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GSI REPORT

The Impact of Fossil-Fuel Subsidies on Renewable Electricity Generation

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Introduction

Fossil-fuel subsidies are prevalent in many countries. The International Energy Agency (IEA) has estimated that consumer subsidies to fossil fuels amounted to US$548 billion in 2013 (IEA, 2014b). In the same year, subsidies to renewable energy were estimated at US$121 billion. However, a comparison of numbers does not reveal the extent to which renewable energy is being disadvantaged in favour of continued reliance on fossil-fuel generation. The high level of fossil-fuel subsidies certainly creates disadvantages for renewable energy, but to understand the true impact it is necessary to explore the range of subsidy mechanisms rather than focus simply on the magnitude of the cost of subsidies.

This paper offers a more complete examination of how fossil-fuel subsidies can impact the deployment of renewable energy from an economic and political economy perspective. The analysis will be of interest to policy-makers and researchers working on barriers to renewable energy and the impact of fossil-fuel subsidies. Section 1 outlines a framework for defining and identifying energy subsidies. Section 2 describes the specifics of the electricity sector, highlighting key differences between renewable energy and fossil-fuel-powered generation in terms of cost structures. Section 3 discusses the mechanisms by which fossil-fuel subsidies impair the deployment and development of renewable energy technologies. Section 4 introduces the process of fossil-fuel subsidy reform, and how it relates to renewable energy deployment.

This paper contends that fossil-fuel subsidies can act as a barrier to the development and deployment of renewable energy technologies. It identifies three impacts of fossil-fuel subsidies on renewable energy. First, subsidies reduce the costs of fossil-fuel-powered electricity generation and thereby impair the cost competitiveness of renewable energy. Second, subsidies create an incumbent advantage reinforcing the position of fossil fuels in the electricity system. Finally, the presence of fossil-fuel subsidies creates conditions under which investments in fossil-fuel-based technologies are favoured over renewable alternatives. Accordingly, fossil-fuel subsidy reform should be a priority for governments, to remove barriers to renewable energy and realize numerous other economic, social and environmental benefits.

1.0 Defining Energy Subsidies

In broad terms, a subsidy is frequently defined as "any government action that lowers the cost of energy production, raises the revenues of energy producers, or lowers the price paid by energy consumers" (World Economic Forum [WEF], 2009). Beyond this, however, there is debate as to whether a specific type of support should be considered a subsidy, with different organizations taking different approaches (Global Subsidies Initiative [GSI], n.d.).

The range of measures that may be considered subsidies can be visualised as a matryoshka nesting doll (Figure 1). At the centre of the definition are components that are widely accepted as being subsidies, such as direct payments to electricity generators by the government. As the definition is expanded to include other measures, such as mandates to include a predetermined quantity of renewable sources in the electricity mix, there is more debate around whether they should be considered subsidies.

Subsidy definition elements
4. Underpricing of social and environmental externalities (e.g. cost of CO2 emissions)
3. Market price support and market transfers (purchase obligations, tariffs and mandates)
2. Provision of services below market rates (provision of land, water, infrastructure, permissions etc.)
1. Direct budgetary spending and tax relief

FIGURE 1. THE MATRYOSHKA NESTING DOLL OF SUBSIDY DEFINITIONS

Source: Gerasimchuk (2014).

Most definitions of subsidies include direct government spending and tax relief, and the provision of services below market rates (the two inner dolls in Figure 1). Market price support (the third doll) creates an incentive to consume more of a good or service and is widely considered a subsidy, but some specific measures may be excluded from certain definitions. For example, mandates are not explicitly considered in the definition of subsidies used by the World Trade Organization's (WTO's) Agreement on Subsidies and Countervailing Measures (ASCM), but are included in definitions adopted by the IEA and GSI (see Lang [2010] and IEA [2013c] for further discussion). Finally, underpricing social and environmental externalities (the outer doll) is not generally considered to be a subsidy. However, since this generates a cost to society (e.g., pollution, lower investment in other sectors) that the liable parties (e.g., energy-intensive industries, energy producers) are not required to pay, they may also be considered as subsidies.[1]

[1] The U.S. "superfund" is a federal program to clean up hazardous waste generated by private sector companies. Its annual budget, which gives some indication of the externalities associated with the economic activity, has been in the region of US$1.2 billion for the past 10 years.

This paper adopts a broad definition, including components 1, 2 and 3, as described above. Further, we also discuss the impact of externalities as these can have a significant and damaging effect on the deployment and development of renewable energy technologies.

BOX 1: DO "GOOD" SUBSIDIES EXIST?

Subsidies are widely understood as being damaging and acting against the public interest. Indeed, the term "incentive" is often used instead of "subsidy" to avoid such negative connotations (Whitley, 2013). However, the definition of a subsidy makes no judgment as to whether that is indeed the case, and there are a range of examples from across the economy where subsidies are used in the public interest (e.g., below-market-cost provision of health services and education).

In the energy sector, properly designed and implemented subsidies can be a valuable tool in overcoming the market failures that are likely to characterize a free market in energy services. In particular, free markets in energy ignore the environmental and social costs associated with fossil-fuel generation. The transnational impacts of burning fossil fuels include climate change caused by emissions of greenhouse gases. At the local level, emissions of carbon monoxide, nitrogen oxides, sulfur oxides, and hydrocarbons, as well as particulates, have a well-documented impact on human health as well as on the local environment. On the other hand, renewable energy generation is largely free of these external costs, and the subsidies granted are intended to capture—at least in part—these benefits.

Pursuing the market failure argument, subsidies to fossil-fuel generation have in the past been justified as supporting the more vulnerable sections of society and ensuring their access to energy, stimulating regional economic development, supporting small and medium-sized enterprises (SMEs) and energy-intensive industries, or promoting energy security (see United Nations Environment Programme [UNEP] [2008] for further discussion). From a historical perspective, fossil-fuel subsidies have been justified on the basis that they support development of technology and industry, an argument that can similarly be advanced in support of renewable energy today.

However, regardless of intentions, subsidies frequently evolve into costly mechanisms that fail to meet their original objectives, due to high rates, excessive duration or poor targeting. An assessment of whether a subsidy is "good" or "bad" evaluates that subsidy against its stated objectives, and considers whether the cost to society is justified by the benefit provided and in light of existing alternatives. In the case of "good" subsidies, the net benefit will be positive, and the subsidy will succeed in meeting its objectives.[2]

[2] That being said, an assessment of costs and benefits that concludes that benefits are greater than costs does not necessarily imply that the subsidy could not be improved.

2.0 The Structure of the Electricity Sector

The last 10 years have seen double digit growth in renewable energy power generation; in 2013, renewable energy accounted for over a third of total growth in the electricity sector (BP, 2014). However, while the growth figures represent a surge in renewable electricity, the share in total power generation remains low. In 2011, renewable energy—excluding hydropower—accounted for just 5 per cent of global power demand. While this figure may be higher in specific countries, globally fossil fuels dominate the energy system, with coal accounting for 40.4 per cent, oil for 5 per cent and natural gas for 22.5 per cent of generation in 2012 (IEA, 2014b).

National electricity systems are generally designed on the basis of large thermal generation facilities, located close to population centres, with power shipped to end users through the transmission and distribution networks, therefore reflecting and reinforcing the dominance of fossil fuels. Renewable energy tends to be more widely distributed, with resources often distant from centres of demand, requiring different infrastructure. Overcoming this incumbent advantage, and developing more flexible systems and structures better suited to renewable energy is one of the challenges facing the sector. However, once implemented, such a flexible system is likely to provide more robust and reliable power supply than the existing fossil-fuel focused infrastructure.

3.0 The Impact of Fossil-Fuel Subsidies on Renewable Energy Development

Comparing fossil-fuel and renewable energy subsidy estimates and concluding that renewable energy is disadvantaged because it receives less government funding than fossil-fuel sources gives an incomplete picture of the effect that fossil-fuel subsidies have on the development of renewable energy sources.[3],[4] This section attempts to describe more fully the ways in which fossil-fuel subsidies can act to hinder the development of renewable energy generation.

The impact of fossil fuels on renewable energy development, described in this section, may be broken down in to four key aspects, though there is some overlap between these. First, fossil-fuel subsidies impair the relative cost competitiveness of renewable energy by reducing the cost of fossil-fuel-based alternatives. Second, since many electricity systems are based on fossil-fuel generation, fossil-fuel subsidies often act to lock in and reinforce incumbent generation technologies, thereby imposing entry barriers for new entrants attempting to develop renewable technologies. Third, a shift to an electricity system including a greater role for renewable energy requires investment, which is undermined by fossil-fuel subsidies that appear to enhance the attractiveness of fossil-fuel technologies compared to renewable energy. Finally, the underpricing of environmental and social externalities means that prices do not reflect the true cost of energy.

The net effect of these impacts is that fossil-fuel subsidies act to prevent the electricity sector from moving away from established, predominantly fossil-fuel-based, modes of operation and supporting a transition to a system in which renewable energy plays a major part.

3.1 Impairing the Cost Competitiveness of Renewable Energy

Today, many renewable technologies are already cost competitive with conventional generation sources in certain applications.[5] The IEA reports that where resources are good, hydro, geothermal, on-shore wind and solar photovoltaic (PV) technologies are cost competitive with new fossil-fuel plants, even without generation-based subsidies (IEA, 2014a).[6] However, by lowering the cost of fossil fuels relative to renewable sources, subsidies can create an artificial cost advantage, and incentivize the continued use of the former, and the less-than-optimal use of the latter.

The following describes some of the ways in which subsidies directly lower the cost of electricity generation from fossil-fuel technologies versus renewable energy technologies. This discussion is summarized in diagram form in Figure 2.

[3] Also, estimates of subsidies are often incomplete, and will vary depending on the definition used and the methodology adopted. See GSI (n.d.) for further discussion.

[4] In fact, some analysts compare the cost per unit of production, and conclude that on this basis, renewable energy does indeed receive more subsidies than fossil fuel. For further discussion see Kitson, Wooders, & Moerenhout (2011).

[5] Competitiveness is typically assessed on the basis of levelized cost of electricity (LCOE) which distributes the cost of electricity—including capital costs, operational costs and decommissioning costs—across the lifetime of a project.

[6] The report cites the examples of onshore wind in Australia, Turkey and New Zealand, and certain markets for PV in Spain, Italy, southern Germany, southern California, Australia and Denmark. See also African Solar Designs (2014) which reports that "the lifetime cost per kilowatt-hour of PV electricity installed on-grid in residential or commercial sites is lower than East African utility electricity."

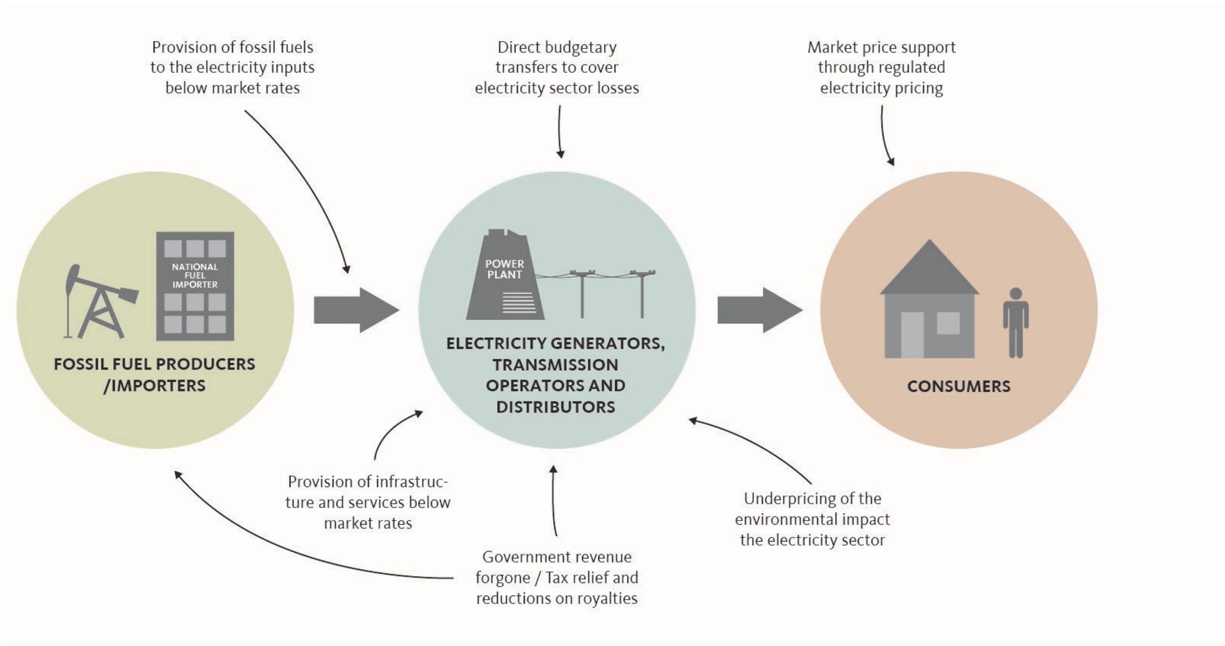

FIGURE 2. OVERVIEW OF FOSSIL-FUEL SUBSIDIES IN THE ELECTRICITY SECTOR

3.1.1 Subsidizing Fossil-Fuel Inputs to the Electricity Sector

Governments frequently choose to subsidize the price of fuel inputs to the power generation sector, often with the rationale of providing stability to the producer and to control the retail price of electricity. By providing subsidies, the government reduces the wholesale price that the generator needs to achieve to break even, with the effect of reducing the wholesale price in the wider market. This downward pressure will be more marked where the government provides subsidies to the inputs of a significant proportion of total generation.

Drawing on the specific case of Tunisia, and similar to structures in a number of other countries, Figure 3 gives an example of a mechanism for subsidizing fuel cost inputs. Here, the government creates a body to act as a "national fuel importer," which coordinates the purchase of fuels—either on the international market or through bilateral contracts. However, the government regulates the price charged to end users in order to control the wholesale price of electricity. The regulation of sale prices means that the fuel importer is unable to increase prices to keep pace with costs. As a result, the end user prices achieved by the national importer do not reflect the costs of fuel inputs. Any difference between the purchase price paid and the sale price must be covered by subsidies in the form of direct transfers or by loans (which may be provided at subsidized rates by the government). These subsidies ultimately feed through into the system by reducing the generation cost and thereby reducing the sale price that generators must obtain in order to break even.

FIGURE 3. SUBSIDIES TO FOSSIL-FUEL IMPORTS, BASED ON THE CASE OF TUNISIA

For renewable energy generators, such subsidies to fossil-fuel inputs have different implications depending on the type of electricity offtake agreement employed. If the generator is selling electricity on the wholesale market, the price received for power may go down, and the generator may not be able to cover the capital costs of the project. Where a power purchase agreement (PPA) exists, the effect may not be as impactful in the short term, but in the longer term it is likely that the price negotiated under future PPAs will fall closer to the subsidized wholesale price, again impairing the ability of the renewable energy generator to cover its costs. In either case, subsidizing fossil-fuel inputs to generation gives the recipient a cost advantage, introducing a barrier to entry for renewable energy.

3.1.2 Funding the Losses of Electricity Sector Companies

In electricity markets where end prices are regulated and electricity sector companies are not able to fully pass through cost increases to consumers, losses may begin to accumulate in the sector. To avoid the risks of power outages or financial collapse of the sector, the government may decide to step in to provide direct funds to bridge the gap between costs and revenues. Direct payments to electricity sector companies act to distort prices by reducing the need for other revenues, such as user fees. In turn, customers are unaware of the actual cost of electricity, and the link between the user and the provider of the service is diluted. Box 2 outlines the experience of Jordan, where the losses of the main public utility and single buyer of generation (the National Electric Power Company, or NEPCo) were covered by the government.

Direct payments to electricity sector companies allow the recipients to remain solvent even when electricity prices are lower than generation costs. However, new entrants to the market—including renewable generators—that do not have access to these subsidies will find it difficult to compete.

BOX 2: COVERING ELECTRICITY SECTOR LOSSES IN JORDAN

Jordan has little domestic production of fossil fuels—there are some reserves of natural gas and large oil shale reserves but these do not play a significant role in the country's energy mix. As a result, imports account for 97 per cent of energy needs.

The electricity system in Jordan is well developed, with access rates close to 100 per cent and relatively low losses. The system has transitioned from a publicly owned, vertically integrated company to a system in which the private sector plays a larger role and there are a range of organizations involved in the generation and distribution of electricity. At the centre of the system is NEPCo, the single buyer of electricity and the transmission system operator. NEPCo purchases electricity from a range of sources including publically owned generators, independent power producers (IPPs), and neighboring countries.

Electricity prices in Jordan are set by the government, but the price of inputs to the sector, including fuel for power generation, is determined by international prices. Subsidies arise in the system as the government covers losses in NEPCo. The losses are caused by regulated tariffs set at a level where revenues from electricity sales do not cover costs, so that NEPCo consistently operates at a substantial loss (see Table 1). By contrast, as NEPCo buys power at prices that reflect the cost of production and other electricity sector companies receive fees that are commensurate with their costs, all the other electricity sector entities run at a profit.

TABLE 1: NEPCO'S PROFIT AND LOSS

YEAR	PROFIT (LOSS) (MILLION US$)
2009	45.3
2010	(226.2)
2011	(1424.5)
2012	(1635.3)
2013 (Estimated)	(1553.3)
Total (2009-13)	**(4794.0)**

To put these losses in perspective, in 2012 losses of approximately US$1.6 billion were suffered compared to total operating expenses of around US$3.3 billion. In recent years, NEPCo's losses resulted primarily from a reduction in the supply of natural gas from Egypt, which has led to a fall in imports of about 75 per cent. In turn, this reduction has led to an increase in other imported fuels, such as heavy fuel oil (HFO) and diesel, and an increase in the cost of electricity generation. Political concerns have prevented the government from raising prices immediately, and as a result revenues have been much lower than costs.

The losses have not affected the ability of the electricity sector to invest, as all of the losses have been concentrated in one entity and the government has been clear that losses will be covered. To resolve the issue of the high costs of covering these losses, The government of Jordan has set out a plan to raise electricity tariffs every year until 2017. These price increases, together with reductions in generation costs, are projected to eliminate the losses and the need for subsidies by 2017. To limit the impact of prices increases on vulnerable groups, higher electricity tariffs will not be applied to households that consume less than 600 kilowatt hours (kWh) per month.[7]

The example of Jordan shows how direct transfers to the electricity sector can be introduced to cover losses due to external shocks, such as disruption to energy supplies from other countries or termination of favourable supply contracts. These direct transfers can grow to be very costly, and affect the government's ability to meet other spending obligations.

[7] Average per capita consumption in 2011 was 2,289 kWh (World Bank, 2014)

3.1.3 Tax Breaks to Electricity Sector Companies

The final means of price support considered here are tax breaks granted by government to fossil-fuel generation (see Section 3.3 for discussion of tax breaks to investors). As with the other mechanisms discussed in this section, tax breaks can have the effect of reducing the price of fossil-fuel generation relative to renewable energy, and thus impede the entry of renewable power sources over the longer term.

The Organisation for Economic Co-operation and Development (OECD) (2013) reports that in most of its member countries, and across the European Union, fossil-fuel generators are exempt from excise taxes on the oil, gas and coal that are used in the production of electricity, that other users of these same energy sources (e.g., transport or industry) are required to pay. Other possible tax benefits could include tax exemptions on the purchase of non-fuel inputs to operation and maintenance of power stations, or lower corporate income tax rates granted to fossil-fuel generators.

Tax breaks are frequently granted on the basis of political influence and connections, meaning that established entities that have the institutional capacity to exert influence on the political process—usually fossil-fuel-based generators—have an advantage over new entrants such as renewable energy sources, which lack the ability to press for special treatment.

3.1.4 Subsidies to Fossil-Fuel Producers

Producer subsidies—i.e., those granted to upstream activities including exploration, development, and production of fossil fuels—also influence the development of renewable energy, but this influence may not be as tangible or as marked as that related to subsidies granted directly to the electricity sector.

In many **fossil-fuel-producing countries**, the full international price of fossil fuels is not passed through; rather the national production cost is used as the basis of energy pricing. In this case, producer subsidies reduce the apparent cost of production eroding the competitive position of renewable energy.

For **fossil-fuel-importing countries**, the influence can be less marked since subsidies to producers of fossil fuels do not necessarily exert a strong influence on the international price of fossil fuels. However, as fossil-fuel markets are driven by supply and demand, the increased supply that producer subsidies can induce creates a downward pressure on market prices for fossil fuels, and thus on the cost of electricity generation using these fuels.

The analysis of producer subsidies and their impacts is complicated by lack of data. Methodological issues mean that analysts frequently adopt an inventory approach based on identifying each subsidy paid (see Box 3 for an example from a GSI study of Canada). However, this approach is frequently hampered due to lack of transparency in government and company accounts, and limited information on off-budget subsidies to producers (e.g., enhanced depreciation allowances).

BOX 3. PRODUCER SUBSIDIES IN CANADA

GSI published a review of producer subsidies to the oil industry in Canada in 2010 (Sawyer & Stiebert, 2010). The research focused on four jurisdictions in Canada: the federal government, Alberta, Saskatchewan, and Newfoundland and Labrador, excluding the rest of Canada (Sawyer & Stiebert, 2010).

The study found a total of CAD$2.8 billion of producer subsidies and a total of 63 separate programs which conferred a subsidy to upstream activities. The programs primarily promoted oil industry development, operations and research through reductions in rates of taxes and royalties. An analysis of the impacts of these subsidies concluded that their presence resulted in an increase in production, exports, GDP and carbon emissions and that they adversely impacted government balances. Furthermore, it was noted that once established, the cost of the subsidies would continue to increase as oil production increased.

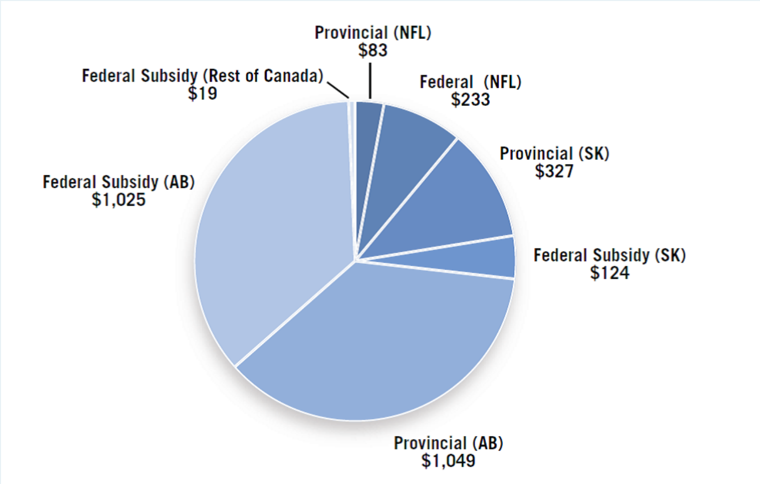

FIGURE 4. BREAKDOWN OF ANNUAL PRODUCER SUBSIDIES IN THE CANADIAN FEDERAL GOVERNMENT, ALBERTA, SASKATCHEWAN, AND NEWFOUNDLAND AND LABRADOR

Source: (Sawyer & Stiebert, 2010)

Because Canada operates with a full pass through of international prices, the impact on the electricity market may be limited. However, funds allocated to producer subsidies could perhaps be better used to promote a more sustainable energy sector in Canada.

3.2 Reinforcing Fossil-Fuel-Based Systems

The following discussion focuses on the role that subsidies to fossil-fuel technologies play in reinforcing the perpetuation of fossil-fuel-based systems. Section 3.1 described some of the direct financial support to fossil-fuel generators, while this section describes some of the more indirect impacts in terms of fiscal space and access to infrastructure or other inputs. Finally, it considers some of the political economy aspects of fossil-fuel subsidies.

3.2.1 Reducing Fiscal Space

Provision of fossil-fuel subsidies reduces the funds available for investment in other sectors of the economy. The International Monetary Fund (IMF) estimates that pre-tax subsidies to fossil fuels account for 0.7 per cent of global GDP or 2 per cent of total government revenues, with significant variation by countries and regions (IMF, 2013). For example, of the 20 countries in the Middle East and North Africa (MENA) region, 12 have energy subsidies of 5 per cent of GDP or more. This in turn crowds out investment in more productive, sectors such as health and education.

More specifically, expenditure on fossil-fuel subsidies reduces the funds available to invest in the renewable energy sector. On the **infrastructure** side, the new paradigm for the electricity sector includes flexible generating facilities that can ramp up and down quickly to match demand and supply, networks that can balance intermittent and variable sources of generation, and demand-side management technologies. Realizing the transition from the current centralized system focused on centres of population will take significant investment, which may be compromised by spending on fossil-fuel subsidies. In terms of **project development**, developers may require subsidies in order to overcome market failures. Examples could include provision of loan guarantees to address the risk aversion associated with less-mature technologies, support in the planning process to help mitigate local opposition to renewable energy technologies, or implementing regulation to facilitate connection to the grid. Finally, the ability to subsidize **generation** from renewable energy sources can also be impaired by reduced fiscal space.[8] Box 4 summarizes the experience of Indonesia, where high electricity subsidies have a marked impact on the ability of the sector to adapt to the changing demand for electricity.

BOX 4. ELECTRICITY SUBSIDIES IN INDONESIA

The electricity sector in Indonesia is heavily subsidized and is struggling to adapt to rapidly growing electricity use. Insufficient investment in generation, transmission and distribution have led to relatively low electricity access rates of around 65 per cent and load shedding (Differ Group, 2012). Electricity sector reforms in 2009 allowed independent power producers into the market and dissolved the monopoly of Perusahaan Listrik Negara (PLN), the state-owned, vertically integrated utility which, nonetheless continues to operate the bulk of the generation and the entire transmission and distribution infrastructure, with the exception of small private wire networks (Differ Group, 2012).

The gap between retail prices and generation costs is balanced by transfers from the government to PLN. These payments appear in the state budget and are shown for a range of fuels in Figure 5. In fiscal year 2013, the Indonesian government allocated 100 trillion rupiah (IDR) (US$9.0 billion) to electricity subsidies. The scale of the subsidy compared to the government budget is remarkable, accounting for 8 per cent of all government expenditure (GSI, 2014).

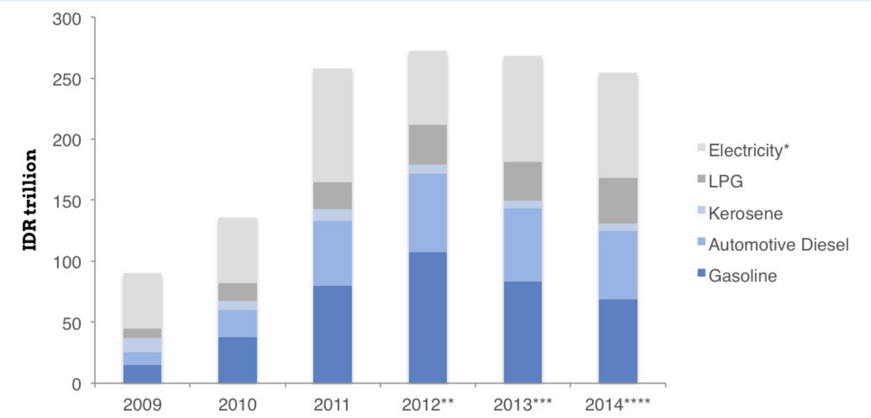

FIGURE 5. FUEL AND ELECTRICITY SUBSIDY EXPENDITURE, BY PRODUCT, 2009-14 (EST., IN IDR TRILLION)

*Notes: * Annual data does not include the carryover from previous year; ** Unaudited; *** Data from Fiscal Note and State Budget 2013, unaudited; **** Planned expenditure for 2014 budget. Source: Government of Indonesia (2013; 2014).*

[8] Although in many cases the cost of the subsidy is recouped from the consumer rather than being paid by the government so that the impact on fiscal space is limited. For example, under the UK Renewables Obligation, the utility can pass on the cost of the subsidy to the consumer.

To address the high levels of electricity subsidy, Indonesia plans to reduce production costs by switching generation away from refined petroleum products towards gas, coal and alternative energy sources, and raising tariffs. In January 2012, the Parliament approved a tariff increase for industrial consumers of up to 65 per cent. To implement the reform plans there are significant political obstacles to overcome; energy pricing remains a sensitive issue without cross-party support for comprehensive reform, though President Jokowi has stated his commitment to reform (GSI, 2014).

Indonesia has a strong legislative foundation for renewable energy promotion, including Presidential Regulation No.5/2006 which includes a target of 17 per cent renewable energy of primary energy by 2025. However, few concrete steps have been taken to achieve this objective (GSI, 2014). For renewable energy to meet its potential, comprehensive reform of the energy sector is needed to place the sector on a firm financial footing and to create a supportive regulatory and institutional context for renewable energy projects.

The case of Indonesia's electricity subsidies illustrates how electricity pricing regimes that do not pass through cost increases can lead to subsidies, particularly when changes in the availability of low-cost sources of energy (in Indonesia's case the switch in 1997 from being a net oil exporter to a net oil importer), lead to rapid increase in generation costs. Once subsidies are embedded in the system they become difficult to remove and reduce flexibility, and care should be taken at the design stage to develop mechanisms and structures that minimize the likelihood of this (e.g., by incorporating sunset clauses or price escalators).

While reform of fossil-fuel subsidies can open up the fiscal space, it cannot be assumed that newly available funds will be allocated to renewable energy subsidies. On the practical side, administrative arrangements and split of responsibilities between government departments may mean that reallocating the budget to renewable energy is not feasible, or the government may have priorities other than renewable energy, such as health and education. From a theoretical standpoint, earmarking funds for renewable energy (or other uses) is sometimes advised against, since it reduces government flexibility in budget setting (the "non-affectation" principle).[9]

3.2.2 Access to Non-Fuel Inputs and Infrastructure

The fossil-fuel-based system is further reinforced by subsidies that reduce the price that fossil-fuel generators pay for infrastructure (such as the transmission network) and inputs (such as water), or that grant them priority access to either. Unless the same conditions are available to renewable generators, these subsidies facilitate continued operation of thermal facilities, mitigate non-financial costs, and also have an impact upon costs and therefore project economics. For example, a 2010 study estimated that provision of cooling water at below-market prices in Australia equated to an annual value of over AU$270 million, an amount that would be incorporated into wholesale prices in a unsubsidized system (Foster & Hetherington, 2010). The historical context of an electricity system developed around a small number of large centralized power generators creates a natural advantage to the incumbents. While not a subsidy, the investment made in developing infrastructure that supports a fossil-based system certainly provides a barrier to accommodating increasing levels of renewable energy in the grid. This barrier may take the form of a financial cost to upgrade infrastructure to support variable generators or a cost in terms of a loss of reliability as generators are operated to balance variable supply (DeCarolis & Keith, 2005).

3.2.3 The Political Economy of the Electricity Sector

The presence of subsidies or other supportive policies in the electricity sector creates constituencies with a direct interest in their continuation. Subsidies facilitate the expansion of organizations, increasing their importance as

[9] The case for earmarking environmental taxes and charges is discussed in some detail in Cottrell et al. (2013).

providers of both energy services and employment. Where the electricity sector is dominated by companies that have built businesses based on fossil-fuel generation technologies, the prospect of policies designed to promote a shift to a greater role for renewable energy will generate opposition.

Within the electricity sector there are a number of groups with a direct interest in opposing reform. They include domestic producers of fossil fuels, fossil-fuel transport infrastructure operators, fossil-fuel-based electricity generators, electricity grid operators, and construction and maintenance contractors specializing in fossil-fuel-based generating plants.

Interest groups come in a number of forms. Public opinion influences the political process as politicians seek to maintain or increase support by taking account of public concerns. People directly or indirectly connected to fossil-fuel-related industries have an interest in ensuring a favourable environment for fossil-fuel industry activities. Industry groups seek to engage with policy-makers at a high level to present their case. Equally, investors in the sector may use their influence to ensure conditions are favourable to safeguard their investments. A large fossil-fuel industry creates interest groups that are numerous, wealthy and influential—and they may be capable of creating significant political pressure to avoid reform and gain additional concessions to the industry.

The renewable energy industry does not generally play such a significant role in the electricity market, and few countries have significant industries involved in the manufacturer of renewable energy technologies that create large numbers of jobs. The difference in scale of the incumbent fossil-fuel industry and the renewable energy industry presents a barrier to reform. To overcome this barrier, politicians will have to take account of all stakeholder groups and develop policies that are acceptable to a critical mass of stakeholders. An in-depth discussion of the analysis of stakeholder opinion and the development of mitigation strategies is provided in the *GSI's Guidebook to Fossil-Fuel Subsidy Reform* (Beaton et al., 2013).

3.3 Distorting Investment Decisions

Previous sections discussed how subsidies to fossil fuels improve the competitive position of fossil-fuel-based technologies versus renewable energy technologies. This in turn affects the investment decisions of the public and private sector—where fossil-fuel technologies receive support that renewable energy does not, project economics (in terms of discounted cash flow and rate of return) will be correspondingly better, and thus investors will choose to fund fossil-fuel-based projects.[10] This results in lower levels of investment in renewable energy (and other productive uses) than would otherwise be the case. While this has short-term implications for the deployment of renewable energy, arguably the more damaging effects occur over the long term, since investments in generation technologies are long-lived and lock in a fossil-fuel-based energy system. This section discusses examples of subsidized and unsubsidized generators to explore some of the ways in which fossil-fuel subsidies distort investors' decision-making processes towards conventional generation and away from cleaner energy sources.

Investment structures in the electricity industry typically disadvantage renewable generation. In the case of renewable energy the main cost is the upfront capital cost of construction—operational costs tend to be very low since the fuel source is free (with the exception of biomass technologies). As a result, renewable energy generators generally sell their power whatever the price in the market: where these prices are low, renewable energy generators will not necessarily be able to cover their capital costs. Mitigating this risk and guaranteeing the financial viability of the project depends upon structures such as PPAs that fix the price of the power generated. In the absence of such structures, the cost of capital (debt or equity) will rise, and the incentives to invest will fall.

[10] Discounted cash flow techniques are based on identifying and summing all the costs and revenues arising from a project. A discount is applied to the net cash flow to reflect the fact that cash is worth more in the near term than in the long term.

In contrast, capital costs for thermal generation tend to be lower and the operational costs higher due to fuel costs.[11] When assessing a project on the basis of discounted cash flow and rate of return, this structure means that thermal generation has an advantage over renewable generation where the majority of cost occurs in the early years of the project. Further, the assumptions on fuel price are crucial—these do not necessarily reflect the potential for rising costs (either based on accessibility of reserves or policy initiatives such as carbon pricing), or the possibility of unexpected variations in fuel price as a result of external shocks. As a result, governments and developers have a cost incentive to develop fossil-fuel power generation over renewable generation.

3.3.1 The Market for Power Generation

At the centre of the electricity market there is a mechanism that ensures that generation is sufficient to meet demand. The role of the mechanism, frequently managed by a single organization with sole authority to buy electricity from generators, is to coordinate generation from a range of sources and to pay the minimum necessary to meet demand while fulfilling regulatory criteria.

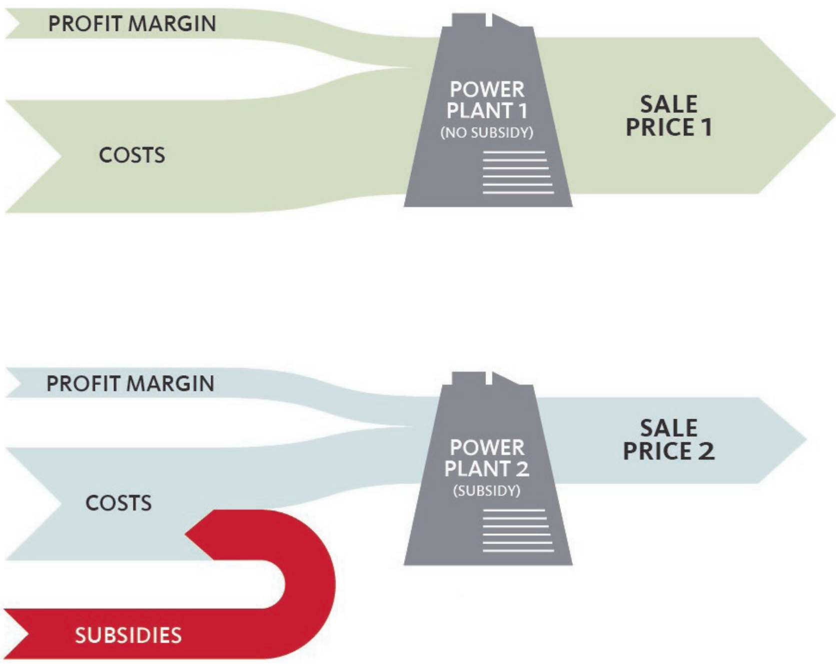

FIGURE 6. THE IMPACT OF INPUT SUBSIDIES ON THE SALE PRICE OF ELECTRICITY GENERATORS

Where generators are receiving subsidies to inputs, the price that they charge in the market can be lower than it would be otherwise (see Figure 6). By contrast, renewable energy generators forced to cover their costs without subsidies will be unable to compete with subsidized generation. A buyer of power is likely to favour the low subsidized price over the high price of renewables—while this comparison is perfectly rational for the buyer, it acts to reinforce the position of fossil fuels in the generation mix and to undermine the viability of unsubsidized energy sources. The overall effect is that the utility buys subsidized thermal power, since the cost for the utility itself is lower than the cost of renewable power. However, this ignores the fact that the cost of renewable energy to society as a whole is

[11] In the United States, fuel cost represents an average of 75 per cent of operating expenses for fossil-fuel-powered steam cycle plants and 85 per cent for gas turbines (EIA, 2014).

often lower than that of thermal energy. In turn, this encourages investors to develop fossil-fuel projects rather than renewable energy projects.

3.3.2 The Cost of Investment

Many of the subsidies targeted at the fossil-fuel sector focus on reducing the costs of investment. These subsidies reduce the direct and indirect costs of investment, and thus improve project economics for the investor. Where equivalent subsidies are not provided to the renewable energy industry, it is correspondingly disadvantaged.

Typically, investment subsidies focus on reducing the costs of research and development (e.g., grants for R&D in the fossil-fuel sector), reducing the costs of capital investment (e.g., by providing grants, tax incentives for investment in the sector), reducing the costs of borrowing (e.g., through low-cost loans), or reducing risk (e.g., through government-provided insurance or indemnification at below-market rates). For example, under the Regional Investment incentive scheme introduced by the Turkish government in 2012, coal mining and electricity-generation projects receive interest support of up to 5 percentage points in respect to loans taken out to finance the project. The Turkish government has also provided loan guarantees to coal-fired power stations (Cayirhan power plant and Isekenderun power plant) (Oil Change International [OCI], 2014).

These subsidies may be provided by national and subnational governments—for one example see The Australia Institute [TAI], 2014) which discusses the grants provided by the Western Australian State government for investment in new and existing fossil-fuel power stations.[12] However, development banks and international finance institutions have, until recently, also been frequent providers of concessionary finance for thermal power stations. Recent years have seen a decline in the number of institutions willing to provide finance to fossil-fuel providers and a tightening of conditions for those projects that go ahead. That said, gas-fired projects are still widely funded, and a number of institutions, including the Asian Development Bank, continue to fund coal-fired power station (Schmidt, 2013).

3.3.3 The Investment Environment

For investors—both in renewable energy and other sectors—macroeconomic and political stability are frequently cited as key considerations when deciding where to invest (see, for example, WEF [2013]). To the extent that subsidies can constitute a large and variable proportion of government spending (see Section 3.2.1), they can aggravate internal budget imbalances and impair the ability of the government to respond to crises. By encouraging excessive consumption of fossil fuels, subsidies can also impair the balance of payments position (see GSI [2014] for particular discussion of Indonesia). This macroeconomic instability in turn impairs the investment attractiveness of a country, including in the renewable energy sector. This is a particular problem for many developing countries since the need for investment in the energy sector is particularly acute and urgent.

Similarly, instability in the energy sector itself is likely to damage the prospects for renewable energy investment. Fossil-fuel subsidies can contribute to such instability by placing a strain on the finances of the system operator and thus create a risk of non-payment for electricity generated. This instability undermines investment in the infrastructure and systems needed to support the development of the energy system including deployment of renewable energy, and jeopardizes the returns made by projects. As a result, investors may choose to withdraw from the market altogether or price the additional risk into their proposals.

[12] The state-owned Electricity Company in Western Australia was given $287.3 million of government funding to support investment in new and existing assets (TAI, 2014).

3.4 Underpricing External Costs

External costs are those associated with production, but that are not charged to the producer and are instead experienced by society as a whole. For fossil-fuel generation, these external costs include the social and environmental cost associated with local air pollution and greenhouse gas emissions. While such external costs are not always considered a subsidy, to the extent that they are not captured in the cost of generation, they represent a financial benefit to the generator.[13] For renewable generation, with much lower social and environmental costs, full pricing of externalities would likely result in a significant cost advantage over fossil fuel. For example, one study estimated the cost of air pollution from coal-fired electricity generation at around US$40/MWh: this cost was greater than the difference between coal and cleaner alternatives (Global Commission on the Economy and Climate, 2014). The "polluter pays principle," which states that that the costs of pollution should be borne by the polluter is a key part of Environmental Fiscal Reform (EFR). Proponents of EFR advocate addressing market failures through the fiscal system by increasing the cost of harmful activities and reducing the cost of beneficial activities. Mechanisms that allow renewable energy projects to benefit from improvements in local and global pollution that they provide would allow them to better compete with fossil-fuel technologies.

The introduction of carbon pricing in markets such as the EU and China has attempted to address the externality associated with burning fossil fuels and resolve the disparity between the pricing of fossil fuels and renewable sources. However, it can be argued that low carbon market prices do not reflect the environmental cost of carbon emissions, and so the externalities associated with fossil-fuel generation remain largely uncaptured. This failure to adequately capture the cost of externalities associated with fossil-fuel use means that renewable generation continues to compete from a disadvantaged position.

[13] The IMF captures some externalities in its post-tax measure which adjusts subsidies to include a level of "efficient" taxation taking into account consumption externalities (IMF, 2013). The IEA, World Bank and GSI do not account for externalities (GSI, n.d.).

4.0 Fossil-Fuel Subsidy Reform and Renewable Energy

The discussion in Section 3 highlighted the ways in which fossil-fuel subsidies can have adverse impacts on renewable energy. For a government looking to develop a sustainable energy system, reforming fossil-fuel subsidies so that renewable energy and fossil-fuel-based power can compete on equal terms is an important consideration. This section discusses some of the possible reform strategies that can facilitate the development of renewable energy, focusing first on reform of fossil-fuel subsidies and then on introduction of renewable energy subsidies.

4.1 Fossil-Fuel Subsidy Reform

Economic theory suggests that the first best solution to correcting the market distortion caused by fossil-fuel subsidies is to remove subsidies on fossil fuels, so that the cost of power is fully reflective of the costs associated with each generation type. This in turn should facilitate the development of an energy mix based on the true costs of each generation type. Where renewable energy sources are cost competitive with fossil-fuel technologies, this energy mix will include a greater proportion of renewable energy than would be the case where fossil-fuel subsidies apply.

Such a scenario does not imply that no subsidies will apply. The existence of market failures means that government support may be required to ensure that each generation source is able to compete in the market.

However, fossil-fuel subsidy reform is rarely an easy process (see the GSI "Lessons Learned" series on attempts to reform subsidies in a range of countries).[14] Governments face a range of issues, amongst which establishing a market-based system, addressing welfare impacts, mitigating the short- and long-term impact on the macroeconomy, and ensuring the viability of key sectors are amongst the most important. Crucially, the government also has to address the political aspects of reform, including managing the vested interests of different groups, many of which will be politically powerful. GSI's *Guidebook to Fossil-Fuel Subsidy Reform* describes these challenges, the reform process, and the strategies that a government can adopt to help maximize the potential for success (Beaton et al., 2013).

For those governments that succeed in reforming, the reward is not only a more sustainable energy system. Fossil-fuel subsidy reform is also likely to reduce fiscal burden, improve macroeconomic stability, encourage energy conservation and efficiency, reduce depletion of resources, and reduce pollution and GHG emissions (Beaton et al., 2013).

4.2 Subsidies for Renewable Energy

Given the challenges associated with fossil-fuel subsidy reform, many governments choose to adopt a "second-best" approach that provides incentives to renewable energy rather than remove subsidies from fossil fuels with the aim of correcting the imbalance. These incentives may include subsidies such as feed-in tariffs and tax benefits, and can be supported by policy initiatives such as setting renewable energy targets and defining national strategies for renewable energy.

Subsidies to renewable energy have been widely used, often with great success—see International Renewable Energy Agency [IRENA]/Global Wind Energy Council [GWEC], (2012) for case studies on Germany and Denmark). However, there are still challenges with the wide use of incentives for deployment of renewable energy technologies. First, subsidies to renewable energy may be opposed by those with an interest in maintaining the existing energy system. Second, if done incorrectly, introducing renewable energy subsidies can increase the distortions in energy markets by further altering the difference between the true market price and prices charged. Using these subsidies effectively (and minimizing distortions) requires that the associated costs and impacts are regularly and rigorously assessed (see del Río & Mir-Artigues, 2014) for an example of how such policies failed in Spain). Finally, as with subsidies to fossil fuels, there is a risk that eventual subsidy removal becomes difficult and any distortions to the energy system become permanent—minimizing these potential effects should be considered during policy design.

[14] http://www.iisd.org/gsi/fossil-fuel-subsidies/case-studies-lessons-learned-attempts-reform-fossil-fuel-subsidies

5.0 Conclusions

International and country-level estimates show that subsidies to fossil-fuel technologies continue to dwarf those to renewable energy. While these estimates give some indication of the financial disadvantage faced by renewable energy technologies, they do not give a complete picture of either the full range of subsidies that benefit fossil-fuel technologies or how these subsidies affect the deployment of renewable energy sources. This paper has presented a more complete assessment of these effects, focusing on how fossil-fuel subsidies impair the competitiveness of renewable energy technologies, reinforce the continuation of fossil-fuel-based systems, and distort investment decisions in favour of fossil-fuel technologies. While not always considered a subsidy, underpricing of externalities in the fossil-fuel sector and the associated effect on renewable energy is also discussed.

These effects combine to discourage not only generation from renewable energy technologies in the short term, but also their longer-term development. These longer-term effects are particularly pernicious since they lock economies into a fossil-fuel path which, given the long lifetimes of generation facilities, will endure for many years into the future.

Reform of fossil-fuel subsidies is the most immediately obvious means by which to address the disadvantage that fossil-fuel subsidies impose upon renewable energy. In addition to promoting renewable energy sources and the development of a clean energy system, reform can be expected to have a wide range of economic, social and environmental benefits (Beaton et al., 2013).[15] Governments may find these motivations to be of greater resonance than arguments based solely on renewable energy. While the challenges involved in implementing meaningful and enduring reform should not be neglected, a number of countries have succeeded in doing so and there is a growing body of evidence regarding the policies and approaches that are likely to be successful (see Beaton et al. [2013] for further discussion).

While removing subsidies is one part of the equation, fossil fuels should be priced so as to reflect the environmental and social costs associated with their use. The introduction of carbon pricing or the payment of fees to discharge water used in cooling (to reflect the environmental damage caused by emissions to air and water) are examples of mechanisms that can be used to do just this. While prices rarely reflect the full extent of the associated costs, they do act to improve the competitive position of less polluting technologies, such as renewable energy, which become correspondingly cheaper by comparison.

Rather than correcting the price of fossil fuels, governments could choose to grant subsidies to renewable energy as a second-best option. On the one hand, this could correct the distortions introduced by subsidies to fossil fuels so that renewable energy does not face a disadvantage. On the other hand, and assuming that the external costs of fossil fuels are not recognized in their pricing, it could be used to capture the external environmental and social benefits associated with renewable energy. However, although adjusting the price of renewable energy may be more politically viable than reforming fossil-fuel subsidies, there is a risk that if subsidies are not appropriately designed or not monitored, they will lead to further distortions in the energy market, and will also become costly policy instruments that fail to meet their objectives. Just as fossil-fuel subsidies should be assessed against their objectives, renewable energy subsidies should also be subject to review and reform as necessary.

However, it remains the case that the deployment of renewable energy and the development of clean and sustainable energy systems are hindered by the legacy of government support to fossil-fuel generation. This legacy allowed these

[15] On the economic side, reform can reduce budgetary expenditure on subsidies and improve the balance of payments position. On the social side, reform offers the opportunity for better targeting of government support for low income households as well as the potential for promoting cleaner fuels with fewer health impacts. On the environmental side, reform can lead to reductions in emissions of local and global pollutants.

systems to develop sheltered from the competitive pressures that apply to renewable energy technologies today, and facilitated the propagation of a system where incumbents have a technical, political and economic advantage over new entrants. While reform and transformational change is undoubtedly difficult, a number of countries have managed to implement policy change, focusing on either reform of fossil-fuel subsidies or implementation of renewable energy subsidies, with benefits for renewable energy and for the economy and society more broadly.

Individual country circumstances and appropriate interventions vary, yet in many cases fossil-fuel subsidies appear to constitute a serious barrier to renewable energy deployment. Fossil-fuel subsidy reform should therefore be considered as a priority for those advocating for renewable energy.

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