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Attaining Carbon Neutrality

Framework for attaining carbon neutrality in the United Nations Economic Commission for Europe (ECE) region by 2050

Note by the Task Force on Carbon Neutrality

Summary

This document is developed by the United Nations Economic Commission for Europe (ECE) Task Force on Carbon Neutrality as part of implementation of the extrabudgetary project on "Enhancing the understanding of the implications and opportunities of moving to carbon neutrality in the ECE region across the power and energy intensive industries by 2050" (Carbon Neutrality project).

The document develops the carbon neutrality framework for the ECE region with a focus on the power sector and energy intensive industries by defining carbon neutrality, the elements and scope of a carbon neutrality framework, and targets for the ECE region and its sub-regions. The carbon neutrality framework for the ECE region will serve as a basis for further Carbon Neutrality project implementation by the Group of Experts on Cleaner Electricity Systems (Group of Experts).

This document will be refined at the workshop on Framework on Carbon Neutrality on 24 September 2020. The document is prepared for the Group of Experts and will be discussed at the workshop on "Attaining Carbon Neutrality" at the sixteenth session of the Group of Experts on 24 November 2020. The Group of Experts will report the findings from the workshop to the Committee on Sustainable Energy at its twenty-nineth session on 25 November 2020 and will seek endorsement of the framework on carbon neutrality.

I. Background: Strengthening the capacity of member States to achieve sustainable energy

1. Energy is critical for assuring quality of life and underpins attainment of the 2030 Agenda for Sustainable Development (2030 Agenda). The role that energy plays in modern society is recognized, but there remains an important disconnect between countries' agreed energy and climate targets and what countries are doing in reality. This is often related to social and economic considerations inherent to every society or the ability to pay for the transition. Cooperation across the region of the United Nations Economic Commission for Europe (ECE) will enhance the countries' ability to overcome these gaps. Basing the cooperation on quality information and informed dialogues will improve the understanding of the choices that are available and will accelerated their implementation.

2. In 2014, member States of the Economic Commission for Europe (ECE) conceived a project called "Strengthening the Capacity of the ECE member States to Achieve the Energy-related Sustainable Development Goals – Pathways to Sustainable Energy"[1] (Pathways Project) to help countries develop, implement and track national sustainable energy policies to mitigate climate change and contribute to sustainable development. The Pathways Project phase I was completed in October 2019 and reported to the Committee on Sustainable Energy (the Committee) at its twenty-eighth session on 25-27 September 2019 (see also document ECE/ENERGY/2019/1).

3. During its session, the Committee[2] acknowledged that attaining sustainable energy is a complex social, political, economic and technological challenge and that the sustainable energy framework in the ECE region is out of balance. It was highlighted that sustainable energy cannot be achieved without significant trade-offs, as maintaining a balance among security of energy supply, carbon emission reductions and energy system cost is not possible. Countries will make their own decisions and there will be necessarily a mosaic of choices across the region and globally.

4. In the context of this paper it is important to stress that countries did not agree on one single definition of what sustainable energy is nor how to attain it. Rather, the region needs to act upon its dependency on fossil fuels and its carbon emission legacy while embracing the concept of "just" energy transition that leaves no-one behind. This requires a bottom-up social, institutional and technological approach while modernising and optimising the existing fossil fuels-based infrastructure and integrating low and zero carbon energy infrastructure. There is no one size fits all solution. Social and quality of life aspirations need to be satisfied and countries cannot economically phase-out fossil fuels as fast as required to stay on a pathway toward the 2°C target pledged during the Paris Agreement.

5. Results from Pathways project show that the countries in the ECE region will need both reduce its dependence on traditional fossil fuels from over 80% to around 50% by 2050, invest in advanced fossil fuels infrastructure and to achieve significant negative carbon emissions. The countries in the ECE region need to cut or capture at least 90Gt of CO_2 emissions by 2050 to stay on a pathway to meet the 2ºC target given the technology options modelled.[3] As fossil fuels are likely to continue to play an important role for ECE member States in the short and medium term, achieving carbon neutrality will require deployment of

[1] More background information about the Pathways to Sustainable Energy project can be found on project website: http://www.unece.org/energy/pathwaystose.html

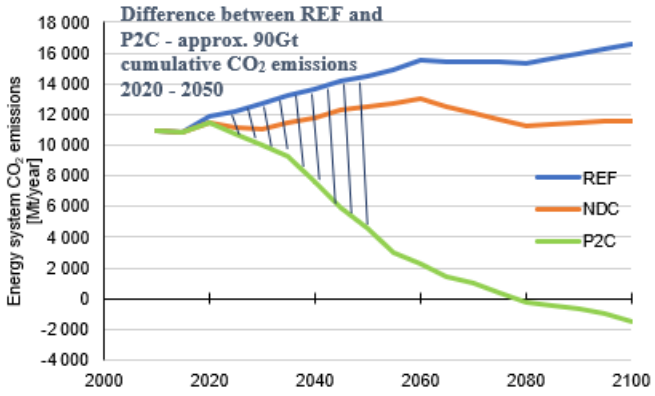
[2] ECE/ENERGY/123, paras. 27, 38-42

[3] Reference scenario is based on shared socio-economic pathway (SSP2) a "Middle of the Road" or Business-as-Usual Pathway, as point of departure. Its socio-economic, market and technology assumptions represent middle-of-the-road developments. SSPs do not include climate mitigations policies or measures (other than those existing in 2010). SSP2 provides an appropriate 'base case' for the exploration of multiple (alternative) pathways and is also basis for the IPCC work. The NDC scenario assumes the implementation of the Nationally Determined Contributions (NDCs) under the Paris Agreement up to 2030 and then maintains them effectively forever. The P2C scenario is a techno-economic scenario, where regional CO2 constraints, consistent with NDC through 2030, are assumed to continue reduction beyond 2030 and thus allows to stay below 2°C by the end of the century.

carbon capture and storage technologies (CCS) and other compensation technologies and measures, such as increasing the absorptive capacity of natural carbon sinks – forests and oceans.

Figure I

CO_2 Emissions in the ECE Region by Policy Scenario for the Energy Sector



6. Many countries and regions are embracing carbon neutrality as a concept to attain climate commitments, effectively recognising that the nationally determined contributions (NDC) in the Paris Agreement are outdated for the purpose of mitigating climate change. Attaining carbon neutrality is recognised as a first milestone towards sustainable energy. This concept was pioneered by many countries in the ECE region, such as Canada, Denmark, France, United Kingdom, who pledged carbon neutrality and revised their national action plans to get to net-zero by 2050. It was also consensually embraced by the European Union and presented in the European Green Deal in December 2019.

7. In its twenty-eighth session, the Committee asked the Group of Experts on Cleaner Electricity Systems (the Group of Experts) to draft a position paper on carbon neutrality and to initiate a dialogue about the challenges in delivering on the 2030 Agenda in all its dimensions in an integrated way that is pragmatic and rational economically, socially and environmentally with a particular focus on carbon capture and storage technologies (ECE/ENERGY/123, para. 34-41).

8. As a consequence, the Group of Experts discussed the request in its fifteenth session on 5-6 November 2019 and recommended that priority areas include carbon capture, utilization and storage (CCUS), negative emissions technologies (e.g. biomass with CCS (BECCS)), smart grids, energy efficiencies, energy storage, demand side management, environment-focused R&D, and a "just" transition coupled with new business models and innovation (ECE/ENERGY/2019/2, para. 11-25).

9. The Group of Experts launched an extrabudgetary project[4] on "Enhancing the understanding of the implications and opportunities of moving to carbon neutrality in the ECE region across the power and energy intensive industries by 2050" (Carbon Neutrality project) and initiated consultations on the concept of carbon neutrality with the wider energy expert community. To implement the project the Group of Experts formed a Task Force on Carbon Neutrality to develop the framework on carbon neutrality that is presented in this document.

10. The document is prepared by the Task Force on Carbon Neutrality for the Group of Experts and will be discussed during the sixteenth session of the Group of Experts on Cleaner Electricity Systems on 23-24 November 2020 at the workshop on "Attaining Carbon

[4] On 19-20 May 2020, the Group of Experts on Cleaner Electricity Systems and UNECE Task Force on Carbon Neutrality organised a two-day consultation workshop and launched the project on Carbon Neutrality. The Workshop gathered over 100 policy makers, industry experts and academia representatives. A number of countries across the ECE region: Austria, Bosnia and Herzegovina, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Montenegro, North Macedonia, Poland, Portugal, Russian Federation, Tajikistan, United Kingdom, presented their national concepts to attain carbon neutrality.

Neutrality". The findings from the workshop together with the framework will be presented to the Committee at its twenty-ninth session on 25 November 2020 for endorsement.

II. A framework on carbon neutrality for the ECE region

11. Defining the carbon neutrality framework is the first step towards implementation of the Carbon Neutrality project. A carbon neutrality framework that is quantifiable for the power and energy intensive sector can serve as a tool to help ECE member States model alternative technology options and define a path towards carbon neutrality in line with their national natural resource endowments, preferred energy mix and needs in terms of energy supply and energy affordability.

12. When defining the carbon neutrality framework, the following elements need to be considered:

(a) How have countries defined "carbon neutrality"?

(b) What are the elements of the carbon neutrality framework under the scope of this project?

(c) What are the project targets and how do countries want to achieve them?

(d) How can sub-regions best contribute to ECE-wide objectives?

(e) What is the carbon neutrality framework for the ECE region?

A. Defining "Carbon Neutrality"

13. According to the Paris Agreement, carbon neutrality is defined as "achieving a balance between anthropogenic emissions by sources and removals by sinks of GHG in the second half of this century".[5] This definition requires that every ton CO_2 emitted by human activity is offset by an equivalent amount of CO_2 removed, either through natural carbon sinks or engineered carbon removal technologies, such as CCS/CCUS, BECCS, direct air capture etc. This definition also assumes that the natural carbon cycle remains stable in the second half of the century and does not become a net source emitter of GHG[6]. Historical emissions of GHG from the ECE region compared to those of other regions are not taken into account.

14. The European Commission in its "Green Deal"[7] advocates for climate neutral[8] Europe aiming to reach net-zero GHG emissions by 2050 mainly by cutting emissions, investing in green technologies and protecting the natural environment.

15. In June 2019, United Kingdom (UK) became the first major economy in the world to pass a net zero emissions law pledging to bring all GHG emissions to net-zero by 2050.[9] For the UK "net-zero" means that "any emissions would be balanced by schemes to offset an equivalent amount of GHG from the atmosphere, such as planting trees or using technology like carbon capture and storage." Canada also pledged to get to net-zero emissions by 2050

[5] Paris Agreement, Art.4. para 1, UNFCCC

[6] Section 3.4.3.4 Changes in ecosystem function, biomass and carbon stocks in "IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)". 2019 Intergovernmental Panel on Climate Change.

[7] The European Green Deal - COM(2019)640 https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

[8] Climate neutrality is occasionally used as a synonym for carbon neutrality or net-zero.

[9] "UK becomes first major economy to pass net zero emissions law", 27 June 2019, Department for Business, Energy & Industrial Strategy, UK

and the Government announced that it would set legally-binding, five-year emissions reduction milestones based on the experts advice and public consultations.[10.]

16. Industry is following the carbon neutrality trend. BP, an oil & gas major, pledged to cut 415mt of carbon emissions from its operations and carbon content of upstream oil & gas production by 2050 or sooner. For BP "certified 'carbon neutral' means that there are no net increases in global emissions of greenhouse gases as a result of business operations, products or services."[11] Dow, an American multinational chemical corporation, has set new sustainability targets that include reducing its net annual carbon emissions by 15% by 2030—from a 2020 baseline — and achieving carbon neutrality by 2050. The company is examining and implementing technologies such as carbon capture, utilisation and storage (CCUS) to achieve carbon neutrality.[12]

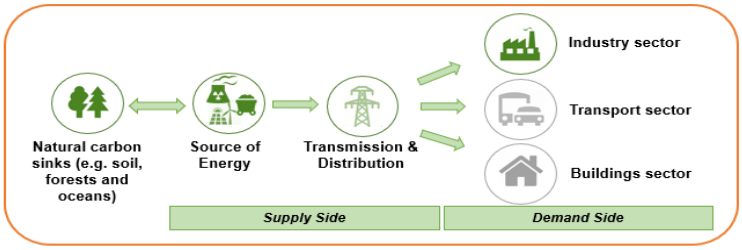
17. Under the scope of this project "Carbon Neutrality" is used rather than "Climate Neutrality" as the relevant framework for the Sustainable Energy Committee as the focus of interest lies in reducing GHG emissions from energy sector. "Carbon Neutrality" refers to 'achieving net zero carbon emissions that constrain global warming to 1.5-2°C by balancing reported carbon emissions (mainly carbon dioxide and methane) with carbon removal (through natural sinks or engineered carbon removal technologies) or by eliminating carbon emissions altogether (the transition to the "post-carbon economy")'.

18. This approach excludes solar radiation geo-engineering solutions and assumes there will be some residual emissions from fossils from hard-to-abate sectors that will be balanced through natural carbon sinks and negative carbon emissions (see Figure II). Carbon neutrality is not an end "state" or "condition" but a process that needs managing. 'Attaining carbon neutrality' will move to "managing carbon neutrality" over time and will need to be periodically revisited.

B. Defining the elements of the carbon neutrality framework for the energy sector and selected energy intensive industries

19. Achieving carbon neutrality will require a holistic energy system approach and an "all technology" strategy involving accelerated deployment of energy efficiency, renewable energy, CCUS, high efficiency/ low emissions technology, low carbon gases (including not only natural gas but decarbonised gases, renewable gases, and hydrogen), nuclear power, and CO_2 removal or other approaches such as increasing forests' absorptive capacity. Technology portfolios can be adapted by member States and sub-regions to reflect their unique circumstances.

Figure II
Holistic Energy System Approach



[10] "Government of Canada releases emissions projections, showing progress towards climate target", 20 December 2019, Government of Canada, https://www.canada.ca/en/environment-climate-change/news/2019/12/government-of-canada-releases-emissions-projections-showing-progress-towards-climate-target.html

[11] "BP sets ambition for net zero by 2050, fundamentally changing organisation to deliver", 17 February 2020, BP press release

[12] "Protecting our climate" https://corporate.dow.com/en-us/science-and-sustainability/commits-to-reduce-emissions-and-waste/climate-protection.html and "Dow's Blueprint for Unlocking Carbon Reductions" https://corporate.dow.com/en-us/science-and-sustainability/2025-goals/blueprint/carbon-reduction.html

20. For the purposes of this project, the framework takes a holistic energy system approach with focus on the contributions from power sector and energy intensive industries to attain carbon neutrality in the ECE region. Although recognised as important sectors to be decarbonised to attain carbon neutrality, transport and buildings will not be analysed in depth under the scope of this project but any significant interfaces will be highlighted.

21. Under the scope of this project the Task Force on Carbon Neutrality decided to limit the analysis on energy intensive industries to steel, cement, chemical industries. For these sub-sectors the project aims to explore the opportunities for reducing carbon emissions by increasing efficiency, circularity, alternatives to fossil fuels for process heat and exploring cluster approach which would allow to utilise carbon as a raw material. Life-cycle assessment will be explored for all sub-sectors.

22. In the ECE region, power and energy intensive sector combined generated about 45% of the total CO_2 emissions in 2019. The current levels of emissions are:

(a) In 2019, the power sector in the ECE region accounted for about 4Gt/yr of CO_2 emissions or 33% of total CO_2 emissions (excl. methane emissions);[13]

(b) In 2019, emissions from the energy intensive industry sector in the ECE region accounted for about 1.5Gt/yr of CO_2 emissions or 11% of total CO_2 emissions;

(c) According to International Energy Agency (IEA) International Technologies Perspectives, in 2017, the share of industry in direct CO_2 emissions by sector constituted 24%, within it the share of iron & steel constituted 28%, cement – 27% and chemicals – 13%, respectively.

23. There are several paths to attain carbon neutrality targets in the ECE region in power and energy intensive industries that will be analysed under the scope of this project and include the following: i) encouraging shifts to low and zero carbon energy sources; ii) cutting CO_2 emissions through engineered carbon removal technologies, such as CCS/CCUS, BECCS, direct air capture; iii) reducing losses in transformation, transmission and distribution by reducing methane emissions, improving power generation and total system efficiencies; iv) improving end-use energy efficiency cost-effectively to reduce needed energy supply; v) encouraging broad deployment of smart technology for systemic decarbonisation that meets quality of life criteria. vi) offsetting any residual carbon emissions through natural carbon sinks[14] (e.g. forest and oceans).

24. Each of the above paths covers a range of technology and policy options. The costs and availabilities of options vary by country as each has its own unique endowment of natural resources and its own cultural, regulatory, and legislative heritage. It is the collective outcome of countries' actions that will deliver on carbon neutrality on the path to meeting the 2°C target and attaining carbon neutrality while delivering citizens' quality of life aspirations.

C. Defining objectives for the ECE region

25. For the project, it is important to define the potential pathways and timelines for the ECE region to attain carbon neutrality to be able to identify related policy options for

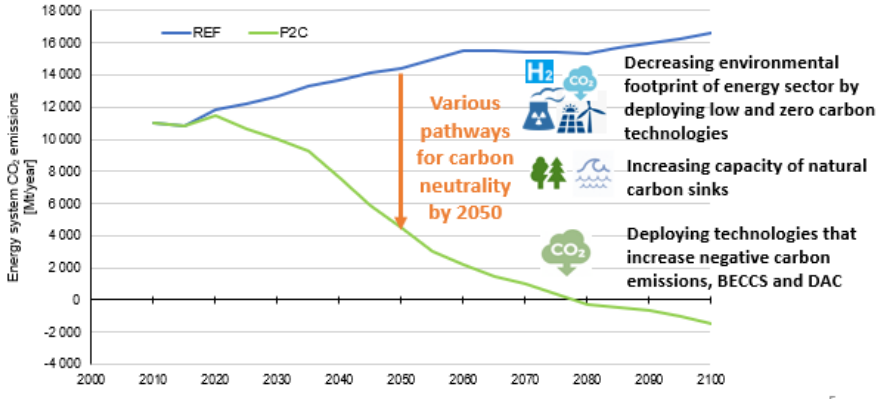
[13] The regional data developed in the Pathways to Sustainable Energy excluded methane emissions in by sector analysis. This will be revised under the scope of this project.

[14] Forest ecosystems in the European Union play multiple significant roles, including carbon sequestration. It is estimated that the forest biomass in the EU27 countries contains 9.8 billion tons of carbon (tC). The total CO_2 emissions of the EU27 countries in 2004 was 1.4 billion tons of carbon. This means that the amount of carbon emitted every year by the EU27 equals to nearly one-seventh of the carbon stored in the EU27 forests. As a result, the value placed on forests in the EU can be seen as a viable way of mitigating GHG emissions through carbon sinks and sequestration. UNECE, 2020, https://www.unece.org/forests/outlook/carbonsinks.html.
Note the IPPC report 2019 suggests that increase in atmospheric CO_2 results in high plant growth over a larger area but global warming increases desertification, droughts, forest fires, etc will increase carbon emissions. The net balance is uncertain but may lead to a net emission of carbon between 1.5-2°C warming. The science is still uncertain.

countries. Various scenarios will be analysed to reach net-zero reported emissions by 2050 for the ECE region, as defined above.

26. It is proposed that there are various ways to define our objective: i) single goal: to attain carbon neutrality by 2050; ii) multiple goals: to attain carbon neutrality and meet the 2°C target by 2050; iii) multiple goals with higher degree of ambition: to attain carbon neutrality and meet the 1.5°C target by 2050, iv) accept an overshoot of the carbon budget in the near term but compensate with negative emissions later to meet the 1.5-2°C objective. Milestones can be proposed to verify any gap versus the pathway that is proposed. The pathway can be summarised by a 'budget' for carbon emission by subregion, policy measure and technology.

Figure III
Defining a common Objective and Timeline



27. The carbon neutrality framework includes ECE-wide targets and policy objectives for the period from 2020 – 2050. Immediate concrete short-term actions are needed on sub-regional level by 2025 to set the region up on a path to attain common mid- and long-term regional objectives.

28. The Task Force on Carbon Neutrality proposed the targets listed below as initial aspirations to the carbon neutrality in the ECE region that can be taken as step-wise targets.[15] The analytical modelling exercise for the portfolio of technologies across all ECE sub-regions to be performed in this work will be used to inform the decision, which approach the region could take and what specific targets (in Gt of CO_2 reduction) are achievable under economically rational scenarios.

29. Aspirational mid-term / long-term targets for 2030 and 2050 include the following:

(a) At least 30% (2030) and 40% (2050) cut of carbon emissions from energy sector;[16]

(b) At least 20% (2030) and 40% (2050) decrease of carbon emissions for energy intensive industries (steel, cement, chemical industries);

(c) At least 30% (2030) and 40% (2050) cut of carbon emissions from power sector;

(d) At least 30% (2030) and 40% (2050) increase of capacity of natural carbon sinks;

(e) At least 10% (2030) and 20% (2050) increase of negative carbon emissions.

[15] This can include a total carbon budget in 10-year increments by energy/process technology (incl. negative emissions technology) and policy measure by sub-region. The 10 years milestones to be reviewed every 5 years.

[16] As part of the European Green Deal, the European Commission aims to propose raising the EU target to at least 50% and towards 55% in a responsible way by 2030.

D. Defining sub-regions and their contributions to attainment of carbon neutrality in the ECE region

30. This project will take an ECE-wide regional approach, then explore the eight sub-regions defined in the Pathways project: North America, Western Europe, Central and Eastern Europe, Western Balkans, Belarus/Moldova/Ukraine, Central Asia, the Caucasus, Russian Federation. The sub-regional approach will help improve the understanding on how to share the burden across the ECE sub-regions to attain carbon neutrality. Strengthening regional cooperation among ECE member states is a precondition to meet common energy and climate challenges cost-effectively as each member State's natural resource endowment is unique.

31. Each subregion will act at its own different speed, depending on progress to date, economic state, and the structure of the economies, i.e. resource based or manufacturing. This approach will allow differentiated actions across the sub-regions to attain common goal for the region as a whole.

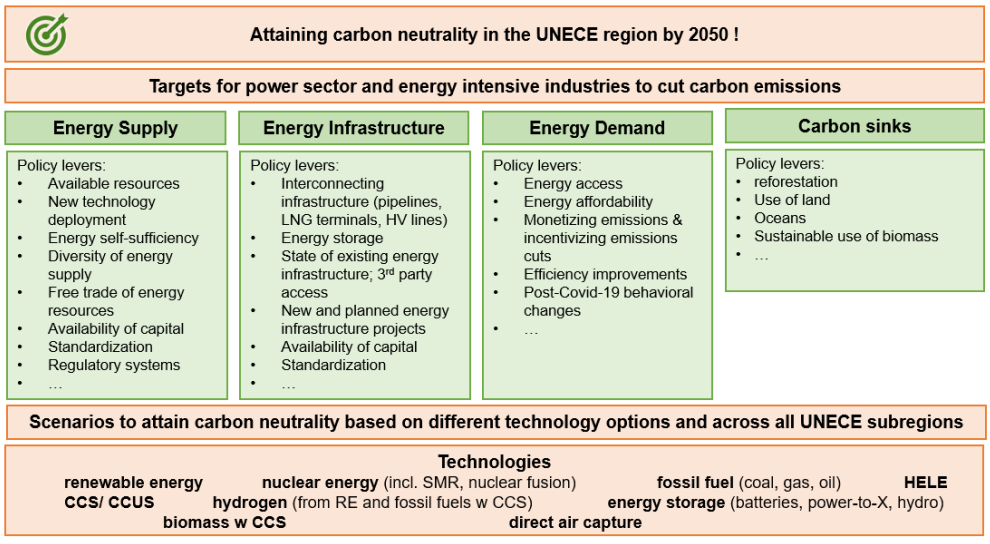
32. Since the region produces 39% of the global CO_2 emissions, has had relatively high emissions historically, and includes countries with the highest level of economic development in the world, one could argue that it should strive to be carbon negative to compensate for countries for which attaining carbon neutrality is more challenging given their level of economic development. This is one of findings of the Pathways Project, which led to the conception of this carbon neutrality project, as is the common sense approach that strengthening regional cooperation among ECE member states will allow a faster and more efficient energy transition.

E. A Carbon Neutrality framework for the ECE region

33. In order to attain carbon neutrality in the ECE region by 2050 and meet interim targets in the power and energy intensive industries by 2030 the following carbon neutrality framework is proposed by the Task Force on Carbon Neutrality.

34. The framework takes energy supply, energy infrastructure and energy demand approach and proposes technology and policy options from the perspective of the power sector and energy intensive industries to be tested to attain carbon neutrality in the ECE region. It also analyses the potential of natural carbon sinks to offset residual carbon emissions.

Figure IV
Carbon Neutrality Framework for the ECE Region



35. Rethinking energy supply by ensuring continuous, adequate, clean and safe supplies of energy from all energy sources to all energy users.

(a) Exploitation of sustainable available energy resources to attain a degree of energy resilience;

(b) Enhancement of collaboration and inter-regional free trade of energy sources and competition on energy markets through greater liberalization;

(c) Diversification of energy supply while increasing access to low, zero and negative technologies across the region and supporting least cost opportunities;

(d) Improvement of access to new clean technologies to accelerate transition to low carbon energy system;

(e) Securing access to capital to accelerate the deployment of cleaner energy solutions;

(f) Exploring technologies with the largest potential for development, taking into account cost-effectiveness;

(g) Improving energy efficiency and circularity for energy intensive industries specifically, considering that heat and carbon as a feedstock are crucial for technological processes.

36. Modernizing existing fossil fuel-based energy infrastructure to prepare it for faster uptake and integration of clean energy solutions.

(a) Promoting energy infrastructure projects of common interest, such as hydrogen distribution networks, CO_2 grids or liquified natural gas (LNG) export-import terminals;

(b) Development of energy transport infrastructure, such as cross-border connectors;

(c) Investing into development of energy storage solutions and smart grids to manage demand and ensure secure energy supply of a system with increasing shares of variable renewable energy;

(d) Promoting concepts of ‘clusters’ for energy intensive industries as a solution for more efficient use and re-use of energy and carbon feedstock and increase of global competitiveness.

37. Optimizing energy demand based on behavioural changes, technological improvements and improved system efficiency to deliver on quality of life with a much lower environmental footprint.

(a) Improving energy intensity cost-effectively and generate energy savings from improved energy performance of products and processes;

(b) Monetizing carbon emissions and incentivising carbon emissions cuts;

(c) Promoting behavioural change of the end-users by enhancing intrinsic awareness and encouraging individuals to take personal actions towards attainment of carbon neutrality.

38. Accelerating the deployment of natural and engineered carbon sinks, such as soil, forests and oceans, as well as industrial and power CCS.

(a) Maximising nature-based solutions by incentivising afforestation and reforestation as well as restoration of coastal and marine ecosystems to improve carbon sequestration;

(b) Enhancing natural processes through land management to improve carbon content in soil through agriculture methods or through ocean fertilisation to increase capacity to absorb carbon;

(c) Engineered CCS such as enhanced oil recovery (EOR), use of old oil and gas wells and saline aquafers and the sea;

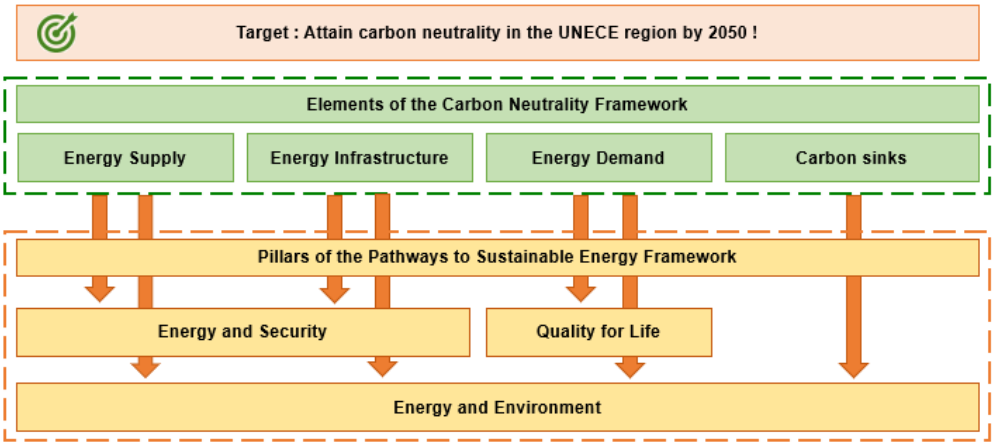
(d) Enhancing the deployment of negative emissions technology for the ECE region.

III. Implementing the carbon neutrality framework and refining assumptions for technology options

39. Building on the Pathways project, it is proposed to assess the carbon neutrality framework in a broader social, environmental and economic context, in order not to lose the triangular relationship between quality of life, environmental and socio-economic considerations. The relationship between elements of the carbon neutrality framework and three pillars of the sustainable energy framework will be further examined during the analytical part of the project.

40. The three pillars of the sustainable energy framework embrace the Sustainable Development Goals: i) Energy Security ('Securing the energy needed for economic development'), ii) Energy and Quality of Life ('Provision of affordable energy that is available to all at all times'), and iii) Energy and Environment ('Minimize impact of energy system on climate, ecosystems and health'). Relevant SDG targets align with these pillars and highlight the inter-connection among the different facets of sustainable energy and the trade-offs.

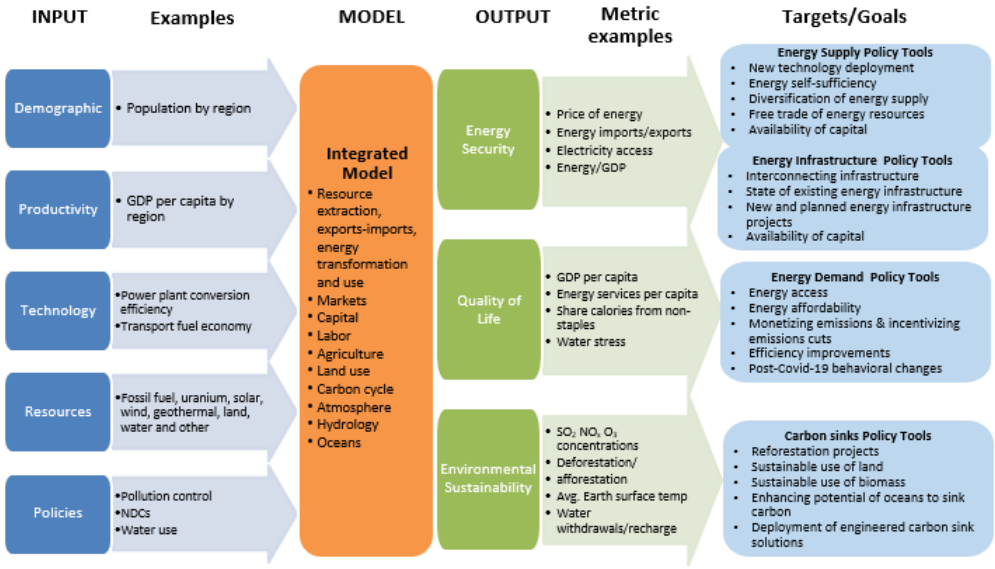
Figure V
Connecting Carbon Neutrality Framework to Sustainable Energy Framework



41. The modelling exercise under the scope of carbon neutrality project will be based on integrated energy and climate models. These assume a 'business as usual' economic growth forecast and apply trends in energy consumption to determine the overall energy demand. The models then satisfy this demand by selecting the least cost energy mix including the time required to install any new capacity consistent with meeting any cap on emissions set by a policy scenario. Assumptions related to capital and operating costs, deployment readiness and lead times, and environmental impact for all technology options will need to be verified.

42. The interplay of two integrated assessment models – the Global Change Assessment Model (GCAM) and the Model for Energy Supply System Alternatives and their General Environmental Impacts (MESSAGE) – provide a unique approach and strengthen the robustness of the results. These were updated to represent the ECE region energy system more accurately during the Pathways project. Modelling results will be analysed in Q1 2021 during project implementation once the model has been recalibrated, all technology assumptions have been verified and vetted by the experts and initial policy and technology scenarios have been tested. The sensitivity of the model to a technology will be examined to understand the impacts of alternative technology options on policies.

Figure VI
Incorporating carbon neutrality framework into integrated climate and energy assessment model



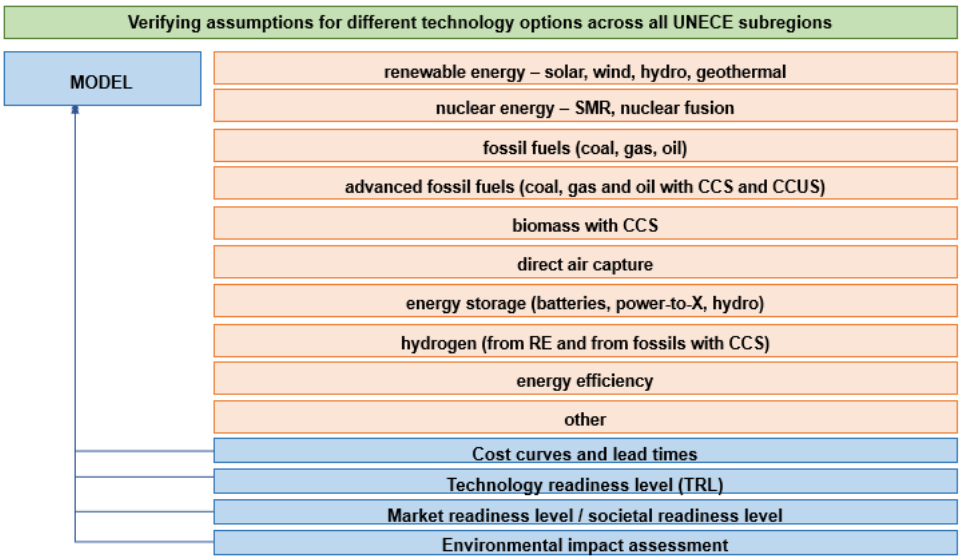
IV. Next steps in Carbon Neutrality Project implementation

43. The carbon neutrality framework for the ECE region will be presented and discussed at the sixteenth session of the Group of Experts on Cleaner Electricity Systems on 24 November 2020 at the workshop on “Attaining Carbon Neutrality”.

44. The framework will be used as a basis for next steps of Carbon Neutrality project implementation that include i) refinement of data and technology assumptions, ii) assessment of contribution of different technologies to attain carbon neutrality, iii) policy dialogue and development of policy guidelines for low-carbon technologies (see annex).

45. The next step will be refinement of data and technology assumption for all technologies listed (renewable energy – solar, wind, hydro, geothermal; nuclear energy – SMR, nuclear fusion; fossil fuels (coal, gas, oil), advanced fossil fuels (coal, gas and oil with CCS/CCUS), biomass with CCS, energy storage, hydrogen, direct air capture, energy efficiency etc. adapted across all eight ECE sub-regions.

Figure VII
Refining assumptions for different technologies



46. Technology assumptions will be verified on four levels: i) technology cost curves and lead times – assumptions are based on the technology cost estimation including capital cost and fixed operational and maintenance cost assumptions; ii) technology readiness level – assumptions are based on estimated technology maturity that take into consideration pilot projects, program concepts, technology requirements, demonstrated technology capabilities; iii) market or societal readiness level – assumptions are based on the level of policy makers awareness of the specific technology, how the technology fits national plans as well as whether and how the policy makers are incorporating it into national frameworks; iv) environmental impact assessment – assumptions are based on the assessment of both positive and negative environmental consequences of a specific technology.

47. The Group of Experts is invited to support the Task Force on Carbon Neutrality in project implementation. Timeline and next steps for the period from November 2020 – December 2021 include the following (see annex):

(a) October 2020 - January 2021: Verification of data and technology assumptions;

(b) December 2020 - April 2021: Finalisation of technology briefs;

(c) January - May 2021: Series of workshops on modelling results and refinement of technology inputs;

(d) February- June 2021: Workshop on development of financial guidelines for the modernisation of the power and energy intensive industries and drafting of guidelines;

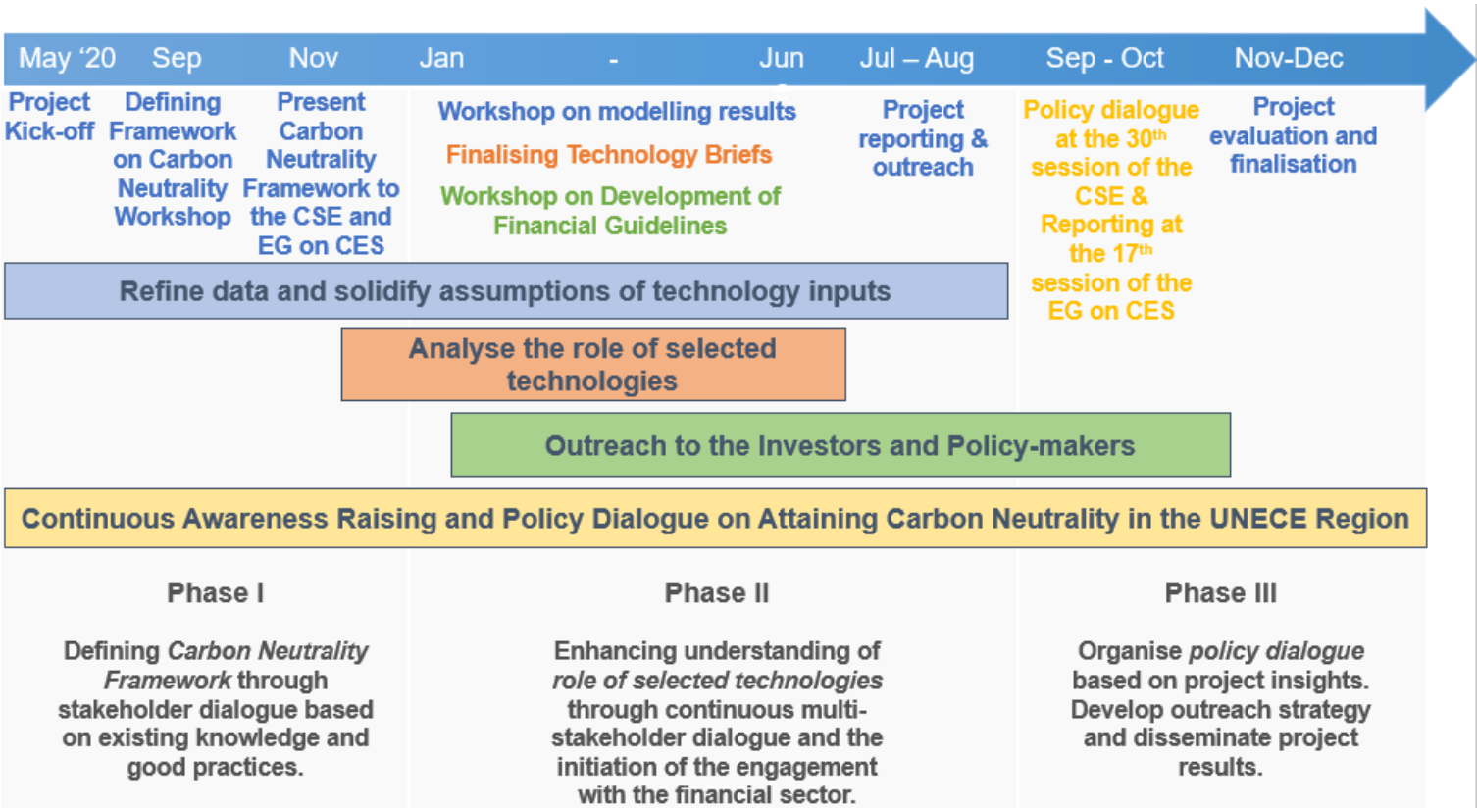
(e) July - August 2021: Project reporting and preparation of outreach materials and strategy;

(f) September 2021: Policy dialogue at the thirtieth session of the Committee on Sustainable Energy;

(g) October 2021: Policy dialogue and final project presentation at the seventeenth session of the Group of Experts on Cleaner Electricity Systems;

(h) August – December 2021: Outreach campaign and dissemination of project results at international events (e.g. World Economic Forum Annual Meeting in Davos in Summer 2021, World Energy Council Energy Week in Nursultan in Autumn 2021, Russian Energy Week in Autumn 2021, COP26 in Glasgow Winter 2021 etc.).

Annex


May '20
Sep
Nov
Jan
-
Jun
Jul – Aug
Sep - Oct
Nov-Dec
Project Kick-off
Defining Framework on Carbon Neutrality Workshop
Present Carbon Neutrality Framework to the CSE and EG on CES
Workshop on modelling results
Finalising Technology Briefs
Workshop on Development of Financial Guidelines
Project reporting & outreach
Policy dialogue at the 30th session of the CSE & Reporting at the 17th session of the EG on CES
Project evaluation and finalisation
Refine data and solidify assumptions of technology inputs
Analyse the role of selected technologies
Outreach to the Investors and Policy-makers
Continuous Awareness Raising and Policy Dialogue on Attaining Carbon Neutrality in the UNECE Region
Phase I
Defining Carbon Neutrality Framework through stakeholder dialogue based on existing knowledge and good practices.
Phase II
Enhancing understanding of role of selected technologies through continuous multi-stakeholder dialogue and the initiation of the engagement with the financial sector.
Phase III
Organise policy dialogue based on project insights. Develop outreach strategy and disseminate project results.