Energy Transition in Support of the Low-Carbon Development Initiative in Indonesia

Transport Sector

REPORT

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Global Subsidies Initiative

Tara Laan
Neil McCulloch

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Head Office

111 Lombard Avenue, Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700
Website: www.iisd.org
Twitter: @IISD_news

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Global Subsidies Initiative

International Environment House 2,
9 chemin de Balexert
1219 Châtelaine
Geneva, Switzerland
Canada R3B 0T4

Tel: +1 (204) 958-7700
Website: www.iisd.org/gsi
Twitter: @globalsubsidies

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Executive Summary

Indonesia undertook major reforms of its transport fuel subsidies in 2015, resulting in savings of over USD 15 billion that year. Budgetary support was removed for "Premium" gasoline and the diesel subsidy was capped at IDR 1,000 per litre (USD 7.5 cents).[1] Premium and subsidized diesel are both supplied as a Public Service Obligation by the national oil company, Pertamina. Under the new arrangements, Premium was only to be sold outside Java, Madura and Bali, as a means of controlling prices in regions with high distribution costs.

Despite these reforms, fuel subsidies have persisted, and the government has again become embroiled in fuel pricing discussions. Prices for Premium were initially adjusted every month, then every three months, then held steady for the year to April 2018 despite a near-doubling of the international oil price.

Rising international oil prices in 2018 prompted the government to intervene further, citing concerns over inflation and the need to maintain consumer spending. Four announcements were made: Pertamina was required to recommence selling Premium in Java, Madura and Bali; the diesel subsidy was increased; prices for Premium and subsidized diesel would not be raised in 2018 or 2019; and private retailers must seek permission to raise fuel prices.

Below-market pricing has resulted in substantial losses for Pertamina. Between 2014 and 2019, we estimate that underpricing of Premium alone resulted in foregone revenue of IDR 54.5 trillion. This subsidy was not reflected in the government budget since it was borne off-budget by Pertamina. The fuel subsidy also results in foregone taxes and dividends for the government. This represents major opportunity costs: the funds could have been used to finance transformative programs in the energy and transport sectors, such as public transport and renewable energy, or to ameliorate the impacts of transport-related air pollution.

In addition to greenhouse gases, the transport sector generates toxic air pollution that causes or exacerbates cardiopulmonary diseases. Premium and subsidized diesel are both low-quality fuels with a high sulphur content. Reducing prices for these fuels encourages their consumption in preference for cleaner-burning fuels. A study in 2010 found that more than half of Jakarta's population experienced health conditions associated with air pollution, with a total treatment cost of IDR 38.5 trillion (USD 4.6 billion). Economic theory suggests that high-polluting fuels should be priced to discourage use and generate revenue to mitigate negative effects. Several studies have found that fuel prices are correlated with traffic and pollution levels.

Relinquishing control of fuel prices is evidently challenging for the government. Fixed prices provide both political and macroeconomic levers and means of equalizing prices across the archipelago. There is also a long-held expectation that the government will shelter the public from price fluctuations and spikes.

The current ad hoc method of adjusting prices is clearly inadequate to prevent subsidies from remerging. The government has recently issued a couple of new regulations on how prices will be set. These have the potential to reduce or remove subsidies by shifting consumption from Premium

[1] Two subsidized diesel brands, Solar and BioSolar, account for 99 per cent of diesel sales. Both are CN (cetane) 48. BioSolar is 20 per cent biodiesel (B20), which is also subsidized.

to Pertalite and Pertamax, higher-quality fuels that are, in theory, unsubsidized. These are promising developments. However, it is not clear that Pertalite is unsubsidized in practice. Moreover, the government has found in the past that consistently applying a pricing formula is politically difficult. Also, the government now appears to be regulating the prices that can be charged by the private sector for higher-quality fuels. While these regulations are probably designed to prevent excess profit making, they run the risk of simply transferring subsidies to higher-quality fuels.

There are several approaches to fuel pricing that can reduce subsidies overall, more accurately reflect market prices and still reduce exposure to price spikes as market prices fluctuate. This paper presents three of these options: smoothing, ratcheting, and installation of price floors and caps.

Implementing an effective pricing mechanism is necessary for Indonesia to complete its landmark fuel subsidy reforms and prevent backsliding into expensive subsidy policies. The current pricing regime aims to deliver a public service but inadvertently contributes major social costs: air pollution and associated illness, greenhouse gas emissions and traffic congestion.

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Acronyms and Abbreviations

B20	biodiesel blending at 20 per cent
CN	cetane
CNG	compressed natural gas
CO_2e	carbon dioxide equivalent
COPD	chronic obstructive pulmonary disease
EOMP	Expected Open Market Price
EV	electric vehicle
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GWP	global warming potential
ICEV	internal combustion engine vehicles
OECD	Organisation for Economic Development and Co-operation
PM	particulate matter
PSO	Public Service Obligation
RON	Research Octane Number
WHO	World Health Organization

1.0 Introduction

In March 2019, the *Low Carbon Development Initiative Report* (Bappenas & LCDI, 2019) was released for Indonesia, which established the socioeconomic case in favour of policies and interventions for an accelerated transition toward clean (low-carbon-intensive) energy systems, most prominently, renewable energy sources. As a contribution to this report, the International Institute for Sustainable Development prepared an analysis of the benefits of Indonesia transitioning to renewable energy, focusing on the electricity sector.

The aim of this report is to expand the analysis to include aspects of the transport sector—specifically fuel pricing—and provide a foundation for deeper work that will include the transport sector. This report sets out the policy context in relation to fuel pricing, specifically:

a) Current transport fuel pricing policies (including subsidies) and changes in policies in recent years
b) Indonesia's transport fuel prices compared to other regions of the world
c) Implications of Indonesia's transport policies on air pollution and health (in particular the Jakarta capital region), comparing Indonesia to other countries with similar contexts
d) Fuel pricing mechanisms that can reduce subsidies overall and more accurately reflect market prices while reducing exposure to price spikes as market prices fluctuate.

1.1 Scope

The scope is limited to the main transport fuels used in Indonesia: gasoline, diesel and biodiesel. Other transport fuels, specifically compressed natural gas (CNG) and electricity, are not included because there is little uptake of these in transportation and few specific policies relating to these alternatives in Indonesia at present. In addition, subsidies for electric vehicles (EVs) tend to apply to import duties, infrastructure and taxation, which were beyond the scope of this study. Instead, a brief outline is provided on the current status of CNG for vehicles and EVs in Indonesia.

1.2 Methods

This short report is based on a literature review and analysis of country data. Section 4, Health and Environmental Impacts, draws on selected key international literature rather than attempting to cover the extensive international literature on this topic. The aim is to set up for a deeper analysis in the next phase of work.

Section 6 provides a set of simulations of how domestic prices and subsidies would have evolved if three different price setting mechanisms had been used in recent years rather than the current fixed price mechanism. It shows that there are methods of setting prices that can protect consumers from large price fluctuations while simultaneously avoiding the emergence of large and damaging subsidies.

2.0 Fuel Consumption and Pricing

Indonesia's transport sector consumes 27 per cent of total energy consumption (International Energy Agency, 2019). Liquid fuels comprise the majority, with natural gas accounting for less than 0.1 per cent of total transport energy and LPG 0 per cent. A small amount of electricity (236 GWh) is also used in transport (approximately 1 per cent of total electricity consumption).[2] Subsidized diesel and gasoline together account for 45 per cent of the volume of fuels consumed (Figure 1).

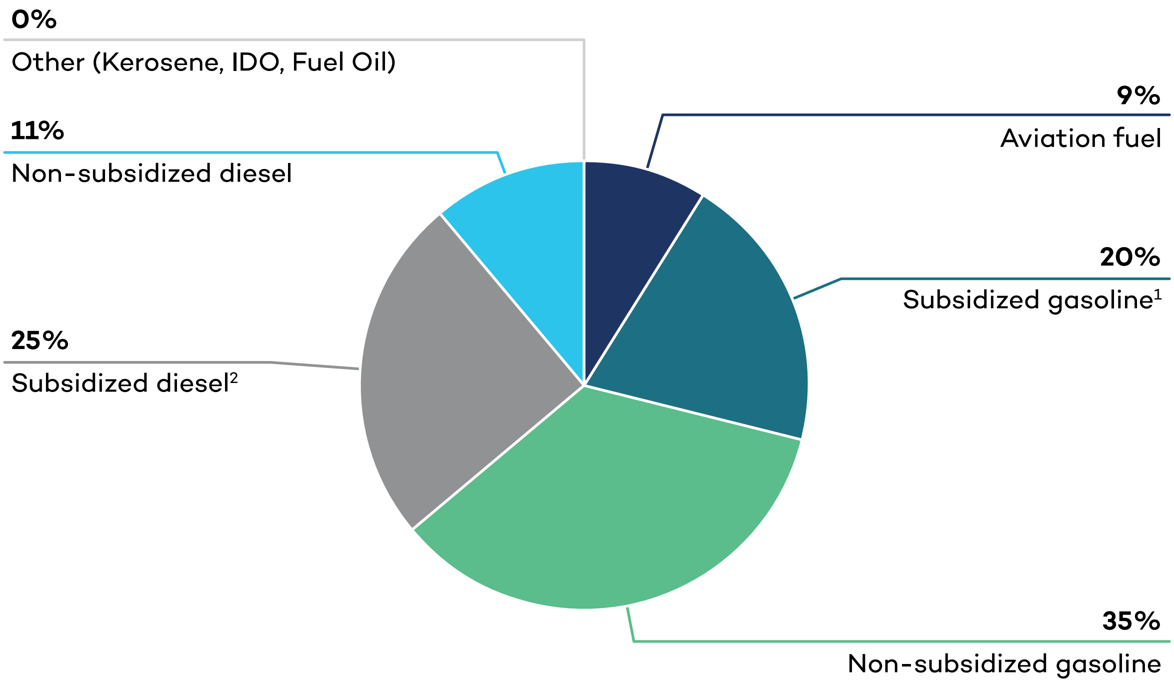

Figure 1. Transport fuel consumption, 2017 (% of total consumption)[3]

[1] Officially subsidized gasoline is Premium (RON 88)[4]; officially unsubsidized gasoline is RON 90, 92 and 95; subsidized diesel is primarily Pertamina's Solar and BioSolar brands (CN 48); unsubsidized diesel is automotive diesel oil (CN 48 and CN 53); aviation fuel is avgas and aviation turbine fuel; the "other" category comprises fuel oil, industrial diesel oil and kerosene.

[2] The Ministry of Energy and Mineral Resources (2017) does not differentiate between unsubsidized and subsidized diesel, therefore subsidized diesel volumes were taken from the State Budget. The volumes in the chart for unsubsidized diesel is (total diesel consumption) – (subsidized diesel consumption).

Source: Consumption volumes: Ministry of Energy and Mineral Resources, 2017; Subsidized diesel volumes: BPH Migas 2016, 2017.

2.1 Current Transport Pricing Policies and Recent Changes

2.1.1 Gasoline and Diesel

The Indonesian government has subsidized transport fuel prices since the 1960s as a means of sharing the country's oil wealth with its citizens (Dillon, Laan, & Dillon 2008). Indonesia's transition from a net oil exporter to a net importer, rising energy demand and volatile international oil prices all contributed to an unsustainable fuel subsidy burden on the government budget. In 2013, 17 per

[2] Based on 2016 consumption of 225.91 TWh (International Energy Agency, 2019).

[3] Also consumed in the transport sector: gas, 521 MMSCF; electricity, 236 GWh

[4] RON is the Research Octane Number, a standard measure of the performance rating of a fuel. Higher octane fuels are used in high performance gasoline engines.

cent of total government expenditure was allocated to fuel and electricity subsidies (Organisation for Economic Development and Co-operation [OECD], 2019).

In December 2014, the Indonesian government announced that it would eliminate the budgetary subsidy on gasoline (except for distribution costs outside of the most populated islands of Java, Bali and Madura) and impose a fixed subsidy on subsidized "Solar" diesel (IDR 1,000 per litre) (OECD, 2019). Solar, Pertamina's diesel, is sold at a discounted price for specific sectors: small businesses, small fishers and farmers, passenger vehicles, public services and ships sailing under the Indonesian flag (Minister Regulation No. 191/2014). Private fuel retailers (Shell, Total and AKR Corporindo) could set their own prices for their fuel brands. Pertamina could also set its own price for its higher-octane, non-subsidized brands (Peralite, Pertamax and Dex).

The government categorized Premium, Pertamina's traditionally subsidized RON 88 gasoline, as a "special task fuel." Premium continued to be sold at regulated and discounted prices outside Java, Bali and Madura. Prices for Premium were initially set close to international prices with the intention of adjusting them regularly in line with oil price fluctuations. In 2015 prices were initially adjusted every month, which slowed to once every three months (McCulloch, Lontoh, Sambodo, Christensen, & Gass, 2017; OECD, 2019). A timeline of recent fuel pricing decisions is provided in Table 1.

Price adjustments were too infrequent and insufficient to keep abreast of international prices. During 2015, Pertamina reportedly lost IDR 80 billion (USD 6 million) per day from subsidized fuel sales (Reuters, 2015). Prices were held steady between April 2016 (when the international oil price was around USD 40 per barrel) and June 2018, during which time the oil price had almost doubled (OECD, 2019). Pertamina's losses from subsidized fuel sales in 2018 may have reached around IDR 24 trillion (USD 1.7 billion) (Hellenic Shipping News, 2018). In addition, the below-market pricing of Premium also contributed to shortages of the fuel in some parts of the country (Jensen, 2018).

One analyst calculated that, based on prices and exchange rates for early 2019, Solar was underpriced by 40 per cent and Premium by 29 per cent (Ping, 2019).[5] We estimate that, between 2014 and 2019, underpricing of Premium alone resulted in foregone revenue of IDR 54.5 trillion (USD $3.8 billion) (see Section 4).

In addition to reduced profitability for Pertamina, below-market pricing of Premium and Solar impact the government budget directly through the per-litre diesel subsidy and indirectly through foregone revenue. Ping (2019) estimated that 87 per cent of the price gap was revenue foregone by Pertamina and 13 per cent revenue loss by the government.

Pertamina's foregone revenue results in lower tax (reduced value-added tax of 10 per cent, motor vehicle fuel tax ["PBBKB"] of 5 per cent and corporate tax of 25 per cent) and lower dividend payments by Pertamina (35 per cent).

By moving from budgetary subsidies to an infrequently adjusted fixed price, the government effectively took the gasoline subsidy "off the books." The burden of the subsidy was transferred from the government budget to Pertamina (Witular, 2015). Commentators also expressed concern that the burden on Pertamina's finances could impact the company's ability to fund its upstream operations, including the Mahakam gas field in East Kalimantan, which requires more than USD 2 billion annually to operate (Witular, 2015).

[5] Assuming a Brent price of USD 67.45 per barrel and an exchange rate of IDR 13,486 per USD 1 in the first two months of 2019.

From March 2018 to May 2018, the government made several decisions to steady or further reduce fuel prices (Table 1). The stated rationale for controlling prices was concern over inflationary pressure and maintaining consumer spending as a driver of economic growth (Asmarini & Diela, 2018). Some commentators noted the proximity of the April 2019 elections as a political driver for controlling fuel prices (Singgih & Listiyorini, 2018).

In addition, the government has a single fuel price program (BBM Satu Harga) applied to subsidized products that aims to provide the same price everywhere, including remote areas where supply is much more costly. There were 73 points of sale established under this program in 2018, which will increase to around 170 points in 2019 (Rahmanulloh, 2018). The cost of the program, IDR 800 billion, is borne by Pertamina as a Public Service Obligation (BBC News, 2018).

Table 1. Timeline of recent Indonesian government announcements related to fuel pricing

Date	Government decisions or announcements	Source
January 2015	Budgetary subsidy removed for Premium gasoline, and Java, Madura and Bali were excluded from its area of distribution; fixed subsidy set for Solar/BioSolar diesel (IDR 1,000 per litre).	OECD, 2019; President Regulation No.191/2014; Minister Regulation No. 39/2014
2015	Ad hoc price adjustments for subsidized fuels (approximately quarterly).	McCulloch et al., 2017
May 2015	Palm Oil Fund established.	President Regulation 61/2015
August 2015	Introduction of biodiesel financing from Palm Oil Fund. Introduction of fine for non-compliance with mandatory biodiesel blending target for retailers who sell Solar.	Minister Regulation No.26/2015
March 2016 to June 2018	No price adjustments for Premium gasoline.	Jensen, 2018
July 2016	Diesel subsidy reduced to IDR 500 per litre.	OECD, 2019; Minister Regulation No.27/2016
Late 2016	Single price for subsidized gasoline and subsidized diesel fuel across Indonesia.	BBC News 2018; Minister Regulation No. 36/2016
March 2018	Price of fuel will not rise in 2018 and 2019.	Reuters, 2018
April 2018	Government enforced the policy on maximum retail price for non-subsidized fuel products introduced in 2014, which shall not be more than its base-price plus tax and 10 per cent profit. Private retailers need to seek approval from the minister to raise non-subsidized fuel prices.	Asmarini, Wilda, and & Diela, 2018; Liputan6, 2018; Minister Regulation No. 39/2014
May 2018	Premium was reintroduced in Java, Madura, and Bali.	Sulaiman, 2018b; Minister Decree No. 1851 K/15/ MEM/2018

Date	Government decisions or announcements	Source
September 2018	Agreement between biodiesel producers, fuel retailers and Palm Oil Fund to supply 1.95 million kilolitres of biodiesel for subsidized diesel blending and 940 kilolitres of biodiesel for non-subsidized diesel blending.	Reily, 2018; Presidential Regulation No.66/2018
September 2018	Diesel subsidy raised to IDR 2,000 per litre.	Minister Regulation No. 40/2018
October 2018	Mandatory biodiesel blend expanded to all diesel products.	Minister Regulation 41/2018
October 2018	Premium price raised to IDR 7,000 per litre; hours later, Premium price restored to its previous level of IDR 6,450 per litre.	Putera, 2018; Sulaiman, 2018a
January 2019	Government allocates 6.2 million kilolitres of biodiesel for subsidized blending in B20 in 2019.	RambuEnergy, 2019
April 2019	New fuel pricing formula announced.	Association of Indonesian Automotive Industries, 2019
May 2019	Premium price in Java, Madura and Bale adjusted to 6,500 per litre.	CNN Indonesia, 2019

The government's current approach appears to be a shift away from Premium toward better quality fuels. Data show that consumption of Premium fell from over 27 million kilolitres in 2015 to only 12.1 million kilolitres in 2017, while the consumption of Pertalite (RON 90) rose from only 380,000 kilolitres in 2015 to 14.5 million kilolitres in 2017 (Ministry of Energy and Mineral Resources, 2017). In principle, this should have had a big impact on reducing subsidies, since, in theory, Pertalite is not a subsidized fuel. In practice, it is not completely clear whether this is the case. While the prices for Pertalite are set by Pertamina and not by the government, Table 3 shows that the retail price for Pertalite is well below our calculation of the Expected Open Market Price (i.e., the international price plus the costs of distribution, margin and tax). This suggests that some kind of arrangement has been agreed for Pertalite that entails an implicit subsidy for consumers.

More generally, the recent regulations are new in that the government is imposing a price band around the sale of unsubsidized fuel in a way that it has not done before. These regulations place a price band around distribution costs and a limit on the profit margin of between 5 and 10 per cent for unsubsidized fuels. This may be an indication of the government's intention to shift consumers toward (theoretically) unsubsidized fuels, but to then regulate the prices that the private sector can charge for those fuels.

2.1.2 Biodiesel

Indonesia's biofuel policy commenced at the national level in 2006 with the aims to: (1) alleviate poverty and unemployment, (2) drive economic activities through biofuel procurement and (3) reduce domestic fossil fuel consumption (Rahmanulloh, 2018).

The main mechanism by which biofuel production and use is supported is a mandatory blending requirement (Table 2). Biofuels are generally more expensive than fossil fuels and therefore financial assistance is required to ensure their uptake. Indonesia has no financial support arrangements for ethanol, which, combined with lack of strong feedstock supply, has meant that consumption of ethanol has been virtually zero since 2010 (USDA Foreign Agricultural Service, 2018)

Biodiesel blending at 20 per cent (B20) was introduced in 2015 for transportation and industrial use.[6] Initially, only public entities such as trains, buses and power stations were required to meet the B20 mandate. In September 2018, the government reached an agreement with fuel retailers to implement B20 blending in all diesel (Reily, 2018). The biodiesel component is subsidized using revenue collected from a palm oil export levy, the Oil Palm Estate Fund.

The Oil Palm Estate Fund collects levies from palm oil exporters and the proceeds are used to finance government palm oil programs such as biodiesel blending and crop replanting. Effectively, the taxes on palm oil exports are returned to the palm industry as subsidies for biodiesel. Thus the blending mandate assists the palm oil industry in two ways: by increasing demand for palm oil and by ensuring a price premium for biodiesel relative to fossil diesel. The government collected IDR 14.2 trillion (USD 972 million) in levies in 2017, and provided subsidies on 2.3 million kilolitres of biodiesel. In the first quarter of 2018, the fund collected IDR 6.4 trillion in fees and subsidized 1.1 million kilolitres of biodiesel (Munthe & Nangoy, 2018).

Biodiesel is therefore subsidized in two ways. First, the price of the fossil diesel is subsidized by IDR 2,000 per litre. Second, the biofuel component is subsidized by the Oil Palm Estate Fund.

Indonesia's biodiesel production was 3.4 billion litres in 2017. Production in 2018 was estimated to be 3.9 billion litres, reflecting demand domestically and for export.

Table 2. Indonesian Biodiesel Mandatory Target (%)

Sector	2016	2020	2025
Biodiesel			
Transportation and industry	20	30	30
Electricity	30	30	30
Ethanol			
Transportation (subsidized)	2	5	20
Transportation (non-subsidized) and industry	5	10	20

Source: Ministry of Energy and Mineral Resources Regulation 12/2015 in Rahmanulloh, 2018.

2.1.3 Indonesia's Transport Fuel Prices Compared to Other Regions of the World

Indonesia's transport fuel prices are lower than most of its neighbours and peers (Figure 2). Of its Asian neighbours, only Malaysia has cheaper retail prices for gasoline or diesel. Indonesia's prices are also lower than major emerging economies, China and India. These findings are the result of a biannual survey of 179 countries by German aid agency, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.[7]

[6] Ministry of Energy and Mineral Resources Reg No. 12/2015

[7] The source of the Indonesia price data is not specified, such as the brand or octane rating of the fuel.

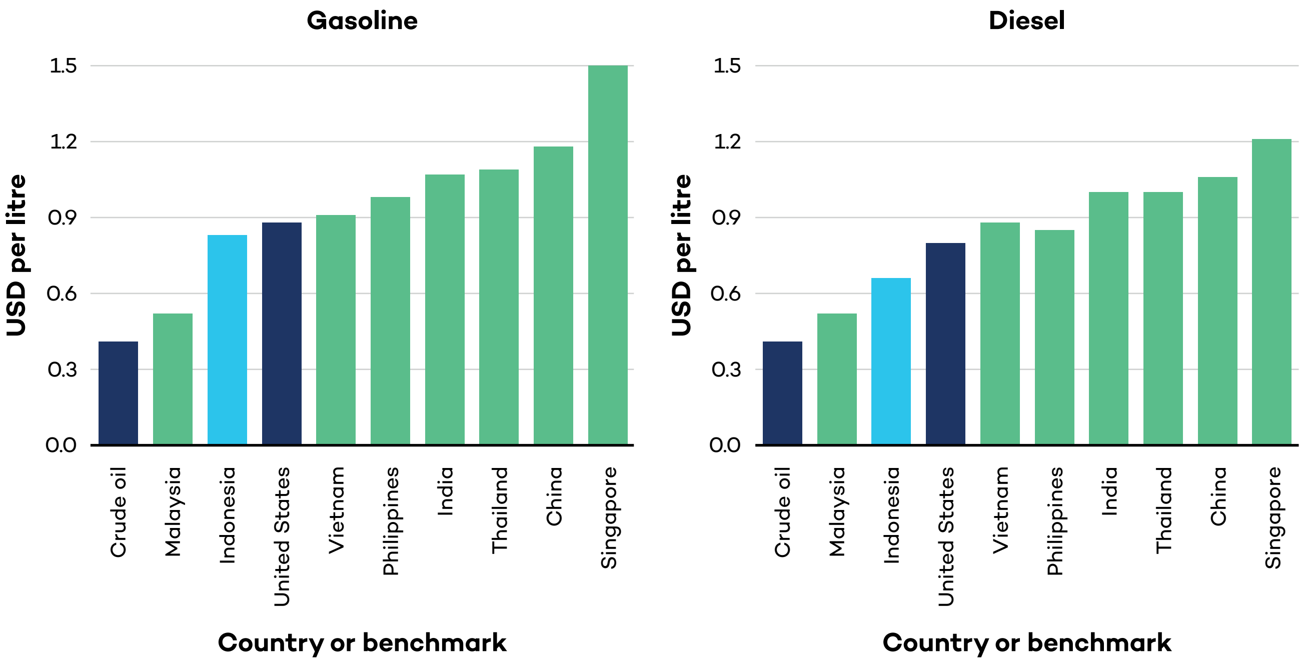

Figure 2. Comparison of Indonesia's transport fuel prices (light blue) with benchmarks (dark blue), neighbours and peers (green), (November 2018)

Notes: Benchmarks are the price of crude oil (at USD 64.90 per barrel, noting that crude oil is not fuel and its price does not include costs of refining, transportation, distribution and margins) and the retail price of fuels in the United States. The U.S. fuel prices are average cost covering fuel prices including transport and margins plus USD 0.10 per litre each for state and federal tax. The U.S. price can be considered a benchmark minimum price for non-subsidized road transport policy, although not covering social and environmental costs.

Source: GIZ, 2019.

In February 2019, Pertamina reduced fuel prices in line with decreases in the international crude oil price. The resulting prices, particularly for subsidized fuels, are considerably lower than those quoted by GIZ (for November 2018). The price for Premium in February 2019 was USD 0.46, only slightly higher than the crude oil price at the time, USD 0.40 per litre (at USD 64 per barrel for the Organization of Oil Producing Countries basket) (OilPrice.com 2019).

Table 3. Prices for Pertamina's subsidized and non-subsidized fuels (May 2019)

	Price per litre	
	IDR	**USD[8]**
Gasoline		
Premium (RON 88) (subsidized, all regions)	6,450	0.45
Expected Open Market Price	8,970	0.62
Pertalite (RON 90)	7,650	0.53
Pertamax (RON 92)	9,850	0.68
Pertamax Turbo (RON 95+)	11,200	0.77

[8] Exchange rate for 20/05/19 1 USD = 14,460 IDR

	Price per litre	
	IDR	USD[8]
Diesel		
Solar and BioSolar (subsidized)	5,150	0.36
Expected Open Market Price	9,985	0.69
Diesel (non-subsidized)	12,250 – 12,500	0.86
Dexlite	10,200	0.71
Dex	11,700	0.81

Sources: Pertamina, 2019; Widiutomo, 2019.

2.1.4 Other Transport Fuels: Gas and electricity

CNG for vehicles was first introduced as the fuel for TransJakarta Bus Rapid Transit buses in Greater Jakarta in 2004. However, generally the uptake of CNG in transport and for buses has been slower than planned, mainly due to a lack of refuelling infrastructure and poor quality of gas supplied for transport use (Allen, Millard, Rahman, & Barlow, 2015).

The Government of Indonesia does not have specific EV policies or incentives. Media reports indicate such a policy may be under development, with an emphasis on production of EVs rather than uptake. Media reports cited the deputy industry minister saying that the government is aiming for 20 per cent of all cars produced in Indonesia to be EVs by 2025. He said Indonesia plans to introduce a fiscal scheme that will offer tax cuts to EV battery producers and automakers, as well as preferential tariff agreements with other countries that have a high EV demand (Reuters, 2019).

Indonesia is the second largest car production hub in Southeast Asia after Thailand.[9] The country has reserves of nickel laterite ore, a key ingredient in lithium-ion batteries used to power EVs. Indonesia will likely seek to leverage these resources to become a regional producer of lithium batteries.

[9] Thailand: 1.99 million cars manufactured in 2017; Indonesia, 1.2 million; Malaysia, 0.5 million (Indonesia-Investments, n.d.).

3.0 Regional Comparisons and the Implications of Indonesia's Transport Policies on Air Pollution and Health

The transport sector contributes to both urban air pollution and greenhouse gas emissions. High concentrations of transport-related air pollution increases risk of cardiovascular and respiratory illnesses, cancer, adverse birth outcomes and death rates (World Health Organization [WHO], 2016, n.d.). Table 4 identifies the major pollutants and their health and environmental impacts.

Table 4. Major gaseous and particulate pollutants to which motor vehicles contribute

Pollutant	Health risk	Environmental impacts
Carbon monoxide	Neurotoxicity, heart disease, reduced reproductive potential	Local impacts only
Particulate matter (PM) (PM_{10}: particles < 10 µm $PM_{2.5}$: particles < 2.5 µm in diameter)	Heart and lung disease, including chronic obstructive pulmonary disease (COPD), exacerbation of respiratory diseases such as asthma Skin and eye irritation	Acidification of rainfall and waterways changing the nutrient balance in coastal waters and large river basins Nutrient depletion Damage to sensitive forests and farm crops Reduced ecosystems diversity
Nitrogen oxides (NO_x)	Irritated airways, causing and aggravating respiratory diseases, particularly asthma Susceptibility to respiratory infections Reacts with other chemicals in the air to form both PM and ozone	NO_2 and other NO_x interact with water, oxygen and other chemicals in the atmosphere to form acid rain. Acid rain harms sensitive ecosystems such as lakes and forests. Contributes to nutrient pollution in coastal waters
Volatile organic compounds (such as aldehydes and benzene)	Carcinogen Immunity impacts Eye and respiratory tract irritation In the case of benzene, reduced production of white and red blood cells	Carcinogen
Ground-level ozone (produced from precursors volatile organic compounds and NO_x)	Lung and throat inflammation and damage, aggravation of lung diseases and susceptibility to infection Continued damage to the lungs even when the symptoms have disappeared COPD	Local impacts only
Sulphur Oxides (SO_x)	Attacks throat and lungs	Gaseous SO_x can harm trees and plants by damaging foliage and decreasing growth; contributes to acid rain
Metal (such as lead, mercury)	Toxicity	Contamination of air, water and soil

Source: Collated from U.S. Environmental Protection Agency, n.d.

In Indonesia, land transportation contributes almost 90 per cent of urban air pollutants (such as those listed in Table 4) (Yudha, 2017), as well as around 12 per cent of total national carbon dioxide emissions. In April 2019, Jakarta ranked 27th in the world air pollution index of cities (where 1 is the most polluted, based on $PM_{2.5}$ levels) (AirVisual, 2019). In Central Jakarta, $PM_{2.5}$ levels are around 42 micrograms per cubic metre (μg/m^3), nearly three times the Indonesian government's target of 15 μg/m^3 and more than four times WHO guidelines (10 μg/m^3) (Lestari, 2019). Ground-level ozone frequently exceeded the government's cap of 50 μg/m^3 from 2011 to 2018 (Lestari, 2019).

Studies on the human health impact and financial burden of air pollution do not distinguish between pollution sources. Other contributors in Indonesia include coal-fired power plants, smoke haze from forest and peat fires, as well as indoor air pollution from solid fuels. Burning coal to produce electricity or heat releases $PM_{2.5}$ and smaller and toxic gases, causing an estimated 7,500 premature deaths in 2011, which is expected to increase to 25,000 by 2030 if no measures are taken (Koplitz et al., 2017). The mortality rate attributed to households and ambient air pollution was 112 per 100,000 population (2010 data) (WHO, 2018), compared to 12 per 100,000 for traffic-related deaths (Tarahita & Rakhmat, 2018).

The extent of the health impacts is much wider. In Jakarta in 2010, for example, an estimated 58 per cent of the population experienced, at one time, diseases and conditions that are either caused or exacerbated by air pollution (asthma, bronchopneumonia, acute respiratory infections, COPD, coronary artery diseases). The health costs associated with treating these diseases was estimated at IDR 38.5 trillion (USD 4.6 billion)[10,11] (Safrudin et al., 2013). The total costs to the economy would be more if they considered lost workdays, absences from school and other impacts on short- and long-term productivity.

Indonesia has several policies to address air pollution in the transport sector.

- Improved fuel quality standards (meeting Euro 2 emission standards and gradually upgrading to Euro 4) (Ompusunggu, 2017)
- The Blue Sky project, including vehicle emission standards and upgrading refineries to produce higher-quality fuels (RambuEnergy, 2015)
- Car Free Day in Jakarta and odd-even number plate rotations
- Mass transit systems (improving bus and commuter rail network)
- Gas and EVs (Yudha, 2017).

Due to limited implementation and reach, plus the absence of meaningful policies to address coal-fired power emissions, these programs are unlikely to be sufficient to address Indonesia's air pollution challenges.

[10] Based on the average 2010 exchange rate of USD 1 = IDR 8,353 (Bank of Indonesia, n.d.).

[11] Incidence of disease and health disorders associated with air pollution in Jakarta in this study were taken from the medical records in two hospitals. The costs of disease incidence and health disorders associated with air pollution are identified based on WHO (n.d.) data.

3.1 Do Fuel Subsidies Contribute to Increased Traffic and Air Pollution?

Indonesia's policy of maintaining low prices for gasoline and diesel exacerbates traffic congestion and transport-related air pollution in two ways. First, by lowering the price of fuel, consumers are sent a signal to increase fuel consumption, or at the least they are not motivated to be more fuel efficient.[12] Second, these subsidized fuels have a worse emissions profile than competitors: locally produced Premium is of lower quality and is higher in sulphur than the non-subsidized, higher-octane brands. In 2016 more than 50 per cent of the Solar sold in Medan did not meet international Euro 2 emission standards (Jong, 2016). Promoting these fuels through lower prices will encourage their consumption relative to alternatives, increasing pollution levels.

Several recent studies have examined the correlation between road traffic levels, air pollution and fuel prices (see below). The majority of these studies found significant correlations between higher fuel prices and reduced levels of traffic or air pollutants (although several studies found no significant impacts for specific pollutants).

- A study in Indonesia found that higher fuel prices resulting from Indonesia's fuel subsidy reforms of 2013 and 2014 reduced traffic volumes on 19 Indonesian toll roads in the second half of 2015 by around 10 per cent relative to the counterfactual without reform (Burke, Batsuuri, & Yudhistira 2017).
- In Bangkok, a study found that higher fuel prices were correlated with reduced air pollution from road vehicles (carbon monoxide, PM_{10}, nitrogen dioxide) during 1996–2006. However, the effect of fuel prices on nitrogen dioxide after 2006 is ambiguous, possibly due to the adoption of CNG vehicles (Ninpanit, 2019).
- In Brisbane, a study found that higher diesel prices were associated with statistically significant short-term reductions in carbon monoxide and nitrogen oxides, but changes in petrol prices had no impact on the four air pollutants monitored (Barnett & Knibbs, 2014).
- In Taiwan, a study found that air pollution declined with higher fuel prices, but the effect was not significant once other factors were controlled for (such as rainfall, numbers of vehicles and changes in the composition of the vehicle fleet) (Chen & Lin, 2015).

Small changes in fuel prices are not the key determinant for consumption and therefore are likely to play only a small role in influencing pollution. Non-fuel price factors are likely to be far more influential, particularly fuel quality and vehicle emission standards, availability of alternatives (public transportation, pedestrian or cycling pathways) and incentives for alternative vehicles or fuels (EV or CNG).

Fuel subsidies are problematic primarily because they divert huge sums of public money that could be used to fund cleaner transport programs, not because marginally higher prices would control pollution themselves. Similarly, a transition from fossil-fuelled vehicles to coal-powered EVs would result in marginal overall pollution reduction (although the source of pollution would be moved from roads to power stations). See Box 1 for a discussion of EVs as a means of reducing pollution.

[12] Burke, Batsuuri and Yudhistira (2017) found that the response of vehicle traffic on toll roads in Indonesia was relatively inelastic to the local fuel price (-0.8 to -0.2). The effect, however, was statistically significant, indicating the Indonesian drivers did drive less when fuel prices increased.

Box 1. Are EVs cleaner than internal combustion engine vehicles (ICEVs)?

The short answer is: it depends on how the vehicle is manufactured and powered.

EVs and ICEVs have significantly different components, manufacturing processes, energy sources and end-of-life options. A fair comparison requires a full life-cycle assessment. Significant research has been done on this issue internationally. This box summarizes results from several recent and authoritative sources, focusing particularly on global warming potential (GWP).

The life-cycle GWP of the vehicle depends on the carbon dioxide emitted during:

- Production of the vehicle and its components, including mining the materials.
- The use phase (when the vehicle is being driven), either directly during fuel combustion or indirectly during electricity production.

Evidently, the carbon intensity of both the production and use phases will vary greatly depending on the source of electricity. Coal-fired power stations are the most carbon-intensive while hydroelectric, nuclear and renewable sources are the least.

EVs are more energy-intensive to produce than ICEVs. Typically, almost half of an EV's life-cycle GWP is associated with its production. Hawkins et al. (2013) estimated that the manufacture of EVs produced 87–95 grams of carbon dioxide equivalent per kilometre (g CO_2e/km), roughly twice the 43 g CO_2eq/km associated with ICEV production (assuming a European electricity mix). Battery production is the single most significant contributor to embodied GWP (35–41 per cent), while the electric engine contributes 7–8 per cent and aluminum-intensive components contribute 16–18 per cent.

EVs can potentially compensate for their carbon-intensive manufacturing phase through lower emissions during the use phase (Ellingsen & Hung, 2018). But the carbon dioxide emissions associated with this phase are evidently highly dependent on the source of electricity. Hawkins et al. (2013) found that EVs, when powered by average European electricity,[13] reduced life-cycle GWP by 20–24 per cent compared to gasoline ICEVs and by 10–14 per cent relative to diesel ICEVs under the base case assumption of a 150,000 km vehicle lifetime. EVs powered by coal electricity, which is the dominant fuel in Indonesia,[14] were expected to cause an *increase* in GWP of 17– 27 per cent compared with diesel and gasoline ICEVs. In contrast, the EV use phase in Norway causes very few emissions because they rely predominantly on hydroelectricity.

Hodges (2019) found that EVs *during the use phase only* are currently less carbon-intensive than ICEVs, even in China, which is more heavily reliant on coal. The carbon footprint of EVs was expected to decline over time as the electricity mix becomes less reliant on fossil fuels (Hodges, 2019).

[13] A mix of coal, gas, nuclear and renewables with a carbon intensity of 521 g CO_2e/kWh (Ellingson, Singh, & Strømman, 2016).

[14] Indonesia's fuel mix is 54 per cent coal, 25 per cent gas, 8 per cent hydro, 6 per cent oil, 4 per cent geothermal and 1 per cent biofuel (International Energy Agency, 2019). The carbon intensity has been estimated at 869 g CO_2e/kWh (Itten, Frischknecht, & Stucki, 2014).

An important consideration is that EVs have the potential to change their use-phase carbon imprint as the electricity mix changes. In the case of the EU, as the carbon intensity of the energy mix is projected to decrease, the life-cycle emissions of a typical EV could be cut by at least 73 per cent by 2050 (European Environment Agency, 2018). In Indonesia, it is unclear how the electricity mix will change over time: coal-fired power is forecast to increase and the government also has a target of 23 per cent renewable energy by 2025, but it is uncertain how it will be met (Bridle et al., 2018).

Greenhouse gas emissions are not the only environmental consideration. EVs reduce air and noise pollution when being driven compared to ICEV, which is a high priority for congested cities such as Jakarta. Particulate matter from brake linings and tire wear will be similar to ICEVs. The mining and manufacturing processes currently used to produce EVs appear to cause a higher potential for human toxicity, freshwater ecotoxicity, freshwater eutrophication and metal depletion impacts (Hawkins et al., 2012). Thus, EVs can be seen to shift pollution from diffuse sources (vehicle emissions) to point sources (mines, factories, power stations).

The large majority (98 per cent) of lead-acid batteries are recycled globally, given the high value of lead and its ease of recovery from used batteries (Gupt & Sahay, 2015). In India, around 50 per cent of recycling is done in "backyard" recycling centres without any pollution or toxicity control (Meyer, 2014).

Harnessing the environmental benefits of EVs also requires a transition to a less carbon-intensive electricity sector and rigorous environmental protection practices in the mining and manufacturing sectors. Recycling batteries and other EV components will also reduce the life-cycle impact of EVs.

3.2 Biodiesel

Combustion of biodiesel produces slightly fewer pollutants, such as carbon monoxide, PM and sulphur (Pool, 2014). On nitrogen oxide emissions, there is a wide spread in the results. One study found that palm biodiesel reduced tailpipe nitrogen oxide emissions by 22 per cent compared to petrodiesel (Peng, 2015), but most studies have found nitrogen oxide emissions are slightly higher than from petroleum diesel (Pool, 2014). The effect on emissions of toxic hydrocarbons depends on the feedstock (Posada, Malins, & Baral 2012). A blend of 60 per cent fossil diesel and 40 per cent palm biodiesel has been found to reduce hydrocarbon *tailpipe* emissions by 73 per cent compared to fossil diesel alone (Senthilkumar, Sivakumar, & Manoharan 2015).

Biofuels are sometimes considered carbon-neutral because the carbon dioxide emitted during combustion is offset by the carbon dioxide taken up during feedstock production. However, this fails to take into account the carbon produced during feedstock production (sowing, fertilizing, harvesting, transporting and processing the crops), as well as in producing, distributing, transporting and blending the fuel. Many of these phases use fossil fuel energy.

In addition, land-use change associated with feedstock production must also be taken into account. Direct impacts occur when land is cleared to make way for feedstock plantations.

Indirect land-use change occurs when demand for biofuel feedstocks displaces demand for other products, such as food, leading to increased land clearing. The spread of palm oil plantations in Indonesia has been associated with widespread clearing of rainforest and peatlands. One estimate suggests that approximately one third of oil palm plantations in Malaysia and Indonesia have been situated on peat-rich primary forests (Fargione et al., 2008).

A 2015 study for the European Commission found that land-use change emissions from biodiesel produced from palm oil is responsible for 231 gCO_2e per megajoule of final energy —2.5 times the total life-cycle emissions of fossil diesel (Valin et al., 2015). Other studies have found wide variations in life-cycle assessments and land-use change estimates depending on underlying assumptions, including the following:

- The extent to which palm co-products are used in palm oil farming (such as using by-products for fertilizing instead of chemical fertilizers) and oil or biodiesel processing (such as use of by-products to generate heat instead of fossil fuels).
- The type of land used to produce the palm oil (plantations on existing or degraded agricultural land compared those on lands cleared for the purpose that formerly contained—in order of carbon intensity—grassland, woodland, carbon-rich forests or peatlands) (for a review see Mukherjee & Sovacool, 2014).

4.0 Models for Fuel Pricing Reform

It is sometimes argued that it is necessary for the government to fix fuel prices in order to protect customers from oil (and therefore fuel) price shocks in the world market. However, there is a range of alternative approaches to setting the fuel price that would enable the government to dramatically reduce subsidies while still protecting ordinary Indonesians from spikes in fuel prices. This section outlines three such methods—smoothing, ratcheting, and cap and floor.

McCullough et al. (2017) sets out the principles that should apply to any approach to fuel price setting. Specifically, it argues that prices should be designed to achieve three objectives:

1. Ensure fiscal sustainability
2. Minimize price fluctuation
3. Minimize fiscal volatility

Ensuring fiscal sustainability means ensuring that very large subsidies do not re-emerge as a result of the widening gap between domestic prices and international prices. Minimizing price fluctuations endeavours to protect consumers by avoiding large month-on-month price changes. Minimizing fiscal volatility means ensuring that the price mechanism does not give rise to large changes in the subsidy required, which can be destabilizing for public finances. The report showed that fixing domestic prices fulfilled none of these criteria: it is fiscally unsustainable as the gap between international and domestic prices widens, enlarging the subsidy; it fails to minimize price fluctuations because, although prices are stable for a while, the fiscal pressure inevitably leads to large changes; and the size of the subsidy is also highly volatile since it depends on the international price of fuel. However, moving to pricing determined purely by the market also fails to fulfill all these criteria. Although market pricing is fiscally sustainable since there is no subsidy—and this also means there is no fiscal volatility—market prices are highly volatile, imposing significant price fluctuations on consumers.

Fortunately, there is a set of price adjustment approaches that fulfills all three criteria: smoothing, ratcheting, and cap-and-floor mechanisms.

4.1 Smoothing

Setting prices monthly using a smoothing formula can significantly reduce subsidies, while ensuring relatively stable prices and levels of subsidy. The price is calculated every month according to the following formula:

> Regulated domestic price (this month) = Regulated domestic price (last month) + β x [EOMP (this month) – Regulated domestic price (last month)]
>
> where EOMP refers to the Expected Open Market Price—that is, the price that the fuel would be sold at if it were sold on the open market.

This smoothing formula shifts domestic prices gradually in the direction indicated by the EOMP. Thus, if the EOMP is rising, then the regulated price will also rise, but it will not immediately jump up to the EOMP; rather, it will just go part of the way up. Similarly, if the EOMP is falling (say because oil prices are falling), the regulated price will not fall immediately to the lower EOMP—it will only move part of the way down.

The extent to which regulated prices follow international prices (i.e., the EOMP) is determined by the value of β. If the value of β is zero, the prices are completely fixed and do not move. If the value of β is one, then this is the same as following international prices. Thus, the value of β determines how "smooth" we wish adjustment to be. A low value of β, say 0.1, makes price adjustment slow and smooth. This means that subsidies can re-emerge if the international price is rising. Equally, it can mean that surpluses emerge when the international price is falling. A high value for β, say 0.9, means that adjustment to the new international price is rapid; this would entail greater price volatility but lower fiscal volatility. Because the regulated price is following the international price, on average over time subsidies are likely to be minimal, so the formula is fiscally sustainable.

To illustrate how this formula might help, Figure 3 shows the prices for Premium (RON 88) for the full first term of the government, from October 2014, when President Jokowi took office, until March 2019. The green line shows the actual regulated domestic price for Premium. The blue line shows the international price (the EOMP).

In January 2015, shortly after taking office, President Jokowi undertook bold subsidy reform, announcing that subsidies were being abolished on Premium and that prices would be determined by a formula designed to track world prices. This formula was applied intermittently for the first two years of the administration with minor adjustments to fuel prices to reflect changes in the world market. However, from April 2016, the price of Premium has remained fixed at IDR 6,450, despite a significant increase in the international price. The widening gap between the international price (and therefore the EOMP) and the regulated price led to the re-emergence of large subsidies (Figure 4). We estimate that, during the course of the first administration, Indonesia spent around IDR 54.5 trillion in subsidies just on Premium—although this is not reflected in the budgets since most of this subsidy was borne off-budget by Pertamina.

What might have happened to prices and subsidies had the government used a smoothing formula to set prices over the same period? The orange line in Figure 3 shows what the prices would have been had the government used a smoothing formula during this period. Because the government initially applied a formula, the performance of the smoothing formula and the formula applied by the government were similar until mid-2016, with small price changes and virtually no subsidy. However, if the smoothing formula had been used thereafter, it would have tracked the gradual increase in the world price from mid-2016 to the end of 2018. This would have gradually increased prices, but without the major jumps experienced on the world market. As a result, subsidies would have been very low (Figure 4).

Moreover, when the price collapsed in late 2018, the smoothing formula would also have reduced prices, but more slowly, allowing the government to recoup a portion of its subsidy losses. Our model estimates that, had a smoothing formula been applied over the whole period, the net subsidy paid by the government would have been IDR -1.8 trillion—that is, a net gain for the government and IDR 56.3 trillion less than was actually incurred.

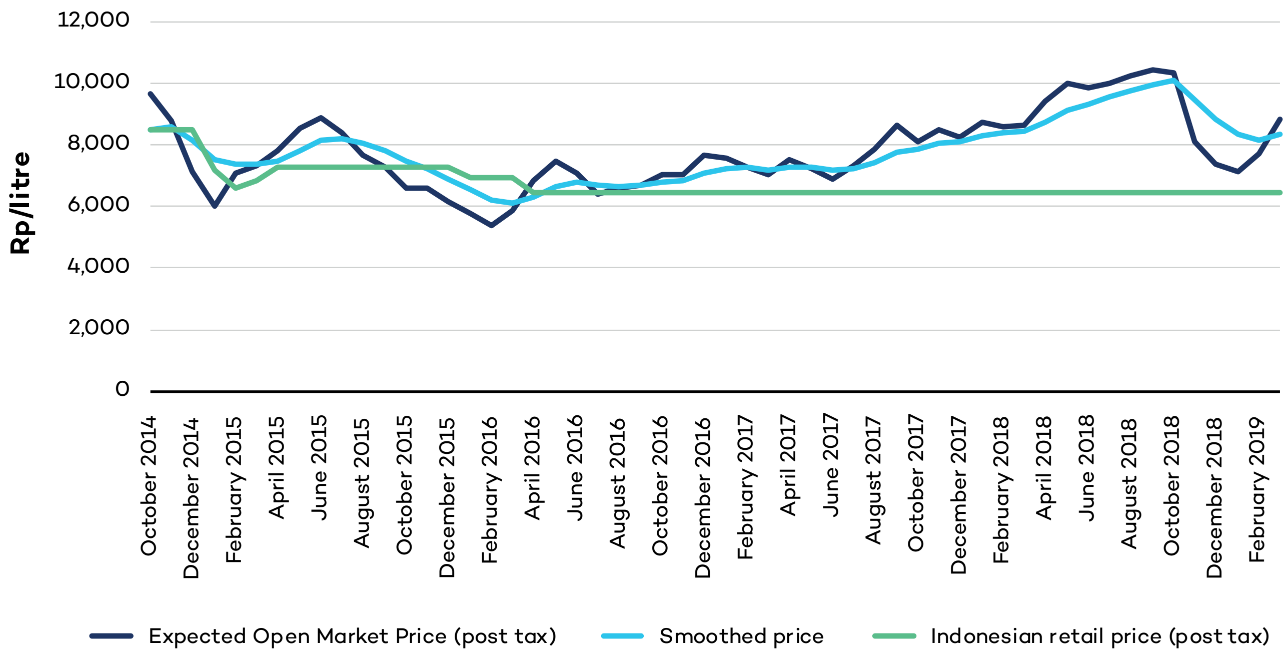

Figure 3. Price adjustment with a smoothing formula

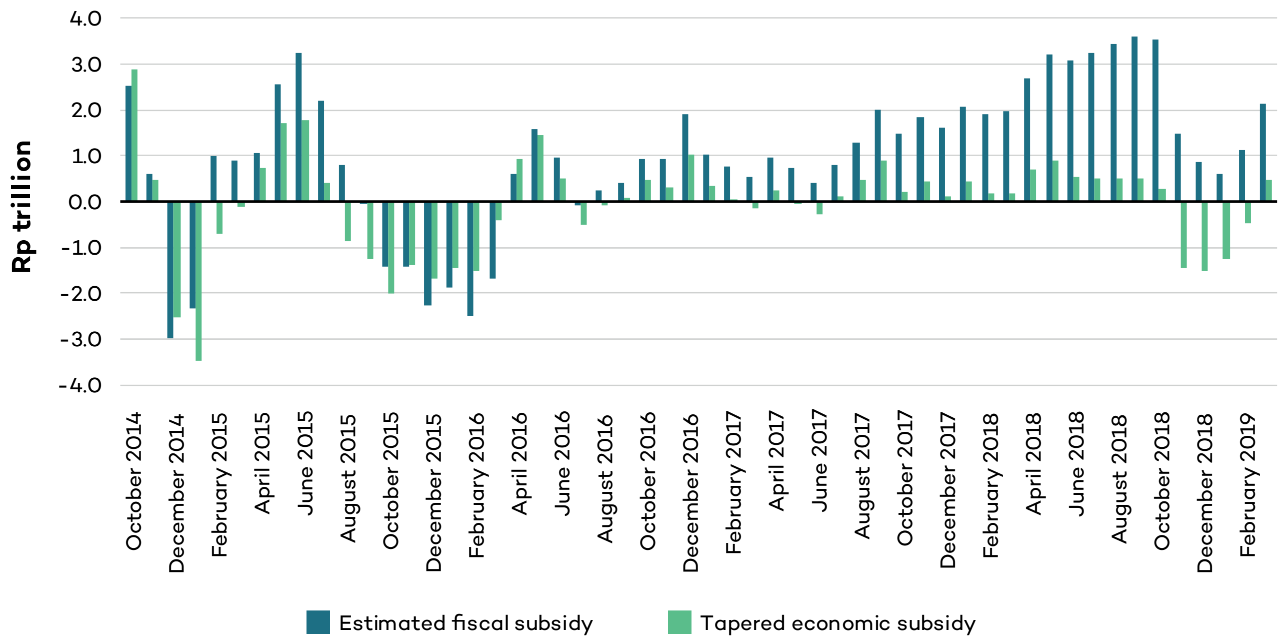

Figure 4. Size of subsidies with and without smoothing

4.2 Ratcheting

One of the disadvantages of the smoothing approach is that, when the trend of international prices is rising (even if there are monthly movements up and down around the rising trend), the smoothed price will also inexorably rise. Continuously rising prices can present a political difficulty for the government, even if the price increases are small. One way to achieve the same objective as the smoothing formula but to overcome this feature is to use a "ratcheting" formula.

In this approach, the regulated domestic price each month is set equal to the previous month's domestic price plus some share of the change in the international prices between the current and previous months. The share that is taken differs depending on whether the international prices move up or down. If the regulated domestic price is currently below the international price, the new regulated price adds a larger share of increases in international prices than decreases (and vice versa).[15] In this way, the domestic price "ratchets" its way up to the international price.

The real value of the ratcheting approach is that, when international prices fall, domestic prices do so too (although not to the full extent). Consumers can see that they are getting something back from the government, and this can make changes more politically acceptable. The disadvantage of the ratcheting approach is that price volatility is greater, although, conversely, fiscal volatility is typically smaller.

Figure 5 replicates Figure 3 above but shows where regulated domestic prices are set using the ratcheting formula (the orange line). Figure 6 shows the sizes of subsidies using the ratcheting formula.[16]

As with the smoothing formula, using the ratcheting formula would have gradually increased the domestic price between mid-2016 and the end of 2018, but this time with fluctuations driven by the fluctuations in the international price. Had the government used the ratcheting formula, the total cost of subsidies over this period would have been IDR 6.4 trillion—a saving of IDR 48.2 trillion relative to what actually happened. Figure 6 shows that the slightly greater price volatility for consumers would have led to less fiscal volatility, as the profile of subsidy payments is smoother over time.

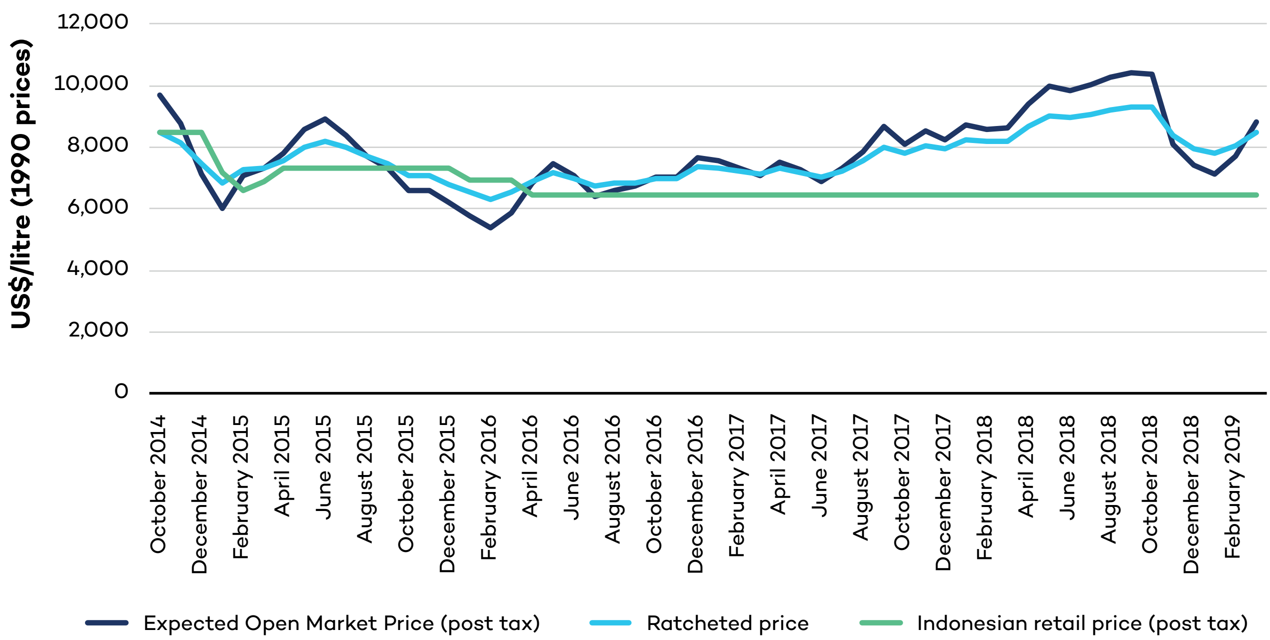

Figure 5. Price adjustment with a ratcheting formula

[15] Full details of the formula are available on request.

[16] Like the smoothing formula, there is a parameter (in fact two parameters) than can be adjusted to make price adjustment more or less rapid and smooth.

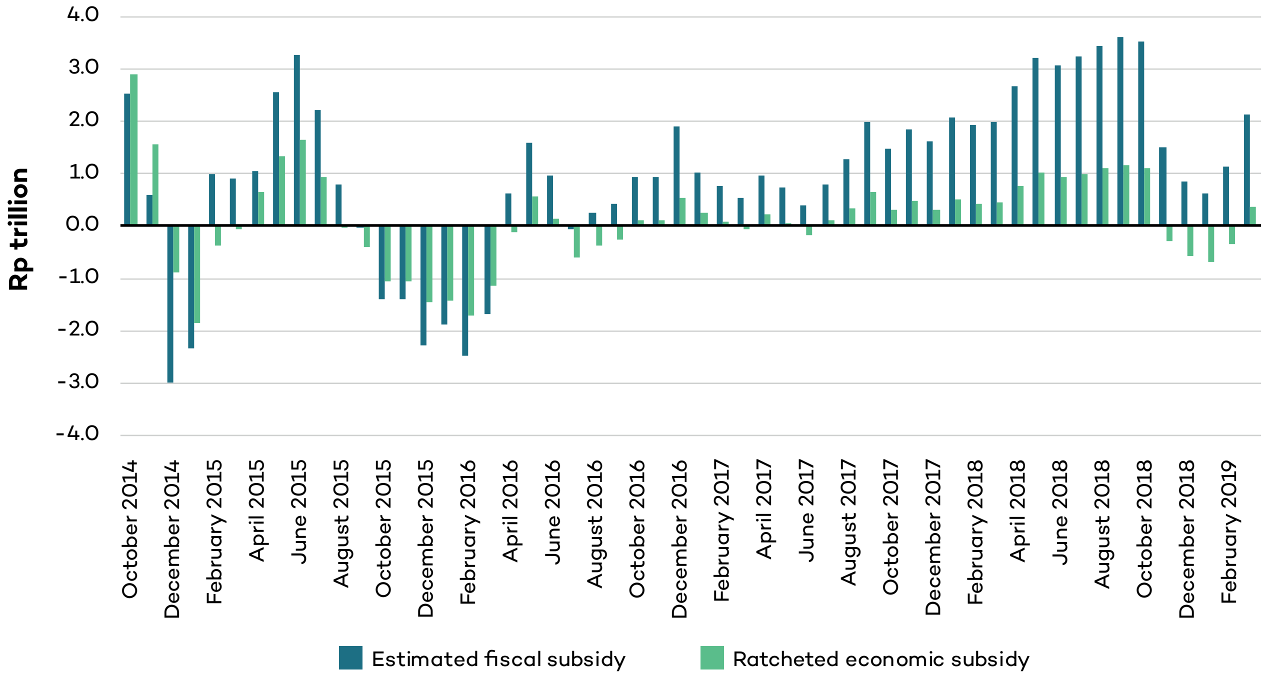

Figure 6. Size of subsidies with and without smoothing

4.3 Comparing Alternative Methods of Price Setting

One of the main concerns of policy-makers is protecting consumers from large price shocks. It is possible to compare the performance of alternative methods of price setting in achieving this. Table 5 compares four different methods of price setting:

1. Setting the EOMP each month
2. Smoothing (as described above)
3. Ratcheting (as described above)
4. Retail price (i.e., the price that was actually set by the government)

Consider first the mechanism that the government actually used. The median monthly change in price was zero—that is, the price typically did not change from month to month. However, as a result, when prices did change, the changes could be large: the largest monthly drop in price was IDR 1,319, while the largest monthly increase was IDR 435. If we define a "large" increase as any increase larger than IDR 250 per month, then there were only two months during which such an increase occurred. However, the cost of this stability was an overall level of subsidy of IDR 55.4 trillion.

If the government had, instead, set the price each month to be the EOMP, there would have been no subsidy at all. The typical (median) monthly change would also have been small, but the minimum and maximum monthly changes would have been much larger. Moreover, in over a third of the months during the period, there would have been an increase in price of over IDR 250.

Smoothing and ratcheting formulas lie between these two extremes. Using a smoothing formula would have resulted in a typical small increase of IDR 76 each month, but the largest decrease would have been smaller than that of any other approach, as would the largest increase (i.e., prices would have been smoother). Only six months during the period would have seen a rise of more than IDR

250, and the overall fiscal cost would have been negative (i.e., a gain to the government). Ratcheting would have been slightly more volatile, with 10 months in which increases were more than IDR 250—and a little more costly in subsidies—but still much less expensive than the policy actually pursued by the government.

Table 5. Comparing alternative methods of price setting

Frequency of adjustments	Unit	EOMP	Smoothing	Ratcheting	Retail price
Median monthly change	IDR	2	76	1	0
Min. monthly change	IDR	-1,953	-633	-898	-1,319
Max. monthly change	IDR	959	374	477	435
Number of months with large increase*	IDR	19	6	10	2
Proportion of months with large increase	%	36%	11%	19%	4%
BUT					
Subsidy required	IDR trillion	0	-2	6.4	54.5

**A large increase is IDR 250*

4.4 Cap and Floor

Another approach to minimizing subsidies while protecting consumers from excessive price increases is to use a price cap and floor. As illustrated in Figure 7, a cap-and-floor system works by setting upper and lower limits for the price of fuel. The cap and floor are set by government regulation, and the price is allowed to fluctuate between these two levels. It therefore ensures that the price paid is never more than the cap and never lower than the floor. As long as the price stays between the floor and cap levels, it fluctuates as normal.

For example, if the cap price is IDR 9,750 (roughly USD 0.75) per unit of energy, and the floor price is IDR 3,250 (roughly USD 0.25) per unit of energy, the price is guaranteed to always be between these levels. If the market price is IDR 6,500 (roughly USD 0.50) per unit, this is what the purchaser pays; however, if it spikes to IDR 13,000 per unit, the actual price paid is still IDR 9,750 and the remaining IDR 3,250 is covered as a form of subsidy. If the price falls to IDR 2,500 per unit, the purchaser still pays IDR 3,250, with the difference effectively serving as funds to government or energy companies that help offset the subsidy required when the market price is above the price cap.

Price caps can significantly reduce economic uncertainty related to energy price fluctuations (Philibert, 2001). This provides for the ability to meet the objective of limiting price volatility, and, depending on how narrow or wide the price cap is, it can also serve to meet the objective of limiting fluctuations. A very wide gap between the cap and the floor could lead to significant fluctuation, while a narrow gap between cap and floor would lead to minimal fluctuations.

A challenge for a cap-and-floor system is in its fiscal sustainability tied to the allowance for fluctuation. A wide gap allows for greater fluctuation but also protects the government and/or companies from having to potentially pay significant subsidies. Price caps do not address the actual cost, only the expected cost (Philibert, 2001). Unexpected changes in prices can therefore lead to a situation where there is significant misalignment between the cap or floor and the market price. Caps and floors may need adjustment over time to account for this, although it would be less frequent changes than smoothing or ratcheting approaches, as there is some natural flexibility built into the pricing system. Cap-and-floor mechanisms are also subject to political influence, with the cap potentially being set too low, which can lead to significant subsidies. Ideally, the cap and floor are only designed to protect from the highest peaks or lowest valleys, but there is a lot of fluctuation for those purchasing energy. If the gap is too narrow, or misaligned, this either creates artificially high prices for purchasers if the market price is consistently below the floor or leads to the potential for high subsidies if the market price is consistently above the cap.

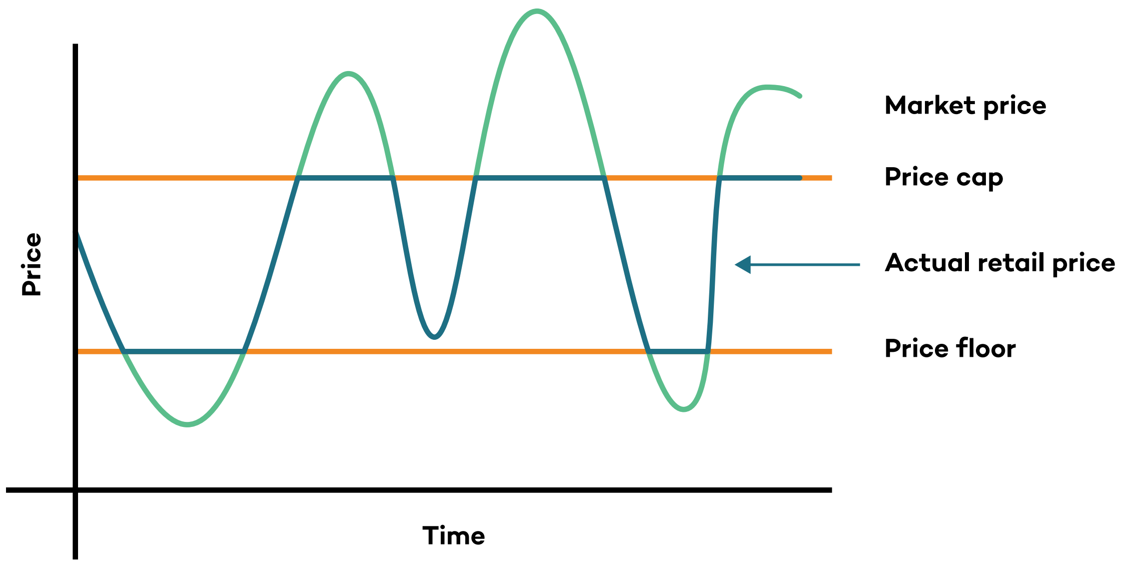

Figure 7. An illustration of how a price cap-and-floor system works

As noted above, absolute cap-and-floor prices have significant weaknesses as a method of protecting consumers and minimizing subsidies. However, there is one type of cap and floor that does not suffer from these problems: the relative cap and floor. With a *relative cap* and floor, no absolute floor or cap is set; rather, the government specifies that prices cannot increase each month by more than a certain percentage (a relative cap). The government can also specify that prices cannot decrease by more than a certain percentage each month (a relative floor). This approach can be combined with any of the formula methods described above.

For example, if the ratcheting formula were preferred, but there was concern that it was not acceptable for the price to rise by more than IDR 250 in a single month, then it would be possible to set a relative cap of, say, 3 per cent per month. This would ensure that any monthly price never exceeded IDR 250, even if the formula said that it should. Adding relative caps to pricing formulas makes them more complicated and also increases the subsidy cost; however, if a reasonable level of cap is chosen, the overall level of subsidy is still significantly below that resulting from fixed prices. Moreover, adding a relative floor—which avoids large falls in the domestic price—mitigates any increase in the overall subsidy cost from applying a relative cap. Thus, a smoothing or ratcheting formula with relative caps and floors can be an elegant solution since that minimizes price and subsidy volatility while still significantly reducing the overall size of the subsidy burden on the government.

4.5 Other Approaches to Reducing Subsidies

In addition to price determination mechanisms, it is possible to significantly reduce subsidies by switching the fuel mix. The government is already doing this. It is increasingly restricting the use of RON 88 (Premium) fuel to islands off Java, Madura and Bali, thereby dramatically reducing the consumption of subsidized fuel. In its place, it is encouraging the use of Pertalite (RON 90), which, in theory, is not a subsidized fuel.[17] The price of Pertalite is set by the companies and it fluctuates up and down, thereby helping to get consumers used to the idea of regular fluctuations in the price of fuel. Switching to a higher-quality fuel in this way provides consumers with a better product, which makes them more willing to pay a little more.

[17] According to current regulations, Pertalite is not a subsidized fuel. However, it currently sells for IDR 7,650. Our estimate of the EOMP for Premium (an inferior fuel to Pertalite) is IDR 7,665 before tax. It is therefore not clear how companies are able to sell Pertalite for IDR 7,650 without a subsidy.

5.0 Conclusions

Indonesia's 2015 fuel pricing reforms were partially successful. For the first time since fuel subsidies were introduced, there was political and public acceptance of the need for meaningful reform. Consistent implementation of the pricing formula proved too politically challenging, however, and subsidies re-emerged as losses for Pertamina and foregone dividends and taxes.

These subsidies are delivered as a Public Service Obligation. But the benefits to the public are not all positive. Fuel subsidies exacerbate air pollution and associated illness, with attendant economic and social costs. The choice to subsidize the most polluting fuels—low-octane gasoline and high-sulphur diesel—is particularly detrimental. This is done because these fuels are cheaper, but the cost to society is large.

The government's proposal to shift price regulation from Premium to Pertamax will help. But significant reductions to air pollution require emission standards for all fuels to be raised and enforced. Reducing the demand for transport fuels is also necessary through public transport, low-emission vehicles and non-vehicle solutions (such as pedestrian and cycle pathways).

Properly enforcing standards and building good public infrastructure is expensive. The necessary funds can be found, at least in part, from fuel subsidy reform. Rather than trying to hide Pertamina's losses due to the fuel subsidies, the government could publicize them and highlight their wastefulness and negative impacts. A commitment could be made that, with full liberation of prices, the funds could be channelled to infrastructure related to transport and energy.

Suitable projects would include public transport and renewable energy solutions that reduce air pollution (such as replacing diesel generators with off-grid solar or installing grid-connected solar panels in urban areas). Funding the transition from coal to renewable energy would reduce air pollution and increase the merits of transitioning to EVs (including low-speed scooters, tricycles and public buses).

Subsidizing biofuels delivers benefits to biofuel and palm oil producers but few to the Indonesian public. While some tailpipe emissions are slightly lower for palm biodiesel compared to petroleum diesel, the total life-cycle emissions are significantly higher. In addition, the higher cost of biodiesel is paid for by taxes that would otherwise be available for alternative government programs.

The pricing mechanisms presented in this report provide means by which the government could continue to shelter the Indonesian people and economy from oil price fluctuations while reducing or eliminating subsidies. The newly elected government has an opportunity to continue its historic fuel pricing reforms, but this time it needs to put in place mechanisms to prevent the subsidy from re-emerging and the government from getting further drawn into fuel pricing.

Based on these findings, we make the following policy recommendations:

- Implement a pricing model such as smoothing, ratcheting or a cap and floor that would reduce price fluctuations while reducing subsidies.
- Phase out or impose higher prices on the most polluting fuels to discourage use. If subsidies must be provided, switch these to cleaner fuels.

- Promote reform with the public by emphasizing that the funds previously directed to fuel subsidies will be used to fund:
    - Infrastructure for low-emission transport solutions, such as public transport, charging stations for EVs, and adapting roads for bicycles and pedestrians.
    - Enforcing higher fuel and vehicle emissions standards.
    - Transitioning from coal to renewables as a means to reduce air pollution.
    - Reducing health and environmental impacts of air pollution.
- Improving biofuel governance to ensure that contributions to the energy sector do not create additional emissions.

References

AirVisual. (2019). Air quality and pollution city ranking. Retrieved from https://www.airvisual.com/world-air-quality-ranking

Allen, H., Millard, K., Rahman, M.S.U., & Barlow, T. (2015). *A study on potential use of compressed natural gas (CNG) in public transport in Indonesia*. Retrieved from https://www.academia.edu/21149033/A_Study_on_Potential_Use_of_Compressed_Natural_Gas_CNG_in_Public_Transport_in_Indonesia

Asmarini, W. & Diela, T. (2018). Indonesia to regulate non-subsidized fuel prices to control inflation. *Reuters.* Retrieved from https://www.reuters.com/article/us-indonesia-gasoline-prices/indonesia-to-regulate-non-subsidized-fuel-prices-to-control-inflation-idUSKBN1HG1DQ

Association of Indonesian Automotive Industries. (2019). The Ministry of Energy and Mineral Resources: A chance for subsidies of Pertamax fuel by 2020. *Gaikindo*. Retrieved from https://www.gaikindo.or.id/en/10594/

Bank of Indonesia. (n.d.). Foreign exchange rate. Retrieved from https://www.rambuenergy.com/2015/11/pertamina-awards-epc-contract-to-jgc-encora-consortium-to-build-cilacap-blue-sky-project

Bappenas & Low Carbon Development Indonesia. (2019). *Low carbon development: A Paradigm shift towards a green economy in Indonesia*. Retreived from https://www.un-page.org/files/public/indonesia_lowcarbon_development_full_report.pdf

Barnett, A. G. & Knibbs, L. D. (2014). Higher fuel prices are associated with lower air pollution levels. *Environment International, 66,* 88–91.

BBC News. (2018). President Jokowi set a 'one fuel price' policy in Papua. BBC News. Retrieved from https://www.bbc.com/indonesia/indonesia/2016/10/161018_indonesia_jokowi_papua_kunjungan

BPH Migas. (2016). Kuota Dan Realisasi JBT Tahun 2016 [Quota and Realisation of JBT Year 2016]. *BPH Migas*.

BPH Migas. (2017). Kuota Dan Realisasi JBT Tahun 2017 [Quota and Realisation of JBT Year 2017]. *BPH Migas*.

Bridle, R., Gass, P., Halimajaya, A., Lonton, L., McCuloch, N. … Sanchez, L. (2018). *Missing the 23 per cent target: Roadblocks to the development of renewable energy in Indonesia*. Retrieved from https://www.iisd.org/sites/default/files/publications/roadblocks-indonesia-renewable-energy.pdf

Burke, P. J., Batsuuri, T., & Yudhistira, M. H. (2017). Easing the traffic: The effects of Indonesia's fuel subsidy reforms on toll-road travel. *Transportation Research Part A: Policy and Practice, 105,* 167–180.

Chen, L.-J. & Lin, Y.-L. (2015). Does air pollution respond to petroleum price? *International Journal of Applied Economics, 12*(2), 104–125. Retrieved from https://www2.southeastern.edu/orgs/ijae/index_files/IJAE%20SEPT%202015%20CHEN%20LIN%2010-28-2015%20Air_Pollution_with_name_IJAE_20150224.pdf

CNN Indonesia. (2019). Fuel price formulation amended, Pertamina confident of safe finance. Retrieved from https://www.cnnindonesia.com/ekonomi/20190211201743-85-368342/formulasi-harga-bbm-diubah-pertamina-yakin-keuangan-aman

Dillon, H. S., Laan, T., & Dillon, H. S. (2008). *Biofuels – At what cost? Government support for ethanol and biodiesel in Indonesia*. Global Subsidies Initiative. Retrieved from http://www.globalsubsidies.org/files/assets/Indonesia_biofuels.pdf

Ellingsen, L. A.-W. & Hung, C. R. (2018). *Research for TRAN Committee – Resources, energy, and lifecycle greenhouse gas emission aspects of electric vehicles* (IP/B/TRAN/NT/2018-04). Brussels. Retrieved from http://www.europarl.europa.eu/RegData/etudes/STUD/2018/617457/IPOL_STU(2018)617457_EN.pdf

Ellingsen, L. A.-W., Singh, B., & Strømman, A. H. (2016, May 6). The size and range effect: Lifecycle greenhouse gas emissions of electric vehicles. *Environmental Research Letters, 11*(5). Retrieved from https://iopscience.iop.org/article/10.1088/1748-9326/11/5/054010/meta

European Environment Agency. (2018). *Electric vehicles from life cycle and circular economy perspectives. TERM 2018: Transport and Environment Reporting Mechanism (TERM) report* (EEA Report No 13/2018). Retrieved from https://www.eea.europa.eu/publications/electric-vehicles-from-life-cycle

Fargione, J., Hill, J., Tilman, D., Polasky, S., & Hawthroen, P. (2008). Land clearing and the biofuel carbon debt. *Science, 219*(5867), 1235–1238.

GIZ. (2019). International fuel prices 2018/19. Retrieved from https://www.sutp.org/files/contents/documents/resources/K_International%20Fuel%20Prices/GIZ_SUTP_IFP_2018-19_EN.pdf

Gupt, Y., & Sahay, S. (2015). Managing used lead acid batteries in India: Evaluation of EPR-DRS approaches. *Journal of Health and Pollution, 5*(8), 52–63. Retrieved from https://www.journalhealthpollution.org/doi/pdf/10.5696/i2156-9614-5-8.52

Gupta, U. (2019, March 25). Innovation boosts lithium-ion battery recycling rate to over 80%. *pv magazine*. Retrieved from https://www.pv-magazine.com/2019/03/25/innovation-boosts-lithium-ion-battery-recycling-rate-to-over-80/

Hawkins, T. R., Singh, B., Majeau-Bettez, G. & Strømman, A. H. (2013). Comparative environmental life cycle assessment of conventional and electric vehicles. *Journal of Industrial Ecology, 17*(1). Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/j.1530-9290.2012.00532.x

Hellenic Shipping News. (2018). Indonesia fuel price fiasco may put $1.7 bln dent in Pertamina's finances. Retrieved from https://www.hellenicshippingnews.com/indonesia-fuel-price-fiasco-may-put-1-7-bln-dent-in-pertaminas-finances/

Hodges, J. (2019). Electric cars are cleaner even when powered by coal. *Bloomberg*. Retrieved from https://www.bloomberg.com/news/articles/2019-01-15/electric-cars-seen-getting-cleaner-even-where-grids-rely-on-coal

International Energy Agency. (2019). Statistics. Retrieved from https://www.iea.org/statistics/

Indonesia-Investments (n.d.). Automotive manufacturing industry Indonesia. Retrieved from https://www.indonesia-investments.com/business/industries-sectors/automotive-industry/item6047

Itten, R., Frischknecht, R. & Stucki, M. (2014). *Life cycle inventories of electricity mixes and grid* (Version 1.3). Uster, Switzerland: Paul Scherrer Institut. Retrieved from http://esu-services.ch/fileadmin/download/publicLCI/itten-2012-electricity-mix.pdf

Jensen, F. (2018). Indonesia's regulator scolds Pertamina over high fuel prices, shortages. *Reuters*. Retrieved from https://af.reuters.com/article/energyOilNews/idAFL4N1QP42L

Jong, H. N. (2016). Medan, Jakarta most polluted. *Jakarta Post*. Retrieved from https://www.thejakartapost.com/news/2016/12/15/medan-jakarta-most-polluted.html

Koplitz, S. N., Jacob, D. J., Sulprizo, M. P., Myllyvirta, L., & Reid, C. (2017). Burden of disease from rising coal-fired power plant emissions in Southeast Asia. *Environmental Science & Technology, 51*(3): 1467–1476.

Lestari, K. R. (2019). Jakarta air quality will worsen, activists warn. *UCA News*. Retrieved from https://www.ucanews.com/news/jakarta-air-quality-will-worsen-activists-warn/84290

Liputan6. (2018). Tetapkan Harga Pertamax Cs Harus Izin Pemerintah, Sri Mulyani Sebut Sesuai Aturan [in Indonesian]. *Liputan 6*. Retrieved from https://www.liputan6.com/bisnis/read/3445992/tetapkan-harga-pertamax-cs-harus-izin-pemerintah-sri-mulyani-sebut-sesuai-aturan

McCulloch, N., Lontoh, L., Sambodo, M., Christensen, L. T. & Gass, P. (2017). *How to respond when prices go up: Objectives and options for fuel price adjustments in Indonesia*. Retrieved from http://www.iisd.org/sites/default/files/publications/how-to-respond-when-prices-go-up-indonesia.pdf

Meyer, C. (2014). Report from India: Lead battery recycling the right and wrong way. Retrieved from https://www.pureearth.org/blog/report-from-india-lead-battery-recycling-the-right-and-wrong-way

Ministry of Energy and Mineral Resources. (2017). *Handbook of energy and economic statistics of Indonesia*. Ministry of Energy and Mineral Resources. Retrieved from https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-economic-statistics-of-indonesia-2017-.pdf

Mukherjee, I., & Sovacool, B. K. (2014). Palm oil-based biofuels and sustainability in Southeast Asia: A review of Indonesia, Malaysia, and Thailand. *Renewable and Sustainable Energy Reviews, 37,* 1–12.

Munthe, B. C. & Nangoy, F. (2018). Indonesia revises palm crop fund rules to back biodiesel drive. *Reuters.* Retrieved from https://www.reuters.com/article/us-indonesia-biodiesel/indonesia-revises-palm-crop-fund-rules-to-back-biodiesel-drive-idUSKCN1L60V1

Ninpanit, P. (2019). *The effects of fuel prices on air quality: Evidence from Bangkok Metropolitan Region.* Presented at 63rd AARES Annual Conference, Melbourne, Australia. Retrieved from http://ageconsearch.umn.edu/record/285055/files/70%20-%20The%20effects%20of%20fuel%20prices%20on%20air%20quality.pdf

Organisation for Economic Development and Co-operation. (2019). *Indonesia's effort to phase out and rationalise its fossil-fuel subsidies: A report on the G20 peer-review of inefficient fossil-fuel subsidies that encourage wasteful consumption in Indonesia.* Paris. Retrieved from http://www.oecd.org/site/tadffss/publication/Indonesia G20 Peer Review IFFS.pdf

OilPrice.com. (2019). Oil price charts. Retrieved from https://oilprice.com/oil-price-charts

Ompusunggu, M. (2017). Regulation on EURO IV adoption signed. *Jakarta Post.* Retrieved from https://www.thejakartapost.com/news/2017/03/28/regulation-on-euro-iv-adoption-signed.html

Peng, D. X. (2015). Exhaust emission characteristics of various types of biofuels. *Advances in Mechanical Engineering, 7*(7).

Pertamina. (2019). List of prices for BBK Tmt 5 January 2019. Retrieved from https://www.pertamina.com/id/news-room/announcement/daftar-harga-bbk-tmt-5-januari-2019

Ping, Lim Yee. (2019) *Indonesia: Fiscal impact for maintaining subsidised fuel and electricity prices.* Retrieved from: https://www.cariasean.org/news/indonesia-fiscal-impact-for-maintaining-subsidised-fuel-and-electricity-prices-2/#.XX9OS2kzZPZ

Pool, R. (2014). *The nexus of biofuels, climate change, and human health: Workshop summary.* Washington, D.C.: The National Academies Press.

Posada, F., Malins, C. & Baral, A. (2012). *Biodiesel carbon intensity, sustainability and effects on vehicles and emissions.* Retrieved from https://theicct.org/sites/default/files/publications/ICCT_biodiesel%20briefing_Jan12.

Putera, A. D. (2018). Jonan: At 18.00 WIB, the Premium price increases to Rp. 7,000. *Kompas.* Retrieved from https://ekonomi.kompas.com/read/2018/10/10/170733826/jonan-pukul-1800-wib-ha

Rahmanulloh, A. (2018). *Indonesia biofuels annual.* Jakarta. https://gain.fas.usda.gov/Recent GAIN Publications/Biofuels Annual_Jakarta_Indonesia_8-13-2018.pdf

RambuEnergy. (2015). Pertamina awards EPC contract to JGC, Encora Consortium to build Cilacap Blue Sky Project. Retrieved from https://www.rambuenergy.com/2015/11/pertamina-awards-epc-contract-to-jgc-encora-consortium-to-build-cilacap-blue-sky-project/

RambuEnergy. (2019). Indonesia govt allocates 6.2 mln kl biodiesel this year. Retrieved from: https://www.rambuenergy.com/2019/01/indonesia-govt-allocates-6-2-mln-kl-biodiesel-this-year/

Reily, M. (2018). Produsen Biodiesel Teken Kontrak Dengan Penyalur Bahan Bakar Besok [in Indonesian]. Retrieved from https://katadata.co.id/berita/2018/08/28/produsen-biodiesel-teken-kontrak-dengan-penyalur-bahan-bakar-besok

Reuters. (2015). Indonesia's Pertamina losing $6 Million a day from fuel sales. Retrieved from https://af.reuters.com/article/energyOilNews/idAFJ9N0YB02D20150805

Reuters. (2018). Indonesia power tariffs, fuel prices to stay unchanged for 2 years. Retrieved from https://af.reuters.com/article/energyOilNews/idAFL4N1QO2CN

Reuters. (2019). Indonesia plans electric vehicle incentives for foreign car makers. Retrieved from https://af.reuters.com/article/energyOilNews/idAFL4N1QO2CN

Safrudin, A., Palguna, A., Adrison, BV., Haryanto, B., Krisnawati, K…Huda, A. (2013). *Cost benefit analysis for fuel qualtiy and fuel economy initiative in Indonesia.* Jakarta. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/16842/CBA_Indonesia.pdf?sequence=1&isAllowed=y

Senthilkumar, S., Sivakumar, G., & Manoharan, S. (2015). Investigation of palm methyl-ester bio-diesel with additive on performance and emission characteristics of a diesel engine under 8-mode testing cycle. *Alexandria Engineering Journal, 54*(3), 423–428.

Singgih, V. & Listiyorini, E. (2018). Indonesia's Jokowi flip-flops on fuel price hike. *Bloomberg.* Retrieved from https://www.bloomberg.com/news/articles/2018-10-10/indonesia-flip-flops-on-fuel-price-hike-as-crude-rupiah-bite

Sulaiman, S. R. (2018a). Government abruptly cancels plan to increase subsidized fuel prices. *Jakarta Post.* Retrieved from https://www.thejakartapost.com/news/2018/10/10/government-abruptly-cancels-plan-to-increase-subsidized-fuel-prices.html

Sulaiman, S. R. (2018b). Jokowi signs rule to require sale of premium gas in Java, Madura, Bali. *Reuters.* Retrieved from https://www.thejakartapost.com/news/2018/05/28/jokowi-signs-rule-to-require-sale-of-premium-gas-in-java-madura-bali.html

Tarahita, D. & Rakhmat, M. Z. (2018). Indonesia's traffic woes. *The Diplomat.* Retrieved from https://thediplomat.com/2018/04/indonesias-traffic-woes/

U.S. Environmental Protection Agency. (n.d.). Health and environmental effects of hazardous air pollutants. Retrieved from https://www.epa.gov/haps/health-and-environmental-effects-hazardous-air-pollutants

USDA Foreign Agricultural Service. (2018). *Indonesia biofuels annual 2018.* Jakarta. Retrieved from https://gain.fas.usda.gov/Recent GAIN Publications/Biofuels Annual_Jakarta_Indonesia_8-13-2018.pdf

Valin, H., Peters, D., van den Berg, M., Frank, S., Havlik, P. … di Fulvio, F. (2015). *The land use change impact of biofuels consumed in the EU: Quantification of area and greenhouse gas impacts.* Utrecht. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Final Report_GLOBIOM_publication.pdf

Widiutomo, A. (2019). List Of BBM prices in Jabodetabek (January 2019). *Otodriver.com.* Retrieved from https://otodriver.com/article/view/daftar-harga-bbm-di-jabodetabek-januari-2019/JbxmcQEmnE6B0JmdYBc9CbifK05J-yVLss9VubwcSag

Witular, R. A. (2015). No reform in fuel subsidies, Jokowi just forces others to pay the tab. *Jakarta Post.* Retrieved from https://www.thejakartapost.com/news/2015/07/31/no-reform-fuel-subsidies-jokowi-just-forces-others-pay-tab.html

World Health Organization. (2016). *Ambient air pollution: A global assessment of exposure and burden of disease.* Retrieved from https://apps.who.int/iris/bitstream/handle/10665/250141/9789241511353-eng.pdf?sequence=1

World Health Organization. (n.d.). Health and sustainable development: Air pollution. Retrieved from https://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/

World Health Organization. (2018). *World health statistics 2018: Monitoring health for the SDGs.* Retrieved from https://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf?sequence=1&isAllowed=y

Yudha, S. W. (2017). *Air pollution and its implications for Indonesia: Challenges and imperatives for change.* Retrieved from http://pubdocs.worldbank.org/en/183201496935944434/200417-AirQualityAsia-Air-Pollution.pdf

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IISD Head Office

111 Lombard Avenue, Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700
Website: www.iisd.org
Twitter: @IISD_news

Global Subsidies Initiative

International Environment House 2
9 chemin de Balexert, 1219 Châtelaine
Geneva, Switzerland

Tel: +41 22 917-8683
Website: www.iisd.org/gsi
Twitter: @globalsubsidies

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