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POLICY BRIEF

# COVID-19 RECOVERY: HOW THE G20 CAN ACCELERATE SUSTAINABLE ENERGY TRANSITIONS IN THE POWER SECTOR BY SUPPORTING THE PRIVATE SECTOR

Task Force 2

**CLIMATE CHANGE AND ENVIRONMENT**


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موجز السياسة

# التعافي من جائحة فيروس كورونا المستجد (كوفيد-١٩): كيف يمكن لمجموعة العشرين تسريع وتيرة التحول نحو الطاقة المستدامة في قطاع الطاقة من خلال دعم القطاع الخاص؟

فريق العمل الثاني

**تغير المناخ والبيئة**

المؤلفون

**تانزيد علم، ماري لومي، يونغ جون بايك، تيموثي سي كوبورن، ألكسندر جارد موراي، نيلا سري هندريتي، شول جو كيم، تشارلز إف كوتشر، جيفري لوجان، روبرت تي مكغراث، وليام تور**

# ABSTRACT

COVID-19 has dramatically changed the socioeconomic context for clean energy transitions worldwide. Fiscal rescue and recovery measures that unaligned with a green, resilient, and just recovery will miss the historic opportunity to realign global economic and energy trajectories with the goals of the Paris Agreement. Given its potential to accelerate sustainable energy transitions and deliver jobs, the private sector should be placed at the heart of targeted post-COVID-19 economic recovery policies. This policy brief outlines recommendations for achieving sustainable energy transitions in the power sector across G20 economies by focusing on how governments can support the private sector to deliver economic growth, jobs, and climate action. The proposed measures involve (1) coordinating on sustainable recovery measures in the G20, (2) expanding renewable energy generation, (3) accurately reflecting environmental externalities and ensuring just transitions in the fossil-fuel sector, and (4) promoting efficient electricity consumption and faster electrification.

تسببت جائحة فيروس كورونا المستجد في تغيرات هائلة على الوضع الاجتماعي والاقتصادي للتحول نحو الطاقة النظيفة على مستوى العالم. تدابير التعافي والإنقاذ المالي، التي لا تتوافق مع التعافي، الذي يراعي البيئة والمرونة والعدالة،ستهدر الفرصة التاريخية لإعادة مواءمة مسارات الاقتصاد والطاقة العالمية مع أهداف اتفاق باريس. وبالنظر إلى قدرات القطاع الخاص على تسريع وتيرة التحول نحو الطاقة المستدامة وتوفير وظائف؛ لا بد من وضعه في صميم سياسات التعافي الاقتصادي المستهدفة لمرحلة ما بعد جائحة فيروس كورونا المستجد.

يعرض ملخص السياسة هذا توصيات لتحقيق التحول نحو الطاقة المستدامة في قطاع الطاقة على مستوى اقتصاديات مجموعة العشرين، من خلال التركيز على كيفية دعم الحكومات للقطاع الخاص لتحقيق النمو الاقتصادي وتوفير وظائف واتخاذ إجراءات تتعلق بالمناخ. وتتضمن الإجراءات المقترحة: (١) التنسيق بشأن تدابير التعافي في مجموعة العشرين. (٢) توسيع نطاق توليد الطاقة المتجددة. (٣) إظهار الآثار البيئية الخارجية بدقة وضمان التحولات العادلة في قطاع الوقود الأحفوري. (٤) تعزيز كفاءة استهلاك الكهرباء والسرعة في التزويد بالكهرباء.

# KEY RECOMMENDATIONS

**1. Coordinate the response**

- Establish a G20-Engagement Group joint taskforce on Post-COVID-19 Sustainable Energy Transitions to focus on delivering coordinated responses to energy transition policy and action-oriented recovery initiatives.

- Mandate the taskforce to develop "Best Practices for Sustainable Power Sector Transitions Post-COVID-19" by early 2021.

**2. Grow the green**

- Facilitate financing for clean energy infrastructure to support clean energy capacity expansions.

- Promote flexible, transparent methods to procure new, renewable electricity generation.

**3. Transition the brown**

- Harmonize and mandate climate-related disclosures from large corporations that are major electricity producers or consumers.

- Accelerate fossil fuel subsidy reforms and implement carbon pricing arrangements that consider economic and policy contexts.

- Develop "green transition assistance" mechanisms for incumbent industries and workers.

**4. Transform the rest**

- Incubate zero-energy community and urban energy developments.

- Fund additional research, pilot projects, and collaborations to overcome barriers to flexible demand response options.

- Regulate the disclosure of lifecycle cost performance for all components of the built environment.

- Accelerate the electrification of transport, including through building infrastructure.

# CHALLENGE

The coronavirus disease of 2019 (COVID-19) has dramatically changed the socioeconomic context for clean energy transitions worldwide. With the global economy heading to a recession and possibly a financial crash, strengthening health systems, minimizing job losses, preventing supply chain breakdowns, and managing return of business to the "new normal" are immediate priorities for governments.

Simultaneously, government actions and pledges remain insufficient to meet the goals of the Paris Agreement. How electricity is produced and consumed remains key for creating new jobs, growing the economy, and addressing climate change (The Global Commission on the Economy and Climate 2018; IRENA 2019a).[1] Fiscal recovery policies supporting the current fossil-fuel-intensive economic system can jeopardize greenhouse gas (GHG) emission reductions at sufficient scale and speed. The climate change agenda is also threatened by the risk of major fiscal deficits due to COVID-19 mitigation measures and foreign capital outflows. Furthermore, electrification of transport could be significantly slowed by low oil prices, which are expected to persist for the coming years (World Bank 2020). Government support to the private sector is needed more than ever to create new jobs and facilitate sustainable economic recoveries.

Since March 2020, there have been growing calls for "green," "just," and "better" recovery and "building back better" by governments, businesses, international organizations, and the civil society.[2] Most incorporate policies from the post-Great Recession (2009) "green growth" agenda and many emphasize social inclusiveness and resilience. However, G20 countries have not yet aligned their financial flows with this rhetoric: in April 2020, only 4% of the US$7.3 trillion earmarked for fiscal rescue measures could be categorized as "green" (Hepburn et al. 2020). This mismatch should be addressed urgently.

1. IRENA estimates that renewable energy generation and end-use electrification could deliver 75% of the required energy-related carbon dioxide reductions. This would require the share of renewable energy in global electricity generation to rise from 25% to 86% by 2050, while global power demand would double. The required energy transition could also benefit the economy: doubling global renewable energy capacity could deliver US$1.2-4.2 trillion in annual savings globally through 2030, primarily from reduced pollution-related costs, and the removal of fossil fuel subsides could generate an additional US$2.8 trillion in government revenues in 2030. These savings can be further invested in green growth and recovery measures.
2. Some examples include South Korea's Green New Deal; the European Alliance for a Green Recovery; EU Ministers' letter on the European Green Deal from April 2020; the Petersberg Climate Dialogue 2020 green recovery commitment; United Nations press release on April 22, 2020; IMF chief's statement on a green recovery on April 30, 2020; Principles for a Just Recovery from 350.org; and other sources cited in this brief.

The opportunities for green recovery policies to accelerate sustainable energy transitions are historically unique and significant. Governments should focus on measures that build on existing policies and have significant potential for positive economic and climate change impacts. These include clean energy and transport infrastructure investments and energy efficiency retrofits in buildings. Job creation should be emphasized, and financial bailouts should be conditioned on climate-related measures and metrics (Hepburn et al. 2020). Green recovery measures should utilize structural opportunities, including low oil prices, improved economics of renewable energy technologies, shifting investor sentiment, and disrupted energy end-use patterns. Finally, they should draw lessons from the "first wave" of green growth policies (Engel et al. 2020; Mathai, de Oliveira, and Dale 2018; OECD 2013, 2020).[3]

Given the potential of the private sector to accelerate sustainable energy transitions and deliver jobs, it should be placed at the heart of targeted post-COVID-19 economic recovery policies. This policy brief focuses on how governments can support the private sector in delivering economic growth, jobs, and climate action. It outlines recommendations in four areas for achieving sustainable energy transitions in the power sector across G20 economies through green recovery policies.

3. These lessons include the following: (i) as short-term costs can hinder implementation, a long-term view should be maintained and environmental externalities should be considered in cost calculations; (ii) overcoming resistance to reforms, particularly in the use of pricing instruments, and compensating incumbents cost-effectively can present significant challenges; (iii) whole-of-government approaches and policy coherence increase green policies' effectiveness; (iv) non-energy sectors, such as food, water, and nature conservation, should not be neglected; and (v) ex-post policy evaluation mechanisms should be incorporated into all green stimulus measures.

# PROPOSAL

### 1. Coordinate the response

Facilitating a green and Paris Agreement-compliant economic recovery requires concerted global cooperation and commitment from all G20 countries. Coordination among G20 countries will be vital for sending market signals to the private sector and ensuring the poorest and most vulnerable receive the most support. A concerted approach to energy and climate change policies would also help minimize carbon leakage and concerns over economic competitiveness. G20 Engagement Groups, including businesses and cities, must also participate, as they are crucial for financial flows and subnational decision-making (Andrews-Speed and Shi 2015) (see Box 1).

**Box 1. G20 Work to Leverage Private Sector Potential for Sustainable Energy Transitions**

Previous joint G20 documents on energy transitions recognized governments' role in supporting the private sector in innovation and investments by promoting enabling environments and sending market signals. The private sector (through the Business 20 [B20]), cities (Urban 20 [U20]), civil society (Civil Society [C20]), and academia (Think 20 [T20]) repeatedly urged governments to accelerate transitions to a low-carbon future through decisive policies and incentives. These include fossil-fuel subsidy reform, carbon pricing, and international climate risk disclosure.

Further engagement is needed to: fully leverage Engagement Groups' knowledge and experience; promote increased transparency and accountability; resolve conflicting interests; identify implementation barriers and enablers; and increase policy ownership among all G20 governments and key national and transnational stakeholders. (See e.g. G20 Argentina 2018; G20 Germany 2017; G20 Japan 2019a, 2019b.)

1.1. Establish a G20-Engagement Group joint taskforce on Post-COVID-19 Sustainable Energy Transitions focusing on delivering coordinated responses to energy transition policy and action-oriented recovery initiatives.

This multi-year, multi-stakeholder taskforce would:

- Set an integrated vision and objectives that help governments develop holistic and impactful solutions to accelerate the global sustainable energy transition;
- Align its outcomes with the priorities of economic recovery, job creation, and the 2030 Agenda for Sustainable Development, including the Paris Agreement;
- Comprise representatives from all G20 governments and Engagement Groups;
- Mandate key Engagement Groups to jointly work on policy recommendations for specific energy transition-related challenges; and
- Meet twice a year to discuss, consider, and endorse the recommendations.

1.2. Mandate the taskforce to develop "Best Practices for Sustainable Power Sector Transitions Post-COVID-19" by early 2021. This should be among the G20's first short-term deliverables. We present suggested elements for this framework in the following subsections.

## 2. Grow the green

Raising the share of renewable energy in global electricity generation from one-fourth to 86% by 2050 would both help address climate change and create an estimated 42 million new jobs (IRENA 2020). Therefore, fostering the growth of new renewable energy capacity must be a priority task for G20 governments (Energy Transitions Commission 2020). Across the "COVID-19 crisis management spectrum," from short-term support to stimulus measures and recovery assistance, G20 governments can design policies that help the private sector accelerate the implementation of renewable energy. Beyond utilities, a large variety of private sector companies can also generate clean electricity and, as electricity users, support greening of the power mix. In particular, we recommend the following:

2.1 Facilitate financing for clean energy infrastructure to support clean energy capacity expansions

In the near term, availability of financing for new clean energy infrastructure could be constrained. COVID-19 countermeasures require budget reallocations, which could cause significant budget deficits in developing countries where the majority of new power capacity will be built. Thus, G20 governments can consider the following:

### 2.1.1 Ease credit guarantees for companies impacted by COVID-19-related disruptions

During the pandemic, renewable energy companies, especially small and medium-sized enterprises (SMEs), could face stricter financing conditions from banks and increased pressures on cash flows, impacting their survival. G20 governments could urge financial sectors to ease the obtaining of credit and increase credit guarantee scheme ratios for renewable energy developers (Taghizadeh-Hesary and Yoshino 2019).[4] Whenever private banks cannot act, government-owned banks should consider offering direct loans to renewable energy companies, especially SMEs.

### 2.1.2 Attract more private-sector financing by implementing an incremental spillover tax revenue

G20 governments can develop instruments that leverage more private financing to accelerate expansion of the sustainable energy infrastructure. One such instrument is spillover tax revenue, which generates returns for infrastructure operators through increases in tax revenue from positive spillover impacts of clean infrastructure projects in surrounding regions. This instrument would be appropriate for COVID-19 economic recovery, as tax revenues will need to rise again (see Appendix).

## 2.2. Promote flexible, transparent methods to procure new, renewable electricity generation

There are four actionable, replicable, and scalable measures for expanding renewable electricity generation:

4. Credit guarantees can support private bank loans to SMEs and renewable energy companies. However, private banks tend to bring risky loans to be supported by credit guarantees, creating a "moral hazard" problem, which could lead the credit guarantee system to accumulate large deficits. Two risk mitigation policies can be introduced: differentiated credit guarantee ratios and differentiated credit guarantee fees. If banks bring very risky SME loans to credit guarantee corporations that turn into default losses, the credit guarantee ratio should be lowered. That is, the credit guarantee ratio can be differentiated by lower and higher default losses. Another strategy is charging higher credit guarantee fees to banks with high default losses.

### 2.2.1 Corporate purchasing of renewables

Frameworks that enable corporate purchasing include tracking and certification systems for renewable energy attributes to certify ownership, clear grid interconnection and permitting rules, open access transmission policies, and utility green tariffs (Bird et al. 2017). More than 100 corporations in 2019 purchased nearly 20 GW of renewable energy across 23 countries, accounting for over 10% of the world's total renewable capacity that year (BloombergNEF 2020; RE100 2020; Smith 2020; UNEP 2019).[5]

### 2.2.2 Requests for proposals (RFPs)

By implementing RFPs, governments introduce greater competition and price discovery into the market. Regulators are advised to ensure bidders meet transparency requirements. Traditional utilities such as Xcel Energy in the US offered RFPs for new generation in 2018. That year saw average combined bids of US$21/MWh and US$36/MWh for wind and storage and solar and storage, respectively (Deign 2018).

### 2.2.3 Auctions

Best practices that enable competitive auctions include auction demand, qualification requirement, sellers' liabilities, and winner selection processes (IRENA 2015). Many G20 countries have used reverse auctions (similar to RFPs but more sophisticated and centralized) to finance new renewable supply at record low prices. Over 100 GW of wind and solar energy was auctioned globally in 2017–2018, with average 2018 onshore wind and solar prices of approximately US$50/MWh (IRENA 2019b). These prices have continued declining.

5. Some large corporations have set ambitious goals that are not always reflected in national policies. To date, more than 500 businesses have set net-zero emissions goals and more than 180 aim to reach 100% renewable/clean electricity. However, only two G20 members (France and the UK) have passed legislation for net-zero emissions, with the EU, Germany, and Italy also beginning this process. Leading global brands such as IKEA, Bank of America, and Coca-Cola all aim for 100% renewable energy by 2020. Microsoft recently committed to becoming carbon negative by 2030 and removing its historical carbon emissions by 2050. Through co-designing national policies with private sector pioneers, governments can lift barriers for these businesses and encourage others to follow.

### 2.2.4 New business models

Regulatory measures that enable new business models for utilities and other generators (especially on the distribution side) can help unleash clean generation, new jobs, and economic growth. Moreover, utilities may embrace more rooftop solar and other distributed energy resources if they are not threatened by lost revenues (Bandyk 2020). Peer-to-peer energy trading could catalyze the growth of entrepreneurial and revenue-sharing business models if regulatory frameworks are designed to be flexible and accommodating (Energy Matters n.d.).

## 3. Transition the brown

The economic slowdown resulting from the pandemic has demonstrated the significant impact the global economy has on climate change, air quality and environmental issues. In April 2020, with global oil demand down by 29 million barrels per day compared with 2019, the International Energy Agency (IEA 2020) projected an 8% fall in energy-related CO2 emissions in 2020. While designing stimulus packages, G20 governments will inevitably face requests from energy companies, car manufacturers, shipping and aviation companies, and other major users of fossil fuels to support them with economic packages to protect jobs and see them through the current difficulties. These “bailouts” must come with strict conditions that safeguard the climate and accelerate the sustainable energy transition. Accordingly, the following recommendations are made to ensure that these “brown” sectors can be ”greened” as part of the planned stimulus packages for large power producers and consumers:

### 3.1. Harmonize and mandate climate-related disclosures from large corporations that are major electricity producers or consumers

The G20 was instrumental in establishing the Task Force on Climate-Related Financial Disclosures (TCFD), which encourages and sets guidelines for major financial institutions and other sectors’ disclosure of transition and physical risks faced by their assets from climate change.[6] The G20’s Sustainable Finance Working Group (SFWG) is suitable to continue this work. It should also lead efforts to streamline climate-

6. As of February 2020, 1,027 corporations supported TCFD, representing a market capitalization of over US$12 trillion.

related disclosures to strengthen existing efforts and momentum on the disclosure of environmental, social, and governance (ESG) risks among businesses.[7]

### 3.2. Accelerate fossil fuel subsidy reforms and implement carbon pricing

Reforming subsidies during economic crises carries enormous political risks for governments. However, the current low oil price environment provides a window of opportunity to lower support without increasing the burden for low- and moderate-income citizens.

#### 3.2.1 Consumer and producer subsidies

Subsidies are major barriers to greater uptake of energy efficiency and renewable energy, on which G20 nations have negotiated for three decades with only modest progress. Now is the time to reform consumer and producer subsidies.

#### 3.2.2 Existing fossil power plants

These are often encouraged to continue operating beyond their lifetimes through subsidies and other institutional measures. In the UK and elsewhere, many coal plants have been retired recently due to carbon taxes and falling costs for competitive generators (Castagneto Gissey et al. 2019). Globally, governments should enhance calls for fossil-fuel subsidy removal during the current low-price period and encourage pricing of externalities in power markets for countries open to those options. Some jurisdictions are successfully using securitization to overcome stranded asset challenges for stakeholders that choose to retire plants early (Trabish 2019; Varadarajan, Posner, and Fisher 2018).

7. The following are some examples: (1) The Sustainable Stock Exchanges Initiative helps stock exchanges collaborate with investors, companies (issuers), regulators, policymakers, and relevant international organizations to enhance performance on ESG and encourage sustainable investment. As of April 2020, it included 101 stock exchanges, with 52,916 listed companies representing over US$88 trillion of domestic market capitalization. (2) In 2015, France passed a law mandating large corporations to disclose climate risks. (3) In 2019, the Government of Abu Dhabi created guidelines for voluntary disclosure on ESG factors by bodies listed on the Abu Dhabi Securities Exchange.

### 3.2.3 Keep focusing on carbon pricing

This can be done by incorporating shadow prices into energy planning processes or using real environmental externalities, which can help accelerate the energy transition post COVID-19 (Energy Transitions Commission 2020). China is set to enact an emissions trading scheme soon, joining the EU, South Korea, and other G20 jurisdictions in using a real price on carbon to overcome some of the distortions of subsidies.

## 3.3. Develop "green transition assistance" mechanisms for incumbent industries and workers

Rapidly shifting to renewable energy threatens to strand power producers and their suppliers' existing fossil fuel-dependent assets (Gros et al. 2016). Political resistance by these incumbents, however, could slow the transition.[8] COVID-19 recovery provides a unique opportunity to realign interests in favor of decarbonization. Unconditional assistance to the power sector would risk carbon "lock-ins" (Erickson et al. 2015; Seto et al. 2016). However, making support conditional on decarbonization[9] could promote recovery while accelerating renewables' deployment.

This green transition assistance should follow three principles. First, all aid should be conditional on concrete progress toward decarbonization, at rates consistent with the Paris Agreement's goals. Second, aid should be limited to offsetting decarbonization costs, not providing windfall profits. Third, to enable just transitions (Newell and Mulvaney 2013) and inclusive recoveries (G20 Saudi Arabia 2020), aid should target both workers and firms (see Box 2).

8. Incumbent firms have resisted energy transitions in many G20 countries, such as through direct lobbying against renewables (Lauber and Jacobsson 2016, Stokes and Breetz 2018), constraining technical discourse (Geels 2014; Stirling 2014), blocking challenger entry (Stenzel and Frenzel 2008), and threatening exit (Kungl 2015). See also Arent et al. 2017; Downie 2017; Markard 2018.
9. Decarbonization requires moving to net-zero GHG emissions on an ambitious timeline. Lower-emitting options may be part of the transition alongside non-emitting ones, but compensation should only be provided for real reductions in net atmospheric emissions aligned with the Paris Agreement goals.

**Box 2. De-Risking Decarbonization through Future-Shifting of Costs**

The market capitalization of the 40 largest privately held utilities is approximately US$1.1 trillion, and that of fossil-fuel producers is around US$5 trillion. A 2°C warming scenario is estimated to cost US$69 trillion by 2100. If aid buys decarbonization, long-term benefits would significantly outweigh short-term costs.

Because future generations generally accrue the benefits, governments can justifiably forward-shift costs of transition aid. This requires setting low discount rates to avoid unnecessarily penalizing the future. One option includes making credit guarantees available to incumbents but leaving them unbacked so future taxpayers cover losses should they occur. Other options include securitizing transition costs and charging future ratepayers or making existing subsidies conditional on decarbonization. Nevertheless, aid to incumbents must include assistance to displaced workers, such as income support, re-training, or early retirement. (See: Bullard and Müller 2012; Coady et al. 2019; Flaherty, Nillesen, and Coughlin 2019; Hoegh-Guldberg et al. 2018; International Labour Organization 2015.)

We recommend that the G20 mandate the Post-COVID-19 Sustainable Energy Transitions taskforce to recommend specific mechanisms to ensure any aid to incumbents promotes decarbonization.

### 4. Transform the rest

On the demand side, governments should adopt holistic approaches to encouraging efficient energy systems and greater uptake of electrified end-use devices such as electric vehicles (EVs), heat pumps, and induction cook stoves. Furthermore, they can increase the stringency of energy efficiency standards and regulations in end-use vehicles, appliances, and buildings, as these both enhance action by the private sector and reduce emissions (Clean Energy Ministerial n.d.).

Energy efficiency measures are considered the most effective sources of new job creation in many economies, especially in the residential and commercial buildings sector. They are estimated to have the potential to generate 21 million new jobs by 2050 while supporting economic growth (IRENA 2020). Retrofits are particularly attractive for economic recovery: commercial and government buildings that are vacant during

the pandemic provide unique opportunities for energy efficiency and electrification retrofits. This experience, in conjunction with government financial incentives, can also be applied to residential buildings (Energy Transitions Commission 2020). Promotion of green buildings and infrastructure can enable a phased approach to lower energy bills, employ citizens, and reduce emissions.

The Sustainable Energy Transitions taskforce could share lessons and develop best practices on the following:

### 4.1 Incubate zero-energy community and urban energy developments

Systems-level, integrated communities benefit from economies of scale and can generate multiple sustainable energy recovery-related benefits. These communities slash lifecycle costs in the buildout and operation of energy, water, and transportation infrastructure systems. Several jurisdictions are already experimenting with highly efficient infrastructures: China is home to half of the world's estimated 1,000 "smart cities" (Silverstein 2020). In the US, the Peña Station NEXT in Colorado is a smart "neighborhood" using cutting-edge planning to integrate housing, transport, renewable energy, and efficiency in a systems-wide approach under a unique partnership model (Peña Station NEXT 2020). Thus, G20 governments should fund the development of design tools, design guides, and training for integrated zero-energy communities.

### 4.2. Fund additional research, pilot projects, and collaboration to overcome barriers to flexible demand response options

Clean technology R&D can have significant climate action and economic multiplier effects (Hepburn et al. 2020). Flexible demand response approaches, including partnerships to deploy smart meters, time of use rates, and distributed energy storage, for example, can maximize clean energy adoption and efficiency (Khanna et al. 2020; World Economic Forum 2017).

### 4.3. Regulate disclosure of lifecycle cost performance for all components of the built environment

Such disclosures can overcome market failures associated with lack of consumer information. In Australia, the extra expense of more stringent building codes is offset by lifecycle cost reductions in heating and cooling for residential homeowners (Morrisey and Horne 2011). In the US, some jurisdictions are experimenting with home energy scores that transparently inform consumers about full heating and cooling costs (US Department of Energy 2017).

### 4.4. Accelerate electrification of transport, including through building infrastructure

An April 2020 survey of G20 financial leaders ranked clean energy infrastructure investments as the recovery policy with the highest positive climate and economic multiplier impacts (Hepburn et al. 2020). Governments could benefit from working closely with utilities and other private sector actors on planning, financing, building, and operating charging stations for EVs. G20 governments should mandate all major vehicle manufacturers, as part of any COVID-19 economic relief packages, to accelerate deployment of EVs (and hydrogen vehicles). Simultaneously, governments should make it economically attractive for end-users to purchase these vehicles by providing incentives such as tax relief, purchase grants, free charging, parking, registration fees, and interest free loans. The G20 could champion these efforts by publicizing the lessons learned from various experiences. Similar experiences in promoting high-efficiency heat pumps and other electrified end-use technologies could also be shared (see Appendix).

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**Disclaimer**

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# APPENDIX

**1. Spillover tax revenue**

Spillover tax revenues consist of generating returns from an increase in tax revenue caused by the positive impacts of infrastructure projects on their surrounding regions. Introduction of new sources of clean electricity supply can enable the construction of new residential areas and attract new businesses into the region. Similarly, it may increase property prices and returns from property taxes, corporate income taxes, sales taxes, and individual income taxes through the growth in business, job opportunities, and overall regional economy.

Currently, many countries consider electricity as a necessary good and therefore maintain its price at low levels. Electricity operators rely on user charges as main sources of revenue, which may be insufficient to cover operation and maintenance costs. Spillover tax revenues from the provision of electricity are collected by the government and not returned to infrastructure operating companies.

The difference-in-differences method (Yoshino and Abidhadjaev 2017) enables calculation of the tax revenue induced by each infrastructure investment. Although sophisticated econometric methods might be impractical, generally, the increase in tax revenue from the water and electricity supply is compared with tax revenues with no new utility supply. If, for example, 50% of tax revenue is shared between the government and infrastructure operators, the latter can receive user charges plus the spillover tax revenue from water and electricity supply. Furthermore, spillover tax revenues can be allocated to infrastructure operators for repair and maintenance.

**2. Strategies to accelerate electrification of transport**

The COVID-19 pandemic has generated uncertainties for clean transformations in transport and personal mobility. Some of these relate to changing consumer preferences; for example, urban residents may prefer personal vehicles to public or mass transportation, leading to higher GHG emissions. Transport remains heavily reliant on fossil fuels, accounting for approximately 14% of global GHG emissions (IPCC 2014). Policy interventions by G20 governments are therefore urgently needed to avoid reversals of past progress and speed up the electrification of transport. Success will require collaboration with stakeholders at all levels, including vehicle manufacturers and electric utility companies.

G20 countries have proposed and implemented various emission-reduction initiatives to improve fuel economy, reduce energy consumption, limit distance travelled, and improve passenger and cargo efficiency. Their collective impact, however, has yet to overcome the rapid increases associated with the transportation demands of global demographic trends.

Full electrification of personal and commercial vehicle fleets represents the best available transformative measure to reduce emissions at the necessary scale and speed. Achieving this requires a combination of policy interventions and technological innovations. Several countries and regions are already pursuing policies and regulatory strategies to more rapidly electrify various transportation modes (IEA 2019). These include purchase price incentives and preferential tax structures encouraging uptake in both personal and commercial market sectors. However, barriers persist because of personal preferences and perceptions, price, driving distance (range), and charging time requirements (Yong and Park 2017).

Among technological challenges, battery life is the most significant. Although new generation battery technologies are on the near horizon with production likely to expand in near-term, additional funding for battery research and manufacturing is needed now. Additionally, more rapid proliferation of EVs will require advanced charging systems for home and commercial use as well as charging infrastructure at a density and availability level similar to that for gasoline and diesel (Seattle Office of Sustainability and Environment 2014). With more EVs, there will be greater demand on existing electricity grids, requiring enhanced grid use and accessibility to and from the vehicles (National Research Council 2013).

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