KEY FINDINGS

- In 2010, renewable energy use in the Russian Federation (hereinafter also referred to as "Russia") was dominated by hydropower in the power generation sector, while bioenergy dominated heating in industry and buildings (including district heat generation). In 2010, hydropower accounted for 70% of the total final renewable energy use of 0.6 exajoules (EJ). Bioenergy accounted for most of the remaining 30%. In the same year, renewable energy's share in Russia's total final energy consumption (TFEC) was 3.6%.

- By the end of 2015, total installed renewable power generation capacity reached 53.5 gigawatts (GW), representing about 20% of Russia's total installed power generation capacity (253 GW). Hydropower represents nearly all of this capacity, with 51.5 GW, followed by bioenergy, with 1.35 GW. Installed capacity for solar photovoltaic (PV) and onshore wind amounted to 460 MW and 111 MW, respectively.

- Based on consultation with the Russian government and relevant stakeholders, this report identifies four main drivers which Russia could consider to accelerate the uptake of renewables in its energy mix: economic activity and job creation; science and technology development; energy supply to isolated areas; and improving the quality of the environment.

- In the draft Energy Strategy of Russia for the period up to 2035 ("Energy Strategy to 2035"), Russia has prepared a detailed projection of its energy use by sector and fuel. Based on the calculations which take into account the latest draft of this strategy and other sources, the Reference Case takes Russia's renewable energy share in its TFEC to 4.9% by 2030. This includes Russia's plan to expand its total solar PV, onshore wind and geothermal capacity to 5.9 GW by the end of 2024.

- In the Reference Case, total final renewable energy use nearly doubles from 0.6 EJ in 2010 to 1.1 EJ in 2030. This consumption would be equivalent to 5% of the country's total energy demand in 2030. Total final renewable energy use includes the consumption of power and district heat from renewable energy sources, renewable transport fuels and renewable fuels for cooking as well as water, space and process heating. The Reference Case renewable energy use continues to be dominated by hydropower, which represents more than half of all final renewable energy use. Given the country's large biomass resource availability, biofuels gain a larger market share for heating and transport, accounting for nearly half of all renewable energy use by 2030. Other renewable energy resources (i.e. solar PV, wind, geothermal) contribute 4%.

- Under REmap – the case that considers the accelerated deployment of renewable energy in the Russian energy mix – the share of total renewable energy increases to 11.3% of TFEC by 2030. REmap assumes a mix of renewable energy technologies in both power and end-use sectors. In REmap, the renewable energy share is estimated to be highest in the power generation sector, at about 30% in 2030. This is split into 20% hydropower and 10% wind, solar PV and geothermal renewable power. In the heating sector, the share of renewable energy would be approximately 15%. Transport would see the largest increase with renewable energy's share reaching 8% by 2030, compared to 1% in 2010.

- Under REmap, onshore wind capacity attains 23 GW, solar PV rises to 5 GW and bioenergy reaches 26 GW by 2030. Total installed hydropower capacity reaches 94 GW by 2030. Total renewable power generation grows nearly threefold between 2010 and 2030, from 169 terawatt-hours (TWh) to 487 TWh per year in the same period. This includes about 100 TWh of renewable power available for export to Asian countries from 30 GW of installed hydropower and onshore wind capacity.

- Under REmap, total primary bioenergy demand amounts to 2.4 EJ per year by 2030. This compares with the country's total supply potential, which starts at more than 2 EJ (similar to the level of all

demand in 2030) and reaches 14 EJ, according to IRENA. This large range depends on the extent to which forest-based biomass feedstock is available. The large availability of biomass feedstock relative to demand is a favourable outcome, as it indicates the availability of additional resources that can be used for exports. Ensuring the supply of energy crops and biogas feedstocks, however, will be critical, as by 2030, demand for them under REmap reaches the limits of their supply.

- Under REmap, the average annual investment required to fulfil the renewable energy mix is estimated at USD 15 billion per year between 2010 and 2030. Investments for renewable power generation capacity account for nearly all of this, at USD 13 billion per year (excluding transmission and distribution infrastructure). The remaining USD 2 billion per year is for renewable energy capacity in end-use sectors.

- Implementing all REmap Options identified in this working paper would require an average substitution cost by 2030 of USD 8.7/gigajoule (GJ) of final renewable energy. This is the additional cost of all renewables to the Russian energy system that are identified under REmap. This cost is from a business perspective that assumes an 11% discount rate, a crude oil price of USD 80 per barrel and a wholesale natural gas price of USD 3.3 per million British thermal units (MMBtu). Gas is the main fuel assumed to be replaced in the power and heat generation sectors. While solar PV and onshore wind are economically viable in isolated regions, in 2030, they remain more expensive in the wholesale market. This is due to the low natural gas price assumption. Decentralised heating in buildings and for industrial processes is close to cost-competitiveness in 2030, provided that low-cost biomass feedstocks are used for generation.

- When externalities related to human health and climate change are accounted for, renewables identified under REmap can save up to USD 8 billion per year by 2030.

- A number of areas require further attention to realise the potential estimated in this working paper. These include: the continuation of long-term energy planning; the integration of renewable energy into existing energy policies and their implementation; minimising investment and market barriers for solar PV and wind to accelerate uptake at their early stages of deployment; and the creation of a reliable and affordable market for bioenergy.

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