Economic and Social Considerations for the Future of Nuclear Energy in Society

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1 Executive Summary

The ECOSENS project, funded by Euratom, aims to integrate societal, economic, and environmental considerations into the assessment of nuclear energy's role in the future energy landscape. Spanning from 2022 to 2025, the project hosted a series of scientific events that engaged stakeholders from various disciplines to discuss nuclear energy's sustainability, governance, and societal impact.

The project's first event, "Powering the Future Responsibly: Assessing the Sustainability of Nuclear Energy," held in 2023, focused on assessing nuclear energy's sustainability within broader energy systems. The event underscored the necessity of incorporating social, cultural, and ethical dimensions into sustainability assessments. The discussion emphasised flexibility in assessment methodologies, recognising the need for contextualised evaluations that reflect public and environmental concerns.

The second scientific event, addressing "Public Participation in Decisions Related to Small Modular (Nuclear) Reactors (SM(n)Rs)" in 2024, explored the growing interest in SMRs as part of Europe's energy transition. The event highlighted the importance of early, transparent public engagement in SMR development. It stressed that public understanding remains limited, with mixed perceptions of SMRs' safety and potential for contributing to climate goals. Key recommendations focused on the inclusion of local communities, NGOs, and diverse stakeholders in decision-making processes.

The third scientific event, also in 2024, centred on assessing the socio-economic viability of nuclear energy at the country level through the "System of Provision" (SoP) approach. SoP model integrated socio-economic, political, and technological factors to evaluate national readiness for nuclear energy deployment. The event also examined the Social Discount Rate (SDR) and its implications for long-term nuclear investments, emphasising the need for transparency and contextual sensitivity in economic models.

The final ECOSENS conference in 2025 provided a comprehensive reflection on the interdisciplinary results of the project. Discussions covered sustainability assessments, the role of SMRs, and socio-economic models. It underscored the political nature of sustainability assessments and advocated for a participatory, inclusive approach to nuclear energy governance. The conference concluded with a set of practical recommendations to enhance public participation, promote transparent communication, and integrate social sciences and humanities into nuclear energy policy.

Overall, the ECOSENS project highlighted the need for adaptable, context-sensitive frameworks that reflect both technical and societal complexities, ensuring that nuclear energy development aligns with democratic values and sustainability goals.

1 Introduction

Between 2023 and 2025, the ECOSENS project organised a series of four Scientific Events aimed at sharing key findings, presenting novel methodological tools, and encouraging open discussion on the sustainability and governance of nuclear energy. The second and third events were thematically linked and delivered in two parts, focusing on public participation and socio-economic modelling. The final event built upon the insights of the previous gatherings and concluded the series by addressing integrated frameworks for nuclear governance.

The first Scientific Event took place during the 9th RICOMET conference, held from 30 August to 1 September 2023 in Dessel, Belgium. During the event entitled "Powering the Future Responsibly: Assessing the Sustainability of Nuclear Energy" (Appendix A), the environmental, social, and economic dimensions essential for evaluating the long-term viability of nuclear energy were explored. The event in Dessel served as an entry point into broader discussions initiated by the ECOSENS project, which hosted annual public events to address key topics emerging from project implementation.

With the progression of the project, the second Scientific Event was organised during the RICOMET conference on 10 to 11 June 2024 in Ljubljana, Slovenia. With the title "Public Participation in Decisions Related to Small Modular Nuclear Reactors (SMRs)" (Appendix B), the event centred on the role of public involvement in shaping decisions around emerging nuclear technologies. It addressed issues of transparency, trust, and democratic legitimacy in nuclear energy policy, particularly in the context of SMRs.

The conversation was further developed in the third event (second part of the Second Scientific Event), held on 1 October 2024 in Bucharest, Romania, as part of a dedicated ECOSENS conference. The event titled "A Novel Approach to Assess and Establish the Socio-economic Role of Nuclear Energy at Country Level" (Appendix C) focused on testing a new assessment model based on the System of Provision approach. Discussions highlighted the use of socio-economic indicators such as the Social Discount Rate and Circular Economy to better understand the country-specific role of nuclear energy. This event expanded the debate on participation by introducing economic evaluation as a tool for evidence-based decision-making.

The final Scientific Event, ECOSENS final conference, took place between 8 to 9 September 2025 in Milan, Italy. The last event, titled "Futures for Nuclear Energy? Social, Economic and Environmental Considerations" (Appendix D), brought together researchers, policymakers, and stakeholders from across Europe to reflect on the interdisciplinary results of the project. It focused on cross-cutting insights, participatory evaluation tools, and the influence of historical and ethical perspectives on shaping nuclear energy trajectories. The event merged discussions on sustainability, socio-economics, and public engagement, offering a forward-looking perspective on inclusive governance models.

2 Powering the Future Responsibly: Assessing the Sustainability of Nuclear Energy

First ECOSENS Scientific Event, 29 August 2023, Dessel, Belgium, RICOMET conference 2023

https://www.ricomet.eu/ricomet-2023/

2.1 Summary of the First ECOSENS Scientific Event

The ECOSENS Zoom meeting, held on August 29, 2023, focused on assessing the sustainability of nuclear energy within broader energy systems and societal perspectives. The event was recorded for documentation purposes. The meeting included presentations and discussions led by various speakers, including project coordinators and stakeholders, covering the objectives, methodologies, and progress of the ECOSENS project. The project, funded by the European Commission, aimed to create a neutral platform for dialogue on nuclear energy's role in society, addressing social, cultural, and ethical aspects, sustainability assessments, and economic modelling.

Key points discussed included three existing methodologies under review for sustainability assessment: NESA, KIND INPRO, and life cycle assessment. Stakeholders were involved in workshops to evaluate these methodologies, highlighting the importance of flexibility and country-specific contexts. Discussions pointed to the need for considering cumulative ecosystem impacts, stakeholder participation, and democratizing energy decisions. Speakers emphasised that sustainability assessments are inherently political and should incorporate various viewpoints, including societal and ethical perspectives.

Panellists debated challenges, such as balancing renewable and nuclear energy, geopolitical implications, and the complexity of integrating unforeseen disruptions like war. The session underscored the importance of resilience, realistic policy-making, and societal trust. It concluded that sustainability assessments should be tools for inclusive, transparent decision-making processes that acknowledge their political nature.

2.2 ECOSENS Project First Scientific Event - Results

The first outcomes of the ECOSENS project, as presented during the Zoom meeting, reflect its early progress in integrating social, economic, and environmental considerations into the sustainability assessment of nuclear energy within the broader European energy landscape. Initiated in October 2022 and funded by the European Commission, the project is scheduled to run until 2025.

Initial workshops were organised to gather insights from stakeholders across various disciplines, including social sciences, policy, and nuclear research. These engagements aimed to refine the methodological framework for assessing sustainability. Three existing approaches, NESA, KIND INPRO, and life cycle assessment, were reviewed in detail. A combined approach using KIND INPRO and life cycle assessment was selected for further development due to its flexibility and potential to accommodate stakeholder input.

Several challenges emerged during this early phase. A key issue involved the need to balance analytical complexity with practical applicability. While comprehensive assessments are essential to fully address sustainability concerns, they must remain manageable and relevant to policy and decision-making. Ensuring meaningful stakeholder participation proved difficult, hindered by time constraints, limited engagement, and varied levels of familiarity with the subject matter. Another unresolved issue was the weighting of indicators, a task central to developing a fair and coherent assessment. Assigning relative importance to different sustainability criteria raised both methodological difficulties and normative debates, pointing to the need for further clarification and consensus-building.

Feedback gathered so far indicates general stakeholder support for the chosen methodological direction. Nonetheless, several suggestions were made to enhance future assessments. Particular attention was drawn to the need for better integration of societal and environmental interdependencies, which are often overlooked in conventional models. Ethical dimensions were also identified as a crucial element, deserving treatment not as an optional consideration but as an integral, cross-cutting principle alongside the environmental, economic, and social pillars of sustainability.

Preliminary findings reinforced the view that sustainability assessments cannot treat energy technologies in isolation. Effective evaluations should take into account the full energy mix and the interactions between different technologies within complex systems. Resilience was highlighted as a key factor, particularly in light of geopolitical uncertainties and systemic vulnerabilities. The discussion made clear that assessments of this kind are not solely technical exercises; they are inherently political, reflecting broader societal values, institutional priorities, and global interdependencies.

The initial results indicated progress in defining an adaptable, comprehensive methodology and the importance of broad stakeholder engagement for the project's success.

2.3 Assessing the Sustainability of Nuclear Energy

During the panel discussion, several positions were pointed out by the panel participants, representing the organised civil society with regards to radioactive waste repository establishment in Belgium, the nuclear industry and NGOs. Several topics can be summarised from the ECOSENS panel discussion on the sustainability assessment of nuclear energy in Europe's future energy mix.

2.3.1 Assessment Methodologies and Criteria

The panel concentrated on the development of sustainability assessment methodologies aimed at providing fair and unbiased evaluations of different energy sources. A critical perspective is the limitations of current Life Cycle Assessment (LCA) reports, particularly highlighting inconsistencies in a recent report by the Joint Research Centre (JRC). It was argued that such assessments often fail to consider all relevant criteria when evaluating nuclear power and advocated for a shift towards analysing entire energy scenarios. The holistic approach would assess combinations of technologies within a system rather than comparing individual technologies in isolation, offering a more realistic and context-sensitive evaluation. Namely, sustainability assessments must comprehensively account for all risks, including those uniquely associated with nuclear energy. These include long-term concerns such as radioactive waste management, facility decommissioning, and geopolitical ramifications. Therefore, it was recommended to adopt the broader evaluative framework of the Intergovernmental Panel on Climate Change (IPCC), which considers multiple sustainable development criteria beyond carbon emissions, ensuring a more holistic and future-oriented assessment.

2.3.2 Energy System Scenarios and Comparisons

Panellists emphasised that assessing the sustainability of nuclear energy gains relevance when situated within broader energy system scenarios, rather than through isolated comparisons with individual technologies. Scenarios incorporating nuclear energy were considered most informative when evaluated alongside fully renewable or hybrid configurations, allowing for a clearer understanding of their respective roles and contributions. It was noted that in energy systems aiming for high shares of renewables, potentially up to 80–90%, nuclear energy may occupy a relatively modest position, possibly below 10%. Attention was also drawn to the need for shifting the discourse away from abstract numerical targets for 2050 and towards practical, implementable steps that can guide the realisation of diverse energy transition pathways.

2.3.3 Unique Risks and Challenges of Nuclear Energy

Unique risks associated with nuclear energy, such as the potential for accidents, long-term waste disposal challenges, and geopolitical security concerns, were identified as particularly difficult to quantify and compare directly with renewable sources in sustainability assessments. Long-term territorial and intergenerational risks require consideration well beyond the typical 2050 policy horizon, given that nuclear projects can have societal implications spanning centuries. Additional concerns were raised regarding societal trust, geopolitical entanglements, and regulatory complexity, all of which contribute to the difficulties in governing nuclear power within a truly sustainable framework.

2.3.4 Public Perception and Local Community Insights

Representatives of local communities shared experiences related to nuclear facilities and waste management, expressing confidence in the nuclear sector's capacity to manage waste securely. In areas where nuclear operations are well established, levels of public trust in safety and oversight were described as high. A local organisation emphasised its neutral position regarding energy sources and underscored the need for a balanced energy mix at least until 2050. Broader sustainability considerations were also highlighted, including health, safety, and employment, as essential components of long-term energy planning.

2.3.5 Resilience and Contingency Planning

Panellists underlined the importance of incorporating resilience into sustainability planning, particularly in light of recent geopolitical crises such as the conflict in Ukraine. Resilience was presented as a critical priority in energy scenario development, with calls for strategies that reduce resource consumption and limit dependence on technologies prone to geopolitical or infrastructural vulnerability. While acknowledging that it is unrealistic to account for every possible future scenario, participants stressed the need for robust contingency planning to address potential disruptions in energy supply and ensure system stability under adverse conditions.

2.3.6 Complexity, Uncertainty, and Limitations of Current Models

Panellists acknowledged that energy assessment models frequently oversimplify complex realities and may fail to capture the intricate interdependencies between energy systems, societal structures, and ecological dynamics. The combination of technological uncertainty, evolving social values, and external shocks complicates the development of reliable sustainability assessments. It was noted that governance models often neglect the unpredictable nature of energy markets, extreme climate events, and political volatility, all of which can profoundly influence long-term planning. Concerns were also raised that overly simplified assumptions embedded in scenarios may mislead policymakers. To address this, models should incorporate a broad spectrum of potential futures, including those that envision reduced energy consumption and alternative pathways to economic and social development.

2.3.7 The Political Dimension of Sustainability Assessments

The panel concluded that sustainability assessments are not neutral technical exercises but fundamentally political processes. Decisions regarding which energy sources to include, which criteria to prioritise, and

how to interpret outcomes inevitably reflect underlying societal values and political orientations. The notion of a completely objective or "neutral" assessment was widely challenged, with agreement that every methodological choice, whether favouring nuclear, renewables, or a particular mix, constitutes a political stance. It was proposed that energy planning and policy development should be guided by the core principles of sustainable development, including precaution, equitable distribution of costs and benefits, and long-term ecological responsibility. These principles should inform decisions across local, national, and European contexts to ensure legitimacy and resilience in future energy transitions.

2.3.8 Practical Policy Recommendations and Realism in Implementation

Many panellists emphasised the importance of formulating clear and actionable policy recommendations, grounded in a realistic understanding of what can be achieved within existing technological and political limitations. Merely informing the public or decision-makers about sustainability objectives was seen as inadequate for catalysing meaningful change. Effective strategies must take into account human behaviour, institutional inertia, and the influence of entrenched interests that can shape or obstruct energy policy. The consensus was that while evidence-based assessments are essential, policy guidance must also be attuned to the social and political contexts in which energy transitions unfold, ensuring that proposed measures are not only scientifically sound but also practically implementable and socially accepted.

2.3.9 Assessment Summary

The discussion emphasised the need for an inclusive and comprehensive approach to sustainability assessments. Participants acknowledged the complex, multidimensional nature of energy planning and advocated for scenario-based assessments that reflect the long-term impacts of energy choices on society, environment, and economy. Ultimately, the panellists agreed that sustainability assessments are both necessary and inherently political, and that the process should involve transparent, evidence-based, and democratic engagement with all stakeholders.

3 Public Participation in Decisions Related to Small Modular Reactors (SMRs)

Second ECOSENS Scientific Event, 10 June 2024, Ljubljana, RICOMET conference 2024

https://www.ricomet.eu/

3.1 Summary of the Second ECOSENS Scientific Event, Part One

The ECOSENS panel discussion, held on June 10, 2024, during the RICOMET conference in Ljubljana, Slovenia, addressed public participation in decision-making processes related to SMRs. Organised as part of the ECOSENS project, funded by Euratom, the event explored the societal dimensions of SMRs within broader discussions on nuclear energy and sustainability. Presentations and panel debates brought together stakeholders, including policymakers, local authorities, NGOs, and researchers, to evaluate perceptions, participation strategies, and the evolving role of SMRs in Europe's energy transition.

The session began with an overview of the ECOSENS project's objectives and findings, particularly its interdisciplinary approach integrating technical, social, and economic perspectives. Key goals included assessing public perceptions of nuclear energy, developing a comprehensive sustainability assessment framework with 72 indicators, and exploring new economic models such as the "system of provision" concept. Work Package 1 highlighted recent qualitative research through focus groups in six countries, which revealed mixed and evolving perceptions of SMRs. Participants expressed a desire for coherent national energy policies, greater transparency, and early, inclusive engagement in technology planning.

Preliminary findings indicated that while SMRs are seen by some as a component of future energy systems, public understanding remains limited. Concerns included safety, technological novelty, decentralisation, and geopolitical dependencies. Participants questioned whether SMRs offer meaningful innovation or merely repackaged older reactor models, and whether their development is timely enough to contribute to climate objectives.

The central panel discussion engaged a diverse group of experts in a debate about how and when to involve the public in SMR-related decisions. Speakers stressed the importance of early, structured, and honest engagement, informed by lessons from past experiences in nuclear waste management. Technological neutrality, the role of local authorities, and the need for meaningful partnerships with communities were emphasised. Some panellists raised scepticism about the viability and cost-effectiveness of SMRs, urging policymakers to avoid "over-promising" unproven technologies.

Discussions also highlighted that public participation should not be confined to specific siting decisions but should include broader deliberations on research funding, national energy strategies, and societal values. Comparative examples from the Netherlands and Slovenia demonstrated successful models of participatory planning through citizen panels and local partnerships.

The session concluded with calls for transparent and sustained public dialogue about nuclear technologies, particularly SMRs. Panel members agreed that public trust can only be earned through inclusive, realistic, and values-based decision-making processes. They underscored that while SMRs may hold potential in certain contexts, their deployment must be preceded by robust societal engagement and critical assessment of alternatives, costs, and long-term sustainability.

3.2 ECOSENS Project Second Scientific Event, Part One - Results

The ECOSENS project integrated technical, social, and economic perspectives to address the complex challenges posed by climate change and energy security. It aimed to evaluate whether nuclear energy could be considered a viable and socially accepted solution, while also seeking to advance the state of knowledge from its inception. By bringing together expertise from the social sciences, economics, management, and nuclear engineering, the project involved a wide range of stakeholders and disciplinary perspectives.

One of the core objectives was to assess societal perceptions of nuclear energy, including views on both existing infrastructure and emerging technologies. This involved examining how people perceived associated risks, benefits, and potential contributions to energy transitions. The project also focused on sustainability assessments, evaluating nuclear energy across the full fuel cycle. A new methodological framework was developed, drawing on existing approaches and structured around three overarching goals: planetary well-being, supply reliability and resilience, and social feasibility. This work resulted in the creation of 72 indicators for data collection and evaluation.

In addition, ECOSENS introduced innovative tools for economic analysis. Among these was the "system of provision" approach, which allowed for a more contextual understanding of nuclear energy's economic

dimensions. The project also explored the role of the social discount rate in shaping the economic appeal of nuclear technologies, especially in long-term policy scenarios.

Key results emerged from Work Package 1, which focused on social investigations and included four main tasks. These involved examining citizens' perceptions of nuclear risks and benefits, analysing the influence of new social movements, including the rise of pro-nuclear activism, reviewing existing energy governance structures, and engaging societal actors in discussions and workshops. Particular importance was placed on understanding public attitudes within the broader framework of sustainability. Rather than limiting the inquiry to technical assessments, the project aimed to construct a more holistic view by linking these social insights with the sustainability analyses conducted under Work Packages 2 and 3. The emphasis shifted toward imagined energy futures, acknowledging that these are shaped as much by values and expectations as by data.

Two major outcomes further demonstrated ECOSENS's commitment to inclusive, reflective dialogue. International workshops in Brussels, titled "The Art and Science of Imagining Energy Futures" and "Decarbonising Europe's Energy System: Checking and Choosing Indicators for a Sustainability Assessment," brought together a diverse group of participants to explore how sustainable energy futures could be envisioned. The discussions stressed the importance of transdisciplinary and inclusive approaches, the need to balance idealistic visions with practical constraints, and the role of deeply held motivations and values in shaping energy narratives.

Participants also explored the evolution of sustainability models, noting a shift from weaker conceptions, where trade-offs between environmental, economic, and social goals are acceptable, to stronger models that recognise ecological and social boundaries as fundamental limits within which economic stability must be maintained. The workshops included critical debates on the relationship between sustainability and economic growth, questioning whether continued growth is a necessary condition for achieving sustainable outcomes. Caution was advised when relying on models, with a strong call to ensure that they reflect a plurality of values and remain open to collaborative development and scrutiny.

Overall, the workshops illustrated the importance of collective, deliberative exercises in shaping energy futures and reaffirmed the need to move beyond conventional sustainability metrics. The findings supported ECOSENS's overarching aim: to deliver assessments that are not only scientifically rigorous but also socially inclusive and attentive to diverse worldviews and expectations.

3.3 Assessing Public Participation and SMRs

The ECOSENS project, with a particular focus on Work Package 1, examined public perceptions of new nuclear technologies, especially SMRs, within the broader context of climate change and energy security. SMRs have recently gained prominence in both political and public discourse across several European countries, including the Czech Republic, Belgium, and Slovenia, reflecting a notable shift compared to the situation a decade earlier.

The research explored how citizens perceived, expected, and expressed concerns about SMR technologies. This was achieved through focus groups conducted in six European countries: Belgium, the Czech Republic, Slovakia, Slovenia, Spain, and the United Kingdom. Recruiting participants, particularly in the UK, proved difficult due to the abstract nature of SMRs, which remain largely unfamiliar to the general public. Preliminary observations from these focus groups pointed to a widespread desire for more coherent and stable energy policies. Participants expressed frustration with the frequent shifts in national energy strategies, which they felt undermined clarity about long-term objectives. There was a clear call for public involvement in shaping these decisions, supported by scientific and expert input.

Although nuclear energy was generally seen as part of the present and future energy mix, many participants were uncertain about the role SMRs would ultimately play. While some considered SMRs to be safer due to their smaller and decentralised design, others expressed concern that the increased number of units and distributed sites might introduce new safety and security challenges. Uncertainty also surrounded the technological novelty of SMRs. Some participants struggled to distinguish SMRs from conventional nuclear power, and contrasted this with fusion energy, which they more readily identified as a truly new and innovative technology. Opinions on the potential of SMRs to contribute meaningfully to climate goals were divided. Some believed that SMRs might come too late to make a significant difference, while others still saw value in investing in them as a bridge technology towards a more renewable or fusion-based future.

Perspectives on energy security were similarly mixed. SMRs were viewed by some as a means of strengthening national energy independence through domestic development and operation. Others questioned whether such independence was realistic, pointing to concerns about continued reliance on foreign expertise and the technological complexity of SMRs.

These themes were explored in greater depth during a central panel discussion on public participation in decision-making related to SMR development. With more than 80 SMR designs under consideration in Europe and none yet commercially scalable, numerous critical decisions remain unresolved. The panel addressed who should be involved in these decisions and how public engagement should be structured. Participants included experts with experience in policymaking at local, national, and EU levels; researchers involved in siting a low- and intermediate-level waste repository in Slovenia; members of environmental NGOs active in nuclear policy; and representatives from the European network of municipalities hosting nuclear facilities.

One contribution focused on technological neutrality in climate policy, stressing that SMRs and other nuclear technologies should be considered alongside renewables in the transition to a low-carbon economy. Early and transparent public engagement was seen as vital to ensure that both risks and benefits are clearly communicated during the formative stages of technology development. Another perspective, based on the Slovenian experience with nuclear waste management, highlighted the value of initiating dialogue with local citizens and NGOs from the outset. This approach not only helped reduce opposition but also fostered greater public understanding of the issues involved.

The panel also addressed persistent scepticism regarding the cost-effectiveness and feasibility of SMRs. While SMRs are often described as innovative, some argued they represent only incremental improvements over conventional reactors. The discussion raised concerns about the economic viability of SMRs, especially given the historical record of delays and cost overruns in the nuclear sector. The need for critical expertise and realistic assessments of energy security risks was repeatedly emphasised.

Local authorities were identified as key actors in the public engagement process. Representatives from the association of municipalities hosting nuclear facilities underscored the importance of recognising mayors and other local leaders not merely as stakeholders, but as active partners in decision-making. This implies meaningful engagement with citizens at an early stage, not just formal consultation.

The conversation also touched on global ambitions for nuclear energy. Panellists referred to the international pledge signed by 25 countries to triple the number of nuclear power plants by 2050. While the ambition was acknowledged, doubts were expressed about the financial, social, and environmental feasibility of such rapid expansion. Examples from countries like France, China, and India were cited to illustrate both the potential and the considerable challenges involved.

The session concluded with a strong call for transparent and honest public communication about nuclear energy, particularly SMRs. Early, inclusive, and well-informed engagement was seen as essential for building public trust and ensuring legitimacy in decision-making processes. While nuclear energy,

including SMRs, may have a role to play in meeting climate objectives, panellists agreed that its future must be considered with full awareness of the associated risks, costs, and societal implications.

4 A Novel Approach to Assess and Establish the Socio-economic Role of Nuclear Energy at Country Level

Second ECOSENS Scientific Event – Part Two, 10 October 2024, Bucharest, 2024

https://ecosens-project.eu/

4.1 Summary of the Second ECOSENS Scientific Event, Part Two

The second ECOSENS scientific event, held on 1 October 2024 in Bucharest, Romania, focused on the economic dimensions of nuclear energy, bringing together researchers, policymakers, and stakeholders in a hybrid format. Organised under Work Package 4 of the ECOSENS project (funded by Euratom), the event aimed to assess the economic viability of nuclear technologies and explore frameworks for sustainable deployment. While attendance was lower than expected, the sessions yielded rich interdisciplinary dialogue, building on prior events dedicated to sustainability assessment and public perceptions.

The event opened with a contextual introduction to ECOSENS, which unites experts from nuclear engineering, social sciences, and economics to evaluate whether nuclear energy can be part of the solution to Europe's climate, energy, and economic crises. Key themes included the integration of diverse disciplinary insights, rather than juxtaposing them, to produce coherent recommendations for policymakers and the broader nuclear community.

A central presentation by Politecnico di Milano introduced the "System of Provision" (SoP) approach as a socio-technical and cultural framework for assessing energy systems. Drawing on a case study of the French nuclear sector, the presentation demonstrated how historical policy decisions shape current pathways and influence future options. A novel SoP-based Excel model was also unveiled to evaluate the readiness of specific national contexts for nuclear deployment by scoring preconditions, enablers, and barriers across six dimensions: socio-economic, political, technological, environmental, siting, and socio-cultural.

Participants engaged in a hands-on group activity using the model to assess nuclear readiness in three countries: Romania, Belgium, and Spain. Acting as policymakers, each group critically evaluated key determinants and provided feedback on the tool's structure, usability, and conceptual clarity. Romania's case revealed strong political and technological support, moderate socio-economic conditions, and limited socio-cultural acceptance. Spain's assessment reflected a phase-out context with limited political support, weak media and public engagement, and prioritisation of renewables. Belgium's team did not complete the full assessment but raised valuable critiques about ambiguous terminology, implicit assumptions, and the need for clearer scoring guidelines and definitions.

In the afternoon, a session explored the application of the Social Discount Rate (SDR) in evaluating long-term nuclear investments. The presentation illustrated how different discounting methods, while based on the same data, can yield vastly different investment appraisals. Using examples from Italy and the US, the discussion underscored the influence of discount rates on perceived attractiveness of nuclear projects. Participants debated the ethical implications of valuing future social and environmental benefits, the difficulty of incorporating non-economic impacts into financial models, and the need for this indicator to complement, rather than replace, other sustainability criteria.

The event concluded with feedback from group presentations, which highlighted model improvements such as distinguishing present vs. potential enablers, allowing more nuanced rating scales, separating conflated indicators (e.g. government willingness vs. financial ability), and clarifying whether questions pertain to nuclear-specific or general energy policy. The model's aggregation method and logic behind "red flags" were also questioned, calling for transparency in underlying assumptions and a more robust theoretical grounding.

Overall, the event offered a meaningful opportunity to stress-test the economic assessment model and refine interdisciplinary tools for evaluating nuclear energy's future in Europe. Participants agreed that inclusive modelling, demographic sensitivity, and conceptual rigour are essential for producing actionable insights and guiding informed decision-making. A revised version of the model, integrating the extensive feedback received, is anticipated within six months.

4.2 ECOSENS Project Second Scientific Event, Part Two - Results

The second ECOSENS scientific event, held on October 1, 2024, in Bucharest, Romania, focused on economic aspects of nuclear energy within the broader goals of the ECOSENS project, funded by the Euratom programme. The project addresses societal and economic dimensions of nuclear energy by integrating technical, social, and economic perspectives to explore whether nuclear energy can contribute to resolving the interlinked climate, energy, and economic crises. Its interdisciplinary character brings together nuclear engineers, economists, social scientists, and decision-makers to produce coherent recommendations.

This scientific event concentrated primarily on the outcomes of Work Package 3 (economic analysis) and included the testing of a new assessment model. The agenda encompassed key topics such as the "system of provision" (SoP), the social discount rate (SDR), and for the first time, the circular economy in relation to nuclear technologies.

The event provided a platform to present and test several intermediate results and methodological approaches: a new model based on the SoP approach was introduced to assess the readiness of countries to adopt or expand nuclear energy. It evaluates political, socio-economic, technological, environmental, siting, and socio-cultural factors through preconditions, enablers, and barriers. The model was tested by three participant groups using national case studies for Romania, Spain, and Belgium. In the Romanian case, the evaluation was predominantly positive, with the highest scores observed in the political and technological dimensions. Key strengths included political stability, clear long-term energy planning, and a strong commitment to energy independence. Nonetheless, limited private investor interest and weak media engagement were identified as areas needing improvement. Based on the overall assessment, Romania was placed in a moderate-to-positive scenario, indicating that conditions for potential nuclear expansion were generally favourable.

The case study for Spain reflected its current policy trajectory of phasing out nuclear energy. The analysis highlighted serious gaps in political support, long-term strategic planning, and public acceptance, while media coverage was largely negative. Despite some strengths, such as grid infrastructure and a degree of research and development capacity, the country fell within the poor-to-worst scenario range. This outcome pointed to very limited feasibility for new nuclear investment under current conditions.

In the Belgian case, the testing group did not carry out the full model assessment but instead focused on critically reviewing its structure and logic. Their feedback raised important concerns about the clarity of terminology, the presence of implicit normative assumptions, and the validity of the aggregation method used. Questions were also raised about whether the model accurately reflected real-world decision-making

processes, particularly in light of the varied energy strategies and political environments found across different countries.

In the afternoon session, a detailed presentation introduced the Social Discount Rate (SDR) as a pivotal concept in cost-benefit analyses for long-term infrastructure investments. The discussion showed how different discounting methods can significantly affect the economic viability of nuclear energy projects. Using the same data, a nuclear project could appear either highly attractive or economically unfeasible depending on the discount rate applied. This underscores the need for careful methodological transparency in sustainability assessments.

Participants also debated ethical implications, such as how to value long-term social and environmental benefits and how these are (or are not) included in financial calculations. It was emphasised that SDR should complement, rather than replace, other criteria in evaluating nuclear sustainability.

A related study presented preliminary results on public acceptance of nuclear technologies, with a focus on legacy sites. The findings showed that communities with historical experience of nuclear installations tend to exhibit higher acceptance levels, especially among older residents. This suggests that familiarity plays a crucial role in public perceptions and could inform siting decisions for new projects or waste repositories.

Participants provided detailed feedback on the structure and usability of the model. The scoring system, which included categories such as "adequate" and "inadequate," was often found to be unclear or insufficiently defined. Several items were criticised for conflating unrelated factors, such as combining willingness with financial capacity, which could distort the interpretation of results. There was a strong recommendation to differentiate more clearly between current conditions and potential capabilities, allowing for a more nuanced and forward-looking assessment. Additionally, participants emphasised the importance of stronger theoretical grounding and greater transparency in how scores are aggregated, to enhance the model's credibility and analytical value.

All teams agreed that while the model prompted valuable discussion, it would benefit from a refined structure, clearer definitions, and options for more nuanced responses (e.g. medium scores or "don't know" entries). The ECOSENS team announced plans to release an improved version (v2.0) within six months, incorporating these suggestions.

4.3 Assessing the Novel Approach

The ECOSENS project developed an innovative methodological approach for assessing national readiness for nuclear energy deployment, with particular emphasis on socio-economic, political, technological, and cultural factors. Designed within Work Package 3 and tested during the second scientific event in Bucharest, the approach was based on the "System of Provision" (SoP) framework and implemented through an Excel-based tool. Unlike conventional economic assessments, the model incorporated context-specific enablers, barriers, and conditions across multiple societal domains, marking a clear departure from technology-centric evaluation methods.

The tool was intended to facilitate deliberative and participatory processes rather than produce definitive rankings. It relied on qualitative scoring scales ranging from "excellent" to "severely inadequate" and generated visual outputs such as "red flags" and overall scenario types, including moderate and worst-case classifications. Its primary function was to support structured reflection and discussion among stakeholders on nuclear development pathways, rather than to deliver fixed or quantitative conclusions.

The model was piloted through interactive group work focused on national case studies for Romania, Spain, and Belgium. Participants assumed the role of policymakers and completed the model using their knowledge of country-specific conditions. This exercise revealed several key strengths of the new approach.

The model encouraged structured reflexivity and the integration of diverse perspectives. It enabled participants from different disciplinary backgrounds to question assumptions, articulate national priorities, and examine the interplay between political goals, economic capacities, and societal perceptions. The group discussions made visible the tensions embedded in energy strategy design and illustrated the model's value as a tool for policy foresight.

By anchoring nuclear readiness in the national context, the model enabled comparative insights. Romania was assessed as having moderate to strong enabling conditions, while Spain, due to its commitment to phasing out nuclear power, scored poorly in most areas. These comparisons helped illuminate how factors such as institutional legacies, governance structures, and political culture influence the feasibility of nuclear initiatives.

Feedback from participants also revealed important limitations in the model's design. Several indicators combined dissimilar elements, such as political consensus and political stability, which complicated scoring. Others lacked definitional clarity or intermediate scoring options, making it difficult to express nuanced assessments. Ambiguity in distinguishing between current realities and future potential further contributed to interpretive disagreements, highlighting the need for refinement.

In response, the ECOSENS team welcomed suggestions for improvement and initiated the development of a revised version of the model. Proposed updates included more precise labelling of indicators, clearer differentiation between nuclear-specific and general energy factors, and the integration of geopolitical elements such as foreign fuel dependency. Participants also encouraged the addition of a "medium" score to better reflect gradations in performance.

The model was seen as having applications beyond research. Participants proposed its use in stakeholder consultations, national strategy formation, and community-level dialogues. Visual outputs were considered helpful for communicating complex assessments to wider audiences, including non-experts.

Overall, the testing of the SoP-based model demonstrated ECOSENS's commitment to interdisciplinary, user-informed tool development. In contrast to purely techno-economic approaches, the model captured how infrastructure, governance, public trust, and international interdependencies shape the practical feasibility of nuclear deployment. While refinement is ongoing, the approach showed considerable promise for supporting inclusive and context-sensitive decision-making on nuclear energy across Europe.

5 Futures for Nuclear Energy? Social, Economic and Environmental Considerations

Third ECOSENS Scientific Event, 8-9 September 2025, Milano, ECOSENS Project Conference 2025

https://ecosens-project.eu/

Book of Abstracts: https://ecosens-project.eu/book-of-abstracts-ecosens-project-conference-2025/

Presentations: https://ecosens-project.eu/presentations-ecosens-project-conference-2025/

5.1 Summary of the Third ECOSENS Scientific Event

The ECOSENS Final Conference, held on 8–9 September 2025 at Politecnico di Milano, brought together researchers, practitioners and policymakers to examine the future of nuclear energy across social, economic

and environmental dimensions. Marking the conclusion of the ECOSENS project (funded under Euratom), the two-day programme combined plenary talks with four themed tracks (societal perspectives, sustainability assessment, socio-economic models, and historical and ethical reflections) and showcased 36 abstracts from across Europe.

Key points discussed included advances in sustainability assessment and stakeholder participation. Sessions under sustainability assessment reflected on how we "imagine energy futures", presented a participatory methodology with 62 indicators comparing renewables, hydro, nuclear and gas, and offered critiques to strengthen the approach. Technical papers examined how flexible nuclear (e.g., iPWR SMRs and LFR AMRs) could support renewable-dominated systems and how to better integrate stakeholder input into technoscientific assessments.

Societal Perspectives dominated the programme, with new evidence on public and stakeholder engagement around SMRs: media framing (e.g., Sweden), public attitudes across Belgium, Czechia and Spain, local community integration in France, and country cases such as Slovenia's cancelled 2024 referendum and Spain's decommissioning process. Contributions also addressed youth radiation-risk perception, NGO engagement and lead-cooled technologies.

Socio-economic models sessions explored discounting choices for long-lived infrastructure, drivers of life-extension decisions in the US fleet, SMR bankability, and the role of nuclear in Belgian 2050 decarbonisation pathways.

Historical and ethical reflections traced how promises around SMRs gain credibility, the resilience of national nuclear systems to shocks, debates on thorium in Norway, and persistent transparency and justice challenges in Bulgaria and at the "ends" of the fuel cycle (e.g., Pécs).

A highlight was the dedicated panel on 9 September, "Practical implementation of recommendations". Panellists discussed where engagement works, barriers to best practice, responsibility for participatory governance, and the limits of transparency. They noted that "success" is perspective-dependent and cited obstacles: divergent national contexts, project-centred debates that sideline wider citizen interests, motivation and capacity gaps (including among youth), power imbalances, an over-emphasis on "trust", low awareness of long-term issues (e.g., high-level waste), persistence of Decide-Announce-Defend, and limited impact.

The conference closed by underlining that credible sustainability assessments and governance processes are inseparable from inclusive participation. The ECOSENS recommendations poster and summary called for earlier, continuous involvement; clearer responsibilities and independent oversight; better resourcing of civil society; integration of SSH expertise into R&D; and stronger transparency and communication practices, so that decisions about nuclear energy are technically robust, publicly accountable and socially legitimate.

5.2 ECOSENS Project Third Scientific Event - Results

The ECOSENS Final Conference, held on 8–9 September 2025 in Milano, Italy, represented the culmination of a three-year interdisciplinary effort to explore the societal, economic, and environmental dimensions of nuclear energy in Europe. Funded under the Euratom programme, the ECOSENS project has sought to understand whether and under what conditions nuclear energy can contribute to climate neutrality and energy resilience, while remaining socially acceptable and ethically robust. The conference served as a venue to present key results from all four work packages.

36 contributions showcased new analyses and methods while underlining the need to connect technical modelling with societal insight. Societal Perspectives featured the largest share of work (public attitudes,

media discourse, youth risk perceptions, and engagement practices across several countries); Sustainability Assessment advanced participatory approaches; Socio-Economic Models examined financing and long-term planning; and Historical & Ethical Reflections traced credibility, justice and transparency issues over time.

Methodologically, the project reported a participatory life-cycle sustainability assessment that engaged 40 participants (balanced between technical and socio-humanistic profiles) to score four energy options across 62 indicators. Results suggested no large perceived differences among technologies, pointing instead to context-dependence and the need to capture subtler distinctions in future applications.

Technical systems assessed how flexible nuclear (e.g., iPWR SMRs and LFR AMRs) could complement renewable-dominated grids under storage constraints, contributing evidence on integration costs and operational limits.

Socio-economic analyses reviewed social discount-rate methods for long-lived infrastructure, explored life-extension decisions, SMR bankability, and modelled nuclear's role in Belgium's 2050 decarbonisation pathway.

Historical and ethical studies interrogated credibility narratives around SMRs and flagged persistent transparency and justice challenges (e.g., Bulgaria; fuel-cycle "ends").

The conference also presented a consolidated set of practical recommendations to strengthen participatory nuclear governance, calling for early and continuous engagement, independent oversight, stable support for civil society, stronger community rights in siting, and systematic integration of social sciences and humanities into R&D and sustainability assessments.

In the closing panel on 9 September, participants from different EU countries (Poland, Romania, Sweden, Italy, Belgium, Spain/Finland; Figure 1) debated how to implement the ECOSENS recommendations in practice. They stressed that perceptions of "success" in engagement differ by perspective point, highlighted national-context barriers, project-centric framing, motivation and capacity gaps (including for younger people), power imbalances, and the persistence of Decide–Announce–Defend routines; and argued for partnerships and civic education to rebalance expertise. On transparency, they advocated being as open as possible about plans, benefits and risks, rather than withholding information for fear of backlash.



Figure 1. Panel discussion on stakeholder engagement. Photo: N. Železnik.

Overall, the event advanced an actionable, participatory assessment framework, supplied fresh evidence on system integration and economics, and crystallised governance recommendations.

5.3 Assessing the Futures for Nuclear Energy

The ECOSENS Final Conference in Milano provided a comprehensive platform to reflect on the project's interdisciplinary achievements. It was examined how the public understands and evaluates emerging nuclear technologies, especially SMRs, against the backdrop of climate change and energy security. A multi-country research design covered Belgium, the Czech Republic, Slovakia, Slovenia, Spain and the United Kingdom, combining representative surveys (Belgium, Czech Republic, Spain) with qualitative work (desk research, focus groups, expert interviews) across all six countries. Early evidence shows the topic's rising salience, yet generally low public familiarity with SMRs.

Findings to date indicate that media and expert debate have expanded rapidly in recent years, but citizens still seek clearer, factual information about SMRs and their claimed advantages. Where media narratives are influential, as in Sweden, SMRs are frequently framed as distinct from, and "better" than, existing nuclear, although reporting can blur terms and underplay risks.

Across case countries, attitudes link closely to perceived contributions of SMRs to energy security and environmental performance. Regression analyses show that the desired role of SMRs in the national electricity mix is associated with perceived energy-security benefits and with views of SMRs as clean or environmentally friendly; acceptance of a nearby SMR correlates with perceived environmental friendliness, perceived societal risks (negatively), perceived inclusiveness of nuclear decision-making, expected CO_2 reduction and general climate concerns.

Participants frequently called for a more coherent, stable energy policy and for earlier, better-structured opportunities for public involvement, supported by scientific and expert input. While many regarded nuclear as part of Europe's present and future energy mix, views diverged on SMRs' novelty and safety profile: smaller, modular design was seen by some as an advantage, yet others cautioned that multiplying units and sites may introduce new safety, security and governance challenges.

Conference themes fed directly into the conference's concluding panel on 9 September, which focused on how to implement ECOSENS recommendations in practice. The panel scrutinised who should be involved in decisions and how engagement should be structured, stressing that perceptions of "success" differ by perception point and that national contexts, power imbalances, motivation and capacity gaps (including for younger people), and the persistence of Decide–Announce–Defend routines remain significant barriers.

Panellists argued for early, transparent and non-defensive communication of plans, benefits and risks; for recognising local authorities as active partners rather than peripheral stakeholders; and for building partnerships and civic education that value diverse forms of expertise. These priorities align with the project's practical recommendations to institutionalise early and continuous participation, strengthen independent oversight, support civil-society capacity, and embed social-science and humanities expertise into R&D and sustainability assessment.

ECOSENS translated the sustainability assessment from a purely technical exercise into a participatory, life-cycle framework. WP2 convened 40 participants (balanced between technical and socio-humanistic profiles) who evaluated four energy options (variable renewables, hydropower, nuclear and gas) against 62 indicators supplied through structured fiches. The exercise surfaced both promise and friction: judging whole life cycles and interdependencies in the energy mix proved demanding, and no option approached a

"maximum" score, underscoring context-dependence and the need to capture subtler distinctions in future applications.

Complementing the stakeholder scoring, WP2 tested how flexible nuclear could support renewable-dominated systems under tight storage constraints, using real-world RES data in the FRAMES tool and examining iPWR SMR and LFR AMR operation, integration costs and technical limits: evidence intended to feed back into participatory deliberation. To keep the assessment reflexive rather than merely procedural, the workshop "The art and science of imagining energy futures" probed the normative assumptions behind indicators and scenarios, arguing that making such references explicit is a pre-condition for credibility across stakeholder groups.

WP3 advanced the economic and governance lens needed to turn scenarios into bankable decisions. A review of social discount-rate (SDR) methods showed wide cross-country variation (SRTP, SOC and declining-rate approaches), concluding that SDR choice is inherently normative and materially shapes long-lived infrastructure appraisals, hence the call for transparent, context-sensitive practice aligned with sustainability goals.

The studies then explored "stay or go" choices. Interviews on U.S. life-extension decisions found revenue-side conditions (power-market prices, gas competition, and risk-mitigating instruments such as PPAs) often dominate, in contrast to new-build debates that fixate on cost overruns and schedule. A companion analysis of build/no-build governance highlighted how ownership and leverage structures, the degree of government involvement, and the allocation of completion and market risks can tip decisions towards construction or cancellation.

On prospective deployment, a bankability framework for SMRs mapped financing features (self-financing, servitisation, cogeneration prospects, smaller unit size and volume deployment) to enabling and constraining pathways mediated by co-siting economies, learning effects, workforce depth and supply-chain development. Finally, system-level modelling of fully decarbonised Belgian pathways to 2050 (rotors, reactors, imports) integrated TIMES modelling with industry insight to test nuclear–RES interactions and dispatch/infrastructure sensitivities, clarifying where nuclear adds value under differing assumptions.

Taken together, WP2 and WP3 moved from "whether" to "how": a participatory assessment that recognises context and trade-offs, paired with economic and governance levers that make credible pathways executable.

6 Conclusions

Between 2023 and 2025, the ECOSENS project convened a series of four Scientific Events designed to explore the multifaceted dimensions of nuclear energy in the context of sustainability, public engagement, socio-economic evaluation, and governance. Each event built upon the previous, gradually broadening the project's scope, from developing robust sustainability assessment methodologies to testing participatory economic models and culminating in an integrative vision for future energy governance in Europe. Taken together, the events highlighted that the sustainability of nuclear energy cannot be evaluated through technical parameters alone, but must reflect public values, political realities, and institutional capacities.

The initial event marked an important milestone in developing a methodology for assessing the sustainability of nuclear energy within broader energy systems that integrate social, economic, and environmental dimensions. While significant progress was made, particularly in framing the theoretical foundation, several challenges became evident. Notably, public participation was identified as both

essential and problematic, essential because inclusive processes are crucial for legitimacy and reflexivity, yet difficult to achieve due to knowledge gaps, limited stakeholder interest, and the inherently time-intensive nature of meaningful engagement. The discussions underscored that sustainability assessments are not merely technical exercises; they are fundamentally political processes involving contested values and complex trade-offs. Incorporating geopolitical considerations, ethical dilemmas, and stakeholder diversity into the methodology emerged as both a necessity and a challenge. Ultimately, the event concluded that ECOSENS must pursue a flexible and adaptive framework, one that captures diverse societal inputs while supporting resilient, sustainable energy policy.

The research focus on stakeholder inclusion and governance in the first scientific event laid the groundwork for the next event, which shifted attention toward a specific and timely case: the public acceptability of Small Modular Reactors. Held in the context of a broader dialogue on emerging nuclear technologies, the session explored both the potential and the uncertainty surrounding SMRs. Experts highlighted the need for transparent, structured, and inclusive engagement strategies, stressing that early and honest communication about both the benefits and risks is critical to cultivating public trust. While some viewed SMRs as tools for advancing decarbonisation and enhancing energy security, others cautioned against inflated expectations, pointing to unresolved issues related to feasibility, cost, and societal impact. Speakers argued that SMR projects must embed participatory processes from the outset, involving local communities, NGOs, and diverse expert groups in shaping development trajectories. The event reinforced the view that technological innovation cannot succeed without corresponding investment in social dialogue, especially in domains marked by uncertainty and controversy.

The emphasis on inclusion continued in the third event (the second part of the second event), which examined the socio-economic dimensions of nuclear energy readiness through the lens of an innovative assessment model. Designed to capture the complex interplay between technical feasibility, political will, and societal priorities, the model aimed to serve as a deliberative rather than prescriptive tool. Participants welcomed the model's conceptual ambition but noted that further refinement was required. Concerns emerged around the aggregation of indicators, definitional clarity, and the ability of the model to accommodate the diversity of national contexts without imposing normative assumptions. Nevertheless, these limitations were not seen as failings, but as opportunities for iterative co-development. The session affirmed that economic modelling in the nuclear domain must be participatory, transparent, and capable of reflecting non-linear, contested, and value-laden policy environments. By facilitating dialogue among researchers, decision-makers, and civil society, such models can become dynamic instruments for steering strategic energy debates.

The concluding event brought all threads together and expanded them further. Through four thematic tracks, the conference highlighted the central ECOSENS message: that sustainable nuclear governance must be participatory, interdisciplinary, and context-sensitive. Participants revisited earlier discussions on SMRs, public trust, and economic modelling, now seen through the broader prism of institutional readiness, historical memory, and ethical accountability. There was a consensus that policy tools should not aim to produce definitive answers but rather to support informed and pluralistic decision-making. The conference featured national case studies, which illustrated how gaps in transparency and policy coherence can hinder trust and delay implementation. While the tools developed under ECOSENS were recognised as valuable foundations, participants advocated for continued refinement through stakeholder co-creation, clearer conceptual structures, and greater adaptability to national specificities. In essence, the final event reaffirmed that the future of nuclear energy will depend not only on technical capacity but on the ability of institutions to align technological promise with democratic legitimacy and societal expectations.

7 Appendix A: Invitation and agenda RICOMET 2023

RICOMET 2023

Dessel, Belgium

Hotel Corbie & hotel Huron

29 August, 13:30-17:30

Frist ECOSENS Scientific Event

Powering the Future Responsibly: Assessing the Sustainability of Nuclear Energy

Panel discussion

Introduction

The focus of the Scientific Event will be the ECOSENS sustainability assessment methodology integrating a societal perspective on Europe's future energy system that includes advanced and innovative technologies including nuclear. The influence of the stakeholder input gathered at the ECOSENS workshops in March 2023 will be consolidated. Results from the morning 2050 Scenario workshop will be shared. The event will be hybrid, and will welcome not only RICOMET conference participants, but also a wider audience interested in social, economic and environmental issues of future energy.

Preliminary Agenda

13:30-14:30 Introduction:

- Overview of ECOSENS | Daniela Diaconu (RATEN), project coordinator
- Feedback from the morning's 2050 Scenario workshop | Marc Poumadère (Symlog)
- The March 2023 methodological workshop and stakeholder insights | Claire Mays (Symlog)
- Methodological progress and uptake of insights for the ECOSENS sustainability assessment | Marin Constantin (RATEN)

14:30-15:30 Panel discussion: Assessing the Sustainability of Nuclear Energy

Moderation by Gaston Meskens (SCK.CEN) with invited panellists from organised civil society, industry and NGOs.

16:00-16:55 Workshop: Group work on Energy Demand Drivers

Moderation by Aylin Erden (SYMLOG) and Marin Constantin (RATEN): Participants will check and debate the societal and technological assumptions used for the ECOSENS 2050 energy demand scenario.

16:55-17:00 Closing remarks: wrap up by Daniela Diaconu (RATEN), project coordinator

Panel participants

The panel brings together a wide range of stakeholders, representing policy makers, NGOs, local communities, practitioners and researchers.

8 Appendix B: Invitation and agenda RICOMET 2024

RICOMET 2024

Ljubljana, Slovenia

Best Western Premier Hotel Slon

10 June, 16:00-17:30

Second ECOSENS Scientific Event – part 1

Public Participation in Decisions Related to Small Modular Nuclear Reactors (SMRs)

Panel discussion

Introduction

In recent years there has been a surge of attention towards the development and implementation of Small Modular Reactors (SMRs) for energy production purposes, with several (European) countries showing a special interest in pursuing its development. Although SMR's most salient characteristics and the related advantages are still fiercely discussed by scientists and policy-makers alike, it has become clear that this new technology warrants special attention. In light of a rising interest and concerns regarding the development and implementation of SMRs, the present panel discussion aims at exploring and discussing the possibilities and modalities for public participation in decision-making on this new technology. In what stage should participants ideally be involved? Is it possible to identify specific challenges and opportunities, based on prior experience in the involvement of publics in decision-making? The introduction of SMRs will undoubtedly pose new social and economic challenges in the immediate future. Hence, the present panel discussion is of timely relevance.

Preliminary Agenda

16:00-16:10 Welcome and overview of ECOSENS project | Daniela Diaconu (RATEN), ECOSENS project coordinator

16:10-16:25 Selected results from the ECOSENS project | Gaston Meskens & Robbe Geysmans (SCK CEN)

16:25-17:15 Moderated panel discussion: Public participation in decisions related to Small Modular Nuclear Reactors

Moderators: Gaston Meskens, Robbe Geysmans (SCK CEN)

Panellists: Franc Bogovič (MEP), Miroslav Gregorič (Slovenian Parliament), Patricia Lorenz (Friends of the Earth Europe), Meritxell Martell Lamolla (GMF), Nadja Železnik (EIMV)

Rapporteur: Willem Brabants (University Liège & SCK CEN)

17:15-17:30 Questions and wrap-up | Willem Brabants (University Liège & SCK CEN)

17:30-17:35 Closing remarks | Daniela Diaconu (RATEN)

Main topics addressed:

- Views on public participation in decisions on SMRs
  - At what moment should it start?
  - Are there specific challenges and opportunities for participation?

- Lessons learned from the past (related nuclear or other energy technologies) relevant to public participation in decision-making on SMRs

Panel participants

The panel brings together a wide range of stakeholders, representing policy makers, NGOs, local communities, practitioners and researchers.

9 Appendix C: Invitation and agenda ECOSENS 2024

ECOSENS 2024

Bucharest, Romania

Pullman Bucharest World Trade Center

1 October, 9:00-17:00

Second ECOSENS Scientific Event – part 2

A Novel Approach to Assess and Establish the Socio-economic Role of Nuclear Energy at Country Level

Introduction

One of the objectives of the ECOSENS project is to introduce a groundbreaking, comprehensive socio-economic model for assessing nuclear energy, utilising the System of Provision (SoP) approach. This new model aims to address the significant shortcomings of existing purely economic models by offering a wide suite of indicators useful for a relevant plethora of stakeholders, including investors (e.g., equity holders), consumers, governments, and suppliers.

The second ECOSENS scientific event will explore the novel SoP-based model, socio-economic indicators like the Social Discount Rate (SDR), and sustainable principles like the Circular Economy (CE) within the empirical context of nuclear technologies. The scientific event aims at presenting the current state of the work performed in the frame of Work Package 3 and to exchange on different options and frameworks. The event will feature opportunities for discussion and active engagement, ensuring that all participants can contribute to and benefit from the discourse.

Preliminary Agenda

9:00-9:15 Welcome and Introduction to the ECOSENS project | *Daniela Diaconu (RATEN), project coordinator, Nadja Železnik (EIMV)*

9:15-9:35 Introduction to Work Package 3 (Aims and objectives, Tasks and deliverables) | *Giorgio Locatelli (POLIMI)*

9:35-9:55 A systematic literature review on the System of Provisions (SoP) approach (Research method, Findings and Discussions) | Giacomo Dei (POLIMI)

9:55-10:15 Application of the SoP approach to the French nuclear system (Major nuclear programs, Adoption of the SoP approach, A novel framework for assessing the value of nuclear programmes)| Giacomo Dei (POLIMI)

10:45-11:15 A novel model based on the SoP approach (Presentation of the cases, Structure of the model) | Giorgio Locatelli (POLIMI)

11:15-12:45 Group work and discussion

13:45-14:05 A systematic literature review on the Social Discount Rate (SDR) (Introduction to the SDR, Main methods to calculate the SDR, Advantages and Disadvantages)| Giacomo Dei (POLIMI)

14:05-14:25 Social acceptance of NPP near old plants (Unwanted infrastructure, Nuclear in Italy, Main results)| Benito Mignacca (UNICAS), Giorgio Locatelli (POLIMI)

14:25-15:30 Group work and discussion

16:00-16:20 Circular Economy (CE) and megaprojects (Introduction to CE, CE strategies, Life extension as a CE project)| Benito Mignacca (UNICAS)

16:00-16:50 Closing remarks | Daniela Diaconu (RATEN)

Invited: ECOSENS participants, stakeholders, other interested

10 Appendix D: Invitation and agenda ECOSENS 2025

ECOSENS 2025

Milano, Italy

POLIMI Milano Bovisa Campus

8-9 September

Third ECOSENS Scientific Event

Futures for Nuclear Energy? Social, Economic and Environmental Considerations

Introduction

Our society faces significant challenges shaping desired energy futures: the urgent need for decarbonisation, and ensuring the economic, environmental and social sustainability of energy systems in the face of growing energy demand. Nuclear energy presents a potentially important, yet contested, low-emission option for tackling these challenges. Currently attention is directed worldwide towards advanced nuclear technologies and Small Modular Reactors, as a way to meet decarbonisation and broader sustainability goals. Their development seeks to improve the characteristics of existing reactors on multiple levels, e.g. safety, lower proliferation risks, potentially reduced volumes of radioactive waste, or more efficient use of fuel. However, such technologies are still under development in Europe, and not a proven and ready to use solution.

From this perspective it appears essential to open up the techno-scientific issues of new and emerging nuclear technologies to the social, political, cultural and ethical context and to create interdisciplinary space for research, dialogue and collaboration between researchers, civil society and other stakeholders.

Topics

The ECOSENS 2-day conference in Milan will feature a dynamic format, combining short topical presentations with both structured and informal opportunities for dialogue and debate. Contributions received which include research findings, critical reflections, practical insights, and project-based work directly address with the core themes explored throughout the ECOSENS project. The key topics focused in the final conference are as follows:

1. Societal Perspectives:

   - Stakeholders' and wider publics' perceptions of risks, benefits and potentials of nuclear technology (including new and emerging technologies) in the context of major societal challenges such as the climate crisis, sustainable development, and energy security
   - Stakeholder engagement and communication needs
   - Inter- and transdisciplinary research initiatives

2. Sustainability Assessment:

- Long-term sustainability of energy systems (including life-cycle analysis, resilience, and system integration analysis)
- Environmental, economic and social impacts of various energy technologies involved in the energy transition (case studies)
- Nuclear energy as a low-carbon solution: role of SMRs and advanced nuclear technologies in sustainable energy futures
- Synergies and trade-offs between energy security, climate change mitigation, and social equity in the context of nuclear energy

3. Socio-Economic Models:

- New and improved quantitative and qualitative socioeconomic models for assessing the potential role of nuclear energy in today's society
- Experiences of socioeconomic assessment engaging stakeholders, including suppliers, investors, consumers, governments, and others
- Models of a broad scope, addressing the nuclear supply chain, policies, or nuclear governance

4. Historical and ethical reflections:

- Understanding current trajectories of nuclear energy development through the lens of historical cases and experiences
- Ethical frameworks to assess potential challenges and values informing the use of nuclear energy in society

Conference Format and Structure

The detailed programme of the conference is outlined below. Presentations will be grouped into thematic sessions aligned with the core topics of the ECOSENS project. Each speaker will be allocated 15 minutes, including time for Q&A. Sessions will conclude with a moderated discussion to stimulate exchange across perspectives.

To conclude the conference, a panel discussion will address the implementation of stakeholder engagement recommendations developed by the ECOSENS project. Panellists from academia, industry, civil society, and policymaking spheres will reflect on the practicalities, challenges, and opportunities for fostering inclusive engagement in nuclear energy governance.

Preliminary Agenda

Day 1:

9:00-9:30 ECOSENS project – objectives and achievements | Daniela Diaconu (RATEN)

9:30-9:45 The art and science of imagining energy futures | Gaston Meskens (SCK CEN)

9:45-10:00 The Role of Nuclear Energy in Securing a Resilient, Renewable-Dominated Power System | Marin Constantin (RATEN)

10:00-10:15 Looking for a new way to gather stakeholder input to technoscientific assessment | Marin Constantin (RATEN)

10:15-10:30 Engaging stakeholders in energy life cycle sustainability assessment: Critiques and recommendations for the ECOSENS methodology | Claire Mays (SYMLOG)

10:30-10:45 Moderated discussion | All presenters

11:15-11:30 A comparative analysis of anti-nuclear protesters in Western Europe | Anouk Luypaert (University Antwerp)

11:30-11:45 Integration of nuclear projects in local communities | Meritxell Martell (Merience)

11:45-12:00 Framing Nuclear: an analysis of online political discourse on nuclear energy in Belgium | Peter Thijssen (University Antwerp)

12:00-12:15 Generational Shifts in the Perception of Nuclear Power Plants in Communities Surrounding Old Sites | Giorgio Locatelli (POLIMI)

12:15-12:30 Some remarks concerning NGO engagement in the ECOSENS project | Peter Mihok (UMB)

12:30-12:45 Moderated discussion | All presenters

14:00-14:15 Community Engagement and Evidence-Based Risk Communication in Environmental Impact Assessment for Small Modular Reactors | Rui Gaspar (Lusófona University)

14:15-14:30 The greening of nuclear power: addressing the challenge of doing STS on small modular reactors | Susan Molyneux-Hodgson (University of Exeter)

14:30-14:45 Public and Stakeholder Engagement in the SMR Ecosystem of the European Industrial Alliance | Meritxell Martell (Merience)

14:45-15:00 SMR development in Belgium: Making experience count | Willem Brabants (SCK CEN, Uliège)

15:00-15:15 Public attitudes towards small modular reactors as an emerging field of social research | Martin Durdovic (Institute of Sociology of the Czech Academy of Sciences)

15:15-15:30 Media reporting on Small Modular Reactors in Sweden – benefits, risks and actors involved | Åsa Thelander (Lund University)

15:30-15:45 Moderated discussion | All presenters

16:15-16:30 How do we build stakeholder engagement during the deployment of a fleet of SMRs in an embarking country? | Mariusz Ilnicki (Orlen Synthos Green Energy)

16:30-16:45 Stakeholder and Public Engagement in Environmental Impact Assessments: Considerations and Lessons for the Implementation of Small Modular Reactors | Jonathan Reese (Lusófona University)

16:45-17:00 Understanding public attitudes towards SMRs in Belgium, Czech Republic and Spain | Catrinel Turcanu (SCK CEN)

17:00-17:15 Public Attitudes toward Small Modular Reactors (SMRs) in Slovenia | Nadja Železnik (EIMV)

17:15-17:30 Perceptions and Prospects for Lead-Cooled Nuclear Technologies: Insights from R&D and Public Stakeholders in Belgium | Robbe Geysmans (SCK CEN)

17:30-17:45 Moderated discussion | All presenters

Day 2:

9:00-9:15 Discounting the Future? Reviewing Social Discount Rate Calculation Methods for Nuclear Infrastructure Investments | Giacomo Dei (POLIMI)

9:15-9:30 Retirement or Renewal? Investigating Life-Extension Projects in the USA Nuclear Large Technological Systems | Benito Mignacca (Technical University of Sofia)

9:30-9:45 Building Nuclear Plants: a Study on Drivers and Barriers | Alessandra D'Alessandro (POLIMI)

9:45-10:00 Valorization of LFR-SMR Energy Output in Self-Sustaining Semi Off-Grid and Fully Off-Grid Configurations | Kerem Enes Ayyildiz (SCK CEN)

10:00-10:15 Financing Small Modular Reactors: Implications on Bankability | Rohunsingh Sam (University of Leeds)

10:15-10:30 The impact of nuclear energy integration in the 2050 fully decarbonized Belgian energy system | Luc Van Wortswinkel (VITO, Energyville)

10:30-10:45 Moderated discussion | All presenters

11:15-11:30 Stakeholder engagement and transdisciplinary collaborations in nuclear decision-making in different EU countries: results from an online survey | Roser Sala (CIEMAT)

11:30-11:45 When public and stakeholder engagement fails: The Slovenian nuclear referendum case | Tanja Perko (SCK CEN)

11:45-12:00 Stakeholder engagement in Spanish nuclear phase-out and decommissioning decision-making | Lila Gonçalves (CIEMAT)

12:00-12:15 Slovenia's Nuclear Energy Debate and Stakeholder Engagement in the NEPN Process | Barbara Horvat (EIMV)

12:15-12:30 Adolescents Radiation Risk Perception Survey towards a Transdisciplinary Approach | Ana Rita Melo (Lusófona University)

12:30-12:45 Moderated discussion | All presenters

14:00-14:15 Nuclear Norway: Should thorium be part of the deal? | Yevgeniya Tomkiv (NMBU)

14:15-14:30 System Momentum and Exogenous Events: Understanding the Resilience of Nuclear Large Technological Systems | Giacomo Dei (POLIMI)

14:30-14:45 How nuclear promises are made credible and legitimate: Historical examples of SMRs, fast breeders, and megaprojects in Canada, France, and the UK | Markku Lehtonen (Pompeu Fabra University)

14:45-15:00 How a Green, Sustainable City Faces the Two Dirty Ends of the Nuclear Chain? Uranium Mining and High-Level Radioactive Waste Disposal in Pécs | Joseph Kóbor (Green Circle of Pécs, NTW, University of Pécs, Medical Center)

15:00-15:15 The never-ending struggle for transparency, participation and justice regarding nuclear projects in Bulgaria – civil society, courts, professional obfuscators and media dependence | Petar Kardzhilov (NTW)

15:30-15:45 Moderated discussion | All presenters

16:15-17:15 Actions for implementation of recommendations for stakeholders' engagements

Moderators: Susan Molyneux-Hodgson (University of Exeter)

Panellists: Mariusz Ilnicki (acting director of communications, ORLEN Synthos Green Energy, agency for the launch of new SMRs in Poland, Poland), Daniela Diaconu (researcher, RATEN, Institute for Nuclear Research, Romania), Åsa Thelander (researcher, Department of Communication, Lund University, Sweden), Isabella Maschio (researcher, scientific project officer, Joint Research Centre - European Commission, JRC-EC), Robbe Geysmans (researcher, SCK CEN, Belgian Nuclear Research Centre, Belgium), Markku Lehtonen (researcher, ECOSENS advisory board, Department of Humanities, Pompeu Fabra University, Barcelona; Finland)

17:15-17:30 Closing the Event | Daniela Diaconu (RATEN)

Target Audience: Researchers and practitioners addressing societal, environmental and economic considerations of nuclear energy, from civil society, academia, industry, and government. 50-60 participants are expected.

Format: Moderated plenary and break-out sessions for presentations and dialogue.

Fees: The conference benefits from support under the Euratom ECOSENS project. Luncheons and breaks will be provided at no fee. Pay-your-own-way social event on 8th September 2025. Possibility of partial travel support for a limited number of civil society stakeholder presenters.

Abstract Submission Guidelines:

- **Format:** Maximum 250 words, *docx format.
- **Content:** Include the title, authors, affiliations, and a summary of the proposed contribution.
- **Email for abstract submission:** conference@ecosens-project.eu

Important Dates:

- **Submission deadline:** 30 April 2025.
- **Notification to Authors:** 20 May 2025.
- **Programme Finalisation:** 10 June 2025.