**European Parliament**
2019-2024

*Plenary sitting*

**A9-0408/2023**

6.12.2023

# REPORT

on small modular reactors
(2023/2109(INI))

Committee on Industry, Research and Energy

Rapporteur: Franc Bogovič

PR_INI

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# MOTION FOR A EUROPEAN PARLIAMENT RESOLUTION

**on small modular reactors**
**(2023/2109(INI))**

*The European Parliament*,

– having regard to the Treaty on the Functioning of the European Union (TFEU), and in particular to Article 194 thereof,

– having regard to the Treaty establishing the European Atomic Energy Community,

– having regard to the agreement adopted at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change in Paris on 12 December 2015 (the Paris Agreement),

– having regard to the Commission proposal of 16 March 2023 for a regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020 (COM(2023)0160),

– having regard to the Commission proposal of 16 March 2023 for a regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act) (COM(2023)0161),

– having regard to Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU[1], which is currently being revised,

– having regard to Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity[2], which is currently being revised,

– having regard to Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy[3], which is currently being revised,

– having regard to Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC[4],

[1] OJ L 158, 14.6.2019, p. 125.
[2] OJ L 158 14.6.2019, p. 54.
[3] OJ L 327, 22.12.2000, p. 1.
[4] OJ L 158, 14.6.2019, p. 1.

– having regard to Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088[5] (EU Taxonomy Regulation),

– having regard to Commission Delegated Regulation (EU) 2019/856 of 26 February 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council with regard to the operation of the Innovation Fund[6],

– having regard to Commission Delegated Regulation (EU) 2022/1214 of 9 March 2022 amending Delegated Regulation (EU) 2021/2139 as regards economic activities in certain energy sectors and Delegated Regulation (EU) 2021/2178 as regards specific public disclosures for those economic activities[7] (Complementary Climate Delegated Act),

– having regard to Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations[8], as amended by Council Directive 2014/87/Euratom of 8 July 2014[9],

– having regard to Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste[10],

– having regard to Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom[11],

– having regard to the Commission communication of 1 February 2023 entitled ‘A Green Deal Industrial Plan for the Net-Zero Age’ (COM(2023)0062),

– having regard to the Commission communication of 18 May 2022 entitled ‘REPowerEU Plan’ (COM(2022)0230),

– having regard to the Commission communication of 10 March 2020 entitled ‘A New Industrial Strategy for Europe’ (COM(2020)0102),

– having regard to the Commission communication of 12 May 2017 entitled ‘Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty - Final’(COM(2017)0237), as well as its accompanying staff working document,

[5] OJ L 198, 22.6.2020, p. 13.
[6] OJ L 140, 28.5.2019, p. 6.
[7] OJ L 188, 15.7.2022, p. 1
[8] OJ L 172, 2.7.2009, p. 18.
[9] OJ L 219, 25.7.2014, p. 42.
[10] OJ L 199, 2.8.2011, p. 48.
[11] OJ L 13 17.1.2014, p. 1.

– having regard to its resolution of 19 May 2021 on a European strategy for energy system integration[12],

– having regard to its resolution of 10 July 2020 on a comprehensive European approach to energy storage[13],

– having regard to its resolution of 14 March 2019 on climate change – a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy in accordance with the Paris Agreement[14],

– having regard to the Commission communication of 11 December 2019 on the European Green Deal (COM(2019)0640),

– having regard to its resolution of 15 January 2020 on the European Green Deal[15],

– having regard to its resolution of 15 December 2015 on Towards a European Energy Union[16],

– having regard to the conclusions of the European Nuclear Energy Forum in 2022,

– having regard to the Nuclear Alliance's joint statement of 16 May 2023,

– having regard to the proposal for a European small modular rector partnership, resulting from the first EU workshop on small modular reactors, organised by the Commission on 29 June 2021,

– having regard to the Commission's high-level nuclear roundtable held on 15 March 2022,

– having regard to the Commission declaration of 4 April 2023 entitled 'EU Small Modular Reactors (SMRs) 2030: Research & Innovation, Education & Training',

– having regard to the Commission's Directorate General for Energy report of 9 October 2019 entitled 'Benchmarking of nuclear technical requirements against WENRA safety reference levels, EU regulatory framework and IAEA standards'[17],

– having regard to the Euratom Work Programme 2023-2025 for nuclear research and training,

– having regard to Rule 54 of its Rules of Procedure,

– having regard to the report of the Committee on Industry, Research and Energy (A9-0408/2023),

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[12] OJ C 15, 12.1.2022, p. 45.
[13] OJ C 371, 15.9.2021, p. 58.
[14] OJ C 23, 21.1.2021, p. 116.
[15] OJ C 270, 7.7.2021, p. 2.
[16] OJ C 399, 24.11.2017, p. 21.
[17] https://data.europa.eu/doi/10.2833/972513.

A. whereas the EU is a party to the Paris Agreement and has committed to reducing net greenhouse gas emissions by at least 55 % by 2030 compared to 1990 levels and to achieving climate neutrality by 2050 by the latest;

B. whereas global energy demand is expected to increase by 30 % by 2040, according to the International Energy Agency's New Policies Scenario; whereas demand for electricity might double by 2060 according to the World Energy Council's 'World Energy Scenarios';

C. whereas the EU will face increasing demand for electricity;

D. whereas, according to the Commission, the EU needs to double its electricity production in order to electrify sectors such as heating, cooling and transportation in light of the green transition;

E. whereas the EU must mitigate its own risks of external dependence in terms of energy supplies, including the supply of fuel for nuclear power plants;

F. whereas the EU must develop its strategic autonomy, enhance its supply chain resilience and reach a degree of self-sufficiency, especially since Russia's war of aggression against Ukraine has shown Europe's vulnerabilities in these spheres;

G. whereas the EU's energy mix and future electricity market must ensure constant, reliable renewables and carbon-free power for EU industries and citizens;

H. whereas nuclear energy is a zero emissions technology that does not lead to air pollution and therefore SMRs have the potential to contribute to meeting the EU's climate and environmental goals;

I. whereas nuclear energy can contribute to improving energy security in Europe and particularly in Member States that choose to use it, given its relatively low fuel and operating costs and proven ability to provide a stable and reliable baseload of electricity supply;

J. whereas the EU should further explore the relationship between the land use intensity of electricity and lifecycle greenhouse gas emissions in its energy system modeling and its impact on land use;

K. whereas innovative developments in SMRs and advanced modular reactors (AMRs) could offer a potential pathway towards achieving the Union's energy and climate objectives, while the possibilities offered by SMRs in terms of electricity production and grid stability, heat for industrial processes, district heating and cooling, hydrogen generation and water desalination is to be further explored;

L. whereas SMRs can be defined as nuclear reactors in a range of power typically between 10 and 300 MW, designed to be built in factories in a standardised modular form;

M. whereas many of the benefits of SMRs are inherently linked to the nature of their design (small and modular): integral designs, inherent safety, lower core inventories, improved modularisation and manufacturability, enhanced flexibility; whereas SMRs can offer

savings in cost and construction time and can be deployed incrementally to match increasing energy demand;

N. whereas specific climate and energy dialogues on SMRs could promote best practices and solutions, bring new business and collaboration opportunities and help Member States identify and reflect on possible gaps in implementation; whereas such dialogues can contribute to building the SMR business model further and present solutions to decarbonise industry;

O. whereas further EU efforts should be made to evaluate the future contributions of SMRs to the EU's security of electricity supply, given their flexible base load capacities;

P. whereas SMRs could potentially offer a lower initial capital investment, greater scalability and siting flexibility for locations unable to accommodate more traditional larger reactors, and now have the potential for enhanced safety and security features, feedback from existing large power reactors, more sustainable waste management and the potential benefits of using novel cooling systems and fuels;

Q. whereas the deployment of SMRs can help drive economic growth, create jobs and contribute to the EU's global competitiveness in this rapidly developing sphere of technology, making Europe an attractive continent for investments in this sector;

R. whereas EU competitors and trade partners are massively investing domestically and abroad to gain leadership in next-generation SMRs; whereas further investment in research and development of SMRs could be decisive for the European nuclear industry to regain global leadership and requires advance planning;

S. whereas there is a growing interest for deploying SMRs in the EU and therefore the full involvement of fuel cycle actors should be considered from the early stages of potential projects;

T. whereas the Commission, in its declaration of 4 April 2023 on EU SMRs 2030, welcomed the collaborative efforts of the European nuclear industry and scientific community to achieve the common goal of a modern, resource-efficient and competitive economy and recognised that nuclear, and particularly SMRs, can play an important role even beyond electricity production, especially if the funds committed to research, development and innovation on SMRs lead to the development of successful design solutions;

U. whereas, according to the Nuclear Alliance's joint statement of 16 May 2023, nuclear power could provide up to 150 GW of installed capacity by 2050 to the EU, thereby potentially contributing, directly and indirectly, to 450 000 jobs in the EU over the next 30 years, including 200 000 highly skilled workers;

V. whereas the Commission has emphasised that nuclear and radiation protection expertise is needed across the Member States to ensure the safety, security and safeguarding of existing and future nuclear power plants, including SMRs, industrial and medical applications and space exploration initiatives;

1. Welcomes the Commission declaration on EU SMRs 2030, which emphasises the role of research, innovation, education and training in the safety of SMRs in the EU and the need for all sectors to contribute to the transformation of the EU's economy to achieve climate neutrality, energy security and strategic autonomy;

2. Acknowledges that the climate crisis needs to be solved; believes that the EU should focus on the full range of net zero emissions solutions in order to amplify its chances to reach climate neutrality by 2050, as well as diversify its energy production capacity to enhance security of supply;

3. Underlines the need to explore the potential of SMRs in providing the EU with a reliable, affordable and on-demand supply of electricity, with the potential capacity to provide a firm baseload of clean electricity, heat and steam for industry and households, including possibly retrofitting coal-fired power stations; highlights the need for continued research and development in SMRs to ensure the safety, efficiency and cost-effectiveness of these technologies;

4. Calls for the development of a comprehensive strategy for the deployment of SMRs in the EU, taking into account the specific needs and circumstances of different regions, including remote and sparsely populated areas and different economic sectors; believes that such a strategy should pave the way to establishing clear guidelines for planning, permitting and timelines, regulation and safety;

5. Acknowledges the socio-economic impacts arising from the deployment of SMRs in terms of highly qualified jobs and high-added-value companies created in the EU;

6. Encourages the Commission and the Member States to raise public awareness and understanding of the potential benefits of SMRs and to ensure transparent and inclusive decision-making processes in this area;

***The EU as a significant potential market for SMRs***

7. Acknowledges the European nuclear fuel supply chain as a strategic asset and recognises the important role it will play in supporting the evolution of the next generation of reactor technology;

8. Encourages the exploration of the potential use of SMRs for low-carbon hydrogen production, both for its direct use in industry, as well as for the production of sustainable synthetic fuels; recalls that vast amounts of new electricity capacity is needed to ensure the expected scale of hydrogen production required to decarbonise European industry, considering the predicted global expansion of hydrogen demand;

9. Recognises the potential role of SMRs for heat and steam production for industrial processes, in particular in hard-to-abate industries;

10. Encourages the exploration of the potential of SMRs for district heating and cooling where other clean energy sources are not available; recalls that heating and cooling constitute approximately half of all EU energy consumption, and the majority of this is currently covered by fossil fuels; acknowledges that SMRs could provide zero-emission, low temperature heat to the district heating systems; notes that SMRs can be

designed to produce only heat and therefore can be operated at lower temperatures and pressure;

11. Acknowledges the potential use of SMRs for competitive and sustainable water desalination;

12. Recognises the potential value of SMRs for increasing electrical production and improving grid stability;

***Global race for leadership in the future SMR market***

13. Emphasises that, so far, SMRs are operational only in Russia and China, but that more than 80 SMR designs are currently at different stages of development and deployment in 18 countries; stresses that the EU should maintain its technological leadership in the future SMR market; underlines that competition around SMRs is intense with many initiatives already launched;

14. Emphasises that nuclear energy, in those countries that use it, has a role to play in balancing the overall energy system, limiting dependencies on non-EU countries and achieving energy security and stable energy prices;

15. Recognises that the EU already has a high degree of expertise and experience in nuclear technologies that can be applied to the development and deployment of SMRs; notes that the fuel cycle will require further adaptation, with the ultimate aim of developing a supply chain for SMR production that could generate most of the added value within Europe;

16. Maintains that SMRs could create additional industrial opportunities beyond the traditional nuclear sector and could open perspectives for new players to enter the nuclear supply chain and thereby strengthen EU competitiveness in a range of economic sectors;

17. Recognises that the extent of SMRs' contribution to European energy independence relies greatly on the localisation of their value chain within European territory; underlines that an EU-based value chain will also strengthen the skills and know-how around this technology; calls therefore for a European preference in future public procurements related to SMRs;

***Partnership on SMRs***

18. Recognises that a growing number of Member States are considering nuclear for their energy mix, hence the need to coordinate efforts, and notes the opportunity for these Member States to jointly develop a European SMR;

19. Welcomes the creation of the so-called European SMR partnership in the form of a collaboration scheme involving industrial stakeholders, research and technological organisations, interested customers, European regulators and the Commission;

20. Notes that the Nuclear Alliance asked the Commission to actively support the pre-partnership on SMRs and transform it into a full partnership;

***Adapted policy and regulatory framework: technology neutrality***

21. Recognises that a basic condition for SMRs to develop in the EU is to ensure that a conducive and technology-neutral policy, as well as a stable, long-term regulatory framework, is in place, which considers different clean energy technologies and addresses questions of nuclear safety; highlights the need for a predictable legal framework that provides investor certainty throughout the lifetime of SMRs;

22. Notes that there is currently no unified market for SMRs, given the national sensitivities around nuclear energy technology and the desire of many countries to champion their own industries; recognises that for SMRs to benefit from possible economies of scale, a standardised licensing framework would need to be put in place;

23. Recognises that the implementation of appropriate contractual and financial mechanisms, such as bilateral long-term contracts and contracts for difference, is needed to provide long-term predictability of energy markets and to foster future investments in SMRs;

24. Calls on the Commission to launch a specific EU industrial strategy for SMRs, which includes a focus on efficient permitting procedures and access to finance and stable supply chains, with a view to enabling the deployment of domestic SMR technologies and raising awareness of SMRs;

25. Recognises the necessity to protect the vulnerability of information technology systems needed for SMRs to function, given the risk of cyberattacks; emphasises that cybersecurity needs to be considered as a fundamental part of overall nuclear security;

***Market integration and deployment***

26. Emphasises the importance of proactive anticipation, innovation and adaptation to effectively meet SMR designers' expectations in terms of fuel cycle and waste management, including preparatory work to ensure the operational readiness of specific front-end fuel cycle requirements prior to the deployment of SMRs;

27. Emphasises that decisions on front-end as well as back-end issues should be taken early in the development phase, with the active involvement of the fuel cycle industry in order to optimise and validate new concepts, with a focus on life-cycle operating costs and long-term security of supply, as well as spent fuel and radioactive waste management programmes; notes that this early involvement of fuel cycle players is key to enabling an easier and faster commercial deployment of SMRs;

28. Emphasises that clear support from public authorities to guarantee the competitiveness of the SMR supply chain will be essential in enabling service providers to take a long-term view and accelerate their projects to meet the market window of opportunity; emphasises the need for fast permitting procedures when SMRs are market

ready; encourages the Commission to consider ways to speed up the permit processes for the rollout of SMRs;

***Harmonisation of SMR licensing regimes***

29. Emphasises that the key success factor of SMRs is serial production, which would allow manufacturers to improve their processes and reduce costs and production time;

30. Calls for the acceleration of the cooperation of national nuclear safety regulators in order to harmonise a pre-licensing process and standardisation of SMR designs based on commonly accepted safety assessments; acknowledges that standard designs of SMR models are a pre-requisite for their successful deployment on a commercial scale and must overcome the existence of different regulatory approaches across the EU Member States;

31. Welcomes international initiatives to develop specific SMR designs; maintains that joint SMR design reviews can accelerate the licensing process without compromising nuclear safety and security;

32. Calls on the Commission to take a proactive role in establishing and supporting 'regulatory alliances' among the Member States, where necessary in cooperation with international organisations; considers that one of the objectives would be to ensure a greater degree of equivalence in SMR licensing procedures;

33. Encourages regulatory bodies and national authorities to continue creating the conditions to streamline and harmonise the licensing process of SMRs across the Union; believes it is in the EU's strategic interest to encourage national regulators to adopt technology-inclusive, performance-based and risk-informed licensing processes that can streamline safety assessments, reduce regulatory burdens, enhance safety, lower costs and facilitate innovation;

***Financial support for the domestic production of SMRs***

34. Recognises the need to sufficiently explore and identify all possible options for financing European SMR production and scale-up and support the related supply chain; calls on the Commission and the Member States to assess available funding sources for the deployment of SMRs and, if deemed necessary, outline a plan for addressing funding shortfalls;

35. Emphasises that the domestic production of SMRs has high capital costs that could be facilitated by numerous levers such as private investments, national subsidies, European funds, and European Investment Bank (EIB) loans; notes that this would require the EIB to align its energy lending policy with EU taxonomy in order to fully support investment in SMR production;

36. Calls on the Commission to explore the possibility for Member States to use any eligible fund or the Just Transition Fund to finance the research and development of SMRs;

37. Recognises the need for the inclusion of nuclear fission and fusion energy technologies, including nuclear fuel cycle technologies, in the list of net-zero technologies under the Net Zero Industry Act, as currently eligible for support under the Strategic Technologies for Europe Platform (STEP) and potentially eligible under similar instruments in future;

38. Welcomes the fact that the Euratom research and training programme already funds research projects related to the safety and licensing of SMR and AMR technologies; emphasises that more coordinated and focused funding is urgently needed if the EU wants to remain competitive in developing the SMR industry, including improvements to waste management and recycling fuel capacities;

39. Recommends considering the inclusive access of SMRs to EU funding beyond the Euratom funding schemes;

40. Calls for the establishment of a dedicated European structure for SMRs, such as a new joint undertaking or an industrial alliance for SMRs, or the creation of an Important Project of Common European Interest specifically for SMRs, which could aim to develop an advanced reactor demonstration programme;

41. Considers that European financial support is needed to launch feasibility studies for SMRs; believes that developing a nascent SMR industry in the EU could be beneficial for its employment objectives by potentially fostering the creation of high-quality jobs and traineeships and facilitating the reskilling or upskilling of workers;

42. Expresses concerns about the overall budget for SMRs compared to the generous subsidies given by economic partners and competitors, in particular China, Russia and the USA;

***Supply chain and fuel cycle adaptation***

43. Emphasises that a robust, capable and reliable EU-based supply chain is critical for the success of producing SMRs; recalls that the EU remains dependent on imported uranium, which poses inherent risks for its strategic sovereignty and security of supply;

44. Calls on the Commission to carry out an assessment to ensure that the development of SMRs is not hampered by potential shortfalls in the supply chain and to adapt accordingly;

45. Recognises the importance of identifying the main challenges in adapting the value chain to the specific characteristics of SMRs compared with large reactors and the need for consultations with all the key public and private actors in the energy market;

46. Acknowledges both the adaptations needed in the fuel cycle to supply SMRs and the investment needs for additional facilities;

47. Encourages the efforts of European industry to secure the supply of new types of fuels that could become necessary for some SMRs;

48. Emphasises that the opportunity to include standardised equipment and high quality industrial commercial grade components within SMR designs can greatly contribute to supply chain optimisation, thereby accelerating approval times;

***Innovation, research and development***

49. Recognises the need to define a comprehensive research and development (R&D) roadmap that meets both market expectations and safety requirements and, furthermore, to identify the experimental infrastructure required to implement this roadmap, alongside the necessary training and education programmes;

50. Welcomes the fact that in collaboration with the Joint Research Centre (JRC), the Euratom community is opening up EU research infrastructures and supporting access to unique nuclear research infrastructures in Europe;

51. Argues that to maintain the highest safety and radiation protection standards, it is crucial to keep the need for experimenting, testing and qualifying novel fuels, materials and technologies for the whole lifecycle of advanced SMRs, training and human capacity-building, disseminating knowledge and bridging the gap between research and industry;

52. Welcomes Horizon Europe and Digital Europe Programme initiatives that bring new benefits in additive manufacturing, digital technologies, robotics and artificial intelligence and emphasises that such synergies between the Euratom Programme and other EU programmes should be fully realised;

53. Underlines that R&D should not only focus on the needs of the first generation of SMR light water reactors, expected to be connected to the electricity grid by the beginning of the 2030s, but should also further support fourth-generation types of reactors, known as AMRs;

54. Stresses that increased EU resources for R&D in SMRs are needed, which can lead to positive socio-economic impacts for the EU;

***Skills***

55. Acknowledges the need to refine existing training in key nuclear construction skills all along the value chain and match these with the particular requirements of SMRs, while ensuring the prevention of skills shortages across the broader nuclear industry, particularly in skills in high demand;

56. Underlines the importance of strategic workforce planning, which should be forward-looking and adaptable, taking into account the potential shifts in skills requirements for the deployment of SMRs in the broader supply chain;

***Decommissioning and waste management***

57. Recognises the already well-established rules regarding the responsibility of nuclear power plant owners and licence holders for the safe handling, storage and disposal of radioactive waste, as well as for the management of spent nuclear fuel;

58. Welcomes the potential for waste minimisation in new SMR technologies, in particular through the reduction in both volume and radiotoxicity of waste; supports the latest R&D efforts in nuclear waste management, recycling and reuse; underlines the major importance of reuse for the stability of supply;

59. Calls for the establishment of a specific strategy on closing the nuclear fuel cycle based on innovative technology developers' support;

60. Notes that according to the JRC, for high-level radioactive waste and spent fuel there is a broad consensus among the scientific, technological and regulatory communities that final disposal in deep geological repositories is the most effective and safest feasible solution, which can ensure that no significant harm is caused to human life and the environment for the required timespan; acknowledges that some Member States are at an advanced stage of implementing their national deep geological disposal facilities, which are expected to start operation within this decade;

***Accountability and reporting***

61. Stresses the need for an annual report by the Commission assessing progress made in the development of SMRs; asks that this report evaluate the geographical breakdown of funding, the number of jobs created and changes in supply and demand, and assess the changing costs of SMRs deployment, the development of dedicated SMR infrastructures, as well as transnational collaboration in this field; is of the opinion that the report should additionally evaluate the technical feasibility, licensing, siting, financing, supply chain, safety measures, engagement and fuel progress of different SMR reactors; believes that, finally, the report should examine regulatory barriers to the uptake of SMR technologies and recommend measures to potentially mitigate these challenges;

62. Calls on the Commission to eagerly engage with the development of SMR projects and in particular prepare a legal framework regarding this technological choice, by revisiting and harmonising licensing frameworks, and other legal aspects;

63. Calls on Member States with a strong interest in nuclear and SMRs to demonstrate financial and regulatory commitment to contributing to the successful development of SMRs in the EU, in close collaboration with the Commission, which should seek to advance developments in this field;

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64. Instructs its President to forward this resolution to the Council, the Commission, the European Economic and Social Committee, the European Committee of the Regions and the Member States.

## EXPLANATORY STATEMENT

### *Introduction*

The EU's ambition to reach net-zero emissions by 2050 is the major challenge that lays ahead of us. This objective requires a very low carbon energy system, based on both renewable and nuclear energies, the two backbones of the future energy mix.

Currently 12 out of 27 EU Member States (Belgium, Bulgaria, Czechia, Finland, France, Hungary, Netherlands, Romania, Slovakia, Slovenia, Spain, and Sweden) host nuclear power plants on their territory. Furthermore, other countries such as Poland are proposing to develop nuclear energy for the first time. In 2021, nuclear energy made up 13.1% of the EU energy mix and accounted for 25 % of all electricity produced.

The debate on nuclear energy in the EU focuses on both opportunities and challenges. Many Member States see potential in solutions offered by extending the operating of existing large nuclear power plants and the construction of new ones, alongside the development of Small Modular Reactors (SMRs). Likely to become a commercially viable nuclear product by the early 2030s, SMRs could be used for electricity production, district heating, desalination, process heat for energy-intensive industries and production of hydrogen.

### *Small modular reactors*

Small modular reactors (SMRs) are nuclear reactors in a range of power between 10 and 300 MW. They are based on existing technologies and designed to be built in factories in a standardised modular form. They have a reduced power capacity compared to large nuclear power plants, but a major advantage is they can be factory-assembled and then shipped and installed on site. SMRs could be used inter alia for power generation in remote areas with limited grid capacity or in areas where the use of large traditional nuclear power plants may not be possible. SMRs offer savings in cost and construction time, and have reduced fuel requirements. SMRs use nuclear fission reactions to generate heat to produce energy.

One of the most important advantages of SMRs is design simplification and standardization, which can have a positive effect on the overall price of investment and can be incrementally expanded given increasing energy demand. The main challenge of SMR deployment is the uncertainty coming from the fact that designs are not yet at the advanced stage of maturity. The scientific community still needs to test and prove the expected advantages. This affects the risk perception and limits the potential size of the market. Another challenge would be establishment of a robust supply chain.

The last three years have been particularly busy in this field. Numerous initiatives have been launched: in R&D to develop new concepts, and in industry with the emergence of various designs. Public players have also been mobilised to devise a favourable financial and regulatory framework; safety authorities have invested in the field. A whole ecosystem is therefore emerging, which still needs to be consolidated, in a context of strong international competition.

The development and deployment of SMRs require a comprehensive strategy that takes into account the specific needs and circumstances of different regions and sectors. This includes continued research and development to ensure the safety, efficiency, and cost-effectiveness of these technologies. It is also crucial to promote public awareness and understanding of the benefits and challenges of nuclear power and SMRs, ensuring transparent and inclusive decision-making processes. EU efforts in education, training, research, and innovation are key to managing radioactive waste and spent fuel and developing the technologies of tomorrow.

The OECD states that SMRs could become a commercially viable nuclear product by the early 2030s. SMR's expected use is for electricity production, district heating, desalination, process heat for energy-intensive industries (steel, ammonia, etc.) and production of hydrogen. They could support decarbonisation of hard-to-abate applications in power generation, industry, and transport sectors. To maximise the economic advantage of SMRs, it would be crucial to establish an almost global market for one design of reactor to be manufactured via mass production. That would require higher levels of regulatory harmonisation and market consolidation than exist at present.

***Importance of Small modular reactors***

For electricity production, SMRs present some key benefits such as a reduced initial capital investment compared to large power plants, both in terms of volume and timeframe for construction, simplified design due to their smaller size, and an industrial series effect associated with the repetitive production of SMRs in factories, thereby lowering costs. SMR also have a potential to open new markets for supply of low carbon electricity, such as isolated or remote areas, and they are adapted to small and medium sized electricity grids. In their range of power, SMRs could potentially substitute medium-sized fossil fuel power plants, such as coal-fired power plants in the EU.

In addition to low-carbon electricity production, the hybridisation capacity and size of SMRs make them a beneficial option for decarbonising certain uses or industries that, until now, rely on fossil fuels. Furthermore, SMR use can be complementary to high-power reactors (existing nuclear power plants and new build) as well as renewable energies, thanks to their small size. SMRs could alleviate grid constraints, reuse former industrial sites and thus help to limit land artificialization. They are also less demanding in terms of water-cooling systems, which, in the context of climate change, is an ever-pervasive issue.

In industry, the chemical, paper and food industries are potential outlets for the heat produced by the SMR. Other industrial sectors, such as the steel industry in combination with hydrogen production, or the production of e-fuels for the aviation and maritime sectors, are other potential market applications for SMRs. In the hydrogen sector, coupling both SMR and AMR with high-temperature electrolysers would make it possible to meet a demand for hydrogen that is set to grow by 50% between now and 2050, with excellent energy efficiency.

***Declaration on EU SMR 2030 in April 2023***

In June 2021, the European Commission organised first EU workshop on SMRs[1] to engage EU industrial actors and to consolidate the industrial value chain. Its tangible outcome was the

[1] https://www.nuclearеurope.eu/wp-content/uploads/2022/12/2022-10-14_ESMRP_WorkshopPresentation.pdf.

proposal for the creation of the so-called 'European SMR Partnership'[2], a collaboration scheme involving industrial stakeholders, research and technological organisations, and interested customers. As a preparation phase 'European SMR pre-Partnership'[3] strives to identify conditions and constraints of safe design, construction and operation of SMRs in Europe and, once in place, its compliance with the EU legislative framework. Its Steering Committee was established in 2022 and is tasked with overseeing the drafting and rolling out of a roadmap of SMR development in Europe.

With a signature of Declaration on EU SMR 2030[4] in April 2023, the European Commission has reiterated its commitment to support research, innovation, education and training with an aim to deploy SMRs in Europe by 2030. The declaration highlights the importance of an improved regulatory framework and stakeholder involvement. It presents the SMR as 'an opportunity to further improve nuclear safety and increase the stability of the grid, complementing the higher penetration of renewables.

***Challenges***

Since Russia invaded Ukraine in February 2022, the European Union has focused on decreasing its dependence on imported fossil fuels. However, EU's major dependencies on Russian nuclear technology, uranium supplies and handling of spent nuclear fuel have remained largely below the sanctions radar. According to data from the World Nuclear Association[5], an industry organization, the EU sources 20 % of its natural uranium from Russia.

Another challenge are costs stemming from adapting reactors for the authorization of new fuel suppliers. These costs create an obstacle, but diversification of supply resulting from them is a way to ensure continuous operation of facilities.

In addition, some challenges still exist in validating the business case for SMRs, assuring predictable and streamlined licensing processes and frameworks, developing global supply chains to ensure profitability, identifying suitable nuclear sites and achieving a transparent dialogue model between the concerned stakeholders.

***Waste management***

Radioactive waste is a result of the production of electricity in nuclear power plants or the non-power-related use of radioactive materials (medicine, research, industry and agriculture). Although radioactivity decreases over time (radioactive decay), these materials can remain dangerous for thousands of years.

Radioactive wastes coming from the production of electricity in nuclear power plants is uranium mill tailings, spent (used) reactor fuel, and other radioactive wastes. Most of the waste (by volume)[6] resulting from nuclear power has a relatively low level of radioactivity.

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[2] https://snetp.eu/wp-content/uploads/2022/06/SNETP-TS1-P1-Foratom.pdf#page=3.
[3] https://snetp.eu/european-smr-pre-parnership/.
[4] https://research-and-innovation.ec.europa.eu/system/files/2023-04/ec_rtd_eu-smr-declaration-2030.pdf.
[5] https://www.world-nuclear.org/information-library/country-profiles/others/european-union.aspx.
[6] https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php#:~:text=Nuclear%20energy%20produces%20radioactive%20waste,health%20for%20thousands%20of%20years.

The spent fuel is considered high-level radioactive waste. Today two dominant options to manage it are reprocessing and direct disposal in deep geological repositories, or a mixture of both.

***'Nuclear revival'?***

The decision to use nuclear power lies with the Member States, while the European Commission repeatedly has committed itself to technological neutrality. When taking a decision on including nuclear in their energy mix, Member States must analyse not only the needs of the energy market but also public perception. The last Eurobarometer on nuclear energy production conducted in 2008 showed that public opinion in the EU was strongly divided, as almost identical shares of respondents expressed support (44%) and opposition (45%) to nuclear energy. The poll showed that citizens in countries with operational nuclear power plants were more likely to support nuclear energy. Recent studies[7] show that since 2019 there has been a gradual rise in support and the war in Ukraine has become a focal event increasing support for use of nuclear power in the EU.

Some Member States have been vivid supporters of nuclear energy. Apart from France, a dedicated advocate of these solutions, a strong commitment towards nuclear energy comes from Eastern Member States: Bulgaria, Czechia, Poland, Romania and Slovakia. Those countries see nuclear as a way to phase out coal and other fossil fuels. Furthermore, also Sweden recently announced it would build new nuclear power plants.

Debates on the use of nuclear became more intense in light of Russia's invasion on Ukraine. The sudden reduction of fossil fuel supplies from Russia and the rapid rise of energy prices became something of a turning point. Some countries hesitant towards the nuclear energy have turned to it out of pure necessity.

***Innovation, know-how***

Although SMR opportunities are developing quickly, some uncertainties remain. Therefore, clearer global support is needed to incentivize European actors to go ahead and mobilize their skills and technological know-how. This necessary global approach towards SMR deployment requires an industrial strategy in which European expertise can be focused on its areas of excellence. There is a need to structure this emerging sector at the European level to preserve the EU industry's competitiveness.

***Financial support for the domestic production of small modular reactors***

There is also a clear need for significant European financial support to foster innovative solutions for new reactor concepts, new fuels, an increasingly circular spent fuel management through the development of new recycling processes, and a safe and competitive logistics base.

Positive developments have been observed these recent years in the Euratom research and training programme, but many issues remain to be tackled, especially for advanced SMR concepts. The Euratom programmes only focuses on R&D activities, and its budget is very

[7] https://www.robert-schuman.eu/en/european-issues/0662-a-return-to-grace-for-nuclear-power-in-european-public-opinion-some-elements-of-a-rapid-paradigm.

limited compared to other strategic technologies that will also play a role in decarbonizing the energy system. It is thus important for the successful development of SMRs to increase funding for the Euratom research and training programme and to give access to other European funding programmes that currently are not available for nuclear projects.

## ANNEX: ENTITIES OR PERSONS
## FROM WHOM THE RAPPORTEUR HAS RECEIVED INPUT

Pursuant to Article 8 of Annex I to the Rules of Procedure, the rapporteur declares that he has received input from the following entities or persons in the preparation of the report, until the adoption thereof in committee:

| **Entity and/or person** |
|---|
| Bulgarian Atomic Forum Association (BULATOM) |
| CEA (French Alternative Energies and Atomic Energy Commission) |
| Clean Air Task Force, Inc. |
| EDF (Électricité de France) |
| EGE (Ecole de Guerre Economique) |
| European Commission |
| Euratom |
| EU Advisor Climate and Energy at the Dutch House of Representatives, Kasper van der Gugten |
| ENSREG (European Nuclear Safety Regulators Group) |
| Finland, Mr Kai Mykkänen, Minister of Climate and the Environment, Finland |
| Foratom |
| Fortum Oyj |
| Hydrogen Europe |
| Naarea |
| neucleareurope |
| NEA (Nuclear Energy Agency) |
| Nuward |
| OECD |
| Orano |
| PGE Polska Grupa Energetyczna SA |
| Slovenian Chamber of Commerce |
| STUK Radiation and Nuclear Safety Authority in Finland |
| Teollisuuden Voima Oyj (TVO) Finland |
| **Organisation / attendance at events / policy debates** |
| 1. Working Policy Breakfast on SMR Report - 19 September 2023 - European Parliament, Brussels. |
| 2. Dinner debate on how to speed up SMR development in Europe – case of Finland - 25 October 2023, European Parliament, Brussels. |
| 3. Eurelectric, Launch of Eurelectric Position Paper on SMRs, 9 November 2023. |
| 4. EEF - The role of SMRs in EU's strategic autonomy and decarbonisation: A value chain approach, 21 November 2023, European Parliament, Strasbourg. |
| 5. World nuclear Exhibition Paris, 30 November 2023, Paris. |
| 6. K4I - The Role of SMRs in the EU's Energy and Climate Strategy, 6 December 2023, European Parliament, Brussels. |

The list above is drawn up under the exclusive responsibility of the rapporteur.

## INFORMATION ON ADOPTION IN COMMITTEE RESPONSIBLE

| | |
|---|---|
| **Date adopted** | 28.11.2023 |
| **Result of final vote** | +: 40<br>–: 9<br>0: 6 |
| **Members present for the final vote** | Nicola Beer, Tom Berendsen, Vasile Blaga, Paolo Borchia, Marc Botenga, Jerzy Buzek, Ignazio Corrao, Beatrice Covassi, Ciarán Cuffe, Josianne Cutajar, Nicola Danti, Valter Flego, Niels Fuglsang, Lina Gálvez Muñoz, Jens Geier, Nicolás González Casares, Bart Groothuis, Christophe Grudler, Robert Hajšel, Ivars Ijabs, Romana Jerković, Izabela-Helena Kloc, Zdzisław Krasnodębski, Georg Mayer, Marina Mesure, Iskra Mihaylova, Angelika Niebler, Johan Nissinen, Mauri Pekkarinen, Mikuláš Peksa, Tsvetelina Penkova, Morten Petersen, Clara Ponsatí Obiols, Robert Roos, Sara Skyttedal, Maria Spyraki, Riho Terras, Patrizia Toia, Henna Virkkunen, Pernille Weiss |
| **Substitutes present for the final vote** | Pascal Arimont, Franc Bogovič, Damien Carême, Francesca Donato, Matthias Ecke, Marian-Jean Marinescu, Alin Mituța, Jutta Paulus, Massimiliano Salini, Ernő Schaller-Baross |
| **Substitutes under Rule 209(7) present for the final vote** | Carmen Avram, Peter Jahr, Virginie Joron, Ljudmila Novak, Milan Zver |

## FINAL VOTE BY ROLL CALL IN COMMITTEE RESPONSIBLE

| 40 | + |
|---|---|
| ECR | Izabela-Helena Kloc, Zdzisław Krasnodębski, Johan Nissinen, Robert Roos |
| ID | Paolo Borchia, Virginie Joron |
| NI | Francesca Donato, Ernő Schaller-Baross |
| PPE | Pascal Arimont, Tom Berendsen, Vasile Blaga, Franc Bogovič, Jerzy Buzek, Peter Jahr, Marian-Jean Marinescu, Angelika Niebler, Ljudmila Novak, Massimiliano Salini, Sara Skyttedal, Maria Spyraki, Riho Terras, Henna Virkkunen, Pernille Weiss, Milan Zver |
| Renew | Nicola Beer, Nicola Danti, Valter Flego, Bart Groothuis, Christophe Grudler, Ivars Ijabs, Iskra Mihaylova, Alin Mituța, Mauri Pekkarinen, Morten Petersen |
| S&D | Carmen Avram, Josianne Cutajar, Nicolás González Casares, Robert Hajšel, Romana Jerković, Tsvetelina Penkova |

| 9 | - |
|---|---|
| ID | Georg Mayer |
| S&D | Beatrice Covassi, Patrizia Toia |
| The Left | Marc Botenga, Marina Mesure |
| Verts/ALE | Damien Carême, Ignazio Corrao, Ciarán Cuffe, Jutta Paulus |

| 6 | 0 |
|---|---|
| NI | Clara Ponsatí Obiols |
| S&D | Matthias Ecke, Niels Fuglsang, Lina Gálvez Muñoz, Jens Geier |
| Verts/ALE | Mikuláš Peksa |

Key to symbols:
+ : in favour
- : against
0 : abstention