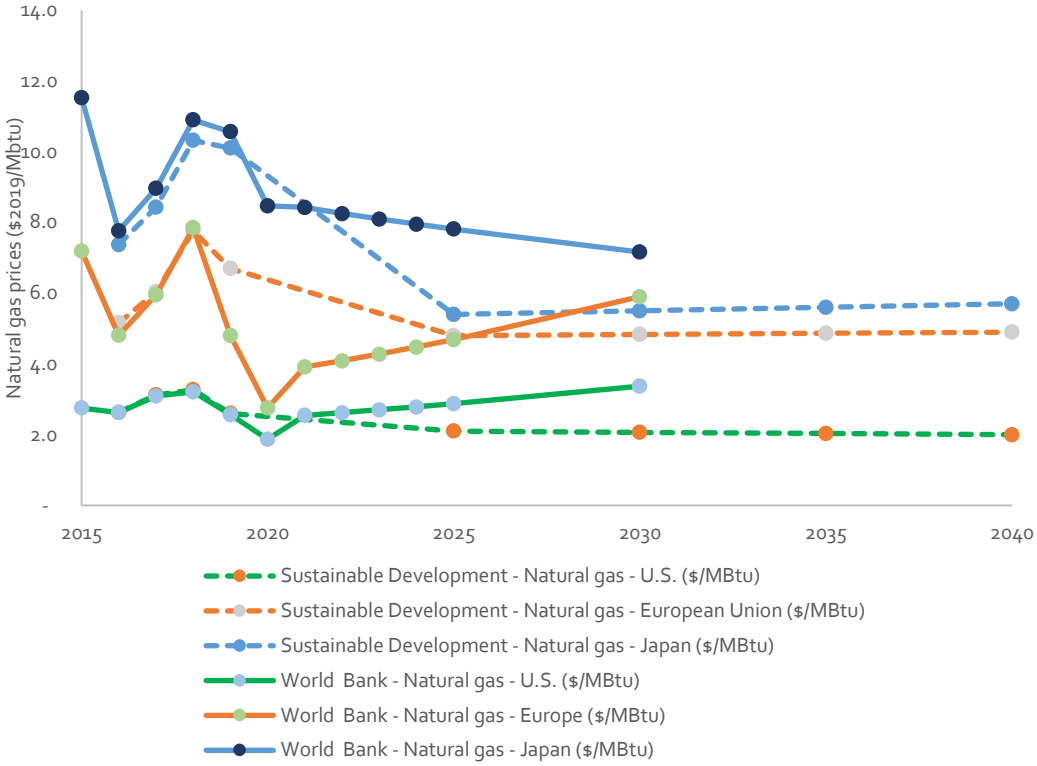

Figure 14: WEO natural gas price forecasts for various regions in the Sustainable Development scenario, and the World Bank price forecasts for the same regions. All prices are in 2019 USD per MBtu. Dots represent years with data points.

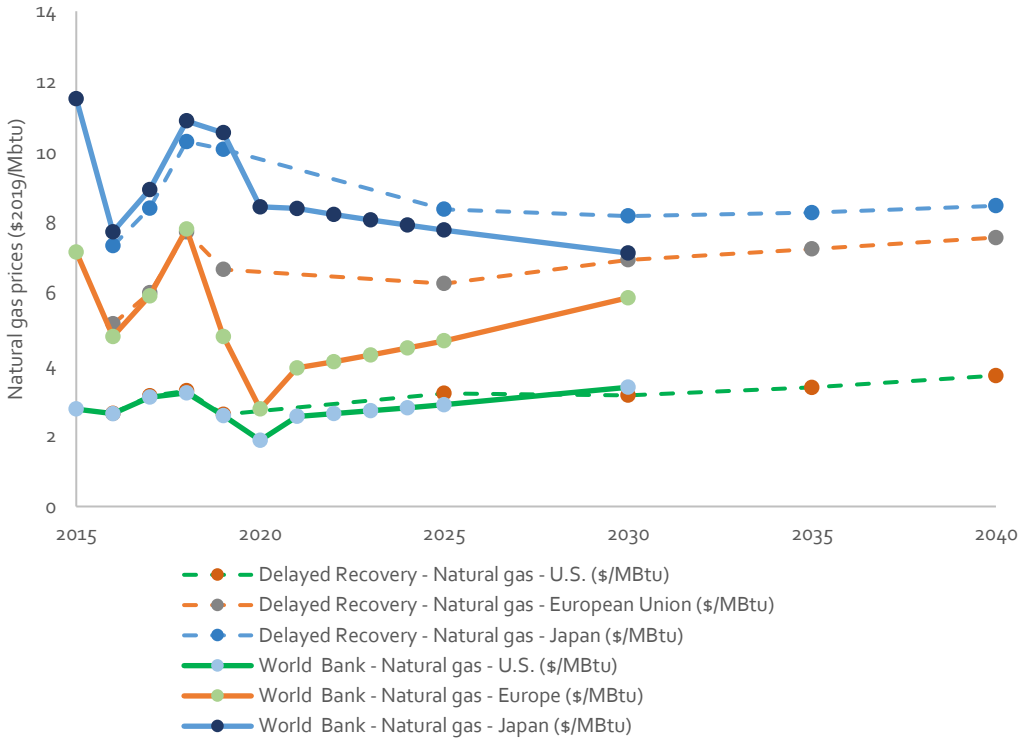

Figure 15: WEO natural gas price forecasts for various regions in the Delayed Recovery scenario, and the World Bank price forecasts for the same regions. All prices are in 2019 USD per MBtu. Dots represent years with data points.

5 Comparison of historic IEA price projections

This chapter compares the different fuel price projections from previous IEA WEO publications going back to 1994. When reviewing price forecasts, it is relevant to investigate how the same price forecasts have developed over time, and how current prices at the time of the forecast impacted the price predictions. This will provide context and understanding to evaluate the recent long-term projections and demonstrate uncertainties and challenges when predicting the future. As the IEA World Energy Outlook has been published on a regular basis with a standard methodology for many years it is quite suitable for this form of review. It is assumed that the New Policies and Stated policies represents the same methodology for the outlook of the energy sector.

Numerous oil forecasts from WEO publications since 1994, along with the historical IEA crude oil price are displayed in Figure 11.

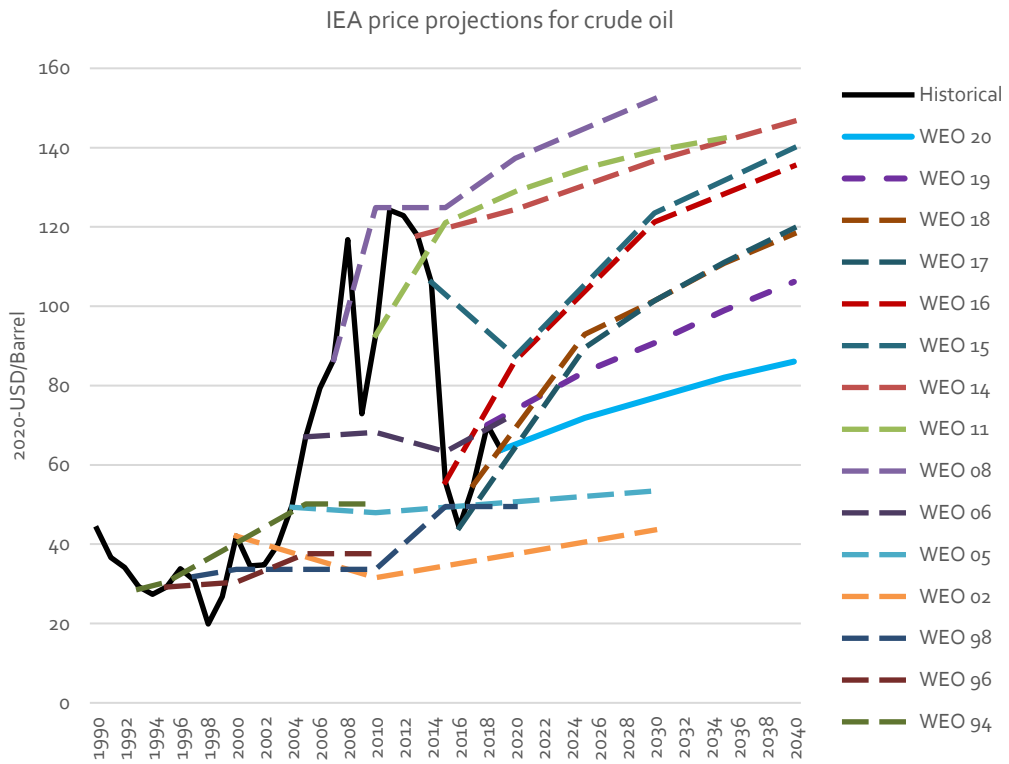

Figure 16: Prior IEA WEO price forecasts for IEA crude oil in what corresponds to the Stated Policies Scenario and actual historical prices (2020 USD per barrel). IEA crude oil is a weighted average import price amongst IEA member countries.

It is evident from the figure that the price level at the time of the publication is extremely relevant for the future price forecasts. Prior to 2004, when the average annual oil price had not been over $40 for more than a decade, none of the WEOs predicted a future oil price over $45. However, as oil prices started to increase rapidly from 2005 to mid-2008, the WEOs in these years also started to forecast much higher future prices. More recently, lower oil prices have once again seen lower forecasted future oil prices, as the 2017 WEO forecasted a 2040 price of $110 per barrel, considerably lower than the high forecasted values for 2040 seen in the editions from 2016 ($124/barrel), 2015 ($128/barrel), and 2014 ($134/barrel). It is noticeable that the 2020 edition projects oil prices at a lower level than recent year's edition. The oil price at the time of publication in 2020 was very low due to the effects of the COVID-19 pandemic. On the decreased prices from IEA, the WEO 2020 writes the following (IEA, 2020, a):

> *The equilibrium prices for fuels have been revised down from those in the WEO-2019 because of the dampening effect of the crisis on demand, and because of changes to strategies and cost structures on the supply side. However, although prices are lower, the possibility of price volatility and of new price cycles has risen.*

In reviewing the same data for European natural gas (Figure 12 below), the story is nearly the same. Given that European oil and gas prices have historically been quite highly correlated, this is not surprising. If the same values were selected for US natural gas, the picture would be somewhat different, as the shale gas revolution in the US has led to a greater de-coupling of oil and natural gas prices in the US.

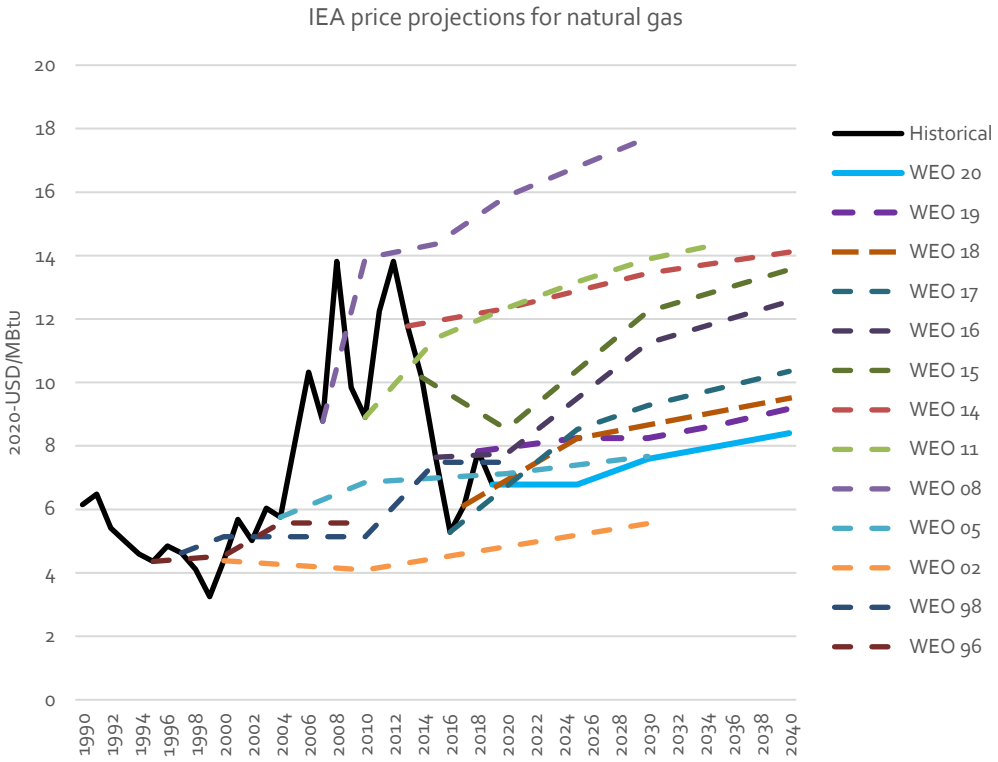

Figure 17: Prior IEA WEO price forecasts for the EU import price of natural gas in what corresponds to the Stated Policies Scenario and actual historical prices (2020 USD per MBtu).

Perhaps the clearest example of the current price having a direct effect on future prices is seen when reviewing the historic WEO forecasted prices for steam coal in Figure 13. While the future prices from various forecasts do converge slightly, many of the WEO forecasts are represented by somewhat straight, slightly rising lines, regardless of the current price level.

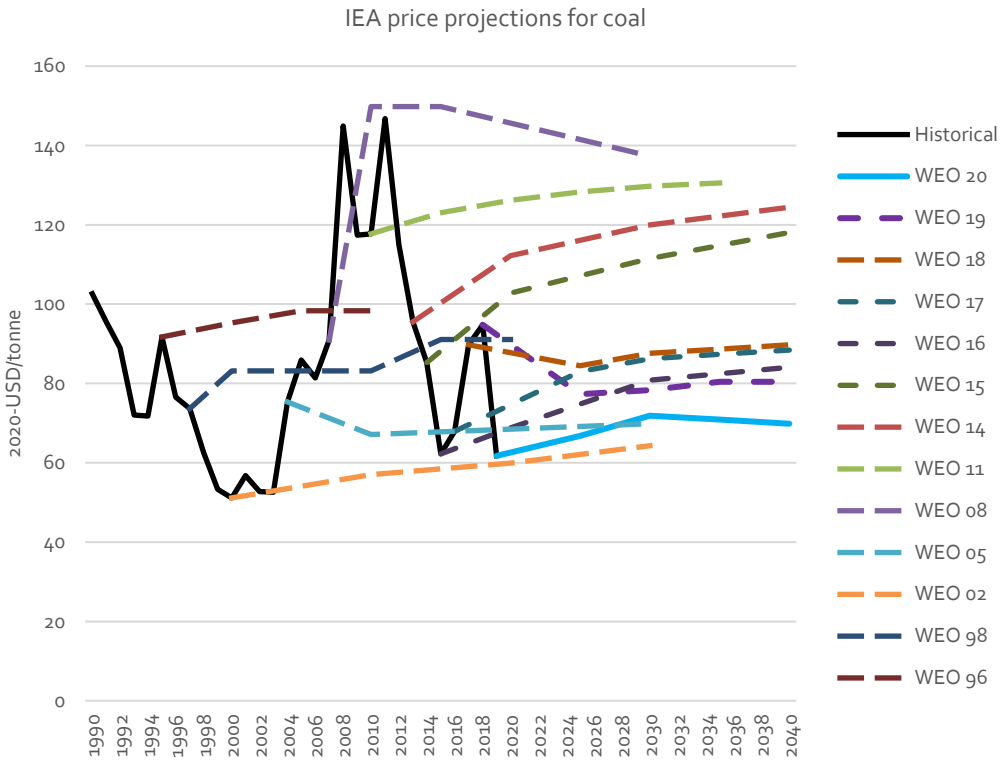

Figure 18: Prior IEA WEO price forecasts for coal in what corresponds to the Stated Policies Scenario and actual historical prices (2020 USD per tonne). For WEOs prior to 2016, the coal price is the OECD average steam coal import price. For WEO 2016 and 2017 the coal price is the EU average steam coal import price.

For coal, the projections demonstrate the same coherence between high price projections and high levels of the historical price prior to the publication.

It is interesting that for all three fossil fuels the price projections from WEO 2020 are one of the lowest since 1994. Whether this is mostly driven by the low current prices of 2020, the green transitions lowering the expected demand of fossil fuel or one of the many other aspects influencing the fuel price markets is difficult to quantify. However, the latest fuel price projections from WEO 2020 falls quite good in line with the expectations by Ea Energy Analysis which have viewed the New Policies / Stated Policies projection to be on the high side in earlier years. A further in-depth analysis and comparison of the WEO publications would be required to provide exact clarification on the changes in the projections.

In viewing the price projections publications over time, the charts demonstrate how predictions for the future can vary significantly. It is clear that mar-

ket prices at the time have historically affected long-term projections significantly. While it is often reasonable to base decision on latest available information perhaps the fuel price projections of IEA have suffered from too high correlation between current market prices and long-term projections, or so it might seem. However, looking at recent years the fuel price projections are closer in relation to the respective historical price, e.g. comparing WEO19 and WEO20, indicating that the effects of current market prices might be less signification in the latest publication.

The price spread of the different projections also demonstrates the difficulties and uncertainties in long-term projection with high variations in prices across publications. It is always important to be critical of any prediction of the future and it can thus be beneficial to investigate analysis and decisions under several different assumptions. Even though the methodology and documentation of the WEO projections are of a very high calibre it stands to reason that predicting the future is quite difficult. But having a well-explained main scenario with a solid foundation is a very strong tool in scenario analysis and the SPS is a well-know and highly regarded one. Alternative scenarios can then function as other perspectives on the future and help investigate the effects on energy systems if the future deviates from expectations of the main scenario.

6 Prognoses for imported fuels

6.1 Conclusions on price comparison

This chapter outlines the conclusions for the chosen methodology for long-term fuel price projections for Vietnam.

Methodology availability	In evaluating which price forecasts to use in the future, it is important to understand how these prices are derived, and what the most important drivers are. While complex, the IEA methodology for the World Energy Outlooks is well documented and constantly under refinement. On the contrary, the methodology for the World Bank prices has previously not been publicly available. However, in the latest version of the Commodity Markets Outlook a chapter is added to provide context to the World Bank's methodology to forecasting commodity prices. However, this is still quite limited compared to the thorough documentation from IEA.
Depth of analysis	The World Bank report encompasses over 40 commodities and only utilises a few pages to describe their five fuel price forecasts, whereas the WEO is an extensive publication numbering over 500 pages focused solely on energy-related matters. While this by no means exclude the World Bank projections for being usable and reliable, it is still favourable to have an extensive description with well-documented assumptions for the chosen projections. Especially when these projections are to be used in a multi-actor collaboration across both state agencies and private parties.
Additional scenarios	The fact that the WEO has three well-described primary scenarios is an advantage, as it both provides insight as to why future energy commodity prices are expected to develop, while also allowing the user of the data to determine which of the 3 scenarios are the most plausible going forward, and therefore which price data would be most appropriate to use.
Cost	The World Bank publication is free, whereas the IEA's WEO costs in the range of €120-600 depending on the number of users.
Time focus	The World Bank commodity forecast focuses more on the short-term price forecasts, whereas the WEO looks further into the future (WEO has 2035 and 2040 data points as well). Using a methodology that in the short term relies on forward/future prices which contain the most up-to-date market infor-

mation (which are freely available), it is assessed that for the long-term projections, it is important to focus on a data source that can provide medium to long-term forecasts, such as those provided by the WEO.

Quality assurance

Back in 2019, when the first Fuel Price Projection report and methodology were development for the Vietnam, the World Bank publication was found to contain a significant error in its natural gas price forecasts. The error was found when reviewing the World Bank nominal price forecasts where it became apparent that there was an error regarding the price forecasts for US and European natural gas in 2025 and 2030. It appeared likely that the Japanese price appeared where the US price should be, the US price appeared where the European price should be, and as a result there was no nominal price forecast for US natural gas during 2025 and 2030. This was not corrected until over half a year after the report publication.

6.2 Recommendations on long-term projections

Since the methodology for the Vietnamese fuel price projections utilizes forward prices in the short to medium term, the importance of having good and reliable sources for fuel prices beyond the medium term becomes important. Normally, forward prices are not even available for more than 3-5 years into the future. Furthermore, the more volatile nature of the forward price markets in comparison to equilibrium model projections, does not make them suitable for long-term projections.

Based on the above aspects, it is still recommended to utilise the World Energy Outlook scenario prices as inputs for developing price forecasts for imported oil, coal and LNG in Vietnam, with the IEA Stated Policies Scenario (the IEA's central scenario) as the main scenario. The WEO provides projections further into the future and the well-documented assumptions and methodology in the WEO and the WEM, together with the renowned and well-known reputation of IEA makes for a good foundation for the fuel price projections on the medium and long term. The methodology for fuel price projections converges into WEO prices in 2030 and use WEO prices also in 2035 and 2040. These price levels are then assumed to be constant towards 2050.

6.3 Short-term fuel price projections

The following section outlines suggested methodologies for oil, coal and LNG that both incorporate near-term forward prices, and long-term WEO scenario price forecasts from the WEO 2020.

The World Energy Model (WEM), the main tool used in the development of the IEA WEO scenario projections, operates under the assumptions of long-term equilibrium, i.e. a state of the economy where the general price level is fully reflecting – and adjusted to - the existing set-up of the main price drivers and market factors (as opposed to short-term equilibrium or cyclicality where the price level might not be fully adjusted to the concurrent situation in the market due to different short-term market factors and distortions/fluctuations). As such, it is reasonable to apply the WEM in price projections in the medium- to long-term based on fundamental supply and demand dynamics (subject to the realization of the assumptions regarding these dynamics in the respective scenarios). In the short- to medium-term, however, it is reasonable to assume that the price projections based on the best available actual market information (likely incorporating the price effects of short-term market distortions and/or cyclicality) would be more representative.

Future and Forward contract prices represent specifically this kind of information. Forward and Future financial contract prices express the market actor's willingness (and commitment) to pay for the commodities in question at a predefined future point in time. It is fair to assume that the prices of these financial contracts have been set based on the best currently available information, and, as such, serve as an indication of the best estimate of future price expectations shared among the market participants. This is the reason for the Future/Forward contract prices to be used for price pathway projections in the short- to medium-term, whilst WEO scenario projections – in the long-term.

Convergence prices

The 'convergence prices' in the context of this report are to be understood as short- to medium-term price projections that are a combination of forward price and the IEA WEO long-term prices for a given period of time. The convergence prices are produced as a weighted mean between IEA prices and forward prices (oil used as an example):

$$Convergence\ price_t = w_t \times WEO\ price_t + (1 - w_t) \times Forward\ price_t$$

where: w_t is the linear evolving weight from 0 to 1 in the years "Year of origin" to "Year of convergence". At the time of this report the Year of origin was chosen as 2023 with the year of convergence being 2030 (e.g., w_t will be 0 for 2023 price point; 0.143 for 2024 price points; 0.286 for 2025 price pointed and so forth reaching 1 for 2030 price points, respectively); t is the year of the respective price point. The convergence prices provide a gradual

link between the short- to medium term price projections as expressed forward prices and the long-term IEA WEO price projections in a way that puts more weight on forward prices in the beginning of the convergence period, and on the IEA WEO prices towards the end of the convergence period, respectively. Until 2023 the forward prices are used directly with a 100% weighting (i.e., no influence from WEO prices). The reason for this arrives from the very low prices seen in the current COVID-19 situation where market fluctuations are quite volatile and will historically be seen as outliers in regard to what market equilibrium models would predict. It is believed that the newest available information as dictated by the forward market prices is the best source for market prices in the next two years (2021-2023).

Crude oil

Vietnam is home to the 145,000 barrels/day Dung Quat and the newer 200,000 barrels/day Nghi Son refineries. Their aggregate refining capacity of 345,000 barrels/day are expected to cover around 70-80% of domestic fuel consumption (Chew, 2020). Plans for upgrading and expanding the Dung Quat refinery are undergoing with the expectation of increasing capacity by 30%.

Vietnam has recently inaugurated its 2nd oil refinery and combined with projected growth in demand for oil-based products, and falling domestic crude production, it is anticipated that imports of crude oil will grow in the years to come. It is therefore relevant to develop a methodology for forecasting future oil import prices.

Forward prices for delivered crude

Most of the the initial crude oil deliveries to the new 200,000 barrels per day (bpd) Nghi Son refinery came from Kuwait, and it is assumed that the Middle East Gulf will likely be the primary exporter of oil to Vietnam going forward (Reuters, 2018). According to Platts, 'Platts Dubai' is one of the most widely used global oil price benchmarks, and it is the pricing reference for crude oil delivered to Asian refineries from the Persian Gulf (S&P Global Platts, 2018).

Long-term WEO prices for delivered crude

As noted previously, the IEA crude oil price published in the WEO is a weighted average import price amongst IEA member countries. Given that a large share of IEA member countries oil imports currently consists of oil imported by Asian countries from the Middle East, it is assumed that the Platts Dubai and IEA oil prices should be closely correlated. This appears to very much be the case when comparing the historic prices (see Figure 15).

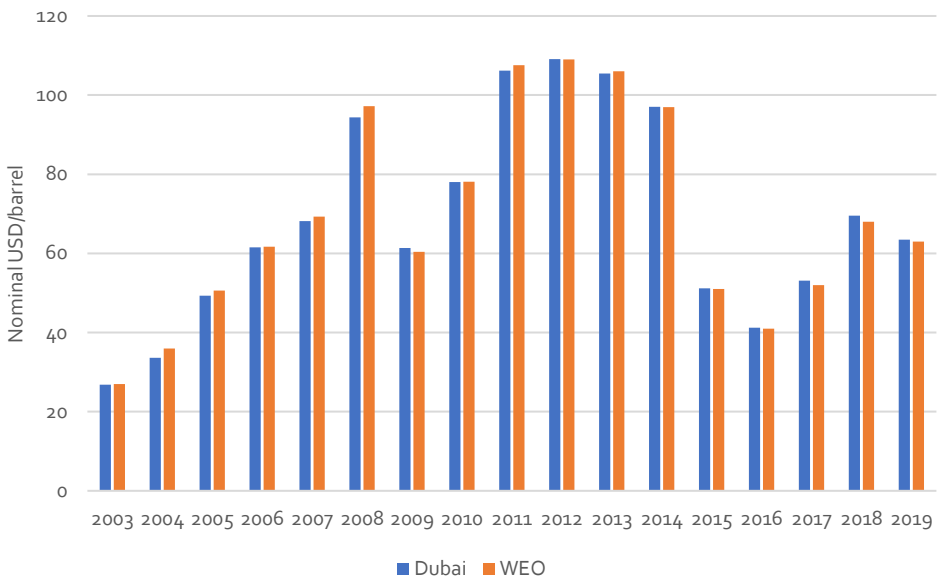

Figure 19: Historic prices for Platts Dubai crude (Ycharts, 2021), and IEA WEO crude oil.

Convergence profile

Utilising a publicly available forward price for Platts Dubai crude oil supplied by CME Group, and the long-term IEA price inputs, it is suggested to converge the two inputs together wherein forward prices weigh 100% during the first few years (until 2024), and gradually rely 100% on the IEA long-term price forecasts in 2030 (CME Group, 2020). Both of these price quotes represent delivered prices that are deemed to be representative of CIF Vietnam prices.

The suggested methodology results in price forecasts (black, blue and green solid lines) for the three IEA scenarios as displayed below in Figure 16.

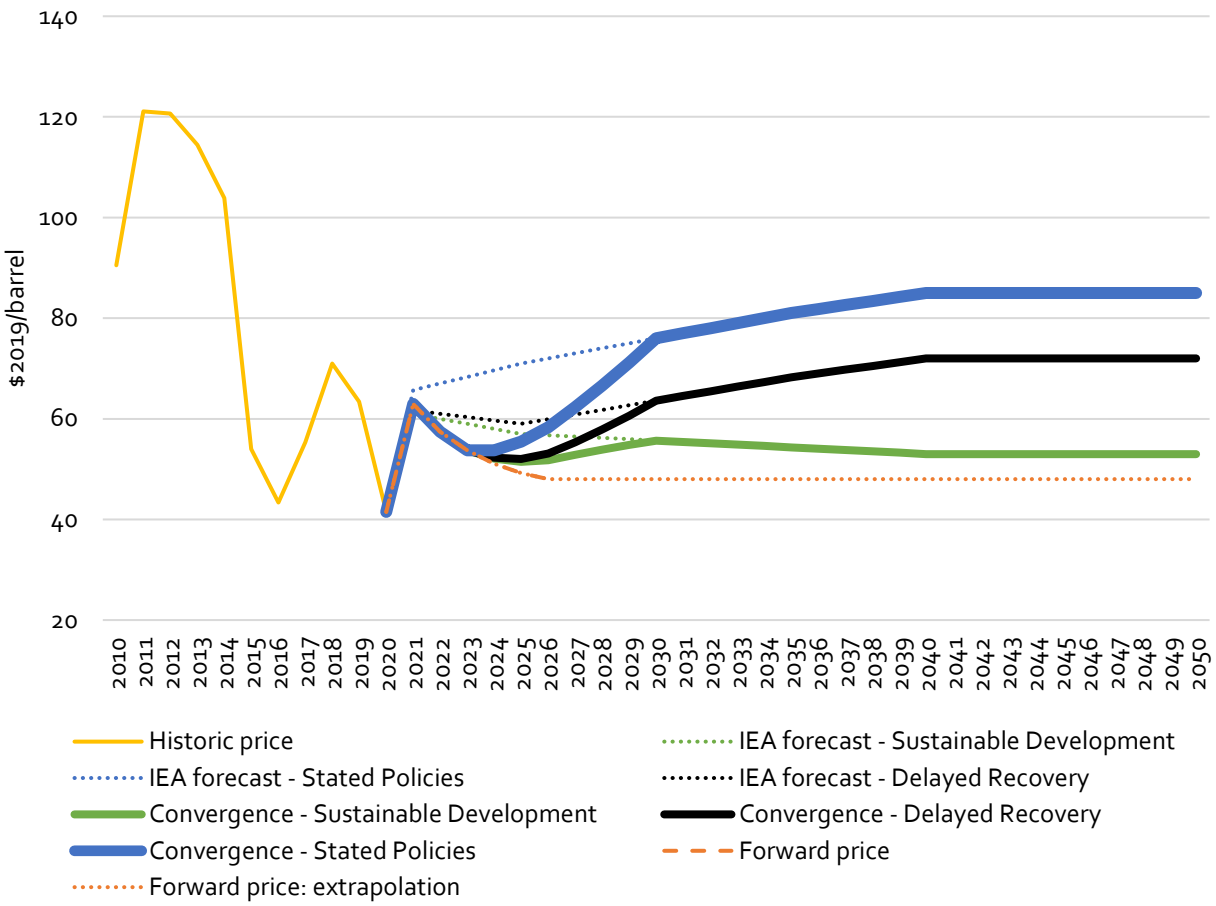

Figure 20: Imported oil price forecasts for Vietnam with the proposed methodology. All prices are CIF Vietnam. Note that the axis starts at 20.

Coal

Historically, Vietnam has been a net exporter of coal, but this changed in 2016 when Vietnam became a net importer. Net imports of coal have grown significantly since this time. Vietnam's coal import to supply power plants in 2019 is estimated to reach 32 million tons, doubling that of 2018 and three times higher than that three years ago. According to the Vietnam's Ministry of Industry and Trade, the country needs 54.3 million tons of coal in 2019, compared to 44.37 million in 2018 (Hanoi Times, 2020). Looking back at recent years most coal imports come from Indonesia, followed by Australia and Russia. As of 2019, the two most important import supply sources of coal to Vietnam were Australia and Indonesia, accounting for more than two-thirds of coal imports into Vietnam (Argus Media, 2021b). Taking this into consideration, it is likely that going forward the most relevant import markets are assessed to be Indonesia and Australia, and the historic coal prices from these two countries are displayed below.

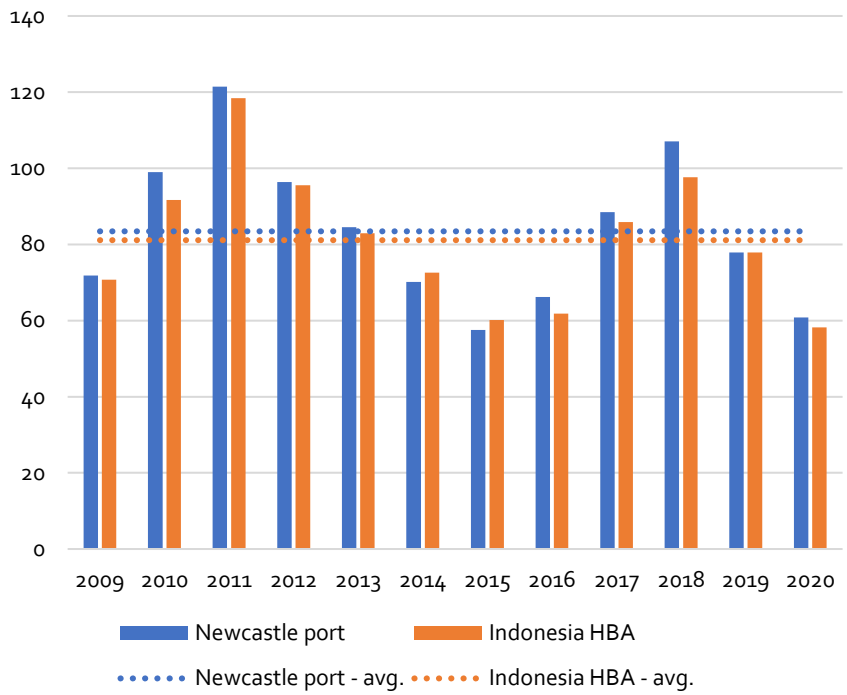

Figure 21: Historical coal prices in Indonesia (HBA) and the Australian port of Newcastle (FOB).

Figure 17 highlights how closely correlated the Indonesian and Newcastle (Australia) prices have been historically, with the average difference between the two during the 10-year period being 2,6 USD/tonne. This is not surprising given that Indonesia's benchmark HBA price is set by Indonesia's Ministry of Energy and Mineral Resources based equally on 4 price elements (Platts, 2018):

- Platts Kalimantan (5,900 kcal/kg GAR assessment)
- Argus-Indonesia Coal Index 1 (6,500 kcal/kg GAR)
- Newcastle Export Index (6,322 kcal/kg GAR)
- globalCOAL Newcastle (6,000 kcal/kg NAR).

Forward prices: Indonesian coal

While there does not appear to be any free publicly available future/forward price estimates for Indonesian coal, there are a number of publicly available sources for forward prices for Newcastle coal, including the example displayed below from KPMG's quarterly Coal Price and FX Market forecasts (KPMG, 2020), see Figure 22: Newcastle thermal coal (nominal USD/tonne).

Newcastle thermal coal (USD/t Nominal)

Year ended 31 December	Reporting date	2021	2022	2023	2024	2025	LT (2021)
Contributor 1	17-Jan-21	77.0	80.0	n/a	n/a	n/a	70.0
Contributor 2	15-Jan-21	65.0	70.0	75.0	75.0	n/a	75.0
Contributor 3	15-Jan-21	63.8	n/a	n/a	n/a	n/a	n/a
Contributor 4	13-Jan-21	70.0	75.0	75.0	75.0	65.0	65.0
Contributor 7	11-Jan-21	62.0	59.0	60.0	59.0	n/a	54.4
Contributor 9	7-Jan-21	65.0	67.0	71.0	75.0	76.0	68.1
Contributor 10	7-Jan-21	63.8	n/a	n/a	n/a	n/a	n/a
Contributor 11	6-Jan-21	60.0	65.0	65.0	67.0	n/a	75.0
Contributor 12	6-Jan-21	74.0	70.0	n/a	n/a	n/a	65.0
Contributor 13	5-Jan-21	55.0	55.0	n/a	n/a	n/a	n/a
Contributor 14	4-Jan-21	80.0	78.0	75.0	73.0	70.0	70.0
Contributor 15	4-Jan-21	65.0	68.0	n/a	n/a	n/a	70.0
Contributor 16	18-Dec-20	75.0	74.0	75.0	n/a	n/a	67.0
Contributor 18	15-Dec-20	65.0	68.0	n/a	n/a	n/a	75.0
Contributor 19	11-Dec-20	75.3	72.0	66.3	61.3	n/a	n/a
Contributor 20	10-Dec-20	77.5	69.5	n/a	n/a	n/a	n/a
Contributor 21	10-Dec-20	70.0	73.0	75.0	75.0	n/a	70.7
Contributor 22	9-Dec-20	75.0	78.7	n/a	n/a	n/a	n/a
Contributor 23	8-Dec-20	63.0	64.0	n/a	n/a	n/a	n/a
Contributor 24	1-Dec-20	55.0	59.0	63.0	63.0	63.0	n/a
Low		**55.0**	**55.0**	**60.0**	**59.0**	**63.0**	**54.4**
High		**80.0**	**80.0**	**75.0**	**75.0**	**76.0**	**75.0**
Average		**67.8**	**69.2**	**70.0**	**69.3**	**68.5**	**69.2**
Median		**65.0**	**69.8**	**73.0**	**73.0**	**67.5**	**70.0**
Previous bulletin (Sept/Oct20)							
Average		**61.5**	**65.5**	**68.3**	**67.9**	**n/a**	**69.2**
Median		**61.4**	**66.5**	**69.0**	**69.0**	**n/a**	**70.0**

Source: Thomson Research, the Contributors, KPMG Analysis
n/a: forecast not available

Figure 22: Newcastle thermal coal (nominal USD/tonne).

As a result of the close correlation between the prices of Indonesian and Newcastle coal, it is decided to use the forward price for Newcastle coal and adjust it with the historic average difference of 2,6 USD/tonne to arrive at forward price for Indonesian coal. If 2021 is taken as an example, then an estimate of a forward price for Indonesian coal could be 65,0 USD/tonne (median for 2019 from Figure 17) minus 2,6 USD/tonne, thus 62,4 USD/tonne.

WEO long-term price: Indonesian coal

The WEO has future price forecasts for Japanese coal, the majority of which comes from Australia (IEA, 2018b). Given an estimate of the shipping costs from Newcastle to Japan, it is therefore possible to determine an IEA-based estimate for the future price of Australian coal. An estimate of this shipping cost can be derived from a Platts publication (see Figure 23), where it can be seen that the shipping cost was roughly 14 USD/tonne during 2017.

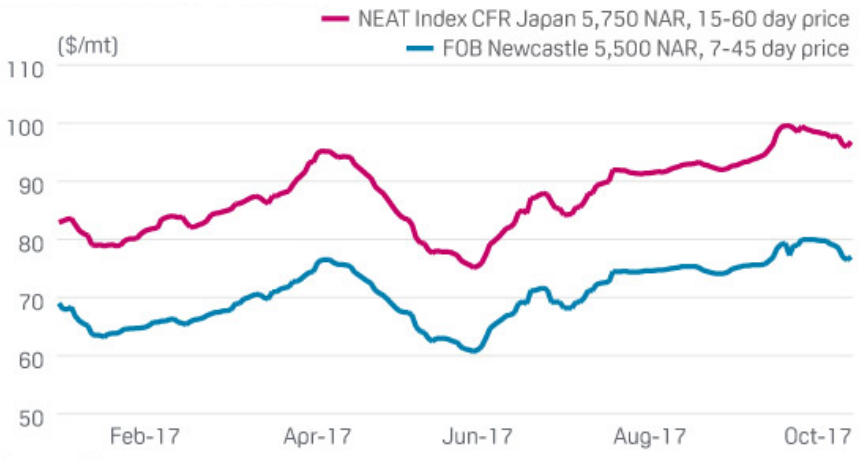

Figure 23: Thermal coal prices in Japan, and Newcastle, Australia during 2017 (Platts, 2017)

To arrive at an estimate for Indonesian coal in 2040 based on the SPS for example, then one would take the WEO price forecast for Japanese coal of 77 USD/tonne, and subtract 14 USD/tonne to arrive at an FOB Newcastle price of 63 USD/tonne. Assuming the same price difference between Indonesian coal and Newcastle coal of 2,6 USD/tonne, this yields an Indonesian price of 60,4 USD/tonne.

Conversion of Indonesian coal prices to CIF Vietnam

The last step then involves converting Indonesian prices to CIF (Cost Insurance and Freight) Vietnam prices, or simply stated, the price of a commodity on a ship sitting in a Vietnamese harbour prior to offloading. The estimate of Indonesia to Vietnam shipping costs arrives from comparing the historical import price gathered from the Vietnam Customs with the historical Indonesia's benchmark HBA price (Vietnam Customs, 2021):

	2016	2017	2018	2019	2020
Import volume (tonne)	13,198,727	14,677,046	22,855,625	43,770,107	54,811,643
Import value (nominal USD)	959,455,738	1,534,094,180	2,554,990,471	3,788,751,927	3,777,658,763
Implicit import price (nominal USD/tonne)	73	105	112	87	69
Newcastle Port (nominal USD)	66	89	107	78	61
Indonesia HBA (nominal USD)	62	86	98	78	58
Transport cost (nominal USD)	10.9	18.6	14.1	8.7	10.8
Transport cost (USD2019)	11.5	19.4	14.4	8.7	10.6

Table 6.1: Historical imports of coal for Vietnam and comparison with Indonesia's benchmark HBA coal prices. Difference resulting on estimated transport costs from Indonesia and Vietnam.

The average resulting transportation costs between Indonesia's benchmark HBA price and the CIF prices in Vietnam from the period 2016-2020 is then 11.6 USD19/tonne. Following the price example above for 2040 the CIF price in Vietnam is then 72 USD19/tonne.

Convergence profile

The aforementioned convergence profile (i.e., forward prices weigh 100% during the first few years until 2024, and gradually give weight to 100% reliance on the IEA long-term price forecasts) is then applied to the above forward and long-term IEA price inputs. In this respect it should be noted that the IEA price has been adjusted via the described add-on so that it reflects a Vietnamese CIF price. The suggested methodology results in price forecasts (black, blue and green solid lines) for the three IEA scenarios as displayed below in Figure 20.

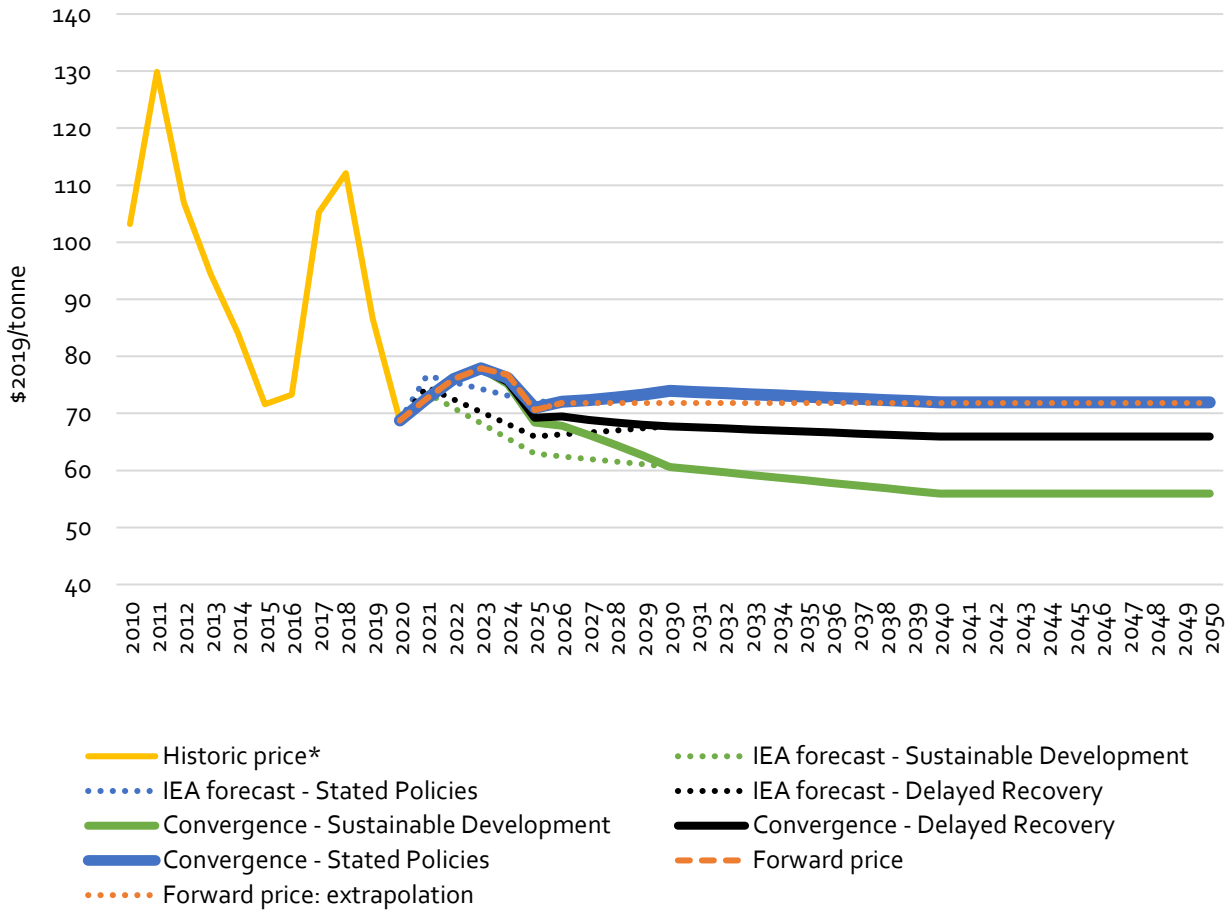

*Figure 24: Imported coal price forecasts for Vietnam with the proposed methodology. All prices are CIF Vietnam. Note that the axis starts at 40. *Historical cost is an estimate based on historic Indonesian prices converted to CIF Vietnam estimates.*

As can be seen from Figure 20, all three price forecasts rely solely on the forward price in 2021, 2022, and 2023. Thereafter, a growing weight is placed on the IEA-based long-term price forecast, which is fully converged to in 2030.

There are a number of open issues that can be discussed and improved in such a methodology, including:

- Until which year forward prices are used (currently 2024)
- The desired full convergence year (currently 2030)
- How to extrapolate the forward price in the years in which there are no forward prices. Currently this occurs from 2027 where the value from 2026 has been held constant towards 2050 (but has no effect after 2029, as there is full convergence in 2030)
- How to extend the IEA price forecasts from 2040 to 2050 as the last IEA data point is in 2040. Currently, the price levels of 2040 are assumed to be constant towards 2050. However, another option could be to apply the average growth rate from 2035 to 2040 through to 2050.

Imported LNG

In Asia, there are essentially two main LNG price markers: the Japan Korea Marker (JKM) by Platts and the Argus Northeast Asia (ANEA) marker. Given that the shipping distances from Australia to Japan are very similar to those between Australia and Vietnam, it is assumed that Japanese LNG import prices can serve as a good proxy for Vietnamese import prices. Furthermore, a large portion of Japan's LNG imports currently come from Australia, and this is anticipated to only increase in the future. It is also likely that a significant portion of Vietnam's LNG imports in the future could come from Australia, as this country overtakes both Qatar and the USA and becomes the world's largest LNG exporter (Oil & Gas Journal, 2020).

Regarding projections, there are both IEA long-term forecasts for LNG delivered to Japan as well as the publicly available prices for the JKM contract, covering the period up to 2026. Using the convergence price methodology already described, it is possible to construct the LNG price scenarios depicted below in Figure 21.

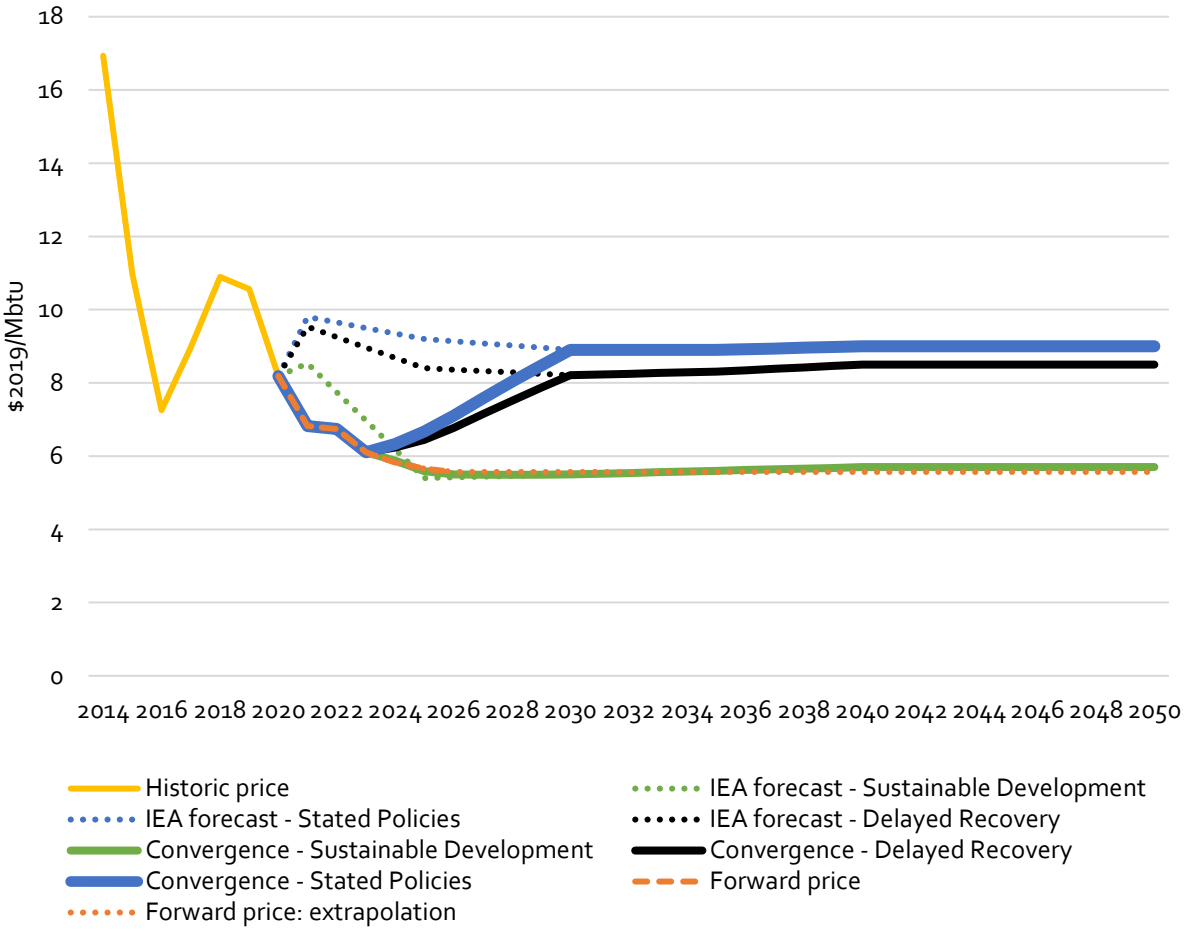

Figure 25: Imported LNG price forecasts for Vietnam with the proposed methodology. All prices are CIF Vietnam.

6.4 Alternative LNG price scenarios

During January 2021, in the middle of a colder-than-usual winter, the Asian LNG market experienced an unprecedented price spike, which revealed potentially relevant challenges to the future development of both price levels and pricing mechanisms in the region (Fulwood, 2021; S&P Global, 2021). Regarding price levels, it is possible that price markers will become more volatile in the future, making it more challenging to produce an accurate forecast of the LNG price.

More generally, the price spike revealed two possible fundamental underlying issues at play in the Asian LNG market (Fulwood, 2021):

- Although price markers for the LNG market do exist, such contracts are not backed by a physical market, which allow market participants to hedge future risks, rather than to secure short-term deliveries.

- Gas infrastructure, particularly storage, is very limited in most Asian markets, which means that in situations where demand experiences sudden increases, it is not possible to rely on existing storages. Instead, LNG consumers need to secure the delivery of the fuel, which among other things, depends on the availability of LNG tanker capacity from the delivery point.

Although these structural issues may not decidedly trigger a revival of long-term oil indexing and impede the evolution of the Asian LNG market into a hub pricing, market participants may feel compelled to use other benchmarks with physical delivery, as a long-term pricing strategy.

As a specific example of this possibility, an alternative price scenario based on one of the oldest oil-indexed LNG contracts (for LNG import to Japan) has been used. Specifically, we use the 1973 SPA between Pertamina (from Indonesia) and the so-called Western Buyers in Japan (Finizio et al., 2020):

$$LNG\ price = 0.1485 \times Crude\ Oil\ benchmark + 0.60$$

The slope of the formula (0,1485) reflects the extent to which the change in the price of the indexed crude oil is passed through to the buyer on an energy equivalent basis.[6] The constant, which in this case is set to 0,6 reflects the cost of delivering the LNG to its destination. The most commonly used price index for crude oil in LNG contracts in the Asia Pacific region is the Japan Customs-cleared Crude (JCC), often called the Japanese Crude Cocktail. However, for Vietnamese context and utilizing a long-term price projection it is chosen to use the crude oil price for Vietnam described above in Chapter 6 using the SPS scenario as the benchmark for the oil index pricing. Following the same methodology as with the previous fuel price projections, the oil-indexed scenario converges from forward prices for LNG in 2024 to the long-term prices in 2030 found by the oil indexing formula described above.

As described above the WEO provides three scenarios for long-term LNG price projections: SPS, DRS and SDS. These along the Oil index scenarios is shown in Figure 26.

[6] In this case, as the slope is lower than 0,1724, less than the full change in the price of crude oil is passed along to the buyer.

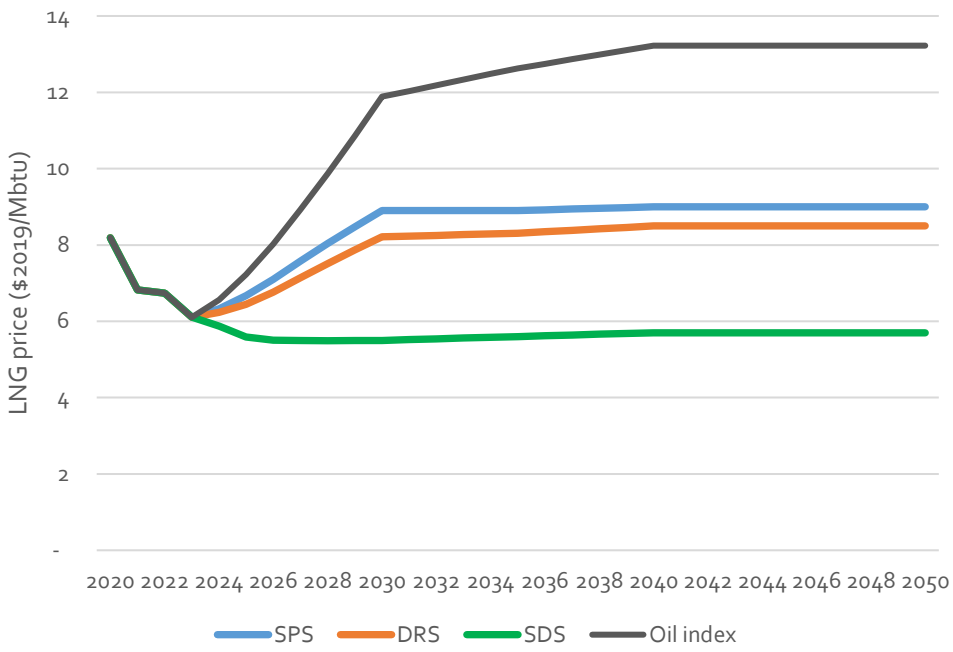

Figure 26: LNG price scenarios for Vietnam. Four scenarios: Stated Policies, Delayed Recovery Scenario, Sustainable Development Scenario and Oil index scenario.

The levels of the four LNG price scenarios are seen here:

LNG price scenarios ($2019/Mbtu)	SPS	DRS	SDS	Oil index
2020	8.19	8.19	8.19	8.19
2025	6.67	6.44	5.59	6.57
2030	8.90	8.21	5.50	11.89
2035	8.90	8.31	5.60	12.63
2040	9.00	8.50	5.70	13.22
2050	9.00	8.50	5.70	13.22

Table 6.2: LNG price scenarios for Vietnam. Four scenarios: Stated Policies, Delayed Recovery Scenario, Sustainable Development Scenario and Oil index scenario.

6.5 Fuel prices at place of consumption

From CIF to consumption

The above price forecasts are all CIF Vietnam prices, i.e. the price of a fuel while still on a ship in a Vietnamese harbour. In order to arrive at prices at the place of consumption, sometimes referred to as gate prices, various adjustments to the CIF price must be made. Elements in these 'add-ons' include (but are not limited to):

- Harbour fees
- Offloading costs
- Storage costs in the harbour

- Costs related to loading, transportation, and offloading at the final destination.

For LNG, costly terminals are required in order to receive the LNG and convert it to natural gas. Therefore, this cost, along with the costs associated with usage of a pipeline to transport the natural gas, must also be added to the CIF price in order to arrive at a 'at power plant' natural gas price.

Many of these elements can be site/ship/fuel specific in nature. For example, unloading of a large coal ship may be cheaper on a per tonne basis because larger cranes can be utilised. Distances from a power plant to a harbour can also vary greatly.

Due to the site-specific nature of these cost elements, these will be addressed below in Chapter 9.

7 Ability to import LNG and coal

After a period of strong economic growth (5,9%/year on average during 2016-2020) and even stronger growth in load demand (10,5%/year on average during 2011 – 2019 on average), Vietnam expects to continue with this upward trend up to 2045, propelled by even further economic growth. This vision is confirmed by Vietnam's draft national power development plan (PDP8), prepared by Vietnam's Ministry of Industry and Trade and the country's Institute of Energy (MOIT & IoE, 2021).

It follows from Figure 23 that load demand is projected to grow throughout the entire period covered by the PDP8, but it is expected to decelerate from the average growth rate of 8,5%/year in the period 2021-2030 to 4,7%/year in 2021-2040 and further down to 2,5%/year in 2041-2045. This development is expected because of structural changes in the Vietnamese economy, together with an increased level of energy efficiency (MOIT & IoE, 2021). It also follows from Figure 23 that economic growth is expected to reach an average of 6,6%/year in 2021-2030 and 5,8%/year in 2031-2040 and 5,5%/year in 2041 – 2045.

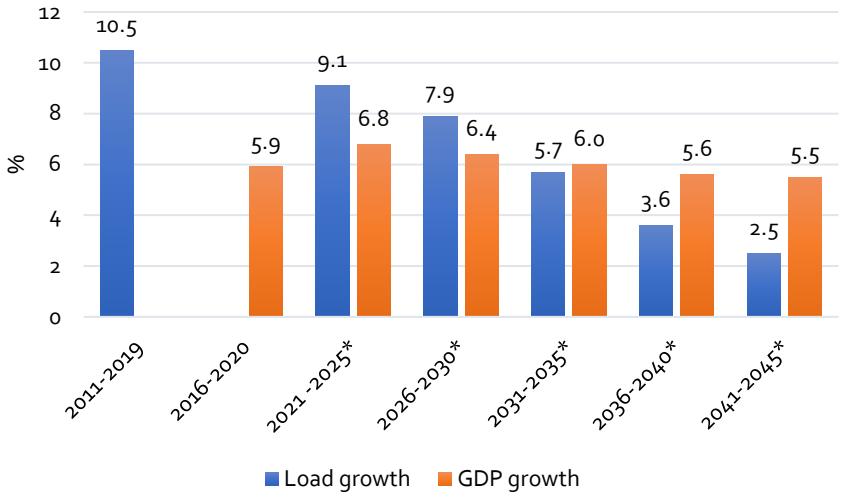

Figure 27: Load growth and GDP growth in Vietnam (percent; average yearly growth in the period) according to the base scenario. Source: PDP8 prepared by (MOIT & IoE, 2021) in cooperation with Vietnam's Ministry of Planning and Investment. Note: figures for the periods 2011 - 2019 and 2016 – 2020 are realized, whereas those with (*) are forecasts.

Against this backdrop, Vietnam needs to secure sufficient electricity generation sources to sustain its projected growth. As of 2020, hydropower and coal-fired plants are the two largest sources of electricity generation, accounting

for respectively 30,4% and 30% of total installed capacity in the country.[7] These two sources are followed by solar power with 24,5% and gas-fired power plants (10,4%).

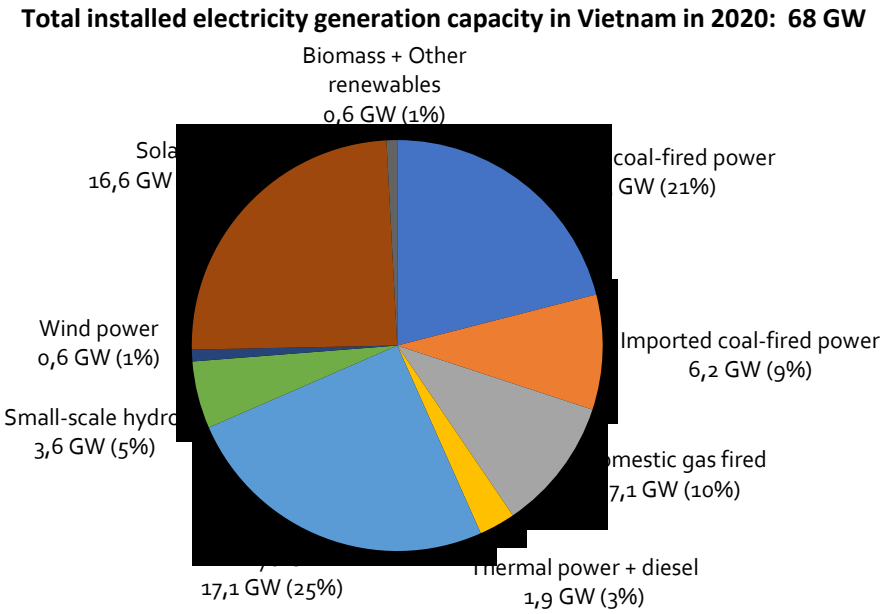

Figure 28: Breakdown of total installed electricity generation capacity in Vietnam in 2020. Source: PDP8 (MOIT & IoE, 2021) with data summary by Baker McKenzie (2021).

As hydro resources have been developed nearly to its potential and domestic production of coal has remained stable but lower than expected, there has been a growing need to rely on imported coal in recent years. Total imports went from 22,8 million tonnes (mt) in 2018 to 43,6 mt in 2019, of which 7,24 and 17,24 mt were destined to electricity generation in 2018 and 2019, respectively (MOIT & IoE, 2021).

Moreover, despite ongoing natural gas production in the country, LNG imports are set to become even more relevant role to fuel the energy needs of Vietnam's foreseen economic expansion. Solar generation has already gained considerable prominence in the country and both onshore and offshore wind are expected to further increase the role of renewables in the country.

[7] According to the PDP8, 25,1% corresponds to large-scale hydropower and 5,3% to small-scale hydropower. Furthermore, observe that 21% of coal used in Vietnamese power plants is domestically produced, while 9% is imported (MOIT & IoE, 2021).

However, to meet the country's need for dispatchable capacity, imported fuels – particularly LNG and coal – are expected to continue playing a central role. Although both fuel sources are expected to grow in absolute terms up to 2045, gas-fired electricity production is expected to gain more relative weight in Vietnam's electricity generation mix, while coal decreases its relative importance. The geographical sources and the prices at which these fuels will be obtained are an important element for the future of Vietnam's energy economy.

7.1 Domestic natural gas production and LNG import capacity

At present, Vietnam has 26 natural gas producing fields, in addition to other fields producing associated gas. All of Vietnam's gas production is used domestically, and as of 2019 the country produced approximately 10,01 billion m^3 (bcm), of which 77% was destined to electricity generation, 11% to nitrogen production and 12% to other uses (MOIT & IoE, 2021). Furthermore, Vietnam does not presently have any gas import or export infrastructure, although it does export crude oil and petroleum products, despite having limited refining capacity to meet its domestic demand (UK Department for International Trade, 2019a; US Energy Information Administration, 2017a).

Although Vietnam possesses proven gas reserves in the range of 702,8 - 743 bcm (IES & EMCa, 2017; US Energy Information Administration, 2017a) and there have been recent discoveries and ongoing development projects, the country is not expected to be able to meet its future gas requirements with domestic production alone (MOIT & IoE, 2021; UK Department for International Trade, 2019b; US Energy Information Administration, 2017b). This can be seen in the PDP8 projections presented in Figure 25, where gas-fired electricity generation fuelled by domestically produced gas increases up to 2030 and decreases thereafter, while LNG-fired electricity generation increases. Figure 25 also shows that overall gas-fired production capacity is expected to play an increasing role in Vietnam's overall electricity generation capacity, going from 10,2% in 2020 to 24% in 2045.

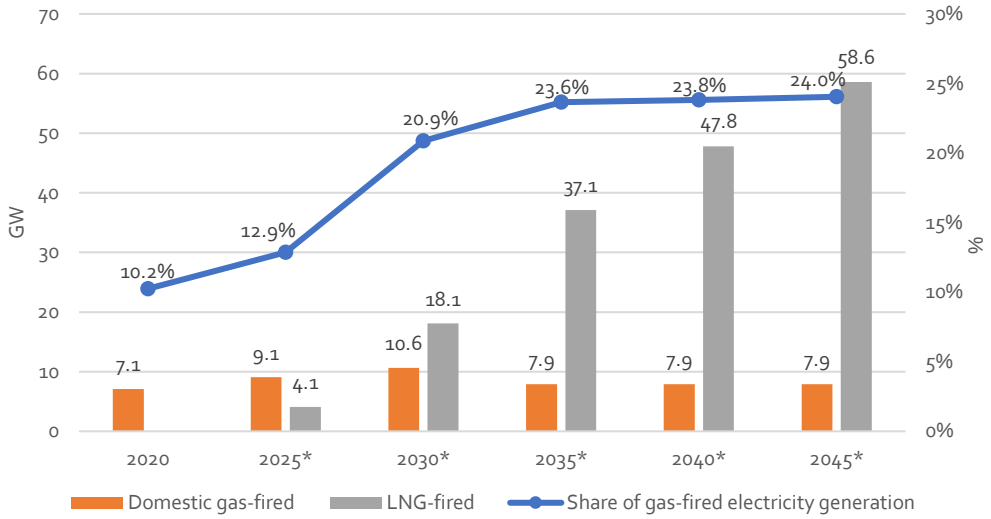

Figure 29: Expected evolution of gas-fired electricity generation capacity in Vietnam. Source: PDP8 baseline scenario (MOIT & IoE, 2021) with data summary by Baker McKenzie (2021). *Note: figures for 2020 are realized, whereas those with (*) are forecasts.*

Regarding domestic discoveries of natural gas, ExxonMobil and partners made in 2011 an important offshore gas discovery holding an estimated 150 bcm in the Ca Voi Xanh (or Blue Whale) field. However, the project has proven to be more challenging to develop than previously expected, due to the geographical distance to a nearby market and the CO2 content of gas from the field, among other things (Energy Voice, 2020a; ExxonMobil, 2018).

More recently, in 2020, Eni announced another major discovery, containing an estimated gas in place in the range of 198 – 254 bcm, in addition to 400 – 500 million barrels of associated condensates. Even with a conservative recovery factor of 60%, there could approximately 136 bcm of recoverable resources. A successful progress into the operational stage could drastically ease Vietnam's need to rapidly develop LNG import infrastructure in Vietnam (Energy Voice, 2020b; Eni, 2020).

As there presently are no LNG terminals in Vietnam, it remains unclear exactly when will LNG import infrastructure will come online. In addition, information sources differ in their time estimates, between 2022 and 2025 (Allens, 2020; MOIT & IoE, 2021). What is so far known, is that there are three approved projects underway (Allens, 2020; Argus, 2020):

- Thi Vai LNG terminal, developed by PVGas
- LNG terminal in the Cai Mep Industrial Zone, developed by Hai Linh Energy

- Nam Dinh Vu LNG terminal, reportedly developed by ITECO

Regarding LNG import sources, Vietnam expects to obtain supplies from Qatar, Australia and the USA, which are the three biggest producers globally. However, the country's ability to secure imports will depend on its relative position relative to other LNG consumers in Asia. China, Japan and Korea are all among the largest consumers of LNG in the world, a fact that could challenge Vietnam's ability to obtain LNG. With a longer-term perspective, the country expects to diversify its import sources from Russia, Turkmekinstan and Iran (MOIT & IoE, 2021).

Implications for gas price projections

Given that Vietnam is a relatively small player in a region characterized by the concentration of big LNG consumers, price formation for this fuel in the region is likely to be more sensitive to the demand of larger countries in the region, like Japan, China, and Korea, than to Vietnam's LNG demand.

As the price spike of Asian LNG prices in January 2021 reveals, there may be structural issues in the market, which could make it likely that a similar episode happens again (Fulwood, 2021; S&P Global, 2021). As Vietnam enters the LNG market, it is important for the country, not only to secure sufficient supplies, but also to agree on supply contracts that safeguard it from potential volatility in the market. A number of options exist in this respect: oil indexation, spot purchases, and a variety of hub-linked pricing options, such as the Japanese LNG cocktail or the Japanese Korea Marker (TLG, 2018).

7.2 Coal

Vietnam possesses indigenous coal production, which reached 45,9 mt in 2019. However, this production covers only one part of its electricity generation and industrial requirements. Presently, 76% of domestic coal production (roughly 35 million tonnes/year) is used in electricity generation while the remainder is used in other industrial applications (MOIT & IoE, 2021). Total coal demand for electricity production in Vietnam was 52,3 mt in 2019 (MOIT & IoE, 2021).

The present situation stands in contrast to the past two decades, when Vietnam exported a large part of its production and imported a small amount given that the country's production exceeded its demand (US Energy Information Administration, 2017b).

As Figure 26 indicates, Vietnam expects imported coal to continue playing an important role in electricity generation up to 2045, which means gradually increasing imports, as has been the case in recent years. However, coal-fired electricity production is expected to decrease from the present-day 29,5% to 18% in 2045.

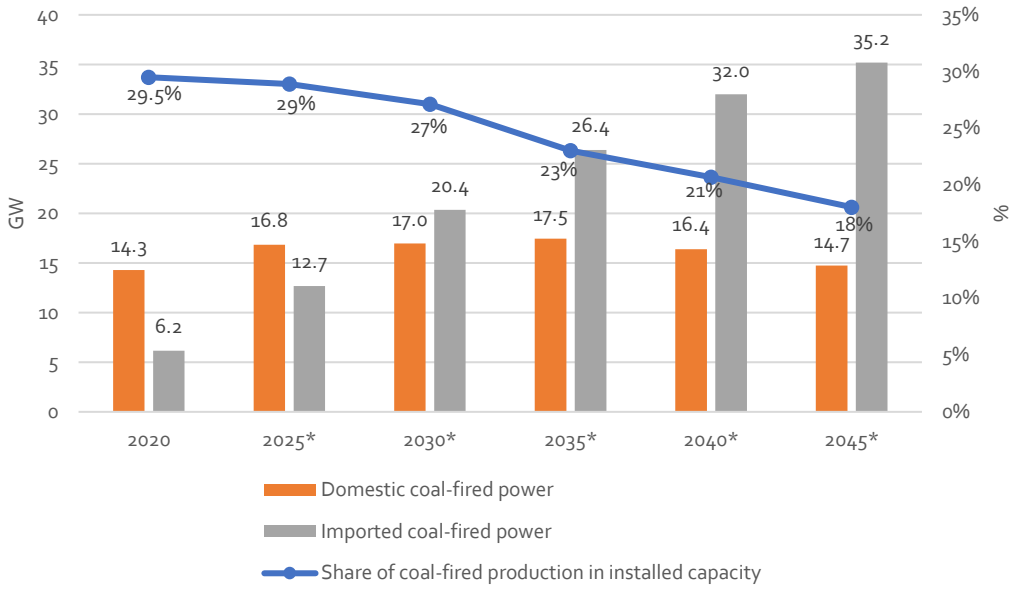

Figure 30: Expected evolution of coal-fired electricity generation capacity in Vietnam. Source: PDP8 baseline scenario (MOIT & IoE, 2021) with data summary by Baker McKenzie (2021). *Note: figures for 2020 are realized, whereas those with (*) are forecasts.*

Regarding sources, Indonesia, Australia, South Africa and Russia appear to be in the position to provide the necessary supplies to Vietnam. Given geographical considerations, reserves and infrastructure, Indonesia and Australia seem to be in relatively better conditions than Russia and South Africa to provide coal supplies to Vietnam.

Although Russia has abundant reserves and domestic gas usage in Russia is prioritized (which facilitates exports), transportation costs to Southeast Asia can constitute a barrier, given that an important part of production takes place in Siberian mines. A similar situation with respect to South Africa, as transportation costs to Vietnam can be significant. However, unlike Russia, demand for South African coal is high in places like India (South Africa's largest buyer of coal), but also in other African countries, which makes it difficult for Vietnam to obtain coal from these countries.

Australia has significant coal reserves and good geographical conditions to be a stable supplier to Vietnam. In fact, Vietnam has already helped to absorb some Australian supplies that were frozen out of their traditional key market (China), following an unofficial ban imposed by Beijing, which have nonetheless been de facto lifted (Argus Media, 2021a, 2021b). As a supplier to Vietnam, Australia's main challenge is that the country may experience limits to the expansion of its production in the medium to long run. In fact, one of Australia's major coal producers (Glencore) pledged to cap output amid shareholder pressure to limits its environmental impact (Associated Press, 2019).

Geographical proximity is the most favourable argument for Indonesia to remain as one of Vietnam's more stable suppliers. After India, Vietnam has the largest coal-fired power plant projects in terms of capacity among countries in Southeast Asia and South Asia, which makes of it an important buyer of Indonesian thermal coal (Reuters, 2020). However, due to the limited extent of Indonesia's reserves (which may last for 60 more years), it may only be a stable supplier in the medium to long term, meaning that further diversification of suppliers will still be required (MOIT & IoE, 2021).

All in all, as of 2020, Australia and Indonesia accounted for more than two-thirds of Vietnam's coal imports, which highlights the increasing need for Vietnam to diversify its import sources.

Implications for coal price projections

Given the relatively limited geographical sources from which coal can be obtained, as well as the competition faced by Vietnam against other consumption centres in Asia (e.g., India), it is possible that coal import prices to Vietnam experience spikes in the future.

Although demand for coal was weak in 2020, due to among other things the COVID pandemic, coal prices received a boost because of increased imports from Vietnam. It is worth noting that the increase (in prices and in imports) took place at a time when there was a de facto import ban on Australian coal by China. Now that the ban has been lifted, price might experience further increases (Argus Media, 2021a, 2021b).

8 Historical Vietnamese fuel prices

For some domestic fuel, via Law No. 11/2012/QH13, the following products are subject to price stabilisation:

- Petroleum products;
- Electricity;
- Liquefied petroleum gas (LPG).

The regulation means that the prices for energy products should be stabilized under two circumstances: (i) the prices fluctuate abnormally and (ii) the prices have negative impacts on socio-economic stability. Moreover, in the energy sector, the Government also sets tariffs for electricity transmission and auxiliary services. Tariff schemes for electricity generation, bulk-supply and retail are under the Government's control as well.

Petroleum products

For petroleum products, the government sets "base prices" as price ceilings. The formula to calculate ceilings for consumer price includes various taxes and fees, including: import duties, special consumption taxes on gasoline and E5, a stabilization fund fee, an environmental protection tax and VAT. These taxes and fees are where the Government can exercise discretion to adjust petroleum product selling prices. The government has historically influenced end-user prices by adjusting import duties and making use of a price stabilization fund. Figure 31 shows the domestica average retail prices for petroleum products in Vietnam.

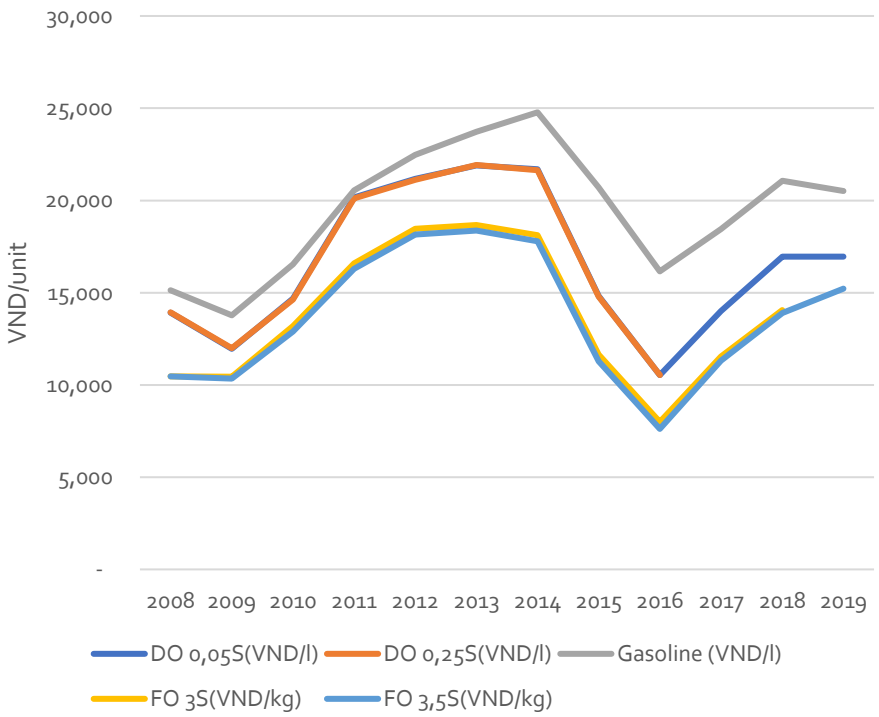

Figure 31: Domestic average retail prices for petroleum products. DO 0,05S means diesel oil with sulphur content less than 50 part per million (ppm).

Natural gas

The Exploration and exploitation of oil and gas in Vietnam is mainly concentrated in: Cuu Long basin, Nam Con Son, PM3-Ca Mau and Ham Rong-Thai Binh. In which, the volume mainly comes from the Nam Con Son basin (Lot 06.1, Hai Thach-Moc Tinh, Lot 11.2, Lot 12W), accounting for about 60-70% of the total, followed by is the PM3-Ca Mau basin, with about 20% of the output. In recent years, the decline in the fields at the end of the exploitation period with low price (Bach Ho, Su Tu Den / Trang, Lot 06.1, Lot 11.2 in Cuu Long and Nam Con Son basins) was offset by the gas fields that have just come into operation which have large reserves and high price (Hai Thach-Moc Tinh).

Region	Field	Note
South East	Cuu Long	Cuu Long was in operation in 1995, The oil and gas potential of Cuu Long basin is assessed at ~ 130-215 million tons of oil scale. Cuu Long is still the most important oil and gas deposit basin, contributing over 30% of the increase in reserves in the 2011-2019 period. Production in decline.
	Nam Con Son	Nam Con Son was in operation in 2003. With the oil and gas potential assessed at about 260-450 million tons of oil, the Nam Con Son basin has contributed over 30% of the increase in reserves in the 2011-2019 period. NCS2 in operation since 2016.
South West	Malay-Tho Chu	Offshore area administered jointly with Malaysia. Ca Mau pipeline in operation since 2007. Ca Mau supplied from Block PM3-CAA + Cai Nuoc field Delivered > 10 Bcm (8%) of nationwide gas production. Not yet reached maximum production capacity
North	Song Hong	Gas extraction from small deposits has recently commenced. Production expected to increase.
Central		Production expected to be started with Ca Voi Xanh (2024) and Ken Bau (2028) fields.

Table 8.1: Natural gas fields in Vietnam

Regarding the price of raw gas, the price mechanism is determined by the Government, according to a fixed or floating mechanism:

- Fixed price for Cuu Long and Nam Con Son basins: The price of gas is determined through GSA for long-term gas between PVN/PVGas and upstream investor through fixed price, slipped 2% / year.
- Floating price for PM3-Ca Mau and Ham Rong-Thai Binh tanks: The price of gas is based on the monthly average MFO oil price listed on Platts Singapore page, which is determined by the formula: gas price = 46% * MFO.

However, from October 2019, when Vietnam ran out of priority to receive gas at PM3, the gas price at PM3 was split into two components, the part under the right to receive from Vietnam was calculated at 46% * MFO, the supplement gas from Malaysia are calculated according to Brent oil prices, depending on the period: (i) Oct 2019 – Feb 2020: P = 0.9MFO, (ii) Mar 2020-2026: P = 12.7 Brent price, (iii) 2027-2031: P = 13.7 Brent price.

Regarding to the price sold to consumers (including wellhead price, pipeline and distribution costs), is determined as follows:

Price = 46% FO (but not lower than wellhead price) + pipeline cost + distribution cost

Wellhead prices can be set based on bilateral negotiations, Government pricing regulation or indexation to fuel oil price. Pipeline and distribution costs vary much by natural gas field. Wellhead prices for future gas are forecasted to be much higher than the existing ones. Future gas price may be determined via "pass-through" mechanism in relation to electricity buyback rate of gas-fired power plants. Past trends of natural in the East (NSC+CL) and the West (PM3) of the South are as below:

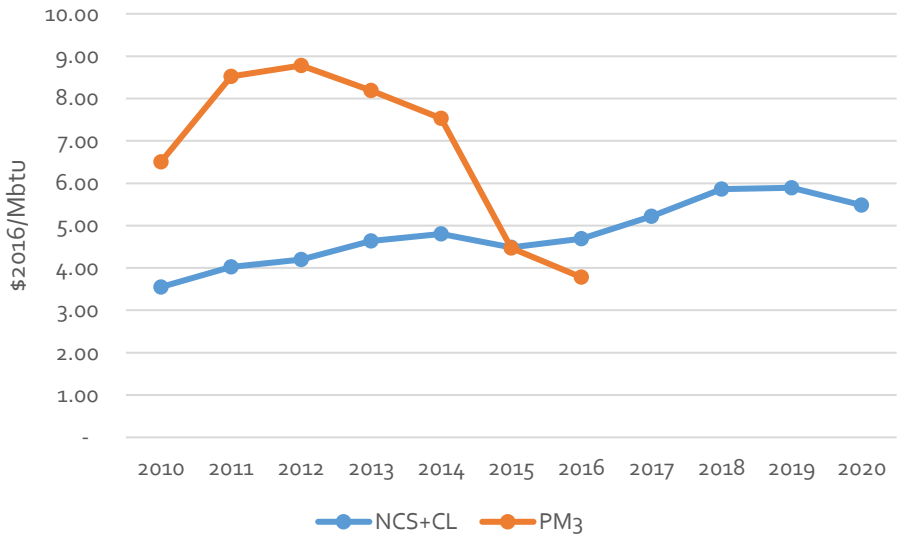

Figure 32: Historical gas prices by field

Coal

Vietnamese coal prices have also been regulated by the Government, and historically domestic coal prices (shown in Figure 33) were kept artificially low. Revenues from coal export were used to compensate for the domestic coal subsidises. There were also cross-subsidies between coal for power plants and coal for other domestic users. Coal prices for power plants were 60% in 2012 and ~25% in 2013 lower as compared to coal prices for other users. From 2014, the subsidies were removed from coal prices for power plants.

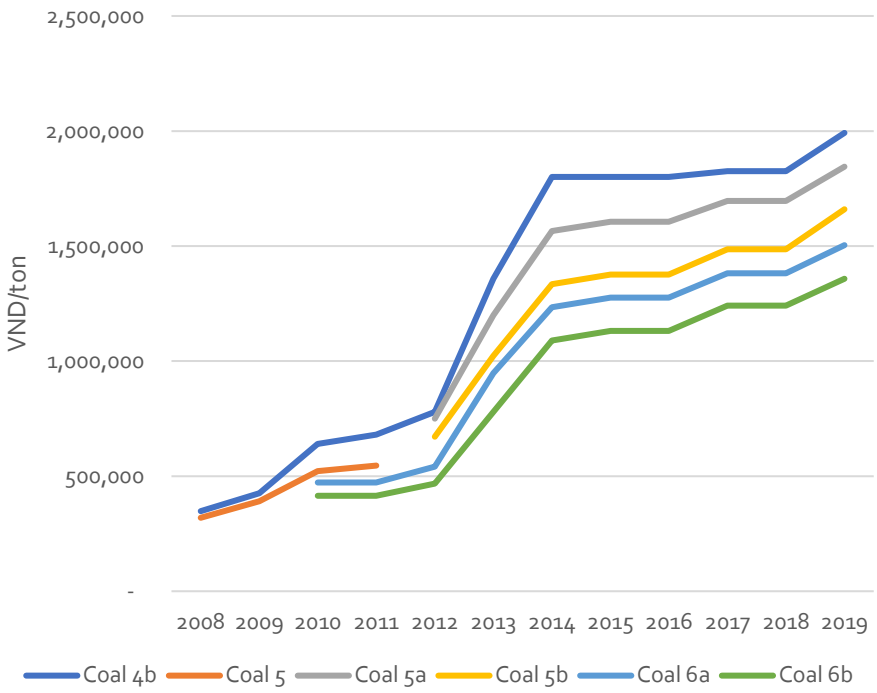

Figure 33: Average domestic coal prices by main coal type

The current coal price scheme is comprised of the following:

- Coal prices are subjected to natural resource, environmental protection and export taxes;
- The frequency for adjusting coal prices is still low, with a late response to world coal price for keeping stable prices for domestic users;
- Government regulates export tax and/or export quota to limit coal export for meeting domestic demands sufficiently.

The result of these regulations is that the *regulated Vietnamese coal prices* have historically been far below the *international market prices*. Starting in 2012 however, Vietnamese coal prices have begun to converge to the international prices. By 2015, international steam coal prices were below the Vietnamese prices, but it is interesting to note that when international coal prices fell drastically (particularly in 2015 and 2016) prices were so low that a number of large coal producers filed for bankruptcy, with a prominent example being Peabody in the US. Commentators have since indicated that global prices in a number of regions were below the marginal production cost for some producers (IEA, 2017, a), and these bankruptcies would support these assertions. Domestic coal prices in 2018-2019 had increased slightly for all coal types.

9 Prognoses for domestic fuels

9.1 Roadmap for energy markets

Roadmap for developing competitive energy market by 2030 with vision toward 2045 is regulated in the Decision No. 2233/QD-TTg dated 28 December 2020. Roadmap for coal and gas markets are summarized below:

Coal market

Period from 2021 to end of 2025:

- Maintaining the model where state-owned enterprises play key roles in the exploitation, production and trading of coal nationwide.
- Keeping the current model of dispensing of coal to consumers.

Period from 2026 to end of 2030:

- Continuing the execution of government-guaranteed coal purchase agreements and coal trading contracts already signed and remaining valid, exporting coals under the Prime Minister's direction.
- Continuing to boost the core roles that state-owned specialized enterprises play in domestic coal mining, production and trading activities.
- Gradually developing a coal market with various sellers and buyers, diversifying coal sources (produced domestically, blended and imported coals) and suppliers of coals to consumers.

Period from 2031 to end of 2045:

- Continuing the execution of government-guaranteed coal purchase agreements and coal trading contracts already signed and remaining valid; exporting coals under the Prime Minister's direction.
- Operating the fully competitive coal market at coal market segments where market participants perform transactions and trades in coals, provide services for these coal transactions and trades comply with market regulations and practices; encouraging foreign and private enterprises to invest and do business in the coal sector.

Gas market

Period from 2021 to end of 2025:

- Maintaining the current gas market model in which competition occurs at the stages of exploitation and import of natural gas (through pipeline systems), and each gas exploitation and distribution system has an upstream gas aggregator (except for projects obtaining the Government's approval of other mechanisms in gas sale and purchase

contracts); going into competition in the face of import and distribution of LPG and CNG on the domestic market (without using pipeline systems);

- Permitting contractors or investors of new gas exploitation projects (Blue Whale, Block B, etc. projects) to choose to negotiate about selling gas directly with household consumers or wholesaling gas to PVN/PVGas;
- Putting new business models of imported LNG projects in operation (LNG importers can sell gas directly to customers).
- Developing and completing a legal framework to pave the way for implementation of the rights to lease and use third-party infrastructure, including technical, commercial and financial regulations and standards that need to be completed before coming into use.
- Designing and issuing a set of engineering and safety standards and regulations for construction and operation of LNG storage facilities at ports of entry and LNG transport equipment, ensuring quality, design, engineering, construction and operation safety for LNG projects.
- Gas markets existing in the period of 2021 - 2025 should be built and developed according to the principles of promoting the leading roles of state-owned specialized enterprises (Vietnam Oil and Gas Group, Vietnam Gas Corporation) to ensure national energy security; should take advantage of available experience, infrastructure and optimize investments, especially at the start of LNG import; at the same time, encourage foreign enterprises and domestic private enterprises to invest in LNG import infrastructure to increase investment resources and diversify gas supplies for the national economy.

Period from 2026 to end of 2030:

- Gradually developing the market model in which competition occurs at the downstream gas distribution by adopting regulations on the rights to rent and use third-party infrastructure. State regulatory authorities shall consider and direct the construction and application of charges for the use of shared infrastructure and supervise the import and distribution of electricity-generating gas.
- Continuing to implement the Government's commitments and commercial commitments already signed and develop gas collection and distribution systems based on domestic gas projects.
- Continuing to uphold the core roles of state-owned specialized enterprises; at the same time increasingly attracting foreign and private enterprises to invest and do business in the gas sector.

Period from 2031 to end of 2045:

- Ensuring the ongoing implementation of the Government's commitments and commercial commitments already signed and remaining in effect in relation to domestic gas projects and gas projects of foreign investors (if any).
- Fully operating competitive markets for the import and distribution of downstream pipeline gas and the rights to rent and use third party infrastructure; operating Vietnam's gas market in sync with Vietnam's electricity market.

9.2 Domestic fuel price components

Domestic coal

Domestic coal types include anthracite, peat and fate coal with differences in size, heating value and other characteristics. Anthracite coal types are grouped into several subgroups, such as lump and dust coal, based on sizes of coal. Characteristics of the different domestic coal types are shown below, including size and lower heating value (Table 3).

No.	Coal type	Size (mm)	Lower heating value LHV (kcal/kg)
1	Anthracite lump	15-100	7100-7950
2	Anthracite dust	<15	
	Dust coal 1-3	<15	6750-7800
	Dust coal 4	<15	5300-6400
	Dust coal 5	<15	4800-5600
	Dust coal 6	<15	3700-4350
	Dust coal 7	<15	3150-3900
3	Peat	<0.5	3100-5550
4	Fat coal		

Table 9.1: Domestic coal types (VIMCC, 2016).

The domestic coal used in the Vietnam-TIMES model is one typical anthracite coal with heating value of 5000 kcal/kg (21 GJ/ton), while the imported coal with heating value of 5500 kcal/kg.

Domestic coal prices are subjected to mining license fee, natural resource, environmental protection and other levies. Coal taxes in 2016 are summarized below:

No.	Components	Level	Amount	
			VND/ton	USD/ton
1	Natural resource tax (%)	10% (underground) 12% (open pit)	109,063	5.02
2	Mining license (%)	2%	28,738	1.32
3	Environmental fee (VND/ton raw coal)	10.000	11,600	0.53
4	Environmental protection tax (VND/ton)[8]		20,000	0.92
5	Other levies (%)	0,50%	8,000	0.37
	Total		**177,401**	**8.17**
6	**Financial cost**			**5.50**
7	**Return**			**4.90**
8	**Domestic shipping**			**5.00**

Table 9.2: Domestic coal price components. Source: (VIMCC, 2019).

Calculated domestic coal price is estimated as 79.6 USD/ton covering all price components (production cost plus add-ons). The cost was projected based on total cost and total coal production by Vinacomin in future years. Domestic coal cost without taxes is estimated at 73.2 USD/ton which accounted for 92% of the final price. Main assumptions for the production cost and the add-ons are as below:

- Production cost for domestic coal is projected to increase in the Coal Development Plan Revised (VIMCC, 2016) due to increasing amount of coal from underground mines in future years. Production cost will rise from 56.6 USD/ton by 2016 to 72.4 USD/ton by 2030 and to 78.3 USD/ton by 2050 (2% escalation rate in 2030-2050);
- Domestic shipping cost is projected to decrease from 5 USD/ton by 2016 to 3 USD/ton by 2050 due to improved road and waterway freight transport.
- Mining license fee is projected to remain constant at 1.3 USD/ton in 2016-2050.

Domestic natural gas

Domestic natural gas is being extracted mainly in the South of the country, from oil-prone basin and gas-prone basins in the South East and from offshore area jointly with Malaysia the South West. In the North, gas extraction from small deposits has commenced in 2015. Natural gas distribution geographically is further detailed as below (Table 5):

[8] Environmental tax protection for anthracite coal will be 30,000 VND/ton from 1st January 2019

Region	Basin	Features
South East	Cuu Long	Oil prone basin in operation since 1995, delivered > 5.66 Bcm (44%) of nation-wide gas production. Production in decline.
	Nam Con Son	Gas prone basin in operation since 2003, delivered > 61.33 Bcm (48%) of nation-wide gas production. NCS2 in operation since 2016. Production in decline.
South West	Malay-Tho Chu	Offshore area administered jointly with Malaysia. Ca Mau pipeline in operation since 2007. Ca Mau supplied from Block PM3-CAA + Cai Nuoc field Delivered > 10 Bcm (8%) of nationwide gas production. Not yet reached maximum production capacity
North	Song Hong	Gas extraction from small deposits has recently commenced. Production expected to increase.
Central		Production expected to be started by 2024 with Ca Voi Xanh and 2030 with Ken Bau fields

Table 9.3: Domestic natural gas by region.

Domestic gas prices include wellhead price, pipeline and distribution costs. Wellhead prices can be set based on bilateral negotiations, Government pricing regulation or indexation to fuel oil price[9]. Pipeline and distribution costs vary much by natural gas field.

Natural gas price from Nam Con Son – Cuu Long field from October 2015 was regulated as 100% of formula-based value, which is indexed to fuel oil price[10]. This price for April 2016 was calculated at 3.0831 $2016/MMBtu, which was based on the following components:

- Wellhead price: *46% price of HSFO 180 = 0.46 x 153.84 ($2016/ton) x 42.84 (GJ/ton) x 0.9478 (GJ/*MMBtu*) = 1.7429 $2016/*MMBtu
- Pipeline cost: 1.19021 $2016/MMBtu with escalation rate of 2% per year;
- Distribution cost: 0.15 $2016/MMBtu with assumption of remaining constant over time.

[9] Singapore 180 CST high sulfur fuel oil as in Platt (HSFO 180)
[10] Official letter of Government Office No. 2175/VPCP-KTTH on market-based natural gas price

Natural price for Ca Mau from PM3-CAA to 2031:

*Natural gas price = 0.9*HSFO in 2020-2026 and 1.0*HSFOin 2027-2031*

Natural gas price for Block B: $P_n = P_0 * (1+ x_{\%})n$

In which:

P_n = gas price in year n

P_0 = wellhead price at year 2016, P0 = 9.36 $2016/MBtu

x: escalation rate of 2.5%/year for whole project life

Distribution cost: Tn = T0 * (1+ x%)n

In which:

Tn = cost in year n ($2016/MBtu)

T0 = cost at 2016, P0 = 1.53 $2016/MBtu

x: escalation rate of 2%/year for whole project life

Natural gas price for Blue Whale: under agreement between PVN and Exx-onMobil with approval from MOIT: P0 at 2016 equals 9.048 $2016/MBtu with escalation equalling US's CPI.

9.3 Domestic add-ons for imported fuels

Imported oil products

Vietnam has two existing refineries with Binh Son Refinery started operating in 2009 and Nghi Son Refinery in 2018. Total oil refinery capacity currently is of 16.5 Mt of crude oil. The former refinery consumes local crude oil while the latter refines imported crude oil. Vietnam is still importing all oil products to meet the country's demand. In 2019, Vietnam imported 12.7 Mt oil products as below (Table 9.4):

Product	Import amount (million tons)	Production amount (million tons)	Average import price 2019 ($2016/ton)
Diesel oil	4.75	5.64	603
Kerosene	0.03		638
Jet fuel	2.05	0.56	627
Gasoline	1.96	5.47	681
Fuel oil	0.83	0.18	419

Table 9.4: Import of oil products in 2016. Source: Institute of Energy

Domestic oil product price consists of several components such as import duties, special consumption taxes, a stabilization fund fee, environmental protection tax, VAT, distribution cost norm, return. Details on these components currently are presented below:

Component	Gasoline	Gasoline E5	Diesel oil	Kerosene	Jet fuel	Fuel oil
Distribution cost norm (VND/l)	1050	1250	950	950	0	600
Profit margin (VND/l)	300	0	300	300	0	300
Import duty (%)	10.0		0.85	0.13	7.0	3.04
Special consumption tax (%)	10	8	0	0	0	0
Environmental protection tax (VND/l)	4000	0	2000	1000	3000	2000
Stabilization fund fee (VND/l)	300	0	300	300	0	300
Value added tax (%)	10	10	10	10	10	10

Table 9.5: Domestic oil products' price components

Imported coal

Coal is being imported into Vietnam from four main sources: Indonesia, Australia, Russia and China. Amount of coal import in 2019 reached 43.7 million tons.

Main domestic add-on for imported coal prices is cost of port handling, this cost is differentiated by region such as North, Central and South. The cost for port handling and domestic shipping for imported coal are as below:

Region	North	Central	South
Location	Pha Lai	Nghi Son	Duyen Hai
Cost of port handling and domestic shipping	12.14	8.35	13.56

Table 9.6: Costs of imported coal by region. Source: EVN (2020). Study on optimal option for developing coal ports.

Imported LNG

Alternative terminals under evaluation/planning for imported LNG in the period 2021-2030 have been identified as below

No.	Region	Possible terminal	Capacity	Main users
	2021-2025			
1	South East	Thi Vai	1-1.5 Mt	Nhon Trach 3&4 CCGGT
2	South West	Nam Du (FSRU)	1-2 Mt	Kien Giang, O Mon, Ca Mau GDC
3	South East	Ba Ria Vung Tau LNG		
	2026-2030			
1	North	North LNG	0.5-1.0 Mt	Industrial users
2	North	Thanh Hoa LNG	1-3 Mt	Power plants, industrial users
3	South East	Son My	3-6 Mt	Son My, Phu My GDC
4	Central South	LNG Hub	6-10 Mt	Power plants, industrial, chemical users
5	South East	South East LNG	1-3	Power plants, industrial users
6	South West	South West LNG	1-3	Power plants, industrial users

Table 9.7: Identified LNG terminals. Source: (IE, 2021).

As regulated, LNG prices = imported CIF price + other costs (receiving, storage, regasification, transport, distribution, return). For imported LNG price, the add-ons including port, storage, regasification by region are estimated as below[11]:

[11] Petro Vietnam's Official Document No. 6886/DKVN-HĐTV

Region	North	North Central	Mid Central	South Central	South East	South West
Location	Quang Ninh	Nghi Son	Chan May	Central Hub	Son My	Ca Mau
Cost for port, storage, regasification ($2016/MMBtu)	0.87	0.848	0.61	0.524	0.614	0.58

Table 9.8: Addons for importing LNG. Source: Internal estimation by Institute of Energy.

9.4 Domestic fuel price prognoses

This section provides an overview of the final fuel prices used as input in the models for long term scenarios in energy/power modelling. The prices used as input to the modelling do not contain taxes and subsidies because the purpose of the scenarios is to find the least socio-economic cost under the given constraints of each scenario.

Oil price

Base prices for domestic oil products are adjusted for every 15-day based on world oil prices. Therefore, domestic oil prices are highly correlated with world crude oil prices. Domestic CIF oil prices are forecasted based on the growth rate of projected world crude oil price (see section 5.2).

Prices at place of consumption projected for oil products in CP and SD scenarios (with added distribution cost and return and without taxes) are presented below:

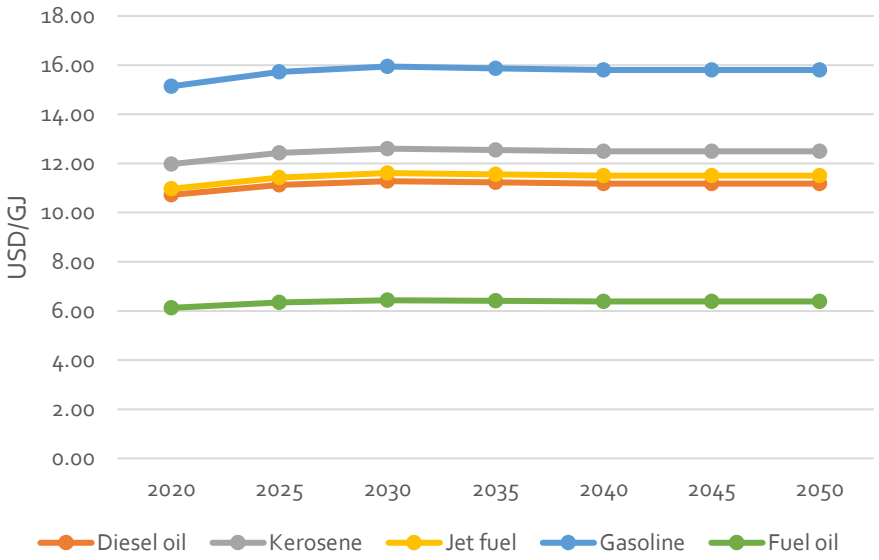

Figure 34: Domestic oil product prices in Sustainable Development scenario.

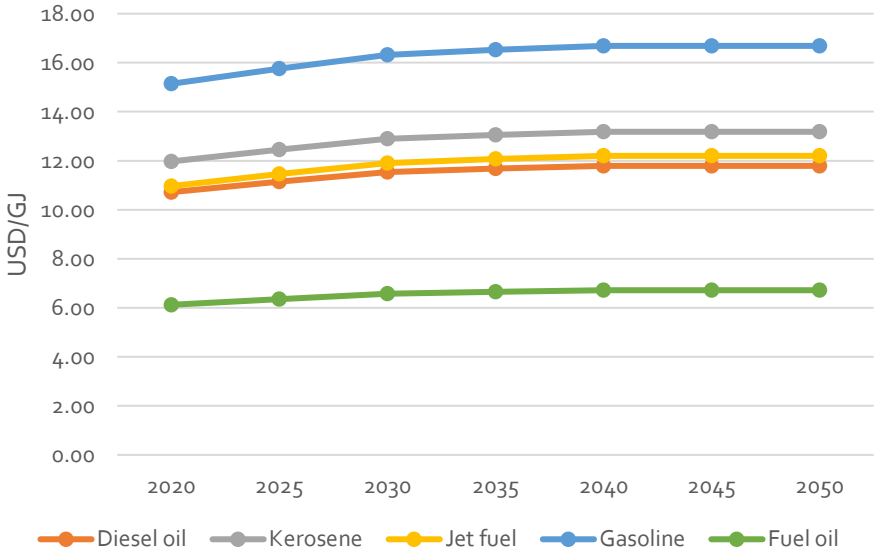

Figure 35: Domestic oil product prices in Delayed Recovery scenario

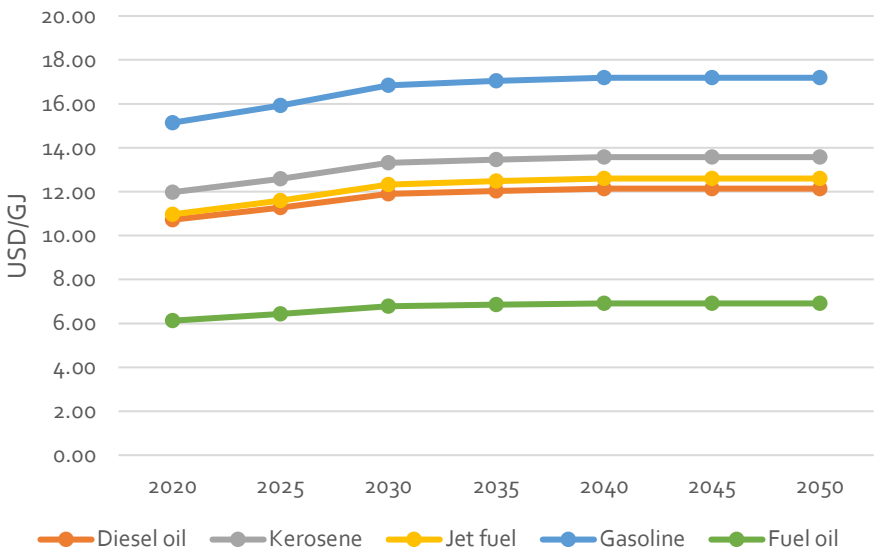

Figure 36: Domestic oil product prices in Stated Policies scenario.

	2020	2025	2030	2035	2040	2045	2050
SPS							
Diesel oil	10.72	11.27	11.90	12.04	12.14	12.14	12.14
Kerosene	11.97	12.59	13.31	13.46	13.57	13.57	13.57
Jet fuel	10.97	11.60	12.33	12.48	12.60	12.60	12.60
Gasoline	15.14	15.93	16.85	17.04	17.19	17.19	17.19
Fuel oil	6.12	6.43	6.78	6.85	6.91	6.91	6.91
DRS							
Diesel oil	10.72	11.14	11.54	11.68	11.79	11.79	11.79
Kerosene	11.97	12.45	12.90	13.06	13.18	13.18	13.18
Jet fuel	10.97	11.45	11.91	12.07	12.20	12.20	12.20
Gasoline	15.14	15.75	16.32	16.53	16.69	16.69	16.69
Fuel oil	6.12	6.36	6.58	6.66	6.72	6.72	6.72
SDS							
Diesel oil	10.72	11.12	11.28	11.23	11.18	11.18	11.18
Kerosene	11.97	12.43	12.60	12.55	12.49	12.49	12.49
Jet fuel	10.97	11.43	11.61	11.55	11.50	11.50	11.50
Gasoline	15.14	15.72	15.94	15.87	15.80	15.80	15.80
Fuel oil	6.12	6.35	6.43	6.41	6.38	6.38	6.38

Table 9.9: Summary on prognoses results for oil product prices ($2016/GJ).

Coal price

Coal prices in energy terms are forecasted for three different domestic coal types. Projections for domestic coal prices at place of consumption (i.e. including production cost, shipping and mining license fee, and excluding taxes)

are presented below and compared with imported coal prices for three different scenarios.

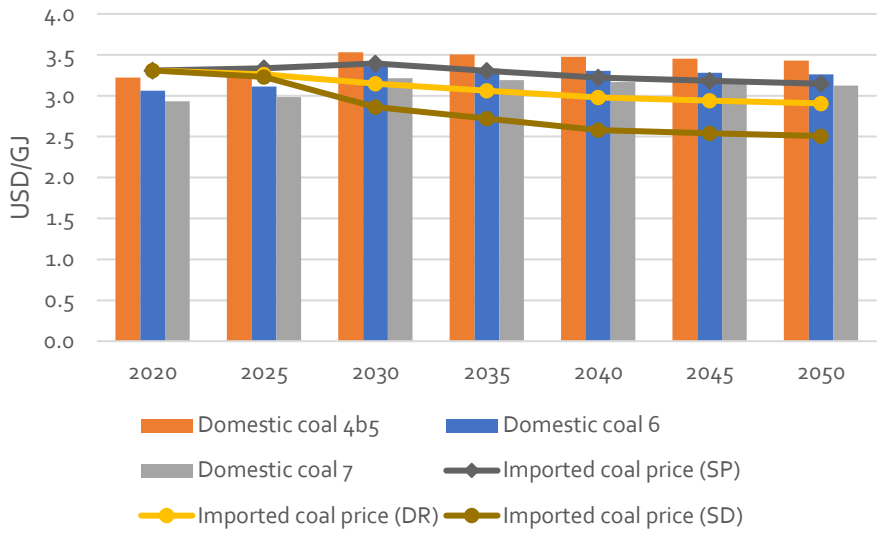

Figure 37: Comparisons of domestic coal and imported coal prices.

Domestic coal prices before 2020 are well below the imported prices. After 2020, the price of domestic coal 4b5 is even higher than imported coal price. Prices of the other two coal types will be lower than imported coal before 2030. Due to the increased trend of domestic production cost, domestic coal production may be lower than planned in case of world coal price decrease due to climate change policies. Domestic coal prices are forecasted higher imported coal after 2030. Final domestic coal prices are projected as below:

	2020	2025	2030	2035	2040	2045	2050
Imported coal (SDS)	3.3	3.2	2.9	2.7	2.6	2.5	2.5
Imported coal price (WD)	3.3	3.3	3.1	3.1	3.0	2.9	2.9
Imported coal (SPS)	3.3	3.3	3.4	3.3	3.2	3.2	3.1
Domestic coal 4b5	3.2	3.3	3.5	3.5	3.5	3.5	3.4
Domestic coal 6	3.1	3.1	3.4	3.3	3.3	3.3	3.3
Domestic coal 7	2.9	3.0	3.2	3.2	3.2	3.1	3.1

Table 9.10: Summary of domestic coal price prognoses ($2016/GJ). Source: authors' calculations.

Domestic coal 6 and 7 (two main coal types for power) can compete with imported coal in three scenarios. In the SD scenario with very low world coal price, domestic coal prices must be adjusted to lower values due to market mechanisms to compete with imported coal from abroad. Domestic coal prices might align with the international prices at certain point of time. This

means that the domestic coal utilities would adjust production following the price signals. To keep domestic coal price competitive, the coal utility would produce coal at the quantity where its supply cost intersects international coal price.

Gas price

Comparison of future trends for domestic gas prices and IEA´s imported LNG prices at the place of consumption are presented below:

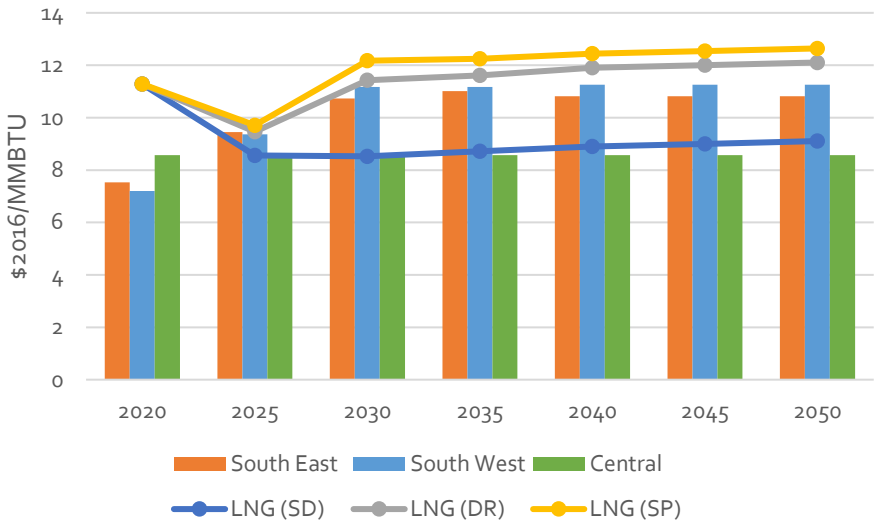

Figure 38: Comparisons of natural gas and LNG prices in South East region.

Price at the place of consumption of domestic natural gas in the South East region will be lower than imported LNG in all three scenarios. Only in SD scenario, imported LNG will be lower than domestic gas from 2040 onwards.

Due to high natural gas price from Block B, imported LNG can compete with domestic natural gas from 2020-2025 in all three scenarios. After 2025, the price of domestic gas in the South West must be adjusted to compete with imported LNG. The gas price in the region may be set by LNG price from 2025 onwards. Detailed fuel price prognoses for natural gas and imported LNG are as below:

Year	Domestic natural gas			LNG South East			LNG South West		
	South East	South West	Central	SDS	DRS	SPS	SDS	DRS	SPS
2020	7.53	7.2	8.57	10.65	10.65	10.65	11.10	11.10	11.10
2025	9.45	9.36	8.57	7.92	8.83	9.08	8.44	9.36	9.60
2030	10.73	11.17	8.57	7.89	10.80	11.54	8.50	11.41	12.15
2035	11.01	11.17	8.57	8.08	10.99	11.62	8.77	11.68	12.31
2040	10.82	11.26	8.57	8.27	11.28	11.81	9.06	12.07	12.60
2045	10.82	11.26	8.57	8.37	11.37	11.91	9.26	12.27	12.81
2050	10.82	11.26	8.57	8.47	11.47	12.01	9.49	12.49	13.03

Table 9.11: Projection results for natural gas and imported LNG in $2016/MMBtu. Source: Authors' calculations.

Biomass prices

Biomass prices are collected from recent Biomass Development Plan (IE, 2016). Due to lack of data for different components in prices (i.e. transport, treatment etc.), biomass prices considered here are the final prices to end-users (i.e. industrial and power plants). Biomass prices are as below:

Year	Heating value	Fuel prices					
		2014		2020		2030	
Unit	Kcal/kg	USD/ton	VND/kg	USD/ton	VND/kg	USD/ton	VND/kg
Wood	3500	26.85	600	29.06	649.46	35.42	791.69
Bagasse	1850	1.12	25	1.21	27	1.48	33
Rice husk	3000	22.37	500	24.22	541.2	29.52	659.7
Straw	2800	6.71	150	7.26	162	8.86	198

Table 9.12: Biomass price projections. Prices are given in 2016 values. Source: (IE, 2016).

The projections for biomass prices up to 2050 are built with simple escalation rates applied for different biomass types, considering the development trend in the period 2010-2016

Year	Heating value	Fuel prices						
Unit	Kcal/kg	2020	2025	2030	2035	2040	2045	2050
Rice husk	3000	1.92	2.37	2.37	2.37	2.37	2.37	2.37
Bagasse	1850	0.15	0.16	0.19	0.19	0.19	0.19	0.19
Straw	2800	0.63	0.63	0.74	0.74	0.74	0.74	0.74
Wood	3500	3.06	3.06	3.06	3.06	3.06	3.06	3.06

Table 9.13: Biomass prices projections in 2020-2050.

Appendix 1 – fuel price forecasts, CIF Vietnam

	Imported Oil ($2016/barrel)			Imported Coal ($2016/tonne)			Imported LNG ($2016/MBtu)		
Year	Stated Policies	Delayed Recovery	Sustainable development	Stated Policies	Delayed Recovery	Sustainable development	Stated Policies	Delayed Recovery	Sustainable development
2020	41.5	41.5	41.5	68.8	68.8	68.8	8.19	8.19	8.19
2021	62.9	62.9	62.9	72.6	72.6	72.6	6.82	6.82	6.82
2022	57.4	57.4	57.4	76.0	76.0	76.0	6.74	6.74	6.74
2023	53.7	53.7	53.7	77.9	77.9	77.9	6.10	6.10	6.10
2024	53.7	52.3	52.1	76.2	75.5	75.1	6.33	6.23	5.88
2025	55.4	52.0	51.4	71.0	69.2	68.4	6.67	6.44	5.59
2026	58.3	53.1	51.8	72.0	69.4	67.8	7.10	6.77	5.50
2027	62.3	55.3	52.8	72.3	68.9	66.2	7.57	7.14	5.49
2028	66.6	57.8	53.9	72.8	68.4	64.5	8.03	7.51	5.49
2029	71.1	60.6	54.8	73.3	68.0	62.6	8.48	7.87	5.49
2030	76.0	63.6	55.7	73.9	67.7	60.6	8.90	8.21	5.50
2031	77.0	64.5	55.4	73.7	67.5	60.1	8.90	8.23	5.52
2032	78.0	65.5	55.1	73.5	67.4	59.7	8.90	8.25	5.54
2033	79.0	66.4	54.9	73.3	67.2	59.2	8.90	8.27	5.56
2034	80.0	67.3	54.6	73.1	67.0	58.7	8.90	8.29	5.58
2035	81.0	68.2	54.3	72.9	66.8	58.3	8.90	8.31	5.60
2036	81.8	69.0	54.1	72.7	66.6	57.8	8.92	8.35	5.62
2037	82.6	69.7	53.8	72.5	66.5	57.3	8.94	8.38	5.64
2038	83.4	70.5	53.5	72.3	66.3	56.9	8.96	8.42	5.66
2039	84.2	71.2	53.3	72.1	66.1	56.4	8.98	8.46	5.68
2040	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2041	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2042	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2043	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2044	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2045	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2046	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2047	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2048	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2049	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70
2050	85.0	72.0	53.0	71.9	65.9	55.9	9.00	8.50	5.70

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