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A Climate for Change

Embracing the Transition towards Energy-Efficient, Climate and Resource-Friendly, Competitive Economies

B20 TASKFORCE

ENERGY, CLIMATE AND RESOURCE EFFICIENCY

POLICY PAPER 2017



Table of Contents

Foreword by the Taskforce Chair Kurt Bock

A successful transition towards a sustainable world economy – enabled by an innovation-friendly and predictable global framework.

To address climate change, action must be taken. The Paris Agreement lays out the essential goals, and all stakeholders must now live up to their commitments. We need to change how we produce and consume energy in all parts of our societies. At the same time, we need to ensure competitiveness, economic growth and jobs, thus enabling businesses to use their innovative power to protect the climate and enable the transition towards a sustainable world economy. A global robust price mechanism for CO_2, increased investments in climate-friendly technologies and innovations, a sustainable energy infrastructure, and improved energy efficiency are key elements to achieve these goals. As climate and energy policies are becoming more interconnected, we welcome the initiative of the German G20 presidency to establish the G20 Sustainability Working Group that brings together both climate and energy working streams. The B20 has set up a dedicated Taskforce for energy, climate and resource efficiency, with 97 members representing over 80 businesses from more than 20 countries and diverse economic sectors.

Optimized, resource-efficient industrial production significantly contributes to global sustainable development and provides economic benefits by reducing costs, which are a key factor for competitiveness. The G20 needs to prioritize resource efficiency and life-cycle based thinking and initiate an exchange of best practices to unlock the full potential on a global scale.

The B20 is embracing the drive towards greater energy and resource efficiency as a business opportunity. We are committed to accelerating and shaping this development. To unleash necessary technological solutions around the world, the G20 governments need to provide an unambiguous long-term direction and certainty by defining consistent and predictable framework conditions. This will foster market-oriented and cost-effective approaches to reduce CO_2 emissions while encouraging healthy competition among technologies. In this way, we can ensure that the best solutions will be found to address climate change and help create a sustainable world economy.

Sincerely,

Dr. Kurt Bock

Chairman of the B20 Energy, Climate and Resource Efficiency Taskforce

CEO, BASF

Recommendations

Recommendation 1: Curtail Climate Change – The G20 should curtail climate change by implementing the Paris Agreement and developing consistent and robust carbon pricing.

Policy Action 1.1: Implement the Paris Agreement – The G20 governments should support the UNFCCC in developing an effective Paris rule book with close business participation, submit NDC with high and comparable ambition levels, and develop transparent national long-term low GHG emission development strategies.

Policy Action 1.2: Drive Carbon Pricing – The G20 should establish an intergovernmental G20 Carbon Pricing Platform as a forum for strategic dialogue to create a basis for global GHG emissions pricing mechanisms, and to phase out inefficient fossil fuel subsidies, using its revenues to finance an energy transition that benefits everyone.

Recommendation 2: Foster the Global Energy Transition – The G20 should accelerate the market readiness and deployment of low-carbon technologies through effective and predictable energy policies, a joint innovation agenda, and strengthened Energy Access Action Plans.

Policy Action 2.1: Develop Effective and Predictable Energy Policies – The G20 should promote effective and predictable policies for accelerated investments into low-carbon technologies by broadening the technology scope of the G20 Voluntary Action Plan for Renewable Energy and developing an energy policy toolkit.

Policy Action 2.2: Accelerate Energy Innovation – The G20 should develop a G20 Energy Innovation Action Plan to accelerate the market readiness of innovative technologies, business models, and digital solutions that can contribute to large GHG emissions reductions within the next decades.

Policy Action 2.3: Enhance Energy Access – The G20 should strengthen the G20 Energy Access Action Plans by supporting the development of national, urban and rural action plans, and by mobilizing private sector participation in sustainable infrastructure development.

Recommendation 3: Advance Resource and Energy Efficiency – The G20 should advance resource and energy efficiency by establishing a Resource Efficiency Platform and translating the Voluntary Energy Efficiency Investment Principles into a policy toolkit.

Policy Action 3.1: Improve Resource Efficiency – The G20 should establish an intergovernmental G20 Resource Efficiency Platform as a forum for international collaboration with the goal of reducing the resource intensity of the world economy.

Policy Action 3.2: Accelerate Energy Efficiency – The G20 should accelerate the efforts within the G20 Energy Efficiency Leading Programme by translating the Voluntary Energy Efficiency Investment Principles into a policy toolkit.

Introduction

Economic growth has lifted billions of people out of poverty and is indispensable in fulfilling the 2030 Agenda and its Sustainable Development Goals (SDGs). At the same time, economic growth and a growing world population are increasing the stress on ecosystems and natural resources that are already scarce today, such as agricultural land, terrestrial and marine wildlife, water, and minerals. The effects of climate change have made action inevitable. Meeting the future demand for reliable, affordable, and sustainable energy will require significant and timely investment in resource-efficient and climate-friendly infrastructure. Accelerating innovation is transforming most industry sectors and is offering opportunities and solutions to master the transition towards a sustainable world economy.

In 2015, with the SDGs and the Paris Agreement, the governments committed themselves to taking decisive action towards sustainable development and against global warming. The agreed climate target is to limit the global temperature increase to below 2°C compared to pre-industrial levels, and pursue efforts to reach 1.5°C. To achieve this, the Parties agreed to aim for a peaking of global greenhouse gas (GHG) emissions as soon as possible and reach net-zero emissions in the second half of the century.

The emerging global energy and climate policy and market frameworks for the implementation of the Paris Agreement, such as international carbon pricing mechanisms, constitute important future business factors. Both the SDGs and the Paris Agreement have upgraded at the G20 level the relatively young discussions on energy and environmental issues and laid the foundation for further exchange on resource efficiency.

About two thirds of global anthropogenic GHG emissions originate from the use of fossil fuels for the use of energy.[1] The transformation of the energy sector is therefore the centerpiece of global climate mitigation efforts. Reaching the climate targets requires an accelerated deployment of low-carbon and energy efficient technologies in all sectors and across the entire energy system.

To provide the necessary business solutions, companies need a predictable and stable climate and energy policy framework that is market-oriented, cost-effective, and strengthens competition among technologies. Efforts to mitigate and adapt to climate change create opportunities for the private sector. Digital innovation research and development (R&D) and the development of new products and services can increase the resilience of the energy system along the whole supply chain. The Paris Agreement can be used as the basis for capitalizing on low-carbon development as one of the big economic opportunities as well as to create jobs and secure the competiveness of businesses, if established on a global level.[2]

A continued focus needs to be placed on energy-poor and fast-growing countries, mostly located in sub-Saharan Africa and Southeast Asia. The way the energy infrastructure is set up in the coming decades will determine their GHG emission levels for the rest of the century.[3] Existing G20 efforts need to be further strengthened by more concrete action plans at different levels and mobilizing the private sector. As modern energy is a vital catalyst for social and economic development and growth, universal access to clean and affordable energy greatly contributes to the SDGs.

The 2030 Agenda also highlights the importance of using resources more efficiently. Of 17 SDGs, 12

[1] IEA, *IEA Key CO2 Emission Trends* (Paris: IEA, 2016), accessed November 18, 2016, https://www.iea.org/publications/freepublications/publication/KeyCO2EmissionsTrends.pdf.
$GtCO_2e$ = billion metric tons of carbon dioxide equivalent; in 2014, global GHG emissions amounted to about 50 $GtCO_2e$, of which CO_2 emissions for the use of energy accounted for $32GtCO_2e$. The other GHG emissions originated from agriculture, industrial processes, and other purpose (such as biomass burning and decay). About 7% were fugitive emissions from the energy sector, which correlate with the use of fossil fuels.
[2] See B20 Financing Growth and Infrastructure Policy Paper (Policy Action 1.3: Fostering Green Finance).
[3] IEA, *World Energy Outlook, Energy Access Projections*, accessed November 18, 2016, http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessprojections/.

refer to the sustainable management of global resources.[4] Natural resources, especially raw materials, are key production factors and are therefore at the heart of human prosperity. In many industry sectors, raw material costs represent more than 50 percent of total costs. Therefore, for many companies, resource- and cost-efficient production structures are essential factors in maintaining international competitiveness.

If the current trends continue, the extraction of natural materials is expected to double by 2050.[5] To avoid unsustainable environmental degradation and economic losses from price increases, price fluctuations, and increasing scarcity of raw materials, the efforts to improve resource efficiency have to be accelerated. Businesses have already developed innovative solutions towards more resource-efficient and life cycle-oriented production processes. It is therefore a good time for the G20 to put resource efficiency and life-cycle-based economy thinking on its agenda, discuss its potential, and initiate formats for best practice exchanges.

The Energy, Climate and Resource Efficiency (ECRE) Taskforce of B20 Germany is convinced that a future-oriented, sustainable, and competitive world economy can only be successful if businesses keep on finding innovative solutions for curtailing climate change, fostering the energy transition, and decreasing the resource intensity of the world economy. The work of the ECRE Taskforce partly builds on that of previous B20 work regarding investment in sustainable energy and new technologies, energy governance frameworks, energy efficiency, and energy access.[6] But B20 Germany is also placing new topics on the G20 agenda, such as the issue of resource efficiency and the life-cycle-based economy.

Climate and energy policies are cross-cutting topics that are closely connected to existing core topics of the G20, such as finance, growth, and development. While business commends the G20 efforts in the areas of energy efficiency, renewables, and partly also with regard to energy access, the G20 has not yet come up with predictable market-based policies on climate change.[7] As a main forum for international economic cooperation, the G20 should take the lead in maintaining the momentum of the Paris Agreement and support the international bodies that are responsible for its implementation. The G20 can furthermore support efficient GHG emissions reductions on a global level playing field by driving predictable international carbon pricing mechanisms and by phasing out inefficient fossil fuel subsidies. These recommendations thus remain at the forefront of business demands vis-à-vis the G20.

The G20 countries possess the necessary capacities to drive the transition towards a future-oriented, sustainable world economy and should take the lead in developing policies that leverage the potential of business to innovate and invest. By cooperating with international and regional organizations and (standard-setting) bodies, the G20 can make its messages and decisions heard and implemented also in non-G20 countries.

[4] UNEP, *Resource Efficiency: Potential and Economic Implications* (Nairobi: United Nations Environment Programme, 2016), 12.
[5] UNEP, *Resource Efficiency*, 33, op.cit.
[6] B20 Turkey, *B20 Energy Forum Statement* (Istanbul: B20, 2015), accessed November 1, 2016, http://www.g20.utoronto.ca/b20/B20-Energy-Forum-Statement-121015-final1.pdf.; B20 China, B20 Infrastructure Taskforce Policy Paper (Beijing: B20, 2016), accessed November 1, 2016, http://upload.b20-china.org/upload/file/20160810/1470798976425048023.pdf.
[7] ICC, *ICC G20 Business Scorecard, Sixth Edition* (Paris: ICC, 2016), 67-78, accessed January 6, 2016, http://www.iccwbo.org/global-influence/g20/reports-and-products/icc-g20-scorecard/.

Recommendation 1: Curtail Climate Change

The G20 should curtail climate change by implementing the Paris Agreement and developing consistent and robust carbon pricing.

Policy Actions	
1.1	**Implement the Paris Agreement –** The G20 governments should support the UNFCCC in developing an effective Paris rule book with close business participation, submit NDCs with high and comparable ambition levels, and develop transparent national long-term low GHG emission development strategies. • The G20 governments should support the UNFCCC in developing effective MRV standards that ensure transparent NDC setting and stocktaking and enable carbon pricing mechanisms as well as transparent tracking and reporting of climate finance and the verification of the results achieved. • The NDCs of the G20 governments should aim to deliver on the agreed 2°C target and outline in a transparent way how the G20 governments intend to use voluntary cooperation and market-based instruments under the Paris Agreement. • The G20 governments should back up their NDCs with national long-term low GHG emission development strategies, supported by technology needs assessments and transparent GHG abatement cost calculations and methodologies. The G20 governments should make use of the 2050 Pathways Platform and the NDC Partnership for knowledge exchange and capacity building in these fields.
Owner G20 governments[8]	**Timing** 2018: Paris rule book including MRV standards 2019: NDC pledges, GHG reduction strategies
1.2	**Drive Carbon Pricing –** The G20 should establish an intergovernmental G20 Carbon Pricing Platform as a forum for strategic dialogue to create a basis for global GHG emissions pricing mechanisms and to phase out inefficient fossil fuel subsidies, using its revenues to finance an energy transition that benefits everyone. • The G20 should use the G20 Carbon Pricing Platform to coordinate the support for the UNFCCC work on Article 6 of the Paris Agreement, with the aim of establishing operational rules and modalities for international carbon pricing mechanisms by 2019. • Within this platform, the G20 should coordinate the phase out of inefficient fossil fuel subsidies by agreeing on a time line and commissioning an international organization with rationalizing subsidy data, monitoring, and progress reporting. • The G20 should use this platform to share best practices for the use of revenues from carbon pricing and for the redirection of fossil fuel subsidies. As such, they should address the risk of carbon leakage and aim to ensure an energy transition that benefits everyone.
Owner G20[9]	**Timing** 2017-2018: G20 Carbon Pricing Platform

[8] Ownership by G20 governments: differentiated action by individual governments in their own right.
[9] Ownership by G20: Collective action via the G20 process (such as elaborating principles, action plans, or toolkits).

Context

With the 2030 Agenda and the Paris Agreement[10], the global community has strengthened its commitment to combat climate change. In the last 150 years, increasing anthropogenic GHG emissions have led to atmospheric concentrations in carbon dioxide (CO_2), methane (CH_4), and nitrous dioxide (NO_2) that are unprecedented at least for the last 800,000 years. Their effects are considered to be extremely likely the dominant cause of the observed global warming since the mid-20th century.[11] The impacts of climate change range from extreme weather events to draught, desertification, melting glaciers, and to rising sea levels.

Based on the global warming analysis and the politically agreed limit of below 2°C, the IPCC has developed a so-called carbon budget approach. This approach determines the amount of GHGs that can still be emitted into the atmosphere in order to prevent pervasive and irreversible impacts for people and ecosystems. The derived emission reduction pathways imply that global GHG emissions need to peak early in the 2020s and decrease by more than half by 2050 compared to today's level. By 2100, about net-zero GHG emissions are needed.[12]

A successful transition towards GHG neutrality requires that businesses continue accelerating innovations and investments in sustainable technologies and infrastructure. As many of these investments can have economic lifetimes of several decades, businesses need to be provided with unambiguous, consistent, and predictable policies and market frameworks.

In this respect, the endorsement of the Paris Agreement by the G20 at the 2016 G20 summit in China was a good step forward. In the next years, continued commitment of the G20 governments to the Paris Agreement is needed in order to retain business confidence. Going forward, the G20 should address three prominent shortcomings.

First, the 2016 G20 communiqué encourages the G20 members to join the Paris Agreement, but does not address how the G20 can collectively and individually contribute to an effective implementation. Furthermore, the current GHG reduction strategies and ambitions of the G20 members do not back up the climate ambitions of the Paris Agreement.

Second, while carbon pricing is being addressed as an essential factor for efficient and cost-effective GHG reductions by different international organizations and institutions (such as the World Bank, the OECD, G7, and others), it is neither mentioned in the G20 Energy Principles nor addressed by a dedicated G20 action plan, ministerial statement, or supporting document.

Third, since 2009, the G20 has been stating its commitment to phase out inefficient fossil fuel subsidies over the "medium term". In addition to ongoing voluntary peer reviews, setting the time frame and the scope of such a reform represents a key opportunity for the G20 members to demonstrate their commitment to the Paris climate ambitions.

[10] SDG 13 of the Agenda 2030 links to the Paris Agreement.
[11] NOAA, *Climate at a Glance: Global Time Series*, accessed February 6, 2017, https://www.ncdc.noaa.gov/cag/time-series/global/globe/land_ocean/12/12/1880-2016. For instance, eight years of the last decade have been amongst the warmest ten years since the start of temperature recording in the 19th century, and each one of the last three decades has been the warmest since then.
[12] IPCC, *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, (Geneva: IPCC, 2014), 78-82.

Policy Action 1.1: Implement the Paris Agreement

The G20 governments should support the UNFCCC in developing an effective Paris rule book with close business participation, submit NDCs with high and comparable ambition levels, and develop transparent national long-term low GHG emission development strategies.

The Paris Agreement lays out goals and the commitment of the Parties to reduce their GHG emissions through their Nationally Determined Contributions (NDCs). Yet the ability to deliver on the set targets depends on commonly agreed rules, guidelines, and processes for governing the Agreement. At COP22 in Marrakech, the Parties agreed to finalize and adopt the operational aspects of the Paris Agreement (the "Paris rule book") at the latest at the COP24 in 2018.

First, each G20 government should support the UNFCCC in elaborating a Paris rule book with effective rules for NDC-development, assessment of adaptation methods, transparent reporting and stocktaking of GHG emissions, and accounting of public and private climate finance. The G20 members should particularly support the UNFCCC in developing effective monitoring, reporting, and verification standards (MRV), with the following goals:

- Develop accounting guidance to track progress towards the NDCs, guided by agreed upon principles: The integrity and transparency of the MRV systems will be essential for enabling stocktaking of countries' emission levels and effective GHG sinks, ensuring comparability of the NDC ambition levels, and measuring of the progress made towards mitigation actions.
- Create the indispensable base for international carbon pricing mechanisms: To encourage investments by business and reduce risks it is vital that future emission reduction projects deriving from Article 6 of the Paris Agreement are supported by strong and robust MRV systems that cover the mitigation of emissions as well as removals by sinks of GHG. Such frameworks are also essential to demonstrate net emission reductions, safeguard environmental integrity, and prevent double counting. Without clear MRV systems, parties, businesses and other stakeholders may be hesitant to engage in emission reduction projects derived from the Paris Agreement.[13]
- Enable transparent tracking and reporting of climate finance provided by donor countries, receipt of support by developing countries, and measurement and verification of the results achieved: The MRV standards should determine the specific information countries should report, as well as specify by when this information should be delivered and how it will be reviewed.

The B20 invites the G20 governments to support the UNFCCC in developing appropriate MRV standards by 2018, so that they can be applied starting with the implementation of the Paris Agreement in 2020. It will be important to link MRV for the mechanisms of Article 6 of the Paris Agreement to the Transparency Framework that is being developed under Article 13. Throughout this process, the G20 should use business knowledge and experience (see Exhibit 1).

[13] ICC, *Business View on Market Mechanisms - Article 6 (1) – (7) of the Paris Agreement* (Paris: ICC, 2016), 2, accessed February 28, 2017, https://www.xing-events.com/eventResources/6/J/ZBWYa8BAm6YIEs/ICC_Business_views_on_market_mechanisms_2016.pdf.

Exhibit 1 | Emissions Accounting and Reporting Guidelines from the Chemical Industry

Chemical companies have found that corporate action on climate change provides an opportunity for businesses to address energy use, identify efficiency gains, develop new products, and find new market opportunities. Therefore, a global stakeholder process led by the World Resource Institute (WRI) and the World Business Council of Sustainable Development (WBCSD) has developed sector guidelines for accounting and reporting value chain GHG emissions for chemical companies. The guidelines follow six principles: relevance, completeness, consistency, transparency, accuracy, and feasibility. They are based on life cycle assessment (LCA) methodologies to assess the environmental impact of products and technologies over their complete life cycle, including production, use and end-of-life handling. The consistent measurement and reporting of LCAs increases the credibility and comparability of the results, leading to better decision-making by stakeholders along the value chain. As such, they are critical for assessing – and ultimately improving – sustainability.

Source: WBCSD, *Addressing the Avoided Emissions Challenge* (Conches-Geneva, Switzerland: WBCSD, 2013), 8-15.

Second, until the start of the implementation phase in 2020, the G20 governments should submit NDCs with high and comparable ambition levels, aiming to deliver to the agreed 2°C target. Current NDCs are likely not sufficient to deliver on the climate ambitions. Climate Action Tracker analysis suggests that the fulfillment of the existing NDCs will result in global GHG emissions of 53–56 $GtCO_2e$ in 2030, which is 15–18 $GtCO_2e$ higher than the median value of the 2°C pathway of 38 $GtCO_2e$.[14] As foreseen by the Paris Agreement, the NDCs should reflect the highest possible ambition of the Parties, reflecting their common but differentiated responsibilities and respective capabilities, in light of different national circumstances. The G20 governments should also outline in a transparent way how they intend to increase their ambitions using voluntary cooperation and market-based instruments under Article 6 of the Paris Agreement.[15]

Third, the G20 governments should develop national long-term low GHG emission development strategies (LEDs) by 2020. This is in line with Article 4.19 of the Paris Agreement, which states that all Parties should strive to formulate and communicate LEDs by that year.

Currently, few countries have such strategies in place. B20 encourages all G20 members to elaborate their long-term GHG reduction strategies, which should back up their submitted NDCs with technology deployment roadmaps. These strategies should be supported by technology needs assessments (TNA) as well as by transparent GHG abatement cost calculations and methodologies. This work should help to identify the effectiveness and feasibility of specific policies and increase trust in government abatement policy decisions by promoting fiscal discipline and economic accountability. The G20 members could also use the 2050 Pathways Platform to foster knowledge exchange and capacity building in this field.[16] In addition, the G20 governments could make use of the NDC Partnership for ensuring that developing countries receive the support they need to implement their NDCs and for facilitating enhanced and targeted financial support, for instance by aligning development finance more strongly and coherently with NDC implementation.[17]

[14] Climate Action Tracker, *Emissions Gaps,* accessed November 15, 2016, http://climateactiontracker.org/global/173/CAT-Emissions-Gaps.html. The data reflects the broader scientific literature on the energy system transformation, incorporating IPCC AR5 reports and UNEP emissions gap studies. The 2°C pathway represents a chance greater than 66% of staying below 2°C global warming in 2100 compared to pre-industrial levels. 38 $GtCO_2e$ represents the 2030 median between the 10th (45 $GtCO_2e$) and 90th (28 $GtCO_2e$) percentile range. The emissions range of 53–56 $GTCO_2e$ results from uncertainties in the pledge projections.
[15] ICC, *Business View on Market Mechanisms - Article 6 (1) – (7) of the Paris Agreement* (Paris: ICC, 2016), 3, op. cit.
[16] Besides the COP22 negotiations in Marrakech, the 2050 Carbon Market Platform was launched to facilitate long-term low GHG emissions development strategies. 22 countries, among them 10 G20 members, are participating.
[17] NDC Partnership, *About NDC Partnership*, accessed February 22, 2017, http://www.ndcpartnership.org.

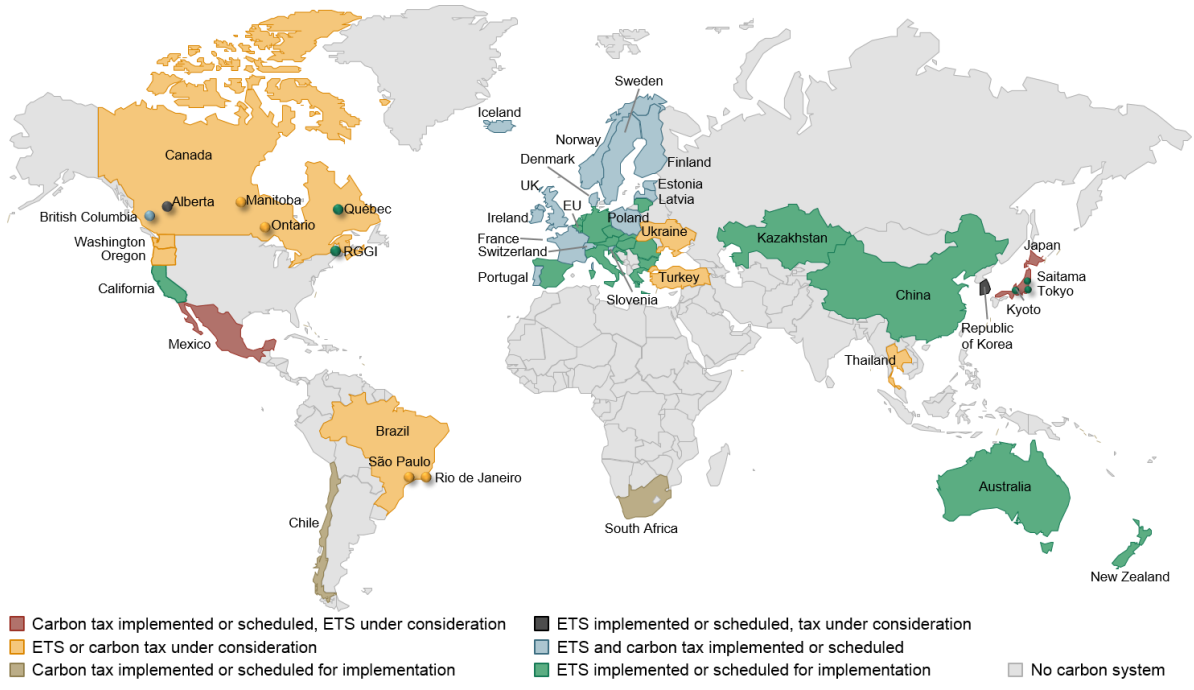
Policy Action 1.2: Drive Carbon Pricing

The G20 should establish an intergovernmental G20 Carbon Pricing Platform as a forum for strategic dialogue to create a basis for global GHG emissions pricing mechanisms and to phase out inefficient fossil fuel subsidies, using its revenues to finance an energy transition that benefits all.

There are two types of carbon pricing[18]: explicit (such as emissions trading systems [ETS] and carbon taxes) and implicit (such as feed-in tariffs, petroleum taxes, and industry action plans). The best policy mix depends on different national circumstances, such as the structure of the industry and of the energy system.

Explicit carbon pricing is spreading (see Exhibit 2). In 2016, about 40 national jurisdictions and over 20 cities, states, and regions, including 7 out of the world's 10 largest economies, put an explicit price on carbon, by means of either ETS, carbon taxes, or a combination of both. After the start of the new nationwide ETS in China in 2017, the emissions covered by explicit carbon pricing amount to about 20 to 25 percent of global GHG, or around 13 $GtCO_2e$.[19]

Exhibit 2 | Fragmented Carbon Pricing Development with Diverse Mechanisms



Source: World Bank, Ecofys and Vivid Economics, *State and Trends of Carbon Pricing*, (Washington DC: World Bank Group, 2016), 25.

[18] In this paper, the term carbon pricing refers to the pricing of anthropogenic GHG emissions, not only to CO_2.
[19] World Bank, Ecofys and Vivid Economics, *State and Trends of Carbon Pricing* (2016), 22–26., op. cit.

New business opportunities can arise when carbon pricing leads to efficiency investments in industry and private households – or indeed other areas of the economy. Many businesses also understand that carbon risk management is a business imperative. In 2016, 1,249 companies put an internal price on their carbon emissions in order to reallocate capital towards areas of business that will see a higher return in a low-carbon economy. This represents a 23 percent increase from 2015.[20]

Article 6 of the Paris Agreement provides the opportunity for countries to cooperate on a voluntary basis when implementing NDCs. Market-based cooperative action would permit parties and businesses to identify and enable emissions reductions where the costs are lowest.[21] For instance, an analysis by the World Bank suggests that international carbon markets will lead to annual cost savings of $115 billion in 2030 and $3,940 billion in 2050, compared to regional carbon markets. These figures are based on (pre-Paris) INDCs.[22] Some major challenges need to be overcome to enable international carbon pricing mechanisms:

- The development of national and regional carbon pricing initiatives is taking place in a fragmented manner with little international coordination. This raises concerns regarding carbon leakage, a situation in which productions and the associated emissions shift to jurisdictions with less stringent carbon pricing policies.[23] The absence of adequate carbon leakage protection would thus affect the competitiveness of energy-intensive sectors facing high international competition. This in turn would likely lead to reduced participation in international carbon pricing mechanisms.
- Currently, some carbon markets are struggling with market uncertainties regarding transparency, environmental integrity, and legal stability. Therefore, in these markets the carbon price does not fulfill its purpose, which is to reduce emissions and to trigger appropriate investments.
- Furthermore, fossil fuel subsidies represent countervailing policies to carbon pricing, as they act as a negative carbon price. They make it cheaper to undertake activities that increase emissions, and encourage lock-in of carbon-intensive infrastructure. Although the setup of carbon pricing mechanisms does not have to wait until fossil fuel subsidies are phased out, the removal of fossil fuel subsidies would increase the effectiveness of the carbon pricing signal.

To address these challenges, the B20 calls on the G20 to establish an intergovernmental G20 Carbon Pricing Platform as a forum for strategic dialogue. To leverage the competences of existing networks, the G20 Carbon Pricing Platform should also engage with the business community and with the Carbon Pricing Leadership Coalition, and the Carbon Pricing Corridors initiatives. This platform should facilitate alignment, support, and action along three main areas:

- First, the G20 should use the platform to create a basis for global carbon pricing mechanisms. Under the UNFCCC work stream, the G20 governments should aim to establish operational rules and modalities for international carbon pricing mechanisms before the start of the implementation phase of the Paris Agreement in 2020. To ensure large international participation, these rules should address the issue of carbon leakage (see Exhibit 3). They should provide national policy-makers with the necessary transparency to decide on their degree of participa-

[20] Bartlett, Nicolette, Hannah Cushing and Sara Law, *Embedding a Carbon Price into Business Strategy* (CDP, 2016), 8, accessed February 23, 2017, https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/001/132/original/CDP_Carbon_Price_report_2016.pdf?1474453251.
[21] World Bank, Ecofys and Vivid Economics, *State and Trends of Carbon Pricing* (2016), 83–86, op. cit. Without international carbon markets, the World Bank assumed the cost of meeting INDC at $354 billion (0.25 percent of global GDP) in 2030 and $7,243 billion (3.1% of global GDP) in 2050.
[22] World Bank, Ecofys and Vivid Economics, *State and Trends of Carbon Pricing* (2016), 80, op.cit.
[23] PMR, *Carbon Leakage – Theory, Evidence and Policy Design* (Washington: International Bank for Reconstruction and Development, World Bank, 2015), 10–13; ICC, *Carbon Pricing Principles* (Paris: ICC, 2016), 3, accessed March 10, 2017, https://cdn.iccwbo.org/content/uploads/sites/3/2015/05/Carbon-Pricing-Principles.pdf.

tion in the carbon pricing mechanisms, taking their concerns about competitiveness, preferences, technical possibilities, and circumstances into account. The G20 governments should use the platform to share good practices on explicit and implicit carbon pricing policy options and to explore possibilities for bi- or multilateral collaborations that might converge into larger international carbon pricing systems over time. The Carbon Pricing Platform could also channel the input of the G20 governments to the Paris rule book concerning the development of a clear and robust transparent MRV framework.

- Second, within the Carbon Pricing Platform the G20 should coordinate the rationalization and phase out of inefficient subsidies and other forms of support for exploration, production, and consumption of fossil fuels. The G20 governments should agree on a timeline for the phase-out of fossil fuel subsidies and report progress on an annual basis. For this scope, the G20 governments should commission an international organization (such as the IMF, OECD, or the IEA) with collecting fossil fuel subsidy data, analyzing the efficiency of the subsidy (such as on employment, income distribution, and energy security), and monitoring and progress reporting.
- Third, the G20 should use the platform to share best practices for the use of revenues from carbon pricing and the redistribution of the savings from fossil fuel subsidy reforms. Possible options are financing climate change mitigation and adaptation measures, scaling up R&D support for climate-friendly technologies, or providing compensation for trade-exposed energy-intensive sectors. The G20 should also discuss options of how to ensure a just transition, aiming to protect the poor from high energy prices and to manage the workforce transition that might be induced by the energy transition.[24] The steering of the G20 Carbon Pricing Platform could be done by rotating co-chairs, for instance by three co-chairs from the country of the previous, present, and upcoming G20 presidencies.

Exhibit 3 | Reducing GHG Emissions in the Aluminum Industry

The International Aluminum Institute (IAI)[1] and the Aluminum Stewardship Initiative[2] play key roles in the promotion of low-carbon standards for the world aluminum industry. Internationally accepted common standards for "climate-friendly" aluminum will ensure its sustainable production and consumption globally.

Russia accounts for 6 percent of the world production of aluminum.[3] The Russian aluminum industry is a key driving force in Russian companies' joint efforts towards introducing national and international carbon pricing as a stimulus for the encouragement of technological modernization. For this scope, internal carbon pricing is used as an instrument to manage the Russian aluminum sector carbon footprint.

The major aluminum producers are exposed to global competition and operate in different national jurisdictions. Achieving substantial GHG emissions reductions in this industry will require the harmonization of international carbon regulations in order to address concerns about competitiveness related to carbon leakage.

Sources: 1. International Aluminum Institute, *Bauxite Residue Management: Best Practice* (IAI, 2016), 2, accessed February 23, 2017, http://www.world-aluminium.org/media/filer_public/2015/07/28/bauxite_residue_management_-_best_practice.pdf; 2. Aluminum Stewardship Institute, *About ASI*, accessed February 23, 2017, https://aluminium-stewardship.org/about-asi/; 3. US Geological Survey Home Page, *Aluminum - Statistics and Information*, accessed February 23, 2017, https://minerals.usgs.gov/minerals/pubs/commodity/aluminum/mcs-2016-alumi.pdf.

[24] See Policy Paper of B20 Financing Growth and Infrastructure Taskforce.

Recommendation 2: Foster the Global Energy Transition

The G20 should accelerate the market readiness and deployment of low-carbon technologies through effective and predictable energy policies, a joint innovation agenda, and strengthened Energy Access Action Plans.

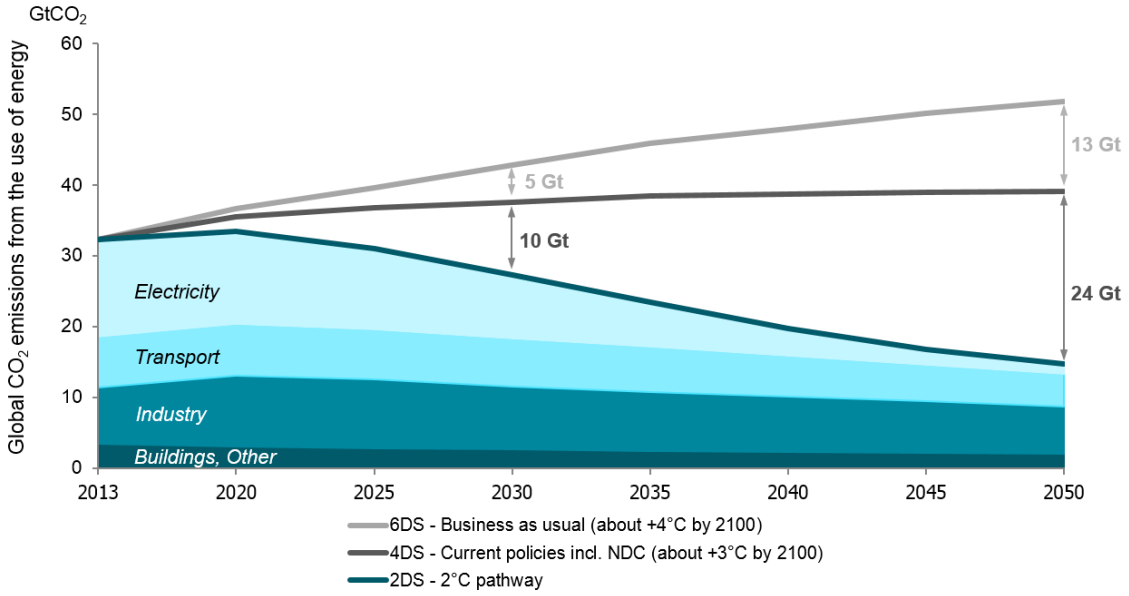
Policy Actions	
2.1	**Develop Effective and Predictable Energy Policies –** The G20 should promote effective and predictable energy policies for accelerated investments in low-carbon technologies by broadening the technology scope of the G20 Voluntary Action Plan for Renewable Energy and developing an energy policy toolkit. • The energy policy toolkit should allow the G20 governments to develop power market designs that provide adequate long-term price signals to invest in low-carbon generation capacity, transmission and distribution assets. At the same time, the power market designs should adequately remunerate operational flexibility of power generation and enable residential and industrial consumers to actively participate in energy demand-side management schemes. As a guiding principle energy policies should allow reliable and cost competitive power supply to all consumers. • The toolkit should contain good practices to accelerate the deployment of a digital and interconnected energy infrastructure, including a suitable charging infrastructure for electric vehicles. • The toolkit should also provide methodologies and good practices to increase the resilience of energy infrastructures to climate change, cybercrime, and other distorting events.
Owner G20	**Timing** 2017-2018
2.2	**Accelerate Energy Innovation –** The G20 should develop a G20 Energy Innovation Action Plan to accelerate the market readiness of innovative technologies, business models, and digital solutions that can contribute to large GHG emissions reductions within the next decades. • The G20 should develop an R&D innovation roadmap to facilitate collaborative and focused R&D on energy generation, energy storage, interconnection, distribution, and smart consumption technologies and applications that show a credible pathway to cost-efficient and rapid scaling. • Within the Energy Innovation Action Plan, the G20 should develop good practices for efficient public-private partnerships as valuable elements to de-risk private sector R&D opportunities, accelerate the market readiness of the most promising technologies, and ensure continuous capacity build-up and retention in critical areas. • The action plan should also define policies that the G20 may adopt to boost market-driven innovation and the rollout of digital energy standards, technologies, business models, and solutions, while mitigating emerging risks for the energy infrastructure, with special focus on cyber-security.
Owner G20	**Timing** 2017-2018
2.3	**Strengthen Energy Access –** The G20 should strengthen the G20 Energy Access Action Plans for sub-Saharan Africa and Asia and the Pacific by supporting the development of national, urban and rural action plans, and by mobilizing private-sector participation in sustainable infrastructure development. • The G20 Energy Access Action Plans should define policies to support the development of transparent urban and rural energy access plans for energy-poor countries, aiming to provide universal access to affordable, reliable and modern energy services according to SDG7. • The Action Plans should define measures aiming to mobilize private-sector investments in sustainable infrastructure development, such as by sharing good practices and cooperating with national governments to adopt policies towards appropriate market frameworks.
Owner G20	**Timing** 2017-2018

Context

The combustion of fossil fuels in the power, industry, buildings, transportation, and agricultural sectors accounts for more than two-thirds of global GHG emissions and close to 90 percent of global CO_2 emissions.[25] The transformation of the energy system is therefore the centerpiece of global efforts to curtail climate change. Reducing especially CO_2 emissions in line with the 2°C pathway requires a significant shift in the technology mix in all energy-using sectors across the entire energy value chain.

This shift needs to occur fast. It is reported that compared to today's levels, CO_2 emissions from the use of energy need to peak in the early 2020s and decrease by more than half by 2050.[26] At the same time, the world economy is expected to increase about threefold during that period.[27] Mastering that challenge requires both carbon intensity[28] and energy intensity[29] of the global economy to decrease by over 60 percent by 2050 compared to today's values.[30]

Exhibit 4 I Global CO_2 Emissions from the Use of Energy Need to Peak in the 2020s



Source: Data from IEA, *Energy Technology Perspectives* (Paris: IEA, 2016).

[25] IEA, *Key CO2 Emission Trends* (Paris: IEA, 2016), 4–5, accessed January 13, 2017, https://www.iea.org/publications/freepublications/publication/co2-emissions-from-fuel-combustion---2016-edition---excerpt---key-trends.html.
[26] IPCC, *Climate Change 2014 Synthesis Report* (Geneva: IPCC, 2015), 8- 9, accessed January 16, 2017, https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf. Multiple lines of evidence indicate a strong, consistent, almost linear relationship between cumulative CO_2 emissions and projected global temperature change to the year 2100. As any given level of warming is associated with a range of cumulative CO_2 emissions, higher emissions in early decades imply lower emissions later.
[27] Calculated by BCG using data from IMF, *World Economic Outlook*, accessed November 16, 2016, http://www.imf.org/external/pubs/ft/weo/2016/02/weodata/download.aspx; 2013 World GDP on PPP escalated with the world economic growth projections from IEA, *Energy Technology Perspectives 2016* (Paris: IEA, 2016), 385.
[28] Carbon intensity describes the amount of CO_2 per MWh of energy used.
[29] Energy intensity describes the amount of MWh fuel for every dollar of GDP.
[30] Calculated by BCG using data from IEA, *Energy Technology Perspectives* (2016), op. cit. and IMF, *World Economic Outlook*, accessed November 16, http://www.imf.org/external/pubs/ft/weo/2016/02/weodata/download.aspx. To meet the 2°C pathway, the global carbon intensity would need to decrease from 0.2 tCO_2/MWh in 2013 by 22 percent in 2030 and by 62 percent in 2050. The final energy intensity would need to decrease from 1.1 MWh/$ in 2013 by 47 percent in 2030 and by 65 percent in 2050.

This requires accelerated action in two equally important mitigation areas: 1) deploying low-carbon technologies (covered in policy action 2.1) and 2) energy efficiency measures (covered in policy action 3.2). As energy technology cycles are usually long, policy-makers should create market and regulatory frameworks that enable accelerated innovations and increased deployment of all economically available technologies that can contribute to that journey. In contrast, a limitation to a subtotal of technologies will likely increase total GHG mitigation costs or endanger reaching the set mitigation targets.[31]

Concerning low-carbon technologies, decreasing the carbon intensity of global electricity production and extending electrification across the transport, heat and industrial sectors are the core pillars of the energy transition (see Exhibit 4). Low-carbon electricity can be produced from renewable sources (wind, solar power, hydropower, biomass, and geothermal), nuclear power, and conventional power plants with carbon capture utilization and storage (CCUS). Especially in industrial processes, such as iron, steel, refining, chemicals, and cement manufacturing, these technologies are among the few potentially available options to avoid GHG emissions.

Directing conventional power production towards natural gas can contribute to GHG emissions reductions in a transitional period. This effect was observed in the United States, where a mainly North American market-induced shift towards natural gas contributed to a 229 million ton CO_2 reduction in 2014 relative to the fuel mix and efficiency in 2005. In parallel, renewable and nuclear generation growth contributed to 169 million tons reductions of CO_2.[32]

The integration of increasingly large shares of intermittent and decentralized renewable electricity (mostly wind and solar PV, which have experienced significant cost reductions) will increase the demand for flexibility. On the generation side, flexible dispatchable generation assets will be needed to back up renewable growth. Additional flexibility will be needed from storage technologies, flexible demand, and interconnected and innovative electricity grid infrastructure. In this context, smart grids and digital technologies can support active demand-side energy management, sector coupling, system-relevant steering of decentralized generation units, and innovative business models.

Switching from fossil fuels to low-carbon electricity can contribute to large emissions reductions in the other energy-using sectors, such as transportation, buildings, and industry. Technologies such as electric vehicles, electric heaters, heat pumps, and power-to-x technologies (such as power-to-hydrogen or -methane) are less carbon-intensive than fossil fuel alternatives when powered by clean electricity. Apart from contributing to GHG reductions, electrification will also contribute to improved air quality, especially in urban areas. On the other side, this would result in higher demand for electricity.

In the transportation sector, oil is expected to remain the dominant fuel in all scenarios, yet biofuels, electricity, natural gas, and hydrogen will increasingly gain market share. Low-emitting fuels with high energy density, such as biofuels and natural gas (CNG, LNG), are particularly well suited to replace oil for long-distance trucking, shipping, and aviation.[33] Unlocking the potential of biofuels will require the maturation of innovative biomass technologies that convert agricultural and forestry residues. This could enable a sustainable use of land for both food and biofuels supply, while preserving biodiversity.[34] Electric mobility is expected to expand its market share predominantly in light duty vehicles and short-range heavy duty vehicles.

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[31] IPCC, *Climate Change 2014 Synthesis Report* (2015), 25, op. cit. For instance, IPCC analysis suggests that if CCS was not available, total discounted mitigation costs (2015--2100) would increase by 138% compared to the default assumption, in which the technology is available.

[32] EIA, *U.S. Energy-Related Carbon Dioxide Emissions 2014*, accessed February 1, 2017, http://www.eia.gov/environment/emissions/carbon/.

[33] IEA, *Energy Technology Perspectives* (2016), 42-52, op. cit. In the 2°C scenario, the share of biofuels of the final energy demand in the transportation sector is 24%, electricity 11%, natural gas 5%, and hydrogen 2%.

[34] IRENA, *Boosting Biofuels – Sustainable Paths to Greater Energy Security* (IRENA, 2016), 10–30, accessed January 13, 2017, http://www.irena.org/DocumentDownloads/Publications/IRENA_Boosting_Biofuels_2016.pdf.

The deployment of electric mobility could be accelerated by a quicker build-out of charging infrastructure.[35] If supplied by sustainable and low-carbon electricity, particularly in urban areas, electric mobility offers benefits beyond GHG emissions reductions, such as improved air quality, particles and noise reduction.

The policy actions that B20 recommends to the G20 for fostering the energy transition address the following challenges:

- First, the investments into low carbon technologies across the entire energy value chain need to be accelerated. At the same time, a successful global energy transition requires the alignment of the climate targets with the goals of security of supply and economic efficiency. The 2016 G20 Communiqué reaffirms the Principles on Energy Collaboration and the commitment to build effective energy markets to foster this energy transition. However, the G20 does not specify good practices for such market frameworks. To address this shortcoming, the focus of the G20 Energy Action Plan on Renewable Energy will need to be expanded to all low-carbon technologies across the energy system that could contribute to the goals of the energy transition.
- Second, the number of competitive low-carbon technologies is currently limited to relatively few options. Increased R&D and innovation activities are needed to accelerate the pipeline of technologies that can be brought to market. The G20 Blueprint of Innovative Growth and the G20 Innovation Action Plan do not address the need for collaboration on energy and climate innovation to tackle the global challenge of climate change.
- Third, a continued challenge and priority of the global community is to provide universal access to clean and affordable energy by 2030 in line with the SDG7[36] of the 2030 Agenda of the United Nations. The existing G20 Energy Access Action Plans provide a good basis for intensifying the collaboration with Sub-Saharan and Asia-Pacific countries.

Policy Action 2.1: Develop Effective and Predictable Energy Policies

The G20 should promote effective and predictable energy policies for accelerated investments in low-carbon technologies by broadening the technology scope of the G20 Voluntary Action Plan for Renewable Energy and developing an energy policy toolkit.

The complexity and the speed of change in the energy system are increasing, with the result that each country faces the need to continuously align its energy policy mix in more and more frequent cycles. Without increased international cooperation, international energy policy and market landscapes risk drifting apart.

Therefore, the B20 advises the G20 to ask the G20 energy ministers and the G20 Energy Sustainability Working Group to regularly align global energy-related policies. The consideration of other countries' experiences and a thorough analysis of the energy policy options and their implications will likely lead to higher environmental and cost effectiveness in the policy mix of each member country.

The G20 should thus broaden the scope of the G20 Voluntary Action Plan for Renewable Energy to cover all low-carbon technologies and supporting infrastructure that are needed for the energy transition. In addition, they should agree on a toolkit of policy actions that the countries may consider in order to provide a consistent and predictable framework.

[35] CPI, Copenhagen Economics, *A New Electricity Era: How to Decarbonizes Energy Systems through Electrification* (Copenhagen: Energy Transition Commission, 2017), 3, accessed February 13, 2017, http://www.energy-transitions.org/sites/default/files/A-new-electricity-era.pdf.
[36] SDG 7 aims to "Ensure access to affordable, reliable, sustainable and modern energy for all".

The design of this toolkit could be assigned to an international organization (such as IRENA, the World Energy Council, or the IEA) and leverage the work of the Clean Energy Ministerial:

- The toolkit should allow the G20 governments to develop power market designs, adequately remunerate operational flexibility of power generation, and enable residential and industrial consumers to actively participate in energy demand-side management schemes. Additional flexibility for the integration of increasing shares of intermittent renewables can be facilitated by short-term markets that provide participants with adequate price signals for dispatching flexible generation capacity and storage, and for flexible consumption. Such short-term, energy-only market price signals will also increase the efficiency of the explicit carbon pricing signal (should the G20 governments decide to make use of such carbon pricing policies).

Exhibit 5 | Italy as a Frontrunner in the Digitalization of the Energy Infrastructure

Since 2001, Italy has been pioneering the digitalization of the energy infrastructure, starting with the deployment of more than 32 million smart meters. The automated and intelligent management of the Italian power grid (in particular, more than 2,100 primary stations and about 140,000 secondary stations are re-motely controlled) enabled the infrastructure operators to minimize faults, significantly reduce recovery time, and realize significant cost reductions. The latter were passed on to the consumers giving a significant contribution to the network tariff reduction: the network component of the tariff decreased by 20 percent in real terms between 1999 and 2016.[1] At the same time, the quality of service improved threefold, as measured by the duration of service interruptions to final customers.[2]

The digitalization of the electricity grid infrastructure has also enabled the system integration of about 630,000 distributed renewable generation units with a total installed capacity of 27 GWel. These contribute by more than 40 percent to total Italian electricity production. Smart grids, matching the use of traditional technology with innovative digital solutions, allow for flexible, advanced network management. They enable new value-added urban services, such as remote controlled LED lighting and e-mobility, fostering the inception of Smart Cities.

In 2016, Italy launched the industrial business investment plan "Industry 4.0", with the further digitalization of the energy infrastructure playing a central role. Innovative smart grid technologies will enable remote control and self-healing of the power grid, predictive maintenance, storage management, new cost-efficient services (such as real-time monitoring of energy consumption, cloud-based IT systems, Internet of Things and big data analytics), and support other sectors offering public services (such as operation of e-mobility charging stations, or data collection from other utility meters).[3]

The country's main grid operator will develop fiber-to-the-home networks at a national level using its own electricity network. The usage of the electricity network for laying down the fiber optics has been estimated to lead to significant cost savings in the areas of market failure, compared to green-field telecommunication networks.

Sources: 1. The Italian Regulatory Authority for Electricity Gas and Water (AEEGSI), accessed February 14, 2017, www.autorita.energia.it. Tariffs are published and regularly updated by the Authority – data of electricity are based on net inflation rates and based on the average household tariff (2,700 kWh/year and 3 kW) and it includes both transportation and distribution services; 2. Italian Authority for Electricity, Gas & Hydro System, *Relazione Annuale Sullo Stato Dei Servizi e Sull'attività Svolta* (Milano: Autorità per l'energia elettrica il gas e il sistema idrico, 2016) 104-107, accessed February 7, 2017, http://www.autorita.energia.it/allegati/relaz_ann/16/RAVolumeI_2016.pdf; 3. Italian Ministry of Economic Development, *Investimenti, Produttività e Innovazione. Piano Nazionale Industria 4.0* (presentation held in Milan, Italy, on September 21, 2016), accessed February 7, 2016, http://www.sviluppoeconomico.gov.it/images/stories/documenti/Industria_40%20_conferenza_21_9.

- The power market designs should also provide investors with adequate long-term price signals for cost recovery, including adequate returns on the needed investment in new generation capacity. The G20 should regard energy price volatility and remuneration of capacity as complementary and agree to combine these two aspects into a common framework that is market-oriented, cost-effective, and strengthens competition among technologies.
- The toolkit should also contain good practices to accelerate the deployment of a digital and

interconnected energy infrastructure, including a suitable charging infrastructure for electric vehicles.[37] This smart grid infrastructure forms the physical basis for innovative digital services that provide a better quality of service at a lower cost, with social and economic benefits for local communities (as exemplified in Exhibit 5). In particular, smart meters are a field-proven technology able to open the way for the digitalization path, enabling demand response functionalities and a better integration of distributed generation from renewable energy sources (as described under policy action 2.2). The generated good practices should be aligned with the Global Infrastructure Hub.

- In addition, the toolkit should provide methodologies and good practices that allow the G20 governments to develop plans to increase the resilience of the energy infrastructure to the effects of climate change, cybercrime, and other distorting events. Given the frequently weak business case for enhancing resilience, governments should also distribute risks in this area by providing financial guidelines, and using financial instruments and international financing facilities (such as the World Bank's Global Infrastructure Facility).[38]

Clear and harmonized global policy signals, regulations, and market frameworks are key drivers of market creation and investment decisions. These factors will limit the need for concessional financing (for instance from climate funds such as the Green Climate Fund, multilateral, bilateral and national development banks). Conversely, the slower and more uncertain the policy signals, the higher the need for concessional finance.[39]

Policy Action 2.2: Accelerate Energy Innovation

The G20 should develop a G20 Energy Innovation Action Plan to accelerate the development and market readiness of innovative technologies, business models, and digital solutions that can contribute to large GHG emissions reductions within the next decades.

International R&D cooperation and knowledge flows help raise scientific quality and innovation capabilities. This is especially true for the long-term, higher-risk R&D and innovation activities that are needed to help tackle global challenges, such as climate change. Production of scientific knowledge has been shifting progressively from the national domain to the international arena. However, several G20 economies show a low level of international research collaboration, and, at the same time, a low level of scientific impact.[40] Current international R&D collaboration frameworks are frequently slowed down by bureaucratic hurdles, which range from complicated and burdensome application procedures to opaque prohibitions of transnational corporations between industry and universities/academic institutes.

To accelerate the pace of development and market introduction of energy technologies and digital solutions, the G20 should develop a G20 Energy Innovation Action Plan starting in 2017. This new action plan should be embedded within the overall G20 Innovation Action Plan and should bundle specific G20 activities to accelerate international R&D and innovation cooperation focused on tackling climate change. The G20 plan should connect with Mission Innovation and leverage the capabilities of international institutions, such as IRENA, the World Energy Council, IEA, or OECD. [41]

[37] See Policy Paper of the B20 Financing Growth and Infrastructure taskforce.
[38] Ibid.
[39] Ibid.
[40] OECD, *G20 Innovation Report* (Beijing: OECD, 2016), 11–12.
[41] Mission Innovation, accessed November 1, 2016, http://mission-innovation.net; Mission Innovation is a shared commitment of 22 countries and the European Union, among them 15 G20 members, to double public investment in clean-energy R&D to about $30 billion in 2021, share information, and collaborate on joint research and capacity building.

The G20 Energy Innovation and Action Plan should facilitate following activities:

- Based on the principles of technology-neutral and innovatively open research, it should enable the G20 to identify key unaddressed innovation needs and specific opportunities for international collaboration. Based on the identified needs, the G20 should develop an intergovernmental R&D innovation roadmap to facilitate collaborative and focused R&D on energy generation, distribution, energy storage, interconnection, and smart consumption technologies and applications that show a credible pathway to cost-efficient and rapid scaling.
- Within this action plan, the G20 should develop good practices for efficient public-private partnerships as valuable elements to de-risk R&D opportunities of companies, enhance their R&D pipelines, accelerate the market readiness of the technologies with the most potential for cost-efficient scaling, and ensure continuous capacity build-up and retention in critical areas.
- One particular focus should be placed on digital technologies and solutions, which will induce significant and permanent change to the energy system. Digitalization is a core enabler for managing the increasingly complex energy landscape (see Exhibit 6). It will define new ways for energy producers, grid infrastructure operators, and customers to interact and do business with each other. From a system perspective, digital technologies act as enablers for unlocking flexibility and energy efficiency potential in various sectors (see Exhibit 7). The G20 Energy Innovation Action Plan should define measures to create a common understanding regarding developments and underlying drivers of digital energy technologies and identify emerging risks for the energy infrastructure, with special regard to the cyber-security domain. This work should aim to define policies that the G20 can adopt to boost market-driven innovation and rollout of digital energy standards, technologies, business models, and solutions. Close alignment between the G20 Energy Sustainability Working Group and the G20 Digital Economy Taskforce is recommended on this topic in order to implement adequate standards in the development of new digital infrastructure.

Exhibit 6 | German R&D Program to Integrate Intermittent Renewables

In 2015, the German Federal Ministry for Economic Affairs and Energy (BMWi) started the four-year support program SINTEG. The goal of this program is to develop and demonstrate solutions for a safe, economic, and climate-friendly energy supply with high shares of intermittent renewables from wind and solar PV. The focus of the project is to develop innovative digital technologies, standards, and business models that enable the interconnected steering of electricity supply and demand assets, under consideration of possible electricity grid constraints. The showcase addresses central challenges of the energy transition, such as system integration, flexibility, and security of supply, system stability, energy efficiency, smart grids, and new market designs. The BMWi granted about €200 million to a group of 200 companies and scientific organizations, organized in five model regions. The involved companies contribute with about €500 million spent on innovative solutions, such as power-to-heat, power-to-gas, and other demand-side assets.

Source: BMWi, *Informationen zum Förderprogramm „Schaufenster intelligente Energie – Digitale Agenda für die Energiewende (SINTEG)“*, accessed December 12, 2016, http://www.bmwi.de/Redaktion/DE/Downloads/I/informationen-schaufenster-intelligente-energie-sinteg.pdf?__blob=publicationFile&v=15.

Policy Action 2.3: Enhance Energy Access

The G20 should strengthen the G20 Energy Access Action Plans for sub-Saharan Africa and Asia and the Pacific by supporting the development of national, urban and rural action plans, and by mobilizing private sector participation in sustainable infrastructure development.

It is estimated that in 2014 about 1.2 billion people around the world did not have access to electricity. More than 95 percent of those without electricity live in sub-Saharan Africa and Southeast Asia, most of them in rural areas. About 2.9 billion people did not have access to nonsolid fuels[42], of which 97 percent lived in developing Asia (including India and China) and sub-Saharan Africa.[43] The pollution resulting from cooking and heating with unhealthy fuels and combustion methods is estimated to lead to over four million premature deaths per year.[44] This situation is not sustainable. Modern energy is a vital catalyst for larger social and economic development. It contributes to basic needs, such as clean water, food preservation, sanitation, healthcare, transportation, education, and telecommunication.

The situation is especially urgent in sub-Saharan Africa, where strong population growth offsets current efforts to deliver on the goal of providing universal access to energy until 2030, as targeted by the SDG7 and the related Sustainable Energy for All (SEforAll) initiative. IEA analysis suggests that average annual investments of $49 billion per year are needed to provide universal access to electricity and clean cooking facilities by 2030.[45] In 2013, global investments in energy access accounted for $13 billion.[46]

The B20 encourages the G20 to reconfirm its support for the UN SEforAll goal of universal energy access by 2030. The G20 should further strengthen the Energy Access Plans for sub-Saharan Africa and Asia and the Pacific by facilitating the following activities.

Exhibit 7 | Digital Applications in the Transportation Sector

Innovative digital applications in the transportation sector can lead to substantial fuel savings. The energy efficiency potential can be optimized by increasing interoperability between vehicles and transportation infrastructure. Within vehicles, navigation systems some with real-time eco-routing can lead to about ten percent fuel savings, depending on factors such as the journeys, road topography, traffic conditions, or driver's knowledge of the route. Such systems are already on the market, and further improvements to adapt eco-routing to traffic conditions in real-time are under development. Eco-driving systems aim to assist drivers in CO_2 reduction efforts by calculating and recommending the optimal speed, selected gear, and pedal action for each road type. Emerging systems can lead to fuel savings of up to 20–30 percent. Regarding infra-structure applications, intelligent traffic applications can achieve up to five percent fuel savings in urban areas. Connecting these systems with in-vehicle applications could increase these savings to 10–15 percent, although this presents the challenge of creating on-board applications that work with different traffic signal technologies and strategies in different cities and countries. Similar applications can also enable intelligent parking, which leads to reduced time spent searching for parking spots, thereby reducing overall traffic.

Source: Pandazis, Winder, *Study of Intelligent Transport Systems for Reducing CO2 Emissions for Passenger Cars* (Brussels: Ertico – ITS Europe, 2015), 1-2.

[42] Sustainable Energy for All, *Progress Toward Sustainable Energy 2015* (Washington: International Bank for Reconstruction and Development, World Bank, IEA, 2015), 48–49. This indicator is underpinned by the WHO Household Energy Database. With the new WHO guidelines, access to modern cooking solution in the home will be defined as "access to clean fuels and technologies".
[43] IEA, *World Energy Outlook, Energy Access Projections* (2016), op. cit.
[44] United Nations Department of Economic and Social Affairs, *Sustainable Development Knowledge Platform, Energy for Sustainable Development*, accessed February 3, 2017, https://sustainabledevelopment.un.org/topics/energy.
[45] IEA, *World Energy Outlook, Energy Access Projections* (2016), op. cit.
[46] IEA, *World Energy Outlook – Financing Energy Access,* accessed November 15, 2016, http://www.worldenergyoutlook.org/resources/energydevelopment/energyforallfinancingaccessforthepoor/.

The G20 Energy Access Action Plans should define policies that the G20 governments may adopt to support the development of national and regional energy access plans for energy-poor countries. The energy plans should be transparent for all market actors, result in deployment roadmaps, and identify area-specific facilitating policies and bureaucratic procedures.

- In urban areas, the high energy demand density requires a balanced and pragmatic approach between all primary and final forms of energy to ensure reliable and affordable access. Clean city action plans should be developed with the goal of facilitating the development of sustainable urban infrastructure that enables access to modern heat, clean water, and sustainable mobility, and to clean waste disposal systems.
- Especially in rural areas and on islands, where a large part of the additional efforts needs to be spent, off-grid and small-scale renewable solutions, such as solar PV and storage installations, are well suited to provide clean electricity access at a lower total cost.[47] Areas with significant farm activity, biogas from manure and agricultural residues could be a source of renewable and reliable energy. Energy access plans in rural areas should be supported by cooperation networks combining development banks (multilateral, regional, and bilateral) and green funds together with local banks in order to enable end-user finance, such as microfinance arrangements. Furthermore, as energy access projects will be small and high in numbers, developing replicable business models will be of importance to reach scale. Recent experiences suggest that appropriate national policies can lead to fast results at high scale (see Exhibit 8 on policies to provide access to clean cooking in India).

Exhibit 8 | India's Program to Create 250 Million New LPG Users by 2019

In 2014, over 800 million people in India (63% of the population) relied on the traditional use of biomass for cooking.1 Many of them are left exposed to pollution from the poor combustion of wood, crop residues, and dung in traditional cook stoves, which contribute an estimated 25 percent of ambient air pollution in India. This causes more than 0.9 million premature deaths every year, more than in any other country.[2]

To address this issue, over the past three years the Indian government has adopted a number of strategies to better target liquefied petroleum gas (LPG) access to those most in need. In May 2016, the government announced "Pradhan Mantri Ujjwala Yojana", a new scheme to provide 50 million LPG connections to poor households by 2019, benefiting about 250 million people. To achieve this goal, the government released a budget of $1.5 billion. The LPG connection (mostly start-up equipment with a 14.2kg filled cylinder) is in the name of the woman of the household.[3]

The goal of the "Ujjwala" scheme is to improve the health of rural households, address environmental issues, and enable women and children to spend their time more productively than collecting firewood. "Ujjwala" is having a successful rollout: by December, 2017, 16 million poor households (about 80 million people) received free LPG connections, raising India's national LPG coverage to over 70 percent on the way to near-universal access.[4]

This example highlights the necessary elements to boost access to clean energy: a government defining a specific national priority, implementation and enforcement of a complementary policy and regulatory framework, a well-designed support scheme, national energy companies able to deliver the product along the supply chain to the end-customer, and appropriate public and private human and financial resources.

Sources: 1. IEA, *Energy Access Database*, accessed January 30, 2017, http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/; 2. Sagar et al., *India Leads the Way: A Health-Centered Strategy for Air Pollution* (Delhi: Environmental Health Perspectives, 2016); 3. Government of India, Ministry of Petroleum & Natural Gas, *Annual Report 2015-2016* (New Delhi: Government of India 2016), 14, http://petroleum.nic.in/docs/Annual_Report/AR15-16.pdf; 4. Government of India, Ministry of Petroleum & Natural Gas, *Pradhan Mantri Ujjwala Yojana*, January 2017, Power Point presentation sent to the author by e-mail on January 26, 2017.

[47] Sustainable Energy for All, *Progress Toward Sustainable Energy 2015* (2015), 26 op. cit.

The Energy Access Action Plans should define measures aiming to mobilize private-sector investments in sustainable infrastructure development, such as by sharing good practices and cooperating with national governments to adopt policies towards appropriate market frameworks. To enable private-sector investors to make decisions based on solid risk-return assessments, a focus needs to be placed on capacity building during the project preparation and planning phases. For cases with marginal risk-return profiles, specific attention needs to be paid to cost recovery as a basis for private or PPP financing in sustainable infrastructure development.[48]

[48] See Policy Paper of the B20 Taskforce Financing Growth & Infrastructure.

Exhibit 9 | Compact with Africa

In sub-Saharan Africa, a severe shortage of essential electricity infrastructure is undermining efforts to achieve a more rapid social and economic development. IEA analysis suggests that strong population growth will offset the ongoing efforts to provide energy access to the currently 632 million people without electricity. In 2030, sub-Saharan Africa is projected to have still 619 million people without access to electricity, out of 784 million people worldwide. The problem affects both cities and villages: 47 percent of the Sub-Saharan urban population and 81 percent of the rural population live without electricity, a large part of the rest experiences frequent outages and high prices.[1,2]

As pointed out in the SDG7 of the 2030 Agenda of the United Nations, reliable and affordable energy services are a precondition for the functioning of modern societies. Energy access will be paramount for attaining the aspirations of the African Union's (AU) 2063 Agenda. Sub-Saharan countries, given their extremely low GHG emissions levels, should focus on all options for establishing universal access to energy in order to alleviate poverty and foster economic development.[3]

The AU 2063 Agenda endorses this goal and calls for action in harnessing all African energy resources to ensure universal access to energy.[4] The Programme for Infrastructure Development in Africa (PIDA) estimates the average annual investment needs of $42 billion to meet forecasted African demand in 2040. PIDA experts have identified projects in the energy sector with the greatest transformative potential and have set up a Priority Action Plan (PAP). This PIDA PAP contains 15 energy priority projects with a total investment need of $40.3 billion, with a focus on hydropower and international transmission lines.[5]

The B20 acknowledges the vital role of energy access for the sustainable development of the continent. It welcomes the initiative of the G20 Presidency to develop country-specific Compacts with Africa in that regard. The compacts with African states should provide an investment-friendly policy framework that facilitates or complements the expansion of the PIDA energy investment pipeline. While harnessing all available energy resources, clean city action plans should work to avoid creating carbon-intensive lock-ins that will be costly to reverse later. A special focus needs to be put on projects that address the drastic energy poverty in rural areas as well. To enable the development of an investment pipeline with a larger number of high-quality energy infrastructure projects, the compacts should support the financial and capacity-related scaling up of existing project preparation facilities of Multilateral and Regional Development Banks, such as the NEPAD Infrastructure Project Preparation Facility.

The Compact with Africa could also define policy reforms that the partner countries can adopt to attract foreign private investment. Such policies can be clear legislation with enforcement of commercial law, transparency in procurement, efficient and transparent PPP governance, and effective banking systems.[6] Furthermore, the Compacts could identify ways for enabling the partner countries to better mobilize their own public and private domestic resources to invest in energy projects. In this respect, the Compacts could facilitate upstream mineral, oil, and gas investments that would enable partner countries to distribute a higher share of the resulting fiscal revenues productively to reverse deficiencies in energy access.

Sources: 1. IEA, *World Energy Outlook, Energy Access Projections (2016),* op. cit.; 2. IEA, *Africa Energy Outlook Executive Summary* (Paris: IEA, 2014), 1. 3. Cf. Fay et al., *Decarbonizing Development, Three Steps to a Zero-Carbon Future* (Washington, D.C.: The World Bank, 2015) 3; 4. African Union Commission, *Agenda 2063 – The Africa We Want* (Addis Ababa: African Union Commission, 2015), 16, accessed February 28, 2017, http://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf; 5. PIDA, *The Pida Energy Vision* (Belvédère, Tunisia: African Union Commission, 2016), 5–8, accessed February 28, 2017, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/PIDA%20brief%20Energy.pdf; 6. See PIDA, *Financing PIDA Projects* (Belvédère, Tunisia: African Union Commission, 2016), 3–5, accessed February 28, 2017, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/PIDA%20brief%20financing.pdf.

Recommendation 3: Advance Resource and Energy Efficiency

The G20 should advance resource and energy efficiency by establishing a Resource Efficiency Platform and translating the Voluntary Energy Efficiency Investment Principles into a policy toolkit.

Policy Actions	
3.1	**Improve Resource Efficiency –** The G20 should establish an intergovernmental G20 Resource Efficiency Platform as a forum for international collaboration with the goal of reducing the resource intensity of the world economy. • G20 governments should use this platform to share best practices and knowledge to build a robust and consistent international understanding of and scientific basis for resource efficiency, and identify areas of further potential international collaboration. • The Resource Efficiency Platform should facilitate the assessment of concrete resource efficiency opportunities and the development of resource efficiency action plans by the G20 governments. • Leveraging the Resource Efficiency Platform, the G20 should commission the UNDP and the OECD to establish Resource Efficiency as a new Sustainable Development Sector within the G20 Action Plan on the 2030 Agenda for Sustainable Development.
Owner G20 , G20 governments	**Timing** 2017
3.2	**Accelerate Energy Efficiency –** The G20 should accelerate the efforts within the G20 Energy Efficiency Leading Programme by translating the Voluntary Energy Efficiency Investment Principles for G20 into a policy toolkit. • This energy efficiency investment toolkit should contain good practices that the G20 governments may adopt for the allocation of public funds to stimulate private-sector investments in energy efficiency and public procurement guidelines in favor of total cost of ownership approaches and life cycle assessments. • The toolkit should provide methodologies and best practices for country-specific assessments and energy efficiency roadmaps to identify specific energy efficiency investment opportunities within the development and upgrade cycles of the infrastructure, resulting in financeable pipelines of energy efficiency investment opportunities. • The toolkit should provide good practices to stimulate cost-effective energy efficiency spending, increase awareness on energy efficient consumption, and improve the capacity to manage energy as a valuable resource of consumers and small and medium-sized enterprises (SMEs). • Within the energy efficiency investment toolkit the G20 should also develop policies to remove barriers to supply and facilitate access to energy efficiency finance.
Owner G20	**Timing** 2017

Context

Natural resources, especially raw materials, are key production factors and are therefore at the heart of our prosperity. It is projected that, because of accelerated population growth, global extraction of natural resources will double by 2050, compared to 2015. This projected development will not only cause severe environmental impacts but highlights the need to produce and consume in a resource-efficient way. Cost-efficient production structures are essential for maintaining international competitiveness, all the more since material costs in many industry sectors can represent more than 50 percent of total costs. Thus, improving resource efficiency can offer concrete business opportunities and a source of competitive advantage. It is the key to a sustainable and secure supply of materials, while protecting the environment and the climate.

Under the 2030 Agenda for Sustainable Development, countries have committed to sustainable management and efficient use of natural resources by 2030. Increased resource efficiency can improve economic and environmental resilience and improve the resource security that is vital for human development, as envisaged by the SDGs.[49] Hence the challenge ahead for all G20 countries is to improve resource efficiency in consumption and production. Reports of the OECD and UN Environment International Resource Panel show that this is possible and that improved resource efficiency can contribute to economic growth and job creation.[50]

Improvements in energy efficiency are equally important to save costs and increase businesses' competitiveness. Most technologies needed to increase resource and energy efficiency are available and could be further developed to be deployed on large scale, given adequate policies that stimulate increased investments and efficient consumption.

However, businesses face certain limitations and trade-offs that need to be taken into account. For instance, technical requirements and specifications for products such as safety features and durability concerns can conflict with the goal of increased recyclability. Trade-offs between resource and energy efficiency can also occur when aiming to decrease the usage of certain primary materials within a product, frequently at the cost of a higher amount of energy or water in the production process. An example for this trade-off can be found in the use of light metals in the automotive industry.

The French and Mexican G20 presidencies acknowledged the importance of (energy-related) raw material governance, placing the focus on price volatility. While the G20 is endorsing energy efficiency with a G20 Energy Efficiency Action Plan and related investment principles, they do not yet explicitly or comprehensively address resource efficiency. The 2016 G20 Action Plan on the 2030 Agenda for Sustainable Development does not identify resource efficiency as a Sustainable Development Sector, but highlights that it is open to accommodate future priorities. Both issues, resource and energy efficiency need to be placed firmly on the G20 agenda.

[49] United Nations, *The SDGs Explained for Business United Nations*, accessed January 2, 2017, https://www.unglobalcompact.org/sdgs/about ICC, *Business Charter for Sustainable Development - Business Contributions to the UN Sustainable Development Goals* (Paris: ICC, 2015), 16, accessed March 9, 2017, https://cdn.iccwbo.org/content/uploads/sites/3/2015/09/ICC-Business-Charter-for-Sustainable-Development-Business-contributions-to-the-UN-Sustainable-Development-Goals.pdf.
[50] Ekins, Paul and Nick Hughes, *Resource Efficiency: Potential and Economic Implications* (Nairobi: United Nations Environment Programme, 2016), 28–31.

Policy Action 3.1: Improve Resource Efficiency

The G20 should establish an intergovernmental G20 Resource Efficiency Platform as a forum for international collaboration with the goal of reducing the resource intensity of the world economy.

Since 2000, the primary material intensity of the world economy has increased slightly. This means that the rate at which the world economy is exploiting natural/primary resources and generating emissions and waste is increasing faster than the economic benefits gained. The main underlying driver has been a shift of production away from material-efficient economies to less material-efficient economies.[51] In 2015, about 85 billion tons of materials were extracted, processed, consumed, and disposed. By 2050, current projections suggest that world economic growth will cause raw material extraction to increase to 186 billion tons per year.[52] This economic growth is also projected to lead to a global water demand that is significantly higher than currently available. Going forward, counteracting these trends and decoupling economic growth from primary resource consumption growth is imperative in order to avoid unsustainable environmental degradation, economic losses, and conflicts.

Instead of the current economic model of "make, use and dispose", a new way of thinking is necessary that includes the economic, environmental, and social consequences of a product or process over its entire life cycle. For businesses, increased resource efficiency can contribute to reducing uncertainties about price increases, price fluctuations, and generally about the availability of raw materials. These uncertainties can affect economic and social development in both exporting and importing countries. Experiences in many countries show that businesses can save costs by using materials, water, and energy more efficiently, for instance by optimizing production processes, developing resource-efficient product designs or business models, avoiding waste, and using waste as a resource.

While not everybody will benefit equally and the transition needs to be managed, increased resource efficiency can yield higher economic growth and employment, as well as offer ample investment opportunities. Barriers to increased resource efficiency vary by sector and resource. These barriers can be contradictory regulations (such as waste definitions that hinder the trade of products for remanufacturing) or lack of public investment in waste collection, recovery and recycling infrastructures. There are also technical and economic barriers to refurbishing, remanufacturing, and recycling increasingly complex products. Since a large part of global resource flows takes place across borders, international cooperation can be a catalyst towards increased resource efficiency.

The G20 should take the lead and address resource efficiency by establishing an intergovernmental G20 Resource Efficiency Platform as a forum for international cooperation to reduce the resource intensity of the world economy. Within this platform, the G20 should work together with businesses and international institutions.

First, the Resource Efficiency Platform should facilitate good practices and knowledge sharing among the G20 in order to develop an international understanding of and scientific basis for resource efficiency and identify areas of further potential international collaboration. These activities should enable the G20 to agree on focus areas, ambition levels, and gradually guide the G20 towards formulating a common resource efficiency strategy. Close engagement with businesses, organizations, and think tanks active in this field is recommended in order to identify focus sectors and areas, and formulate specific, measureable, achievable, realistic, and relevant resource efficiency ambition levels.

This process will enable all participating countries to develop a greater knowledge of resource efficiency and to agree on common ways of measuring, assessing, and implementing resource efficiency in their

[51] UNEP, *Global Material Flows and Resource Productivity* (Nairobi: United Nations Environment Programme, 2016), 40. Material intensity describes the amount of materials extracted in kilos for every dollar of GDP.
[52] Ekins, Paul and Nick Hughes, *Resource Efficiency: Potential and Economic Implications* (2016), 33, op. cit.

own countries. In this context, the G20 should aim for the following goals:[53]

- Close information gaps: Reliable indicators as well as accurate and internationally comparable data are essential to understanding the development of circular patterns and measure international trade flows of primary and secondary materials, resource use by different sectors and parts of society, quality and size of resource stocks, as well as progress in resource efficiency.
- Introduce formats for public-private collaboration at an international and national level, including on R&D: Public procurement can be a major factor in creating demand for life cycle-based business models and technologies, and in incentivizing companies to upscale and accelerate the production of resource-efficient technologies and efficiency improvements.
- Establish process standards regarding remanufacturing and refurbishing: Ensuring that remanufactured and refurbished products are as effective and safe as new products will increase consumers' acceptance of products from such regeneration life cycles as viable alternatives to new products. Standards are also needed for the digitalization of production processes, for example with regard to data security.[54]
- Collaborate to educate consumers and SMEs about the importance of resource efficiency: Seeking to design and offer services such as helpdesks that assist consumers in making more sustainable consumption choices and achieving more sustainable lifestyles.
- Promote synergistic approaches that reaffirm the intrinsic value of biodiversity: Illustrate them both for society and for business.

Second, the Resource Efficiency Platform should facilitate the assessment of concrete resource efficiency opportunities and the development of resource efficiency action plans. These assessments should be conducted in different working groups, with close involvement of business representatives. The working groups should map, specify, and prioritize resource efficiency opportunities and projects, identify barriers to implementation, agreeing on action plans to address them, and set up monitoring and reporting bodies for implementation control. Exhibit 10 provides examples that could be the subjects of further specifications and deep dives.

In addition, through the Resource Efficiency Platform the G20 should commission the UNDP and the OECD to establish Resource Efficiency as a new Sustainable Development Sector within the G20 Action Plan on the 2030 Agenda for Sustainable Development.[55]

The steering of the G20 Resource Efficiency Platform could be done by rotating co-chairs, for instance by three co-chairs from the country of the previous, present, and upcoming G20 presidencies.

[53]Adapted from ICC, *Green Economy Roadmap – A Guide for Business, Policymakers and Society* (Paris: ICC, 2012), 25, accessed February 28, 2017, https://cdn.iccwbo.org/content/uploads/sites/3/2012/08/Green-Economy-Roadmap-a-guide-for-business_-policy-makers-and-society.pdf.
[54] See recommendations on Industry 4.0 in the Policy Paper of the B20 Digitalization Taskforce.
[55] The UNDP and the OECD were the international institutions that designed the G20 Action Plan on the 2030 Agenda for Sustainable Development in 2016.

Exhibit 10 | Selected Opportunities to Increase Resource Efficiency and Minimize Waste

Energy recovery from municipal solid waste (MSW): The total global amount of MSW is estimated at 2 billion tons of which about 70 percent is driven to dumpsites. This amount will further increase in Asia and Africa along with strong population growth.[1] MSW could be turned from a burden into a profitable investment opportunity. It has the potential to replace 10EJ of fossil fuel, which corresponds to the current annual primary energy use of Brazil.[2] This potential could be unlocked by platforms for transparent waste monitoring, knowledge and good practice exchange (like separately collecting and sorting waste), and dialogue between municipalities and the private sector as a basis for developing PPP. MSW in regions with little established waste management would have the additional benefit of keeping waste out of the environment including the seas. This would contribute to the long-term fertility and capability of land and marine environments to provide natural resources.

Recovery of Indian farm waste: Rural India generates about 550 million tons/year of agricultural residues of which about 200 million tons are burned in the fields. In addition, the population of 300 million bovine animals generates manure of over 1,500 million tons/year. Using the recoverable parts of these waste fractions for the production of pellets, cellulosic ethanol, biogas, and bio-fertilizers would contribute in addressing the energy deficit in rural India, enhance the environmental sustainability of the Indian agriculture, and create a large amount of jobs.[3]

Industrial biotechnologies: Industrial biotechnology materials could replace fossil resources for chemical, food, detergents, pulp and paper, textile, and transportation fuel production, and contribute to 1.0–2.5 $GtCO_2e$ in annual reductions by 2030. Realizing this potential depends on innovation policies to upscale these technologies and help secure finite biomass feedstock for high-value applications.[4]

Efficient water use through modern agrotechnology: With continuing population growth, rising incomes and urbanization, food demand is projected to roughly double in the next fifty years. Because agriculture currently accounts for 71 percent of global water withdrawals, a sustainable increase of the food supply requires better use of water along the whole chain from the farm to the market while preserving and restoring healthy ecosystems.[5] Modern agrotechnology, such as breeding plants with limited need for water, developing advanced irrigation systems, and designing sustainable fertilizing schemes, can contribute significantly to the efficient use of water resources. The agricultural sector is based on economic life cycles and heavily depends on it.

Recycling of plastic waste in the European Union: Plastic waste in the EU amounts to around 25 million tons per year of which almost one-third can be recycled mechanically. 18 million tons per year would be available for advanced recycling technologies other than energy recovery. This, however, would require equitable financing mechanisms.[6]

Recycling of electronic waste: The spread of e-mobility and renewable energy sources depends on the secured and affordable supply of (technology) metals.[7] In many cases, recycling metals from end-of-life products is far less energy-intensive than obtaining these from mining.[8] Hence, closing the loop for metals increases resource efficiency and broadens the supply base for essential raw materials. While in many areas metal recycling is well established, deficits exist for complex consumer goods, such as electronics and vehicles.

Electronic-waste is one of the fastest growing waste streams globally. From 1990 to 2015, the volume of e-waste has grown from about 20 million tons to approximately 75 million tons. Recent studies show the benefits of developing and implementing new strategies for recycling these scrap flows in a manner that respects public health, is environmentally sound, and is socially acceptable. Comprehensive collection and sustainable recycling can enable recovering large portions of scarce and valuable metals (such as precious metals, copper, cobalt, indium) from end-of-life electronics and end-of-life vehicles.[9]

Carbon capture and utilization (CCU): In many non-energy-related applications, carbon cannot be readily substituted or will remain an indispensable ingredient. Examples of such cases include the manufacturing of chemicals and pharmaceuticals, where carbon is an integral part of the product, or the production of cement or lime, where non-substitutable raw materials contain carbon. CCU could be an important alternative mitigation strategy in a circular economy. Given the adequate availability of low-carbon electricity and intelligent design of closed carbon circles, the long-term mitigation potential of CCU could amount to several $GtCO_2e$ per year. By maintaining carbon-based materials while keeping coal in the ground, CCU combines climate change mitigation with increased resource efficiency.[10]

Sources: 1. UNEP, *Global Waste Management Outlook* (Nairobi: UNEP, 2015), 52; 2. IEA, *IEA Technology Perspectives 2016* (Paris: IEA, 2016), 274; 3. Skill Council for Green Jobs, e-mail message to B20 editing team from February 27, 2017. 4. Bang et al., *Industrial biotechnology - More than Green Fuel in a Dirty Economy?* (Copenhagen: WWF Denmark, 2009),

3; 5. UNEP, *Resource Efficiency: Potential and Economic Implications* (2016), 20, op. cit. FAO, *Water use efficiency*, accessed February 20, 2017, http://www.fao.org/resources/infographics/infographics-details/en/c/218941/; 6. Plastics Europe, *Plastics – the Facts 2014/2015, An Analysis of European Plastics Production, Demand and Waste Data*, 20, last modified February 2, 2015, http://www.plasticseurope.org/documents/document/20150227150049-final_plastics_the_facts_2014_2015_260215.pdf; 7. Angerer et al., *Rohstoffe für die Energieversorgung der Zukunft: Geologie – Märkte – Umwelteinflüsse* (München: Acatech, 2016), 11-23, accessed January 10, 2017, http://www.acatech.de/de/publikationen/empfehlungen/kooperationen/detail/artikel/rohstoffe-fuer-die-energieversorgung-der-zukunft-geologie-maerkte-umwelteinfluesse.html; 8. Buchert et al., *Potentials for Climate Protection offered by Metal Recycling and the Anthropogenic Metal Stock* (Darm-stadt: Öko-Institut, 2016), 5, accessed January 10, 2017, http://metalleproklima.de/wp-content/uploads/2016/08/Recyclingstudie_%C3%96koInst_EN.pdf; 9. Öko Institut, *Global circular economy of strategic metals - best-of-two-worlds approach (Bo2W)*, accessed January 9, 2017, http://www.resourcefever.org/project/global_circular_economy_of_strategic_metals.html; Step-Initiative, accessed January 9, 2017, http://www.step-initiative.org; 10. ICC, *Role of Carbon and Long-term Mitigation Strategies beyond 2050 Through Carbon Capture and Use (CCU) and Closing the Carbon Cycles*, accessed January 28, 2017, http://www.iccwbo.org/Advocacy-Codes-and-Rules/Document-centre/2016/Role-of-carbon-and-long-term-mitigation-strategies-beyond-2050-through-CCU-and-C%C2%B3/.

Policy Action 3.2: Accelerate Energy Efficiency

The G20 should accelerate the efforts within the G20 Energy Efficiency Leading Programme by translating the Voluntary Energy Efficiency Investment Principles for G20 into a policy toolkit.

The B20 supports energy efficiency as a critical component of the energy transition and stands ready to collaborate with public authorities to unlock the vast potential for profitable energy efficiency investments. Slowing down the growth of demand for energy is the key driver for reducing energy-related emissions to a sustainable level, next to reducing the carbon intensity of the energy supply. In the last few years, some progress has been made in decoupling economic growth from energy demand growth in both developed and fast-growing countries. For instance, between 2010 and 2015, global gross domestic product (GDP) grew at an average annual rate of 5.1 percent, while global final energy demand grew by only 1.4 percent per year.[56] Following the 2°C pathway requires a further slowdown of final energy demand growth to 0.2 percent per year between 2015 and 2050. At the same time, the world economy is expected to grow by an average of 3.2 percent.[57]

In 2015, global energy efficiency investments amounted to $221 billion, of which the building sector accounted for 55 percent, the transport sector 28 percent, and the industry sector 18 percent.[58] To reduce energy consumption in line with the 2°C pathway, these investments need to triple to about $650 billion each year.[59] Available studies further suggest that there are sufficient profitable opportunities to invest this amount in energy efficiency in the industry, transport, and building sectors, given an appropriate policy framework.[60]

[56] BCG analysis based on databases from The Economist (2016); Enerdata (2016).
[57] IEA, *Energy Technology Perspectives 2016* (2016), 385, op. cit.
[58] IEA, *World Energy Investment 2016* (Paris: IEA, 2016), 37, this figure represents incremental spending on equipment that consumes less energy than would otherwise have been used, if the purchaser had opted for a less efficient model or continued using the existing equipment.
[59] IEA, *Energy, Climate Change and the Environment* (Paris: IEA, 2016), 69–70.
[60] Ibid.; with current policies, about two-thirds of cost-effective energy efficiency opportunities will remain untapped in the next 20 years.

The B20 therefore recommends strengthening the efforts within the G20 Energy Efficiency Leading Programme (EELP) to provide an appropriate framework for mobilizing increased investments in energy efficiency. The G20 should identify and remove barriers to energy efficiency investments by developing the Voluntary Energy Efficiency Investment Principles for G20 into an actionable toolkit for G20 members. [61] This toolkit should align the interests of governments, financial institutions, and businesses. It should contain good policy practices that stimulate demand for energy efficiency, remove barriers to supply, and facilitate access to finance for energy efficiency projects. This energy efficiency investment toolkit should address the following issues:

- To increase involvement of the public sector in energy efficiency investments, the toolkit should contain good practices for the allocation of public funds to stimulate private-sector investments in energy efficiency (such as in buildings or industrial processes). It should also contain public procurement guidelines in favor of total cost of ownership approaches, considering the energy consumed throughout the life cycle of a product.
- The energy efficiency investment toolkit should provide methodologies and best practices for country-specific assessments and energy efficiency roadmaps to identify specific energy efficiency investment opportunities within the development and upgrade cycles of the infrastructure. These reviews could result in a financeable pipeline of energy efficiency investment opportunities.[62]
- The toolkit should provide good practices to stimulate cost-effective energy efficiency spending, increase awareness of energy efficient consumption, and improve the capacity to manage energy as a valuable resource of consumers and SMEs. This could be facilitated through targeted communication strategies, education plans, and by strategies to increase the deployment of energy monitoring, control, and management systems.
- Within the energy efficiency investment toolkit the G20 should also develop policies to remove barriers to supply and facilitate access to energy efficiency finance. The financial sector is increasingly aware and supportive of energy efficiency investments (as exemplified in Exhibit 11). However, as energy efficiency investments are typically small and local, financial institutions frequently lack adequate methodologies, internal processes, and standards that enable them to assess risks and provide tailor-made financial products to their customers who ask for energy efficiency financing. Additionally, simplifying public support programs and enabling their combination with private finance streams can contribute to de-risking and mobilizing energy efficiency investments. The G20 could facilitate dialogue and identify options to unlock finance for energy efficiency by interlinking the activities of the Green Finance and Climate Finance Study Groups with those of the existing Energy Efficiency Finance Task Group (EEFTG).

[61] These principles were developed in 2015 and call for further collaboration to identify and unlock barriers to energy efficiency investments.
[62] See Policy Paper of the B20 Financing Growth and Infrastructure Taskforce.

Exhibit 11 | EBRD Activities to Upscale Supply for Energy Efficiency Investments

Since 2006, the European Bank for Reconstruction and Development (EBRD) has financed energy efficiency with cumulative investments of €17.9 billion, with over half this amount in the private sector. Beyond its policy work on energy pricing and energy efficiency regulations and standards, the EBRD has developed specific financing channels for energy efficiency that address a range of sectors in Central Europe, the Balkans, the southern and eastern Mediterranean regions, and central Asia, including:

- Industrial energy efficiency: In addition to direct lending to industries involving energy audits and energy management systems, the EBRD supports the implementation of low-carbon pathways for specific energy-intensive sectors, such as the cement industry.
- Sustainable Energy Financing Facilities: The EBRD extends credit lines to a network that currently comprises 125 local private financial institutions that in turn lend funds to small and medium-sized businesses, corporate clients and households. Over 80,000 sub-loans have been made through this network, including for residential energy efficiency.
- Supply-side energy efficiency: This activity involves projects aimed at enhancing the efficiency of electricity production, transmission and distribution, including smart grid investments. Financing is generally channeled through direct loans to public and private utilities.
- Energy efficiency in cities: Reflecting the strong role of cities as channels of energy efficiency action, the EBRD launched a Green Cities Programme to drive energy efficiency investments in district heating, water, and transport networks with high environmental and financial returns, and to accelerate project preparation, financing, and implementation.
- Energy efficiency in buildings: Different instruments to finance building energy efficiency projects have been employed, including direct lending to municipalities or property developers, indirect financing through local banks, PPPs and energy performance contracts. This is accompanied by a range of technical assistance activities including efficiency audits and the capital appraisal of building designs.

Source: E-mail message from EBRD Taskforce member to the B20 Secretariat, December 16, 2016. See http://www.ebrd.com/what-we-do/sectors-and-topics/sustainable-resources/energy-efficiency-sector.html%20.

Annex

Acronyms

2030 Agenda	2030 Agenda for Sustainable Development of the United Nations
AU	African Union
B20	Business20
BMWi	Bundesministerium für Wirtschaft und Energie (German Federal Ministry for Economic Affairs and Energy)
Carbon pricing	in this paper, the term carbon pricing refers to the pricing of greenhouse gases, not only to CO_2. A price is put on climate-relevant emissions into the atmosphere, not on the occurrence of such gases in the production process as such
CCS	carbon dioxide capture and storage
CCU	carbon capture and use
CCUS	carbon capture, utilization and storage
CO_2	carbon dioxide
COP 21	The Conference of the Parties refers to the countries that signed up to the 1992 UNFCCC. The COP in Paris was the 21st such conference
DMT	domestic material consumption – measures the total amount of materials used directly by an economy, and is calculated as domestic extraction, plus all physical imports, minus all physical export
EBRD	European Bank for Reconstruction and Development (EBRD)
ECRE	Energy, Climate and Resource Efficiency
EELP	Energy Efficiency Leading Programme of the G20
EEFTG	Energy Efficiency Finance Task Group of the G20
EJ	exajoule, 10^{18} joule
ETS	emission trading system
e-waste	e-waste includes almost any household or business item containing circuitry or electrical components with either a power or battery supply
G20	Group of 20
GDP	gross domestic product
GHG	greenhouse gases
$GtCO_2e$	gigatons of CO_2 equivalent
GW	gigawatt, 10^9 watts
IAI	International Aluminum Institute
IEA	International Energy Agency
INDC	intended Nationally Determined Contributions are GHG reduction pledges that the Parties announced before the COP21 in December 2015
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IMF	International Monetary Fund
KPI	key performance indicator
LCA	life-cycle assessment
LCOE	levelized costs of electricity – all costs incurred during the lifetime of a generating technology (including capital costs) divided by the units of electricity produced during the lifetime, expressed in $/MWh
LEDs	low GHG emission development strategies
LPG	liquefied petroleum gas
low-carbon technologies	low-carbon technologies are found across the entire energy value chain and contribute to reducing the carbon intensity in line with global climate goals
MRV	Measuring, Reporting and Verification
MSW	municipal solid waste
MoU	memorandum of understanding
MWh	megawatt hour = 10^6 watts x 3,600 seconds

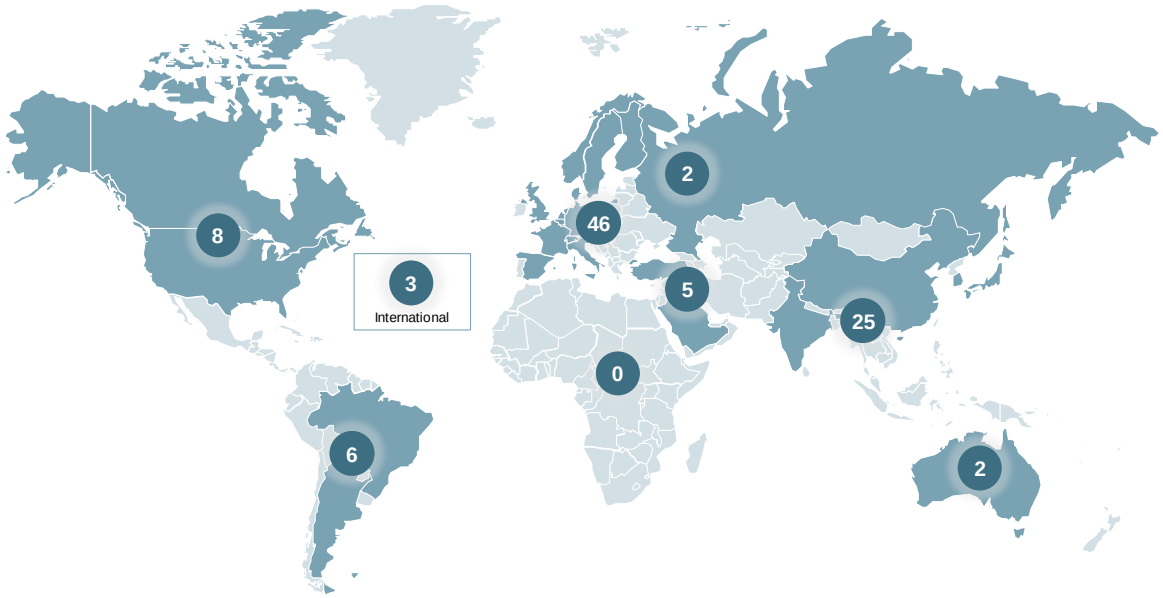
NDC	Nationally Determined Contribution – GHG reduction pledges within the implementation of the Paris Agreement
OECD	Organization for Economic Cooperation and Development
PAP	Priority Action Plan
PIDA	The Programme for Infrastructure Development in Africa
primary raw material	material derived from "virgin" sources, such as mining the earth
PPA	power purchasing agreement
PV	photovoltaic
R&D	research and development
SDG	Sustainable Development Goals of the United Nations
secondary raw material	material derived from residues, scraps or waste during production processes or at the end of a product's life
SEforAll	Sustainable Energy for All
SMEs	small and medium-sized enterprises
TNA	technology needs assessment
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council of Sustainable Development
WHO	World Health Organization
WRI	World Resource Institute

Schedule of Taskforce Meetings

#	Date	Location	Theme
1	October 24, 2016	Conference call	Discussion of Taskforce focus topics
2	December 2, 2016	Berlin	Discussion of Taskforce recommendations in a first policy paper draft and exchange with G20 presidency representatives
4	January 25, 2017	Conference call	Refinement of Taskforce policy proposals in a second policy paper draft
5	February 20, 2017	Conference call	Refinement of Taskforce policy proposals in a third policy paper draft
6	March 22, 2017	Paris	Discussion of final policy paper draft with G20 Sherpas
7	May 2-3, 2017	Berlin	B20 Summit with Chancellor Merkel

Distribution of Members

Country	#	Country	#	Country	#	Country	#
Argentina	3	Germany	22	Saudi Arabia	1	International	3
Australia	2	India	9	Spain	5	Other	5
Brazil	3	Italy	3	Turkey	4	Total	97
Canada	1	Japan	2	United Kingdom	2		
China	12	Korea	1	United States	7		
France	5	Russia	2	European Union	5		



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