CHAPTER 27

Energy Subsidies

Tom Moerenhout

1 Introduction

Energy subsidies are widespread among OECD and non-OECD countries and exist for all energy types. Governments often give noble and legitimate rationales for the introduction and continuation of various energy subsidies. Such reasons include the protection of household welfare, energy access, environmental sustainability, the development of new technologies and the expansion of an industrial base that is able to generate jobs and compete on international markets.

But the reality of energy subsidy policies is nearly always more complex than the stated rationale. A wide spectrum of stakeholders pushes governments to satisfy various policy objectives at once. As a result, governments have tried to balance the energy trilemma by implementing several types of energy subsidies at once. Even when some policy priorities clearly change, the phasing out of existing subsidies may prove politically challenging when powerful vested interest groups exercise their influence over governmental decision-making.

The result of the energy trilemma and the complex political economy of subsidy policies has made energy subsidies rather pervasive. Once implemented, they appear difficult to eliminate. With many governments subsidizing all sorts of energy types, the net impact of a country's energy policy is often unclear and likely suboptimal.

This chapter aims to highlight the pervasiveness of subsidies. It will first introduce the notion of subsidies generally and discuss why energy subsidies

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are important in the context of the energy trilemma. Then it will discuss the objectives, types, estimates, and politics of fossil fuel consumption subsidies, fossil fuel production subsidies, and renewable electricity subsidies.

2 Subsidies and Energy Subsidies

2.1 Different Types of Subsidies

Subsidies have been defined in many ways and depending on the definition, one measure can constitute a subsidy or not. One of the most commonly accepted definitions is the one found in the Agreement on Subsidies and Countervailing Measures (ASCM) of the World Trade Organization (WTO). At the time of writing, the WTO has 164 members and covers both energy importing and exporting countries.

The ASCM stipulates that a subsidy exists if a policy measure confers a benefit and constitutes a financial contribution or provides price or income support. The ASCM does not include an exhaustive list of subsidy types but references a number of general subsidy types such as: (1) direct and indirect transfer of funds and liabilities (including direct spending and credit support); (2) government revenue foregone (including tax expenditures and excise taxes); (3) provision of goods or services below market value; (4) income or price support.

Beyond these well-accepted subsidy types, some other categories have often been considered as potential subsidies. Examples include the exclusion of social and environmental externalities, or forms of market price support such as tariff policies. An easy visual representation of the complexity of defining subsidies is a Russian nesting doll. In Fig. 27.1, the inner layers are generally accepted as subsidies, whereas the outer two are more contentious, with especially the underpricing of externalities normally not considered as a subsidy.

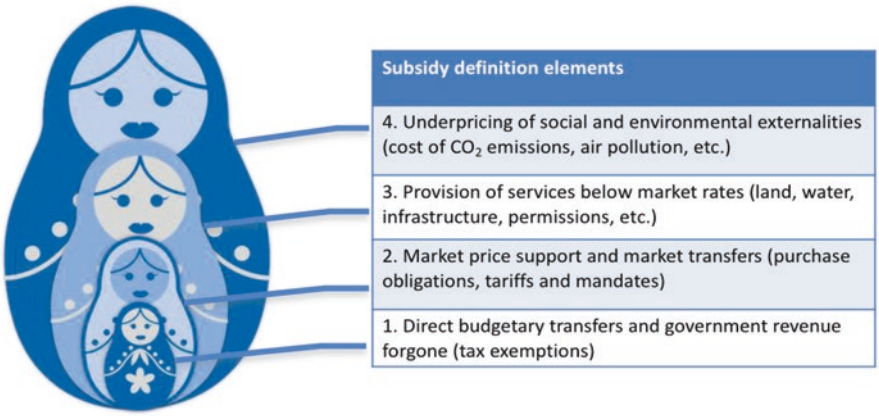

Fig. 27.1 Russian nesting doll of subsidy types. (Source: Own elaboration based on Gerasimchuk et al. 2012)

2.2 *Categorizing Energy Subsidies*

Because defining exact subsidy types is so difficult, energy subsidies have often been first categorized by energy resource. These include broad categories such as fossil fuel subsidies and renewable energy subsidies. In theory, fossil fuel subsidies should include subsidies to oil, gas, coal, and nuclear consumption and production. In reality, however, the term "fossil fuel subsidies" is mostly used for policy measures affecting the consumption and production of oil, gas, and coal. They also include electricity subsidies in so far as the electricity consumed relies on the use of aforementioned resources in power production. Similarly, renewable energy subsidies should theoretically include biofuel subsidies but instead mainly refers to renewable electricity subsidies such as those to wind, solar, and biomass (Table 27.1).

Only in a second step is the exact type of financial contribution and benefit assessed. Here there are, like with the general subsidy definition, different conceptions of what constitutes an energy subsidy. Generally, there is no disagreement over the inner cores of the Russian nesting doll. There is also the agreement that subsidies exist in all parts of the value chain such as R&D, extraction, transport, storage, production, refining, distribution, consumption, and decommissioning. Other than that, the approaches of international organizations diverge considerably.

The International Energy Agency has defined energy subsidies broadly as "any government action that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by consumers" (IEA 2006). The IMF on the other hand adopts a wider approach and includes the underpricing of social and environmental externalities in its subsidy

Table 27.1 Taxonomy of energy subsidies

	CO_2 intensity	*Taxonomy*	*Examples of subsidy and support types*
Finite resources	High	Fossil fuel subsidies (Oil, gas, coal)	Retail price support; consumption tax reductions (value-added tax, general sales tax, excise tax on consumption); producer tax reductions; government provided goods and services below market rates; SOE investment
	Low	Nuclear energy subsidies	Capital cost subsidies; production and investment tax credits; feed-in tariffs; combined legacy subsidies
Renewable resources	Variable	Biofuel subsidies	Excise tax reductions; blending mandates; tariff policies; agricultural subsidies for feedstock production
	Low	Renewable electricity subsidies (wind, solar, biomass)	Feed-in tariffs; renewable portfolio standards; tendering; production tax credits; investment tax credits; net-metering and billing

Source: Author

definition and calculation. The OECD, though, has been much more prudent and explicitly refers to "support" rather than "subsidy" when discussing policy measures that provide a benefit to energy producers or consumers.

3 Fossil Fuel Consumption Subsidies

3.1 Subsidy Objectives

Fossil fuel consumption subsidies are the largest category of energy subsidies worldwide. They are primarily intended to reduce the price of energy consumption by end users. Formal objectives of these types of pricing policies vary according to the consumers.

For households, consumption subsidies are legitimized as energy has no close substitute, but unquestionably provides essential functions to human life. Especially in developing countries, governments keep the price of energy products low, thereby often providing subsidies. Low energy prices are intended to alleviate poverty by safeguarding commodity prices, keeping inflation in check and sheltering consumers from the volatility of international commodity prices. In short, fuel consumption subsidies are a method to preserve welfare or, at least, provide some form of social safety net.

For firms, fuel consumption subsidies have been used to promote economic development by supporting factors of production in general and competitiveness for international trade in particular. As such, low prices have been used as a part of industrial policy with the explicit goal of supporting export competitiveness. Resource-rich countries in particular have used their domestic endowment to incentivize energy-intensive industrialization (though low prices in this case do not always constitute subsidies in the economic sense of the word—see below).

Besides such stated objectives, many fossil fuel consumption subsidies also serve hidden interests. Fuel consumption subsidies are often considered as an instrument to stay in power and control political stakeholders. Governments use them to direct (financial) benefits to key political stakeholders. Businessmen are often politically connected and able to influence decision-makers directly. To make things even more complicated, underpricing energy has led to the establishment of black markets and smuggling practices, often with the involvement of political stakeholders.

3.2 Subsidy Types

Most fossil consumption subsidies are implemented via pricing mechanisms in which consumers are charged a price which is below the cost-reflective level. There are two critical debates among experts and practitioners on what constitutes a fossil fuel consumption subsidy. A first debate is about whether or not to include environmental externalities into the subsidy calculation. The second

is about what constitutes a subsidy in countries that are fossil fuel producers. These two questions are intrinsically linked to the subsidy type and definition.

In general, the optimal price of a product is often considered to be equal to the marginal cost, which is the cost of bringing an additional unit of capacity on the market (i.e., including production, operation, and maintenance costs). Since fossil fuels are depletable resources, it is often expected that the long-run marginal cost will go up and therefore the highest unit under current production is used as a proxy. Many however also believe that the marginal value of energy should not simply be determined by supply, but also by the social value of energy, which includes pricing externalities linked to environmental and health considerations.

Externalities aside, it is economically intuitive that producing countries have consumption subsidies when the retail price levels are below the production cost at which they produce the unit of energy. Importing countries, on the other hand, have subsidies when retail prices are below the import cost of fossil fuels, adjusted for transportation costs. In the case of petroleum products, this is often an international price. In the case of gas, prices have more regional variation.

Many analysts, however, have also used international (and regional) market prices for petroleum (and gas) as the benchmark to assess whether a producing country has fossil fuel consumption subsidies. It is clear, however, that the production cost of producers and international market prices of their products are often not the same. As a result, in economic terms, there are price levels at which producers do not have a subsidy, but importers do. These end-user price levels do constitute an opportunity cost for producers: they could earn more money by selling their produced fuel on the international market, as the price level is higher than the domestic end-user market. This is why sometimes this particular category is described as "opportunity cost subsidies" (Fig. 27.2).

3.3 Subsidy Estimates

Fossil fuel consumption subsidies have mostly been calculated using a price gap approach in which the value of a country's subsidy is considered as the difference between their end-user price and a benchmark price, multiplied by the amount of fuel consumed.

The below estimates should be taken with a heavy grain of salt since the benchmark prices used by the International Energy Agency and International Monetary Fund are international market prices. This means that they include producing countries that sell fuel at a price above production costs but below international market prices. As mentioned, this is economically speaking not a subsidy but an opportunity cost. For example, in 2018, the top fuel consumption subsidizing countries included producers such as Iran, Saudi Arabia, Russia, Venezuela, and Algeria. In many of these countries, however, retail prices of energy product lie above domestic production costs. For example, Russia produces gas at a very low price, Saudi Arabia produces petroleum

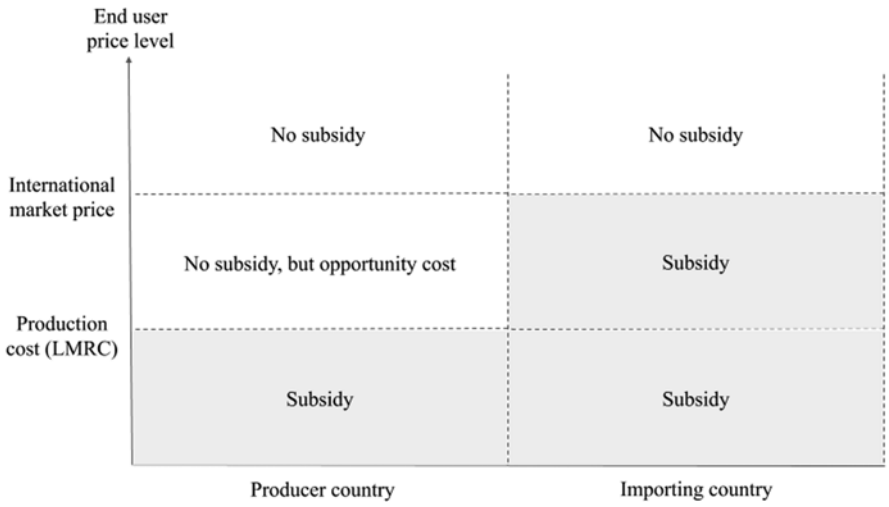

Fig. 27.2 Energy consumption subsidies in producer versus importing countries. (Source: Author)

products at a low cost, and so on. All of this represents an opportunity cost, but not always an economic subsidy.

The absolute value of fossil fuel consumption subsidies has, logically, followed the path of the price of crude oil. During the 2010s, the total value of fuel consumption subsidies hovered roughly US$ 200 and 500 billion, depending on the oil price. Fuel consumption subsidies are the sum of subsidies to oil products, gas products, coal, and electricity. Between 2009 and 2016, subsidies to oil products covered about half of total fuel consumption subsidies. Over time, the electrification of energy provision has meant that electricity subsidies have become relatively larger. When the oil price plummeted in 2015 and 2016, electricity subsidies shortly became the largest category of consumption subsidies. This changed again when the oil price increased (Figs. 27.3 and 27.4).

When including externalities, the absolute value of fossil fuel subsidies changes considerably. The IMF first produces "pre-tax subsidies," which are reliant on a conventional price gap approach that measures the difference between end-user price levels and international market prices (they also include OECD producer support estimates, see below). They then also calculate a broader measure which they call "post-tax subsidies," which reflect the difference between the end-user price and a theoretical price that end users should pay if the price were to reflect supply costs, environmental costs, and revenue requirements. Since this price adjustment would be done by utilizing taxes, they coined the broader subsidy definition "post-tax subsidies."

While pre-tax subsidies fall in the hundreds of millions and are often between 0.3% and 0.7% of world GDP (depending on the oil price), post-tax subsidies are around US$ 5 trillion or closer to 6% of world GDP. The huge difference

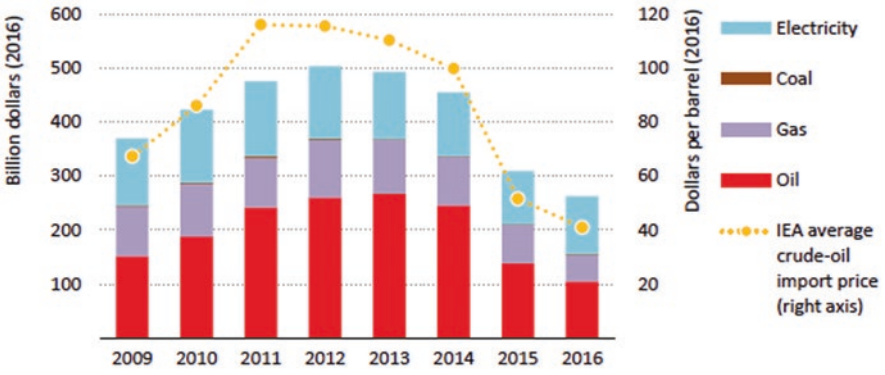

Fig. 27.3 Distribution of FFCS over fuel. (Source: IEA 2017, 84)

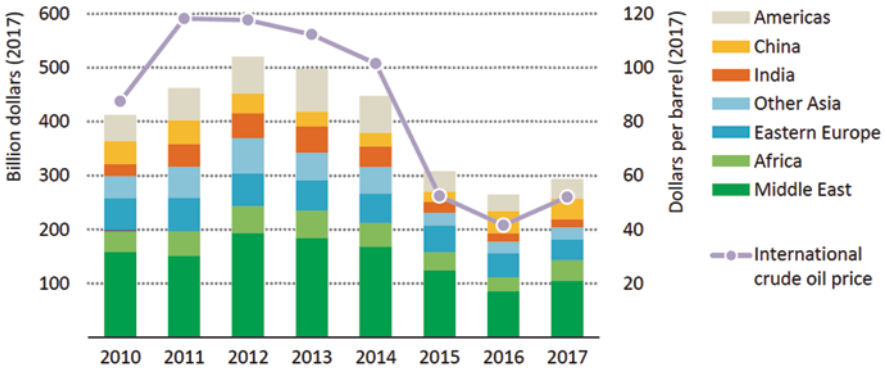

Fig. 27.4 Geographical distribution of FFCS. (Source: IEA 2018, 112)

is mainly explained by accounting for negative externalities related to the emission of carbon dioxide and other pollutants. The single largest form of externality is related to local air pollution, which impacts human health. The second largest source of externalities is found in the contribution of emissions to global warming. Because of these two, coal subsidies become the largest category of post-tax subsidies, while its absolute value was almost negligible when considering pre-tax subsidies. The main lessons learned from including externalities is exactly how polluting coal subsidies are and how relatively cleaner natural gas is (Figs. 27.5 and 27.6).

3.4 The Politics of Fossil Fuel Consumption Subsidies

3.4.1 The Drivers of Fossil Fuel Consumption Subsidy Reform

Fossil fuel consumption subsidies are problematic for a number of reasons linked to government budgets and governance, the misallocation of resources

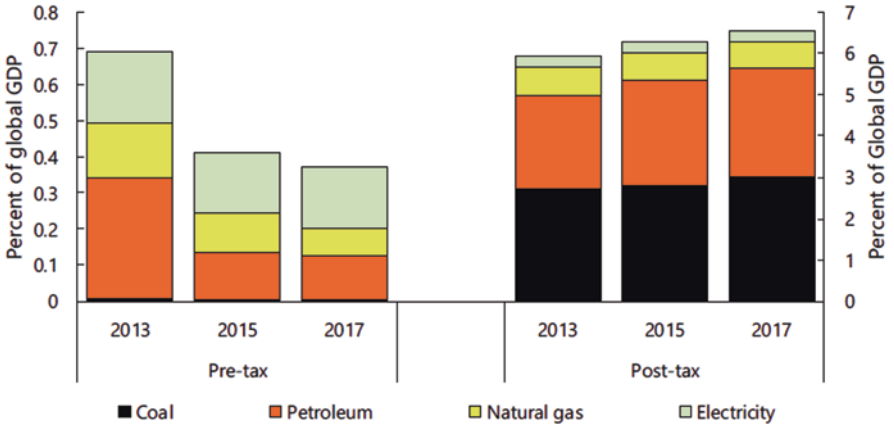

Fig. 27.5 Energy subsidies by product. (Source: IMF 2019, 21)

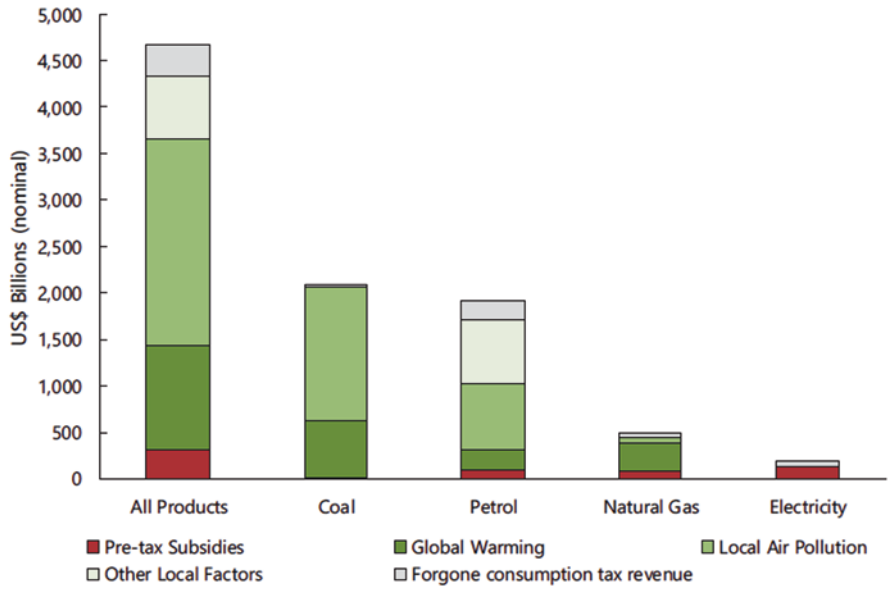

Fig. 27.6 Energy subsidies by product and component. (Source: IMF 2019, 21)

in the economy, the operation of energy sectors, excess consumption, and the environment (Table 27.2).

Intuitively, fuel subsidies may thus seem like a bad idea. They cause excess consumption linked to air pollution and carbon emissions. They cause corruption and the loss of fiscal revenue. They cause inefficiencies in the economy and the energy sector. And they, in absolute terms, mainly benefit the wealthy. While the distribution of benefits is country and fuel specific, in many

Table 27.2 Impacts of fossil fuel consumption subsidies

Impact dimension	*Specific impacts*
Government	Fiscal costs and opportunity costs
	Corruption
Misallocation of resource	Incentivize resource inefficient sectors
	Relative or absolute rise of resource intensity of GDP
	Resource overexploitation
Energy sectors	Harming competitiveness of alternative forms of energy
	Cost-recovery problems for utilities and other service providers
	Threats to infrastructure, quality, and supply
	Fuel smuggling and adulteration
Excess consumption	Negatively affects trade balance
	Inequitable distribution of benefits
Environment	Carbon emissions
	Air pollution

Source: Author

developing countries the share of benefits for the poorest 40% is between 15% and 25% of the total value of consumer subsidies (Coady et al. 2006; Diop 2014), while the top quintile often received more than 40% (del Granado et al. 2010; IMF 2013). The logic is clear: rich people consume more energy, so universal price subsidies benefit them the most, at least in absolute terms.

As a result of those various negative consequences from fossil fuel subsidies, many international organizations started putting their institutional weight behind energy pricing reform. The G-20 and APEC both committed to fuel subsidy reform in 2009. In 2015, countries re-emphasized their commitment to fossil fuel subsidy reform in the Financing for Development Addis Ababa Action Agenda. Eventually, "Rationalizing inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions" was also included as a target of the Sustainable Development Goals under SDG 12.c.

Perhaps more important than international norm creation is the inclusion of pricing reform under IMF and World Bank loan conditions. While this is nothing new—in fact they have conditioned loans on such fiscal reforms for decades—it became more pronounced throughout the 2000s and 2010s as increasing international oil prices caused fiscal crises for many (importing) governments. By the time financing institutions such as the IMF and World Bank are requested for assistance, there are often few options but consumption subsidy reform to strengthen a country's fiscal position. Governments, however, remain wary of implementing reforms fast, frightened by some notable examples of political instability peaking after fuel subsidy reforms as has been the case in, among others, Yemen, Indonesia, Bolivia, and Egypt.

3.4.2 The Drivers of Fossil Fuel Consumption Subsidies

Despite rational arguments in favor of, and international pressure for, consumption fuel subsidy reform, such subsidies remain pervasive for three main

reasons: first, there is a social rationale for maintaining subsidies. Many governments rely on price subsidies to protect the social welfare of citizens. Contrary to advanced social protection mechanisms, fuel consumption subsidies are administratively easy and do not require advanced methods of social data collection and subsidy targeting. In some countries, citizens have also become accustomed to low prices, and consider it their right. Increasing energy prices does not only lead to direct price increases; it also impacts households indirectly via inflationary shocks that accompany upward price shocks.

In so-called allocation states low energy prices are often considered as part of an implicit social contract, in which citizens acquiesce to the ruling elite in exchange for the distribution of welfare, among others through the provision of low-priced energy. Whenever governments have decided to increase prices without mitigation measures (such as cash transfers), citizens have often voted them out of office or, in the case of authoritarian regimes, have taken to the street to protest.

Second, there is an economic rationale to maintain consumption subsidies. Many states have used low prices to promote economic development by supporting factors of production in general and competitiveness for international trade in particular. Low prices have thus been part of an industrial policy with the explicit goal of supporting export-competitiveness. Adjusting prices upward too fast may cause those industries to close down or relocate since they affect firms directly by increasing their energy input and indirectly via the effects of price increases on the price of intermediary goods or services. The sectors that suffer the most are logically energy-intensive industries such as heavy manufacturing, transport, petrochemicals, cement, aluminum, and steel.

Third but not least, there are political reasons to maintain consumption subsidies. Given the potential social and economic impacts of pricing reform, it is no surprise that implementing price increases is politically costly and can even threaten political stability. It is now uniformly recognized that political economy factors are the primary barriers to reforming energy prices. Low energy prices and subsidies are also often used as an instrument to stay in power and control political stakeholders. Governments use them to direct (financial) benefits to key political stakeholders, thereby consolidating power. As a result, low energy prices create interest groups that then lobby to maintain them low in the long run. Such lobby groups push for asymmetric decision-making that favor their own interests over a country-wide development plan, and it has been observed time and again that these groups have played a key role in solidifying energy subsidies.

4 Fossil Fuel Production Subsidies

4.1 Subsidy Objectives

Governments have used fossil fuel production subsidies for various reasons, and the main reasons to do so vary according to a country's economic and political context, and whether they are already strong fossil fuel producers or

not yet. A similar economic objective involves the ambition to develop and protect an energy-based industrial policy. Fossil fuels are among the largest traded commodities worldwide and owning them can grant governments many benefits. Oil, gas, and coal extraction and production can be an important source of fiscal revenue or a method to assist the diversification of national economies or a country's energy system. For example, switching from coal to natural gas involves a huge amount of investment, which might not occur in the absence of government support.

Perhaps the most important reason for many countries with fewer domestic resource capacity is the quest for more energy security. A negative fossil fuel trade balance implies a relatively heavier reliance on external suppliers. This weakens a country's geo-political position. Heavy importers are also more exposed to commodity price fluctuation, especially in the case of oil. When a country is a producer, however, they have some protection against inflationary impacts from price volatilities. They may also wish to subsidize fossil fuels to step up their geopolitical power.

Fossil fuel producer subsidies, however, often have much stronger and less pronounced policy objectives. On the one hand they can be used to foster governmental legitimacy with the wider public. There are many jobs in fossil fuel extraction and production, and jobs mean votes or, at least, political support. On the other hand, fuel subsidies might be granted for political patronage. Often, fossil fuel extraction and production companies have direct access to politicians, via the existence of cronies and/or campaign financing tactics in exchange for increased profits after taxes.

4.2 Subsidy Types

"Fossil fuel production subsidies" is a generic term used to refer to various support measures to exploration, extraction, transport, processing, and distribution and decommissioning of oil, gas, and coal resources, as well as to associated infrastructure.

Linked to the WTO definition above, there are two general categories of subsidies. A first includes national and subnational fiscal support. Such production subsidies can include direct budgetary transfers such as research and development grants, tariff policies, and tax expenditures. Of current reported estimates, tax expenditures cover about two thirds of fossil fuel production support measures. Such tax measures include tax exemptions or tax reductions for fossil fuel producers, for example on corporate income or on royalties they pay.

A second set of potential support measures includes public finance through which governments provide financial services to fossil fuel producers via state-owned financial institutions (i.e., institutions in which the government holds at least a 50% ownership). Such financing support can come in the form of loans, equity, insurance, and guarantees. These types of support measures are more difficult to gauge since they involve estimating risk transfers and foregone

revenue by quantifying a specific subsidy fraction of credit assistance. Such credit assistance can come from multilateral finance institutions, export credit agencies, or state-owned enterprises.

4.3 Subsidy Estimates

Fossil fuel producer subsidy estimates cannot be attained with a simple formula like the price gap approach and have to be constructed bottom-up through an inventory approach. This makes producer subsidy estimates more time-consuming and, therefore, less holistic. It also means that transparent countries might score higher in subsidy figures than those that hide support in more complicated or subnational tax codes. Furthermore, it is more difficult to compare countries, especially with regard to tax expenditure. Estimating the subsidy value of a tax expenditure relies on a country's benchmark tax regime, and tax regimes vary widely between and even within countries.

The OECD compiles estimates of direct budgetary transfers and tax expenditures, and currently explores a new methodology to quantify the support estimate of government credit assistance. It does so for the 36 OECD economies and 8 partner countries (Argentina, Brazil, China, Colombia, India, Indonesia, Russia, and South Africa). Between 2009 and 2017, total direct budgetary support and tax expenditure to fossil fuel producers hovered between around USD 20 and 56 billion. In recent years, this support has declined from USD 56 billion in 2013 to USD 24 billion in 2017. This decline has mainly been driven by Western Europe's hard coal phase out and fiscal tightening in Indonesia and Argentina (IEA & OECD 2019). At the same time, new measures have been introduced to foster the production of unconventional oil and gas resources. Among the largest "subsidizers" on record are Russia and the US, followed by the UK, Australia, Brazil, and China (OECD 2019).

Besides budgetary transfers and tax expenditures, the Overseas Development Institute (ODI) has focused attention on SOEs and public financing. However, because of a lack of information, ODI could only estimate the total investment by SOEs in fossil fuel production, rather than the specific sub-components that can qualify as a subsidy. With this crude metric, they showed that China has the largest fossil fuel production through SOEs (about USD 77 billion in 2013 and 2014), followed by Russia and Brazil (respectively USD 50 billion and USD 42 billion per year during the same time frame), and Indonesia and Saudi Arabia. ODI has done a similar exercise with public finance, again without the possibility of identifying the subcomponent of public finance that constitutes a subsidy. They found that Japan and China had the largest public financing of fossil fuels in 2013 and 2014 (USD 19 billion and USD 17 billion respectively), followed by Korea (USD 10 billion). Most emerging economies within the G-20 relied on domestic public financing, whereas most public finance from other G-20 countries was aimed at fossil fuel production abroad (Bast et al. 2015).

Overall, fossil fuel production subsidy estimates are severely incomplete and more difficult to attain than consumption subsidy estimates. As a result, various specialized NGOs such as the Global Subsidies Initiative have complemented OECD data by using an inventory approach to study national and subnational fossil fuel production subsidies of various countries. In the context of the G-20 and APEC commitments to phase out inefficient fossil fuel subsidies, various countries have started voluntary peer reviews. The OECD chairs such reviews for the G-20. Starting in 2016 with the US and China, peer reviews had been completed for Germany, Indonesia, Italy, and Mexico by 2019 with Argentina and Canada under way.

4.4 The Politics of Fossil Fuel Production Subsidies

Fossil fuel production subsidies remain difficult to reform because their most notable beneficiaries are large, powerful, and politically connected companies. For example, in the US, the Obama administration submitted proposals to eliminate some of the most abhorrent oil and gas production subsidies from the budget every year. Congress, on the other hand, has refused to consider this measure, given that the majority of its members rely on campaign financing from the fossil fuel industry. In other large producing countries, such as Russia, Saudi Arabia, and Nigeria, many oil and gas companies are also often directly linked to the ruling elite and, as mentioned above, subsidies are used as a rent to keep clients in check.

In addition to beneficiaries, there is also a lack of transparency about various producer subsidies, and a lack of public understanding of those subsidies that we do know. Understanding a price-gap whereby the government is directly funding oil and gas consumption is more intuitive than a tax reduction which constitutes foregone revenue. When such subsidies are linked to clear and legitimate policy rationales such as strengthening the trade balance by reducing a country's reliance on foreign imports, then maintaining such subsidies seems reasonable, even if some of them simply result in windfall profits for producers. In both democratic and authoritarian countries, certain large media corporations often play a critical role in keeping public knowledge about subsidies limited, further deteriorating potential public pressure for their reform.

Internationally, the push for production subsidy reform has been ambivalent, at best. While G-20 and APEC countries committed to fossil fuel subsidy reform in 2009, country reports on their progress were meager, with some countries like Saudi Arabia initially even arguing they had no "inefficient fossil fuel subsidies" at all. As a result of the discussions over definitions and the lack of transparency, the G-20 set up country peer-reviews of each other's fossil fuel subsidies. While the set-up of the system took some time, these peer reviews have given a more holistic and detailed overview of producer subsidies than individual country progress reports on their G-20 and APEC commitments (IEA & OECD 2019). Besides these international commitments, the WTO could have also theoretically played a role in guiding fuel subsidy reform. While

many oil and gas subsidies include local content requirements—a prohibited subsidy under WTO law—not one single oil and gas producing country has brought a complaint against another about fossil fuel production subsidies.

Box X: Nuclear Energy Subsidies

Nuclear energy subsidies are found in all parts of the nuclear fuel cycle. As the largest cost component of nuclear energy is the capital costs associated to reactor construction, a lot of subsidies try to reduce those costs. In addition, nuclear energy developers have also often benefited from shifting the economic value of long-term risks (such as waste management, accident risk insurance, security management, and decommissioning costs) to the government.

In the absence of such burden-sharing, the nuclear industry would face potentially prohibitive costs. For example, while the chances for an accident are small, the consequential costs would be of huge magnitude, and if this would have to be covered by private insurance, nuclear energy's levelized cost of electricity would increase substantially.

One notable example of a recent nuclear subsidy was to the UK's development of Hinkley Point C. Here, the government promised a feed-in tariff (see below) of GBP 92.5/MWh for a guaranteed period of 35 years. This subsidy was "out of the roof" for an allegedly mature technology (in comparison, the global average levelized cost of electricity of solar PV in 2018 was around GBP 72/MWh). The nuclear subsidy is large even in comparison with emerging technologies such as wind and solar PV in the 2010s. In addition to the feed-in tariff, the government also employed loan guarantees to transfer project risk, including the risk of cost overruns and delays (which are very common in the construction of new reactors). And a third subsidy was related to waste disposal, promising the developer that any costs above GBP 5 billion would be carried in full by the government.

5 Renewable Electricity Subsidies

5.1 Subsidy Objectives

Renewable electricity subsidies, which mostly focus on the deployment of renewable electricity, have three main objectives, all covering facets of the energy trilemma. First, but not always foremost, there are two environmental objectives. On the one hand, governments subsidize renewables to decarbonize the power sector and mitigate carbon emissions that cause climate change. On the other hand, various governments also seek accelerated deployment to reduce air pollution. Especially the latter is becoming a key reason for subsidizing renewables in rapidly growing Asian countries with metropolitan centers.

Second, governments use renewable energy subsidies to achieve social and economic goals. They often try to link deployment subsidies to the creation of long-term and short-term construction jobs. They have also often used such subsidies as an industrial policy tool, trying to achieve a comparative advantage in emerging technologies so that their producers can compete at home and abroad. It has not been uncommon for renewable electricity subsidies to have been linked to local content requirements. This strategy serves the dual purpose of job-creation and fostering other, supportive industries, such as the steel industry in the case of wind turbine towers or the module manufacturing industry in the case of solar PV.

Third, renewable energy subsidies have been used to foster energy security and access. From one side, more renewables can imply a relatively lower dependence on foreign resources. From the other side, renewables can be installed in remote areas to foster electricity access there.

5.2 Subsidy Types

There are five main types of renewable energy subsidies, aimed at different types of stakeholders and projects: (1) quotas and certificates, (2) feed-in tariffs and premiums, (3) auctions, (4) net metering and billing, and (5) investment and production tax credits (Fig. 27.7).

First, quotas and mandates (also often called renewable portfolio standards or renewable purchase obligations) mandate utilities to source a certain percentage of distributed electricity from renewable sources. They are used in around 100 jurisdictions in 2016. Governments often increase that rate over time to encourage a gradual uptake of renewable electricity. The advantages of this system are that it theoretically guarantees that a certain amount of

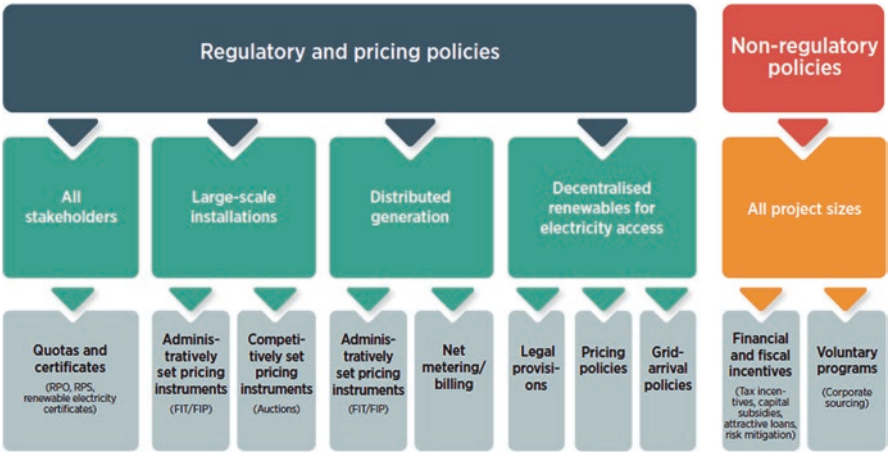

Fig. 27.7 Classification of power sector policies

renewable electricity is used, and that this amount is generated at the lowest cost. To foster compliance, this system is often linked to a trading system of renewable electricity certificates in which each MWh of renewable electricity is granted a certificate, which can then be traded from those with a surplus to utilities that do not reach the quota.

Second, feed-in tariffs (FIT) or premiums (FIP) consist of administratively set tariffs and premiums in which utilities are obliged to purchase electricity from developers at a certain fixed price (FIT) or at the variable market price plus a premium (FIP). FITs and FIPs are used in about 80 countries in 2017. The costs for FITs and FIPs are mostly incurred by utilities, which then mostly pass on that cost to consumers (in the case of liberalized markets) or the government (in the case of government-owned utilities). Feed-in tariff or premium policies can also include a "degression" rate, that lowers the FIT and FIP every year as to foster innovation and technology cost reduction. This system has been hailed as the most successful system for subsidizing renewables. Besides it being easy to differentiate the rates between various technologies, FITs and FIPs have also been most preferred by investors as it guarantees a certain price or premium over a longer term. It can also reduce capital costs by driving down the interest rates on lending.

Third, auctioning (also often called tendering or bidding) is a system in which governments write out auctions to invite companies to submit bids for a long-term contract to install a certain amount of renewable electricity capacity and supply electricity therefrom. Governments can tailor auctions to their demands in terms of policy or technology objectives. Bids subsequently compete over the lowest cost at which they could provide electricity. The winning bid then receives a subsidy equal to the difference between the market price for electricity and the winning bid price. Auctions have been used in 70 countries around the world by 2016, of which 34 had auctions in 2016 alone. In recent years, auctions have become more popular because various RE technologies such as onshore wind and solar have become more cost-competitive. It also avoids the need for regulators to set prices themselves (as is the case in FITs and FIPs).

Fourth, investment and production tax credits give favorable tax treatment to owners or investors in renewable energy. They can give them a partial tax write-off, generally or linked to a particular amount of electricity that has been generated by their company in the last year. This subsidy thus consists of foregone revenue, rather than a direct burden on either the government or the consumer.

Fifth, net-metering and billing are used to compensate distributed generation owners (i.e., smaller scale installations) for the electricity they produce and export to the grid when they have surplus generation. Either they can earn credit by a bidirectional meter running backwards as they export electricity, or they can receive credit measured on a net export meter and then adjusted in their billing cycle through the distribution company.

5.3 Subsidy Estimates

In total, subsidies to renewables and electric vehicles were estimated at about USD 150 billion in 2018, up from about USD 50 billion in 2010. While growing in absolute terms, their relative importance has declined since two of the largest technologies—onshore wind and solar PV—have seen drastic cost reductions. As a result of this and the growing use of auctions, the price-differential between the market price and winning bid price is expected to drop further.

Even though the methods to estimate the two most used renewable energy subsidies are not that complicated, there is not yet a systematic overview (in 2019) of the value of different types of renewable electricity subsidies. FITs, FIPs, and auctions are pricing policies, so an estimation of their net subsidy value requires an assumption of the evolution of the market power price over the period that grid operators are mandated to purchase the renewable electricity. The difference between the market price and the feed-in tariff or winning bid tariff is then the per unit subsidy. The total value can then be calculated by multiplying it by the total amount of kWh produced in a given year or, when calculating ahead, an estimated amount of generation including inflation.

For the other subsidies, renewable purchase obligations can be estimated more easily when there is a market for renewable energy certificates. A subsidy estimate can then be reached by taking the net-value of such certificates and multiplying it by the amount of electricity produced. Tax credits need a benchmark tax rate against which the subsidy value is calculated. Estimating the subsidy value of net-billing and net-metering requires knowing the per unit economic value of electricity exported or the rate at which the meter runs backward.

Toward the end of the 2010s, subsidies for solar and wind were being phased out in some countries around the world since the technologies were nearly cost-competitive. Initially, Spain was leading in solar deployment without subsidies, but generally across the world there has been a move to accept shorter term power purchase contracts. While initially they were about 20 to 25 years long, many developers now accept PPAs of 15 years or less (Chediak and Eckhouse 2019).

5.4 The Politics of Renewable Electricity Subsidies

As renewable electricity subsidies are relatively new, so are the politics that accompany them. Both domestically and internationally, fierce discussions have complicated subsidy design and implementation.

On a domestic level, every type of subsidy has certain disadvantages that welcome criticism. Perhaps most discussed is the disadvantage of feed-in tariffs and premiums. With FITs and FIPs, the information asymmetry between the regulator and the renewable electricity industry can lead to either overly high prices that create windfall profits for developers but large pains for consumers

and government budgets, or overly low prices that prohibit investment altogether. This asymmetry has led, in a few instances, to the retro-active adjustment of feed-in tariffs, destroying investor confidence altogether and often leading to investment arbitration. For example, in Spain, the solar energy FIT was so generous and without degression rate that deployment boomed from 103 MW in 2006 to 2708 MW in 2008. As a result, the government changed FIT policies in 2008 and ultimately abandoned the whole FIT program in 2012. In 2013, they shocked the industry by announcing that the statutorily guaranteed FIT for earlier installations would be reduced with retroactive effect, spurring several lawsuits against the government.

Besides FITs and FIPs, other subsidy types also have considerable disadvantages. The drawback of quotas and mandates is that it is difficult to decide on the exact size of the penalty. Tradable certificates may also lock in existing asymmetries between regions with existing capacity in renewables and those without. Even regions with potential might find it difficult to explore that potential while satisfying quotas at the same time. The disadvantage of auctions, from its side, is that bids have not always been realized because the bidding price was set unrealistically low just to win the project. In some countries, bids have also been tailored to favor specific companies, adding to corruption concerns. And finally, bids bring less certainty for investors than FITs and FIPs, especially when there is not a lot of certainty about when the next bidding round will arrive.

Importantly, several renewable energy subsidies to both large-scale producers and distributed generation are met with skepticism from stakeholders that fear the system's flexibility for short-term large-scale uptake, as well as the impact on operations of distribution companies that are all of a sudden confronted with power purchasing agreements and distributed generation that might conflict with existing contracts and business models.

On an international level, renewable energy subsidies have been followed by various lawsuits, undermining the confidence investors can have in them. On the one hand, various WTO cases have focused on local content requirements attached to renewable electricity subsidies. For example, Ontario, China, India, and US states have seen cases initiated against their renewable energy subsidies. On the other hand, various companies have also sued states through investor-state dispute settlements whenever they believed legislative changes countered their legitimate expectations. Case in point is Spain, where several investors have sued the government after their retroactive change in FIT rates.

Box X: Biofuel Subsidies

There are three main types of biofuel subsidies around the world. A first type consists of blending mandates that set targets to have a certain amount of ethanol and biodiesel as part of the fuel mix. These are a form of market price support, as they guarantee a market for biofuels and

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enhance market predictability for investors. A second type comprises excise tax exemptions in which biofuels are granted tax exemptions or reductions compared to the excise taxes lifted on conventional petrol and diesel. A third type includes trade policies such as import duties or anti-dumping measures which aim at protecting domestic markets from foreign competition of either ethanol, biodiesel, or the feedstock needed to produce either.

Biofuel subsidies have been surrounded by political controversy. On the one hand, first-generation biodiesel is not carbon-reducing when integrating indirect land use change (ILUC) effects. In some cases, depending on feedstock, it accounts for even higher emissions than conventional diesel. ILUC takes into account the effect that a heightened demand for vegetable oils as a feedstock for biodiesel has on agricultural expansion and the conversion of natural land, either domestic or abroad. One specific example was the importation into the EU of oil palm that originated from converting high carbon stock lands in Indonesia and Malaysia, or of soy from savannah and rainforest lands in South America. On the other hand, first-generation ethanol, while having a positive carbon reduction impact compared to conventional petrol, was found to impact local and global food prices.

The fact biofuel subsidies were and still are pervasive, even when negative developmental impacts became increasingly evident, was and still is linked to their primary policy objective. Rather than supporting "renewable" energy in transport fuels, biofuel support policies have been used as an indirect agricultural subsidy. By increasing demand for agricultural products, governments have used biofuel support to lift the prices of agricultural commodities, thereby supporting domestic farmers. In the EU, the blending mandate was pushed for by the agricultural directorate during a reform of agricultural subsidies, all while the climate directorate and the joint research center (the European Commission's scientific advisory body) expressed caution and even concern about first-generation biofuels. In the US, ethanol subsidies have been used to support farmers in politically important states. For example, former Vice-President Al Gore has admitted in 2010 that "first generation ethanol I think was a mistake… One of the reasons I made that mistake is that I paid particular attention to the farmers in my home state of Tennessee, and I had a certain fondness for the farmers in the state of Iowa because I was about to run for president." Both the EU and the US have attempted to reform subsidies but have far from eliminated them.

6 Conclusion: Energy Subsidies and the Politics of Reform

Energy subsidies are pervasive, for two reasons. On the one hand, no single energy subsidy can resolve the contradictions of the energy trilemma. Governments cannot simultaneously support the affordability of energy, energy security, and environmental sustainability. Rather, they are required to implement various types of subsidies to various energy types to try and reach an elusive balance of those three policy objectives.

What objectives weigh more heavily in decision-making depends on a country's developmental context, its politics, and its current energy infrastructure. It is however safe to say that all three objectives are becoming ever more pronounced in many countries. This is a direct result of various simultaneous drivers such as population growth and associated demand for energy, a deepening of socio-economic inequalities, the increase in air pollution and global climatic change, and the quest for economic competitiveness to manage the turmoil of economic globalization.

On the other hand, energy subsidies are also pervasive because of whom they benefit. Once installed, domestic interest groups form around the subsidies' beneficiaries and make their reform politically costly. As shown, these beneficiaries are not only energy companies, but can also include, among others, households, farmers, and politicians that directly collect rents from maintaining those subsidies. These vested interests have put the political economy of subsidies and subsidy reform at the forefront of debates on fiscal policy in the field of energy. Likewise, they will also determine what level of progress can be made against the several sustainable development goals linked to affordable and clean energy, the phasing out of fossil fuel subsidies, and global climate change.

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