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Item 2 of the provisional agenda
Just Transition for Resilient Energy Systems in the United Nations Economic Commission for Europe region

Just Transition for Resilient Energy Systems [*]

Note by the Chair of the Group of Experts on Coal Mine Methane and Just Transition and the secretariat

I. Introduction

1. Achieving the goals of the Paris Agreement and Sustainable Development Goal (SDG) 7 requires a whole of society approach. The path towards Resilient Energy Systems in the Economic Commission for Europe (ECE) region requires an inclusive approach that ensures that there is justice for all as societies pass though deep changes in the ways that energy is produced, transported, and consumed. Good governance requires that policies establish programmes and guarantees that no one is left behind and that the transition to a low-carbon economy is just and fair.

2. At its thirty-second session, the Committee on Sustainable Energy noted with appreciation the framework on resilient energy systems presented that is based on three dimensions, namely on (i) energy security that ensures energy needed at any time is met through a diversity of supply; (ii) affordability of sustainable energy that reduces the costs of electricity, heating, cooling, and transport while increasing systemic energy efficiency; and (iii) environmental sustainability that lowers the carbon footprint and enhances the efficiency across the energy supply chain.[1] It further recalled that building a resilient energy system requires engaging with all stakeholders to the extent that warrants their ownership of the process and a sense of responsibility for its results. While the transition towards climate neutrality, being a key element of improving resilience of an energy system, will create new opportunities, it may also have disruptive effects on carbon- and energy-intensive industries, as well as on regions, communities, and enterprises that depend on them.

3. Therefore, the Committee called upon ECE member States to assess the social impacts of the energy transition at the planning phase, so that proper protective and ameliorating mechanisms are developed and relevant policies are in place to prepare stakeholders for the new reality.[2]

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[*] This document was scheduled for publication after the standard publication date owing to circumstances beyond the submitter's control.

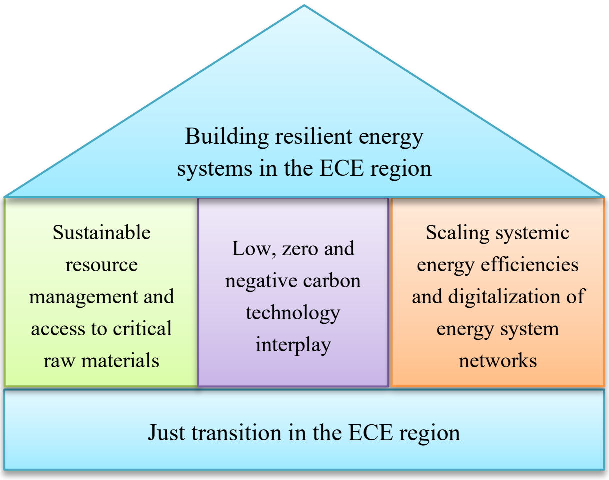
[1] ECE/ENERGY/149 paragraph 13 b

[2] ECE/ENERGY/149 paragraph 13 e

4. Providing energy transition justice for all, or a just transition is the result of an integrated effort that establishes sustainable development bringing together social progress, workers' protection, environmental consciousness, and economic success into a framework of democratic governance and institutional support. Effective "just transition" strategies require local, bottom-up participation of all affected stakeholders and commitment by the governments to guarantee their acceptance and provide planning security.

5. The objective of this document and the dialogue during the thirty-third session of the Committee on Sustainable Energy is to explore the adoption of just transition approaches across the sustainable energy subprogramme and all its Groups of Experts in pursuit of the overarching objective of attaining resilient and carbon neutral energy systems in the ECE region. ECE programme on sustainable energy is well positioned to help countries in the ECE region to embrace the concept of just transition for resilient energy systems through its work across the energy value chain. Figure I describes how the Committee on Sustainable Energy and its six subsidiary bodies are providing the knowledge base and platforms for dialogue through their current work on sustainable resource management and access to critical raw materials; interplay of low, zero and negative carbon technology interplay; and scaling systemic energy efficiencies and digitalization of energy systems networks.

Figure I
Just transition and its relationship to resilient energy systems in the ECE region



Principles of just transition that have guided the ECE sustainable energy subprogramme work

6. The Group of Experts on Coal Mine Methane and Just Transition has defined just transition as an integrated approach to sustainable development that brings together social progress, workers' protection, environmental consciousness and economic success into a framework of democratic governance and institutional support.[3]

7. The Committee on Sustainable Energy at its thirty-second session[4] requested all subsidiary bodies to engage in the topic of just energy transition and **explore joint activities** that can contribute to accelerate a just energy transition across the ECE region; it also requested the Group of Experts on Coal Mine Methane and Just Transition to consider developing a **theoretical framework** conceptualizing the role of coal in the green economy and to test its findings through the development of a pilot project. The Committee further invited member States to engage in that work and to volunteer to host such a project.

8. To date, the Group has conducted a number of activities towards this goal, including:

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[3] ECE Group of Experts on Coal Mine Methane and Just Transition, Task Force on Just Transition, Work Plan for 2023-2024, paragraph 1 e

[4] ECE/ENERGY/149 paragraph 50 a, b

(a) Development of a new approach that sees coal mining not as fuel supply, but as provider of a multipurpose platform that might be an important component of the green economy and therefore promises to facilitate the transition away from fossil-fuel based economy; the concept of coal as multi-purpose resource significantly broadens the range of opportunities for just transition strategies (clean energy transitions require new technologies to serve the energy needs of growing and advancing economies; while coal as a fuel may be at varying stages of decline globally, its value as a critical resource for the emerging needs of clean energy economies is in its very early stages of development. Coal should not be burnt for energy production. To the contrary, its true value lies in its potential to be refined and utilized for high value resources, such as graphene, carbon nanotubes, lithium, Rare Earth Elements, cobalt, and manganese, as well as other materials);

(b) Mapping for a green and just transition in Albania: Launched a project on mapping Albania's readiness for just transition, including development of a geographic information system (GIS) database characterizing Albania's coal mining areas, including an index indicating a country's readiness for just transition;

(c) Started work on intergenerational issues in the energy sector, among others by facilitating a two-week programme for international students on "Forging a just transition: towards green jobs and rights-based futures", focused on the coal-mining sectors in Kazakhstan and Poland;

(d) Contributing to the development of a UN Framework on Just Transitions for Critical Energy Transition Minerals;[5]

(e) Is developing an initiative to raise funds for building a regional platform for collaboration and knowledge exchange on just transition among universities in Central Asia;

(f) Is developing the theoretical framework requested by the Committee through the present paper.

9. ECE and the sustainable energy subprogramme conceptualisation of just transition across the subprogramme is a foundational element to achieve resilient and carbon neutral energy systems:

- The Group is to lead the work on the social aspects of the process of building resiliency, as any changes to the existing energy systems should occur in compliance with the **principles** of a just transition
- Resilient and carbon neutral energy systems for a just energy transition refer to energy infrastructure and policies designed to withstand and adapt to various challenges, including environmental, social, and economic factors, while ensuring equitable access to clean, reliable, and affordable energy for all members of society.

Principles:

- Social progress: improve the well-being of people, both individually and as a community
- Environmental protection: improve the quality of the natural environment, aligned with Member States' commitments made in the 2030 Agenda for Sustainable Development and the Paris Agreement
- Economic success: improved economic situation of the communities that have undergone the transition
- Democratic governance: people subject to the transition are actively engaged in designing and implementing transition strategies to ensure ownership of the process
- Institutional resilience: existence of institutions competent to design, prepare for and implement the transition.

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[5] https://www.greenpolicyplatform.org/initiatives/working-group-transforming-extractive-industries-sustainable-development/UN%20Framework%20on%20Just%20Transitions%20for%20CETM

10. Proposed path to adopt a just transition approach in the work of the other subsidiary bodies of the Committee:

- The Committee on Sustainable Energy at its thirty-second session (report, para 50a) requested subsidiary bodies to engage in the cross-cutting topic of 'just energy transition' and explore joint activities that can contribute to accelerate a just energy transition across the ECE region.

II. Scope and purpose

11. The goal of this document is to request and encourage the experts serving and supporting the Sustainable Energy Division of ECE to pool and leverage experience, knowledge, creativity, and goodwill more comprehensively. Doing so will assist and strengthen ECE's efforts to encourage and support actions that lead to decarbonizing the energy sector, increase its resilience by doing so, and ensure that necessary people, process, and technology transitions are justly executed.

12. The underlying ECE principles for energy transitions continue to be (a) non-zero-sum coal phaseouts and transition away from hydrocarbons as a fuel source are a priority, (b) all parties must benefit from such phaseouts, and (c) said phaseouts must be founded on sustainable energy supplies and services integrated into clean (circular) economies. It is worth noting that "all parties benefiting," or an often-used phrase is a signifier and is embedded in the 2030 Agenda for Sustainable Development, where it is styled as Leaving No One Behind. Yet the pledge will be empty of meaning and results will be unsatisfactory unless measurable targets are established to yield meaningful transition outcomes.

13. As noted above, energy systems resilience must be acknowledged as a presumptive necessary element in achieving energy transitions. Also previously noted, energy resilience is a term used in many ways. It is a term whose use continues to evolve with social, economic, environmental, and other circumstances. Over the last several years, climate change causation – storms, wildfires, widespread droughts, degradation in the reliability of hydro power in some locations, and much more – presses the notion of resilience to evolve. That evolution must involve strengthening systems and facilities disrupted by climatic events. Also, evolving the term resilience already has broadened to include interdependencies amongst critical infrastructures. That is, energy resilience takes on more significance and value because energy is intensely critical to ensuring the maintenance and uptime of water, wastewater, gas distribution, communications, and transportation infrastructures, as well as vital facilities integrity.[6] Recent geopolitical events have heightened the importance of energy security, whereby energy resilience must now include active investments in strategic security matters[7] ensuring that critical infrastructure remains operational and reliable under physical and cyber attack.

III. Acknowledgements

14. The Secretariat provided guidance and assistance in developing this document. Mr. Raymond Pilcher, Chair of the Group of Experts on Coal Mine Methane and Just Transition, Mr. David O. Jermain, a Senior Fellow of the Boston University Institute for Global Sustainability, Mr. Z. Justin Ren, Associate Professor of the Questrom School of Business of Boston University, and Mr. Eugene J. Berardi, a Boston University Questrom School of Business of Boston University MBA and advisor to renewable energy enterprises, were

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[6] For an example of a government posture on energy resilience see: US Department of Energy, "Energy resilience is the ability of the grid, buildings, and communities to withstand and rapidly recover from power outages and continue operating with electricity, heating, cooling, ventilation, and other energy-dependent services." (https://www.energy.gov/eere/energy-resilience). ECE definition of energy resilience system is discussed in Section I.

[7] Note also that energy security includes issues related to nuclear power and it considers the effects of geopolitical conflicts and energy resilience in policy analysis.

supporting contributors to this document. Their contribution is acknowledged with appreciation.

IV. Methodology

15. This document was developed using interviews and discussions with staff of the Sustainable Energy Division and experts of the Committee and its subsidiary bodies, review of ECE documents pertinent to Committee Programme of Work, reports, and performance reviews. Additionally, extensive review of deep and diverse academic, commercial, financial and investment analysis, and trade literatures were conducted. Key actors involved have meaningful lived experience in the coal industry, the energy sector overall, as well as particular expertise in electricity production, transmission, distribution, and end-use (demand-side) services. Experience in institutional change management, critical infrastructure policy and planning, in an array of energy related business ventures are additionally resident in individuals contributing to this document.

V. Process for leveraging the Committee and its subsidiary bodies

16. This section offers a design for identifying opportunities to demonstrate new ways to actively promote transition justice using the depth of experience in the Committee and its Groups of Experts. The design is presented as an illustration, not as an answer. Actual use of the design depends on the staffing capacity of the Sustainable Energy Division to drive it, and the expert groups agreeing that its use would be worth the effort. The focus is on ways to enhance engagements across multiple Groups of Experts by creating novel projects and initiatives, which require the expertise of more than one expert group.

Enhancing value with integrating projects

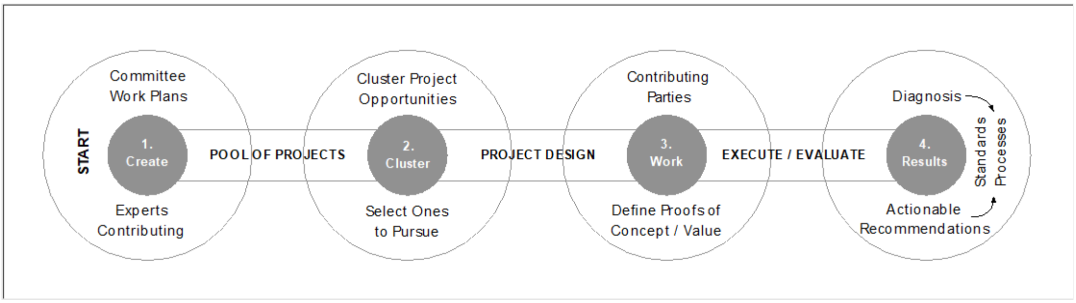
17. Each of the Groups of Experts has a work plan covering 2024-2025. Each plan maps areas of focus and activities through to the end of 2025. Most activities of the Groups include ambitions to increase coordination and joint work among the Groups of Experts. Generally, the main interlinkage focus is on information creation and sharing, coordination and facilitation, and issue identification. Building awareness is an implicit focus.

18. The Groups of Experts have capacity, directly and indirectly, to enhance work plans to include proactive efforts to strengthen the linkage between policy and practice in a number of ways. A flexible structure for organizing opportunities may enable each Group to engage with other Groups. A consequential outcome may be a new form of “practice focused convening,” which can enhance focus and initiative on ECE decarbonization efforts in the context of “energy resilience.”

19. Figure II presents a simple process workflow for developing joint-Group potential and actual initiatives. The process begins by creating a pool of opportunities composed of nominations from each Group, consolidated into a matrix of actual plans and potential projects. In this process, attention will be paid to ensuring that nominations include representatives from a variety of stakeholders. Once compiled, the matrix is sorted and selection of a manageable group of projects from that pool of possibilities occurs. Then, projects are designed to maximize testing and evaluation of potential benefits supporting transition justice. Once designs are completed and process workflows for execution of projects are at least sketched to the level of main steps from start to finish, efforts to budget and start work can occur. Reporting results of initiatives and offering recommendations, e.g., changes in standards or processes will be the main focus once a project begins. Each workflow step in the above overview is discussed below.

Figure II

Simple Process Workflow for Practice-Based Shared Groups Initiatives



20. Table 1 illustrates how the work plans of each Group can be used to imagine possible projects – focus on meeting decarbonization goals and ECE energy resiliency. The boxes in Table 1, framed in purple, are simplified characterizations of the core focus of the Groups of Experts:

(a) Boxes on either side of the diagonal are populated with possible activities that help drive core policy and diplomacy roles of the ECE Secretariat, the Committee, and its Groups of Experts. **It is important to emphasize that the content is hypothetical**. That is, the content should be viewed as illustrations of potential activities – projects and/or programmes;

(b) The table is intended to enable the Committee and its Groups of Experts to self-nominate potential activities and consider potential activities nominated by other Groups. The aim and expectation of the table is to (1) create a pallet of potential activities, (2) deepen the engagement of experts in a meaningful way, and (3) identify gaps (divergent views amongst experts, important overlooked matters to consider, mis-prioritization of matters already under consideration) whose consideration and narrowing (if not closure) strengthen the use-value of the Groups;

(c) Populating this table happens using opportunities developed by the Secretariat and the Groups. Content represents a pool of possible activities from which specific projects can be crafted if so desired.

Table 1

CONCEPTUAL FRAMEWORK FOR INTEGRATING THE WORK EXPERT GROUPS ON ACHIEVING RESILIENT ENERGY TRANSITIONS FROM CARBON TO CLEAN

Committee/Groups nominate potential activities (rows)

How would the Committee / Groups engage with the proponent?

Committee/Groups react to nominated potential activities (columns)

What projects can one Group of Experts pursue jointly with other Groups?	Cleaner Electricity Systems	CMMJT	CMMJT or Gas	Energy Efficiency	Gas	CMMJT or Gas	CSE	Renewable Energy	Resource Management
Cleaner Electricity Systems — *activities that significantly reduce GHG emissions from fossil fuel-fired electricity generation*	**Minimize GHGs while securing reliable and agile systems** 🟦	1. Use of CBM-to-H2 as fuel; 2. harvest coal wastes for new materials 🟪🟩	Develop best practices re: local grids using H2 + fuel cells 🟦🟧	Help minimize GHG emissions using microgrids networked to grids 🟦🟪🟧🟩	NG plants to H2, reduce GHGs, use H2 hubs and upgraded gas pipelines 🟦🟩	NG plants to H2, reduce GHGs, use H2 hubs and upgraded gas pipelines 🟦🟩	Contribute data, analysis, cases on fossil-fuel plant GHGs to project 🟦🟧	Contribute energy storage expertise for better RE grid integration 🟧🟩	Contribute operating standards, practices to UNFC / UNRMS 🟦🟧🟪
Coal Mine Methane and Just Transition (CMMJT)— *activities that significantly reduce greenhouse gas emissions from fossil fuel-fired electricity generation*	Clean up of coal wastes at power plants for refining CRMs 🟦🟩	**Transition justice on exiting coal as fuel** 🟪🟩	Demo model for H2 and carbon materials from CBM/CMM 🟦🟪🟧🟩	Least energy cost processing solutions, set new EE standards 🟦🟧🟪	Standards and practices for processing blended NG and methane 🟦🟩	Demo model for H2 and carbon materials from CBM 🟦🟧🟪🟩	Contribute data, analysis, cases to project re: CBM management 🟦🟧	Focus on how to use methane + refined H2 onsite 🟦🟪🟧🟩	Contribute ops standards, practices re: refining CBM for H2 and CRMs for UNRMS 🟦🟧🟪
CMMJT or Gas — *partnered with various prominent institutions and experts operating in the relevant industries to undertake identifying and consolidating best practices in the field*	Methane to H2 for local microgrids, community development 🟦🟧🟩	Demo for processing H2 + CNTs from CMM 🟦🟪🟧🟩	**Information on best practices fed to policy and operations groups** 🟧	Least energy cost EE processing solutions for MM 🟦🟪🟧🟩	Globalized methane management standards 🟦🟧	MM best practices during demo for H2 + CM processing 🟦🟧🟪🟩	Contribute data, analysis, cases to project on MM 🟦🟧	Demo onsite MM using renewable energy for processing 🟦🟪🟧🟩	Contribute MM operating standards, practices to UNFC / UNRMS 🟦🟧🟪
Energy Efficiency — *works to help achieve significant improvements in energy efficiency as energy resource of its own right*	Changed role of utilities providing major end-user EE enhancements 🟦🟩	EE for coal process circuits yielding CRMs 🟦🟪🟧🟩	Best practices re: EE for methane emission reductions 🟦🟧	**Standards, practices, priorities** 🟦🟧🟪	EE along from end-to-end of natural gas supply chains 🟦🟧	Analysis of EE solutions for H2 supply chains as developed 🟦🟧🟪	Contribute data, analysis, cases to project on EE innovations 🟦🟧	Passive house/ building demos across all ECE member states 🟦🟧🟪	Contribute EE operating standards, practices to UNFC / UNRMS 🟦🟧🟪
Gas — *deliver on key political commitments, I.e., 2022 Agenda for Sustainable Development, Paris Agreement on climate change*	Gas-H2 hybrid plants to reduce GHG emissions 🟦🟩	Methane + H2 storage practices and pricing 🟦🟪🟧🟩	End-to-end gas supply chains maximizing methane + H2 integration 🟦🟧	Least energy cost processing solutions, set new EE standards 🟦🟪🟧🟩	**Generalized decarbonization focus** 🟦🟧🟪	NG + H2 blended product value vs H2 only 🟦🟪🟧🟩	Contribute data, analysis, cases to project on NG GHG reductions 🟦🟧	NG / RE hybrids (+ batteries) demo for integration to grids 🟦🟪🟧🟩	Contribute NG GHG reductions ops standards, practices to UNFC / UNRMS 🟦🟧🟪
CMMJT and Gas — *H2 as a bridge to net zero, especially in hard-to-abate industries; but H2 is not an energy source, it's an energy carrier that must be produced, transported, and stored at scale*	Policy + CI proposals re: H2 + transportation 🟦🟪🟧🟩	Demo for coal mine onsite use of process H2 from CBM/CMM 🟦🟪🟧🟩	Practices relevant to managing H2 leaks and risks from production to use 🟦🟧🟪	Model potential for H2/fuel cells for DSM onsite uses 🟦🟪🟧🟩	Incentive to drive NG out and bring H2 in 🟦🟧🟪	**How to build an H2 value chain at scale** 🟦🟪🟧🟩	Contribute data, analysis, cases on H2 supply chain development 🟦🟧	Demo on RE + storage for multi-tiered resilience from onsite to grid 🟦🟪🟧🟩	Contribute H2 operating standards, practices to UNFC / UNRMS 🟦🟧🟪
Committee on Sustainable Energy — *project that seeks to help countries develop, implement and track national sustainable energy policies*	Tracking metrics re: clean electricity systems 🟦🟧	Tracking metrics for coal-as-fuel transformations 🟦🟧	Tracking metrics for methane management 🟦🟧	Tracking metrics for EE standards across sectors 🟦🟧	Tracking metrics for NG use and substitution 🟦🟧	Tracking metrics for H2 supply chain development 🟦🟧	**Sustainable energy policy advocacy** 🟦🟧	Develop financing models using Trust structures 🟦🟪	Contribute operating standards, practices to UNFC / UNRMS 🟦🟧🟪
Renewable Energy — *carry out action-oriented, practical activities on renewable energy*	Local to regional RE storage practices, costs, pricing, practices 🟦🟪🟧🟩	Integrated solar,, wind, geothermal, + storage demo at mine site 🟦🟪🟧🟩	Methane management for renewable bio-energy sources 🟦🟧🟪	Analysis — EE of RE projects and operations and how to improve 🟦🟧	Optimal use of integrated RE & NG as storage + onsite backup for grid support 🟦🟧	Optimal scale for RE assets supporting H2 production and use 🟦🟧	Contribute data, analysis, cases on innovative RE applications 🟦🟧	**Make it happen policy and advocacy focus** 🟦🟧🟩	Contribute operating standards, practices to UNFC / UNRMS 🟦🟧🟪
Resource Management — *a universally acceptable and internationally applicable scheme for the sustainable management of all energy and mineral resources*	Power gen decarbonization continuous improvement standards 🟧🟪	New accounting standards for valuing CRM & CMM as part of coal asset values 🟦🟧	Standards for managing methane from extraction to end-use 🟦🟧	Emissions and use standards for mining operations EE 🟦🟪🟧🟩	Methods and standards for NG processing to reduce GHGs 🟦🟪🟧🟩	Valuation standards and practices in H2 supply chain development 🟦🟪🟧🟩	Standards for de-risking CI interdependencies 🟦🟧	Identify and correct via codes and standards barriers to clean energy systems 🟦🟧🟩	**Standards, practices, priorities** 🟦🟧🟪

🟦 Policy & priorities focus
🟧 Focus on tools and capabilities
🟪 Innovation focus
🟩 Transaction focus

Actual
Potential

GLOSSARY

CBM – coalbed methane
CES – clean energy systems
CI – critical infrastructure
CMs – carbon materials
CME – coal mining enterprise
CMM – coal mine methane
CRM – critical raw materials
DSM – demand side management
GHG – greenhouse gas
H2 – hydrogen
MM – methane management
NG – natural gas
RE – renewable energy
SRM – sustainable resource management
UNFC – UN framework classification for resources
UNRMS – UN resources management system

21. For this illustration, Table 1 uses four areas of focus to help clarify the value potential of opportunities, noted below. Actual use of the Table would begin by Groups of Experts' Chairs, the Committee and the Secretariat specifying areas of focus. But, areas of focus would be applied to each cell in the matrix after content was populated for the whole table. The four areas used for this illustration are:

(a) policies and priorities related to energy decarbonization efforts;

(b) work aimed at developing tools and capabilities supporting effective execution of clean energy solutions from local community to member state levels;

(c) innovations in the broadest sense of the term as a core organizing principle for initiatives based on the phasedown and phaseout of hydrocarbons used for fuel;

(d) a transaction driven approach to an initiative. One that would involve investment evaluations and capital placements, economic development programs, business premises for new value creation at the community and enterprise levels, and exchanges of benefits between enterprises in transition, and various government authorities that can reward negotiated phaseouts and phase-ins.

22. With areas of focus specified, populating the content of the Table begins. Continuing with the example, each Group of Experts builds a row of possible activities, connecting the Group's interests and priorities to other Groups by identifying possible activities that could be jointly worked. Columns in the Table serve as points of correlation, which serve as the grist for discussion amongst Group of Expert Chairs. A hypothetical example:

(a) The Expert Group on Resource Management suggests there is a possible joint activity involving creating and advocating for new accounting standards applied to co-operative and mutual entities (CMEs) for valuing Critical Raw Materials (CRM),[8] minor and trace elements in coal, nonfuel uses of coal lands, e.g., deployment of renewable energy, and coal mine methane (CMM) as part of coal asset values;[9]

(b) The Group of Experts on Coal Mine Methane and Just Transition agrees that there is a need for doing so. It maps how changed accounting standards would impact geological evaluations, mine planning, raw coal processing and refining, and the overall valuation of coal assets. This in turn may impact CME valuations and change the global market value of the coal sector;

(c) The Chairs of the two Groups of Experts along with the Committee and the Secretariat develop a programme of activities that is designed to model new accounting standards and map changes in core coal mining processes from end-to-end. A series of convenings as part of the effort are designed to engage policymakers across ECE member States and coal sector specific CMEs and related enterprises, e.g., accounting houses and financial institutions typically serving CMEs. The outcome of the programme is a formal report with recommendations on changing accounting standards coupled with specific inclusions into the United Nations Framework Classification for Resources and United Nations Resource Management System standards and practices;

(d) Possibly a demonstration project unfolds during or based on the results of the work. Such a project would involve work with a CME and one of its mines to pilot new accounting practices coupled with modifications in geological and mine planning work. The desired outcome would be testing the decarbonization, energy resiliency, and transition justice benefits of such modifications.

23. Populating the content of Table 1 would be done by the Chairs of the Groups of Experts through consultation with their respective Bureaus Secretariat, possibly, staff from

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[8] ECE, "COP28: UN urges coordinated action to align soaring Critical Raw Materials extraction and use with sustainable development," 06 December 2023. Refer to website: https://unece.org/climate-change/press/cop28-un-urges-coordinated-action-align-soaring-critical-raw-materials#:~:text=Critical%20Raw%20Materials%20(CRM)%20like,the%20global%20shift%20to%20electrification.

[9] David O. Jermain, Ibid., Pre-Print -- "Coal in the 21st Century: Industry Transformation and Transition Justice in the Phaseout of Coal-as-Fuel and the Phase-In of Coal as Multi-Purpose Resource Platform".

organizations associated with specific experts, and ideally, supporting resources — people, technology, analytics, and cost coverage — from member States.

Clustering identified opportunities

24. The initiatives from Table 1, pursuable between two or more Groups (hence referred to as joint Groups), may initially seem overwhelming due to redundancies and overlaps. However, similar initiatives could be consolidated into clusters and in so doing show how clustering opportunities can enhance priority setting for joint Group initiatives, focusing on practice-based outcomes. It is proposed that Groups Chairs and the Secretariat review Table 1 to identify and cluster similar initiatives:

(a) Content can be organized in many ways, either by clustering related activities or by defining opportunities within each cluster.

25. Potential clusters could be:

(a) Actionable Programmes and Projects that show decarbonization value. These could be grouped as follows;

(i) Demonstration Projects: piloting accounting standards change or extracting hydrogen (H_2) and CRMs from CMM;

(ii) Design / Develop / Operate programmes and projects: may be pursued through public-private partnerships, the use of Trust[10] structures, or other enterprise models;

(iii) Develop legislation or Regulation Models: legislative bills and/or regulatory rules to advance specific initiatives around energy transitions from carbon-based to carbon-neutral and resilient energy systems.

(b) Information platforms for efficient Committee and division activities to demonstrate that the impact of the Groups of Experts as a whole is far greater than the sum of individual Groups work plans. Such information platform could focus on Groups contributions to monitoring and tracking progress in achieving a just transition;

(c) Managing people, organizations, and resources for decarbonization: These could be grouped as follows:

(i) Using Technology and Process Workflows: A number of technologies in energy transitions could herald new industries into tomorrow such as hydrogen produced from waste methane and biogas, with the Energy Futures Initiative Foundation and other researchers outlining its superstructure. Project-level exploration of value is opaque due to financial risks. ECE projects could bring transparency to these developing industries. Early-stage workflows of new technologies are immature, requiring pilot projects to determine best practices;

(ii) Defining and integrating the transition ecosystem: energy systems are complex and increasingly automated. Despite evolving roles, people, organizations, and resources remain critical. Engaging people with process workflows and developing technologies can reduce innovation errors and enable smoother societal adoption. Factors affecting adoption include perceived advantages, compatibility with existing systems, complexity, ease of adoption, and observable benefits.

Example: Joint Resource Management and Coal Mine Methane Project

26. Shifting and sorting potential opportunities into more focused bundles can serve the Groups aiming to maximize the shared value of contributing experts. Further, it helps staff focus their support capacity when specific work plans for inter-Group projects are made concrete.

27. Figure III illustrates one way to move smoothly from selecting priorities to making priorities actionable. A hypothetical joint effort between the Expert Group on Resource

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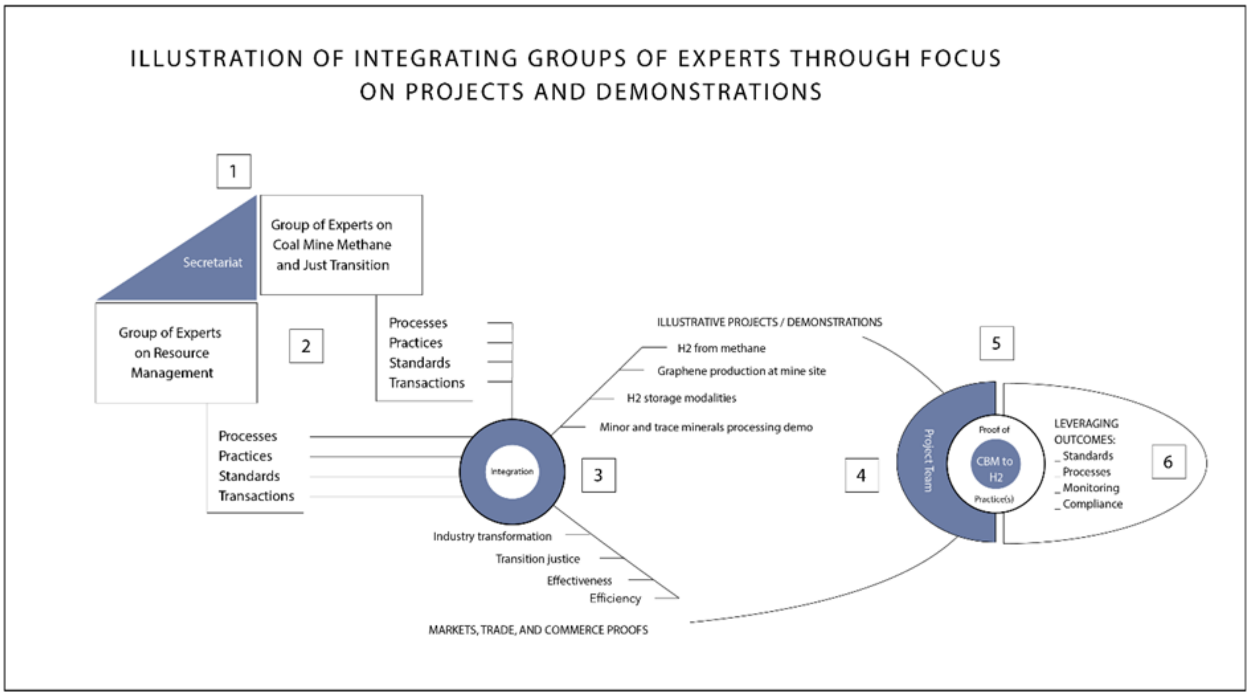
[10] David O. Jermain, Raymond C. Pilcher, “Trusting clean energy: novel perspectives on transition pathways for coal phaseouts and clean electrification phase-ins,” The Electricity Journal, Volume 36, Issue 7, August-September 2023, https://doi.org/10.1016/j.tej.2023.107318.

Management and the Group of Experts on Coal Mine Methane and Just Transition is used to describe a process for enhancing Groups of Experts pursuing joint Group initiatives.

Figure III
Illustration of Groups of Experts integration through focus of projects and demonstrations



28. There are six steps to moving a potential activity into one that is an executable project. The following steps continue for the hypothetical process in the illustration from above. This hypothetical project assumes cooperation with a hosting member State and would likely include local experts and contractors:

(a) Step 1 Secretariat works with the Chairs of the Expert Group on Resource Management and the Group of Experts on Coal Mine Methane and Just Transition. Through discussion and engagement with experts from both Groups a framework for crafting one or more projects from a selected opportunity area emerges. The processing of CMM to derive value is used as an example. The value of the work must not only be gauged as a technical success but must be an economic success that has socially acceptable outcomes that increase the potential for adoption by the community;

(b) Step 2 creates shared work streams tying the two Groups to a primary task. As an example, if we take the case of processing hydrogen (H_2) from CMM, progressing to a tangible project involves scoping operations for processing of H_2; that is, specifying processing steps. Since CMM comes from mining operations, specific processing steps also must detail how mine operating assets will be leveraged to reduce costs of adding H_2 extraction. A shadow operation and business model may emerge from this project;

(c) Step 3 maps what to do with processed H_2. For example, how to eliminate CMM by processing H_2, then how to use H_2 that is processed, e.g., for fuel and/or other uses. Defining measurable proofs of concept and value emanating from the project is a key success factor. Analytics should address industry transformation potential, realization of transition justice, and the effectiveness and efficiency of the demonstration itself. This is an important point at which the mining operation must indicate acceptance and support the idea for what it is—a transformative step in the operation of the coal mine. Moreover, the community that provides workers and is part of a broader economic and social ecosystem must be informed and engaged in dialogue;

(d) Step 4 establishes the project team to drive and deliver proofs of concept and value. Also, these overriding proofs must include proofs of practices that are most cost-effective in the transition from CMM to commercial products derived from processing;

(e) Step 5 involves actual execution of the project, including documentation of its performance in terms of proofs specified in its project plan. Part of this analysis will include assessment of the impact on the local and regional economy, workforce, and community at large;

(f) Step 6 consolidates findings, documents outcomes in a report, and recommends policies and practices, which contribute to better execution of transitions justly executed. Further, the results should be used to enhance both decarbonization goals and ECE energy resiliency requirements.

29. A successful project can yield results that help prove coal transitions can occur justly with no one, including CMEs, left behind. Also, the process of joint Group projects, from design to execution, can strengthen long-established ECE roles of defining critical social and economic issues and facilitating dialogue amongst member states. The ability to incorporate actionable tests of policies — i.e., pilots, demonstrations — arguably enhances core ECE roles. Moreover, it demonstrates that the ECE possesses the capacity to inter-link its role of convening parties to consideration of proposed policy through tests of its potential value in practice. The key word and focus is around how to make policy validly actionable.

Practice-based results: enhancing energy decarbonization and resiliency through actionable programmes and projects

30. Climate mitigation principles and protocols should include actionable steps, with metrics, execution controls, and compliance enforcement.[11]

31. Demonstrating actionable climate mitigation programmes and projects can validate or prompt modifications to policy, enhancing ECE's mission by revealing critical interdependencies for effective energy decarbonization and resiliency policies.

Project Scoping

32. Using the hypothetical example described above, a project testing the processing of CMM to produce H_2 primarily focuses on the engineering and operation of the process, including safety and integrity of materials, structures, and flows. For hydrogen production from coal mine methane, considerations include onsite use, pipeline transport, or sale to carriers. The project scalability is crucial for validating its broader socioeconomic impact and fit within interdependent infrastructures.

Some process mapping can be simulated, but most must be executed at a mine site. Key consideration for hydrogen are:

(a) Onsite electricity generation for mine operations and/or sale to a local electricity grid;

(b) Sale to nearby users, requiring pipeline to transport the gas to the point of use;

(c) Sale to gas transmission or distribution carriers.

33. If the project explores options beyond onsite production, it must align with current and future interdependent infrastructures. Even small tests should consider large-scale infrastructure socioeconomic relevance to validate the proof of concept and scalability from local to national and/or regional levels.

34. Critical infrastructures are increasingly interdependent due to digital platforms. In recent years, many types of actors have sought, and in some cases succeeded, in penetrating electric grids and local electric utility systems. Once in, disruptive applications can migrate throughout other systems. An excellent discussion, albeit somewhat dated, is found in the US Department of Energy's Quadrennial Energy Review, previously referenced, and other analysis that is more recent-[12] The key point is that pilot projects must consider the

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[11] Jonas Verstraete, et.al., "Turning Data into Actionable Policy Insights," chapter from the book The Data Shake, part of the SpringerBriefs in Applied Sciences and Technology book series, 05 March 2021, available at: https://link.springer.com/chapter/10.1007/978-3-030-63693-7_6.

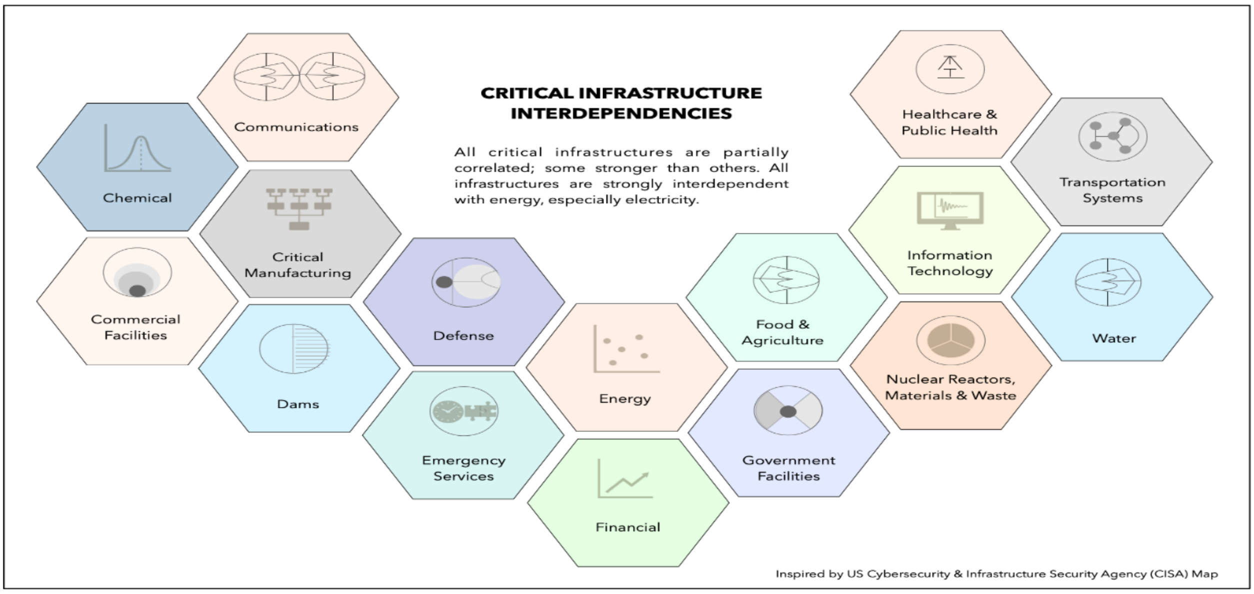
[12] See also Marc Casanovas, Aloys Nghiem, "Cybersecurity – is the power system lagging behind," International Energy Agency, 01 August 2023; refer to website:

interdependencies of critical infrastructures to ensure valid proof. All energy decarbonization and resiliency policies and practices should be contextualized in the vital frame of critical infrastructure interdependencies, as well.

35. Energy systems are highly digital and interdependent, with disruptions in one area potentially impacting others. Effective decarbonization policies must consider these interdependencies to ensure continuous and reliable energy supply.

36. The trend lines are toward a ubiquitous digitalization of all energy systems, from small micro-scaled systems to national and international scaled supply chains for producing and delivering electrons, liquids, and gases. Digital platforms for infrastructures now apply to most areas of critical infrastructure. Figure IV below is an adaptation of the US Department of Homeland Security, Cybersecurity and Infrastructure Security Agency (CISA) map defining sixteen infrastructures deemed to be critical (hence strategic).[13] Of course, similar frameworks exist for most countries; but the practice of using and managing the frameworks from country to country is highly variable.

Figure IV
Critical Infrastructure and Interdependencies



Inspired by US Cybersecurity & Infrastructure Security Agency (CISA) Map

37. Critical infrastructures (CI) are inherently interdependent. First, because their digital footprints function within the established core information infrastructures that have evolved over the last few decades. Second, the operation of CIs are partially correlated across all CIs, at varying degrees of connection. For instance, water infrastructure depends on electric power. It breaks down when power is lost, but service can be sustained at some level for some period of time, depending on the severity of interruptions. The same applies to communications. But, energy supply cross-impacts are what amplify the cascade effects that are one of the core risks of CIs. Figure V is an adapted rendering of a US Department of Energy visualization of co-dependent physical,

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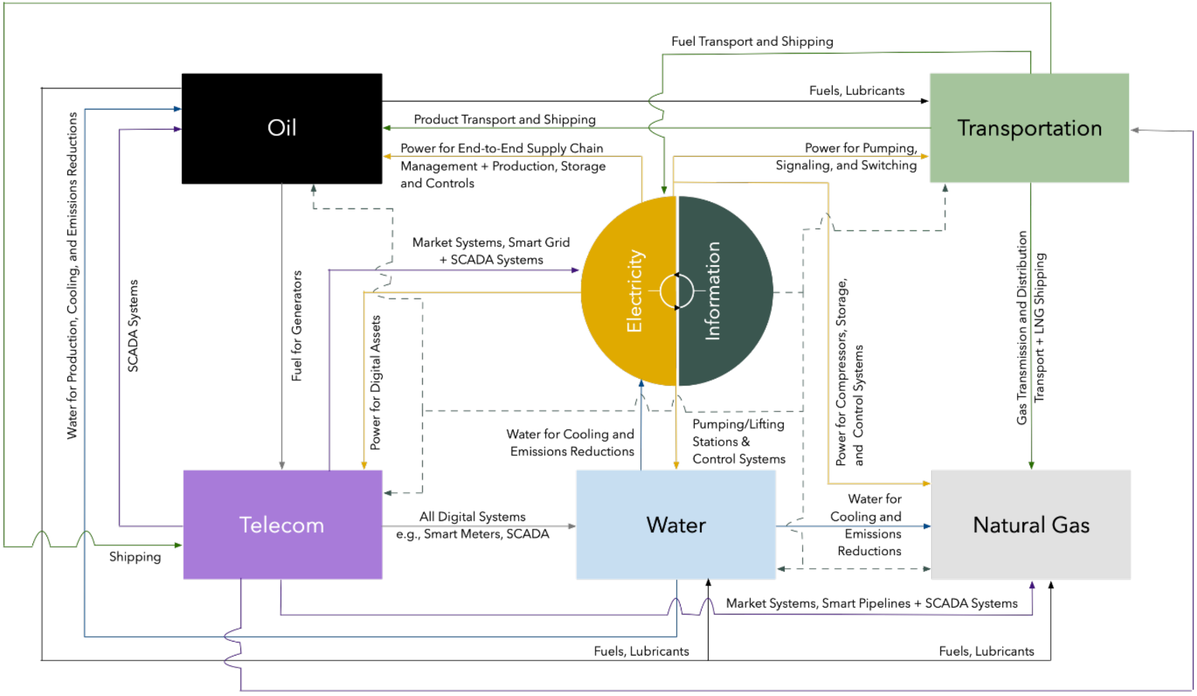
https://www.iea.org/commentaries/cybersecurity-is-the-power-system-lagging-behind#. Charalampos Avraam, Luis Ceferino, Yury Dvorkin, “Operational and economy-wide impacts of compound cyber-attacks and extreme weather events on electric power networks,” Applied Energy, Volume 349, 1 November 2023; https://doi.org/10.1016/j.apenergy.2023.121577. Xiao Ding, et al., “Dual nature of cyber-physical power systems and the mitigation strategies,” Reliability Engineering & System Safety, Volume 244, April 2024; https://doi.org/10.1016/j.ress.2024.109958. Suleyman Yildiz, Burak Yildirim, Mahumt Temel Ozdemir, “Enhancing load frequency control and cybersecurity in renewable energy microgrids: A fuel cell-based solution with non-interger control under cyber-attack,” International Journal of Hydrogen Energy, 20 February 2024; https://doi.org/10.1016/j.ijhydene.2024.02.145.

[13] Refer to website: https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors.

financial, and information flows related to energy infrastructure.[14] The example uses oil as the natural resource that is refined transported, marketed and used, but it could be coal or other energy fuels.

Figure V

Dominant Elements of Energy Infrastructure



38. Energy profoundly influences most socioeconomic sectors. The flow of electrons is dependent upon information systems and flows — so much so that the language of energy policy, investment decision-making, and associated energy transitions must be viewed as units of energy-information. This interconnectedness is often taken for granted, but in cases where advanced systems bypass segments of the population, access to energy, clean environment is not justly distributed, resulting in parts of the population being underserved while progress is made elsewhere. While this is an example of transition that was not justly delivered, but in some cases, unexpected impacts of climate change have widespread and expensive consequences. For example, energy decarbonization must include decarbonization of information centers, such as server farms and high-performance computing centres.[15] A stunning example of CI cascade effects is the case of Christchurch, New Zealand where electricity, water supply, and wastewater networks failed following a range of coastal flooding events caused by climate change.[16]

39. The final step in the joint Group potential activities development process is delivering results from joint Group projects. If projects are contextualized in the broader frame of CIs and the consequential effects of interdependencies that yield broader disruptions when energy services (used here as a generic term) fail, then the delivery of results of pilots also should be framed in relevant energy-specific and related outcomes, including cross-impacts on interdependent CIs. Table 2 illustrates a simple energy-specific framework accomplishing certain identified factors. Taken as a whole the impact of the project on the community and progress toward a just transition must be evaluated as a part of the assessment of the success of the project. Favourable impacts must be real and measurable.

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[14] Refer to website: https://www.energy.gov/sites/prod/files/2017/02/f34/Quadrennial Energy Review Summary for Policymakers.pdf

[15] C.A. Silva, et.al., “A review of the decarbonization of high-performance computing centers,” Renewable and Sustainable Energy Reviews, 189 (2024), available online 7 November 2023; https://doi.org/10.1016/j.rser.2023.114019.

[16] L.G. Brunner, et al., “Understanding cascading risks through real-world interdependent urban infrastructures,” Reliability Engineering & System Safety, Volume 241, January 2024; https://doi.org/10.1016/j.ress.2023.109653.

Table 2

Assessing Energy-Specific Decarbonization and Resilience Results of Joint Projects

Sustainable energy priorities / Execution instruments	Always Available	Always Reliable	Assured Delivery	Systemic Integrity	Deep Inventory
	Fuel Flows	kWh	Industry / Commerce	Critical Infrastructure	Strategic Resources
Technology					
People					
Organizations / Institutions					
Assets and Value					

40. All projects must be proven to meet the socioeconomic necessities of ECE's member States:

(a) If requirements include transformations from carbon to clean platforms, it means that ensuring that fuel flows will continue, then this goal must be prioritized as ensuring "always available" at scale;

(b) Kilowatt-hour flows must be prioritized as being "always reliable," where delivery is scaled to uses;

(c) Industry and commerce must be sustained and continuous, so "assured delivery" of sustainable energy is the priority;

(d) CIs must maintain "systemic integrity," for reasons noted above;

(e) Increasingly important, valuable, and necessary "strategic resources," such as those that enable the digital economy and decarbonized energy platforms, secured and stockpiled are the priority. However, often missing is and evaluation of the possible or negative impacts on communities. This must be integrated into the process, and measured as a part of a resource management system that defines indicators tailored to the needs of the communities involved.

41. Execution instruments for meeting said sustainable energy priorities include technology, people, organizations and institutions to organize, enable, and guide, and the core assets and associated values derived therefrom.

42. Table 3 provides an example of application of the framework described in Table 2, in the hypothetical case of processing H_2 from CMM. Table 3 is populated with answers to concluding questions that follow from the completion of the H_2-from-CMM pilot.[17]

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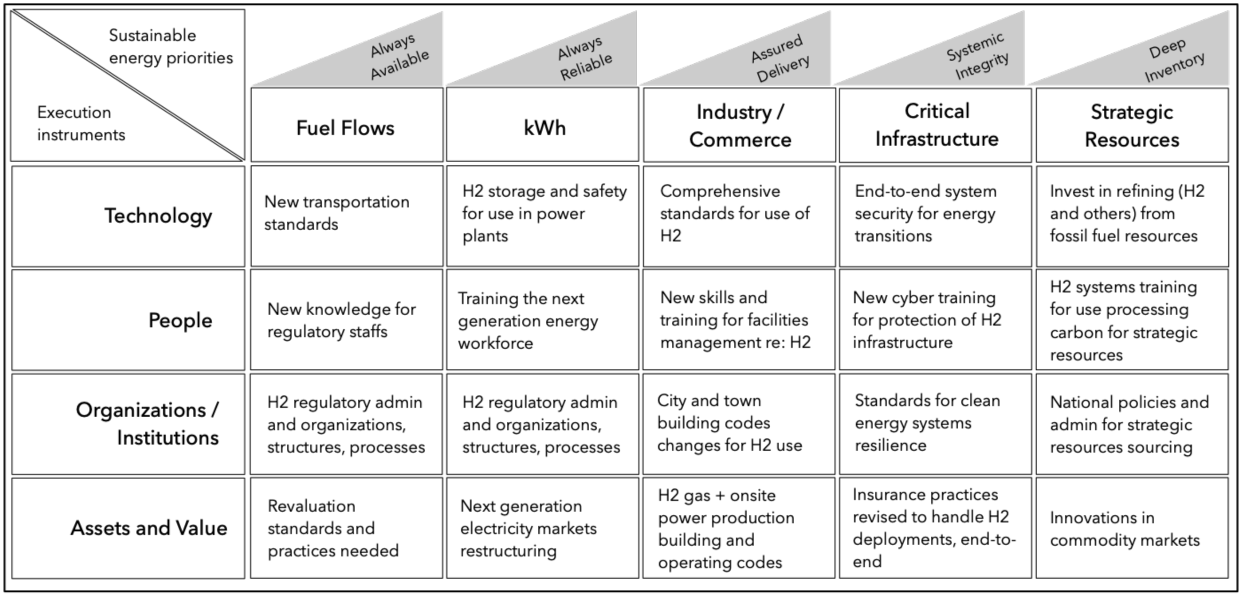
[17] For this illustration, the assumption is made that hydrogen-from-CMM case yields a successful proof of operational concept and value, but in reality, other outcomes are possible and this will have to be considered if such projects are pursued.

Table 3
Matrix to Organize H_2 Post-Project Results into Actionable Recommendations



Sustainable energy priorities	Always Available	Always Reliable	Assured Delivery	Systemic Integrity	Deep Inventory
Execution instruments	**Fuel Flows**	**kWh**	**Industry / Commerce**	**Critical Infrastructure**	**Strategic Resources**
Technology	New transportation standards	H2 storage and safety for use in power plants	Comprehensive standards for use of H2	End-to-end system security for energy transitions	Invest in refining (H2 and others) from fossil fuel resources
People	New knowledge for regulatory staffs	Training the next generation energy workforce	New skills and training for facilities management re: H2	New cyber training for protection of H2 infrastructure	H2 systems training for use processing carbon for strategic resources
Organizations / Institutions	H2 regulatory admin and organizations, structures, processes	H2 regulatory admin and organizations, structures, processes	City and town building codes changes for H2 use	Standards for clean energy systems resilience	National policies and admin for strategic resources sourcing
Assets and Value	Revaluation standards and practices needed	Next generation electricity markets restructuring	H2 gas + onsite power production building and operating codes	Insurance practices revised to handle H2 deployments, end-to-end	Innovations in commodity markets

43. Based on a successful H_2-from-CMM pilot, the answer to the “what is to be done?” question is the following:

(a) To ensure always available fuel flows, new technologies (digital and physical) that enable a safe use of H_2 must be deployed along with new fuel transportation standards related to safety and security and more. People must be trained to deal with new technologies and standards. This is especially true for regulatory staffs whose responsibilities include ensuring safety and security standards are met and sustained. Possibly, a new H_2 regulatory administration, organization, structures, and processes are needed. Most likely, energy assets and values must be revaluated based on changed standards and practices, and the market share impacts of H_2 deployment and use against conventional fossil-based fuels;

(b) To ensure always reliable electricity service, H_2 storage and safety for use on power plants, as well as distributed resources in local distribution networks and onsite, must be established. This requires advances in technologies already available but warranting improvements in managing leaks and related safety risks, e.g., fires. This requires training the next generation energy workforce if tomorrow’s is to be significantly H_2 based. It means new H_2 regulatory administrations, as previously noted. But, regulations for onsite use may require additional people, processes, and technologies;

(c) Much the same circumstances applied to kWh must be applied to industry and commerce as well;

(d) Critical infrastructure requires end-to-end security systems for energy transitions and cyber and security training for people. The former is particularly technology dependent, the latter is both technology and people dependent, but in both cases focused on process workflows. New organizations are required, ones that focus on standards for clean energy system resilience and associated compliance with standards. Finally, all of the changes related to H_2 will have cross-impacts on valuation and risk, especially insurance related risks.

44. The results of a pilot involving production of H_2-from-CMM would cover points made above and others based on what is learned from a real pilot and its outcomes. Evaluation of the results must include the technical and economic performance of the pilot and assess the impact of the pilot on the community The assessment will be designed to gauge the level to which the benefits of the project have been imparted to the people and businesses of the hosting community, adding to the local economy by creating new potential industry around what was a waste by product of coal extraction. Similar pilots could be created for natural gas that is flared in oilfields. Key in evaluating the benefits derived from the project will be to measure the extent to which the demonstrated changes are sustainable and beneficial to the local environment as well as the global climate. While a hypothetical illustration may be

helpful for seeing how such a process can help leverage the inherent value of the Groups of Experts, nothing compares to actual piloting.

45. If there is value in the approach presented herein, hopefully it pertains to finding new ways to think about and to pursue desired outcomes for sustainable (decarbonized) and resilient energy justly achieved. Also, in discovering new issues that merit attention of the sustainable energy subprogramme and ECE.

VI. Conclusions and Recommendations

46. This document presents a framework for developing and executing joint ECE Committee on Sustainable Energy Groups of Experts initiatives.

47. The subsidiary bodies of the Committee on Sustainable Energy can play an important role in demonstrating that clean energy can be achieved even in strategically perilous times. That, in fact, the transition to clean energy platforms offers a more robust formula for secure resilience of ECE energy supplies — and, importantly, for securing interdependent critical infrastructures that are necessary for the security of individual countries and the continued evolution of human societies and economies. Yet that is only half of the story, the other half is that social and economic benefits can be derived from successful projects which are from inception designed to achieve the SDGs.

48. These pilot projects can be designed to achieve SDGs at the community level. These pilot projects must directly benefit hosting communities and set the stage for development of policies and programmes that serve to expand the scale and number of projects coupled with upskilling, technical and vocational training and development of university curricula which produce the workforce needed to create a sustainable industry.

49. Through these initiatives, the sustainable energy subprogramme will asks the groups to identify and document, through their discussions and piloting of the just transition approach, the value added of adopting a just transition at the regional or subregional levels, and whether and their working methods and platforms are conducive to the implementation of the just transition principles, for example if they include representative of all relevant stakeholders.

50. The Committee on Sustainable Energy is invited to:

(a) Endorse a just transition approach across the sustainable energy subprogramme and all its Groups of Experts that creates the necessary foundation to achieve resilient and carbon neutral energy systems;

(b) Encourage member States in the region to share priority sectors with ECE for piloting its just transition approach;

(c) Explore the possibility of bringing the just transition approach to the attention of the ECE Commission session in 2025 as the suggested theme of a future Commission session, so inviting ECE to consider adopting the just transition approach at the programme level given its cross-cutting nature that requires a whole-of-society approach. The discussion about bringing the just transition topic at programme level will also focus on how to valorize ECE regional platforms (Regional Forum on Sustainable Development; Forum of Mayors; Regional Coordination Platform/Issue Based Coalitions) as platforms for discussion of common regional approach/definitions of just transition and as venues to monitor progress in implementation of just transition approaches.