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**Carbon neutrality as a pathway to sustainable energy**

# Carbon neutrality through synergies between gas and renewable energy

## Note by the Group of Experts on Gas

## I. Introduction

1. This document is a summary of a larger study, prepared by the Group of Experts on Gas, in consultations with the Group of Experts on Renewable Energy. The study discusses trends, developments, scenarios, and case studies dealing with the interactions between natural gas and the intermittent renewable energy sources. Its integral version is available at the United Nations Economic Commission for Europe (ECE) natural gas website as a pdf document.

2. In 2015 the United Nations General Assembly agreed a set of 17 sustainable development goals (SDGs) to be achieved by 2030. The SDGs address all three dimensions of sustainable development (environmental, economic and social) and are fully integrated into the United Nations global development agenda. One of these goals – SDG 7 – covers affordable and clean energy.

3. Achieving SDG 7, at least on paper, appears to be a simple matter. In practice, however, reconciling often conflicting environmental, economic and social priorities is a daunting task in any given country, let alone on regional or global levels where different economic, social and political circumstances dictate radically different approaches. The SDG 7 has set five targets for the United Nations Member States to achieve. Among them are to:

(a) Increase substantially the share of renewable energy[1] in the global energy mix (target 7.2);

(b) Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced

[1] Although from a legal and technical perspective the concept of renewable energy is very wide and covers many different technologies, in practice the term "renewable energy" it is commonly identified basically with renewable electricity produced out of wind and sun. This document advocates extending the common concept of renewable energy to cover not only solar and wind electricity, but also non-electric renewable energy, mainly renewable gases, such as renewable hydrogen and biomethane. Liquid biofuels are not considered for the purpose of this document.

and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology (target 7.A).

4. This document explores the interplay between the interrelated targets 7.2 and 7.A, arguing that a deep and genuine transformation of today's energy system could be greatly facilitated by harnessing synergies between the traditional and emerging energy sectors–in this case natural gas and renewable energy. These synergies could be stated as:

(a) The natural gas infrastructure could accelerate the deployment of variable renewable energy (VRE) sources;

(b) The renewable, low carbon and decarbonized gases[2] should soon become an important energy vector.

5. The 2015 Paris Agreement aims to limit the increase in the global average temperature to well below 2°C above pre-industrial levels. To achieve this objective, global greenhouse gas (GHG) emissions, particularly carbon dioxide ($CO_2$), will need to be reduced substantially. The current discourse on the transition to a decarbonized energy system future is dominated by renewable energy solutions. However, the initial conditions for this transition may vary across different regions and countries. Today in the ECE region—as in the rest of the world—about 80 per cent of energy comes from fossil fuels. Even under a scenario that meets the 2°C target, fossil fuels will still account for at least 56 per cent of the region's energy mix by 2050.[3] Accelerated decarbonisation is therefore a must.

6. The September 2019 Climate Action Summit reinforced the 1.5°C goal as the socially, economically, politically and scientifically safe limit to global warming by the end of this century, and net zero emissions by 2050 as the global long-term climate objective for all. Countries need to urgently accelerate work to define what this entails for the short-term (2020) and mid-term (2030) commitments that will be captured in their Nationally Determined Contributions (NDC) and ensure the alignment of strategies to meet those commitments.

7. With the above in mind, at its 28th session held in September 2019, the Committee requested the Group of Experts on Gas (GEG) and the Group of Experts on Renewable Energy (GERE) to support ECE member States in assessing the synergies between renewable energy and gas. The outcome of this report could be used, in a second stage, to propose and develop policies aimed to:

(a) Harness the above-mentioned synergies between renewable energy and gas;

(b) Accelerate development and deployment of renewable/decarbonized gas projects and seek extra budgetary funding continued work in this crucial field.

8. The Group of Experts on Gas holds the belief—shared to an extent by the Group of Experts on Renewable Energy—that under certain circumstances and in some ECE member States gas represents the shortest and least-cost path towards decarbonizing the energy sector and increasing its overall efficiency.

# II. Conclusions and Recommendations

## A. Conclusions and guiding principles on which the recommendations are based

9. The strong business case for VRE technologies such as wind and solar photovoltaic (PV) has positioned these technologies at the core of the energy transition.

[2] Renewable gases are produced by using renewable electricity (e.g. renewable hydrogen is produced when using renewable electricity through a power-to-gas facility) and/or as a result of bio-chemical processes using different types of biomass. Decarbonised gases and low-carbon gases are produced through different technologies with very low carbon emissions, including carbon capture and storage.

[3] UNECE Pathways to Sustainable Energy.

10. There is ample evidence that VRE and fast-reacting generation technologies, such as natural gas, appear as highly complementary and that they should be jointly installed to meet the goals of cutting emissions and ensuring a stable and resilient power supply.

11. Gas-fired power generation has enabled VRE diffusion by providing reliable and dispatchable capacity to hedge against variability of renewable supply.

12. The flexibility of the overall power system will need to be increased as the share of VRE reaches higher levels.

13. Innovations being trialled in front-running countries show that power systems can be operated with very high shares of VRE in a secure and economical way.

14. Flexibility can be provided through a number of technological options; the least-cost options available to individual grids depend on the overall flexibility of the grid because of the generation mix (including the renewable energy penetration), regulatory structure, presence or absence of markets, operational practices, and institutional structures. A better understanding of the least-cost mix of generation sources is needed for identifying and evaluating the available solutions to deal with higher levels of wind and solar energy. Certain generation technologies are inherently more flexible than others, for example gas-fired generation as the main option for providing large amount of cost-efficient flexibility among all the available of technologies.

15. Sector coupling and sectoral integration can offer important added value in the decarbonisation process of the European Union (EU) energy system, by contributing to the increasing flexibility needs and to the reliability of the energy system, and by reducing the global costs of the energy transition.

16. The role of new gases will be crucial in integrating VRE while advancing in the decarbonisation process. The new gases will facilitate decarbonisation of different economic sectors, especially those more difficult-to-electrify.

## B. General recommendations to the ECE member States, energy industry, and other stakeholders

17. In developing these recommendations, the Group of Experts on Gas worked under the auspices of the Committee on Sustainable Energy, in close collaboration with the Group of Experts on Renewable Energy.

18. The recommendations outlined below are based on the belief that a successful transition to an affordable and clean energy system of the future will require that both traditional (in this case natural gas) and emerging (renewable energy/electricity) sectors fulfil their decarbonisation potential. The recommendations take a wider perspective on how gas could improve the energy efficiency of the energy system. They highlight the comparative advantages of gas in terms of flexibility and efficiency and identify its optimal combination with renewable energy, from the perspective of enhancing energy efficiency and decreasing emissions and energy industry’s carbon footprint:

(a) **Recognise the value of the flexibility provided by gas-fired power plants**: In some countries with low demand growth, the shift to high shares of VRE has led to a considerable reduction in the utilization of conventional power capacity. When VRE installations are generating electricity, conventional plants (mostly gas-fired because of their flexibility) are forced to reduce output and move into a load-following mode. In some countries, the loss of revenues for gas-fired power plants has led to write-downs and, ultimately, to the decommissioning of some plants, as well as lack of appetite for new investment. This negative impact on existing gas-fired generation has potential implications for longer term adequacy and stability of the power grid as a consequence of the reduced investment in dispatchable and flexible plants. Solutions to remedy this situation should be proposed and could be applied by authorities in countries at the beginning of a planned VRE scale up. The underlying concept is that certain services—such as firm capacity and flexibility—are essential in a system with high VRE penetration, and the value of these services should be recognized and compensated. The value of flexibility in the system should be recognized through policy and regulation, and remuneration mechanisms for flexible capacity. For the most part, flexibility requirements should be technology-agnostic in the absence of a strong reason to use a specific technology. The close link between scale-up of VRE and natural gas-fired power generation in many countries may lead to additional gas supply flexibility requirements. Policy-makers, planners, and system operators must coordinate closely to achieve security of gas and electricity supplies;

(b) **Take into account the impact of variability from VRE on natural gas demand:** the variability in gas-fired power generation associated with an increasing share of VRE can have implications on the gas demand and on the gas infrastructure system. The close link between a scale up of VRE and the use of gas-fired power generation to provide power system flexibility may imply the need for additional flexibility on the gas supply side. Policy-makers, planners, and system operators in the electricity and gas sectors need to consider the impact on the natural gas sector of high levels of VRE, and coordinate closely on planning, infrastructure investments, and operating rules, to achieve security of gas and electricity supplies;

(c) **Set up a policy and regulatory framework to enable a Hybrid Energy System:** Ensure a strong cooperation between gas and electricity grid operators to increase the visibility of the new flexibility resources that could provide services to the system, including not only gas-to-power but also power-to-gas. Further progress towards integrated planning of gas and electricity networks would be advisable. Some degree of regulatory alignment between gas and electricity would be also appropriate. Any new energy infrastructure (gas and electricity) should be future-proof and consider interlinkages between gas and electricity;

(d) **Implement an adequate regulatory framework for VRE integration**: Finding the optimal VRE integration approach requires designing the regulatory interventions in order to minimize overall energy system costs subject to meeting performance targets, rather than minimizing the costs of VRE generation alone;

(e) **Be flexible in the planning process**: Planning for flexibility is a complex multi-step process that needs to account for a variety of factors that, together, form a complex mathematical problem that can only be solved using appropriate tools. Assessment of current flexibility is key as it creates the foundations for a least-cost, long-term pathway for a flexible power system that is ready to incorporate significant shares of VRE;

(f) **Get ready in advance for short-term imbalances**: A comprehensive approach to planning can help to minimize VRE integration costs for the power system. The growing share of VRE must be taken into account in gas and power systems planning to make sure that development plans and specifications for both VRE and flexible conventional generation are aimed at achieving the least cost for the overall energy (gas & power) system functioning. This planning will take into account that the performance of a power system is modelled at timescales, ranging from years to fractions of a second, and across spatial regions, from a local area to the whole system. Some of the potential issues associated with VRE variability and limited predictability occur at timescales that are typically assessed in short-term simulations;

(g) **Take advantage of the existing gas flexibility**: Countries should anticipate future power system needs. Ensuring cost-effective integration of VRE at scale requires balancing present needs (a focus on deployment of renewable generation technologies) with future needs (a focus on integrating high shares of VRE). Difficult trade-offs exist between quick wins and long-term strategies. In targeting high levels of renewable deployment and integration, policy makers should not focus on quick wins alone. They need to look ahead to a time when renewable energy deployment is already ubiquitous and design the markets and the energy system around this future. Unlocking existing flexibility provided by gas-fired plants is the first action to be taken; the restructuring of markets and operations is key. Regulation can be a barrier and requires attention;

(h) **Promote sectoral integration**: couple the electricity, gas and end-use sectors. Create synergies between renewable power supply, the electricity grid, the gas grid, the electric mobility, heating and cooling, intensive industry, etc. Valuable synergies exist between these different sectors that must be harnessed with the aim of wider societal changes, reducing emissions and improving overall energy system efficiency at the lower possible cost. Make further progress towards integrated planning and operation of different parts of the energy system;

(i) **Foster research, development and innovation** since they are needed to develop the existing technologies and facilitate pilot projects. The concept of "regulatory sandbox" could be applied to support scalability. "Regulatory sandboxes" will allow actors to experiment and test innovations without being restricted by either the existing regulatory environment or the lack of a proper regulatory framework which is still not implemented. Innovation needs to engage different actors from both the public and private sectors and across developed and developing countries. Knowledge and experience should be shared more widely. There is ample opportunity to learn more from other sectors and from different players. Interplay with industrial segments that are not considered part of the energy sector could bring great opportunities to harness synergies;

(j) **Establish principles for how to transport new gases (hydrogen, biomethane and others) whilst maintaining a non-fragmented market where all gases can be traded:** it will be necessary to set the right regulatory framework which allows for construction of new hydrogen pipelines, the conversion of existing gas pipelines into pure hydrogen pipelines, the injection of hydrogen (up to certain levels), biomethane and other new gases into the existing natural gas pipelines, and the integration of existing hydrogen pipelines into the new gases system to avoid fragmentation in the new gases market;

(k) **Clarify market access and grid access rules** for renewable, decarbonised and low carbon gases to the gas grid, as well as technical rules for their injection and blending with natural gas. Set up the national legislation and technical rules to facilitate the connection of new gases plants (e.g. biomethane, P2G) to the gas grid;

(l) **Manage gas quality in a proper way**: with the penetration of new gases, a coordinated approach for managing the changes and possibly fluctuating gas compositions would be appropriate. Measures need to be adopted to avoid market fragmentation and technical barriers. Technical and regulatory coordination is necessary to facilitate cross-border gas. Precise and quick exchange of gas quality data will be crucial – applicable for guarantees of origin and certificates for the various types of gases, operating the gas systems, providing information to end-user appliances as well as for ensuring fair and transparent billing processes;

(m) **Implement standardised GOs/certificate frameworks across the ECE region for renewable, decarbonised and low-carbon gases**. Ensure the transferability of GO/Certificates from one energy carrier to another (molecules and electrons). Make GO/Certificate framework for gas compatible with the existing regulations in every country;

(n) **Support the development of a hydrogen market** which will be needed to ensure sufficient cost-reductions for hydrogen to play a significant role in the future energy system;

(o) **Widen the concept of "renewable energy**": this requires a change of mind-set. The "renewable energy" concept should no longer be commonly identified with variable renewable electricity (basically solar and wind) but it should be enlarged to cover both electric and non-electric renewable energy (such as biomethane and renewable hydrogen). This is more important in view of renewable gases expanding an occupying a significant place in the future energy mix;

(p) **Introduce a "new gases" terminology**: introduce the terms renewable, decarbonised and low-carbon gases in legal texts and include them as part of the solutions to achieve the climate and energy goals;

(q) **Enable synthetic methane to be classified as a renewable energy**. However, guidance is needed to avoid double counting of $CO_2$ reduction between the provider and the user of $CO_2$;

(r) **Deploy a digitalization environment**: managing properly this element is an essential task to achieve the accomplishment of a Hybrid Energy System (gas and electricity);

(s) **Share knowledge and experiences across the ECE region**: Countries beginning to deploy VRE should implement well-established best practices to avoid integration challenges, especially when moving beyond VRE specific shares (> 10%) of annual VRE generation.