Strategic Energy Technology Plan

Annual Conference 2024

Cluster Workshop

Implementation Working Groups
and
European Technology Innovation Platforms

Workshop Outcomes

Date of event: Wednesday 13 November 2024 (14:00 – 18:00 CET)

Location: In-person event, at Báthory utca 10, Budapest, 1054 Hungary

Introduction

The Communication on 'the revision of the Strategic Energy Technology (SET) Plan'[1] calls for the establishment of five time-bound Task Forces dedicated to cross-cutting topics:

- Circularity and materials substitution (Task Force 1);
- Research and innovation (R&I) for societal needs (Task Force 2);
- Digitalisation (Task Force 3);
- Skills (Task Force 4);
- Access to market (Task Force 5).

This Cluster Workshop brought together the Secretariats of the Implementation Working Groups (IWGs) and the European Technology & Innovation Platforms (ETIPs) of the Strategic Energy Technology (SET) Plan. The objective of the workshop was to identify their priorities for five cross-cutting topics, in order to inform the future work of the respective Task Forces (starting their work in 2025). The workshop was attended by 54 participants and was organized by the SET Plan Secretariat (DG ENER, DG RTD and the JRC) and the SET Plan Support Office.

The main take-aways from the Cluster Workshop are:

- **Many priorities were identified per cross-cutting topic**. The written contributions from each IWG and ETIP have been recorded, grouped and listed below. References to specific ETIPs and IWGs have been made in square brackets (see table below for an overview of the abbreviations used).
- The **cross-cutting topics** are **interrelated,** with advancements in one area strengthening others when coordinated effectively. For example, digitalisation plays a role in the priorities put forward for skills and circularity.
- The Task Forces have the **potential to support EU policy initiatives** by offering input on cross-cutting topics. By identifying short-, medium-, and long-term contributions, members can contribute to policies that promote cohesive energy transition efforts.

Table 1: Abbreviations of ETIPs and IWGs

ETIPs	IWGs
WIND	**WIND**
PV (Photovoltaics)	**PV** (Photovoltaics)
GEO (Geothermal)	**GEO** (Geothermal)
OCEAN	**Ocean**
SNET (Smart networks for energy transition)	**ES** (Energy systems)
BIO (Bioenergy)	**RFB** (Renewable fuels and bioenergy)
ZEP (Zero Emissions Platform)	**CCS-U** (Carbon capture, storage and utilisation)
SNETP (Sustainable Nuclear Energy Technology Platform)	**NS** (Nuclear safety)
RHC (Renewable Heating and Cooling)	**EEB** (energy efficient buildings)
HYDRO (Hydropower)	**H2** (Hydrogen)
ECTP (European Construction Technology Platform)	**PED** (Positive energy districts)
BAT (Batteries)	**IND** (Industry)
	DCT (Direct current technologies)
	CST (Concentrated solar thermal)

To build on the outcomes of this workshop, Task Force members will be asked to comment on and select the priorities to further elaborated over 2025.

[1] COM(2023) 634 final: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0634&qid=1698315020718

TF 1: Circularity and Material Substitution

The topic of 'Circularity and Material Substitution' should expand the concept to incorporate lifecycle thinking, capitalise on recycling innovation and prioritise the use of abundant materials with low environmental impact. – *Summary from plenary.*

- **Harmonisation of regulations and standards for circularity:** Divergent regulations between Member States were identified as a barrier to a unified circular economy, particularly for technologies reliant on cross-border supply chains like hydropower [ETIP Hydropower]. Harmonisation of regulations is necessary to enable a **single market for circular economy** products. For example, the functional requirements for materials in advanced manufacturing must be **standardised** to avoid sub-optimal outcomes [SNETP, IWG Ocean]. Recycling systems require **harmonised** collection and processing facilities [H2]. This harmonisation must extend to **norms** ensuring the upgradability of storage systems to meet future technological needs [IWG ES, ETIP SNET].
- **Circularity by Design as a fundamental principle:** Embedding **circularity by design** is crucial across technologies, from concept to pre-commercial deployment [IWG Ocean]. Frameworks like "safe and sustainable by design" [SNET] and modular reactors like Small and Advanced Modular Reactors [SNETP]. The design process should incorporate principles of second-life use and recyclability, especially for grid technologies and components in smart grids [SNET]. Ocean energy systems identified the need for designing equipment for decommissioning and recycling to reduce environmental impacts [IWG Ocean]. **Social sustainability** was also highlighted as a necessary inclusion in Life Cycle Analysis to evaluate broader impacts of these design frameworks [IND].
- **Life Cycle Assessments (LCA) as a tool for collaboration:** Implementing **LCAs** at all stages of development is critical for reducing environmental impacts. Many identified specific use cases for their technology, including using LCAs for e.g. assessing geothermal energy projects for waste reduction [IWG GEO], or LCA on grid technologies to reduce environmental impact [SNET]. A call was made to **improve the tools for LCAs and reporting** [DCT]. Specifically, LCA tools for industry and SMEs should be accessible and simplified to ensure compliance with sustainability standards, thereby fostering wider adoption [RHC].
- **Material recycling challenges and common needs: Recycling challenges** were underscored for materials such as steel, copper wiring, and composites, which are **shared** between some sectors [IWG IND, ETIP Wind, HYDRO]. Hydrogen technologies emphasised the need for recycling processes that prioritise material quality and efficiency [H2]. Increasing the recycled content of wind turbine blades using carbon fibre and glass reinforcement was identified as a sectoral priority [ETIP Wind].
- **Infrastructure repurposing for circularity:** Repurposing existing infrastructure provides significant opportunities to **reduce material demand** while **fostering circularity**. For example, abandoned oil and gas wells could be converted for geothermal energy production [ETIP GEO], and old wind monopiles could support wave energy systems [ETIP Ocean]. Existing CO2 pipelines and storage facilities could be adapted for carbon capture, utilisation, and storage (CCUS), reducing the need for new infrastructure [ETIP ZEP].
- **Material substitution to enhance resilience:** Transitioning to **low-impact, abundant materials** was emphasised across sectors. Examples include PFA-free electrolysers and fuel cells in hydrogen technologies [H2] and lead-free cables for advanced electrical systems [DCT]. Bio-based regenerative materials offer promising alternatives for certain energy applications but require further R&I [IWG EEB]. Efforts to replace hard-to-recycle composites in wind turbine components are ongoing [ETIP Wind]. A shared challenge is ensuring that

substituted materials are **scalable and economically viable** while avoiding replicating scarcity issues.

- **Economic viability and funding mechanisms**: **The economic viability** of recycling and circular products remains a bottleneck, as current market mechanisms often fail to ensure profitability [SNETP]. **Public funding mechanisms** and levers to develop a sustainable and viable market for recycled products by design were identified as crucial for creating markets [ETIP Wind, GEO]. Advanced manufacturing grants could support functional materials designed for sustainability, but these need to be complemented by regulatory obligations to ensure widespread adoption [SNETP].
- **Digitalisation as a driver of circularity:** Digital tools, such as AI-based material acceleration platforms, enable faster and more automated material testing [BAT]. **Digital twins** were identified as essential for **predictive maintenance and lifecycle management**, improving operational efficiency [SNET]. Circularity indicators supported by digital tools could standardise measurements across sectors, enabling shared progress tracking [IWG EEB].
- **Collaboration across value chains and sectors:** Building synergies across value chains is essential to close material loops. For instance, composite users and blade manufacturers in the wind sector could collaborate to ensure end-of-life recycling [ETIP Wind]. Extracting critical raw materials like lithium from geothermal fluids presents opportunities to align resource extraction with energy production [IWG GEO]. Lessons from mature sectors can guide emerging industries [IWG Ocean], while **synergies with other value chains** to enable circularity should be fostered [ETIP PV]. Moreover. an **international harmonisation** of regulations is necessary to prevent monopolies and promote responsible material sourcing [BAT]. Alignment, across value chains and sectors is required for the recycling market to take off [BAT].

TF 2: R&I for Societal Needs

The topic of 'R&I for Societal Needs' should not just focus on gathering public acceptance for strategic energy technologies, but on shifting the public perception, so that strategic energy technologies are the preferred option. It should also consider fair business models and the environments of affected communities. – *Summary from plenary.*

- **Better engagement of stakeholders:** There is a need to better inform stakeholders on the functioning, benefits, success stories, externalities and/or safety of strategic energy technologies [CST, HYDRO, WIND, RHC, GEO, OCEAN, H2, CCS-U, CST, SNETP, BIO]. There are specific concerns about the presence of **misinformation or bad public perception** about certain energy technologies, e.g. that the energy technology is connected to oil, unsafety, or pollution [NS, CCS-U, GEO]. On the other hand, for some technologies, there is a perception that there is a long way to go to inform communities about how the technology works and why it is beneficial [OCEAN, GEO]. Additionally, there is a need to inform stakeholders about industrial processes, the cheap prices that clean electricity could lead to or the negative effects of fossil fuels [RHC, SNETP, WIND, HYDRO]. To improve awareness, messaging should be well-targeted to different audiences using different approaches for various target groups, e.g. youth and elderly. There is a need for **improved engagement processes,** with customers and communities at the core [BIO, WIND, PV, SNETP, HYDRO, CST]. Engaging the public early in the process is crucial and helps to build trust and gather valuable input from the community and ensures that the solutions developed meet the needs and expectations of end users [WIND, BIO]. Innovations should **empower end users**, foster a sense of ownership, and capture their needs and concerns [WIND, HYDRO, CST]. Some advocated for the need of tools which will help with mapping and engaging stakeholders and setting up tailored and easy stakeholder processes [WIND]. There is a need to tailor the stakeholder engagement approaches to the specificities of a specific SET Plan technology. Careful consideration should be made for target audiences, as well for which individuals will implement stakeholder engagement (e.g. engineers).

- **Governmental awareness and support across levels:** There is also a need to better inform governments on the various strategic energy technologies. Governmental actors need to be first well-informed about the technologies so that they can also better support and address the challenges related to specific technologies. Policy and regulatory actors should be assisted to achieve a better understanding [GEO, CST, SNET]. It responsibility of the EU to create a clear, transparent and well-communicated strategy and information **campaign on the benefits of strategic energy technologies** targeting citizens, communities and governments. This could follow the idea of a one-stop shop of practical information on strategic energy technologies, and for example, include template materials that can be used across governmental levels to inform people [H2, RHC, PV].
- **Support bottom-up approaches and fair business models:** Sustainable and socially sound business models should be developed to ensure a **fair distribution of profits/costs** among companies, government and local communities/customers [WIND, PED, H2]. Also, supporting bottom-up stakeholder engagement approaches and neighbourhood initiatives are important. Some technologies have a specific interest in supporting **local energy communities**, making these processes simpler, less costly and better supported [PED, H2, PV].
- **Energy affordability and accessibility:** Ensuring that communities prefer strategic energy technologies above fossil fuels is strongly linked to the need for affordable and accessible energy. **Energy access** refers to the availability of reliable and modern energy services to all individuals and communities. **Energy affordability**, on the other hand, relates to the cost of energy services and the ability of consumers to pay for them without compromising other essential needs. For some energy technologies, affordability is a key topic [EEB, SNET], while for others, with for example a lower TRL, it is less of a priority topic yet [H2, OCEAN]. Some technologies can develop strong energy security and reliability but struggle with very high initial costs [H2, NS, OCEAN, GEO]. Related needs that are to be addressed include increasing knowledge on the correct use of equipment for it to be accessible [RHC] and enough financial support to enable affordability [RHC, BAT]. Practices that can contribute to addressing these challenges include local production of energy and neighbourhood approaches [ES, EEB], increased impact investing [IND] and cost reduction through optimising operations and maintenance [WIND]. Some energy technologies place a lot of focus on the need for a socially inclusive energy transition in which **vulnerable households and minorities** should not be left out and are put at the centre of the energy transition [EEB, IND]. Key related topics include addressing **energy poverty** and ensuring that there is a just transition to an upgraded housing stock with renewable energy technologies [EEB, SNET]. Especially, the need for subsidies, grants and financial incentives to boost affordability for all are needed herein [BAT, EEB]. In addition, other needs of society should be taken into account, including respecting living conditions, minimising land use and ensuring environmental protection of land [EEB, SNETP, PED, CCU-S, BIO].
- **Interdisciplinary and citizen science:** Interdisciplinary and citizen science play a crucial role in advancing strategic energy technologies aligned with the public's preferences. Citizen

science can enable **local data collection and engagement** and ensure a focus on the questions from society [WIND, EEB]. Research activities should be connected to the needs of owners and users [ES]. A collaboration between STEM (Science, Technology, Engineering, and Mathematics) and SSH (Social Sciences and Humanities) [BAT] and the integration of economic and social sciences [H2] will enable useful cross- and transdisciplinary research, which can better benefit society.

- **Well-being of workers:** Various technologies underline the importance of appropriate **safety measures** [DCT, H2, ZEP, EEB, BAT, SNETP, NS, CST]. Both the physical and mental health and safety of workers and communities throughout the value chain (production – transportation – consumption) are herein of importance.

TF 3: Digitalisation

The topic of 'Digitalisation' should consider data sovereignty and the different use-cases for which digital tools can be applied. Digital tools can enable targeted contributions such as predictive maintenance, system optimisation, and lifecycle impact assessments that improve operational efficiency. – *Summary from plenary.*

- **Digital tools for energy technologies:** There are a variety of digital tools that can help operations and maintenance (O&M), reduce costs and improve performance [CST]. Some specific tools are presented below.
    - **Digital Twins** are seen as a useful tool [RHS, IWG PV, ETIP PV, WIND, ETIP OCEAN, DCT, SNETP, ETIP GEO, IWG NS, BAT, H2, PED, CST, IWG IND]. They can be used for many kinds of process systems [IWG PV] and help with optimisation for smart monitoring and control for efficient operation [RHC]. They are virtual replicas of physical systems and can be used for simulation purposes [SNETP] or with predictive models to ensure process design accuracy [IWG IND]. Specific examples of the use of Digital Twins include: lifetime extension of turbine components [WIND]; health monitoring for energy systems [DCT]; national electricity grids [ETIP OCEAN]; predict system behaviour under various conditions geothermal systems (allowing for better planning, risk assessment, optimisation of operations) [ETIP GEO]; design, maintenance and operation [IWG NS]; urban and energy planning [PED]; proactive systems improve plant safety and efficiency [SNETP]; cost reduction in the production stage [BAT]; optimal planning if the (integrated) European energy system (H2 + electricity) [H2]; virtual power plants [IWG CST]; predictive maintenance of plants [EIP PV]; planning, deployment and for operations and maintenance [ETIP WIND]. Digital Twins however require accurate modelling and validation [SNETP].
    - **Artificial Intelligence (AI)** is also useful [DCT, ETIP OCEAN, SNET, IWG IND, IWG ES, ZEP] and has machine learning capabilities [ETIP OCEAN]. AI has multiple use cases and can improve the efficiency of processes [IWG IND]. It can inform decision-making [IWG ES], facilitate operations and maintenance [ETIP WIND], determine CO2 storage potential and model CO2 network planning [ZEP] as well as identify (in the design phase) effective geometrics, develop control strategies etc. [ETIP OCEAN]. For operation and control [DCT], it can: be applied to establish control parameters for power take-off linked to weather models, resource observation etc. [ETIP OCEAN]; conduct real time monitoring [IWG ES]., as well as; operationalise energy management [IWG ES]. Several aspects need to be addressed to unfold AI (e.g. data; complex model building) [IWG IND] and it would be helpful to quantify the benefits

of AI [SNET]. Insights can be drawn from the upcoming paper 'Unlocking the potential of AI' [SNET].
    - **Other digital approaches** include the Internet of Things (IoT) [SNET], 3d subsurface imaging [ETIP GEO], big data [H2, HYDRO], physical sensors [CST] as well as robotics, for example for the autonomous operations of wind turbines [ETIP WIND]. The benefits of automation and robotics should be compared to those of AI [SNETP].
- **Use-cases of digital tools:** Digital systems can support decision-making for operations and maintenance [WIND] and improve performance and reliability [ETIP OCEAN]. Examples of use cases, *not* linked with specific digital tools, are listed below.
    - **Management of the energy system** can be supported by digital tools. For example: Integrated supply exchange management [IWG IND]; monitoring production vs. demand [N/A]; data exchange with secure pricing measures [IWG IND]; digitalization of the energy system; local energy management and operations and management of wider grid [PED]; optimise production planning [IWG IND]. The Clean Energy Technology Partnership[2] is aiming to establish a common IT framework that supports to cross-sector and cross-border connectivity [IWG ES]. Digitalisation could help sector coupling approach which means reducing costs and resources [CST]. **Predictive modelling and forecasting** can be used [IND] to model multiple scenarios for the transformation of pan-European energy system [H2]. Models can be used to/for: network simulation modelling [ETIP OCEAN]; enable a faster planning and commissioning of infrastructure [WIND]; forecast resources or yield quantification [ETIP WIND]; determine future energy system needs, assessing impact on grids [WIND]. Improved modelling/forecasting will better address citizen characteristics going against the homogeneity approximation of current models [IND].
    - Digital tools to **monitoring specific installations** can be used with automatic controls [IWG ES]. Tools can be used to facilitate data collection [IND] and processing [ETIP OCEAN], for example through: real-time monitoring [IWG IND]; smart sensors for data acquisition [SNETP]; real-time monitoring, control systems and automation [SNETP]. Monitoring tools can allow for a better display of data for public use (and improve public acceptance) [ZEP]. **Predictive maintenance** can be useful in many ways: asset performance [BATT]; condition monitoring [IWG OCEAN]; operations and maintenance of Solar thermal plants [IWG CST]; predictive maintenance e.g. gear boxes [WIND]; safety monitoring, increased reliability and reduce operational costs [SNETP]; avoid severe incidents and better risk management for operation [HYDRO]; identify early signs of wear and, direct anomalies and schedule maintenance [IWG GEO]; Induce downtimes and extend the lifespan of geothermal installations (pumps, heat exchanges etc.) [IWG GEO]; and facilitate better safety by anticipating incidents [BATT].
    - Digital tools can be helpful at a **project level**. For example, for tools which help assess the performance of CCS projects (e.g. capture captivity as actual performance storage) can help with understand the risks, improve public acceptance and improve efficiency of collecting and display of data (reducing the high administrative burden the EU Projects face with reporting obligations [ZEP]. Additionally, analysis of external factors can help clarify project viability, reduce production costs, etc. [H2].
    - Tools can also be used to **facilitate energy use,** for example to enhance flexibility: to help energy intensive industries adapt to electrification and energy supply

[2] See: https://cetpartnership.eu/

fluctuation [IWG IND] as well as integrate renewable heating and cooling systems at a building level with price signals on electricity market [RHC]. In general, we should recognise the demand-side flexibility potential of buildings. Additionally, user-friendly energy efficiency tools [IWG Build] and smart meters can help energy management by end-users [PED].

  - **Other use cases** include for exploration (i.e. interpretation of subsurface areas) [IWG GEO, CCS, ZEP] and mapping of storage sites [H2], faster design and commissioning [DCT], as well as digitalisation of permitting processes [ETIP PV]. Additionally, **automation** can be used in different cases: automated drilling, analytics and reservoir modelling (accuracy, reduce risks, optimise resource extraction) [ETIP GEO]; Automation of manufacturing [PV]; automation of multi-generational systems for heating and cooling [RHC ETIP], and; automated quality control processes [WIND].

- **Collections and exchange of data:** There is a need to improve **data collection and availability,** for example, data could be provided by energy companies/grid operators [PED]. Open data could be provided across the supply chain [ETIP WIND], or between different sectors (e.g. geological data can be requested from operations and maintenance geothermal actors to enable CO2 storage) [IWG CSS]. Heterogeneous data models are needed [SNETP], and a proprietary neutral dataset could be used for AI model learning in the EU [IWG NS]. Data collection efforts could focus on material research [ETIP PV] or on missing data on whole life carbon of buildings/material life cycles [n/a]. Data should be digitalized, for example sub-surface data: CO2 storage potential and well records from oil and gas exploration and production (most data exist on paper which NZIA will release) [ZEP]. Cross-data integration [IWG IND] and the **interoperability of data** [ETIP PV] should be addressed and **standardisation** can play a role: Standardised data formats to facilitate the exploitation of shared data [ETIP PV], harmonisation (e.g. data sharing data requirements, open BIM, LCA methods, databases) [IWG Build]; examine standards, protocols and industry decision-making for connectivity [SNET]; Develop common standards, protocols and services for interoperability [SNET]; Harmonise metadata for different energy systems [SNETP]; Interoperability between devices [DCT]; cross-cutting data management (energy, mobility, etc.) inter-operability. [PED]; open interfaces between operators [DCT]. A funding program could be established for the qualification and standardisation European platforms [SNETP]. There is a need for **platforms to centralise data**. These should function as: a centralised platform to standardise, store, and share the geothermal data across regions and projects, promoting collaboration and enabling cross-comparison to improve resource management and efficiency [ETIP GEO]; a mapping of initiatives to harmonise data exchange [SNET]; a robust repository or exchange platform [SNETP]; a digital platform for the entire value chain of H2 (to collect analyse and use data in real time, informed decisions, optimise processes, allowing for scalability and flexibility) [H2]. Related initiatives, which foster transparency and interconnectivity, include the European digital platforms such as the Clean Hydrogen Joint Undertaking[3] and the European Hydrogen Observatory[4] [H2]. Insights can be drawn from the

[3] See: https://www.google.com/search?q=EU+CHJU&rlz=1C1GCEA_enBE1100BE1100&oq=EU+CHJU&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRigATIHCAQQIRiPAjIHCAUQIRiPAtIBCDE1ODVqMGo0qAIAsAIB&sourceid=chrome&ie=UTF-8

[4] See: https://observatory.clean-hydrogen.europa.eu/

'Energy Data Space' paper[5] as well as BRIDGE work on Data Exchange reference architecture[6] [SNET]. Data sharing also has **future benefits.** For example, for education and knowledge preservation for the next generation [SNETP]. Additionally, data sharing of commercial plants in operation can help understand how to better design the next generation [CST].

- **Security:** It is important to identify the **risks for the adoption of different use cases** of digital tools [SNET]. For example, redundancy in the case of internet/satellite break down [HYDRO] and digital technology sovereignty should be maintained by avoiding an over-reliance on digital components outside of the EU) [SNETP]. There are some **legal issues** related to the increase of digitalisation, for example data protection and data ownership as well as reliability and responsibility (in case of AI given results or generative answers) [SNETP]. It is important to clarify data protection rules for DSOs and TSOs to make collaboration for research and implementation projects easier [IWG ES]. Data should be stored in a secure, organised framework to avoid trust issues (leading to loss of knowhow, competitive disadvantage) [H2]. Additionally, the security of system operation [IWG PV], the reliability and security of digital infrastructures [SNETP] and **cybersecurity** [DST, ETIP WIND] should be ensured. The development of aligned and standardized cybersecurity guidelines and practices in the energy sector [ETIP WIND] would be beneficial. The reliability of the algorithms, codes of AI should be tested for biases [SNETP]. The traceability of data should be ensured (e.g. though block chain, internet of things) so that is can be used for certificates of origin for technology, for materials, for hydrogen) [H2].

TF 4: Skills

The topic of 'Skills' should foster collaboration between industry and academia. It should identify transferable skills from carbon-intensive sectors, standardise trainings and provide adaptable learning pathways. Importantly, it should avoid duplication with the variety of existing initiatives. – *Summary from plenary.*

- **Identifying gaps and anticipating future skills needs:** There is a need for a unified approach on mapping future skills and jobs across industries and member states [ETIP WIND], also at the regional level [ETIP WIND]. **Skill gaps** include those in the stages between R&I pre-commercial phase to the commercial phase (e.g. marine engineering, permitting etc.) [ETIP Ocean]. It would be helpful to develop a **database for new jobs** in Europe [H2]. There is a need to anticipate skills needed by 2030, to be ready for peak activity in the coming years [ETIP OCEAN]. We can continuously assess emerging industry needs and expand accordingly targeted training programs [BAT] and **quantify the demand** for each profile [SNET]. Insights can be drawn from the work of ETIPs (upcoming paper in 2025) as well as the Renewable Energy Skills Partnership[7]. There is a need for interdisciplinarity in specific sectors (engineers, geologists, drilling, social scientists etc.) and a variety of skill sets [IWG GEO]. Some specific skills are presented below.
    - **Non-technological skills:** Impact assessments, life cycle analysis [SNETP]; problem definition applied to the energy transition (disruptive innovation) [H2 IWG]; innovation management [H2]; project management and community engagement [ETIP GEO];

[5] See: https://op.europa.eu/en/publication-detail/-/publication/21b0260e-a2d5-11ee-b164-01aa75ed71a1/language-en
[6] See: https://energy.ec.europa.eu/system/files/2021-06/bridge_wg_data_management_eu_reference_architcture_report_2020-2021_0.pdf
[7] See: https://energy.ec.europa.eu/news/pact-skills-launch-large-scale-renewable-energy-skills-partnership-2023-03-21_en

project development skills such as environmental assessment and project management [ETIP OCEAN]; business skills [ETIP RHC], soft skills [ETIP RHC], and; environmental knowledge [ETIP RHC].

  - **Blue collar skills**: Engineering, civil, mechanical, in all energy sectors [SNETP], skilled engineers [DCT], weld training [SNETP], technology manufacture skills (e.g. welder, lathe operator, crane operator etc.) [IWG NS]. There is opportunity to integrate 'sustainability' in job profiles (e.g. example sustainable power engineer) [SNET]. There is also a need to include technical engineers on safety issues [H2].
  - **Skills for energy systems:** Energy system modelers (who must understand specific characteristics of energy systems) [IWG ocean], system integration skills [SNET]; system customisation [IWG PV], and; system optimization [ETIP RHC].
  - **Digital skills:** AI-related skills (e.g. grid operators) [SNET]; Drive transition from analogue to digital [ETIP wind], equip developers and users with digital skills [IWG ES]; Digital tools integrated in CS thermal applicator and link ICT with thermal energy solutions [IWG CST]; industrial symbiosis facilitation, energy efficient analyst [IWG industry]; Digital knowledge for contractors [DCT]. To leverage the LSP on digital skills[8] [SNET].
  - **Data and security skills:** Information security skills and data engineering [SNET]; Security and intellectual property [DCT]; Skills in geoscience (collaboration with CCS) and skills in surface engineering (collaboration with ETIP-RHC) [IWG GEO].
  - **Other skills:** Operational [ETIP ocean]; Transport logistics (from ports to safety pipelines to trucks) [H2], technical in order to build and operate plants [IWG BIO]; installers [ETIP RHC], and; hybridization [ETIP RHC].

- **Re-skilling and transferring existing knowledge**: Aim to transfer skilled workers from other sectors [ETIP GEO], keeping the knowledge and **experience of the transitioning oil and gas workforce** to match the future demand of skilled personnel: knowledge of the subsurface for example drilling, reservoir engineering, piping, geochemistry, geology for the role of geothermal energy [ETIP GEO]; knowledge of CO2 transport and storage [ETIP ZEP]. Also, the conversion of oil and gas offshore skills as well as shipyard skills toward offshore renewable energies. Map of transferable resources and identify new and similar jobs in other industries [ETIP Wind]. **Retraining or re-skilling** should be considered [IWG OCEAN] for example for the potential to reskill to bio from conventional oil sector [BIO]. In terms of **up-skilling**, installers must learn how to combine bio with other heating techs create expertise in hybrid systems [BIO]. Insights can be drawn from the recently approved EU funded project RESKILL4NETZERO[9] [CST4ALL].
- **Recognition of skills:** There is a need to develop a joint language (between engineering, social sciences, humanities etc.) for transdisciplinary cooperation and strategies [PED]. There is a need to **define and redefine skills** [BUILD] and by **standardising or harmonizing skills** [IWG PV] (e.g. through a taxonomy of competences [SNETP]), we can promote micro-credential harmonisation for workforce mobility [IWG industry] and have a more impact on international point of view [SNETP]. Certification and accreditation processes in the EU for workers [DCT, ETIP GEO] could support a competencies passport [SNETP].

[8] See: https://pact-for-skills.ec.europa.eu/about/industrial-ecosystems-and-partnerships/digital_en
[9] In the renewable energy sector, RESkill4NetZero is dedicated to reskilling the workforce to meet the growing demand for green jobs, with a focus on developing a scalable skills framework. See: https://pact-for-skills.ec.europa.eu/about/news-and-factsheets/8-new-blueprint-alliances-tackle-skills-gaps-industrial-ecosystems-2024-10-01_en

- **Developing education and training programmes:** There is a general need to further establish a community to foster exchange on needs for skills on hydrogen [H2], and encouraging universities, training centres, and industry to develop educational and training programs would help [WIND]. Some key considerations are listed below:
    - Academic training programs should support technology development skills and cover innovation and engineering skills [ETIP OCEAN]. To support this, there is a need for close **collaboration between academia and industry** [ETIP ZEP], for example to design training programmes [ETIP PV]. Industry should better express their skill needs in regular exchange with universities [Hydro]. Cross-sectional training programs should be interdisciplinary [SNET] and have a broad vision of different technologies [CST, PV, BATT]. Additionally, barriers to entry exist for graduates [ETIP ZEP] and there is a need to harmonised education from school (including university) with the employment needs of companies [H2]. In particular bridging programs are needed to encourage STEM[10] graduates [ETIP ZEP, CST, IWG GEO].
    - Specific **initiatives for schools** include: Mobility for education/student exchange (e.g. DAAD[11], international Erasmus) [H2]; ERA fellowships[12] [H2]; green hydrogen academia [H2]; summer camps [RHC ETIP]; PhD scholarships [H2]; specialized master programs (e.g. digitalisation in energy) [CST, SNETP]. There is a need to emphasise early development of interdisciplinary skills [BAT] mentorship programmes can be developed for young people to awaken the interest for studying renewable technologies at early stages of school [IWG CST].
    - Additional ideas for **interdisciplinary programs** include partnerships (with industry and Member States) [SNETP, ETIP WIND], pan-European training programs [DCT], and Centres of Vocational Excellence[13] [DCT]. Transnational training needs to involve non-stem experts in requirements definition and SSH-researchers[14] can complement the expertise needed in each SET Plan priority or target [IND]. Any new initiatives should first **consider ongoing training programs -** the challenge and priority in the longer term is to align initiatives [CST4]. Existing EU initiatives on skills include: RES skills partnership[15] [WIND], RES Academies[16] [WIND], European Hydrogen Academy[17] [H2], European hydrogen skills strategy[18] [H2]. Additionally, collaboration with the Clean Energy Technology Partnership[19] could include networking events for innovation ecosystems as well as training to enhance local regional ecosystems (in relation to regional energy systems and industrial energy systems) [IWG ES]. Education

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[10] Science, technology, engineering, and mathematics (STEM) is an umbrella term used to group together the distinct but related technical disciplines of science, technology, engineering, and mathematics.
[11] The DAAD is the world's largest funding organisation for the international exchange of students and researchers. See: https://www.daad.de/en/
[12] See: https://rea.ec.europa.eu/funding-and-grants/horizon-europe-widening-participation-and-spreading-excellence/era-fellowships_en
[13] See: https://ec.europa.eu/social/main.jsp?catId=1501
[14] SSH CENTRE is a €3m Horizon Europe project representing the cross-European Centre of Research Excellence for Climate-Energy-Mobility Social Sciences & Humanities (SSH). See: https://sshcentre.eu/about/
[15] See: https://pact-for-skills.ec.europa.eu/index_en
[16] See: https://academy.europa.eu/
[17] See: https://pact-for-skills.ec.europa.eu/stakeholders-and-business/funding-opportunities/european-hydrogen-academy_en
[18] See: https://observatory.clean-hydrogen.europa.eu/index.php/media/news/european-hydrogen-skills-strategy-unveiled
[19] See: https://cetpartnership.eu/

initiatives in the EU could benefit from a **standardised European framework for training programs** [WIND, CST, H2]. In particular for 'strong countries' [IWG CST] or for industries directly at the key R&I infrastructures [CST].

  - There are benefits to the **development of modular courses** which can be integrated into already existing wider training programs, enhancing flexibility and reach [IWG IND, SNETP]. A modular approach to training will better handle the overlapping competences and reduce time spent on training [ETIP RHC]. As an example, modular trainings on reskilling and upskilling for hydrogen already exist with Vocational Education and Training (VET) programs and courses [H2].
  - Additionally, the use of **advanced tools** can be applied in training. Examples include: Physical and virtual training labs [BAT]; Virtual Reality and Augmented Reality to simulate and provide risk free training for workers in dangerous environments [SNETP].

  Overall, there should be **no discrimination** in education, considering for example age and gender [H2].
- **Expertise of authorities and policymakers:** Policy makers and public administration require education for expertise [ZEP, H2] – for example the European Commission [ZEP] but also at local level [H2]. At the city level, there is a further need for capacity building [PED] and to ensure the right competence doe planning [RHC ETIP]. Additionally, there is a general need to upskill authorities to understand technologies in order to make informed decisions for permitting [IWG GEO, DCT].

TF 5: Access to the market

The topic of 'Access to the Market' addresses the question of 'how to shorten the innovation cycle?'. It considers advancing SET Plan technologies across TRL levels, alternative financing options as well as streamlining testing progress across Member States to accelerate market entry, enabling faster validation and adoption of new energy technologies and reducing time to commercialisation – *Summary from plenary.*

- **Testing of products:** There is a need for more testing infrastructure and a framework for low-cost (or free) and faster testing of innovations in the field [ETIP WIND, BAT]. We should promote free technological zones for priority testing [H2], for example, certain areas on RES **sites can be dedicated** specifically for the testing of products [ETIP WIND]. These can be facilitated in urban living labs [PED] or hydrogen valleys where local communities are acting as prosumers [H2]. There is a need to ensure continuity between testing, controlled deployment, piloting and scaling up [SNET], and **certification** can play a role in facilitating new technologies/testing [RHC ETIP]. **Regulatory sandboxes** can be used to test solutions in industrial settings [IND, SNET[20]].
- **Tools for sharing data:** There is a need for **transparent tools for investment decisions** [DCT]. For example, a platform can be created to share resource (sub-surface) data helping investors make informed decisions [IWG GEO]. It would be helpful to establish an **EU investor community** and leverage the work on the investor dialogue on energy[21] [SNET]. Post-project

[20] ETIP SNET have conducted work on regulatory sandboxes: https://smart-networks-energy-transition.ec.europa.eu/news/etip-snet-and-isgan-launch-questionnaire-regulatory-experimenting-regulatory-sandboxes
[21] See investor dialogue on energy here: https://energy.ec.europa.eu/topics/funding-and-financing/investors-dialogue-energy_en

communication can also be improved, for example on CORDIS[22] for Horizon Projects [IND]. Data-driven approaches/metrics can help solve supply/demand issues [H2, IWG GEO].

- **Harmonised metrics:** The development of standardised **Key Performance Indicators** can help [IWG ES, H2], for example on battery energy storage and hydrogen [IWG ES], markets and barriers [IWG ES] or on the performance of products (e.g. lithium, efficiency, output) [H2]. Standardisation plays a role [DCT, SNETP]. There is a need to encourage European standardisation committees for robust and **unified standards** for the same products, regardless of the technology [SNETP].
- **Funding and financing instruments:** Public budgets for R&I should focus on **higher TRL key technologies** [ETIP OCEAN] as public spending can reduce the costs scalability of projects [IWG IND]. Additionally, funding programs should be established to support initial **feasibility studies,** exploration and pilot projects, especially in new markets, to accelerate the path viably [ETIP GEO] and to cover delays in implementation of start-ups and cost shortfall (to avoid entities running out of savings) [IWG IND]. There is a need for effective financial support mechanisms for **first-of-a-kind prototypes**[23] and first pilot farms [IWG OCEAN]. There is a need for a mix of public and private funding (grants, publicly backed loans, revenue support) [ETIP OCEAN], in particular loans with low interest rates (hence a low "price of money") for big technologies with long lifeline [N/A]. Financial mechanisms are needed to accelerate industrialization [ETIP WIND], and **innovative financing instruments** should be considered to de-risk [ETIP WIND]. Alternative financing schemes could include crowdfunding, citizens funding and securitization (green bonds) [RHC].
- **De-risking:** There is a need for instruments to bridge the **valley of death** and scale-up of innovative market [ETIP PV]. Demonstration is a de-risking factor for projects (either stand-along, or hybrid projects) [CST], and **demonstration projects** are the only way to reduce costs, validate the technology and business case, and attract private investors [ETIP OCEAN]. Risks should be identified at an early stage [SNET] but the **perception of risk** should also be addressed (e.g. risk acceptance vs. risk avoidance of grid operators and regulators) [DCT]. Regarding the perception of risk, social acceptance is important, and industry needs a 'social license' to operate (learn from the SSH CENTRE[24]) [IND]. For deployment, risks need to be reduced across the supply chain as different entities rely on each other. Options can include governments assuming the risk (via insurances or guarantees) or regulated asset-based models (e.g. for transport) [ZEP]. Contracts for difference (functioning with the ETS price) can help enable price certainty [ZEP]. Additionally, **insurance schemes** can correct for certain risks (e.g. exploration) for some technologies [IWG GEO]. Public/private collaboration can be helpful to underwrite certain operational risks that commercial insurers don't understand and hence over price [IWG OCEAN]
- **Collaborative models:** **Public-Private Partnerships** are helpful [SNET, IWG GEO, ETIP GEO] to address capital and revenue [IWG OCEAN] and to jointly fund and execute projects [ETIP GEO] - particularly in urban areas and rural areas where energy potential is high [ETIP GEO]. Cost sharing and cross-border investments are also important [DCT] and collaborative projects between Member States should be promoted to optimise exploration and development costs [ETIP GEO]. The development of new Important **Projects of Common**

[22] See: https://cordis.europa.eu/

[23] 'first-of-a-kind prototypes' refers to the first item or generation of items using a new technology or design can cost significantly more than later items or generations

[24] SSH CENTRE is a €3m Horizon Europe project representing the cross-European Centre of Research Excellence for Climate-Energy-Mobility Social Sciences & Humanities (SSH). See: https://sshcentre.eu/about/

European Interest (IPCEI)[25] should be encouraged, especially to support higher TRLs [CST] and NZIA technologies [CCUS]. **European centers of excellence** should be fostered in order to speed up innovation [CCUS]. Collaboration can also consider **other industries** (textile, food, steel) which can apply technological solutions [CST]. Additionally, collaboration at **local levels** can include cooperation between municipalities, utilities and real estate [PED], for example to foster energy cooperatives (e.g. for heat delivery) [RHC], support local energy providers in adopting geothermal technologies (with knowledge and finances) [IWG GEO], as well as making use of climate city contracts (as used in the Cities Mission[26]) [PED].

- **Business models:** It is important to recognise the value of the project, not only the costs, through dedicated economic measures [CST]. Lessons can be learned from the BRIDGE[27] project [SNET]. Innovative business models can consider **cogeneration** [SNETP] or **combined models** for district heating (e.g. combined with thermal spas, heat storage, mineral extractions) [n/a]. Another innovative business model to consider is heat- or **energy-as-a-service** [RHC, BATT], which can consider both commercial and individual users [RHC]. Energy Service Companies (ESCos) allowing companies carry out energy services without the need for clients to invest in their own capital [RHC].
- **Market-related regulatory solutions:** Member States have a role to play in creating markets for products [ETIP WIND]. Public Authorities can develop of market-related regulatory solutions to support deployment [IWG WIND]. These can include the design of **auctions** which consider not only costs, but also added value of the solutions/technology (energy security, flexibility) [IWG CST]. Additionally, fair market conditions can be established by ensuring that market prices capture all costs holistically [H2], for example internalizing the external costs on society (e.g. carbon pricing) [H2]. The **distortion effect of subsidies** (of any technology) on the market should be avoided [HYDRO] and in particular subsidies for fossil fuels should be eliminated [BIO]. Additionally, public authorities can help guarantee the offtake for low-carbon products and services, for example through public procurement and mandates [ZEP]. For **public procurement,** certain criteria can be integrated (e.g. green/sustainability metrics, 'EU manufacture) [ETIP RHC, H2, BATT, EEB] and public authorities should also consider pre-commercial procurement [BATT]. Other incentives can include **mandates** and double-counting regimes favour of certain products [BIO]. Signalling tools, such as **guarantee of origin** and **certification schemes** (e.g. on carbon, biodiversity) can also help [H2].
- **Long-term planning:** Relevant policy tools for planning can include large-scale district-level refurbishment/renewal strategies [PED], streamlining of permitting (for faster deployment and reduced costs) [ETIP OCEAN] as well as zoning for innovative technologies [IWG OCEAN]. A stable and simplified regulatory framework is also important [BIO, IWG GEO, NS, SNETP] because government regulations can be complex (not harmonised) [IWG GEO, SNETP]. There needs to be a clear definition of the state of play of energy policy, as well as a national report for the key technology implementation to demonstrate state interest [NS]. At the EU-level, it would be helpful to have an overview of the status of scaling-up SET Plan technologies [SNET]. Additionally, recognised technology development pathways could be used to advocate

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[25] See: https://competition-policy.ec.europa.eu/state-aid/ipcei_en

[26] EU Mission: Climate-Neutral and Smart Cities. See: https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

[27] BRIDGE is a European Commission initiative that brings together projects from Horizon 2020 and Horizon Europe with a focus on smart energy systems, in particular Smart Grid, Energy Storage, Islands, and Digitalisation Projects. One working group is on business models. See: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/

to investors and technology developers [IWG OCEAN]. **Clear political messages** are needed to secure predictability of products and services [IWG PV, SNETP] and national deployment targets could be established to signal to investors [OCEAN IWG]. In particular on the narrative of the **heat transition,** which is lacking behind, while comprising half of European energy use (in industrial and domestic applications) [IWG GEO, IWG CST]. There is a need for strong industrial policy, focusing on the strategic technologies which will be the most difficult to deliver clean energy policy [ETIP WIND].