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Group of Experts on Energy Efficiency

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Regulatory and policy dialogue addressing barriers to improve energy efficiency

Pathways to Sustainable Energy – Policy Recommendations from the Group of Experts on Energy Efficiency

Note by the secretariat

Summary

Improvement in energy efficiency – an important objective of public policy to stimulate transition to a sustainable energy system, yet only one of the targets of the Sustainable Development Goal 7 "Ensure access to affordable, reliable, sustainable and modern energy for all" of the 2030 Agenda – is widely regarded as one of the most cost-effective options for meeting growing energy demand, ensuring more rational use of energy, economic well-being and improved quality of life, and contributing to a better environment and to energy security in most countries.

Recognizing the role of energy in the modern society and broader benefits of transitioning to sustainable energy, the member States of the United Nations Economic Commission for Europe (ECE) conceived a project entitled "Strengthening capacity of the ECE member States to achieve the energy-related Sustainable Development Goals" ("Pathways to Sustainable Energy"), with its objective to help countries develop, implement and track national sustainable energy policies aligned with international agreements and to further support higher-order goals to contribute to climate change mitigation and sustainable development.

This document is informed by the outcomes of this project, summarizes the input of the Group of Experts into the process and is designed to provide information on viable energy efficiency policies to facilitate attainment of sustainable energy in the ECE region.

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I. Background

1. The 2015-2020 project "Strengthening capacity of the ECE member States to achieve the energy-related Sustainable Development Goals" ("Pathways to Sustainable Energy") was funded by the Russian Federation with in-kind contributions from Germany and the United States and was overseen by the Committee on Sustainable Energy.[1]

2. The project developed a policy tool to help countries make informed decisions to attain sustainable energy. The approach combined modelling of energy scenarios with policy dialogue, technology research, and development of an early-warning system concept to monitor and forecast if achievement of sustainable energy objectives is on track.

3. As attainment of sustainable energy is a complex social, political, economic and technological challenge, an inclusive dialogue among the ECE member States represented the means of how to collectively overcome it, and constituted an important step forward by highlighting trade-offs and synergies between the Goals and Targets of the 2030 Agenda, national energy security concerns, quality of life and social aspects, and environmental and economic objectives.

II. The Modelling Exercise and Policy Scenarios

4. The project defines "Sustainable Energy" through three pillars that embrace the Sustainable Development Goals: Energy Security ('Securing the energy needed for economic development'), Energy and Quality of Life ('Provision of affordable energy that is available to all at all times'), and Energy and Environment ('Minimize impact of energy system on climate, ecosystems and health'). Relevant targets of the 2030 Agenda align with these pillars and highlight the inter-connection among the different facets of sustainable energy.

5. The integrated energy and climate models assume an economic growth and apply trends in energy consumption to determine the overall energy demand. The models satisfy this demand by selecting the lowest cost energy mix including the time required to install any new capacity consistent with meeting any cap on emissions set by a policy scenario.

6. Three modelling institutions – the International Institute for Applied System Analysis (IIASA), the Pacific North West National Laboratory (PNNL) and the Fraunhofer Institute – were engaged, and two integrated assessment models – the Model for Energy Supply System Alternatives and their General Environmental Impacts (MESSAGE, an optimisation model that is based on the premise that supply must meet predetermined demand at minimum system costs) of IIASA and the Global Change Assessment Model (GCAM, an equilibrium model that clears markets through iterative price adjustments and feedback loops) of PNNL – were employed, interplay of which provided a unique approach in this scenario-based energy system modelling exercise and strengthened the robustness of its results.

7. The modelling results are based on exploring three distinctive scenarios:

(a) Reference Scenario (REF), which is based on the Shared Socio-Economic Pathway and does not include climate mitigations policies or measures other than those existing in 2010;

(b) Nationally Determined Contributions Scenario (NDC), which is based on Nationally Determined Contributions as pledged under the Paris Agreement up to 2030, and on the assumption that these are maintained effectively up to the projection horizon;

(c) P2C Scenario (P2C), which assumes that the carbon dioxide constraints consistent with the Nationally Determined Contributions under the Paris Agreement are to continue beyond 2030 thus allowing to stay below two degrees above pre-industrial level by 2100.

8. Within each of the scenarios, the sensitivity of the model to the choice of technology was based on a view of costs and timescale for deployment of the selected technologies. The

[1] See https://www.unece.org/energy/pathwaystose.html and https://www.unece.org/energy/se/com.html

costs used in the model are investment and operating costs excluding research and development, government investment and technology learning costs as well as economic incentives for accelerated technology uptake. The sensitivity of the model to a technology was examined in each scenario to understand the impacts of alternative technology options on policies.

III. Modelling Outcomes in Relation to Energy Efficiency

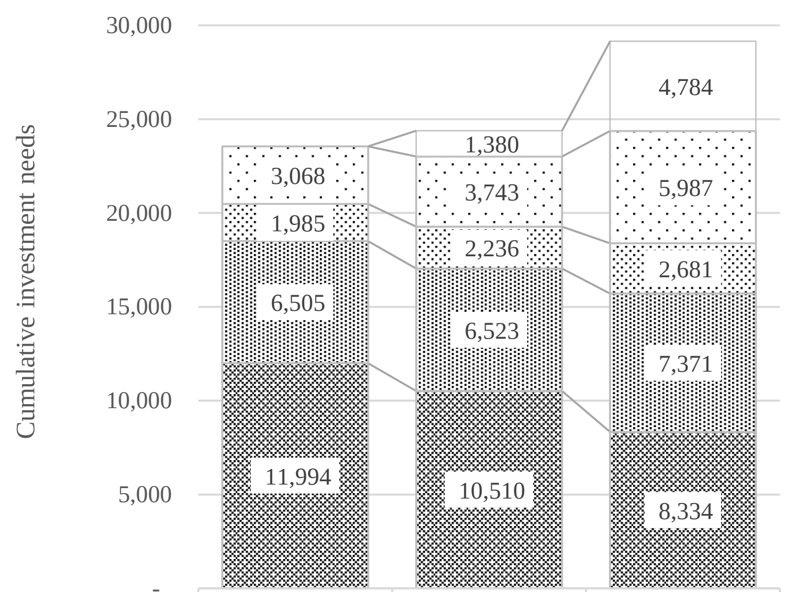
9. The analysis shows that the sustainable energy in the ECE region cannot be achieved unless there are significant trade-offs, provided the share of fossil fuels in the energy mix in the ECE region equals to 80 percent. Fossil fuels remain vital for the majority of the ECE member States as the means to maintain energy security and ensure economic well-being. A transition to sustainable energy systems that may support the target of staying below two degrees Celsius above pre-industrial level through, *i.a.*, reducing the above share, is an ongoing process which is in most cases impacting energy prices; as this is highly unlikely that vast population sacrifices quality of life ambitions in favour of climate targets, at large the structural change in the energy systems in the ECE region remains sporadic.

10. After years of debating climate change, the world is arguably still on a path to global average temperatures that are above the pre-industrial levels by four to six degrees Celsius, and the longer structural and policy reforms are delayed the more expensive these reforms will be, with considerable part of expenses to be eventually borne by the societies. Transitioning to a sustainable energy system comes with its cost, and the models employed in the project show that by 2050 the countries of the ECE region need to invest in a broad range of technologies, including for carbon sequestration options with increasing the absorptive capacity of forests at first instance. However, transitioning does not prove feasible solely on the back of existing or emerging energy technologies; and – an essential point to observe – deployment of energy-efficient technologies and introduction energy efficiency measures themselves cannot lead to achievement of the set objective, too.

11. The modelling exercise, nonetheless, suggests that energy efficiency must be pursued as a basis for systemic efficiencies, *i.e.* improvements in production, transmission, distribution and consumption of energy; and energy efficiency should be the core element of an energy system if the world is to meet the two-degree target. An advantageous combination of those measures mentioned thereof may ultimately lead to limiting growth of, or even reducing, total final energy consumption (TFC) in the ECE region. Specifically – from the referenced 2010 level of 156.88 EJ – the REF scenario suggests TFC increase to 202.35 EJ by 2050, the NDC scenario – to 193.38 EJ, whereas the P2C scenario predicts a TFC decrease to 153.22 EJ. Essentially, with certain scenario-conditioned deviations the TFC structure remains almost unchanged in 2050, with approximately 9 percent attributed to non-energy use, 22 percent to industry, 33 percent to transport, and 36 percent to residential and commercial sectors.

12. Considering cumulative investment for 2020–2050 in the energy system of the ECE region, both NDC and P2C scenarios suggest that energy efficiency emerges as a separate, significant component of the investment structure, and there is a clearly visible shift from upstream investments and fossil electricity generation to expenditures in, *i.a.*, energy efficiency, as shown in Figure I.

Projected cumulative energy system investment needs in the ECE region in 2020–2050, by scenario, billion US$



	REF	NDC	P2C
Energy efficiency	-	1,380	4,784
Electricity generation	3,068	3,743	5,987
Heat, hydrogen, refining, bioliquids, storage, etc.	1,985	2,236	2,681
Transmission and distribution	6,505	6,523	7,371
Extraction of fossil fuels	11,994	10,510	8,334

13. In other words, the most ambitious P2C scenario (to maintain the level of below two degrees Celsius above the pre-industrial level within the period of up to 2100) claims the necessity of additional 5,605 billion US$ of cumulative energy system investment (as compared to REF) in 2020–2050, to reach approximately 29,158 billion US$, of which 16.4 percent should be allocated to improvements in energy efficiency. According to the NDC scenario (assumes infinite maintenance of national pledges under the Paris Agreement), energy efficiency investments account for 5.7 percent of the projected cumulative investment of 24,391 billion US$.

14. Importantly, the results from the modelling of energy scenarios indicate that at least before 2050 there is no economically rational scenario that involves a reduction in the share of fossil fuels below 50 percent in the energy mix of the ECE region. Energy efficiency improvements, in turn, may mitigate the inevitable challenges of energy affordability amid progressively putting pressure on, *i.a.*, the energy supply side and operational efficiencies of power plants.

15. The analysis shows that a sustainable energy system, again, must be designed with systemic efficiency as its core value, with energy conservation and energy efficiency being the core elements, and productivity improvements in production, transmission, distribution and consumption of energy being addressed as a priority. Such measures also protect the population from energy price increases resulting from reducing the carbon footprint of the energy sector in the ECE region.

16. In this context, additionally, the modelling results suggest that the current climate pledges are insufficient to meet the two-degree target of Paris Agreement. It is estimated that meeting it necessitates cutting or capturing of at least 90 gigatonnes of carbon dioxide in the ECE region by 2050. Yet acknowledging a comparably high level of economic development of its member States, the ECE region may need to become carbon-negative by 2050. This concept, however, was not this project's reference and thus might be elaborated further.

IV. Conclusions and Policy Recommendations

17. As regards the conducted modelling exercise, its results and related consultations held, the conclusions on possible ways of accelerating transition to sustainable energy systems in the ECE region from the energy efficiency standpoint are as follows:

(a) Optimizing energy use, both at generation and consumption levels, is an already occurring process driven by technology development and behavioural changes. However, its rate is lower than energy demand increase. It therefore provides a rationale for valuing energy efficiency as energy source of its own right, the first fuel that hence should be considered before investing in new production and supply infrastructure. Possibilities to improve energy efficiency in production, transmission, distribution and consumption of energy as much as it proves operationally, technically, and economically feasible, should be given priority before investing in energy supply infrastructure;

(b) Appropriate energy efficiency improvement solutions should be widely available to ensure their broader deployment for higher-profile, notable results. This raises the issues of, i.a., improving technological exchange and addressing the communication gap between providers and potential end-users of solutions to make better use of the existing available resources, including improving collaboration between government and industry;

(c) The industrial sector is responsible for about one-third of the global final energy consumption and carbon dioxide emissions. The challenge is how to bring about a continuous reduction of emissions, while simultaneously supporting global economy. It is estimated that by only implementing existing best-available technologies and practices industry could reduce its energy consumption by about 30 percent at constant output, and this potential doubles when considering future technological innovation. Energy efficiency in the industry sector already has been proven, as it brings financial benefits to the companies not only by the value of the energy saved, but also of increased productivity due to process optimization. It is recommended that in addition to improving energy efficiency in the industrial sector, a clear target for energy reduction (conservation) to be defined in specific energy intensive industries;

(d) Residential sector is central to meeting the sustainability challenge. In the developed world, approximately one third of total final energy consumption and almost 40 percent of carbon dioxide emissions result from the energy services required in buildings. Improving energy efficiency in buildings is an opportunity to ensure access to affordable, reliable, sustainable and modern energy, build resilient infrastructure, make cities and human settlements inclusive, safe, resilient and sustainable, ensure sustainable consumption and production patterns, and take action on climate change. Technical solutions to improve energy efficiency in residential and commercial sector exist and can transform buildings to align with the highest standards of health, comfort, well-being and sustainability, including improving energy productivity and reducing emissions. Their deployment requires standards, supporting measures and enforcement mechanisms, as well as technical capacity, improved consumer knowledge, and a holistic and consistent policy approach that involves a variety of stakeholders. The residential sector should have clear targets in achieving sustainability within this century: it is recommended that by 2050 all new builds reach passive house standards as design prerequisite, and by 2075 all new builds are ‘plus energy’;

(e) Compulsory fuel economy standards played a pivotal role in boosting efficiency of road vehicles. Carbon taxes have only a limited impact on the cost of mobility. Change in customer preferences coupled with the speed of innovation and commercialization of new technologies, such as electric vehicles, biofuels and hydrogen, are expected to drive further reduction of carbon footprint of transport. In urban areas, transport mostly consists of commuter transportation for short distances, and this could be addressed with proper planning of city infrastructure and transport efficiency. Large freight transport remains a challenge due to the volume and complexity of the transportation system.

18. With reference to the above, it is considered appropriate to set forward the following policy recommendations:

(a) Governments need firm commitment at investing in energy efficiency improvements before investing in increasing energy production and supply infrastructure. ‘Energy efficiency as the first fuel’ should guide sustainable development at national level;

(b) Set clear targets to reduce overall energy consumption according to determined plans (e.g., by 15 percent in 2050 compared to 2020).

(c) On energy efficiency in buildings:

(i) Develop progressive energy efficiency retrofit schemes for residential sector and introduce stringent building standards;

(ii) Set target for energy efficiency retrofits for the existing residential buildings (e.g., 5 percent of building stock to be retrofitted annually);

(iii) Mandatory standard for new buildings’ energy consumption to be set at 40 kWh/m²/year by 2035, then gradual shift to net-zero energy buildings by 2050, and ‘plus energy buildings’ by 2075; all public buildings to be net-zero energy buildings by 2035;

(iv) All energy intensive appliances to be programmable based on open standards framework;

(v) Building materials should be recycled, reused and have clear indication of the value chain with regards to energy usage and materials.

(d) On energy efficiency in industry:

(i) Initiate national programmes and encourage private sector to prioritise improvements in energy productivity for industrial processes;

(ii) Set clear targets for energy intensity (based on what is achievable when using the best available technologies) and for energy reduction (annual percentage); phase-off inefficient technologies (set a clear target to be achieved by a specific year), and; introduce mandatory energy management systems by 2035;

(iii) Invest in research and development for energy intensive technologies (set target as a percentage of revenue invested in research and development aimed at substitution of the existing inefficient technologies).

(e) On energy efficiency in transport:

(i) Develop progressive mobility solutions as part of city planning, to reduce carbon intensity of transport; specifically, promote new technologies to reduce all types of travel, increase the use of shared commuter transport and bicycle schemes;

(ii) Phase-off all oil vehicles according to action plans (e.g., by 80 percent by 2050, and by 100 percent by 2060), phase-off all urban public transportation on oil according to action plans (e.g., by 80 percent by 2030, and by 100 percent by 2040);

(iii) Increase research and development for large freight transport and rural area transportation.

(f) On new business models:

(i) Develop business models with focus on increased energy efficiency and savings, e.g., ‘negawatt pricing’ and/or ‘carbon saving pricing’;

(ii) Promote business models that allow for investments, which can deliver more services for the same amount of energy input, or the same services for less energy input.