Cutting Emissions Through Fossil Fuel Subsidy Reform and Taxation

GSI REPORT

IISD International Institute for Sustainable Development

Global Subsidies Initiative

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July 2021

International Institute for Sustainable Development

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The IISD Global Subsidies Initiative (GSI) supports international processes, national governments and civil society organizations to align subsidies with sustainable development. GSI does this by promoting transparency on the nature and size of subsidies; evaluating the economic, social and environmental impacts of subsidies; and, where necessary, advising on how inefficient and wasteful subsidies can best be reformed. GSI is headquartered in Geneva, Switzerland, and works with partners located around the world. Its principal funders have included the governments of Denmark, Finland, New Zealand, Norway, Sweden, Switzerland and the United Kingdom, as well as the KR Foundation.

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Written by Jonas Kuehl, Andrea M. Bassi, Philip Gass, and Georg Pallaske.

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Abbreviations and Acronyms

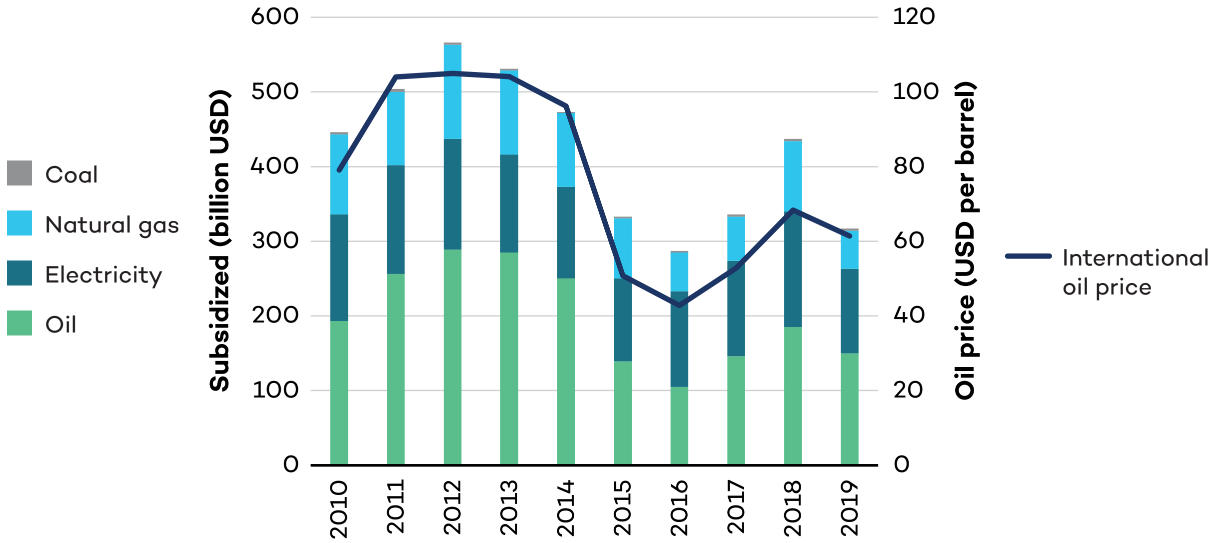
BAU	business as usual
CO_2e	carbon dioxide equivalent
EU	European Union
FFS	fossil fuel subsidies
FFSR	fossil fuel subsidy reform
FFFSR	Friends of Fossil Fuel Subsidy Reform
G20	Group of 20
GHG	greenhouse gas
GSI	Global Subsidies Initiative
GSI-IF	Global Subsidies Initiative Integrated Fiscal model
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
NDC	Nationally Determined Contributions
UAE	United Arab Emirates
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

1.0 Introduction

Fossil fuel subsidies (FFSs) are harmful to both people and the environment. By artificially lowering the price of fossil fuels, such subsidies encourage their wasteful consumption and make fossil fuel investments more competitive compared to investments in clean alternatives, such as renewable energies or electric vehicles. As a consequence, FFSs are local drivers of land degradation, water stress, air pollution, and biodiversity loss, and they further fuel the global climate crisis. At the same time, FFSs contribute to air pollution, which causes millions of deaths every year, and further entrench gender inequality. They are also an expensive and inefficient safety net—and the most benefits go to the wealthy classes in many cases. Simply put, FFSs counteract many of the Sustainable Development Goals.

FFS reform (FFSR) has significant mitigation potential for climate change because it helps to level the playing field for clean energy and reduce energy demand in many end-use sectors due to higher prices, such as transportation, buildings, and industries. Roughly 40 countries seized the opportunities offered by FFSR between January 2015 and May 2020 (Sanchez et al., 2020). Nevertheless, Figure 1 shows that global spending on consumer FFSs has remained high over the last decade and that, depending mainly on the international oil price, it costs governments annually between USD 287 billion (2016) and USD 566 billion (2012) (International Energy Agency [IEA], 2020b). In 2019, global FFSs to consumers added up to around USD 320 billion, a significantly higher amount than the USD 280 billion global spending in renewable energy capacity investments and USD 250 billion global spending in energy efficiency (Frankfurt School-UNEP Centre & BloombergNEF, 2020; IEA, 2020a).

Figure 1. Global fossil fuel consumption subsidies (IEA, 2020b) and international oil price (International Monetary Fund [IMF], 2021a) between 2010 and 2019



The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD) initially designed its Integrated Fiscal model (GSI-IF model) to support countries with their Intended Nationally Determined Contributions in the lead up to the Paris Agreement. With this model, GSI aimed to assess the magnitude of greenhouse gas (GHG) emission reductions that can be achieved with the reform of consumption FFSs as well as a subsequent reallocation of subsidy savings to investments in renewable energy and energy efficiency (a subsidy swap).[1] The model is bounded at the national level, and results are compared with a business-as-usual (BAU) scenario. In 2019, the adoption of a modest 10% energy tax, including the subsequent reallocation of tax revenues to investments in energy efficiency and renewable energy, was added to the model. More information about the GSI-IF model can be found in Annex 4.

The first modelling exercise covered 20 countries. It focused mainly on low- and lower-middle-income countries, where FFSs accounted for a significant proportion of government budgets. It also included some high-income countries with a large number of nominal consumer subsidies, such as the United States (Merrill et al., 2015). To provide a more globally diverse range, six countries were added as part of a second modelling exercise in 2019, including two Latin American, two African, one European, and one Southeast Asian country (Merrill et al., 2019).

Undoubtedly, many of the underlining conditions are much different today. For instance, the global economy contracted by an estimated 3.5% in 2020 because of the COVID-19 crisis, and subsequently, energy demand was estimated to drop by 5% (IEA, 2020c, p. 464; IMF, 2021b). Despite the temporary dip in GHG emissions, the pandemic also slowed down progress on climate action, since the 26th Conference of the Parties (COP 26) to the United Nations Framework Convention on Climate Change (UNFCCC), where countries were expected to commit to enhanced climate ambition, was postponed by one year to November 2021 (Government of the United Kingdom, 2020).

The latest modelling exercise responds to this new reality and provides an updated picture of the impact that FFSR can have on mitigating GHG emissions. The findings are intended to help countries understand how much FFSR could contribute to their emission reductions and thus boost more ambitious Nationally Determined Contributions (NDCs) that include FFSR as a key component prior to COP 26. At the same time, the findings show how FFSR can support a "green recovery" from the COVID-19 crisis by facilitating the efficient use of energy, creating urgently needed fiscal space, and reinvesting it in clean alternatives, such as energy efficiency and renewable energy.

To provide a more comprehensive picture, the number of countries was increased once again by six countries for this modelling exercise, most of them advanced economies, in an effort to offer more geographic and economic balance and include a greater cross-section of the G20 countries in particular. **In total, these countries account for 77% of global CO_2**

[1] More details about the robustness of existing subsidy estimates can be found in Box 1.

emissions, 72% of global GDP, and 72% of the global population.[2] The 32 countries modelled in the research are Algeria, Argentina, Australia, Bangladesh, Brazil, Canada, China, Egypt, Ethiopia, Germany, Ghana, India, Indonesia, Iran, Iraq, Japan, Mexico, Morocco, Myanmar, Nigeria, Pakistan, Russia, Saudi Arabia, South Africa, Sri Lanka, Tunisia, United Arab Emirates (UAE), the United States, Venezuela, Vietnam, the Netherlands, and Zambia.

Our research found that complete removal of consumption FFSs reduces GHG emissions by an average of 6.09% across these 32 countries until 2030 compared to a BAU scenario; it reduces the emissions of certain countries by over 30%. Combined with an FFS swap to energy efficiency and renewable energy, GHG emissions are reduced by about 9%. With an additional energy tax and earmarked tax revenue to be invested in renewable energy and efficiency, the average mitigation potential is about 12%. In aggregate terms, the cumulative GHG emissions abated from FFSR (alone) is 5.46 gigatonnes (Gt) of carbon dioxide equivalent (CO_2e) by 2030—equivalent to the annual emissions of about 1,000 standard coal-fired power plants if running non-stop at full capacity[3]—and 10.42 Gt of CO_2e in combination with the additional policy instruments, which is equivalent to the annual emissions of roughly 2,000 coal-fired power plants. As FFSR is a policy tool that saves government resources while simultaneously reducing GHG emissions, cumulative fiscal savings from FFSR alone by 2030 total USD 2.96 trillion across the countries analyzed. For every tonne of CO_2e removed through FFSR alone, governments save an average of USD 546. When considering the resources reallocated via the FFS swap, the amount declines to USD 164.

[2] These shares are based on 2019 numbers. In contrast, the 26 countries in the 2018 analysis only accounted for 70% of global CO_2 emissions, 61% of global GDP, and 68% of the global population; the 20 countries of the initial analysis accounted for only 64% of global CO_2 emissions, 52% of global GDP, and 60% of the global population.

[3] A standard coal-fired power plant has a capacity of 600 MW and emission intensity of roughly 1 tonne CO_2e per MWh of electricity generated.

2.0 The Need to Drive Greater Ambition on NDCs and Greening COVID-19 Recovery

Climate change is one of the most pressing issues of our time. The manifold consequences, such as rising sea levels or a higher likelihood of extreme weather events, are increasingly felt throughout our planet. After decades of little action, close to 200 nations committed to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (UNFCCC, 2015, p. 3) when they signed the Paris Agreement in 2015. Yet, science shows clear benefits to people and natural ecosystems if global warming could be limited to 1.5°C instead of 2°C (Intergovernmental Panel on Climate Change, 2018).

2.1 The Emission Gap and the Production Gap

Under article 4 of the Paris Agreement, countries are required to submit NDCs in which they lay out which domestic mitigation measures they intend to achieve. Added up together, these contributions determine whether we can reach the long-term goals of the Paris Agreement. To date, the submitted NDCs are highly insufficient to attain these goals. According to the United Nations Emissions Gap Report 2020, current unconditional NDCs would exceed 2030 levels consistent with a 2°C temperature increase by 15 Gt CO_2e and the levels consistent with a 1.5°C increase by 32 Gt CO_2e, eventually leading to a warming of 3.2°C by the end of the century (United Nations Environment Programme [UNEP] & UNEP DTU Partnership, 2020). The IEA (2021) calculated that global energy-related CO_2 emissions decreased by about 6% in 2020 due to a drop in demand as a result of the COVID-19 pandemic compared to the previous year. However, the *Emissions Gap Report 2020* concludes that this drop in emissions had no effect on the emission gap[4]—an indicator that does not assess the current state of GHG emissions but rather a long-term alignment of climate policy with achieving the targeted goal—because only a few NDCs had been updated since the previous year. Moreover, the Climate Action Tracker[5] found that only two countries' NDCs (Morocco and Gambia) are compatible with the 1.5°C goal, and six countries' NDCs are compatible with the 2°C goal (as of November 2020). In contrast, the climate ambitions of 10 countries and the European Union (EU) are insufficient, and seven countries each submitted highly insufficient or even critically insufficient NDCs.

In addition to NDCs that do not meet the necessary ambition, the production gap is another clear indicator that current action is not in line with the ambition needed to meet the goals of the Paris Agreement. According to the *Production Gap Report 2020,* global fossil fuel production would need to decrease by 2% per year between 2020 and 2030 to be compatible with the 2°C goal and by roughly 6% annually to be in line with the 1.5°C goal

[4] The emission gap is the difference between the GHG emission levels consistent with a specific probability of limiting the mean global temperature rise to below 2°C or 1.5°C in 2100 above pre-industrial levels and the GHG emission levels consistent with the global effect of the NDCs, assuming full implementation from 2020.

[5] The Climate Action Tracker assesses the NDCs of all large emitters and a representative sample of smaller emitters (32 countries + the EU) that together cover about 80% of global emissions.

(Stockholm Environment Institute et al., 2020). In detail, coal production would need to decrease by 11% annually, oil production by 4%, and gas production by 3% in that period to follow a 1.5°C-consistent pathway. Yet the report finds plans to increase production capacity by 2% per year until 2030, which will result in a 120% increase in fossil fuel production over goals for limiting global warming to 1.5°C or a 50% increase over goals for limiting global warming to 2°C.

2.2 Recovery Spending

Since early 2020, governments recorded an unprecedented increase in fiscal spending to stimulate their economies and protect their citizens from economic and social hardship due to the COVID-19 crisis. Given the massive scale of this spending, the way it is invested has significant long-term implications. Governments can make use of this opportunity by ensuring a green recovery, where spending is directed primarily at low-carbon sectors of the economy, which stimulates the economy while setting us on track to achieve the goals of the Paris Agreement. However, the *Emissions Gap Report 2020* notes that, so far, this opportunity "has largely been missed" (UNEP & UNEP DTU Partnership, 2020, p. 36). To confirm this, the Energy Policy Tracker found that of the USD 758 billion in COVID-19 government support spending that went into energy-producing and consuming activities across 31 major economies between early 2020 and April 2021, 41% has gone to fossil fuel-intensive sectors. It is also found that in a vast majority of cases, this funding was provided unconditionally, without any climate targets or additional pollution reduction requirements. In contrast, support for clean energy only accounted for 37%, and support for other energy only accounted for 22%[6] (IISD et al., 2020).

Both the *Emissions Gap Report 2020* and the *Production Gap Report 2020* underline the relevance of FFSR with regard to a green recovery. As such, the former lists FFSRs as one of four broad rescue and recovery measures that simultaneously support rapid, employment-intensive, and cost-effective economic recovery and a low-carbon transition (UNEP & UNEP DTU Partnership, 2020).[7] Similarly, FFSR is also reflected as part of six main areas of action where policy-makers can shape a more resilient and sustainable future through a managed, just, and equitable transition away from fossil fuels proposed in the *Production Gap Report 2020*. Specifically, the report notes that the "current crisis provides the opportunity to reconsider many long-standing forms of government support to fossil fuels that stand in the way of a sustainable recovery—including consumer subsidies, producer subsidies, and public finance investment" (Stockholm Environmental Insititute et al., 2020, p. 44). Notably, the report explicitly stresses the fiscal savings that FFSR creates, which can then be redirected to more productive and socially desirable ends, such as

[6] Policies outside of "fossil" and "clean," or in both of them, fall under this umbrella category. These policies support nuclear energy (including uranium mining), "first generation" biofuels, biomass and biogas, incineration, hydrogen of unspecified origin, and multiple energy types, for example, intertwined fossil fuels and clean energy (a sizeable group, since many policies benefit both fossil fuel and clean energy across the board).

[7] The other three measures are (1) support for zero-emissions technologies and infrastructure (e.g., low-carbon and renewable energy, low-carbon transport, and zero-energy buildings), (2) support to research and the development of zero-emissions technologies, and (3) nature-based solutions.

infrastructure, food security, and healthcare, or to fund a clean energy transition (Bridle et al., 2019; Moerenhout & Urpelainen, 2020).

2.3 The Next Wave of NDCs

Article 4 of the Paris Agreement requires countries to submit new, more ambitious NDCs every 5 years; the first round of upgrades was expected in the run-up to the 2020 climate summit (UNFCCC, 2015). As of April 2021, the Climate Action Tracker (2021) shows that only 52 countries and the EU, which together represent about 32% of global emissions and 26% of the global population, have submitted new NDCs. Moreover, only a small majority of the newly submitted NDCs analyzed by the Climate Action Tracker (11 out of a total of 21) actually showed increased ambition, which is concerning, as science shows that emissions need to be significantly reduced by 2030 to keep global warming below 1.5°C.

On a more positive note, a growing number of countries committed to reaching net-zero emissions by around mid-century in 2020. Considering the net-zero emission goals announced by several large emitters (e.g., China, Japan, and South Korea) in 2020 were adequately reflected in updated NDCs, the emission gap could shrink from 3.2°C (according to the *Emissions Gap Report 2020)* to 2.7°C to 2100, or even to 2.5°C–2.6°C if the United States also adopts a net-zero GHG target by 2050. According to analysis from the Climate Action Tracker, global warming by 2100 could be as low as 2.1°C as a result of the net-zero pledges announced as of November 2020, which signals that the Paris Agreement's 1.5°C target is "within striking distance" (Climate Action Tracker, 2020, p. 5).

While long-term targets like net-zero emission announcements (most tending to aim toward around mid-century) are indeed important signals, only short-term action will determine whether those can be met. Therefore, strengthening interim targets and immediately starting action toward these targets is critical.

Over the past decade, FFSR has gained considerable momentum—for example, through commitments to phasing out FFSs made by G20, G7, and the members of the Asia-Pacific Economic Cooperation and as part of the Sustainable Development Goals. The Friends of Fossil Fuel Subsidy Reform (FFFSR) presented a communiqué at COP 21 to support accelerated action to eliminate inefficient FFSs that was endorsed by 43 countries; this commitment was reaffirmed 5 years later with support from the United Kingdom, the incoming co-host of COP 26 (FFFSR, 2015, 2020). Nevertheless, to date, the potential of FFSR is far from being utilized in the context of the NDCs, as only 15[8] countries reference FFSR in their current commitments (Roth & Boelts, 2021). As a tool that delivers GHG emission reductions and saves governments money, countries should raise the ambition of their NDCs in the run-up to COP 26 by integrating FFSR into their new submissions. In addition, the subsidy savings also create urgently needed fiscal space that allows governments to support a green recovery from the COVID-19 crisis with mutual benefits for both the economy and the climate.

[8] These countries are: Burkina Faso, Egypt, Ethiopia, Ghana, India, Kuwait, Morocco, Nigeria, Panama, Saudi Arabia, Sierra Leone, Singapore, Switzerland, United Arab Emirates, and Vietnam.

3.0 GSI-IF Model 2021: Results

The analysis based on the GSI-IF model considered the following four scenarios that, partially, build on each other:

1. Complete FFS removal by 2025 (following a linear trend from 2021)
2. FFS swap: Reallocation of 20% of subsidy savings to investments in energy-efficiency improvements and 10% to investments in renewable energy power plants (from 2021 and continuing through 2030)[9]
3. Introduction of energy taxes in the amount of 10% of current energy prices (following a linear trend from 2025 and reaching 10% by 2030)
4. Earmarked tax revenues: Reallocation of 20% of tax revenues to investments in energy-efficiency improvements and 10% to investments in renewable energy power plants (from 2025 and continuing through 2030).[10]

3.1 Emission Reductions Through FFSR

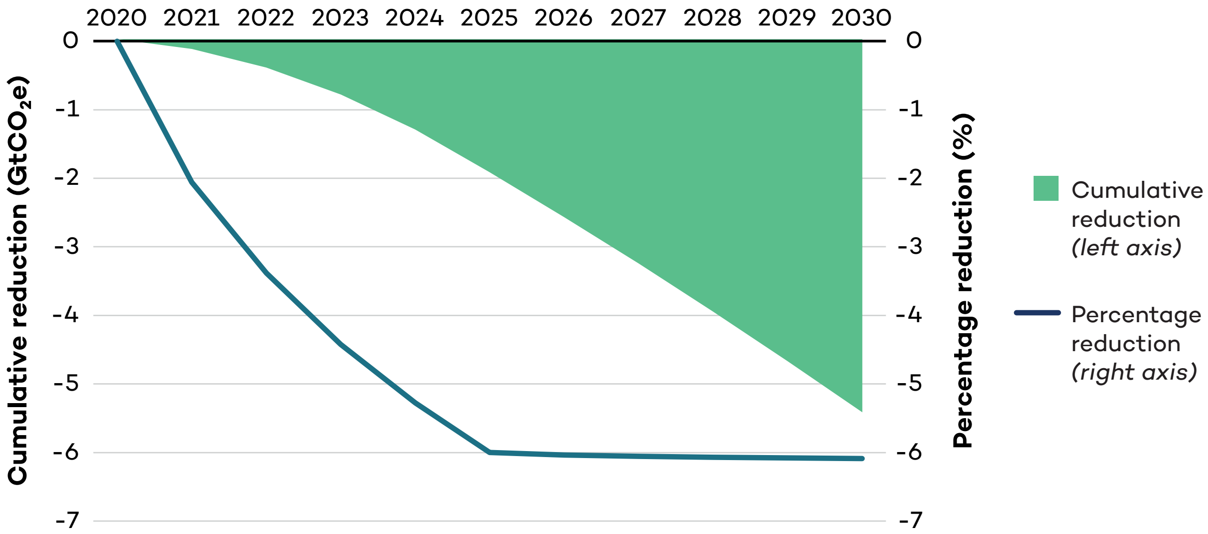
If all FFSs were removed linearly between 2021 and 2025, the modelling results find that FFSR could achieve significant annual emission reductions across all countries that gradually increase from about 2% in 2021 to 6% in 2025. By making the consumption of fossil fuels more expensive, FFSR reduces demand for fossil fuels and facilitates a switch to then more price-competitive, low-carbon alternatives. The annual percentage of emission reductions increases as more FFSs are removed; however, when that potential is exhausted and energy prices stabilize, the percentage of emission reductions starts to level off as well. Therefore, the percentage of emission reductions from FFSR does not increase significantly after 2025 and reaches 6.09% in 2030. A similar trend can be seen for the percentage of emission reductions in the G20 countries separately, which levels off at around 3.50%.

As a result, the annual absolute emission reductions from FFSR increase until 2025 but remain constant in the following years. This has implications for the cumulative emission reductions from FFSR, which start to grow almost linearly from 2025 onwards after showing much faster growth up until 2025. Overall, FFSR will amount to cumulative savings of 1.95 Gt by 2025 and 5.46 Gt CO_2e by 2030 across all 32 countries.

[9] Based on an analysis of past subsidy reform experience in various countries, this number was chosen as a feasible contribution, given that some subsidy savings are often used to protect vulnerable groups from price increases as a result of FFSR and fund other societal priorities like health, education, or debt.

[10] The 30% of tax revenues being reinvested into energy efficiency and renewable energy were chosen to ensure consistency with the amount reallocated as part of the FFS swap.

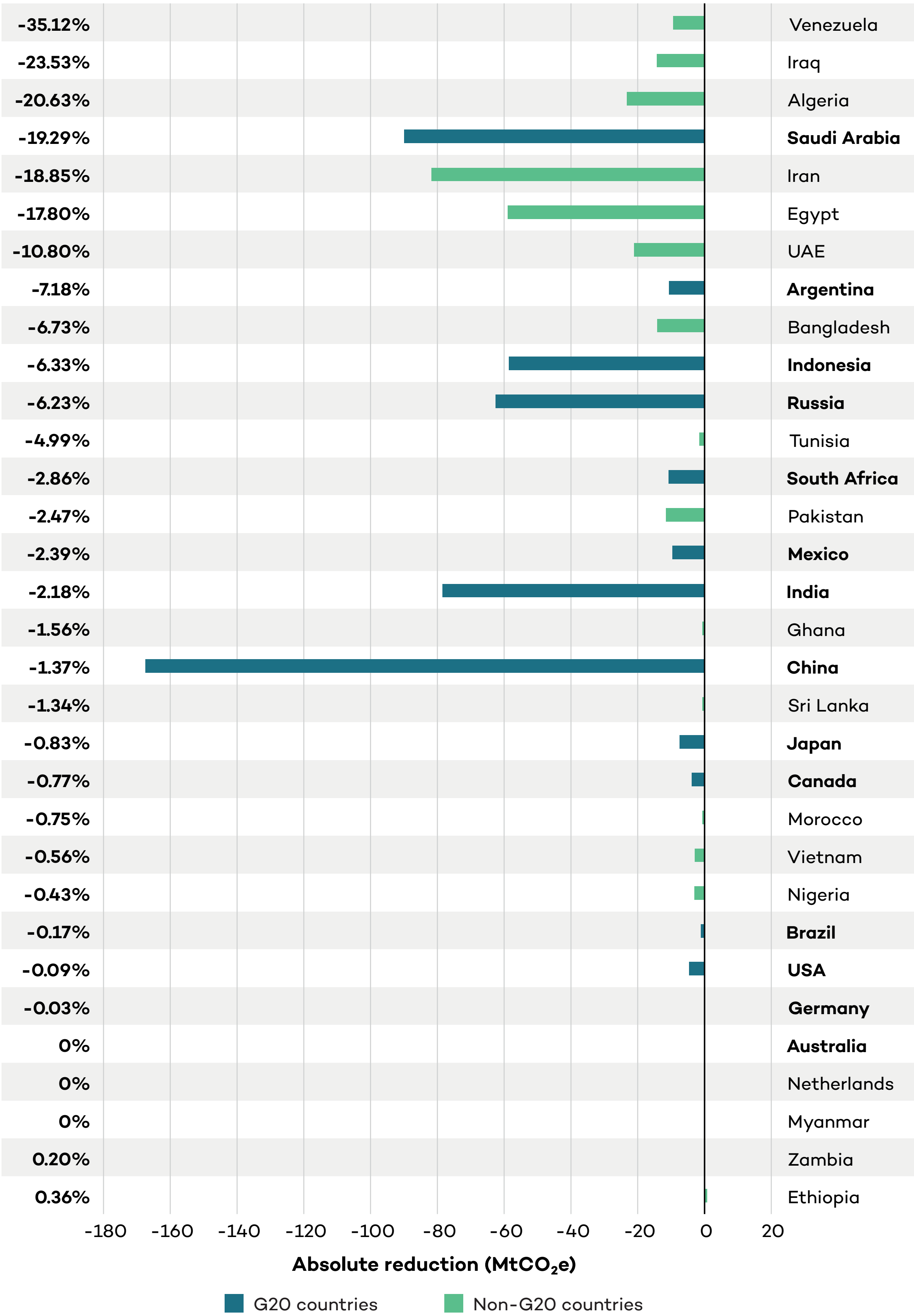
Figure 2. Average percentage and cumulative emission reductions from FFSR across 32 countries between 2021 and 2030



Analyzing the individual results by country shows interesting insights. Countries with the highest percentage of emission reductions from FFSR are Venezuela, Iraq, Algeria, Saudi Arabia, Iran, and Egypt, with average emission reductions above 17% in 2030 (Figure 3); in fact, emission reductions in Venezuela exceed 35%. These countries are characterized by the highest relative amounts of subsidies as a share of GDP among the ones considered for this study. As a result, FFSR leads to large price changes in these countries, which affects energy demand and fuel switching. With regards to the 14 G20 countries, only Saudi Arabia is among the countries with the highest percentage of emission reductions from FFSR. In several G20 countries, such as Argentina, Indonesia, and Russia, FFSR can achieve emission reductions between 5% and 8%, while other G20 countries achieve less than 2% (e.g., China, Japan, and Canada) or even close to 0% (e.g., Brazil, the United States, Germany, and Australia).

On the other hand, five of the seven countries with the highest absolute emission reductions from FFSR are G20 members, given the size of their economies and, subsequently, energy consumption. According to the modelling results, China, Saudi Arabia, Iran, India, Russia, Egypt, and Indonesia all achieve more than 50 megatons (Mt) in GHG emission reductions by 2030, with China achieving more than 160 Mt. All these countries are characterized by high energy intensity and consumption, relatively low energy prices, high carbon intensity (and hence high reliance on subsidized fossil fuels), or a combination of these conditions. In contrast to the percentage of emission reductions from FFSR, the G20 countries are more dominant when it comes to absolute emissions.

Figure 3. Percentage and absolute emission reductions from FFSR in 32 countries by 2030



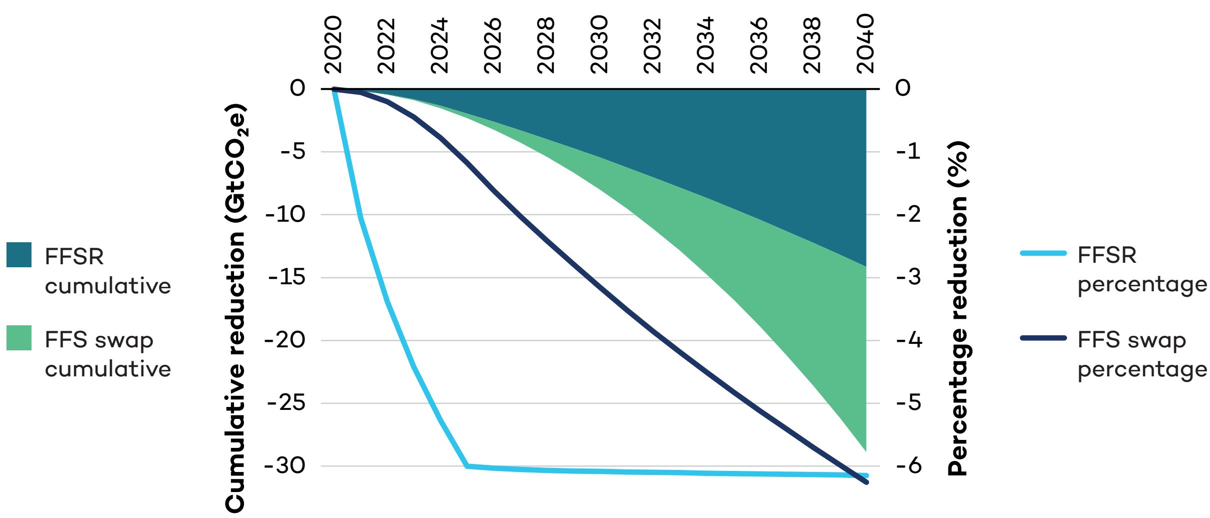
3.2 Emission Reductions Through an FFS Swap

If 20% of the annual subsidy savings from FFSR were invested in energy efficiency and 10% in renewable energy—a so-called subsidy swap—the modelling results find that an additional reduction in emissions can be achieved. These investments would reduce the emission intensity either by lowering energy consumption or substituting a polluting fossil fuel with a low-carbon alternative.

Considering a simple average of the percentage of reductions for all countries studied, the emission reduction gradually increases from 2021 onwards and reaches 3.15% in 2030. Most of this emission reduction across all countries (2.63%) is coming from reinvestments in energy efficiency (which receives 20% of the subsidy savings according to the GSI-IF model, as opposed to renewable energy, which only receives 10%). For G20 countries, the emission reduction from the FFS swap stands at 2.70% in 2030, This means that the gap of emission reductions from the FFS swap between all countries and G20 countries is much smaller compared with the emission reductions from FFSR. Notably, renewable energy has a higher share among G20 countries, as it contributes to a 1.13% reduction in emissions.

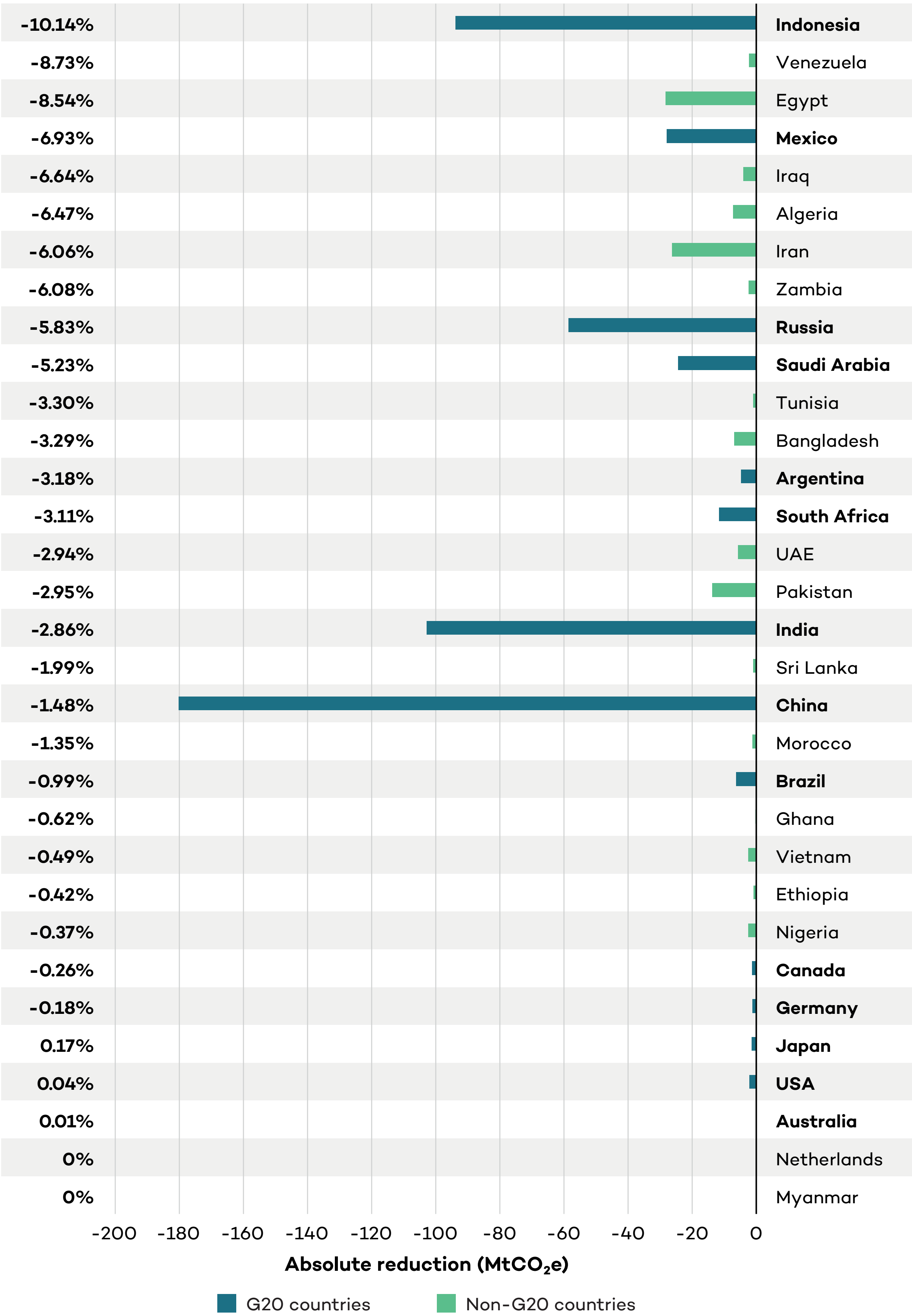
Compared with FFSR, the cumulative emission reductions from the FFS swap are growing faster. This is because absolute annual emission reductions are not levelling off due to an accumulation of emission reductions as a result of the investment history: more energy-efficient equipment is purchased and installed every year, in the same way as more solar panels and other renewable energy capacity are purchased and installed every year. That said, investments in energy efficiency and renewable energies are able to continue to reduce emissions in subsequent years, throughout their lifetimes, and therefore have a lasting impact. As a consequence, both the annual percentage and the cumulative emission reductions from the FFS swap will be higher than from FFSR alone by 2040, which highlights the relevance of implementing an FFS swap (Figure 4).

Figure 4. Average percentage and cumulative emission reductions from FFSR and the FFS swap across 32 countries between 2020 and 2040



With respect to the individual percentage of emission reductions from the FFS swap among the countries studied in this analysis in 2030, the same countries that show the highest percentage of reduction from FFSR, such as Venezuela, Egypt, Iran, or Algeria, are among the countries with the highest values (Figure 5). This is not a surprise, given that the presence of large subsidies implies in the GSI-IF model that a significant amount of additional revenues is raised from the reforms, and 30% of this is then reallocated to investments that improve energy efficiency and expand renewable energy. In addition, several G20 countries, like Indonesia, Mexico, and Russia, also have a large percentage of emission reductions from the FFS swap—with Indonesia having the largest. Compared to the other countries, this is primarily because investments in renewable energy result in significant emission reductions, whereas in several other countries—10 in total—investments in renewable energy increase emissions because they reduce the price of energy and therefore increase consumption. Looking at the absolute emission reductions from the FFS swap, the largest contribution, once again, comes from major economies, such as China, India, Indonesia, and Russia, where an FFS swap reduces emissions by more than 50 Mt CO_2e.

Figure 5. Percentage and absolute emission reductions from the FFS swap in 32 countries by 2030

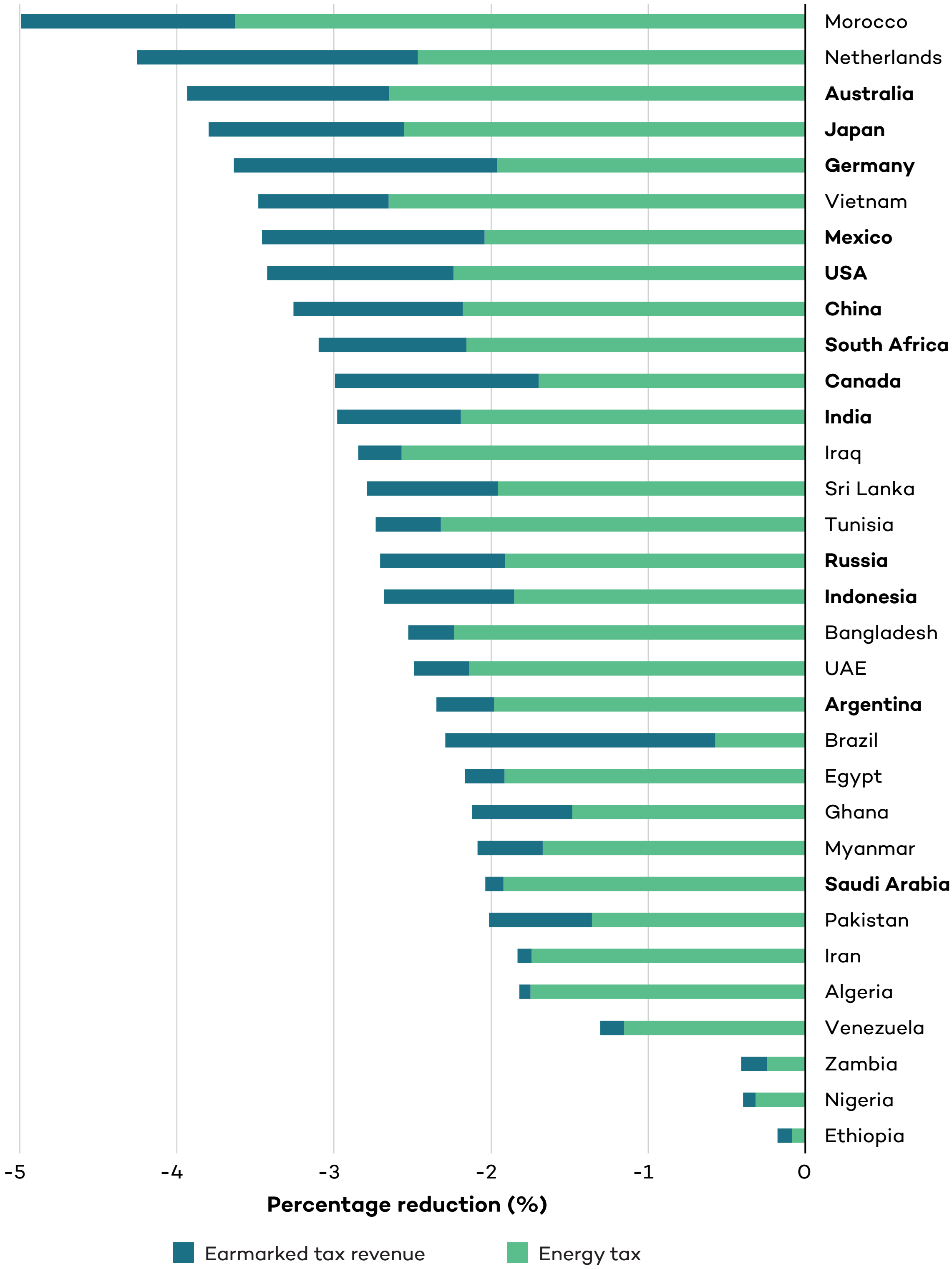


3.3 Emission Reductions Through Fossil Fuel Energy Tax and Earmarking Tax Revenue to Green Development

FFSR and FFS swaps are important instruments to raise climate ambition, but their potential to achieve further emission reductions is finite. In fact, it is exhausted after FFSs are completely removed. In addition, given the negative externalities of fossil fuels, ambition beyond FFSR is required to internalize these if the goals of the Paris Agreement are to be achieved. Therefore, the GSI-IF model also introduces the linear adoption of a 10% energy tax between 2025 and 2030 and the reinvestment of tax revenues into renewables and energy efficiency.

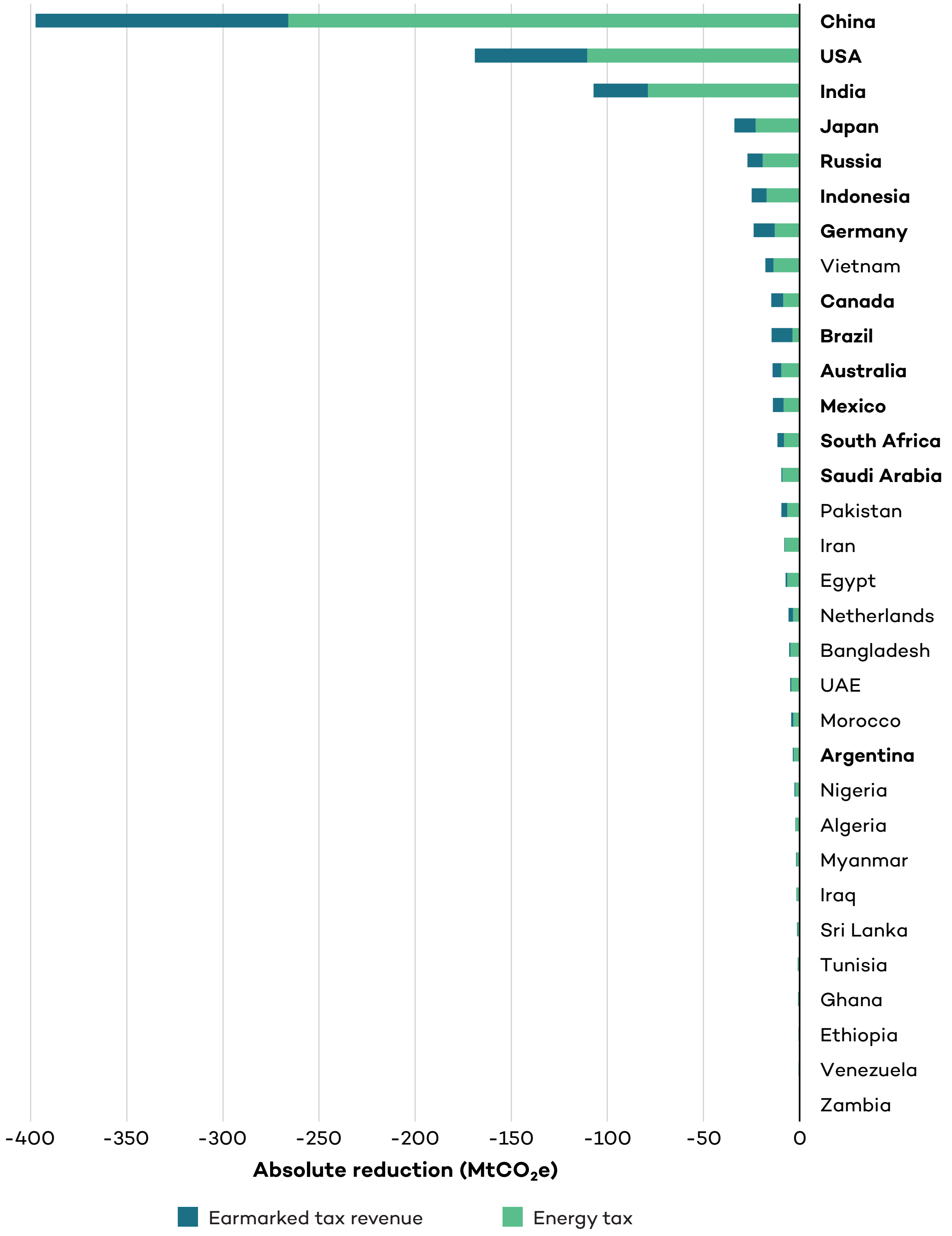
Overall, the results show that the average emission reductions of the combined measures would stand at 2.59% in 2030 and the cumulative emission reductions at 2.41 Gt CO_2e. Notably, looking at the individual percentages of emission reductions across the countries, it is apparent that especially countries with rather small potential to achieve emission reductions from FFSR and the FFS swap are the ones with the highest percentage of emission reductions: Morocco, the Netherlands, Australia, Germany, and the United States are among the countries with the highest reductions (Figure 6). These countries have relatively low FFSs but high consumption, which is why the energy tax of 10% has a substantial impact and generates large revenues. The reinvestment of the energy tax into energy efficiency and renewable energy accounts for additional emission reductions. Moreover, in absolute terms, most emission reductions are coming from the G20 countries, including China, the United States, India, Japan, Russia, Indonesia, and Germany (Figure 7).

Figure 6. Percentage of emission reductions from energy tax and earmarked tax revenue in 32 countries by 2030



Note: G20 countries are in bold.

Figure 7. Absolute emission reduction from energy tax and earmarked tax revenue in 32 countries by 2030

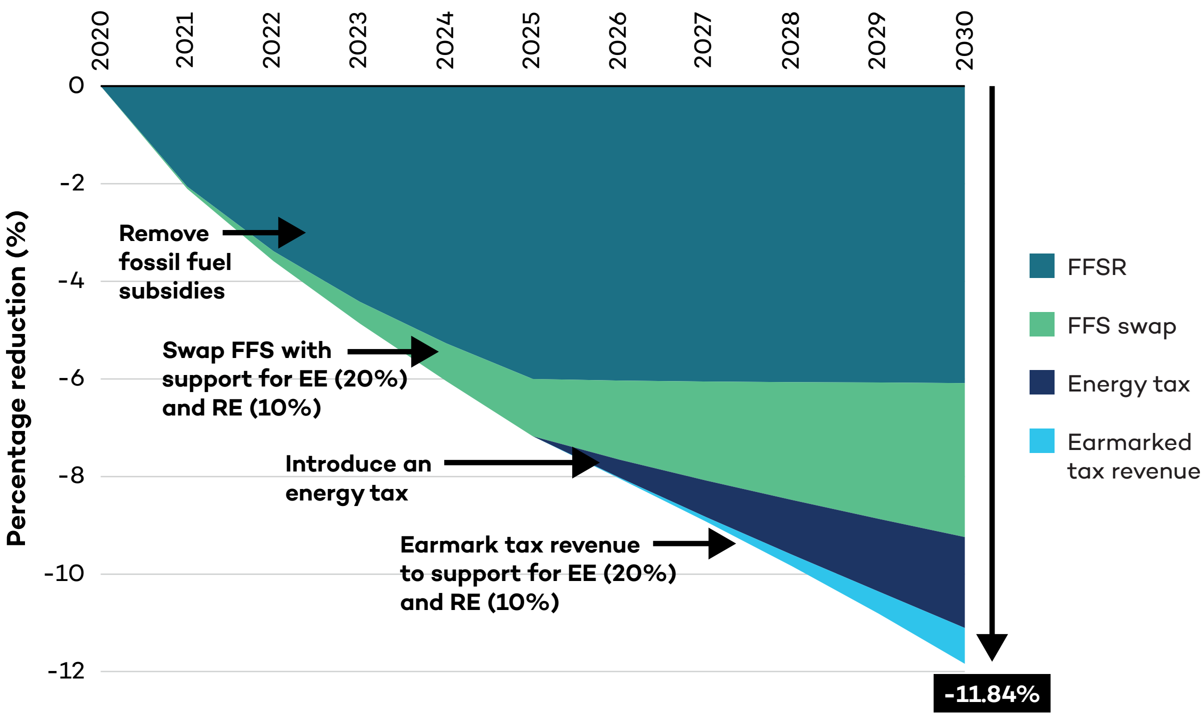


Note: G20 countries are in bold.

3.4 Total Emission Reductions Predicted by the GSI-IF Model

The research found that the FFSR, an FFS subsidy swap, a modest fossil energy tax, and earmarking tax revenue to investments in energy efficiency and renewable energy would lead to an average national emission reduction of 11.84% by 2030 compared to a BAU baseline (Figure 8). When weighting reductions by the size of the economy of the countries using GDP, the average decline in GHG emissions from the combination of these four scenarios reaches 6.46% by 2030 compared to BAU and 7.50% when weighted by the size of GHG emissions.

Figure 8. Average percentage of CO_2e reductions over time from consumer FFSR and 10% energy taxation across 32 countries, with 10% of savings and revenues invested in renewable energy (RE) and 20% in energy efficiency (EE)



Specifically, the different scenarios contribute to the total average emission reduction of 11.84% as follows (Table 1, column 1):

- FFSR: reaching 6.09% by 2025 and remaining constant until 2030.
- FFS swap: Reallocation of subsidy savings into energy efficiency and renewable energy, reaching 3.16% by 2030.
- Fossil energy tax: starting in 2025 and reaching 1.86% by 2030.
- Earmarked fossil energy tax revenue: Allocation of fossil energy tax revenue into energy efficiency and renewable energy, reaching 0.73% by 2030.

In summary, FFSR and the associated FFS swap to support renewables and energy efficiency will achieve close to a 9% emission reduction by 2030, and an energy tax component, including the investment of tax revenues in energy-saving and low-carbon technologies, will contribute an additional 2.5%. In addition, FFSR will amount to cumulative savings of 1.95 Gt CO_2e by 2025 and 5.46 Gt CO_2e by 2030 across all 32 countries, while the FFS swap will account for additional cumulative savings of 0.37 Gt CO_2e by 2025 and 2.55 Gt CO_2e by 2030. In the long run, the FFS swap will contribute more to reducing emissions than FFSR due to the historical accumulation of such investments. Adding a fossil fuel energy tax from 2025 onward would increase the cumulative savings by an additional 1.79 Gt CO_2e in 2030 and by an additional 0.62 Gt CO_2e in 2030 if tax revenue were invested. The cumulative savings across all 32 countries would therefore amount to 2.32 Gt CO_2e by 2025 and 10.42 Gt CO_2e by 2030, which is roughly the amount of the annual emissions coming from 2,000 coal-fired power plants (Table 1, columns 2 and 3).

Table 1. Average percentage of and cumulative GHG emission reductions across 32 countries, per the GSI-IF model 2021

	% national emission reductions as against BAU (2030)				
Average across 32 countries	Simple average	Weighted by GDP	Weighted by emissions	**Cumulative CO_2e by 2025 (Gt)**	**Cumulative CO_2e by 2030 (Gt)**
FFSR: complete removal of subsidies between 2021 and 2025	6.09%	1.72%	2.43%	1.95	5.46
FFS swap: Reallocation of 30% of subsidy savings into energy efficiency (20%) and renewables (10%)	3.16%	1.47%	2.02%	0.37	2.55
Tax: 10% fossil energy tax between 2025 and 2030	1.86%	2.19%	2.07%	-	1.79
Earmarked tax revenue: Allocation of 30% of tax revenue into energy efficiency (20%) and renewables (10%)	0.73%	1.08%	0.98%	-	0.62
Total across all policies (2030)	**11.84%**	**6.46**	**7.5**	**2.32**	**10.42**

Given that most of the added countries for this new modelling exercise were G20 countries, the total number of G20 members covered increased to 14,[11] and the results thus provide an ever more complete picture for this group of major economies and emitters. As shown in Table 2 (column 1), FFSR, an FFS swap, a modest tax, and earmarking tax revenues to investments in energy efficiency and renewable energy would lead to slightly smaller average national emission reductions of 9.47% by 2030 compared to a BAU baseline among the 14 G20 countries. Nevertheless, in absolute terms, these G20 countries contribute the most to emission reductions throughout all countries analyzed. By 2025, their emission reductions represent roughly 62% of all absolute savings from FFSR and 65% by 2030. With regard to all scenarios combined, the 2030 share increases to 76% (Table 2, columns 2 and 3).

Table 2. Average percentage of and cumulative GHG emission reductions across 14 G20 countries, per the GSI-IF model 2021

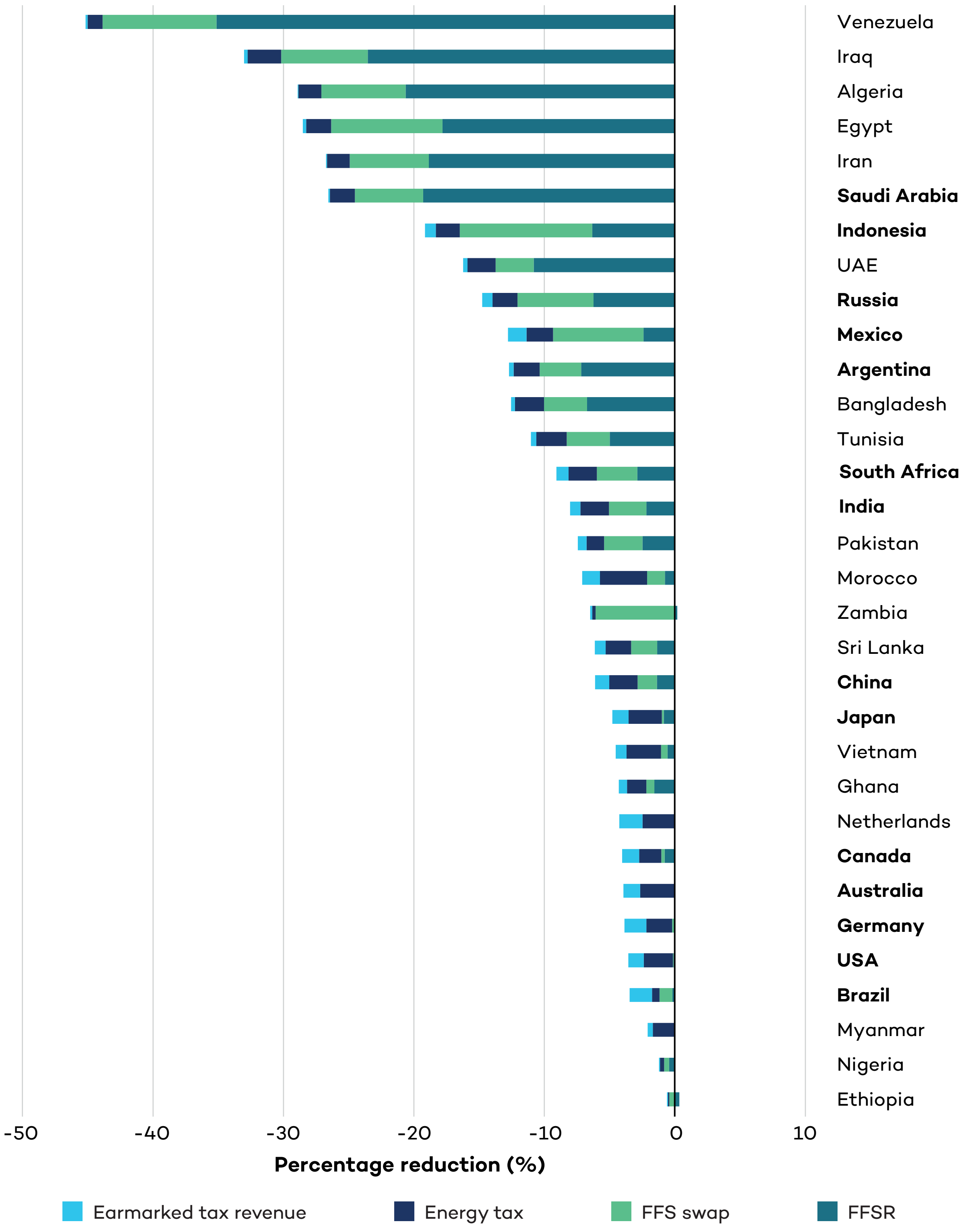
Average across 14 countries	% national emission reductions as against BAU (2030)			Cumulative CO_2e by 2025 (Gt)	Cumulative CO_2e by 2030 (Gt)
	Simple average	Weighted by GDP	Weighted by emissions		
FFSR: complete removal of subsidies between 2021 and 2025	3.55%	1.39%	1.86%	1.21	3.56
FFS swap: Recycling of 30% of subsidy savings into energy efficiency (20%) and renewables (10%)	2.87%	1.38%	1.89%	0.29	2.07
Tax: 10% fossil energy tax between 2025 and 2030	1.99%	2.21%	2.13%	-	1.75
Earmarked tax revenue: Recycling of 30% of tax revenue into energy efficiency (20%) and renewables (10%)	1.05%	1.11%	1.06%	-	0.59
Total across all policies (2030)	**9.46%**	**6.09**	**6.94**	**1.50**	**7.97**

Adding up the emission reductions from all four scenarios individually by country shows which countries experience the largest percentage of emission reductions and absolute emission reductions in 2030, respectively. The countries with the highest percentage of emission reductions are Venezuela, Iraq, Algeria, Egypt, Iran, and Saudi Arabia, which all

[11] The following G20 members are missing: EU, France, Italy, South Korea, Turkey, and the United Kingdom.

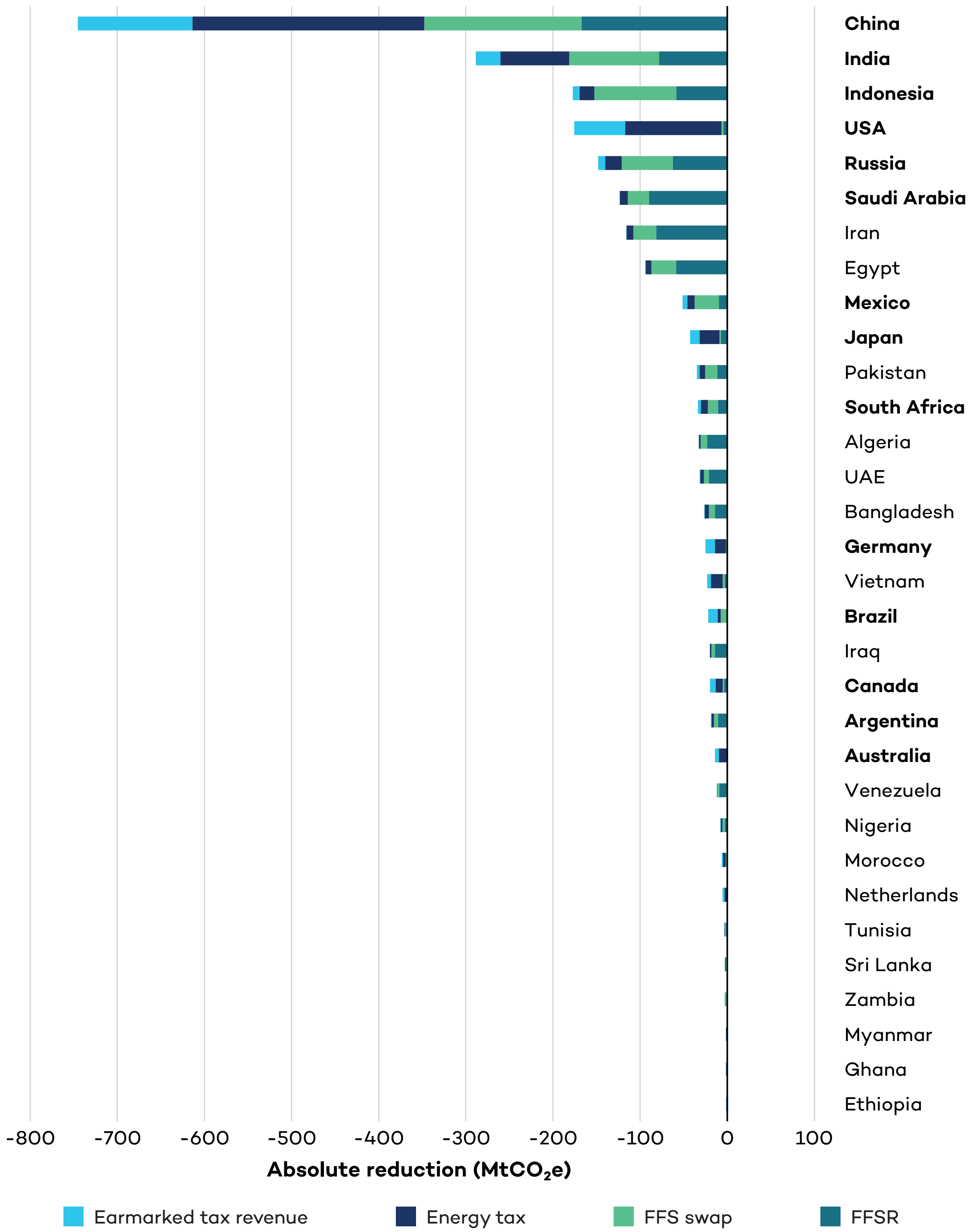
reach more than or close to a 30% reduction (Figure 9). The model shows that, under this scenario, the largest component of emission reductions in these countries is FFSR itself, followed by the FFS swap. In addition, the G20 countries are diversely distributed, with some having a significant percentage of emission reductions (e.g., Saudi Arabia, Indonesia, Russia, Mexico, and Argentina) and others, with most of their emission reductions coming from the energy tax component, having much lower potential (e.g., Japan, Canada, Australia, Germany, and the United States). On the other hand, the countries with the largest absolute reductions in emissions are China, India, Indonesia, the United States, Russia, Saudi Arabia, and Iran, which all achieve more than 100 million tonnes of GHG emission reduction by 2030; China alone achieves more than 700 million tonnes (Figure 10). The model found that, under this scenario and for these countries, for the most part, FFSR is not necessarily the largest contributor to emission reductions; rather, it finds that a subsequent fossil fuel energy tax can lead to larger absolute emission reductions than FFSR.

Figure 9. Percentage of emission reductions in the year 2030 from FFSR, an FFS swap, energy taxation, and earmarked tax revenue by country



Note: G20 countries are in bold.

Figure 10. Absolute emission reductions in the year 2030 from FFSR, an FFS swap, energy taxation, and earmarked tax revenue by country



Note: G20 countries are in bold.

3.5 Fiscal Savings

The subsidies provided by the 32 countries analyzed totalled USD 321.1 billion in 2018. Taking into account forecasted energy consumption and assuming that the subsidy provided per unit of energy consumed remains constant in the future, the cumulative subsidy saving through to 2030 amounts to USD 2.99 trillion for the 32 countries analyzed. Besides, fossil fuel energy tax revenues are forecasted to reach USD 1.72 trillion cumulatively by the year 2030. This leads to a total of USD 4.7 trillion raised via subsidy savings and tax revenue. Of this, 30% (USD 1.41 trillion) would be shifted toward investments in renewables and energy efficiency within the model until 2030. Therefore, FFSR saves government resources while simultaneously reducing emissions, whereas other policy tools to mitigate GHG emissions often usually incur a cost. Specifically, the GSI-IF model estimates that, for every tonne of CO_2e removed through FFSR alone, governments save on average around USD 546.47. When considering the resources reallocated via the subsidy swap, the amount declines to USD 164. This calculation is made by comparing the total cumulative subsidy saving and the cumulative emission reduction by 2030. When all policy options are considered—including FFSR, the energy tax, and the swap for renewable energy and energy efficiency—for every tonne of CO_2e removed, governments save an average of USD 85.6. Finally, when considering the kilograms of CO_2 avoided for each USD of subsidy savings, the inverse of the calculations presented above, governments reduce emissions by between 6 kg and 11.7 kg for every USD saved.

3.6 Comparison with Previous GSI-IF Modelling

There are a number of key differences when the results are compared with those from the previous GSI-IF modelling exercises undertaken in 2015 and 2019. The first is that each new modelling exercise included an additional six countries on top of the countries modelled in the previous versions so that the 2021 update covers 32 countries representing 77% of global CO_2 emissions, 72% of global GDP, and 72% of the global population. The second difference is that the scale of subsidies inputted into the 2015 model was higher than in both 2016 and 2019 due to effective FFS reforms and higher oil prices. Furthermore, the scenarios from 2015 did not include the additional 10% energy taxation, in contrast to the 2019 and 2021 scenarios.

The results indicate average national emission reductions from FFSR across 32 countries of 6.09% by 2030 compared to the BAU baseline. Given the similarities in the model and scale of subsidies, this is almost identical to the 2030 emission reductions from FFSR forecasted by the 2019 modelling exercises across 26 countries (6.0%). Therefore, these new results can be seen to confirm the previous findings. In contrast, the 2015 value of simple average emission reductions across 20 countries forecasted was higher—10.9% by 2020 and 9.85% by 2025—than both the 2019 and 2021 values due to the differences mentioned with regard to the size of the FFSs back then.

Yet, the cumulative emission savings from across all countries is similar to the results from 2015 and 2019. The total emission reductions from FFSR alone, across all 32 countries in 2021, amount to 1.95 Gt CO_2e by 2025 and 5.46 Gt CO_2e by 2030. The results from 2019 amounted to 2.08 Gt CO_2e by 2025 and 4.8 Gt CO2e by 2030 across 26 countries; in 2015, the study forecasted 2.82 Gt CO_2e by 2020 and 6.32 Gt CO_2e by 2025 across 20 countries[12]. The amounts in this case are different for two main reasons: (i) fossil fuel subsidies have declined compared with 2015, but energy consumption has increased, and (ii) the list of countries included in the study has increased, from 26 to 32. Detailed country results with regard to cumulative emission savings for the 2021 study are set out in Annex 3. Table 3 compares these results with the 2019 GSI-IF modelling results.

Table 3. Comparison of 2019 and 2021 GSI-IF modelling results

Current FFS	**2019 GSI-IF modelling** USD 256.7 billion	**2021 GSI-IF modelling** USD 279.1 billion
Emission reductions from FFSR	6.0%	6.09%
Total emission reductions from FFSR by 2025	2.08 Gt of CO_2e	1.95 Gt of CO_2e
Total emission reductions from FFSR by 2030	4.8 Gt of CO_2e	5.46 Gt of CO_2e
Cumulative saving through FFSR until 2030	USD 2.56 trillion	USD 2.99 trillion
Cumulative revenue generation through fossil energy tax	USD 1.94 trillion	1.72 trillion
Revenue recycled in renewable energy and energy efficiency	USD 1.35 trillion	USD 1.41 trillion
Saving per tonne of CO_2e removed through FFSR	USD 93	USD 164

[12] The 2020 values of the 2015 study can be compared with the 2025 values of the 2019 and 2021 studies and the 2025 values of the 2015 study with the 2030 values of the 2019 and 2021 studies.

Box 1. The importance of detailed subsidy data, including producer subsidies

Though we used consistent consumer price support data available from 2018 from the IEA and IMF for consistency, we recognize that these figures are often underestimated and do not capture producer subsidies. Therefore, when we inputted subsidy data collected via a bottom-up inventory approach into the GSI-IF model, we found substantial differences in the level of emission reductions available from subsidy reform. A country example is provided below:

Country X: percentage emission reductions from FFSR alone by 2030:

- IMF pre-tax subsidy data: 0.04% reduction in emissions
- Peer review subsidy data: 1.37% reduction in emissions
- Inventory approach from external researchers: 2.08% reduction in emissions

This highlights that the emission reductions from the GSI-IF modelling undertaken in 2021 (this report) are very likely to be significant underestimates due to the lack of a consistent, detailed set of subsidy estimates at the global scale covering both consumer and producer fossil fuel energy for every country.

4.0 Conclusion

To limit global temperature increases to 1.5°C, we must reduce net human-caused CO_2 emissions by 45% from 2010 levels by 2030 and reach net-zero CO_2 emissions around 2050, according to the Intergovernmental Panel on Climate Change (2018). Estimates from UNEP and others, however, show that the commitments made in current NDCs under the Paris Agreement are highly inadequate for bringing us to this goal and require a more ambitious suite of action. Initially, countries had to submit new NDCs by 2020, but many countries are behind schedule due to the COVID-19 pandemic. So far, only countries that combined represent less than a third of the global GHG emissions have updated their commitments.

Consequently, the countries that have not submitted new NDCs yet will need to do so in 2021 to act on their international obligations. Some countries that have already submitted new NDCs—such as Japan, South Korea, and New Zealand—are planning to reassess their submissions this year and come forward with stronger pledges (Gabbattis, 2021). For achieving the quick GHG emission reductions by 2030 required to stay below 1.5°C, it will be critical that countries respond to this urgency with raised ambition when they submit their new NDCs.

This analysis is intended as an indicator of the potential for FFSR and other measures to contribute to NDC ambitions. The results of the GSI-IF modelling exercise reaffirm findings of past studies that FFSR can contribute to large GHG emission reductions, along with other environmental and health benefits. Notably, our results show that FFSR can achieve emission reductions of about 6% by 2030 across 32 countries modelled compared to the BAU scenario. In addition, FFSR is a policy that does not cost government money but generates fiscal savings. While there are certainly social costs with higher energy prices, these can be addressed by reinvesting recovered funds in socially beneficial priorities, including targeted poverty alleviation programming. These recovered funds can also support a low-carbon transition, including investment in low-carbon technologies like renewable energies and energy efficiency. According to the model, this increases the emission reduction potential of FFSR to 9% while providing positive economic stimuli under the umbrella of a green recovery from the COVID-19 pandemic. Combining FFSR and an FFS swap with a modest fossil energy tax and reinvesting revenues in renewable energies and energy efficiency will increase this reduction to almost 12%. The relative reduction achieved through FFSR is often comparably small in most G20 countries in contrast to other countries analyzed in this study, where FFSR can reduce emissions by over 30%; however, G20 countries account for most of the absolute GHG emission reductions achieved through FFSR (almost 70%) by 2030 across all countries studied.

This analysis was conducted at a high level, and for these sorts of reforms to be undertaken, it would take a more detailed analysis at the individual country levels to get a refined picture of the absolute potential for GHG reduction from FFSR in these countries. FFSR and other measures also have important social implications (including for energy consumers and workers in fossil fuel sectors). Such impacts must be considered and policy developed in an inclusive way, ideally through processes consistent with a just transition (following International Labour Organization guidelines) when FFSR is considered.

Limiting global temperatures to 1.5°C is a massive undertaking that necessitates the simultaneous use of various proven and effective options for absolute emission reductions. So far, however, fewer than 20 countries have made use of FFSR in their NDCs. This modelling details that FFSR is an underutilized but potentially significant tool to achieve GHG emission reductions within a wide range of countries, including some of the largest emitters. Refined over time, this analysis provides new scientific evidence of the contribution that FFSR can make toward global GHG reductions. It reinforces that countries should integrate FFSR as one of many tools into their strategies for reducing GHG emissions and keeping our planet safe and livable.

References

Bridle, R., Sharma, S., Mostafa, M., & Geddes, A. (2019). *Fossil fuel to clean energy subsidy swaps: How to pay for an energy revolution.* International Institute for Sustainable Development. https://www.iisd.org/library/fossil-fuel-clean-energy-subsidy-swap

Climate Action Tracker. (2020). *Global update: Paris Agreement turning point.* https://climateactiontracker.org/publications/global-update-paris-agreement-turning-point/

Climate Action Tracker. (2021, February 25). *CAT Climate Target Update Tracker.* https://climateactiontracker.org/climate-target-update-tracker/

Friends of Fossil Fuel Subsidy Reform (FFFSR). (2015, December). *The Communiqué.* http://fffsr.org/communique/

Friends of Fossil Fuel Subsidy Reform. (2020, December). *Statement on global fossil fuel subsidy reform on the fifth anniversary of the Paris Agreement and FFSR Communiqué.* http://fffsr.org/paris-agreement-ffsr-communique-fifth-anniversary-statement/

Frankfurt School-UNEP Centre & BloombergNEF. (2020). *Global trends in renewable energy investment 2020.* https://www.fs-unep-centre.org/global-trends-in-renewable-energy-investment-2020/

Gabbattis, J. (2021, January 8). *Analysis: Which countries met the UN's 2020 deadline to raise 'climate ambition'?* Carbon Brief. https://www.carbonbrief.org/analysis-which-countries-met-the-uns-2020-deadline-to-raise-climate-ambition

Government of the United Kingdom. (2020, May 28). *New dates agreed for COP26 United Nations Climate Change Conference.* https://www.gov.uk/government/news/new-dates-agreed-for-cop26-united-nations-climate-change-conference

International Energy Agency (IEA). (2020a). *Energy efficiency in 2020.* https://www.iea.org/reports/energy-efficiency-2020/energy-efficiency-in-2019

International Energy Agency. (2020b). *Energy subsidies: Tracking the impact of fossil-fuel subsidies.* https://www.iea.org/topics/energy-subsidies

International Energy Agency. (2020c). *World energy outlook 2020.* https://www.iea.org/reports/world-energy-outlook-2020

International Energy Agency. (2021). *Global energy review: CO2 emissions in 2020. Understanding the impacts of COVID-19 on global CO2 emissions.* https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020

International Institute for Sustainable Development, Institute for Global Environmental Strategies, Oil Change International, Overseas Development Institute, Stockholm Environmental Insititute, & Columbia SIPA. (2020). *Energy Policy Tracker.* https://www.energypolicytracker.org/

International Monetary Fund. (2021a). *Primary commodity price system.* IMF Database. https://data.imf.org/?sk=471DDDF8-D8A7-499A-81BA-5B332C01F8B9

International Monetary Fund. (2021b, January). *World economic outlook update—January 2021: Policy support and vaccines expected to lift activity.* https://www.imf.org/en/Publications/WEO/Issues/2021/01/26/2021-world-economic-outlook-update

Intergovernmental Panel on Climate Change. (2018). *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* https://www.ipcc.ch/sr15/

Merrill, L., Bassi, A. M., Bridle, R., & Christensen, L. T. (2015). *Tackling fossil fuel subsidies and climate change: Levelling the energy playing field.* Norden. http://norden.diva-portal.org/smash/get/diva2:860647/FULLTEXT02.pdf

Merrill, L., Gass, P., Gerasimchuk, I., Garg, V., Viswanathan, B., Bassi, A., & Geddes, A. (2019). *Raising ambition through fossil fuel subsidy reform: Greenhouse gas emissions modelling results from 26 countries.* International Institute for Sustainable Development. https://www.iisd.org/library/raising-ambition-through-fossil-fuel-subsidy-reform

Moerenhout, T., & Urpelainen, J. (2020, May 13). *A sustainable economic recovery from COVID-19: The G-20 must end fossil fuel subsidies now.* https://www.globalpolicyjournal.com/blog/13/05/2020/sustainable-economic-recovery-covid-19-g-20-must-end-fossil-fuel-subsidies-now

Roth, J., & Boelts, S. (2021, March 16). *Are countries walking the talk on cutting carbon?* International Institute for Sustainable Development. https://www.iisd.org/articles/are-countries-walking-talk-cutting-carbon

Sanchez, L., Wooders, P., Mostafa, M., & Bechauf, R. (2020, August 18). *53 ways to reform fossil fuel consumer subsidies and pricing.* International Institute for Sustainable Development. https://www.iisd.org/articles/53-ways-reform-fossil-fuel-consumer-subsidies-and-pricing

Stockholm Environmental Insititute, International Institute for Sustainable Development, Overseas Development Institute, E3G, & United Nations Environment Programme. (2020). *The production gap: Special report 2020. The discrepancy between countries' planned fossil fuel production and global production levels consistent with limiting warming to 1.5°C or 2°C.* http://productiongap.org/2020report/

Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world.* Irwin/ McGraw-Hill.

United Nations Framework Convention on Climate Change (UNFCCC). (2015). *Paris Agreement*. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

United Nations Environment Programme & UNEP DTU Partnership. (2020, December 9). *Emissions gap report 2020.* United Nations Environment Programme. http://www.unenvironment.org/emissions-gap-report-2020

Annex A. GSI-IF Model Results: Total national % emission reductions by country (2030)

Table A1. Percentage of emission reductions in 2030 from fossil fuel subsidy reform (FFSR), fossil fuel subsidy (FFS) swap, energy tax, and earmarked tax revenue, by country

Countries	FFSR	FFS swap	Energy tax	Tax revenue	Total
Venezuela	-35.12%	-8.73%	-1.15%	-0.15%	-45.17%
Iraq	-23.53%	-6.64%	-2.57%	-0.28%	-33.02%
Algeria	-20.63%	-6.47%	-1.75%	-0.07%	-28.91%
Egypt	-17.80%	-8.54%	-1.91%	-0.25%	-28.51%
Iran	-18.85%	-6.06%	-1.74%	-0.09%	-26.74%
Saudi Arabia	-19.29%	-5.23%	-1.92%	-0.11%	-26.55%
Indonesia	-6.33%	-10.14%	-1.85%	-0.83%	-19.15%
United Arab Emirates	-10.80%	-2.94%	-2.14%	-0.35%	-16.23%
Russia	-6.23%	-5.83%	-1.91%	-0.80%	-14.76%
Mexico	-2.39%	-6.93%	-2.04%	-1.42%	-12.79%
Argentina	-7.18%	-3.18%	-1.98%	-0.37%	-12.71%
Bangladesh	-6.73%	-3.29%	-2.24%	-0.29%	-12.55%
Tunisia	-4.99%	-3.30%	-2.32%	-0.42%	-11.02%
South Africa	-2.86%	-3.11%	-2.16%	-0.94%	-9.07%
India	-2.18%	-2.86%	-2.19%	-0.79%	-8.03%
Pakistan	-2.47%	-2.95%	-1.36%	-0.66%	-7.42%
Morocco	-0.75%	-1.35%	-3.63%	-1.36%	-7.10%
Zambia	0.20%	-6.08%	-0.24%	-0.16%	-6.29%
Sri Lanka	-1.34%	-1.99%	-1.96%	-0.83%	-6.12%
China	-1.37%	-1.48%	-2.18%	-1.08%	-6.11%
Japan	-0.83%	-0.17%	-2.55%	-1.24%	-4.79%

Countries	FFSR	FFS swap	Energy tax	Tax revenue	Total
Vietnam	-0.56%	-0.49%	-2.65%	-0.83%	-4.53%
Ghana	-1.56%	-0.62%	-1.48%	-0.64%	-4.29%
The Netherlands	0.00%	0.00%	-2.47%	-1.79%	-4.25%
Canada	-0.77%	-0.26%	-1.70%	-1.30%	-4.03%
Australia	0.00%	-0.01%	-2.65%	-1.28%	-3.94%
Germany	-0.03%	-0.18%	-1.96%	-1.68%	-3.85%
United States	-0.09%	-0.04%	-2.24%	-1.19%	-3.56%
Brazil	-0.17%	-0.99%	-0.57%	-1.72%	-3.46%
Myanmar	0.00%	0.00%	-1.67%	-0.41%	-2.09%
Nigeria	-0.43%	-0.37%	-0.32%	-0.08%	-1.20%
Ethiopia	0.36%	-0.42%	-0.09%	-0.09%	-0.24%
	-6.09%	**-3.15%**	**-1.86%**	**-0.73%**	**-11.84%**

Annex B. GSI-IF Model Results: Total absolute emission reductions by country (2030)

Table B1. Absolute emission reductions in 2030 from fossil fuel subsidy reform (FFSR), fossil fuel subsidy (FFS) swap, energy tax, and earmarked tax revenue, megatonnes of CO_2e by country

Countries	FFSR	FFS swap	Energy tax	Tax revenue	Total
China	-167.35232	-180.25984	-266.025984	-131.492864	-745.131008
India	-78.491392	-102.885888	-78.85056	-28.244736	-288.472576
Indonesia	-58.551616	-93.86688	-17.146688	-7.66272	-177.227904
United States	-4.530176	-2.164736	-110.411264	-58.543104	-175.64928
Russia	-62.533952	-58.554624	-19.170752	-7.998976	-148.258304
Saudi Arabia	-89.920352	-24.377888	-8.962208	-0.52928	-123.789728
Iran	-81.74528	-26.251968	-7.552384	-0.388736	-115.938368
Egypt	-58.89472	-28.259184	-6.332816	-0.835296	-94.322016
Mexico	-9.638176	-27.932416	-8.221632	-5.708576	-51.5008
Japan	-7.410944	-1.492352	-22.80544	-11.111616	-42.820352
Pakistan	-11.55376	-13.801408	-6.366528	-3.0712	-34.792896
South Africa	-10.665088	-11.603296	-8.038944	-3.5	-33.807328
Algeria	-23.227048	-7.284448	-1.970848	-0.078576	-32.56092
United Arab Emirates	-21.04392	-5.728432	-4.166864	-0.68416	-31.623376
Bangladesh	-14.19832	-6.942448	-4.717712	-0.617232	-26.475712
Germany	-0.176	-1.203392	-12.8576	-10.993088	-25.23008
Vietnam	-2.85872	-2.4936	-13.478944	-4.211072	-23.042336
Brazil	-1.104128	-6.311744	-3.646656	-10.897664	-21.960192
Iraq	-14.276284	-4.031932	-1.55862	-0.168468	-20.035304
Canada	-3.798784	-1.295712	-8.345952	-6.377344	-19.817792
Argentina	-10.656192	-4.715888	-2.938448	-0.543416	-18.853944

Countries	FFSR	FFS swap	Energy tax	Tax revenue	Total
Australia	-0.001952	-0.019648	-9.474464	-4.59472	-14.090784
Venezuela	-9.357896	-2.32702	-0.307336	-0.040852	-12.033104
Nigeria	-2.954496	-2.531264	-2.153216	-0.53728	-8.176256
Morocco	-0.666088	-1.198912	-3.21316	-1.20428	-6.28244
The Netherlands	0	0	-3.272312	-2.372744	-5.645056
Tunisia	-1.53421	-1.01337	-0.71318	-0.127732	-3.388492
Sri Lanka	-0.663712	-0.98712	-0.968684	-0.412768	-3.032284
Zambia	0.077904	-2.423956	-0.097392	-0.065644	-2.509088
Myanmar	0	0	-1.423872	-0.35224	-1.776112
Ghana	-0.615964	-0.243288	-0.586236	-0.252964	-1.698452
Ethiopia	0.773952	-0.90432	-0.18504	-0.19392	-0.509328
	-747.569634	**-623.106974**	**-635.961736**	**-303.813268**	**-2,310.451612**

Annex C. GSI-IF Model Results: Cumulative absolute emission reductions by country (2025, 2030)

Table C1. Cumulative absolute emission reductions by 2025 and 2030 from fossil fuel subsidy reform (FFSR), by country

Countries	2025 FFSR (tonne)	2030 FFSR (tonne)
China	315,635,712	1,074,568,192
Saudi Arabia	261,554,432	690,734,912
Iran	271,075,680	677,022,272
India	171,002,880	520,677,632
Russia	198,527,488	508,877,952
Egypt	144,863,392	411,338,288
Indonesia	130,703,488	396,622,848
Algeria	76,122,392	190,784,248
United Arab Emirates	60,263,360	161,642,592
Iraq	46,755,636	117,387,480
Venezuela	54,497,834	106,348,954
Bangladesh	28,455,368	90,241,144
Argentina	35,966,496	89,275,312
Pakistan	30,813,120	83,385,248
South Africa	21,856,032	72,438,176
Mexico	20,109,248	65,272,224
Japan	24,400,000	62,254,848
United States	14,685,696	37,387,776
Canada	12,261,376	31,190,368
Nigeria	9,513,728	23,923,584
Vietnam	4,597,312	16,976,896
Brazil	5,880,640	11,617,216
Tunisia	3,166,892	10,313,008

Countries	2025 FFSR (tonne)	2030 FFSR (tonne)
Morocco	1,864,688	4,992,320
Sri Lanka	1,600,080	4,655,064
Ghana	1,562,926	4,395,770
Germany	664,256	1,564,288
Zambia	1,004,576	711,048
Australia	5,984	15,552
Myanmar	0	0
The Netherlands	0	0
Ethiopia	- 327,056	- 3,521,088
Total	**1,949,083,656**	**5,463,094,124**

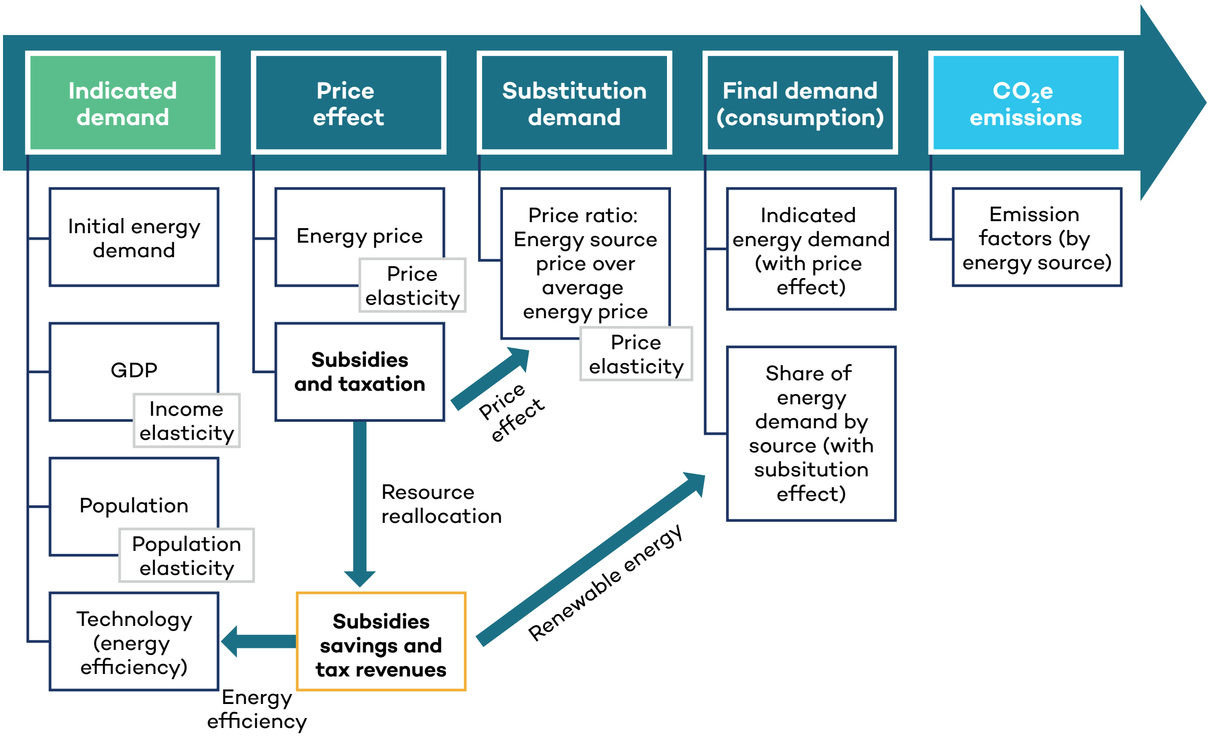
Annex D. GSI-IF Model Methodology

The GSI-IF model is a causal-descriptive partial equilibrium model that uses semi-continuous simulations to forecast energy demand and corresponding greenhouse gas (GHG) emissions. The model is built using the system dynamics methodology (Sterman, 2000). GSI-IF was first created in 2015 (Merrill, et al., 2015) and was updated to capture subsidy removal and modest energy taxation for the 2019 study (Merrill et al., 2019). The aim is to encourage the countries modelled in this research to consider the emission reduction co-benefits that fossil fuel subsidy reform (FFSR) and taxation could afford within forthcoming Nationally Determined Contributions.

The GSI-IF model estimates energy consumption from 1990 to 2040 using differential equations calculated with an annual time step. Historical data (based on International Energy Agency [IEA] World Energy Balance data) are used to parametrize the model in 1990 and to validate model results from 1990 to 2017. Future scenarios forecast energy demand until 2040 using various assumptions, including FFSR. The model forecasts energy consumption by sector (residential, commercial, industrial, and transport) and source (oil, natural gas, coal, biomass and waste, and electricity) using elasticities associated with GDP, population, energy price changes, and energy efficiency (for which various scenarios can also be tested). GDP growth is based on the IMF *World Economic Outlook*, and population is based on the UN World Population Prospects database (medium variant). The price of energy is based on data from the IMF (regional coal and natural gas prices), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (national gasoline and diesel prices), and national databases (electricity prices). The effects of subsidies and taxation are manifest through energy prices. Fossil fuel subsidy data used within the model were drawn from both the IEA and the IMF (pre-tax) for 2019 and 2017 (data available at the time of modelling) across coal, electricity, gas, and oil. Subsidy reform or increased energy taxation that leads to higher prices for a particular source can cause a drop in domestic consumption due to a price response and the substitution of other, comparatively cheaper fuels for consumption. Emission factors are applied to determine total national emissions from the use of energy. As a result, GHG emissions are affected by both the drop in demand and the change to the fuel mix. Demand and fuel mix are also influenced by other policy interventions, namely the reallocation of subsidy savings and tax revenues to investments in energy-efficiency improvements (assumed to be 20% of subsidy savings and additional revenues) and in renewable energy equipment (assumed to be 10% of subsidy savings and additional revenues).

A graphical representation of the process for the GSI-IF model is shown in Figure D1.

Figure D1. GSI-IF model sketch, highlighting the main steps considered for estimating carbon dioxide equivalent (CO_2e) emission reductions resulting from FFSR



In summary, the model performs these key functions across each of the 32 countries reviewed:

- Estimates the impact of the phased removal of fossil fuel subsidies on GHG (CO_2e) emissions starting immediately and with complete removal by 2025.
- Quantifies the impact on emission reductions from the introduction of a subsequent modest energy tax (applied to fuels and electricity) equivalent to 10% of the price of the energy.
- Calculates the fiscal savings from subsidy removal and increased taxation during the period.
- Explores the impacts on GHG emission reductions from the reallocation of 30% of subsidy savings and subsequent tax revenues to other programs—in this case, toward the promotion of energy efficiency and renewable energy.

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