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Note of the Director-General
Innovation: The Age of Renewable Energy

The *Paris Agreement* strengthens the global response to the threat of climate change, including *"holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels"*. This target requires a reduction in GHG emissions by at least 40% to 70% from 2010 levels by 2050 and to zero in the period 2060 to 2080. The magnitude of the challenge calls for bold international action to rapidly deploy technology solutions that will enable this transition for the energy sector. The Strategic Discussion on 'Innovation: The Age of Renewable Energy' aims at defining the elements for a coherent approach to support international efforts for the accelerated development, commercialisation and deployment of innovative technologies for a renewables-based energy system.

1. With renewables becoming the foundation for a low carbon energy system by 2050 on a path to zero carbon in the period 2060 to 2080, efforts to develop, commercialise and deploy innovative technologies must be intensified, while complementary business and policy innovations must be pursued with equal imperative. Promising initiatives with the objective of injecting more capital into the technology development process were announced at the COP21 in Paris – **Mission Innovation** for public funding and **Breakthrough Energy Coalition** for private investment. These initiatives seek to significantly increase the public funding for R&D and scale-up capital flowing into the commercialisation of clean energy technologies. This session will include leading industry, innovation actors and countries to discuss these promising developments and what needs to be included in a global strategy for international cooperation to support renewable energy innovation that brings the world to a zero carbon future for the energy system.

Context

2. Countries agreed at the COP21 to limit global warming between 2ºC and 1.5ºC above pre-industrial levels. Promising developments heading in this direction are already evident, with renewables accounting for the majority of the annual capacity additions in the power sector for the last three years and increased efforts to deploy renewable energy in end-use sectors as transportation and buildings. A future with a zero-carbon energy system requires acceleration of efforts to increase the share of

renewable energy in the global energy system. In the power sector, the global share of variable renewable energy (VRE) from solar photovoltaics and wind power at present stands at 3% of the annual generation. Similarly, current biofuel demand accounts for just 3% of the total liquid fuels demand. Renewables share in the industrial sector is approximately 8%. Accelerated deployment of all renewable energy technologies and continuous innovation will bring the next step-change that is required to set the world on the path of sustainable energy future.

3. At the COP21 in Paris, two new initiatives were announced. The **Mission Innovation** initiative includes 20 governments that committed to double their clean energy R&D investment over five years. The **Breakthrough Energy Coalition** initiative brings together leading private sector investors willing to put patient flexible risk capital into innovative technologies at early development stages. These promising initiatives have the potential to boost innovation in renewable energy technologies; technology push via R&D investment and market pull via commercial diffusion. In order to catalyse this virtuous cycle, government and corporate funding will have to be targeted in the most effective way. Coordination between the participants in the initiatives will be important.

4. Renewable energy generation technologies are rapidly becoming mature, reflected in their current competitiveness against conventional energy generation technologies as well as their reliability. However, the next major challenge for the needed scale-up relates to the integration of these technologies into a dynamic energy system. In the power sector, addressing the variability in supply from solar and wind requires technology and non-technology innovations (new system operation and regulation) as demonstrated by front-runner countries already deploying a high share of VRE. A massive use of renewables in the end-use sectors: transport, building and industry, will require innovation in, for example, logistics and business models for bioenergy. New industrial processes incorporating electrification have to emerge in, for example, the production of cement, iron and steel as well as the transport sector.

5. Innovation will continue to be vital in bringing access to modern energy to the more than one billion people without access to electricity at present. Technology solutions are available. Globally, around twenty million households use solar home systems and solar lighting, and five million households are supplied with electricity by RE mini-grids. However, to address the energy access challenge, technology innovation must be accompanied by innovation in business models, regulatory frameworks and finance. Such a holistic innovation approach will foster the needed enabling environment for investment.

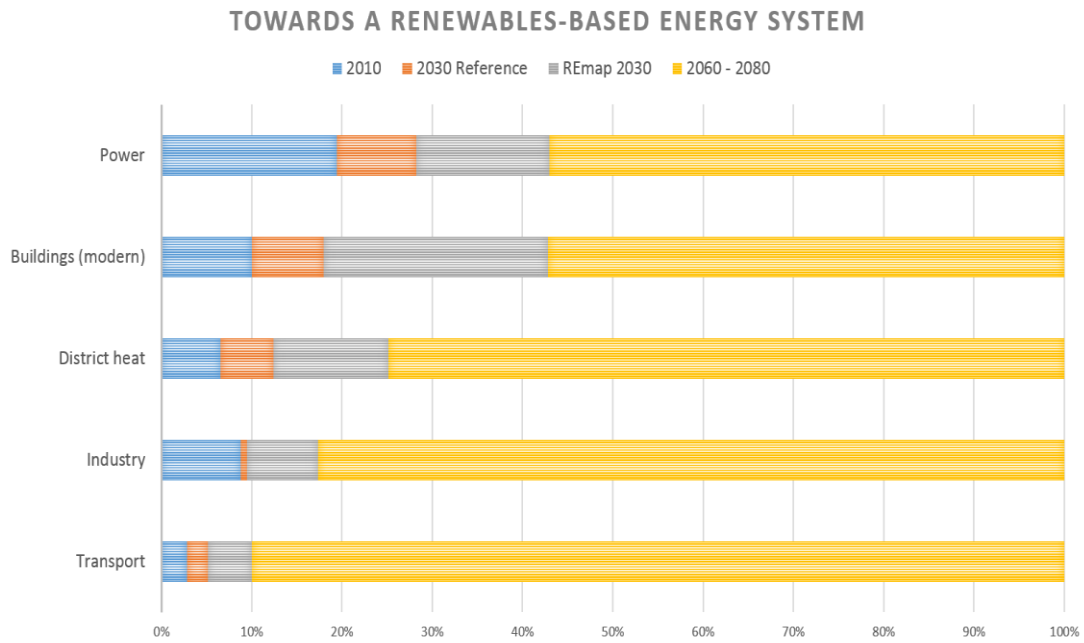

Figure 1.
Magnitude of the challenge to achieve a 100% renewables-based energy system by 2060-2080[1]

6. Despite the magnitude of the challenge, public investment in research and development (R&D) for renewable energy continues to be rather small in contrast to other sectors. According to OECD statistics, the government budget for R&D in the energy sector in OECD countries was approximately 10.4 billion USD (4% of total R&D budget) in 2014[2]. In contrast, the budget for R&D in the health and defence[3] sectors were 41.6 billion USD (16.3% of total R&D budget) and 73.9 billion USD (29.1% of total R&D budget) respectively. Globally, R&D spending observed a slow-down in the period of 2010 to 2011, just starting to increase again in 2013 and 2014. In 2014 around 5.1 billion USD were spent in government R&D for renewable energy, representing an increase of only 3% in comparison to 2013.[4] In OECD countries renewables R&D investment corresponds to only approximately 20% of total R&D investments for the energy sector.[5]

7. In the global landscape, emerging economies are becoming more and more active in R&D for renewable energy technologies. Increasingly on the technology supply side, innovation in renewable energy technologies is not confined to a few developed countries. Most high-tech products include

[1] Based on data from: IRENA (in press) REmap 2.0. End use sectors (buildings, industry and transport) shares refer to fuel consumption only and excludes renewable electricity and district heat consumption.
[2] OECD (accessed on 10 December 2015) Research and Development Statistics. Available at: http://www.oecd.org/innovation/inno/researchanddevelopmentstatisticsrds.htm
[3] N.B. Some countries, as the USA, spend parts of the budget for defense in R&D for clean energy.
[4] FS-UNEP (2015) Global Trends in Renewable Energy Investment 2015
[5] IEA (2015) Key trends in IEA public energy technology research, development and demonstration (RD&D) budgets

components from multiple countries. For PV technologies, for example, Japan and USA have historically led in terms of patents filed. However, in the last 5 years China has taken the lead. From 2010 till now China has filed around 16,500 patents, while USA and Japan around 12,000 each. In wind power, from 2005 till today China has filed more than 23,000 patents while USA and Japan together around 18,000. In biomass, Brazil is one of the world leaders on RD&D. In 2014 China was the country which invested increased public funding in R&D for renewables, with 1.7 billion USD. Simultaneously, on the technology demand side, many emerging economies currently seek new sustainable solutions to satisfy their growing energy needs, also creating new market opportunities for renewables-based solutions.

8. IRENA's work highlights that international collaboration on R&D for renewable energy requires a system perspective, which brings decoupled technology breakthroughs together into system solutions for the energy sector. The establishment of cooperative networks also increase the efficiency in the use of resources for R&D. Analysis on cooperative RD&D for Latin America and the Caribbean, identified a number of priorities to foster the deployment of renewables in the region, including the exchange of information on RD&D plans and activities among policy makers, researchers and market actors.

Developing strategies for international cooperation on RE innovation

9. A strategy for international cooperation on renewable energy technology should consider the role of all actors. All over the world research institutions, companies, and governments alike are intensifying their investments in energy research, development, and demonstration (RD&D). Countries and firms that attempt to go it alone in developing new energy technologies and bringing them to market are likely to be left behind by those who are sharing in the global flow of ideas and resources. Considering the scope of innovation both within and outside of government, cooperation is always balanced with competition. The intensified competition in clean energy technologies is today's reality. But cooperation can occur in the midst of competition and, indeed, can strengthen the competitive position of the countries that are pooling their resources to make new breakthroughs.

10. International cooperation can be a powerful tool for serving the common interest in energy innovation; drawing ideas and experiences from many sources, pooling resources, taking advantage of the best locations to carry out RD&D projects or technology demonstrations, and more. To increase the effectiveness of international collaboration initiatives, it would be useful to identify the key technology innovation needs, map the ongoing and planned R&D activities in different countries, as well as the gaps in R&D support. This would create a shared common understanding of what could be achieved and where to focus international efforts in order to deliver the technology required.

11. One of the challenges for Mission Innovation and the Breakthrough Energy Coalition is to use cooperation to advance global interests. Innovation activities take place across multiple agencies and ministries, laboratories and industry firms. Most international RD&D cooperation is not under government control, but pursued through autonomous academic or private collaborations. There are already countless bilateral and multilateral agreements in place that shape the international landscape. Ultimately, in an increasingly complex and fast-paced international energy innovation environment, coordinated and target oriented cooperative efforts would help achieve the highest outcome from

limited resources available. Hence, the need to discuss the elements for a coherent approach to support internationals efforts for the accelerated development, commercialisation and deployment of innovative technologies for a renewables-based energy system.

Guiding Questions

- How can international cooperation help to increase efficiency and effectiveness of public and private investments in renewable energy RD&D?

- What is best practice in RD&D for renewables?

- What technology and non-technology aspects should be emphasised? System integration, resources potential, improved technology, innovating in business models and finance, innovative policy instruments

- How to engage the private sector in an international public-private collaborative framework that helps driving the global R&D agenda?

- What role can IRENA play to strengthen the international cooperative framework for innovation in renewables?