Joint Programme e3s
clean Energy tranSition for Sustainable Society

Strategic Research & Innovation Agenda 2023 - 2030

v. 3 - February 2024

Contents

Introduction

The EERA Joint Programme on **clean Energy tranSition for Sustainable Society** (e3s) was founded in 2013 with the ambition of addressing some of the systemic and not merely technical and technological aspects related to the energy transition pathways. After almost a decade the institutional, social, economic and technological context for this transition to occur has dramatically changed at all levels of the system. Pushed by changes in the policy framework (just to name a few the Paris Agreement, the Energy Union strategy, the EU Green Deal, the EU Energy Package) and by structural developments, the context change has been catalysed by deep recent crisis such as the COVID-19 pandemic and the Russian invasion of Ukraine.

Given these dramatic changes, if the original ambitions of the Joint Programme remains the same, an update of its main focuses, activities and objectives has become more and more urgent. The JP should be able to address the emerging relevant and multidimensional challenges of the Energy Transition that span from the provision of a systemic view on the transition pathways to the attention paid to the fairness and inclusiveness of the process and the actual sustainability of Renewable Energy Sources (RES) technologies deployment.

Therefore, this Strategic Research and Innovation Agenda (SRIA) aims at (re)positioning the JP e3s in light of these challenges, for what concerns the provision of knowledge, expertise and research on the non-technical aspects of the Energy Transition that, by expanding a bit the traditional range, could be identified as the Social Sciences, Humanities and Environmental domain (SSH-E in the following). This (re)positioning means on the one side to take into account what are the main SSH-E open issues to be considered both from the research and the policy perspective in order to reach the ambitious targets posed by the renewed policy framework (above all, Fit for 55 and REPowerEU). On the other side, exploring the SSH-E skills and competences needed for the open issues to be properly addressed. In short, the ambition of this SRIA is to match the SSH-E competences' demand and supply as much as possible in order to support a just, sustainable and effective Clean Energy Transition (CET).

In line with this ambition of grasping the emerging SSH-E relevant issues related to the CET, the present version of the JP e3s SRIA results from a one-year long discussion among the JP e3s members and has been finalised thanks to the contribution of the entire EERA community. The other Joint Programmes actively took part in the collection and prioritisation of the topics to be considered as the main e3s focus, while the EERA Secretariat provided its support in properly framing the JP e3s role within the EERA mission and strategy and in the wider trajectories of the EU transition towards a sustainable and fair energy system.

The JP e3s repositioning actually starts from the name itself of the Joint Programme. Given the growing relevance of topics addressed by the JP, its members agreed that it was appropriate to give the JP a more effective and up-to-date name. Therefore, an agreement within the JP e3s community has been reached on the full name of the JP that, while keeping the same acronym and visual, has moved from "Economic Environmental and Social Impacts of Energy Transition" to "clean Energy tranSition for Sustainable Society".

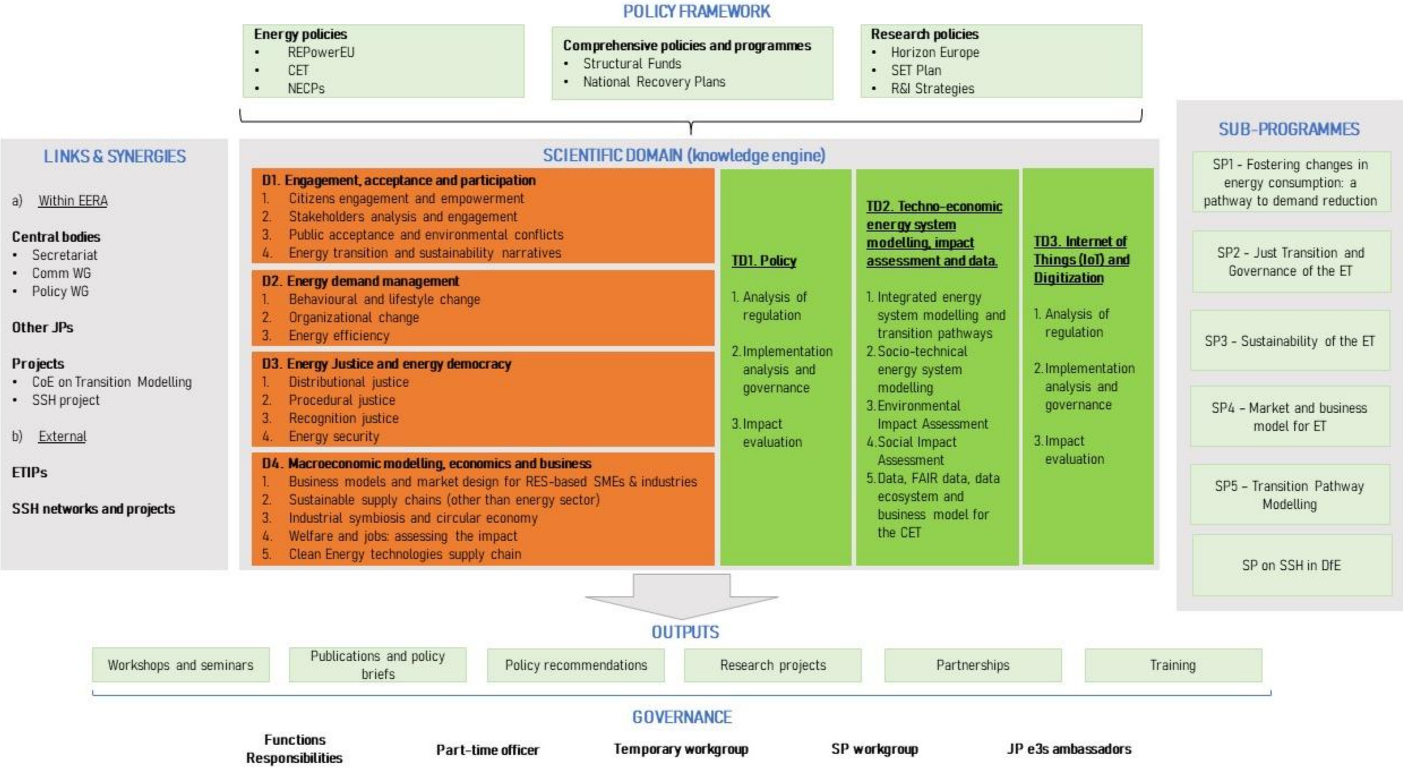

Figure 1 - JP e3s at a glance

Figure 1 provides an overview of the JP structure and summarises the result of this process. In order for making this SRIA an actual working document able to steer the activities of JP e3s for the next months and years, in the following sections attention is paid both to the scientific and organisational aspects and a mission-oriented approach has been adopted for what concerns the main tasks and objectives we feel comfortable in performing, as well as in the identification of the Sub-Programmes. Adopting a mission-oriented approach means keeping separated what we are able to do or what we are interested in (the Scientific Domain in figure 1) from the relevant (policy and research) challenges for ET related to SSH-E aspects we commit the Joint Programme to work on in the next years, with specific objectives and with a good governance of the process (the Sub-Programmes in figure 1).

This SRIA is conceived to last until 2030, in line with the time horizon foreseen by most of the UN and EU policy documents for the energy and emissions targets. Two intermediate updates are foreseen: in 2025, to check the progress of the activities and provide any needed adjustments to the scientific domain, the Sub-Programmes

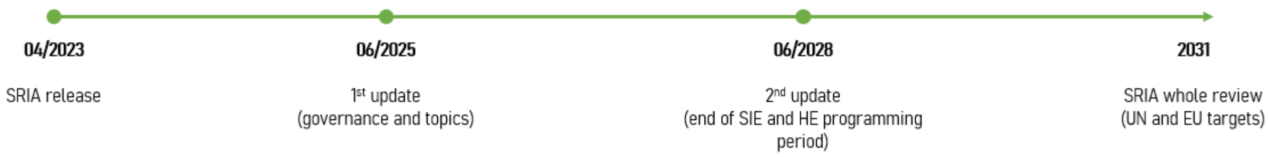

Figure 2 – JP e3s SRIA updating plan

focuses or the governance structure, and in 2028 in line with the completion of the EU programming period both for the Structural Funds and Horizon Europe.

The SRIA is structured as follows. In **section 2** a brief overview of the background and mission of the JP is provided, recalling a few key references from the wider policy and research framework. It then introduces the overall ambition and long-term impact of the JP. **Section 3** outlines the principal objectives to be pursued in order for the JP to fulfil its mission. In **section 4**, the supply of SSH-E competences is addressed. This term refers to the skills, experiences and interests that the e3s members are able to provide to the wider EERA and EU policy and research community. The aim is to present a clear synthesis of what e3s is aiming for. **Section 5** outlines the commitments of the e3s, providing a detailed account of the five Sub-Programmes, including their background, mission and expected objectives. **Section 6** provides an account of the governance of the JP, with particular attention paid to the composition of the JP's governing body and the principal rules governing decision-making, in accordance with the EERA General Statute. In addition, the **annexes** furnish supplementary information, including the current list of JP e3s members, the designated roles within the JP, and the projected annual work plans.

Mission

The mission of the JP e3s is to coordinate and provide the social science research and environmental (SSH-E) expertise necessary for the realisation of the CET. The energy transition represents a complex process of transformation of the entire contemporary EU society, encompassing social, technical, economic, institutional and environmental domains. In order to be properly investigated and supported, this process requires a complex, interdisciplinary and holistic approach. In JP e3s, the scientific community strives to achieve this objective in alignment with the following documents and strategic initiatives and priorities:

- European Green Deal
- Clean Energy Transition
- REPowerEU
- Just Energy Transition
- European Research Area (ERA)
- New European Bauhaus
- Strategic Energy Technology (SET) Plan

The European Green Deal is the most relevant policy reference approved in 2020 about the challenges and priorities for a sustainable transition, clearly identifying in the climate change crisis a great potential for a transformational change. Climate change and the related need for rapidly decreasing CO2 and other greenhouse gas emissions are the biggest challenges of our times. At the same time, they represent an opportunity to build a new, more sustainable, social and economic model. Energy system plays a major role in determining the problem and its transition towards a more sustainable production and consumption model, based on a RES dominated energy mix might consistently affect the solution. As for the overall transition of the contemporary socio-economic model, also the sustainable transition of the energy system is a complex process that can represent a great opportunity for a systemic change involving not only the diverse actors, processes, technologies and businesses related to the energy field but the wider social and economic system.

Energy (through its current ways of production and consumption pattern) is today responsible for more than 75% of the EU's greenhouse gas emissions. Its central role in reaching the EU ambitious targets by 2050 (climate neutrality and 55% GHG reduction compared to 1990 level) implies that to reach climate neutrality, we need to decarbonize the energy system at least six times faster than we did so far and we must increase the share of renewable energy sources and clean energy carriers, and improve energy efficiency while guaranteeing to all citizens not only clean but also secure and safe energy supply[1].

In the Green Deal, a wide room is left for energy topics. A specific policy area is dedicated to energy *Supplying clean, affordable and secure energy*[2] but energy is mentioned as a crucial component of the transformation process in many of the others, from sustainable mobility, to building renovation and industrial transformation towards circularity. As for the energy policy area, a few principle are identified to shape the EU and national energy policies:

- Energy efficiency must be prioritised in view of an overall demand reduction;
- A power sector largely based on renewable sources must be developed and complemented by the phasing out from fossils;

[1] EU Energy R&I, https://research-and-innovation.ec.europa.eu/research-area/energy_en

[2] The European Green Deal COM(2019) 640 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN

- Energy supply needs to be secure and affordable for both consumers and businesses;
- EU energy market is fully integrated, interconnected and digitised;
- Energy transition should involve and benefit consumers and the risk of energy poverty must be addressed;
- Need of developing smart infrastructure;
- Member States commitment via proper energy and climate plans where attention must be paid to all the aspects mentioned above.

A second pillar to frame the e3s mission is the **Clean Energy Transition**, as reframed in the *EERA White Paper on the Clean Energy Transition*, central to EU energy and climate policies. CET extends well beyond climate neutrality to incorporate the essential dimension of social fairness and link it more broadly to the concepts of global sustainability and societal resilience and framework proposed adopts a holistic approach, based on addressing the sources of greenhouse gas emissions across all economic sectors as only a third of those originate directly from the energy sector. Achieving climate neutrality thus entails a much broader challenge than decarbonising the energy sector alone, an approach that differentiates a lot from the more traditional, technology-centric approach to the CET. The White Paper highlights that the transition of the energy system needs to be addressed as a broader transformation of the entire economy and requires involvement of social sciences and humanities and a holistic approach to pursue three objectives: design innovative policies to accelerate public and private investments in low-carbon research, assets and infrastructure; promote a profound change in citizens' consumption patterns and lifestyle (food, energy consumption, transport and living conditions); redesigning markets for more efficient and circular usage of energy and natural resources.

As for the market, a third reference is the current discussion about the energy crises (REPowerEU) and the high ambitions in the energy transition (Fit for 55) and climate neutrality by 2050 that put new focus on energy regulation and market design. While the European Commission and Parliament are pursuing the Energy Union and consider the gas and power markets as important instruments, the *non-paper on Electricity market Design* opens the discussion about possible adjustments and improvements in line with the rapid increase of renewables in the energy mix. The scope of the ongoing work is summarised in the call to the Commission "to speed up work on the structured reform of the electricity market, including an impact assessment, and calls for further progress towards a full Energy Union serving the dual objective of European energy sovereignty and climate neutrality" as quoted from the conclusion of the European Council meeting of 20-21 October 2022. The main proposals in the non-paper are:

- pricing inframarginal technologies based on their true production costs;
- Reduce the role of gas in the short-term markets;
- Better consumer empowerment and protection;
- Improved market transparency, surveillance, and integrity.

This implies the hypothesis that the REMIT framework might require an update to keep abreast. REMIT is the Regulation on wholesale Energy Market Integrity and Transparency, No 1227/2011. Giving research based advice on improved and facilitating market solutions that can work across nations and empower EU citizens is an main ambition and important task of JP e3s which will be addressed in several Sub-Programmes.

Still on the policy field, a fourth crucial reference is the topic of Just Energy Transition[3], as a conceptual umbrella that covers the three pillars of energy justice:

- *distributional justice*, which concerns equity in the distribution of goods in a given society or group and is tied to the concept of substantial equality. In this context, distributional justice should not be understood as limited to financial aspects of the individual dimension but it includes community assets, for example, environmental quality;
- *Procedural justice*, which regards the right of all citizens to participate in an open and inclusive process of decision-making, and it ties to the concept of formal equality;
- *Recognition justice*, which deals with the necessity of recognising vulnerable groups and how they are negatively affected by distributional and procedural injustices, making special arrangements to include them fairly at both levels.

It is also pertinent to mention the European Research Area (ERA), which represents the European Union's ambition to establish a unified and seamless market for research, innovation, and technology throughout the EU. The ERA places an emphasis on investments and reforms in research and innovation, the adoption of innovations in the market, the facilitation of the mobility of researchers, the encouragement of the free flow of knowledge and technology, and the improvement of access to excellence.

Another noteworthy initiative is the New European Bauhaus which establishes a link between the European Green Deal and our everyday lives and living spaces by:

- Serving as a connection between the realms of science, technology, art, and culture.
- Focusing on harnessing our environmental and digital challenges to positively transform our lives.
- Extending an invitation to collectively address intricate societal issues through co-creation.

By creating bridges between different backgrounds, spanning various disciplines and building on participation at all levels, the New European Bauhaus inspires a movement aimed at facilitating and guiding the transformation of our societies based on three intertwined values:

- Sustainability, encompassing climate objectives, circularity, zero pollution, and biodiversity.
- Aesthetics, emphasizing the quality of experience and style beyond mere functionality.
- Inclusion, from appreciating diversity to ensuring accessibility and affordability.

The New European Bauhaus brings citizens, experts, businesses, and institutions together to envision sustainable living in Europe and beyond. Beyond serving as a platform for experimentation and connection, the initiative supports positive change also by providing access to EU funding for beautiful, sustainable, and inclusive projects.

Finally, the revamped SET Plan[4] represents a cornerstone due to its focus on a mission-oriented approach aimed at promoting cross-cutting collaboration beyond technology-oriented topics (social sciences and humanity aspects, digitalisation, demand reduction, heating and cooling, circularity in the context of critical raw materials, etc.). The main reference to frame the JP e3s mission is then the *SET plan stakeholder group dialogue summary*

[3] EERA, 2023, White Paper: A Just Energy Transition in the EU. Available here.

[4] The revamped version of the SET Plan has been published in October 2023. Available here.

report[5] that identifies a number of cross-cutting issues that are central in the energy transition, given the already mentioned key role of energy in the transition of other sectors in society. The cross-cutting challenges refers to the need of adopting multidisciplinary approaches able to cover the technological, techno-economic, socio-technical and environmental aspects in order to investigate and foster integration of a number of renewable, storage and low emission technologies into an energy system where consumers play a central role. **Here are the main challenges that help in defining the scope of the e3s mission:**

- Identifying robust pathways as alternative strategies towards a net zero society;
- How to accelerate the transition through innovation ecosystems;
- The regulation and market design to support optimal resource allocation and value creation both in the short term and long term;
- Policy and actions in support of fair, just and democratic transition;
- Digitalization of the energy transition processes;
- Resource efficiency and circularity principles.

Based on this policy and research background, the main focuses that define the scope of the Joint Programme are the following:

1. providing and implementing a holistic approach to grasp the interaction among and sectors of society and economy;
2. Understanding Just Energy Transition as an inclusive process in its development (procedural) and effects (distributional and recognition);
3. Assessing the economic feasibility and environmental sustainability of ET given the ambitious target for RES based technologies deployment.

Given this scope, the mission for e3s is to advance research and provide EERA, the other JPs and the wider scientific and policy community with knowledge and tools to address the SSH-E challenges of CET, with specific attention paid to the interactions among social, environmental and economic processes and impacts[6]. The final aim is to support public/private decision makers in defining and implementing effective strategies at EU, national and local levels, in order to maximise the exploitation of the immense potential for social innovation and minimise the non-technical barriers.

In order for this mission to be properly addressed, e3s is structured in five Sub-Programmes (SP), each of them representing many research challenges to be tackled in the next years:
Sub-Programme 1 (SP1) – Fostering changes in energy consumption: a pathway to demand reduction;
Sub-Programme 2 (SP2) – Just Transition and Governance of the Energy Transition;
Sub-Programme 3 (SP3) – Sustainability of the Energy Transition;
Sub-Programme 4 (SP4) – Market and business models for Energy Transition;
Sub-Programme 5 (SP5) – Transition Pathway Modelling.

[5] 201106_CETP_Summary_Input_Paper.pdf (eranet-smartenergysystems.eu)
[6] Accelerating Clean Energy Innovation Regulation - 2022/720 - EN - EUR-Lex (europa.eu)

In addition to the 5 SP listed above, JP e3s is responsible also for the Sub-Programme "Social Science and Humanities" of EERA transversal Joint Programme "Digitalization for Energy" (tJP DfE).

Objectives and impacts

JP e3s' mission of supporting a just, sustainable and effective implementation of clean energy policies and technologies and exploiting the potential of social innovation for underpinning the clean energy transition, will be reached through the pursuit of the following main objectives:

1) Contribute to the effective and successful achievement of the European energy and climate targets by addressing a systemic perspective and balancing societal, economic and environmental impacts;
2) Provide strategic inputs for the definition of best energy policies and enhance the proper implementation of such policies to boost the deployment of green and smart energy technologies, increase the competitiveness of European industry and safeguard a just and participatory energy transition;
3) Enhance the integration of SSH-E aspects in energy technologies development processes and in their deployment, including especially citizens engagement, social justice and environmental impact considerations;
4) Obtain a better comprehension of factors influencing the participation of citizens in the energy system and promoting effective strategies of dialogue and collaboration with policymakers, industry, markets and citizens;
5) Support the European Energy Research Alliance's specific objectives regarding the effective implementation of the SET-Plan and improving EERA' s strategic position and influence in the European and international energy and climate strategies;
6) Increase collaboration and mutual learning with EERA's other Joint Programmes to improve the dialogue between STEM and SSH-E disciplines, including the Arts, as required by DG RTD for fostering knowledge valorisation (DG RTD, 2022)[7]. Ultimately, provide holistic knowledge and tools for policymakers;
7) Align different and dispersed scientific profiles, research capacities and experience and generate synergies, which make it possible to develop a greater understanding of the complexity of the energy system and its boundary conditions, market-technology evolution and transition management;
8) Contribute to the dissemination of knowledge generated by the scientific community, supporting transparency, availability and accessibility of research data to feed research, public debate and policy design; Building also on the capacity of Culture and Creative sectors (that include media advertising and marketing, film, TV, video and videogames, museums and libraries) to engage with a wider public.

[7] European Commission, Directorate-General for Research and Innovation, *Fostering knowledge valorisation through the arts and cultural institutions*, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/377987

In terms of impacts, JP e3s aims at producing added value for four different stakeholders:

	Short-term outputs	Medium-term outcomes	Long-term impacts
e3s research community	High-quality research proposals and projects Joint scientific papers	Contributions to and definition of EU research agenda in energy-SSH-E	Positioning of e3s as a leading, reference research platform in energy-SSH-E
EERA	Complementary expertise to more technology-oriented EERA JPs Evidence-based insights supporting EERA's participation in the EU and international policy forums	More holistic understanding of barriers and drivers of energy transition in the EERA JPs Consolidating the policy support function of EERA	Contributions to achievement of objectives of the EERA JPs Reinforcing EERA's positioning in the EU and international decision-making forums
Policymakers	Strategic inputs for policy design, implementation, and evaluation	Enhanced knowledge and tools for policy making	Contributions to better policies to support clean energy transition
Industry	Insights on user acceptance, consumer behaviour and participatory approaches	Better informed decision-making	Contributions towards more competitive EU clean energy industry

JP e3s joins the forces of key research actors of energy-SSH in Europe. The benefits related to pooling together the complementary or reinforcing research capacities of the different member organisations provides synergies for its members in terms of visibility and leveraging the existing knowledge for co-creating new research avenues. In addition, the complementary knowledge and experiences derived from different national contexts, functioning of the national energy systems and markets allow identification of best practices and challenges that need to be addressed on a pan-European or international level.

EERA

e3s complements the more technology-oriented JPs by SSH-E expertise, enhancing the systemic approach to clean energy transition and reinforcing the collaboration among the JPs. e3s allows EERA to broaden its support function for the European institutions, addressing not only the technological challenges but looking at the clean transition from a more holistic perspective, supporting EERA with evidence-based insights in its participation in European and international policy forums.

Policymakers

Policymakers, for their part, are in urgent need of scientific-based evidence for the design, implementation, and evaluation of clean energy policies. By pooling the different knowledge and tools available in this Joint Programme, much more consistent advice can be elaborated for policymakers and uncertainty in decision-making can be reduced. Therefore, the Joint Programme will provide tools and evidence-based information to promote clean energy policymaking.

Industry

JP e3s support the industrial companies operating in the energy sector by directly involving industrial actors in its activities, and by indirectly advancing new knowledge e.g., on individual and collective behaviour of citizens, market barriers and opportunities in different regional settings, as well as on transferrable best practices. Due to the increasing decentralisation of the energy sector, companies are faced with the challenge of implementing an ever-larger number of smaller generation projects and are encountering sometimes unexpected local resistance, causing delays and sometimes the abandonment of planned investments. Insights on user acceptance and participatory approaches support anticipating public opposition and finding new ways of cooperation with local communities.

Citizens

The e3s Joint Programme can also produce considerable added value for the European citizens, by reinforcing the design and implementation of citizen-centric clean energy policies and by directly integrating the citizens as active participants of e3s activities. This will consolidate a more active energy citizenship and energy-empowered European society, and ultimately, to a more efficient, just and inclusive clean energy transition.

Scientific Domains

Similarly to other research groups[8] that in recent years worked on the identification of the most relevant SSH-E topics that should be considered in order to investigate and support Energy Transition, the result of one-year long discussion internal to e3s group complemented by the inputs coming from other EERA JPs and the Secretariat is reported in this session.
In the following, the main competences, skills, tools and experiences referred to the SSH-E aspects that e3s is able to cover and provide to the wider energy (scientific and policy) community are described and clustered. Through our survey we were able to identify 22 main research topics grouped into 6 scientific domains:

- 4 domains (D) refer to specific fields of scientific inquiry:
  - D1. Engagement, acceptance and participation;
  - D2. Energy demand management and reduction;
  - D3. Energy Justice and energy democracy;
  - D4. Macroeconomic modelling, economics and business.
- 3 transversal domains (TD) refer to knowledge that serve as a tool to define and explore the former 4
  - TD1. Policy;
  - TD2. Techno-economic energy system modelling, impact assessment and data;
  - TD3. Internet of Things (IoT) and Digitalization.

Built on these competences and research domains, the JP then identified five Sub-Programmes (SPs) conceived as research missions to be accomplished in the next four years that are presented in section 5.
In the following, for each of the scientific domains, the detailed research topics the e3s community is focused on are reported and briefly described

D1. Engagement, acceptance and participation

***1. Citizen engagement and empowerment*:** refers to energy democracy, to the challenge of making citizens pivotal and powerful actors in the energy system (decision-making process and market);

***2. Stakeholders analysis and engagement*:** identifying the main actors affecting and affected by RES tech, market dynamics, and policy implementation, clearly qualifying them (resources, attitudes and interests) in order to define targeted communication and engagement strategies;

***3. Public acceptance and environmental conflicts*:** refers to: a) the (market, socio-political and community levels) acceptance of the clean energy technologies and infrastructures; b) the explanation of the mechanisms and management of resistance and conflicts;

***4. Energy transition and sustainability narratives*:** exploring how different actors of the energy system represent the transition challenges, as a prerequisite to define engagement and communication strategies.

[8] Two recent examples and suggested readings: Krupnik et al (2022) *Beyond technology: A research agenda for social sciences and humanities research on renewable energy in Europe,* Energy Research and Social Science; Foulds C et al (2022) *An agenda for future Social Sciences and Humanities research on energy efficiency: 100 priority research questions* Humanities and Social Science Communications

D2. Energy demand management and reduction

1. Behavioural and lifestyle changes**:** addressing the challenge of describing the impact of individual and collective behaviours, practices and lifestyles on energy consumption and identifying effective strategies to promote changes able to reduce it;

2. Organisational change**:** addressing the need of redesigning organisational processes and procedures at any level (enterprises, administration, urban planning and services) to make behavioural and practices change possible and to adapt to the energy supply based on sustainable RES and main energy needs;

3. Energy efficiency: investigating potential and strategies of energy efficiency measures and triggers in different domains (building renovation, mobility and transport, industry (e.g., production processes)) taking into account the risk of rebound effects (Javon's paradox).

D3. Energy Justice and energy democracy

1. Distributional justice: distribution of cost and benefits of the energy transition between the different actors and affected groups;

2. Procedural justice**:** citizens participation in an open and inclusive process of decision-making;

3. Recognition justice**:** related to *energy poverty* intended as vulnerable groups negatively affected by distributional and procedural injustices. Focus on measuring energy poverty (i.e. inability of satisfying energy basic needs) taking into account its multidimensionality (interaction with other dimensions of deprivation) and identifying proper strategies for reducing it;

4. Energy security**:** includes system-level aspects of availability and affordability of energy for all.

D4. Macroeconomic modelling, economics and business

1. Business models and market design for RES-based SMEs and industries**:** includes business models related to any type of clean energy technologies (e.g., storage, hydrogen), related business ecosystems and participation of individuals and communities as active market players;

2. Sustainable supply chains (other than energy sector)**:** investigating and promoting a RES based innovation of the current supply chains in all the economic sectors (agriculture, manufacture, etc.) to make them more sustainable;

3. Industrial symbiosis and circular economy: promoting the identification of strategies and measures for supporting the implementation of affordable solutions for companies by including various sector-coupling aspects;

4. Welfare and jobs: assessing the impact: assessing the extent to which the diverse transition pathways might affect labour market and the provision of services and support to diverse social groups

5. Clean Energy Technologies supply chain**:** promoting the (re)construction of an EU supply chain for RES technology (including materials).

TD1. Policy

1. Analysis of Regulation: comprehensive analysis of the effect of (EU and national) normative, policy and regulatory framework in the energy field and its interaction with other (EU and national) policies, planning and programming;

2. Implementation analysis and governance**:** investigating the policy implementation process, i.e. how governments (and other public/private actors) put in practice regulatory and normative provision, through which policy tools and devices (e.g., regulation and sanctions, incentives, subsidies, market based solutions, agencies, experimenting with regulatory sandboxes where new business models) can be tried out involving energy stakeholders and regulators;

3. Impact Evaluation: assessing the actual impacts of policies and measures, i.e. what changes they are actually able to trigger on the targets, beneficiaries and recipient systems (counterfactual analysis, realist evaluation, etc.).

TD2. Techno-economic energy system modelling, impact assessment and data

1. Integrated Energy system modelling and transition pathways: modelling the complexity of the energy transition trajectories by adopting a holistic approach able to grasp the evolution of technology development and deployment, feedback loops, effect of policy and governance, infrastructure development, and the interlinkages between the energy sector and other economic sectors,

2. Socio-technical energy system modelling: complement energy system modelling by focusing on social aspects and dynamics through proper modelling approaches (e.g. Agent Based simulation, etc.);

***3. Environmental Impacts Assessment (e.g., LCA, footprint family, etc.)*:** addressing the environmental impacts of RES and other energy technologies deployment and widening the scope, energy transition strategies and policies

***4. Social Impact Assessment (e.g., social LCA)*:** identifying and measuring indicators for assessing social impacts of RES technologies deployment and energy policies;

***5. Data, FAIR data, data ecosystem and business models for the clean energy transition*:** addressing the needs of building a fair ecosystem of accessible open energy data to properly feed research, public debate and policy design and defining innovative business models to create value from data.

TD3. Internet of Things (IoT) and Digitization

***1. Behavioural Insights*:** IoT generates valuable data for social scientists, offering insights into human behaviour, societal trends, and the impact of technological interconnectedness on social structures.

2. Community Dynamics: the integration of IoT devices influences community interactions and relationships, providing researchers with opportunities to study the evolving dynamics within societies.

3. Efficiency and Productivity: digitization, facilitated by IoT, contributes to economic growth by enhancing efficiency in various sectors, optimizing resource utilization, and improving overall productivity.

4. Innovative business models: IoT technologies serve as catalysts for economic and social innovation. They enable new business models, streamline supply chain management, and contribute to the development of smart infrastructure.

5. Social innovation: simultaneously, smart infrastructure development powered by IoT enhances urban planning, resource management, and public services, nudging communities towards more sustainable and resilient practices.

6. Balancing Economic Benefits and Privacy: The widespread adoption of IoT and digitization raises ethical considerations related to privacy and data security. Finding a balance between economic benefits and safeguarding individual privacy becomes a critical aspect in both social sciences and economics.

Sub-Programmes

As introduced above, this SRIA adopts a mission-oriented approach that requires to keep clearly separated the description of the topics we (e3s), as a research community, are focusing on in our ordinary job and thus are easily able to investigate (our Scientific Domain presented in section 4) from which policy and research challenges and objectives we (e3s), as an EERA workgroup, deem relevant and are committed to address and reach through the Sub-Programmes (SPs) presented in this section.
In practice, the definition of the SPs (conceived as many missions) went through two steps:

- based on an internal discussion about the most urgent policy challenges and research gaps, Sub-Programmes have been assigned with specific targets to be accomplished in support of ET (the mission);
- For each Sub-Programme specific challenges, objectives, and areas of interventions have been identified for the mission to be addressed with attention paid to its contribution to the overall mission of the JP.

As relevant criteria to identify the missions/Sub-Programmes we considered:

- policy relevance in the medium run (2025 – 2030), based on the consideration of the EU framework, EERA overall strategy and the relevance in other communities (such as ETIP);
- Gaps in research and knowledge, based on the consideration of e3s Scientific Domains;
- Feasibility for the JP, based on our competences, resources, organisational capabilities, network:
- Opportunity to be funded, based on the consideration of the main topics of EU grants (e.g., Horizon Europe);

Therefore, the Sub-Programmes are conceived as the actual fields for the JP to act, provide relevant feedback, create and maintain networks, and find funding.

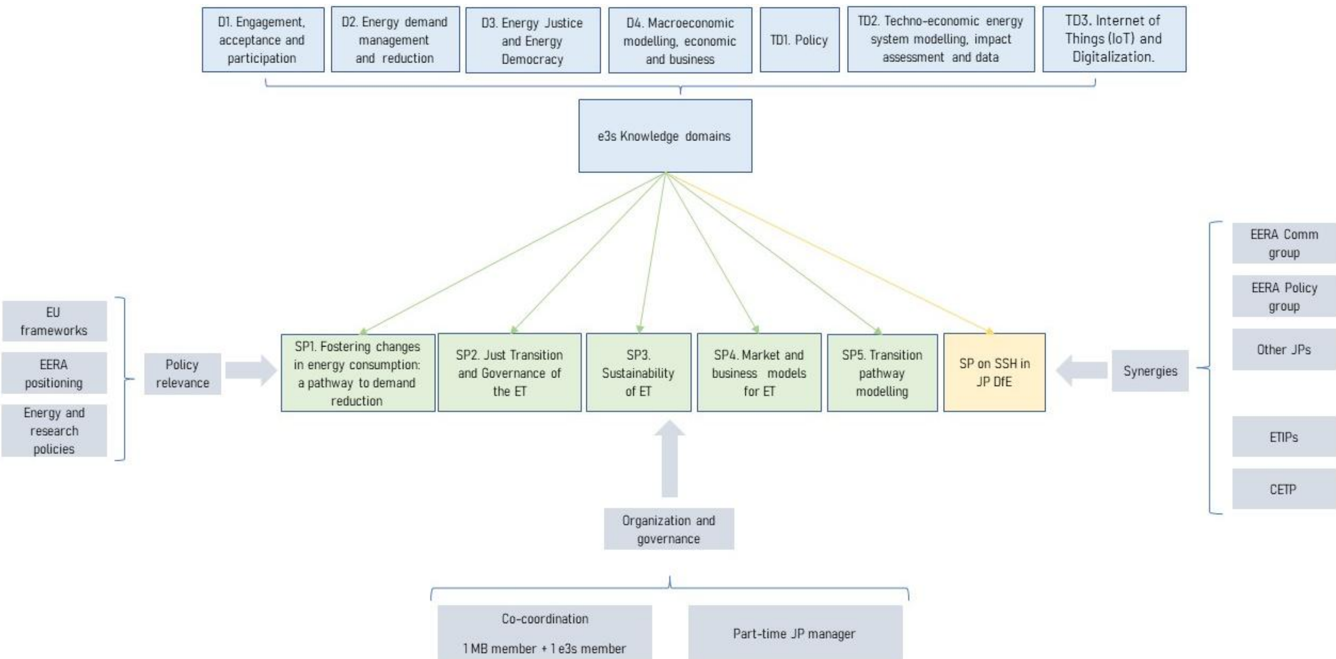

Figure 3 - The e3s domains, competences and Sub-Programmes

In the following, each of the SPs is described along this structure:

- *Mission*: the (non-quantitative) target assigned to the Sub-Programme, that is the evolution able to promote a desired change in the direction of the specific dimension of the ET;
- *Background and challenges*: the motivation that makes the target relevant (Rationale) and the challenges that might hamper the pursuing of the desired change (Research needs, such as conceptual and methodological gaps to be filled, knowledge and expertise to be provided);
- *Areas of intervention*: the specific objects or domains on which to perform SPs activities.
- *Objectives*: quite narrow outputs/trajectories of evolution that the SP aims at producing in line with the SP's mission. They are useful to assess if the SP is working in the right direction for the mission to be accomplished;
- *Methodology:* a brief description of the most suitable methods and tools that the e3s community is able to provide for the Sub-Programme to reach its objectives;
- *Contribution to e3s mission and interaction with other EERA JPs and external networks (ETIPs, CoEs, ect.)*: a short description of the position of the SP in relation with the JP's mission, within EERA and in relation with other components of the energy research and policy community.

1. SP1. Fostering changes in energy consumption: a pathway to demand reduction

The mission

To understand the social, cultural and economic factors that influence contemporary energy consumption patterns, it is essential to identify the challenges and opportunities for behavioural, practice and organisational changes that could potentially reduce the aggregate final energy demand of individuals, companies and public institutions. This will be achieved by accounting for both energy efficiency and energy savings, as well as direct and indirect energy consumption.

Background and challenges

Changes in energy consumption patterns cannot be achieved through attitudinal shifts alone. They require a concerted effort and a collective orientation toward the *common good*, as embodied in the principles of energy citizenship and empowerment. The adoption of new behaviours, organisational changes, and revised everyday practices is often impeded by internal barriers such as a lack of skills, trust, or awareness. The influence of these barriers can vary across social groups and economic sectors, depending on their interaction with external factors, including regulatory frameworks, economic incentives, technological availability, and the effectiveness of information campaigns.

Unconventional channels—such as museums, the performing arts, and other cultural venues—are gaining significance as platforms for raising awareness and fostering public engagement in initiatives related to the just transition and climate change. Public perceptions of climate and energy issues play a crucial role in driving social, behavioural, and organisational change. Understanding how these perceptions shape decision-making can help identify strategies to shift attitudes, behaviours, practices, and investment choices—thereby promoting changes in energy consumption patterns. It can also inform actions to increase the uptake of renewable energy sources (RES), as well as energy efficiency and energy-saving technologies.

Encouraging more active participation of citizens and businesses in the energy market—such as through prosumer models—requires exploring a wider range of behavioural tools. Approaches like gamification and nudging, which leverage behavioural determinants such as social comparison, have already shown success in non-energy sectors and hold promise for energy-related applications as well.

Digitalisation and the Internet of Things (IoT) further enhance opportunities for behavioural change by delivering real-time consumption data and personalised feedback to end users. While these technologies offer considerable potential, they also raise challenges related to privacy, data security, and the digital divide. Importantly, digital tools not only empower users with data but also allow users to contribute data themselves—opening the door to citizen science, which is further explored in the SP2 description.

Academic research—spanning psychology, sociology, and behavioural economics—has extensively examined decision-making related to energy efficiency and energy-saving investments, particularly at the individual level. Despite these multidisciplinary insights, policy approaches to energy consumption and efficiency have often remained narrowly focused on economic metrics such as cost, discount rates, and technological performance.

This limited focus overlooks the complex social dynamics that shape how individuals and organisations perceive and act upon energy issues.

As a result, we face what is known in the literature as the energy efficiency gap or paradox: individuals and firms frequently underinvest in cost-effective energy-efficient technologies, even when such investments are privately or socially beneficial. Addressing this gap calls for an interdisciplinary approach—one that incorporates social sciences—to better understand its underlying causes and design more effective policy mechanisms.

Moreover, tackling the energy efficiency gap must be integrated with broader efforts to reduce energy consumption, including scaling up building renovation and accelerating the deployment of renewable energy. Despite a growing number of energy efficiency initiatives in Europe, overall consumption has not significantly decreased. One reason is the rebound effect: as energy-efficient technologies reduce the real unit cost of energy services, consumers may increase usage, offsetting or even reversing potential energy savings. This well-documented phenomenon in energy economics represents a critical challenge for future policy design.

Areas of intervention

The SP works on the following areas:

- awareness and perception of environmental crisis (climate change and energy-related issues) by individuals, companies and public institutions;
- Analytical approach for investigating and assessing citizen/consumer and companies energy consumption patterns, also building on new Web 3.0 interaction and co-creation opportunities;
- Drivers and barriers to the adoption of RES and energy efficiency technologies at company and individual level;
- Integration of individual and organisation of energy consumption patterns with the whole energy system architecture;
- Opportunities for fostering shifts in energy demand (e.g. digitalization).

Objectives

- Developing a better integration of concepts of behavioural, economic, social, cultural and organisational change to identify measures to improve citizens, companies and public institutions energy consumption patterns;
- Increasing the knowledge about the different perceptions of climate change and energy-related issues and their link with changing attitudes, behaviour, practices and investments in the context of energy reduction;
- Understanding drivers and barriers to the adoption of effective solutions and technologies to reduce energy consumption in households, companies and public institutions;
- Analysing the effect of public measures (e.g. incentives) on behaviour and practices of the actors of the energy market.

Methodology

This SP will use and implement a broad set of methods that are able to address and integrate behavioural, social, organisational and cultural dimensions for investigating citizens, companies and public institutions consumption patterns and understanding factors to adopt effective solutions and technologies to reduce energy consumption. SP1 will implement both quantitative (non-market valuation to elicit public benefits of energy savings, structural equation modelling, economic and econometric analysis, experimental design, etc.) and qualitative methods (case study method, QCA method, etc.). Social marketing approaches will be also adopted to foster changes in behaviours and practices as well social simulation to describe energy behaviour and practices of individual agents (persons, firms, companies)

Contribution to e3s mission and relation to other Sub-Programmes and Joint Programmes and ETIP's

Contribution of SP1 to the objective of JP e3s is to build the research capacity and competence needed for comprehensive assessments of the potential of individual and collective changes in energy consumption and efficiency.

The topic of citizens' engagement and empowerment in energy reduction solutions is better explained in SP2. Energy reduction solutions are also linked to the concept of sustainable transition tackled in SP3, while the analysis of energy consumption patterns and adoption of RES and energy efficiency technologies is strictly linked to SP4.

2. SP2. Just Transition and Governance of the ET

Mission

The mission of SP2 is to identify and address the necessary changes in the governance structures of the energy system at all levels to make the ET a participatory and inclusive process able to meet the climate change targets, jointly with the empowerment of citizens and vulnerable groups and the satisfaction of the energy needs for all.

Background and challenges

The ET is a deep structural change from the fossil-based energy regime to a clean energy system based on renewables. This transition is a highly complex process inseparable from competing interests, power and conflicts and therefore will not materialise without understanding how powerful actors and regimes are interconnected in policy making processes.[9] It is widely agreed that it is crucial to empower all affected actors to successfully govern the energy transition and to realign the power relations between the different types of actors. Thus, the behaviour, practices and decisions of a wide range of societal groups have to be considered, comprising:

i. all actors in the energy system (owners and operators of grid infrastructure, large as well as small-scale producers, storage providers as well as private and industrial end users);
ii. The stakeholders in the process of transforming the energy system (policy makers, public administration, research, civil society organisations, interest groups and citizens).

The political choice for decarbonisation and decentralisation of the energy sector is linked to cross-sector conflicts and tensions. Hereby, it is important to underline that behavioural change, which is often demanded from end-users, will not suffice for breaking out of the fossil fuel regime without fundamentally changing the legal, economic and social frameworks. It is considered necessary to characterise and understand better the multi-level governance of the ET and to develop a strong conceptual and operational framework for wide public engagement.

For the ET to occur in a democratic system, it must be a just transition, as stated in the EU energy strategic framework. This means that fostering transparency and participation (e.g., energy communities) is necessary to democratise the above mentioned change in the governance of the energy system. Social acceptance of the ET will be based on the successful involvement of the diversity of social groups, primarily the most vulnerable which are at risk to suffer. In short, the change in governance must go in the direction of providing effective principles and tools to manage the three pillars of the just transition: *distributional* (equity in the distribution costs and benefits of the ET); *procedural* (right of all citizens to participate in decision-making); *recognition* (recognising vulnerable groups and how they are affected by the previous two).

In this context, the European Innovation Agenda and the New European Bauhaus initiative are promoting rights-based, people-centred approaches to the clean energy transition (CET), using heritage, creativity, and the arts as vehicles for engagement. These initiatives also emphasise the need to gather evidence on the societal impacts they generate. Moreover, the integration of energy, climate, and cultural policies at national, regional, and local levels is already demonstrating positive outcomes.

Digitalisation and the Internet of Things (IoT) also hold significant potential in supporting a just energy transition. These technologies can enhance transparency, improve accessibility, and support the incorporation of renewable

[9] Krupnik et al. (2022)..

energy sources. Additionally, they help facilitate the development of a decentralised, resilient energy infrastructure, aligned with broader goals of sustainability and social equity in energy governance.
A key component of citizen engagement in the energy transition is citizen science. This approach not only fosters public involvement but also empowers individuals to actively contribute to energy-related research and innovation. Citizen science can serve both as a tool for engagement and as a direct means of participation in the transition process, further reinforcing democratic ownership and accountability in the energy system.

Areas of intervention

SP2 will mainly focus on the following domains:

- Characterization of the multi-level governance structure and regulatory frameworks for the ET;
- Transformative governance of the ET;
- Democratising the energy system, securing engagement and empowerment of people by means of new approaches both in real and in virtual environments (e.g., by the means of digital twins, serious gaming, metaverse);
- Energy justice, equity and social inclusion.

Objectives

- To provide a comprehensive characterization of the (multi-level) governance structure of energy system (EU, national, local) and the role of power relations among all energy system stakeholder groups;
- To provide guidance for the governance of the transition process, to identify and address the regulatory gaps that hamper the ET (e.g., regulatory sandboxes) and to support the policy coordination at EU and member states level;
- To identify effective engagement strategies able to contribute to the actual empowerment of citizens in terms of awareness and participation, also through a deeper insight in opportunities coming from collaboration with the cultural and creative sector within living labs, co-creation hubs and immersive VR environments is envisaged
- To identify and measure social impacts of ET with specific attention to the definition and measurement of energy poverty, develop respective countermeasures and subsistent provision of energy services for all in the face of digitalization and economic crises.

Methodology

SP2's objectives will be reached through the adoption of a wide range of quantitative and qualitative methods and tools belonging to the SSH tradition: documental and text analysis, systematic literature review, semi-structured interviews and surveys, field experimentation, implementation analysis and impact assessment, multivariate statistics, social simulation and computational social science (social phenomena study through social analytics).

Contribution to e3s mission and relation with EERA JPs and other networks (ETIP's, CoEs, etc.)

SP2 contribution to the JP mission is twofold. Firstly, it allows one to have a new and deep understanding of the gaps that might hamper a smooth and just ET. Secondly, it provides conceptual tools and evidence on the social impacts of the transition pathways and of the diverse governance settings aimed at their management.
Within JP e3s, there is a close link with SP3 (on the social dimension of sustainability), SP4 for what concerns the fairness of the different market and business models and also with SP5 as regards the diverse institutional contexts where to frame the transition pathways.

Outside JP e3s the SP could benefit by the interaction with all the other EERA JPs, particularly with JP DfE as far as the relevance of the digitalization of the transition is concerned.

3. SP3. Sustainability of ET

Mission

The mission of SP3 is to guide the further development and application of concepts of a stakeholder-based comprehensive assessment on energy technologies contributing to a sustainable energy system, but also of possible energy futures and the paths to them, considering the demands of decision-maker.

Background and challenges

Energy systems are embedded in societies, leading to the understanding that energy systems should be understood as socio-technical systems. The (current and future) energy system is driven by an overtime dynamic set of technical, economic, environmental, and social factors. This means that heading for a sustainable energy system the embeddedness of the energy system in society should be recognized in sustainability assessment of future energy systems, transformation pathways or of single energy technologies.

Although the need of recognizing the different dimensions of an energy systems is (more or less) widely accepted, in practice the following weaknesses can be observed:

- the selected set of factors is determined by the model, which is used to analyse a technology or the energy system, leaving non-modelled factors outside the assessment;
- The cross-impact between identified factors/indicators is not considered appropriately, i.e. assessment indicators are used as if they are not connected;
- Handling of conflicting developments of individual indicators.

Although sustainability assessment of technologies, energy futures and possible pathways towards these energy futures is demanded as a necessary approach to provide orientation knowledge for decision makers, and although sustainability assessment is not a new approach, the weaknesses (not only those mentioned above) need to be overcome. Otherwise arbitrariness of the results will be one of the milder criticisms.

Taking into account the above mentioned weaknesses, there is a need to

- link the claims of sustainability assessment with the common modelling approaches;
- identify ways to model the cross-impacts of indicators and recognize them in the assessment procedure;
- identify sound methods which help to handle conflicting findings.

Sustainability assessment has a comprehensive claim; many analyses of technologies or systems are based on empirical algebraic models. Due to their logic, these models focus mostly on some, although important, aspects, which have mostly a technological or a (simplified) economic background. Many societal, political or economic aspects are either treated exogenously or are not considered at all. However, the findings of the models are used for sustainability assessment. There is a need to find methods to broaden the scope of the models, to include in a systematic and systemic way aspects which are important from a sustainability point of view. This broadening could include soft or hard coupling approaches.

The complexity of systems under review leads to building up a set of sustainability indicators, which are generally treated independently. That means, the influence of one sustainability indicator on the other one is often ignored, reducing the complexity of the interpretation, but also avoiding revealing important connections. This is of particular importance if trade-off relations exist. Thus, there is a need to find methods, which recognize the interrelationship between indicators. Furthermore, the ways and means are necessary not only to reveal possible interrelationships but to find ways to include them in the assessment (see below).

Experience shows that sustainability assessment leads seldom to straight findings, i.e. in most cases some indicators show an improvement whereas others indicate a worsening of the situation. The multi-criteria decision approach (MCDA) gives some indications how to overcome such challenges. However, the conventional MCDA assumes quantitative indicators and proposes different ways to aggregate the findings to a single score. Sustainability assessment could include qualitative indicators. The question arises, how to deal with quantitative and qualitative indicators. Said that, finding sustainability targets for each indicator is another challenge.

Areas of intervention

The Sub-Programme will work on the following topics:

- Coupling model-based analysis with sustainability assessment;
- Revealing and implementing cross-impacts / interdependencies of sustainability indicators;
- Single score approaches to handle conflicting findings of sustainable indicators.

Contribution of SP3 to the objective of JP e3s is to build the research capacity and competence needed for comprehensive assessments of energy technologies, energy futures and of possible pathways.

Objectives

- Development of an approach to couple model-based analysis and sustainability assessment;
- Identifying a method which allows to reveal and qualify the cross-impacts of sustainability indicators;
- Contextualising existing MCDA approaches to sustainability assessment.

Methodology

A challenge for any comprehensive sustainability assessment is at first to find adequate criteria and indicators and secondly to combine qualitative with quantitative information, since it could happen that important information is not available quantitatively, e.g. values. SDG could be a first source for defining appropriate criteria and indicators; however, they have to be contextualised to the system under review. Any approach that addresses the secondly mentioned challenge, topics and objectives should allow for a consistent and reliable combination of different types of information. In literature not too many approaches can fulfil this requirement, e.g. the Cross-Impact Balance (CIB) approach (cross-impact.org). CIB is currently used for identifying scenarios, revealing the cross-impact of the selected parameters. However, there is only small experience to use CIB for a sustainability assessment, in particular in connection with energy system models or energy technology assessment approaches, like LCA. The main challenges are amongst other the systems boundaries, the model logics, and the linking of systemic quantitative approaches, like energy system models or LCA with approaches like CIB, as the hub to provide the sustainability assessment.
In respect to MCDA the main challenge is to find a stakeholder-based but robust approach which allows for reliable sustainability assessment.

Contribution to JP overall mission and relation to other Sub-Programmes and Joint Programmes and ETIP's

Within JP e3s close cooperation to all SP's are recommended. SP1 aims at understanding the social, cultural and economic aspects that shape current energy consumption patterns. These patterns considerably influence not only the (future) energy demand but also the sustainability of energy paths and thus the assessment by the society. Changes of the governance as well as considering energy justice, as aimed at SP2, will influence the assessment of future paths. However, sustainability targets could give some important hints in respect to the direction of the needed changes. The presented challenges build very much on connecting models; thus, a close cooperation with SP5 would be helpful.
Outside JP e3s all JPs are of relevance. However, since it makes a difference, whether the energy system is assessed or energy technologies, the cooperation between more systemic oriented JPs and more technology oriented one will be different in its nature.

4. SP4. Market and business models for ET

Mission

Mission of SP4 is to guide the development of sound and fair markets for energy vectors, flexibility and emissions thereby driving the system forward with an optimal and affordable integration of RES technologies in the energy mix and consumption patterns.

Background and challenges

The Sub-Programme has a micro-economic focus on the energy transition challenge and will work with local planning perspectives related to market design for the energy market triggers possibilities for the technologies both on the generation and the demand side. It will focus on the social science related to operational aspects of the new technologies and their supply chain, as well as on the socio-economic analysis of consumers' behaviour, attitudes and preferences towards fair and sustainable energy markets.

The innovation and implementation of new solutions depends to a large extent on the small and medium sized companies that constitute the larger volume of the energy sector. Therefore, this part of the energy sector is important to boost implementation of new renewables and the innovation that can drive down implementation cost and increase global export opportunities for Europe.

Operation of the zero-emission or even net-negative emission energy systems will require new solutions across technologies and user groups and where interoperability at different levels is essential to cost effective and secure management of the energy system. The combination of regulation, market design and business models that facilitate RES exploitation in combination with flexible solutions in energy demand requires a market design that gives the right signals for both operation and investment. Knowledge about what will work and what design will not is equally important as is the axis of availability of control mechanisms to ensure that such market(s) works properly and creates a level playing field for technologies for generation and consumption control given the aim of a just, affordable and secure energy transition. In this regard, there is a need to understand drivers and barriers that consumers perceive related to the adoption of RES solutions and to the participation in their market (not only in terms of adoption, but also of active participation).

In parallel with the techno-economic optimality of the energy market a stronger connection to the broader concept of sustainability is needed, including externalities (and their quantification in economic and monetary terms) into the energy market. Research is required to understand and propose how sustainability can be included in the regulation and operation of the energy markets and market designs allowing for symbiosis between sectors such as power-2-x and x-2-power but also to the other axis of the sustainability triangle between energy and environment and between energy and social acceptance.

Another important research theme in SP 4 that goes beyond the regulation and energy market operation is what is needed to realise the transition from fossil technologies to renewable technologies which must be seen in the light of energy security not only after but also during the transition period. Europe cannot rely on, should not rely on import of the technology needed for the transition. New competences are needed for understanding and facilitating a sound European supply chain for new clean energy technologies across different sectors, including the LCA perspectives of input factors such as rare minerals and energy intensive materials but also education and innovation. An increase in European innovation is strongly connected to the establishment of green jobs and business possibilities for European energy solutions.

The long-term impact from the transition on natural resources such as raw materials, land and water use are important to assess the feasibility of the transition objective and the different pathways to reach these objectives. The interaction between the operation of the energy system, supply chains and the short-term impact this may

have on basic resources as water and land has gained less interest. The security of energy, food and water are likely to become more closely related, for instance switching between energy crops and food related crops, water used in the energy sector contra water used for drinking and irrigation. Research is needed so that the design of models for RES exploitation takes these aspects into account in the planning process outlined not only by the transition pathways but also in the operation of energy markets.
New competences on how the energy transition can be accelerated through innovation and how new technology and service can be harvested leading to green jobs and export possibilities are important for the success of the energy transition. A better understanding of how market solutions drive innovation may impact the organisation and operation of energy markets. Moreover, the energy market should have a design that leads to exploitation and development of new technologies to drive down the cost of generating and finding the optimal combination of different energy carriers. In SP 4 examples of best practice can be described and lead to new insights and recommendations.

Area of intervention

Contribution of SP4 to the objective of JP e3s is to build the research capacity and competence needed within economic – and market models to support a zero emission European energy system. The Sub-Programme will work on the following areas:

- The combination of regulation, market design and business models that facilitate RES exploitation in combination with flexibility solutions in energy demand. With special focus on creating and exploiting possibilities for the SMEs in energy supply and service industries;
- How sustainability can be included in the regulation and operation of the energy markets and market designs allowing for symbiosis between sectors such as power-2-x and x-2-power but also to the other axis of the sustainability triangle between energy and environment and between energy and social acceptance;
- What new competences that are needed for understanding and facilitating a sound European supply chain for new clean energy technologies across different sectors including the LCA perspectives of input factors such as rare and energy intensive materials;
- Interaction between the operation of the energy system, supply chains and the short-term impact this may have on basic resources as water and land;
- How the market solutions drive the innovation that leads to exploitation and development of new technologies that drives down the cost of generating and using different energy carriers. This can be analysed within different contexts and sectors, also making use simulations (gaming, metaverse, virtual reality, interactions on the web);
- The analysis of supporting factors regarding the adoption and investment of citizens/consumers in RES technologies by integrating behavioural, social and cultural dimension;
- Econometric analysis of the decision drivers of consumers' to partake in the RES market.

Objectives

- Priority one is to contribute with proposals for design and regulation of fair and inclusive energy markets pointing to benefits and challenges of such markets;
- Create a consumer model for use in techno-economic analysis;
- Contribute to sound and efficient supply chain for renewable technologies and their societal role;
- Contribute with proposals of how to include sustainability in the energy markets and their operation.

Methodology

Developed methodologies need to bridge the gaps between traditional techno-economic analyses and sustainability, supply chains and LCA. This requires new approaches to optimisation such as multi-objective capability, application of AI, increased utilisation of measurements and interoperability of technologies and components in day to day operation. With complex interaction between technologies, market products, active optimising demand new methodologies and combinations of methods are required. Consistent modelling of market products are necessary when assessing overall market operation as well as input to the methods needed by the market actors for fast and automatic decision support facilitating use of flexibility provided by consumers and system components. Quantitative survey methods, choice modelling and experimental design and mixed-methods can disentangle drivers and barriers of citizens' active participation in fair and sustainable energy markets.

Contribution to JP's mission and relation to other Sub-Programmes and Joint Programmes and ETIP's

The social science challenge of RES exploitation is strongly related to social science on the macroeconomic and microeconomic level. At the macro-economic level, JP e3s is working as defined for SP5 but also on the modelling work the JP ESI SP1 performs on energy system integration. SP4 will support JP ESI and SP5: Finance & regulation, coordinated by Erik Delarue, KU Leuven and use results from the ESI SP4 work on consumers in system integration. At the microeconomic level, SP4 can cooperate with SP1 to strengthen the behavioural, social and cultural analytical approaches for investigating energy consumption patterns, and with SP2 to develop and integrate an effective regulatory framework.

SP4 will be a relevant partner for the technology focused ETIPs such as ETIP Hydropower but also more generic ETIPs such as ETIP-SNET.

5. SP5. Transition pathway modelling

Mission

Provide state-of-the-art tools and methods for assessment of policy, social and environmental aspects of clean energy transition and energy system development and ensure the integrity of these in the contribution to transition pathway development.

Background and challenges

A large variety of transition strategies could potentially achieve carbon-neutrality by 2050. New methods for analysing and modelling these transition pathways are needed, both regarding the technical system changes and the social and institutional changes. The challenge lies in producing realistic and attractive socio-technical storylines about the future which reflect quantitative scenarios and their implications for society, which in turn reflect anticipated technical potentials.

In the development of these pathways, the focus is on technology choice, timing of investments, policy measures and socio-technical aspects. In this long-term perspective, it is important to have sufficient representation and understanding of the operations of the system the balance between the roles of different energy vectors such as electricity and hydrogen and the interplay between sectors as well as local political criteria. Pathways should take into account physical limitations to the deployment but also economic, environmental, societal, political and regulatory features of a country or region.

Macro-economics on a European level but also including global aspects and impact from and on our European neighbours is within the interest areas of JP e3s SP5. It is important not only to analyse how different regulations will impact on the energy and power sectors but also to be able to calculate the benefit of different solutions and assess the effectiveness of the evolving regulation implemented in the energy market. Consequences of the energy policy can be estimated, helping to build confidence in a policy or leading to suggestions on how such a policy can be more effective driving and adapting to the clean energy transition. On the other hand, modelling will be important for the narrative of energy transition to confirm the value of the transition to the citizens in parallel to the control component of verifying that the energy market works in terms of efficient allocation of resources and just distribution of welfare.

As for the research needs, as a consequence of many new technologies, new market solutions for energy with several energy carriers, larger involvement on the consumer side and an EU wide energy policy, new methodologies that have been used on national level have to evolve and include cross-border and cross-sector collaboration. In parallel, the aim is affordable, reliable and secure energy for all nations, regions and citizens which makes building of competence on models for analysis of different regulations and their effectiveness very much needed. In this situation with new actors on both generation and consumption side it is of great value to have actor-based models for understanding the competition levels in the energy market and make adaptations that can further improve the energy system throughout the transition.

Modelling will provide the high level actors with tools for analysing what happens and how the system develops. By coordinating and joining the research efforts JP e3s might help drawing the line between action and impact in the energy sector(s). Collecting data and modelling national plans in the NECPs and LTS on a European level can make it possible to trace back observed impacts to policy changes which will be very valuable for learning and pointing to efficiency improving policy adjustments. Continued work with modelling platforms such as OpenENTRANCE will be valuable for improving methodologies and data quality in modelling work. Joint work in JP e3s will improve models and methodology that are suitable for pre-assessment of policy measures and for post-impact evaluation of current policies.

With the stated objectives regarding energy justice, empowerment and fighting energy poverty, the link between modelling and social and policy dimension of both the energy system modelling and modelling of transition pathways is important. Connecting the social and policy dimensions to the energy system modelling will give more realistic results and provide new knowledge of importance to the clean energy transition narrative and to promote new policies and regulations on EU level.
Strengthening the more holistic approach of socio-technical energy system modelling is necessary to preserve the links between energy and other important sectors in the economy. Understanding the interaction between different objectives that might or might not be conflicting is increasingly important, for example land use and solar farms where land use represents interests such as agriculture, leisure needs, and environmental aspects such as biodiversity and water quality.

Areas of intervention

The SP will focus on the main following topics:

- regulation of the energy market;
- Policy ex-ante assessment and ex-post impact evaluation;
- Robust transition pathways;
- Socio-technical energy system modelling;
- Environmental impact evaluation of pathways;
- Decision-support systems and scenario planning.

Objectives

The objective of JP e3s requires ability to consider the social science aspects and socio-economic modelling of the energy transition across economic sectors in Europe. SP5 will contribute to the competence base and research capacity needed within socio-economic models across sectors and societal needs including the modelling of policy and tools for assessment and evaluation of the progress of clean energy transition. The Sub-Programme will work on the following topics:

- Build competence and models for analysis of different regulations for the energy market including tools for assessment of market operation of the at-all-times active energy market regulation. This includes actor-based models for understanding the competition levels in the energy market;
- Build models and methodology that are suitable for pre-assessment of policy measures and for post-impact evaluation of current policies. Do research on which policy that effectively pushes forward the energy transition and suggest policy changes that will benefit the transition and the development of the energy system and energy market;
- Ensure the integrity of the environmental, social and policy aspects in models used for analysis of the integrated European energy system modelling and include policy and social impacts into the modelling of transition pathways;
- Analyse the impact of uncertainty and how to design robust transition pathways.

Methodology

A variety of methodologies applied in SP5. Firstly, the stakeholder's intensive process of creating scenarios and pathways with a high degree of acceptance relies on systemic understanding of the energy processes and cross sectoral connections in society. The science of analysing and finding robust pathways uses qualitative and quantitative methods as well as tools for least cost calculation from the starting point of the defined aim. Both cross sectoral techno-economic analysis, equilibrium models often in combination with description of learning and innovation processes are complex to set up and not less complex to understand and sensitise the key results and recommendations based on the modelling result. A broad approach is needed and often with bi-directional cross over to modelling and methodology applied in SP4.

Contribution to the JP overall mission and relation to other Sub-Programmes and Joint Programs and ETIP's

The social science challenge in socio-economic modelling relays on the competence built in SP4 regarding details in implementation of new technologies and market solutions. SP5 in JP e3s will supplement and support the techno-economic model development in JP ESI and make use of results from the ESI SP1 work on the technical aspects of energy system integration covering multiple energy carriers and technologies.

SP5 will be a relevant partner for the technology focused ETIPs such as ETIP Hydropower but also more generic ETIPs such as ETIP-SNET, stating the framework and contributing to efficient energy systems for uptake of the cost effective and secure energy technologies. Aspects from e3s SP2 (and SP1) are important for SP5 where acceptance is closely related to efficient policies.

EERA is currently cooperating with and participating in the European Forum for Energy and Climate Transition (EFECT.EU). The link to this forum and the open platform developed in the OpenEntrance project together with establishing European Centres of Excellence on modelling is part of the ambition of SP5.

6. Sub-Programme on Social Science and Humanities in DfE

The description provided below is a summary. The full text is available here in the SRIA of JP DfE.

Background

The roadmap to the energy transition requires a thorough transformation of the energy ecosystem. One of the main pillars of this transformation is the empowerment of individuals so that they shift their roles from being solely consumers to active players in all fields of the energy ecosystem. This includes the citizens becoming energy producers, members of energy communities, or utilising data about their energy consumption profiles to manage their energy demand.

Another critical pillar of this transformation of the energy ecosystem for the transition is the change from a fossil-fuel-based energy ecosystem to a renewable-based energy ecosystem. As the backbone of the energy transition, this change requires integrating and synchronising a broad spectrum of technological, economic, social, cultural, political, and environmental components.

Along these two main pillars, digitalisation of the energy ecosystem arises as a cross-cutting issue.

To begin with, many of the new roles for individuals in the energy ecosystem require using digital tools or becoming much more efficient. Examples are smart meters for two-way information exchange and demand management or the use of smart grids for integrating community energy plants into the main grid. As the operations and communications in many fields of life become digital, the contemporary roles of the individuals in the energy ecosystem are more likely to be coupled to a higher degree with digitalisation.

Concerning the transformation of the energy ecosystem to become renewables-based, most of the technologies will be based on digital tools. For instance, the management and monitoring of renewable energy plants, risk surveillance, emergency handling, matching of the load, production and demand profiles, and even billing operations are mainly conducted via digital tools.

From a related perspective, technological advances also bring new digital players to the energy ecosystem. These are mainly machines, commonly in the form of AI-based automated decision and control systems that support humans in managing the energy ecosystem.

Although the digitalisation of the energy ecosystem primarily relates to the technology aspect, the most efficient contribution of digitalisation to the energy transition depends on adequately managing this digitalisation. This, in turn, requires the consideration of the multiple facets of digitalisation, including the social, environmental, economic, cultural, and policy-relevant impacts. As well as providing economic benefits, better decisions, and faster and more efficient operations, these impacts are also related to challenges for the stakeholders. For instance, with the rollout of smart meters, households need to adapt and/or develop their skill sets to analyse the data from the smart meters and change their energy-related decisions, possibly even their lifestyles accordingly. On the other hand, the system operators need to be able to cooperate with the machine agents of the energy ecosystem. Individuals that participate in a community energy cooperative need to keep track of their facilities' financial and operational progress. Policymakers need to formulate policies to ensure that the integration of renewables into the energy ecosystem can be realised without issues such as public resistance against technological investments.

Accordingly, steering the digitalisation of the energy ecosystem while fostering technological developments and innovations on the one hand, and balancing the impacts of digitalisation on the other hand, requires the explicit consideration of many aspects in the domain of SSH (Social Sciences and Humanities).

To this end, the Subprogramme on Social Science and Humanities in Digitalization for Energy aims to contribute to the energy transition by addressing the SSH-relevant aspects of digitalisation in the energy ecosystem. In doing so, the Subprogramme on Social Science and Humanities in Digitalization for Energy will conduct research to frame the pathways to manage these aspects and provide policy suggestions.

Objectives

1. <u>Identifying the impacts of digitalisation on the energy ecosystem</u>

Identifying the impacts brought about by the rapid changes in the energy ecosystem, characterised mainly by replacing existing mechanisms with digital counterparts and emerging new digital processes, is a prerequisite to addressing these impacts.
The Subprogramme on Social Science and Humanities in Digitalization for Energy will follow an approach based on the critical dimensions of SSH relevant to the digitalisation of the energy ecosystem.

2. <u>Social acceptability of technological developments and digitalisation of the energy ecosystem</u>

As with any endeavour pertaining to society, the digitalisation of the energy ecosystem cannot be successful without ensuring its social acceptability. However, social acceptability is sophisticated, varies with geography (locality), and depends on a broad spectrum of factors, including the sociodemographic factors, energy profile of the society, and level of trust within the society.
The Subprogramme on Social Science and Humanities in Digitalization for Energy aims to utilise the SSH approach to analyse the dynamics of social acceptance of digitalisation of the energy ecosystem.

3. <u>A human-centric approach to the digitalisation of the energy sector</u>

The SSH approach to digitalising the energy ecosystem is based on the human-centric viewpoint. This viewpoint is also inherent in the energy transition that relies on empowering individuals in the energy ecosystem.
Accordingly, the subprogramme on Social Science and Humanities in Digitalization for Energy will search for the conceptualisation of a framework that prioritises the human-centric approach to the digitalisation of the energy sector.

4. <u>FAIR data and digitalisation</u>

Digitalisation of the energy ecosystem calls for integrating an increasing number and variety of machine-based agents into the energy systems' decision-making, management, and operation. Clearly, these new participants of the energy system require structured and well-defined data for fulfilling their part of the related processes. For this purpose, the energy data needs to be designed, created, captured, processed and shared based on the FAIR (Findable, Accessible, Interoperable, and Reusable) data principles.
The Subprogramme on Social Science and Humanities in Digitalization for Energy aims at identifying the roadmap for ensuring the implementation of the FAIR data principles for digitalisation.

5. <u>Digital Tools for behavioural change</u>

As with any change, the energy transition also calls for behavioural change, both for stimulating and adapting to the change.

The Subprogramme on Social Science and Humanities in Digitalization for Energy aims to analyse the role of one of the core topics of SSH, behavioural change, and its relation to the digitalisation of the energy ecosystem. This objective's primary focus will be identifying how digitalisation can support behavioural change for the energy transition.

In what regards the conceptual models that have been identified, a non-complete of them is listed below: Qualitative analysis, quantitative analysis, mixed methods, discourse analysis, coding, bibliometric analysis, desk research, literature review, surveys, semi-structured interviews, focus groups, case studies, and workshops.

Governance and rules

The JP governance (organisation and internal rules) has been conceived to make the JP able to jointly pursue three main objectives:

- guaranteeing the smooth coordination of the JP's activities;
- Strengthening the relationships with the other EERA JPs, the SEC and the EERA central workgroup:
- Fostering the involvement of e3s members.

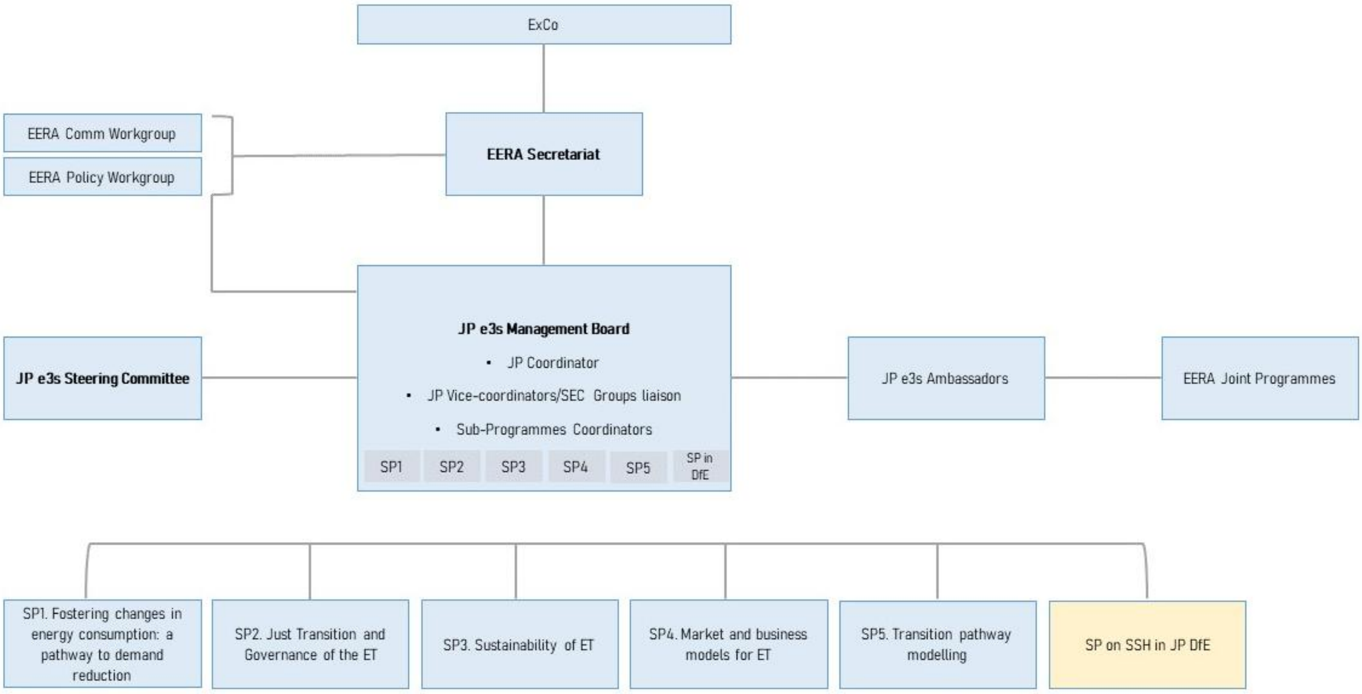

Figure 4 - JP e3s governance' structure

1. JP bodies and roles

The JP's governance relies on the following bodies:

- Joint Programme Coordinator;
- Vice coordinators;
- Management Board;
- Sub-Programmes coordinators and co-coordinators;
- Temporary Workgroup coordinators;
- Steering Committee;
- e3s ambassadors;

Joint Programme Coordinator (JPC)

The JPC chairs the Joint Programme Management Board, performs key administration duties and coordinates the existing and potential members of the programme. The EERA JPCs meet physically twice a year and also hold periodic conference calls when required.

JPC's tasks and responsibilities include:

- Coordination of JP members;
- Interaction with other JPCs, the SEC and the ExCO;
- Facilitating interaction among Sub-Programmes leaders;
- Establishment and coordination of temporary workgroups;
- Coordinate the planning process;
- Discussions with potential EERA members and introduction of new members.

Elected by the Steering Committee (see below), the JPC's term of office is three years.

Vice coordinators (VC)

JPs vice coordinators support JPC in the whole coordination tasks and are specifically responsible to maintain a continuous liaison with the EERA central working groups: the Policy Workgroup and the Communication workgroup. The VC responsible for the Policy workgroup will be asked to periodically report about the relevant changes that might affect the JP's activities while the VC responsible for the Communication workgroup will coordinate with the SPCs to strengthen the JP's relationships beyond EERA.

Elected by the Steering Committee (see below) the VC's term of office is three years (to be renovated together with the JPC). If needed, e.g., in case of change of job etc., SPs coordinators may be substituted in advance.

Management Board (MB)

The Management Board is composed of min 6 and max 10 members:

- Joint Programme Coordinator;
- Five Sub-Programme Coordinators;
- Max 2 vice coordinators (optional);
- Max 2 additional e3s members (optional).

The main MB tasks are:

- Financial, contract and Intellectual Property (IP) management;
- Monitoring of Sub-Programmes activities and support to their objectives;
- Monitoring of progress of JPs Yearly Work Plan (YWP, see section 2 below) and other activities;
- Research planning and strategy;
- Liaison with relevant initiatives within and beyond EERA;
- Preparation of progress reports to the EERA ExCo.

Temporary Workgroups Coordinators (see below) can be invited to take part in MB meetings while the activity they are responsible for are running.

Elected by the Steering Committee (see below) the MB term of office is three years

Sub-Programme Coordinators (SPCs)

It is recommended but not mandatory that each of the five Sub-Programmes is led by two coordinators:

- one MB member that represents the main contact for the correspondent SP and reports to the MB about its activities;
- one co-leader nominated among the full and associate e3s members of the Steering Committee.

The 2 SPCs are responsible for coordinating the collaborative research activities in their respective Sub-Programme and for the implementation of the YWP. SPCs oversee the overall progress of the SPCs activity (organising workshops, monitoring progress of combined research efforts and delivering the workshop reports and other milestones), take part to the release of the YWP and promote e3s communication and collaboration beyond EERA (with other R&I networks, ETIPs, etc.).

Elected by the Steering Committee (see below) the SPCs term of office is three years (to be renovated together with the JPC).

Steering Committee (SC)

The SC is composed by a representative from each participant member and is the main decision-making body of JP e3s. Participation and voting rights in the SC are determined by the type of membership fee yearly paid by members which is € 2,000 for full members and € 1,000 for associate members. Full and associate members have the right to participate and take part in the discussion, only the full members have the right to vote.

JP Ambassadors

In order for the JP e3s to be bridged with the other JPs one member will be identified as the main contact for e3s and will be entitled to maintain a continuous interaction with a specific JP (through mail contacts, participation upon invitation to JPs MB and SC, etc).

Any of the e3s members can be appointed as ambassadors upon his/her voluntary candidature but in order to facilitate the interaction, priority is given to e3s members that have multiple membership in the two JPs to be connected.

Nominated by the Steering Committee (see below), no term of office is foreseen for the Ambassadors.

Temporary Workgroups and Temporary Workgroups Coordinators

When in the YWP a specific task is identified that involve the JP as a whole and cannot be assigned to a specific Sub-Programme, a temporary workgroup is built and a coordinator identified among the e3s (associate and full) members who is responsible for the smooth implementation of the activity and the reporting to the MB. The workgroup composition and the coordinator are nominated upon SC voting jointly with the YWP approval.

2. JPs decision making and Yearly Work Plan (YWP)

All the JP e3s (associate and full) members are asked to actively take part in the decision making process through their participation in the discussion and through the sharing of their ideas, proposals and specific issues that need to be mandatorily taken into account by the JP bodies.

Only the full members are entitled to be a candidate as JPC and to be part of the MB and have the right to vote.

Decisions are normally taken through a voting procedure in the correspondent JP bodies' periodic meetings as summarised in the table below:

Body	Meeting	Voting rules	Note
Management Board	Monthly	Majority of the participants	Vote is allowed if at least 50% of the MB members are present
Steering Committee at General Assembly	Half Yearly	Majority of the full members participants	Vote is allowed if at least 50% of the full JP members are present
Ambassadors	Quarterly (specified in the YWP)	No decision to be taken	Coordinated by JPC

When the participation to the meetings is below 50% of the bodies' members the voting procedure will be performed via email within 5 working days from the date of the meeting.

By the end of December each year, a **Yearly Work Plan** is delivered and approved by the SC.
The YWP reports the list of the activities foreseen for the year after and for each of them a short description (when needed), a timeline and the assignment of responsibilities. Not all the SPs will be active in the YWP every year but a rotation principle is applied in order to concentrate the JP efforts and resources on a narrowed bunch of feasible tasks.
The YWP might contains many diverse items:

- (mandatory) General Assemblies, venue and provisional dates;
- (mandatory) Brokerage Events,
- Workshops and Seminars, with a short description;
- Publication and policy briefs;
- Other tasks.

The YWP 2023 is reported in Annex 3.
The YWP 2024 is reported in Annex 4.

3. Interaction with SEC, central working group and the other JPs

JP e3s is strongly committed in maintaining and reinforcing the communication and interaction with other working groups focused on energy transition research within and beyond EERA.
As for the interaction within EERA, the JPC supported by the VCs are continuously connected with the SEC and the central workgroups on Policy and Communication while the Ambassadors guarantee the continuous link with the other EERA JPs and report the most relevant updates at the quarterly meetings coordinated by the JPC.

As for the interaction beyond EERA, the JPC supported by the VC responsible for the liaison with the EERA Communication group work with the SPCs in order to reach other R&I networks relevant for the specific SP domains, as reported in the SPs description.

ANNEXES

Annex 1 - Membership

#	Member	Affiliation	Main Contact
1	AIT	Full	Manfred.Paier@ait.ac.at
2	CIEMAT	Full	yolanda.lechon@ciemat.es
3	CIRCE	Associate	lmlou@fcirce.es
4	CyI	Full	n.fylaktos@cyi.ac.cy
5	CNR	Associate	agatino.nicita@cnr.it
6	DTU	Full	ramsa@dtu.dk
7	EGE	Associate	gulben.calis@ege.edu.tr
8	EI-JKU	Associate	reichl@energieinstitut-linz.at
9	ENEA	Full	ezilda.costanzo@enea.it
10	HU	Associate	aysens@hacettepe.edu.tr
11	IEN	Associate	andrzej.slawinski@ien.com.pl
12	IFPEN	Full	damienl.bonte@ifpen.fr
13	IREC	Associate	gbenveniste@irec.cat
14	IUE	Associate	efe.biresselioglu@ieu.edu.tr
15	KHAS	Associate	gokhan.kirkil@khas.edu.tr
16	KIT	Full	poganietz@kit.edu
17	METU	Full	pderin@metu.edu.tr
18	NTNU	Full	asgeir.tomasgard@iot.ntnu.no
19	SINTEF Energy	Full	Michael.M.Belsnes@sintef.no
20	SSSA	Full	e.annunziata@sssup.it
21	TECNALIA	Full	izaskun.jimenez@tecnalia.com
22	TNO	Full	charles.lansu@tno.nl
23	TUD	Full	E.J.L.Chappin@tudelft.nl
24	UKERC	Full	chris.foulds@anglia.ac.uk

25	UNIBO	**Associate**	gabriele.manella@unibo.it
26	UNIBZ	**Associate**	federica.vigano@unibz.it
27	UNIPD	**Full**	mara.thiene@unipd.it
28	UNIROMA	**Associate**	mbeatrice.andreucci@uniroma1.it
29	UNITO	**Full**	alessandro.sciullo@unito.it
30	UG	**Associate**	w.jager@rug.nl
31	VITO	**Full**	guillermo.borraganpedraz@vito.be
32	VTT	**Full**	Tiina.Koljonen@vtt.fi

Annex 2 - Roles Assignment

Role	Name	Organization
JP Coordinator	Alessandro Sciullo	UNITO
JP Vice Coordinator - Responsible liaison with Policy Group	Tiina Koljonen	VTT
JP Vice Coordinator - Responsible liaison with Comm Group	Izaskun Jimenez Iturriza	TECNALIA
SP1 coordinator	Mara Thiene	UNIPD
SP1 co-coordinator	Ayşen Sivrikaya	HU
SP2 coordinator	Manfred Paier	AIT
SP2 co-coordinator	Ramazan Sari	DTU
SP3 coordinator	Witold - Roger Poganietz	KIT
SP3 co-coordinator	Yolanda Lechon	CIEMAT
SP4 coordinator	Michael Belsnes	SINTEF Norway
SP4 co-coordinator	Eleonora Annunziata	SSSUP
SP5 coordinator	Asgeir Tomasgard	NTNU
SP5 co-coordinator	Tiina Koljonen	VTT
SP in JP DfE coordinator	Efe Mehmet Biresselioğlu	IUE
MB member	Eleonora Annunziata	SSSA
MB member	Michael Belsnes	SINTEF Norway
MB member	Efe Mehmet Biresselioğlu	IUE
MB member	Izaskun Jimenez Iturriza	TECNALIA
MB member	Tiina Koljonen	VTT
MB member	Manfred Paier	AIT
MB member	Witold - Roger Poganietz	KIT
MB member	Mara Thiene	UNIPD
MB member	Asgeir Tomasgard	NTNU
JP AMPEA	Eleonora Annunziata	SSSA
JP Digital for Energy	Efe Mehmet Biresselioglu	IUE
JP Smart Cities	Gulben Calis	EGE
JP Ocean Energy	Izaskun Jimenez Iturriza	TECNALIA
JP Smart Grid	Izaskun Jimenez Iturriza	TECNALIA
JP Energy System Integration	Johannes Reichl	EI-JKU
JP Photovoltaic Solar Energy (PV)	Pinar Derin-Güre	METU
JP Energy Storage	Yolanda Lechon	CIEMAT
JP Concentrated Solar Power		
JP Bioenergy		
JP Nuclear Materials		
JP Wind		
JP Hydropower	Michael Belsnes	SINTEF Norway
JP Geothermal	Fabio Iannone	SSSUP

Annex 3 - 2023 Work Plan

A) General Assemblies (Steering Committees) + Scientific Conference/workshop

- 30th-31st January 2023
  GA
  Venue: Brussels (BE)

- 24th May 2023
  Scientific Conference + short GA
  Venue: Helsinki (FI)
  Workgroup: JPC + JP Manager + VTT

- 25th-26th October 2023
  GA + Workshop on Demand Reduction
  Venue: Padua
  Workgroup: JPC + JP Manager + UNIPD

B) Brokerage Events

- 3rd March 2023 (targeting fall 2023 calls) - online
  Workgroup (3-5) : JPC + JP Manager + UNIBO

- 16th June 2023 (targeting January/March 2024 calls) - hybrid (Madrid + online)
  Workgroup (3-5) : JPC + JP Manager

- 25th October 2023 (targeting autumn 2024 calls) - hybrid (Padua + online)
  Workgroup (3-5) : JPC + JP Manager

C) Workshops and Seminars

- 16th June 2023 - Joint Workshop with JP ES
  Venue: Madrid (Spain)
  Temporary Workgroup: JPC + JP Manager + SP3 + SP4
- 26th October 2023 – Conference *"Fostering changes in energy consumption: a pathway to demand reduction".*
  Venue: Padova (Italy)
  Temporary Workgroup: JPC + JP Manager + SP1

D) Dissemination: conferences, publications etc.

- Short Publication on results of Joint Workshop JPs PV-e3s held in Turin
- Proceedings of the Scientific Conference in Helsinki
- Proceedings of the Join workshop JPs e3s-ES in June
- Proceedings of the Padova Conference on Demand reduction
- Publication of the White Paper on Just Energy Transition
- Dissemination of the White Paper on JET

- Second International Conference on New Pathways for a Just and Inclusive Energy Transition: Connecting Multiple Stakeholders and Levels (Groningen, 21 June 2023)
- European Week of Regions and Cities (Brussels, October 2023)

E) Other activities

- SRIA Finalization (by the ned of March)
- Formal activation of the following e3s Ambassadors by the end of the year:
  a. JP PV
  b. JP ES
  c. JP Hydropower
- Glossary of e3s concepts and terms to be included in the SRIA;
- February – July 2023 - Building SSH Sub-Programme in JP DfE
  Temporary workgroup: JPC + JP Manager + IUE
- February – June – Website's update
  - Members Profiles
  - Projects
  - Sub-Programme description (dedicated page)

  Temporary workgroup: JPC + VC Comm + SP coordinators + JP Manager

F) Activities by SP

SP1 - Fostering changes in energy consumption: a pathway to demand reduction

- EERA Flagship Report on Demand Reduction: JP e3s SP1 leads the drafting of section 3 of the flagship report;
- Padua Conference on Demand Reduction (26 October 2023);
- White Paper on Demand reduction (start working in late 2023 and finalization in 2024).

SP2 - Just Transition and Governance of the ET

- Finalization and publication of the White Paper on Just Energy Transition;
- Dissemination of the White paper on Just Energy Transition:
  - Second International Conference on New Pathways for a Just and Inclusive Energy Transition: Connecting Multiple Stakeholders and Levels (Groningen, 21 June 2023);
  - European Week of Regions and Cities (Brussels, October 2023).

SP3 - Sustainability of ET

- Support in the organization of the joint workshop with JP Energy Storage;
- Start planning activities for 2024.

SP4 - Market and business models for ET

- Support the organization of an online meeting with JP ESI in late November where both JPs will present their activities, discuss about projects and the organization of a proper workshop in 2024.

SP5 - Transition pathway modelling

- Support to SP3 and SP4 in the definition of their activities for the year to come.

month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

task A	GA				Scientific Conf.					GA + Workshop		
task B			BE			BE				BE		
task C						JW e3s-ES						
task D						Groningen				EWRC	White paper JET (?)	
task E						Website						

Annex 4 - 2024 Work Plan

A) JP e3s General Assemblies (GA)

- 20th March 2024
  - GA
  - Venue: online

- 23rd September 2024 (1 day meeting, back-to-back with the joint workshop with JP hydropower and DfE)
  - GA + Workshop
  - Venue: Brussels (Belgium)

B) JP e3s events

- SP3 workshop
  Date: 14th March 2024, during the NTNU Energy Transition Week
  Venue: Trondheim (Norway)
  SPs involved: SP3 (supported by SP5)
  Topic: Scenario-based sustainability assessment using MCDA-approach

- Joint Workshop with JP Energy System Integration
  Date: 4th June 2024
  Venue: Kaunas, Lithuania
  SPs involved: SP3 (supported by SP5)
  Topic: Scenario-based sustainability assessment using MCDA-approach

- Conference with JP Hydropower and tJP Digitalization for Energy
  Date: 24th September 2024
  Venue: Brussels (Belgium) back-to-back with the Steering Committee meeting of JP e3s
  SPs involved: SP4 (supported by SP5)
  Topic: The future of Hydropower: how can we improve social acceptance and business models and the use of digitalization as an enabler

C) 2 Brokerage Events

- **May 2024** (TBC, calls tbd according to the new HE work programme 2025-2026)
  Venue: online

- **Nov 2024** (calls tbd according to the new HE work programme 2025-2026)
  Venue: online

D) Publications

- Special issue *"Advancing the Just Transition: Navigating Towards a Sustainable Future"* on Frontiers in Sustainable Energy Policy.
  Date: July 2024
  SP responsible: SP2

- Scientific paper on energy demand reduction in Energy Research and Social Sciences

Date: September 2024 ?
SP responsible: SP1

- White Paper on demand reduction
  Date: December 2024
  SP responsible: SP1

- Short Publication (proceedings) following JPs e3s-ESI Joint Workshop
  Date: July 2024
  SP responsible: SP3

- Short Publication (proceedings) following JPs e3s-Hydropower-DfE Joint Workshop
  Date: November 2024
  SP responsible: SP4

- Thematic factsheets on Cultural Engagement and citizen science
  Date: tbd
  SP responsible: SP2

E) Other events (Conferences, workshops etc.)

- NTNU Energy Transition Week
  Date: 14th March 2024
  Venue: Trondheim (Norway)
  SP involved: SP3 with the support of SP5
  Topic: Scenario-based sustainability assessment using MCDA-approach
  Type of contribution: paper/session

- European Sustainable Energy Week (ESEW)
  Date: 11-13 June 2024
  Venue: Brussels
  SPs involved: JP coordination teams with the support of SP1 with nègawatt, JRC
  Topics: dissemination of the flagship report on Energy Demand.
  Type of contribution: policy-session

- IX Symposium on Hydrogen, Fuel Cells and Advanced Batteries
  Date: 30 June – 3 July
  Venue: Milazzo (Italy)
  SPs involved: SP2 (coordinated by CNR)
  Topics: Hydrogen environmental and societal impacts
  Type of contribution: paper

- European Week of Regions and Cities (EWRC)
  Date: October 2024
  Venue: Brussels

SPs involved: JP coordination teams with the support of SP1 with nègawatt (tbc)
Topics: energy demand reduction (flagship report and white paper)
Type of contribution: session

- EERA Science for Policy workshops
  where to involve EU and local policy makers in a dedicated online or in presence workshop
  SPs involved: ?

month	January	February	March	April	May	June	July	August	September	October	November	Dec
General Assemblies			online						In-presence - Brussels			
Brokerage events					online						online	
JP events			SP3 WS			JP ESI WS			JP Hydro & DfE WS			
Publications						e3s- ESI WS proceedings	Special issue on JET		Wide review & White paper DR		e3s-hydro WS proceedings	
Other events			NTNU Energy week			ESEW				EWRC		

Summary of activities by SP

SP1 - Fostering changes in energy consumption: a pathway to demand reduction

- Writing and publication of a wide review on energy demand reduction on Energy research and Social Sciences
- Writing and publication of the white Paper on Energy Demand reduction
- Dissemination of the White Paper:
  - European Sustainable Energy Week
  - European Week of Regions and Cities
  - Other?

SP2 - Just Transition and Governance of the ET

- Session during the IX Symposium on Hydrogen, Fuel Cells and Advanced Batteries (coordinated by CNR) – tbc.
- Survey about Cultural Engagement and citizen science for the clean energy transition, trying to involve JP Smart Cities (by activating the ambassador) in view of a proper activity to be realized in 2025.
- Thematic factsheet about Cultural Engagement and citizen science for the clean energy transition based on the results of the survey.
- Special issue on a synthesis of White Paper on JET on Frontiers in Sustainable Energy Policy.

SP3 - Sustainability of ET

- SP3 workshop on Scenario-based sustainability assessment using MCDA-approach in March 2024, during the NTNU Energy Transition Week in Trondheim (Norway)
- Research activity on Scenario-based sustainability assessment using MCDA-approach
- Joint Workshop with JP Energy System Integration in June 2024 in Kaunas

SP4 - Market and business models for ET
- Preparatory activities for the publication on Electricity Market Design reform in 2025
- Joint Workshop/Conference with JP Hydropower and JP Digitalization for Energy (and SSH centre) in Brussels on 24th September 2024
- Start working on joint publication with JP Hydropower and DfE

SP5 - Transition pathway modelling
- Support to SP3 in the organization of Joint Workshop with JP ESI and SP4 in the preparatory activity to the publication on the electricity market design reform.

SP e3s-DfE
- Participation to the JP AMPEA and COST-Action EU-MACE Workshop on Digitalization and Automation Boost Energy Materials Research to start exploring the topic of SSH approaches about roles of digitalization in Energy Transition (tbc)
- Organization of the Joint Workshop with JP hydropower and DfE
- 'Informal' Meeting / Workshop (hybrid/virtual) on SSH approaches about roles of digitalization in Energy Transition in order to find possible topics to be explore in future activities (seminars, joint publication) and projects.