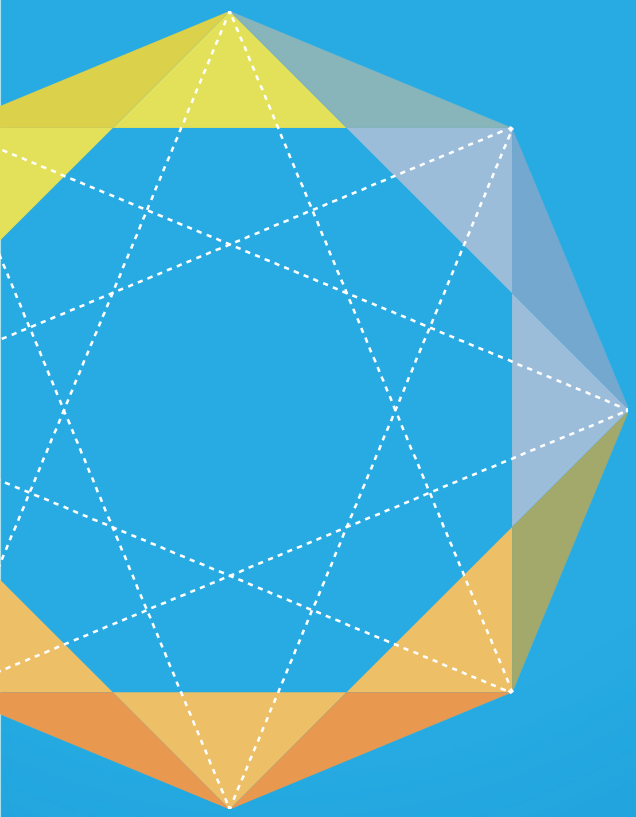
European Commission

Bridging the gap from innovation to market



ETIP SNET

European Technology and Innovation Platform

Smart Networks for Energy Transition

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Bridging the gap from innovation to market

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EXECUTIVE SUMMARY

The energy sector stands at the forefront of innovation and economic transformation within the European Union (EU), serving as both a catalyst for sustainable development and a critical driver of job creation. In recognition of this potential, the ETIP SNET secretariat has developed the policy paper "Bridging the Gap Between Innovation and Market," which seeks to address the multifaceted challenges that inhibit the effective commercialisation of innovative energy solutions. This policy paper is not merely a response to current market dynamics; it is a strategic initiative aimed at ensuring that Europe remains a global leader in technological advancement and competitiveness in the energy market. By focusing on the intersection of innovation and market deployment, the Commission aims to unlock the full potential of new technologies and ideas that can reshape the EU's energy landscape.

In the context of the policy paper, the inclusion of European projects and two national projects serves as a vital resource for illustrating successful pathways to innovation in the energy sector. These projects exemplify diverse approaches to overcoming barriers to commercialisation, showcasing effective strategies in areas such as funding access, regulatory simplification, and stakeholder collaboration. By analysing these real-world examples, the policy paper highlights best practices and lessons learned that can be scaled and adapted across the EU. Furthermore, these case studies provide concrete evidence of the potential impact of innovative energy solutions on job creation and economic growth, reinforcing the urgency and importance of the Commission's initiatives to foster a competitive and sustainable power industry in Europe.

Central to the objectives of this policy paper is the recognition that access to funding is a significant barrier for many innovative energy projects, particularly for small and medium-sized enterprises (SMEs) and startups that often lack the financial resources necessary to scale their innovations. To overcome this hurdle, the paper emphasises the need for policymakers to streamline funding mechanisms, enhance financial support for innovative projects, and foster public-private partnerships. By improving access to funding, the EU aims to ensure that promising ideas can transition from the research phase to successful market implementation, thus fostering a more vibrant and competitive energy sector. There are already several funding programmes in this regard. However, the recommendations at the end of the paper will suggest measures, to foster innovation to market even further.

In addition to financial challenges, the policy paper highlights the importance of simplifying regulatory processes to facilitate the commercialisation of innovative energy solutions. The authors acknowledge that complex and often cumbersome regulatory requirements can stifle market entry for new technologies. Therefore, the paper advocates for the simplification of regulatory procedures, harmonisation of standards across the EU, and the establishment of a more innovation-friendly regulatory environment. By reducing these regulatory barriers, the Commission seeks to cultivate a landscape where innovative ideas can flourish and contribute significantly to economic growth and job creation. Programmes that allow regulatory sandboxes already support implementation of innovations[1].

Securing adequate funding and resources is essential for supporting the innovation-to-market process, enabling projects to conduct research, development, and commercialisation activities effectively. Accessing mentorship, infrastructure, and expertise further propels projects towards market success. Addressing regulatory compliance is crucial for projects to navigate regulatory processes, obtain necessary approvals, and ensure compliance with legal and ethical standards for successful market entry. Effective management of intellectual property rights, including protection, licensing, and commercialisation strategies, is key to unlocking the value of innovations and leveraging intellectual assets for market advantage.

Collaboration among stakeholders is another critical focus of the policy paper. The successful commercialisation of innovative energy solutions requires a cohesive effort between researchers, industry partners, and policymakers. The International Energy Agency (IEA) has underscored the necessity of international collaboration to tackle global energy challenges, recognising that many existing technologies remain underutilised due to a lack of coordination. The policy paper aims to foster greater collaboration by promoting knowledge sharing, networking, and partnership-building among

[1] EU FRAMEWORK FOR EXPERIMENTATION – EBF - https://www.ebf.eu/priorities/innovation-cybersecurity/eu-framework-for-experimentation/

these diverse stakeholders.

Moreover, the paper emphasises the significance of promoting the uptake of new technologies and innovations within the energy sector. It asserts that successful commercialisation goes beyond mere technological advancement—it necessitates market acceptance and widespread implementation. To support this uptake, the policy paper outlines strategies to facilitate technology transfer, advance digitalisation, and encourage the deployment of innovative solutions in areas such as renewable energy, energy efficiency, and grid modernisation. Customer acceptance is one of the vital points in this regard. User-Centric Design and Acceptance already in the research phase and even mor when implementing innovations is crucial.

To further promote innovation and research, it is essential to emphasize the urgency of accelerating the time-to-market for innovative solutions. Given the rapid evolution of the energy sector's needs and the swift pace of digital technological developments, this is particularly critical. Implementing agile funding mechanisms that enable companies to quickly respond to market changes is imperative. By prioritizing fast-track funding and streamlined processes, we can ensure that new technologies and solutions are developed and introduced to the market in a timely manner, meeting the sector's demands and fostering continuous advancement.

Overall, the policy paper "Bridging the Gap Between Innovation and Market" outlines a strategic approach to address the challenges hindering the commercialisation of innovative energy solutions in the European Union. By enhancing access to funding, simplifying regulatory frameworks, fostering collaboration among stakeholders, and promoting the adoption of new technologies, the European Commission should aim to create a more competitive and innovative energy sector, while reaching the 2050 targets set int the European Green Deal[2] and the European Climate Law[3]. This comprehensive strategy is designed to enable Europe to excel in the global marketplace and drive economic growth and job creation through the successful deployment of cutting-edge energy innovations. By aligning policies and initiatives to support the market uptake of innovative ideas, the EU can position itself as a leader in the energy transition and secure a sustainable and prosperous future for its citizens.

The policy paper concludes with ten key policy recommendations for accelerating market uptake of projects results, namely:

- Energy Innovation Incentives
- Public-Private Partnerships in Energy
- Regulatory Reform for Energy Innovation
- Energy Technology Transfer Programs
- Energy Market Access Initiatives
- Startup Support in Energy Innovation
- Industry Collaboration for Energy Innovation
- Energy Skills Development
- Energy Market Intelligence
- Evaluation and Monitoring of Energy Projects

Ultimately, "Bridging the Gap Between Innovation and Market" presents a comprehensive strategy aimed at overcoming the barriers to commercialisation in the European energy sector. Through aligned policies and initiatives, the EU can effectively bridge the gap between innovative ideas and market realities, paving the way for a resilient energy future.

[2] The European Green Deal - https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en -
[3] European Climate Law - European Commission - https://climate.ec.europa.eu/eu-action/european-climate-law_en

1. Introduction

1.1. Background and Context

The European Commission has long been at the forefront of promoting innovation and fostering economic growth within the European Union. In recent years, there has been a growing recognition of the need to bridge the gap between innovation and the market in order to fully realise the potential of new technologies and ideas.[4] This has led to the development of a policy paper titled "Bridging the Gap Between Innovation and Market".

According to its 2030 climate & energy framework, the EU aims to achieve at least 40% cuts in greenhouse gas (GHG) emissions from 1990 levels, at least a 32% share of renewable energy, and at least a 32.5% improvement in energy efficiency.[5] Meanwhile, as part of the European Green Deal, the Commission seeks to raise the 2030 target to 50-55% cuts in emissions, and to reach net-zero emissions by 2050.[6]

At the COP28 in United Arab Emirates (UAE) the UEA Consensus [7] was signed in December 2023. Governments agreed on the following 2 targets:

- Double the annual rate of energy efficiency improvements by 2030.
- Triple the global deployment of renewable energy capacity.

Developing and implementing the necessary technologies into the market is key to reach these ambitious goals.

The background of this policy paper can be traced back to the Commission's overarching goal of creating a more competitive and innovative Europe[8]. The Commission has identified innovation as a key driver of economic growth[9] and job creation[10], and has made it a priority to support and encourage innovation. The Commission is committed to advancing the energy sector, with a focus on fostering competitiveness and innovation. Despite substantial investments in research and development, a challenge persists: how to translate groundbreaking energy innovations into successful market products. Efforts to bridge this gap require collaboration among policymakers, industry stakeholders, and research institutions. However, there is often a disconnect between innovative ideas and their successful commercialisation.

This gap can be attributed to a number of factors, including regulatory barriers, lack of access to funding, and limited collaboration between researchers, industry, and policymakers.

The context in which this policy paper is being developed is one of rapid technological change and increasing global competition. In today's digital age, new technologies are constantly emerging[11], creating both opportunities and challenges for businesses and policymakers alike. The Commission is keenly aware of the need to adapt to these changes and ensure that Europe remains at the forefront of innovation and competitiveness[12].

In light of these challenges, several key objectives have been identified. These include improving access to funding for innovative projects[13], streamlining regulatory processes[14], and fostering greater collaboration between researchers,

[4] IP_22_5682_EN.pdf (europa.eu)
[5] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 (/* COM/2014/015 final */). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0015
[6] The European Green Deal. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640
[7] IEA (2024), Empowering Urban Energy Transitions, IEA, Paris https://www.iea.org/reports/empowering-urban-energy-transitions, License: CC BY 4.0
[8] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024_en
[9] https://investeu.europa.eu/index_en
[10] https://research-and-innovation.ec.europa.eu/research-area/social-sciences-and-humanities/employment-and-new-growth_en
[11] https://competition-policy.ec.europa.eu/about/europes-digital-future/shaping-competition-policy-era-digitisation_en
[12] https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/strategic-insights-research-innovation-and-technology-policy-analysis-europe-amidst-geopolitical-2023-10-20_en
[13] https://www.europarl.europa.eu/factsheets/en/sheet/67/innovation-policy
[14] European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Markianidou, P., Basiakos, Y., Zoboli, E. et al., *Regulatory barriers and firm innovation performance*, Publications Office, 2018, https://data.europa.eu/doi/10.2873/179294

industry, and policymakers.[15] The Commission also aims to promote the uptake of new technologies and innovations across different sectors of the economy, in order to drive growth and create jobs.

Overall, the policy paper "Bridging the Gap Between Innovation and Market" represents a step forward in the efforts to promote innovation and economic growth within the energy sector in the EU. By addressing the challenges that impede the effective market deployment of energy innovations, the report aims to create a more competitive and dynamic European energy economy that is able to thrive in the face of global competition[16].

1.2. Objectives of the Policy Report

One of the key objectives of the policy paper is to give insights in order to improve access to funding for innovative energy projects. The authors acknowledge that lack of funding is a major barrier to the successful commercialisation of innovative ideas, especially for small and medium-sized enterprises (SMEs) and startups. To address this, policymakers should aim to streamline funding mechanisms[17][18], increase financial support for innovative projects, and promote public-private partnerships to leverage additional resources for innovation. The goal is to ensure that innovative ideas have the financial support they need to move from the research stage to the market.

Another important objective of the policy paper is to highlight the need for streamlining regulatory processes[19]. The authors recognise that complex and burdensome regulatory requirements can hinder the market entry of new technologies and innovations. To address this, the regulators and policymakers should simplify regulatory procedures, harmonise standards across the EU, and create a more innovation-friendly regulatory environment.

In addition to inputs on improving access to funding and streamlining regulatory processes, the policy paper shows ways to foster greater collaboration between researchers, industry, and policymakers. Successful innovation requires close collaboration between different stakeholders, including researchers who develop new technologies, industry partners who bring innovations to market, and policymakers who create the regulatory framework for innovation. The recently published report from the International Energy Agency (IEA) on Empowering Urban Energy Transitions[20] additionally recognises that international collaboration is essential to address global challenges and that existing technologies are not widely used due to a lack of co-ordination. By fostering greater collaboration, the Commission could create a more cohesive and integrated innovation ecosystem that can drive economic growth and create jobs.

The policy paper is focused on promoting the uptake of new technologies and innovations within the energy sector. It recognises that the adoption of innovative energy solutions requires not just technological advancement, but also market and customer acceptance and widespread implementation. To support the uptake of new energy technologies, the paper highlights the importance of facilitating technology transfer, advancing digitalisation within the energy sector, and encouraging the deployment of innovative solutions in areas such as renewable energy, energy efficiency, and grid modernisation.

1.3. Methodology

The methodology adopted for this report is a mixed-methods approach, integrating both qualitative and quantitative research techniques. This approach allows for a holistic understanding of the complex factors influencing the market implementation of research projects. The methodology is designed to ensure a comprehensive, systematic, and evidence-based approach to identifying challenges and opportunities within the context of research commercialization.

Data Collection

Literature Review: A comprehensive literature review was conducted to gather existing knowledge on barriers to market implementation. This included academic journals, government reports, industry publications, and case studies related to publicly funded research projects. The literature review served as a foundational framework for identifying key themes

[15] https://research-and-innovation.ec.europa.eu/strategy/past-research-and-innovation-policy-goals/open-innovation-resources_en
[16] https://commission.europa.eu/system/files/2021-05/ec_rtd_com2021-252.pdf
[17] https://eic.ec.europa.eu/news/largest-ever-funding-round-european-innovation-council-accelerator-99-innovative-companies-set-2021-12-16_en
[18] https://energy.ec.europa.eu/topics/funding-and-financing/eu-funding-possibilities-energy-sector_en
[19] https://research-and-innovation.ec.europa.eu/document/download/294b40e0-ad5a-448e-9612-ea87b5b9e48e_en?filename=ec_rtd_factsheet-innovation-principle.pdf
[20] Empowering Urban Energy Transitions – Analysis - IEA

and gaps in current understanding.

Surveys: Surveys were distributed to a diverse range of stakeholders, including researchers and industry representatives. The objective was to capture perceptions and experiences regarding barriers to market implementation and factors influencing successful project outcomes. The survey questions were designed to elicit both quantitative data (e.g., Likert scale responses) and qualitative insights (e.g., open-ended responses). The survey was answered by 30 industry stakeholders (see Figure 1 for country distribution) and 60 researchers (see Figure 2 for country distribution) covering 48 research projects (see Table 1). The responses came from 13 countries across Europe.

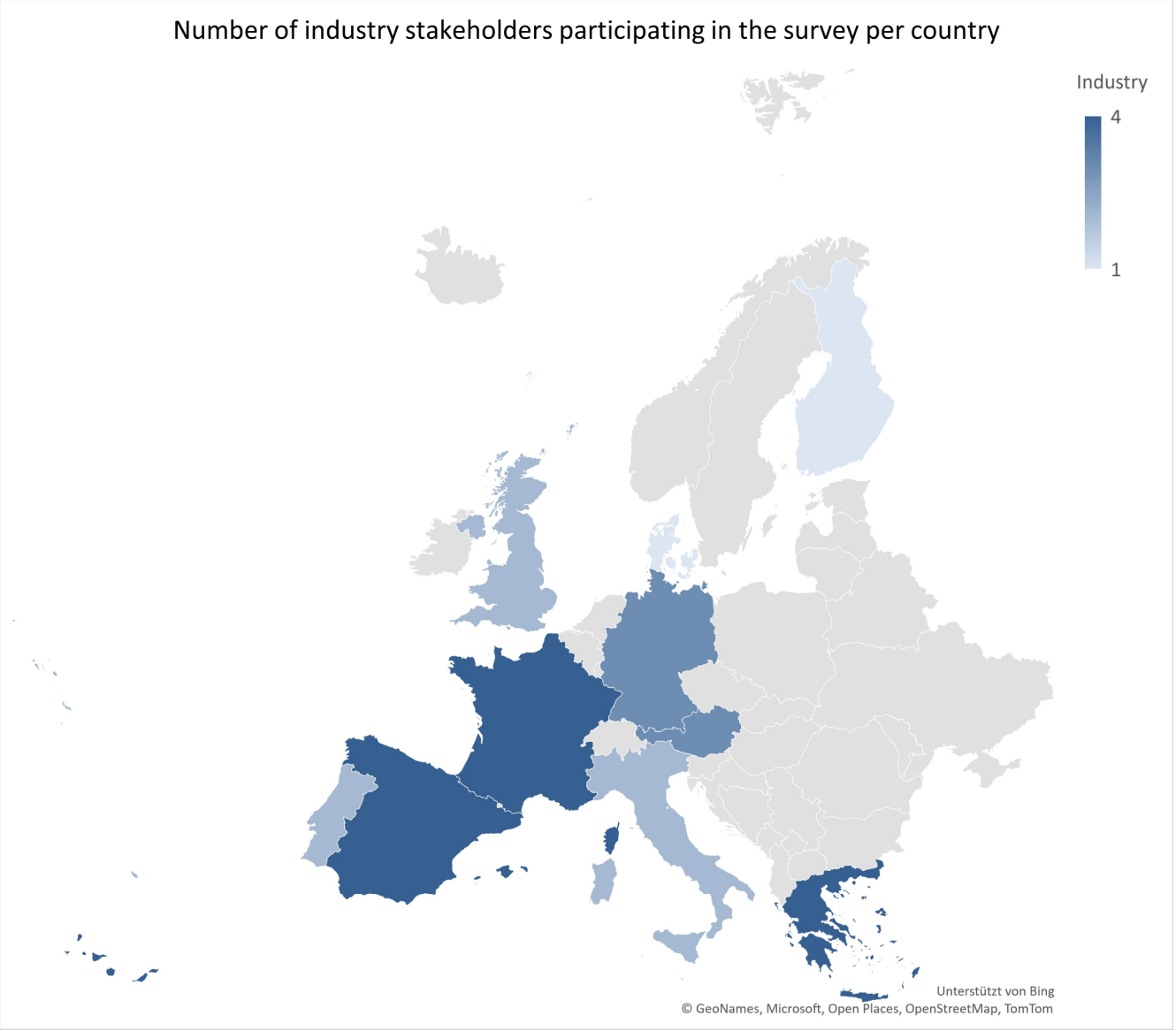

Figure 1 Survey results: number of industry stakeholders participating in the survey.

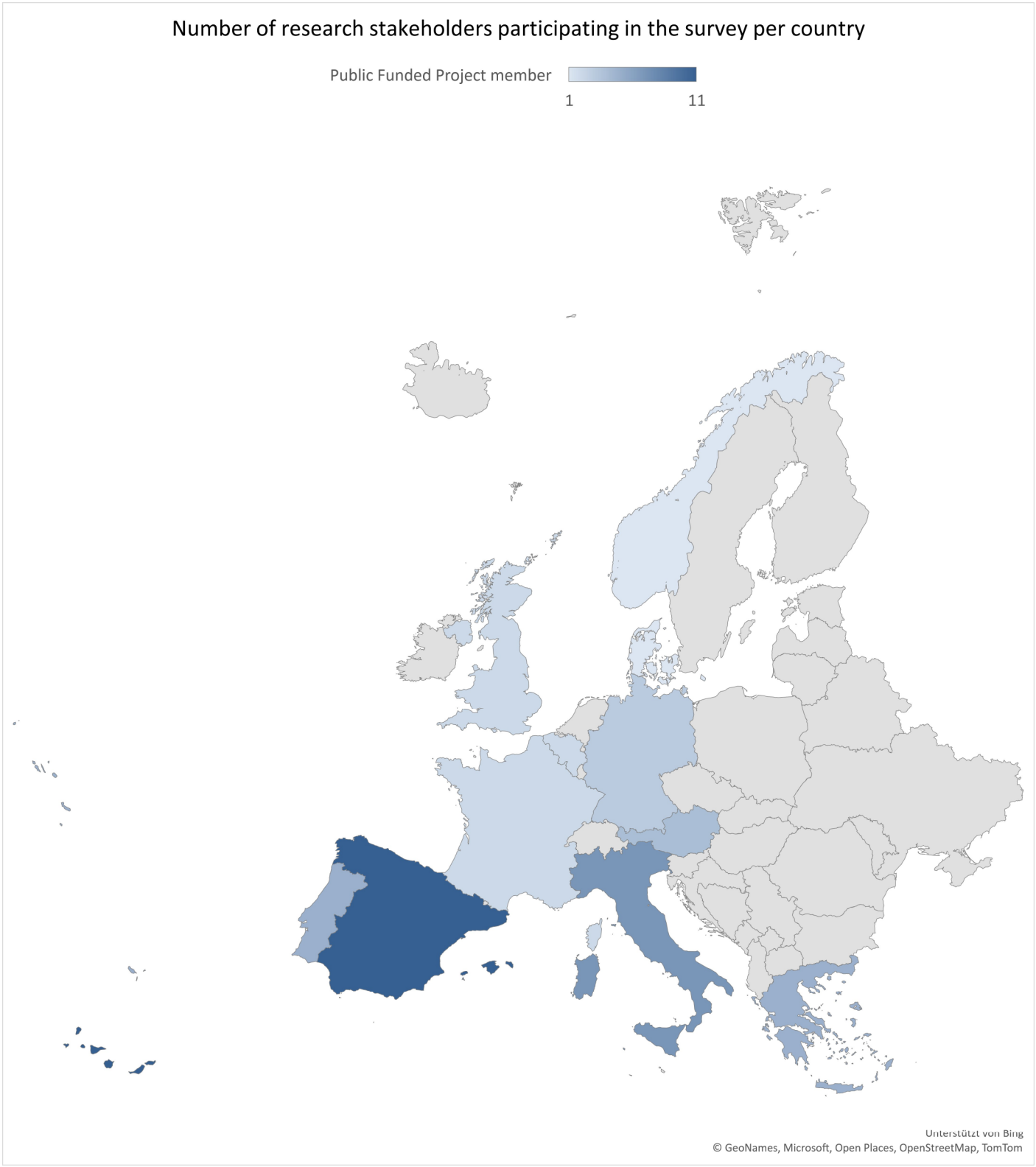

Figure 2 Survey results: number of research organisations participating in the survey per country.

The topic was discussed widely in several national, European and international networks (e.g. Technology Platform Smart Grids Austria, International Smart Grid Action Network (ISGAN), SET PLAN Implementation Working Group 4). The results of these discussions which have already taken place over the last few years, are also included in several recommendations in this paper.

Data Analysis

Qualitative data from open-ended survey responses were analysed using thematic analysis. This involved coding the data to identify recurring themes and patterns related to barriers and successful strategies. The findings were then synthesized to develop actionable insights and recommendations.

Quantitative data from surveys were analysed using statistical methods to identify trends and correlations. Descriptive statistics provided an overview of stakeholder perceptions, while inferential statistics were employed to explore the relationship between various factors influencing market implementation.

To ensure the reliability and validity of the findings, a triangulation approach was employed, combining data from literature, surveys, and case studies. This cross-verification of information helped to reinforce conclusions drawn and provided a more robust understanding of the issues at hand.

Throughout the research process, stakeholders were engaged for feedback on preliminary findings and recommendations. This collaborative approach ensured that the report reflects the perspectives and needs of those directly involved in the implementation of publicly funded research projects.

Limitations: While the methodology aimed to be comprehensive, certain limitations were acknowledged, including potential biases in self-reported data and the challenge of generalizing findings across diverse sectors and regions. Future research may build upon this work by exploring additional contexts or utilizing longitudinal studies to assess long-term impacts.

This methodology provided a structured framework for investigating the barriers to market implementation of public-funded research projects, resulting in evidence-based insights and actionable recommendations for stakeholders. By employing a mixed-methods approach and engaging with a wide range of participants, the paper aims to contribute meaningfully to the discourse on enhancing the commercialization of research outcomes.

2. Lessons Learned from Successful Projects

Successful projects in the energy sector often rely on strong collaboration among researchers, industry partners, policymakers, and stakeholders to drive successful commercialisation efforts. By building robust partnerships and networks, projects can leverage expertise, resources, and market knowledge to navigate the complexities of bringing innovations to market. Market orientation is crucial for projects to succeed, focusing on addressing real-world needs and challenges by understanding customer demand, market dynamics, and competitive landscapes to develop solutions with commercial potential. Projects should be user-centric and tailored to the needs of consumers, businesses, or utilities for widespread adoption.

Researchers and project teams must have a strong business acumen and entrepreneurial skills if they are to translate their research outcomes into market success. They also need to ensure technology readiness, optimal performance and scalability in order to attract investors and industry partners.

For projects to break into the market and have a lasting effect, they need to gather feedback from potential customers, conduct market research, and validate the product-market fit. They need to be open and embrace continuous learning as they set out commercialisation strategies.

Drawing insights from the lessons learned from successful projects can help stakeholders to bridge the gap between innovation and the market, enhancing the prospects of commercialising innovative ideas for significant economic and societal impact.

2.1. Pilot Projects and Case Studies

In the electricity domain, pilot projects and case studies play a critical role in testing and validating innovative technologies, grid solutions, and energy management strategies. These initiatives help utilities, energy providers, grid operators, and policymakers assess the feasibility, performance, and market potential of new electricity innovations. In the survey, “pilot projects” was mentioned most often as an effective strategy to overcome barriers to market implementation (see Figure 3)

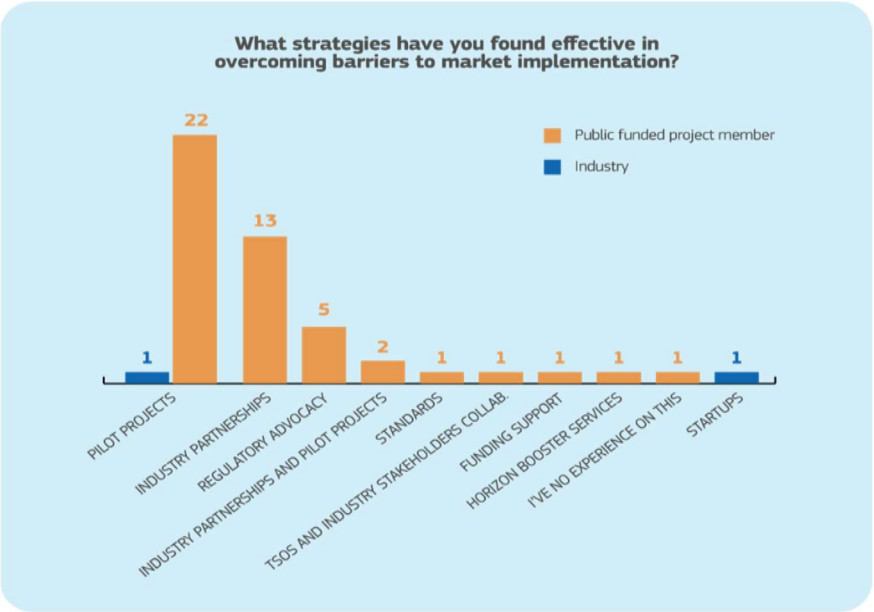

Figure 3 Survey results: Strategies for overcoming barriers to market implementation seen by researchers and industry.

In the context of this policy paper, the inclusion of 45 European projects and 2 national projects (see Table 1) serves as a vital resource for illustrating successful pathways to innovation in the energy sector. These projects exemplify diverse approaches to overcoming barriers to commercialisation, showcasing effective strategies in areas such as funding access, regulatory simplification, and stakeholder collaboration. The policy paper can highlight best practices and lessons learned that can be scaled and adapted across the EU. Furthermore, these case studies provide concrete evidence of the potential impact of innovative energy solutions on job creation and economic growth, reinforcing the urgency and importance of the Commission's initiatives to foster a competitive and sustainable energy landscape in Europe. The following table lists the projects analysed in this context:

Table 1 List of projects that have answered the survey.

#	Project name	Project website	Funding source
1	ACCEPT	https://www.accept-project.eu	EU funds
2	AGISTIN	https://www.agistin.eu/	EU funds
3	AIR4NRG	https://air4nrg.eu/	EU funds
4	ATTEST	https://attest-project.eu/	EU funds
5	Bd4NRG	https://www.bd4nrg.eu/	EU funds
6+7	Citizen-Led Renovation 1 +2	https://futurium.ec.europa.eu/en/citizen-led-renovation	EU funds
8	CRETE VALLEY	https://cretevalley.eu/	EU funds
9	DATA CELLAR	https://datacellarproject.eu/	EU funds
10	DriVe2X	https://www.drive2x.eu	EU funds
11	DR-RISE	https://dr-rise.eu/	EU funds
12	EDDIE	https://eddie.energy/	EU funds
13	eFORT	https://efort-project.eu/	EU funds
14	ENCLUDE	https://encludeproject.eu/	EU funds
15	ENERGETIC	https://energeticproject.eu/	EU funds
16	eNeuron	https://eneuron.eu/	EU funds
17	ENPOWER	https://enpower-project.eu	EU funds
18	EV4EU	https://ev4eu.eu/	EU funds
19	Every1	https://every1.energy/	EU funds
20	FLOW	https://www.theflowproject.eu/	EU funds
21	GLocalFlex	https://glocalflex.eu/	EU funds
22	HESTIA	https://hestia-eu.com/	EU funds
23	HYSTORE	https://www.hystore-project.eu/	EU funds
24	int:net	https://intnet.eu/	EU funds
25	InterOPERA	https://interopera.eu	EU funds
26	InterSTORE	https://interstore-project.eu/	EU funds
27	MASTERPIECE	https://masterpiece-horizon.eu/	EU funds
28	MISSION	https://euprojectmission.net/	EU funds
29	NextFloat Project	https://www.nextfloat.eu/	EU funds
30	ODEON	https://odeonproject.eu/	EU funds
31	One Net	https://www.onenet-project.eu/	EU funds
32	OPENTUNITY	https://opentunityproject.eu/	EU funds
33	PARMENIDES	https://parmenides-project.eu/	EU funds
34	platone	https://www.platone-h2020.eu	EU funds
35	R2D2	https://r2d2project.eu/	EU funds
36	RE-EMPOWERED	https://reempowered-h2020.com/	EU funds

37	Resonance	https://www.resonance-project.eu/	EU funds
38	ROBINSON	https://www.robinson-h2020.eu/	EU funds
39	SENERGY NETS	https://senergynets.eu/	EU funds
40	SERENE	https://h2020serene.eu/	EU funds
41	SiC4GRID	https://sic4grid.eu/	EU funds
42	SINNOGENES	https://sinnogenes.eu/	EU funds
43	TIGON	https://tigon-project.eu/	EU funds
44	THUMBS UP	https://www.thumbsupstorage.eu/	EU funds
45	TwinEU	https://twineu.net/	EU funds
46	XL Connect	https://xlconnect.eu/	EU funds
47	Clean Energy for Tourism (CE4T)	https://nefi.at/en/project/ce4t	National funds
48	ECOSINT	https://ecosint.at	National funds

To assess the marketable results of the projects, it is important to first understand the context and objectives of each project. These projects primarily fall under the European Union's Horizon 2020 framework, focusing on energy efficiency, renewable energy, smart grids, and related technologies. Here's a brief overview of potential marketable results from these projects based on their goals and activities:

1. **ACCEPT**: Focuses on enhancing the accessibility of public services. Marketable results may include tools or platforms that improve service accessibility, training programs for public service providers, and policy recommendations for inclusive practices.

2. **AGISTIN**: Aims to promote sustainable urban mobility. Marketable outcomes could include innovative mobility solutions, apps for public transport optimisation, and strategies for reducing urban congestion, which can be sold to municipalities and transport authorities.

3. **AIR4NRG**: Concentrates on air quality monitoring and improving energy efficiency. Potential marketable products may include air quality sensors, data analytics platforms for energy consumption, and consulting services for urban planners on sustainable practices.

4. **ATTEST**: Focused on assessing and improving the effectiveness of energy transition strategies. Marketable results might include assessment tools, best practice guides for energy transitions, and consulting services for organisations and governments.

5. **Bd4NRG**: While specific details are not provided, projects with similar themes typically focus on data-driven energy solutions. Marketable outcomes could include data analytics services, energy management tools, and software solutions for energy efficiency.

6. **Citizen-Led Renovation 1:** These projects focus on community-driven approaches to building renovation. Marketable results could include community engagement toolkits, renovation guidelines tailored for citizens, and platforms for facilitating local renovation projects.

7. **Citizen-Led Renovation 2:** These projects focus on community-driven approaches to building renovation. Marketable results could include community engagement toolkits, renovation guidelines tailored for citizens, and platforms for facilitating local renovation projects.

8. **CRETE VALLEY**: Aims to develop sustainable tourism and local economies. Marketable outcomes might be tourism management platforms, sustainable tourism strategies, and educational programs for local businesses.

9. **DATA CELLAR**: Focused on data management and storage solutions. Marketable results could include data storage technologies, cloud solutions, and services for organisations looking to optimise their data handling.

10. **DriVe2X**: Concentrates on electric mobility and vehicle technology. Potential marketable outcomes may include

electric vehicle charging solutions, battery management systems, and consulting services for fleet management.

11. **DR-RISE**: Focuses on disaster resilience and recovery. Marketable results could involve risk assessment tools, recovery planning frameworks, and training programs for local governments and organisations.

12. **EDDIE** (Energy Data for Decarbonization): Marketable results could include development of data-driven tools and platforms that facilitate energy efficiency and decarbonization strategies. This may include software solutions for energy consumption analysis, benchmarking tools for organisations, and consulting services to help businesses reduce their carbon footprint.

13. **eFORT** (Energy Efficiency and Flexibility in the Energy System): Marketable results could include innovative solutions that enhance energy efficiency and flexibility in energy systems. This could be demand response technologies, energy management systems, and training programs for energy providers and consumers on flexible energy usage.

14. **ENCLUDE** (Inclusive Energy Transition): Marketable results could include tools and frameworks to promote inclusivity in energy transition efforts. Marketable products may include community engagement strategies, educational materials for marginalised groups, and consulting services for energy companies to ensure equitable access to energy resources.

15. **ENERGETIC** (Energy Efficiency in Public Buildings): Marketable results could include guidelines and tools for improving energy efficiency in public buildings. Potential products could be energy auditing tools, renovation strategies for public facilities, and consulting services for governmental organisations on energy management.

16. **eNeuron** (Smart Energy Management): Marketable results could include smart energy management solutions that optimise energy usage in buildings and industries. This may be IoT-based energy monitoring systems, software for predictive maintenance, and user-friendly dashboards for real-time energy management.

17. **ENPOWER** (Empowering Energy Communities): Marketable results could include solutions empowering communities in energy management and decision-making. Marketable results could be community energy planning tools, platforms for local energy trading, and educational resources for community leaders on renewable energy options.

18. **EV4EU** (Electric Vehicles for European Cities): Marketable results could include strategies and tools to promote electric vehicle (EV) adoption in urban areas. Potential products may be EV charging infrastructure solutions, mobile apps for EV users, and consulting services for municipalities on integrating EVs into their transportation systems.

19. **Every1**: Development of tools for inclusive energy access and management. This could include platforms for community energy initiatives, educational resources for energy literacy, and consulting services for local governments to enhance energy equity.

20. **FLOW:** Solutions for optimising energy flows in smart grids. Potential products may include energy management software, demand response technologies, and training programs for energy providers on integrating renewable sources.

21. **GLocalFlex:** Localized flexibility solutions for energy systems. Marketable results could be tools for local energy trading, community engagement platforms, and frameworks for integrating local renewable resources into the grid.

22. **HESTIA:** Innovations in energy storage technologies and management. This could include advanced battery systems, energy storage optimisation software, and consulting services for businesses looking to improve their energy resilience.

23. **HYSTORE:** Development of hydrogen storage solutions. Marketable outcomes may include hydrogen storage systems, safety protocols, and consulting services for industries transitioning to hydrogen as an energy source.

24. **int:net:** Smart network solutions for energy management. Potential products could include IoT-based energy monitoring systems, software for predictive maintenance, and consulting services for organisations looking to optimise their energy infrastructure.

25. **InterOPERA:** Interoperability solutions for energy systems. This may provide software platforms for seamless integration of different energy technologies, standards development, and consulting services for energy providers to enhance system compatibility.

26. **InterSTORE**: Innovations in energy storage and management systems. Marketable products may include energy storage technologies, data analytics tools for energy forecasting, and consulting services for optimising storage solutions.

27. **MASTERPIECE:** Strategies for enhancing the performance of energy systems. This could include optimisation tools, best practice guides for energy efficiency, and consulting services for organisations aiming to improve their energy operations.

28. **MISSION:** Solutions for effective energy management and transition. Potential products could be energy assessment tools, transition planning frameworks, and consulting services for businesses and governments.

29. **NextFloat Project**: Innovations in floating renewable energy solutions. Marketable results may include floating solar and wind technologies, feasibility studies, and consulting services for maritime energy projects.

30. **ODEON:** Development of energy optimisation tools for buildings. This may involve software for energy management, building performance assessment tools, and consulting services for improving building energy efficiency.

31. **One Net:** Solutions for integrated energy networks. Potential products could include software for network optimisation, frameworks for energy system integration, and consulting services for municipalities.

32. **OPENTUNITY:** Tools for open energy data and collaboration. This could provide platforms for data sharing among stakeholders, community engagement tools, and consulting services for enhancing transparency in energy systems.

33. **PARMENIDES:** Innovations in energy system modelling and analysis. Marketable products may include simulation tools, data analytics platforms, and consulting services for energy planners and policymakers.

34. **platone:** Solutions for decentralised energy management. This outcome may be platforms for peer-to-peer energy trading, community energy management systems, and consulting services for local energy initiatives.

35. **R2D2:** Tools for data-driven decision-making in energy management. Potential products could include data analytics solutions, energy forecasting tools, and consulting services for organisations looking to leverage data in their energy strategies.

36. **RE-EMPOWERED**: Solutions for empowering communities in energy management. Marketable outcomes could include community engagement platforms, educational resources, and consulting services for local leaders on energy transition.

37. **Resonance**: Innovations in energy system resilience. This may involve risk assessment tools, recovery planning frameworks, and consulting services for organisations focused on enhancing energy resilience.

38. **ROBINSON:** Tools for optimising renewable energy integration. Potential products could include software for energy forecasting, grid management solutions, and consulting services for energy providers.

39. **SENERGY NETS**: Solutions for enhancing energy networks. Marketable outcomes may include energy network optimisation tools, training programs for energy professionals, and consulting services for improving network efficiency.

40. **SERENE:** Innovations in energy efficiency and smart grid technologies. Potential products could include energy monitoring systems, software for grid management, and consulting services for utilities.

41. **SiC4GRID:** Solutions for enhancing grid performance and reliability. Marketable results may be grid management software, performance assessment tools, and consulting services for utilities.

42. **SINNOGENES:** Innovations in renewable energy generation technologies. Potential products could include advanced solar and wind technologies, feasibility studies, and consulting services for energy project developers.

43. **TIGON:** Solutions for optimising energy generation and consumption. This project may provide energy management systems, predictive analytics tools, and consulting services for improving energy efficiency.

44. **THUMBS UP:** Innovations in energy storage technologies. Marketable outcomes could include advanced storage systems, safety protocols, and consulting services for industries transitioning to sustainable energy sources.

45. **TwinEU:** Solutions for digital twins in energy systems. Potential products may include simulation software, data analytics platforms, and consulting services for organisations implementing digital twin technologies.

46. **XL Connect**: Innovations in energy connectivity and integration. Marketable results could include platforms for energy network integration, consulting services for energy providers, and training programs for industry professionals.

47. **Clean Energy for Tourism (CE4T):** Solutions for promoting sustainable tourism practices. This may involve guidelines for energy-efficient tourism facilities, consulting services for tourism operators, and educational materials for travellers.

48. **ECOSINT**: Tools for integrating ecological and energy systems. Potential products could include ecological impact assessment tools, energy management solutions for sustainable practices, and consulting services for organisations focusing on environmental sustainability.

2.2. Effective Industry Partnerships: A Key Lesson Learned from Research Projects

In the pursuit of innovative energy solutions, the importance of effective industry partnerships has emerged as a pivotal lesson learned from various research projects across Europe. This underscores the necessity of collaboration between academia, industry, and policymakers to successfully transition research outcomes to market-ready applications. These partnerships not only facilitate the sharing of knowledge and resources but also enhance the alignment of research objectives with market needs. Through the examination of successful case studies, this sub-chapter will highlight how robust industry partnerships could prove instrumental in overcoming barriers to commercialisation, fostering an environment conducive to innovation, and ultimately driving economic growth within the energy sector. By understanding and leveraging the dynamics of these collaborations, stakeholders can better navigate the complexities of the energy landscape and accelerate the deployment of sustainable technologies. The responses to the question regarding the importance of industry collaboration reveal a strong consensus on the critical role that such collaboration plays in the energy sector (see Figure 4). With 87% of respondents indicating that industry collaboration is "extremely important," and an additional 12% deeming it "somewhat important," the data underscores a clear recognition of the necessity for cooperative efforts between various stakeholders to effectively translate innovative research into market-ready solutions.

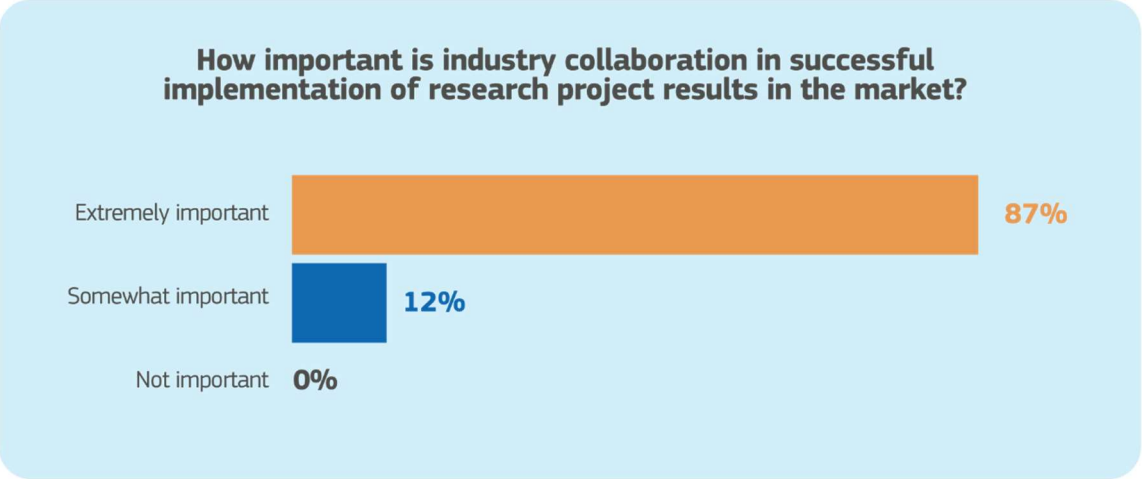

Figure 4 Survey results: on importance of industry collaboration

The high percentage of respondents who view collaboration as "extremely important" reflects an understanding that the energy sector's complexity demands integrated efforts to harness diverse expertise and resources. This insight reinforces the policy paper's call for fostering a collaborative innovation ecosystem that encourages knowledge sharing and partnership-building. The relatively smaller percentage of respondents (12%) who consider collaboration "somewhat important" suggests that while there is broad agreement on the value of cooperation, there may be differing views on the extent or nature of collaboration required. This divergence could indicate a need for further exploration of how various forms of collaboration—whether through public-private partnerships, cross-sector alliances, or international cooperation—can be optimised to facilitate the commercialisation of research results.

The industry representative responses to the question whether results from publicly funded have been implemented in their business led to following results: 60% of respondents answered "yes" and 39% answered "no" (Figure 5). This provides valuable insights into the effectiveness and impact of such initiatives. The fact that 60% of respondents have successfully implemented the outcomes of public funded collaborative research projects indicates a significant level of engagement and success among businesses in translating research into practical applications. This finding aligns with the policy paper's emphasis on the importance of collaboration between various stakeholders in fostering innovation. It suggests that when research projects are effectively designed and executed, they can deliver valuable results that meet the needs of the market.

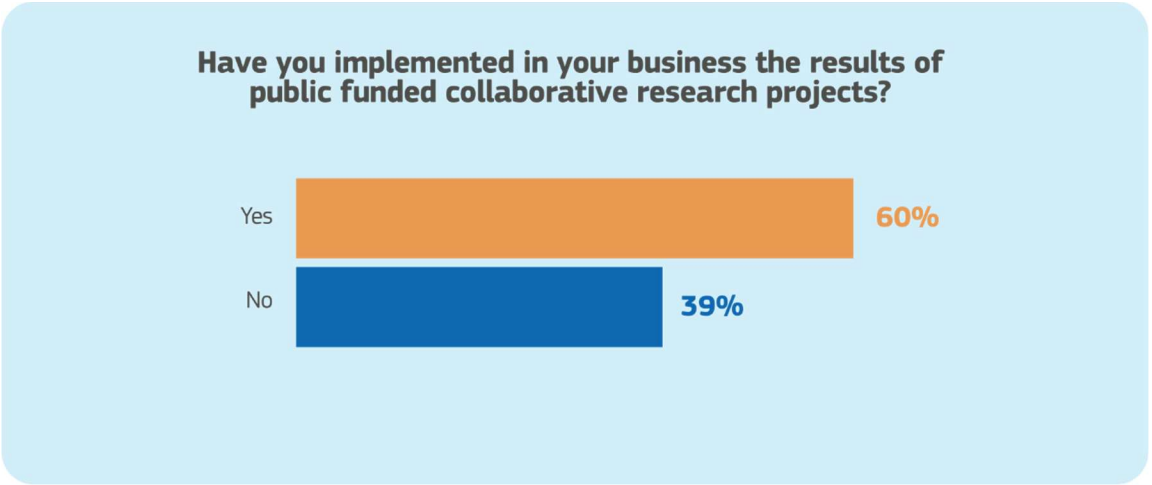

Figure 5 Survey results: on the implementation of project results in industry business

The 39% of respondents who reported not implementing the results raises important questions about the barriers that still exist in the commercialisation process. This aligns with the policy paper's identification of challenges such as access to

funding, regulatory complexities, and the need for stronger partnerships. The reasons behind this lack of implementation include insufficient resources, misalignment between research outcomes and market demands, or difficulties in navigating regulatory frameworks.

Effective industry partnerships are essential in power grid development and the electric power industry. To establish and maintain successful industry partnerships that support the commercialisation of innovative ideas in the energy and power grid sector, stakeholders can consider the following strategies:

- **Identify Strategic Partners in the Energy Sector**: Identify industry partners with a strategic interest in energy research outcomes and align with commercialisation goals. Look for companies operating in relevant energy sectors, possessing complementary expertise, and benefiting from innovative energy solutions.

- **Build Trust and Relationships in the Power Grid Industry:** Invest time in building trust and fostering relationships with potential industry partners. Establish open communication channels, demonstrate the value of energy research, and show a willingness to collaborate to address mutual goals and challenges.

- **Define Clear Objectives for Energy Innovation**: Clearly define the objectives, scope, and expectations of the partnership to align energy research outcomes with market needs in the power grid sector. Develop a shared vision, set clear goals, and establish a roadmap for collaboration and commercialisation of energy technologies.

- **Leverage Complementary Expertise in Power Grid Development**: Tap into the expertise, resources, and capabilities of industry partners to complement energy research strengths and accelerate the commercialisation process. Collaborate on grid modernisation, renewable energy integration, smart grid technologies, and energy storage solutions.

- **Engage in Co-Creation for Energy Solutions**: Engage in co-creation activities with industry partners to develop innovative energy solutions addressing market needs and creating value for customers. Collaborate on grid optimisation, demand response solutions, energy management systems, and grid resilience initiatives.

- **Facilitate Technology Transfer in Power Grid Development:** Facilitate technology transfer and knowledge exchange between energy research institutions and industry partners to transfer research outcomes into commercial products or services. Provide training, support, and access to intellectual property for successful technology transfer in power grid development.

- **Participate in Energy Industry Events**: Participate in energy industry events, conferences, trade shows, and networking opportunities to connect with potential industry partners, showcase energy research innovations, and explore collaboration opportunities. Build relationships with energy stakeholders and stay informed about market trends and opportunities.

- **Monitor and Evaluate Partnership Progress in the Electric Power Industry**: Regularly monitor and evaluate the progress of industry partnerships, assess the impact of collaboration activities, and measure the outcomes of commercialisation efforts. Review key performance indicators, feedback from industry partners, and market validation results to optimise partnership strategies.

2.3. Transnational access to energy research infrastructure

Transnational access to energy research infrastructures programmes can play a significant role in bridging the gap from innovation to market in the electrical power industry. These programmes help researchers, innovators, and industry stakeholders to access cutting-edge resources, expertise, and collaboration opportunities. By providing a gateway to state-of-the-art research facilities, testing laboratories, and pilot plants, transnational access programmes enable stakeholders to conduct groundbreaking research, prototype development, and testing activities that are often beyond the capabilities of their home institutions.[21]

These programs enable stakeholders to leverage diverse expertise, resources, and perspectives, accelerating innovation,

[21] https://erigrid2.eu/about/

addressing technical challenges, and driving market adoption in the electrical power sector by fostering international partnerships and collaborative initiatives. The cross-pollination of ideas, best practices, and research findings through transnational collaboration can lead to breakthrough innovations and transformative solutions that have a significant impact on the industry.

Transnational access programmes provide a unique opportunity for researchers and innovators to validate and demonstrate their technology solutions in real-world settings, pilot projects, and testbed environments. This validation process is crucial for instilling confidence, generating interest, and facilitating the successful market implementation of energy technologies in the electrical power industry.

Additionally, transnational access programmes offer stakeholders access to technical expertise, guidance, and support from experienced researchers, engineers, and industry professionals in the energy sector.

The ERIGRID[22] (European Research Infrastructure for the Integration of Intelligent Grid) project and its follow-up ERIRID 2.0[36], which focuses on the integration of smart grid technologies across various European countries, have yielded several valuable lessons learned from their transnational access initiatives. Here are some key takeaways:

1. Collaborative Frameworks: Successful integration of smart grid technologies requires strong collaboration between different stakeholders, including research institutions, industry players, and regulatory bodies. Establishing clear communication channels and collaborative frameworks is crucial for effective knowledge sharing and joint problem-solving.

2. Standardisation Challenges: The project highlighted the need for standardisation in smart grid technologies and methodologies. Variations in national regulations, technical standards, and operational practices can hinder cross-border collaboration. Developing common standards and protocols can facilitate smoother integration and interoperability.

3. Diverse Regulatory Environments: The diverse regulatory frameworks across different countries pose challenges to transnational projects. Understanding and navigating these regulatory environments is essential for successful project implementation. Engaging with policymakers early in the process can help align project goals with regulatory requirements.

4. Data Sharing and Privacy: Effective data sharing among participants is vital for the success of smart grid initiatives. However, concerns about data privacy and security must be addressed. Establishing clear data governance policies and ensuring compliance with data protection regulations can mitigate these concerns.

5. Technology Adaptability: Different regions may have unique technological needs and infrastructure capabilities. The project underscored the importance of developing adaptable solutions that can be customised to fit local contexts while maintaining overall project goals.

6. Capacity Building: Building local capacity and expertise is crucial for the long-term sustainability of smart grid initiatives. Training programmes and knowledge transfer activities can empower local stakeholders and enhance their ability to implement and manage smart grid technologies effectively.

7. Pilot Projects as Learning Tools: Conducting pilot projects has proven to be an effective way to test new technologies and approaches in real-world settings. These pilots provide valuable insights that can inform larger-scale implementations and help identify potential challenges early on.

8. Stakeholder Engagement: Engaging a wide range of stakeholders, including end users, is essential for the acceptance and success of smart grid projects. Involving communities in the design and implementation phases can lead to better outcomes and greater buy-in from the public.

9. Financial Models: Innovative financing models are necessary to support the deployment of smart grid technologies. Exploring various funding sources, including public-private partnerships and EU funding

[22] https://erigrid.eu/about/

mechanisms, can help secure the necessary resources for project implementation.

10. Continuous Learning and Adaptation: The dynamic nature of the energy sector requires ongoing learning and adaptation. Establishing feedback loops and mechanisms for continuous improvement can help projects remain responsive to changing conditions and emerging technologies.

These lessons learned from the ERIGRID project can inform future initiatives aimed at enhancing the integration of smart grid technologies across Europe and beyond.

The project identified several ways in which transnational access to energy research infrastructure programmes can support the advancement of innovative technologies and facilitate their successful market implementation:

- **Access to State-of-the-Art Facilities:** Transnational access programmes offer researchers and innovators access to state-of-the-art research facilities, testing laboratories, and pilot plants that are often not available at their home institutions. By leveraging advanced infrastructure and equipment, stakeholders can conduct cutting-edge research, prototype development, and testing activities to advance innovative energy technologies.

- **Collaboration and Networking Opportunities:** Transnational access programmes foster collaboration, knowledge exchange, and networking among researchers, industry partners, and technology developers from different countries and institutions. By facilitating international partnerships, joint projects, and collaborative initiatives, stakeholders can leverage diverse expertise, resources, and perspectives to accelerate innovation, address technical challenges, and drive market adoption.

- **Validation and Demonstration**: Transnational access programmes enable researchers and innovators to validate, demonstrate, and showcase their technology solutions in real-world settings, pilot projects, and testbed environments. By conducting validation studies, performance testing, and demonstration projects at leading research facilities and demonstration sites, stakeholders can provide evidence of the technology's feasibility, functionality, and market readiness.

- **Technical Expertise and Support**: Transnational access programmes provide access to technical expertise, guidance, and support from experienced researchers, engineers, and industry professionals in the energy sector. By collaborating with experts in the field, stakeholders can receive valuable insights, feedback, and recommendations to optimise their technology solutions, address technical challenges, and enhance the market potential of their innovations.

- **Market Insights and Commercialisation Support**: Transnational access programmes offer stakeholders access to market insights, commercialisation support, and business development opportunities to facilitate the transition from innovation to market. By engaging with industry partners, market analysts, and business advisors, stakeholders can gain valuable market intelligence, identify commercialisation pathways, and develop strategies to bring their technology solutions to market successfully.

- **Regulatory Compliance and Standards:** Transnational access programmes help stakeholders navigate regulatory requirements, compliance standards, and certification processes for energy technologies. By collaborating with experts in regulatory affairs, standards organisations, and certification bodies, stakeholders can ensure that their technology solutions meet legal, safety, and quality standards, facilitating market acceptance and adoption.

- **Training and Capacity Building:** Transnational access programs offer training, capacity building, and skill development opportunities for researchers, innovators, and industry professionals working in the energy sector. By participating in workshops, training courses, and knowledge-sharing activities, stakeholders can enhance their technical expertise, project management skills, and innovation capabilities to drive successful market implementation of energy technologies.

2.4. Regulatory Advocacy and Support

In the survey, the need of regulatory advocacy and support emerges as a critical need from collaborative research projects in the energy sector. As stakeholders navigate the complexities of bringing innovative solutions to market, it becomes evident that a supportive regulatory framework is essential. Figure 6 shows suggestions of researchers, how policymakers can support the market uptake of their project results.

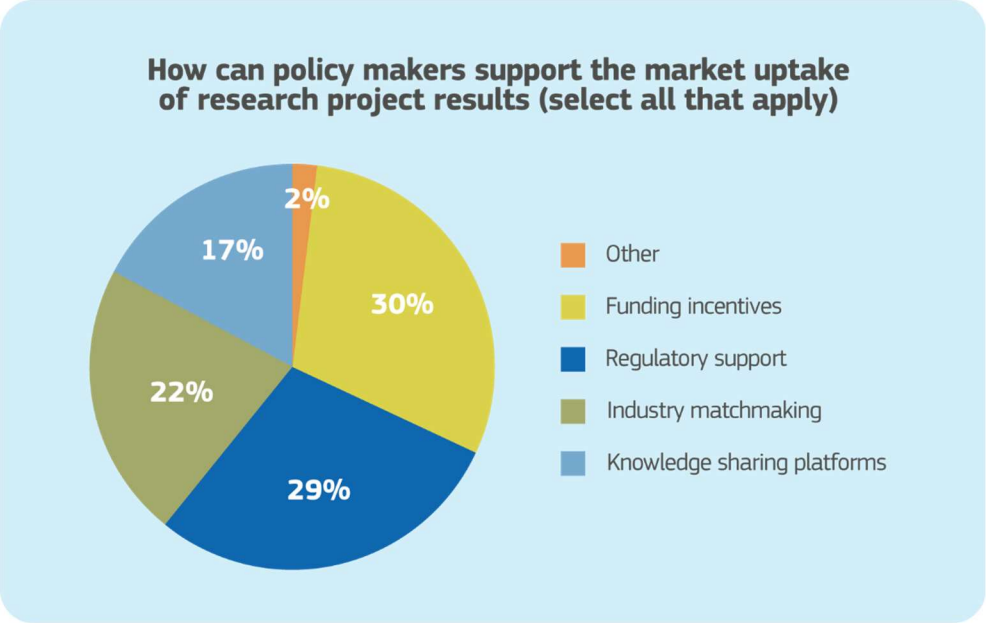

Figure 6 Survey results: support of policy makers for market uptake

Regulatory advocacy involves engaging with policymakers, regulatory agencies, industry stakeholders, and advocacy groups to shape regulations, standards, and policies that support the commercialisation of innovative ideas and technologies.

The international Smart Grid Action Network (ISGAN) published a policy brief[23] where they give policy recommendations on how regulatory experimentation zones can foster market uptake of Smart Grid solutions. Regulatory sandboxes serve as controlled environments that facilitate the testing, validation, and commercialisation of innovative energy technologies in the electrical power industry while addressing regulatory uncertainties and barriers. By providing a safe space for innovators to experiment without regulatory repercussions, sandboxes encourage creativity and accelerate the development of new energy solutions. These sandboxes streamline regulatory processes, approvals, and compliance requirements, reducing time-to-market and fostering the adoption of cutting-edge technologies. Stakeholders can assess the impact of regulations on technology deployment, data privacy, cybersecurity, and consumer protection within these sandboxes, allowing them to identify and address regulatory challenges that may impede market implementation. By mitigating risks, ensuring compliance, and building stakeholder confidence, the sandboxes drive innovation, competition, and sustainability in the electrical power sector.

In essence, regulatory sandboxes play a pivotal role in bridging the gap between innovation and market implementation in the electrical power industry by providing a supportive framework for testing, learning, and regulatory evolution. Programmes with the European Commission can be found under the following links[24,25].

[23] Kubeczko et al. Policy messages on Innovative Regulatory Approaches with Focus on Experimental Sandboxes to Enable Smart Grid Deployment
[24] https://www.ebf.eu/priorities/innovation-cybersecurity/eu-framework-for-experimentation/
[25] https://cdn.digitaleurope.org/uploads/2023/06/DIGITAL-EUROPE-SANDBOXING-THE-AI-ACT_FINAL_WEB_SPREADS-1.pdf

Further strategies for effective regulatory advocacy and support in bridging the gap between innovation and the market:

- **Policy Analysis and Research:** Conduct in-depth policy analysis and research to understand the regulatory landscape, identify regulatory barriers, and assess the impact of regulations on innovation and market entry. Stay informed about emerging regulatory trends, policy developments, and regulatory challenges that affect the commercialisation of innovative technologies.

- **Stakeholder Engagement:** Engage with policymakers, regulatory agencies, industry associations, and advocacy groups to build relationships, share insights, and advocate for regulatory reforms that support innovation and entrepreneurship. Collaborate with key stakeholders to raise awareness about regulatory issues, propose policy recommendations, and influence decision-making processes.

- **Advocacy Campaigns**: Develop advocacy campaigns, position papers, and policy briefs to communicate key messages, policy priorities, and advocacy goals to policymakers and regulators. Mobilise support from industry partners, research institutions, and community stakeholders to amplify advocacy efforts and drive policy change.

- **Regulatory Impact Assessments:** Conduct regulatory impact assessments to evaluate the potential impact of regulations on innovation, market competitiveness, and economic growth. Assess the costs, benefits, and unintended consequences of regulatory measures to inform evidence-based advocacy and regulatory decision-making.

- **Policy Recommendations**: Develop policy recommendations, regulatory proposals, and advocacy strategies that promote regulatory reforms, streamline regulatory processes, and create an enabling environment for innovation and market entry. Advocate for policies that support technology adoption, entrepreneurship, and investment in research and development.

- **Compliance Assistance:** Provide compliance assistance, regulatory guidance, and technical support to innovators, startups, and entrepreneurs navigating regulatory requirements and standards. Help stakeholders understand regulatory obligations, obtain necessary approvals, and comply with legal and regulatory frameworks to facilitate market entry and commercialisation.

- **Regulatory Pilots and Sandboxes**: Advocate for regulatory pilots, regulatory sandboxes, and innovation-friendly regulatory frameworks that allow innovators to test new technologies, business models, and services in a controlled environment. Encourage regulators to adopt agile, flexible approaches to regulation that support experimentation and innovation.

- **Capacity Building**: Build capacity among policymakers, regulators, and industry stakeholders to understand the importance of innovation, entrepreneurship, and regulatory advocacy in driving economic growth and competitiveness. Provide training, workshops, and educational resources on regulatory best practices, innovation policy, and market access strategies.

- **Monitoring and Evaluation**: Monitor regulatory developments, track policy outcomes, and evaluate the effectiveness of regulatory advocacy efforts in bridging the gap between innovation and the market. Assess the impact of regulatory reforms on innovation ecosystems, market dynamics, and technology adoption to inform future advocacy strategies.

2.5. Customer acceptance

Customers should be involved already in high TRL-project developments as well as in the innovation implementation phase in industry. The following strategies can ensure better acceptance and active participation of customers in the energy transition[26,27].

- **Early Engagement**: Involve customers in the project planning and development stages. This could include

[26] Microsoft Word - 230907_Discussions and Conclusions_Session IV_FINAL.docx (eepublicdownloads.blob.core.windows.net)
[27] Isa Diamant, 2023 Methods-for-customer-dialogue_FINAL_230220.pdf (iea-isgan.org)

surveys, focus groups, or pilot programs to gather their input and address concerns early on.

- **Education and Awareness**: Provide educational resources to help customers understand the benefits and impacts of the energy transition. This could include workshops, webinars, or informational materials.

- **Incentives and Benefits**: Offer incentives such as discounts, rebates, or rewards programs to encourage customer participation and investment in new technologies.

- **Feedback Mechanisms**: Establish clear channels for customers to provide feedback and suggestions. This could be through online platforms, customer service lines, or in-person events.

- **Partnerships**: Collaborate with local organizations, businesses, and community leaders to build trust and foster a sense of shared ownership in the project.

- **Customization**: Tailor solutions to meet the specific needs and preferences of different customer segments. This could involve personalized energy plans or customizable technology options.

- **Showcasing Success Stories**: Highlight successful case studies and testimonials from customers who have already benefited from participating in similar projects.

- **Addressing Barriers**: Identify and address potential barriers to customer participation, such as financial constraints or lack of access to necessary technology.

- **Continuous Improvement**: Use customer feedback and data analytics to continuously improve and adapt strategies to better meet customer needs.

2.6. Strategies for Overcoming Barriers

To overcome the barriers to market implementation of public-funded research projects, stakeholders can employ a range of strategies as shown below:

- **Foster Collaboration and Partnerships**: Strengthen collaboration between researchers, industry players, and policymakers throughout the research and development process. Encourage joint research projects involving universities, technology companies, and energy utilities. Facilitate dialogue between researchers and industry to ensure developed solutions address real market needs and regulatory considerations.

- **Focus on User Needs and Market Fit**: Prioritise user-centric research, understanding the needs and motivations of potential customers and end-users (consumers, businesses, utilities). Conduct market research to define target users and their pain points. Design solutions that are cost-effective, user-friendly, and offer clear benefits over existing options.

- **Address Regulatory and Policy Barriers**: Identify and proactively address existing regulatory hurdles that hinder market entry for innovative energy solutions. Advocate for policy changes that incentivise the adoption of new technologies. Work collaboratively to develop regulations that are flexible and promote innovation while ensuring safety and environmental considerations. Test project results within regulatory innovation zones (regulatory sandboxes) [28, 29]

- **Secure Effective Funding and Investment**: Explore diversified funding sources beyond traditional research grants, such as venture capital, private-public partnerships, or crowdfunding platforms. Develop clear business plans and financial models to attract investors. Showcase the potential impact and economic viability of the innovation.

[28] Veseli, A., Moser, S., Kubeczko, K., Madner, V., Wang, A., & Wolfsgruber, K. (2021). Practical necessity and legal options for introducing energy regulatory sandboxes in Austria. *Utilities Policy*, *73*(101296). https://doi.org/10.1016/j.jup.2021.101296

[29] IEA ISGAN Innovative Regulatory Approaches with Focus on Experimental Sandboxes (2019) Report. Web: http://www.iea-isgan.org/wp-content/uploads/2019/05/ISGAN_Casebook-on-Regulatory-Sandbox-A2-1.pdf (2020-11-24)

Create a dedicated funding for research experts to support the development process in a company.

- **Enhance Communication and Technology Transfer**: Effectively communicate research results and the potential benefits of new technologies to stakeholders like investors, policymakers, and the public. Utilise public outreach initiatives, conferences, and media engagement. Develop clear and concise communication materials that highlight the value proposition of the innovation.

- **Prioritise Business Acumen and Market Readiness**: Integrate business development skills and market analysis into research teams. Develop strategies for intellectual property protection (patents, licensing). Prepare clear commercialisation plans that address scaleability, production costs, and market entry strategies.

- **Facilitate Technology Demonstration and Piloting**: Encourage and support pilot projects and real-world demonstrations of promising technologies to showcase their feasibility and value. Develop partnerships with utilities, companies, or municipalities to test and validate new solutions in real-world settings. Use pilot project results to attract further investment and refine the technology for broader market adoption.

- **Standardisation and Interoperability**: Encourage standardisation and interoperability of new technologies across Europe for wider adoption and easier integration with existing infrastructure.

- **Social Acceptance**: Consider the social impact of new energy solutions. Address potential public concerns through clear communication and community engagement strategies.

- **Leverage Digital Tools and Platforms**: Utilise digital technologies to enhance collaboration, communication, and data sharing among stakeholders. Platforms that facilitate knowledge exchange and networking can help researchers connect with industry leaders and investors, fostering a more dynamic innovation ecosystem. Additionally, digital tools can streamline project management and monitoring, ensuring that stakeholders remain aligned and informed throughout the development process.

3. Barriers to Market Implementation of Public Funded Research Projects

In the energy sector, public-funded research projects play a crucial role in driving innovation and technological advancements. However, a common challenge arises when it comes to securing additional resources for the commercialisation and market implementation of energy-related innovations. The lack of funding beyond the initial stages can significantly impede the progress of energy research projects, limiting their capacity to further develop and scale their innovations for successful market entry. This funding gap poses a substantial barrier to realising the full potential of groundbreaking energy research outcomes and translating them into tangible solutions that benefit society[30] [31].

In its recently published report Horizon Europe support for the European Green Deal [32] the European Parliament Research Service analysed the following areas for improvement in order to foster innovation to market:

- Foster collaboration between academia and business.
- Improve accessibility and visibility of funding calls.
- Simplify the path from research to commercial success.

Figure 7 lists the barriers to market implementation identified by members of funded research. With a share of 25%, regulatory hurdles are mentioned most often as a barrier to market implementation.

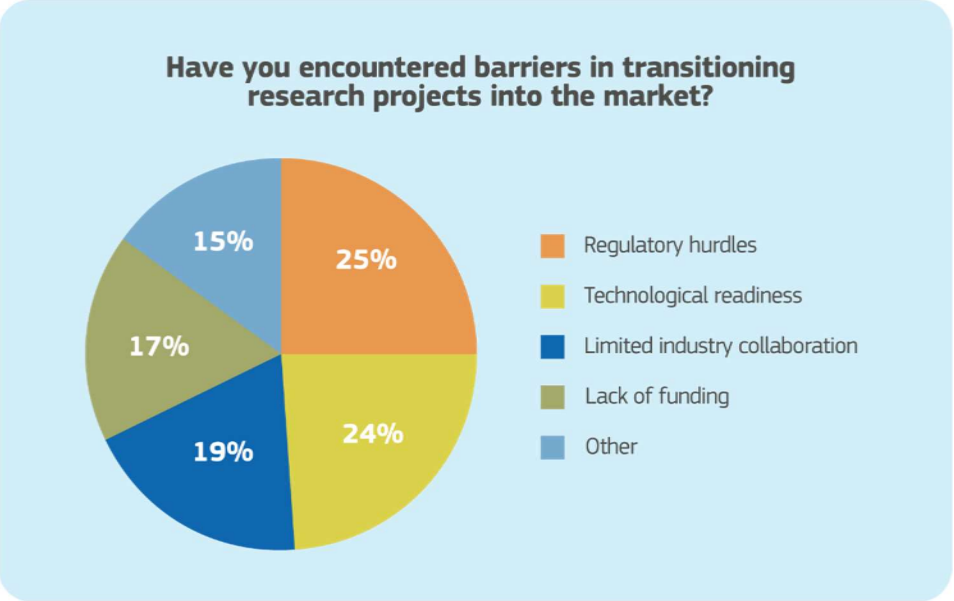

Figure 7 Survey results: barriers to market implementation seen by researchers

[30] Ford, George & Koutsky, Thomas & Spiwak, Lawrence. (2007). A Valley of Death in the Innovation Sequence: An Economic Investigation. Research Evaluation. 18. Https://doi.org/10.2139/ssrn.1093006 .

[31] Carlo Cambini, Raffaele Congiu, Tooraj Jamasb, Manuel Llorca, Golnoush Soroush,Energy Systems Integration: Implications for public policy, Energy Policy, Volume 143, 2020; https://doi.org/10.1016/j.enpol.2020.111609 .

[32] Horizon Europe support for the European Green Deal | Think Tank | European Parliament (europa.eu)

Additional barriers were listed (answer “Others”) as follows:

- User engagement & acceptance.
- End user caution.
- Standards.
- Fragmented energy market in EU countries.
- Making the results known by potential adopters.
- Social acceptance.
- Users not ready or not skilled to use the technology.
- Competition among smaller and larger industries.
- Governance/Societal acceptance.

3.1. Interoperability readiness.

Figure 8 presents the main challenges identified to bridge the gap from innovation to market. With a share 31%, technology transfer issues have been identified as most challenging for a market adoption, followed by regulatory barriers with a share of 29%.

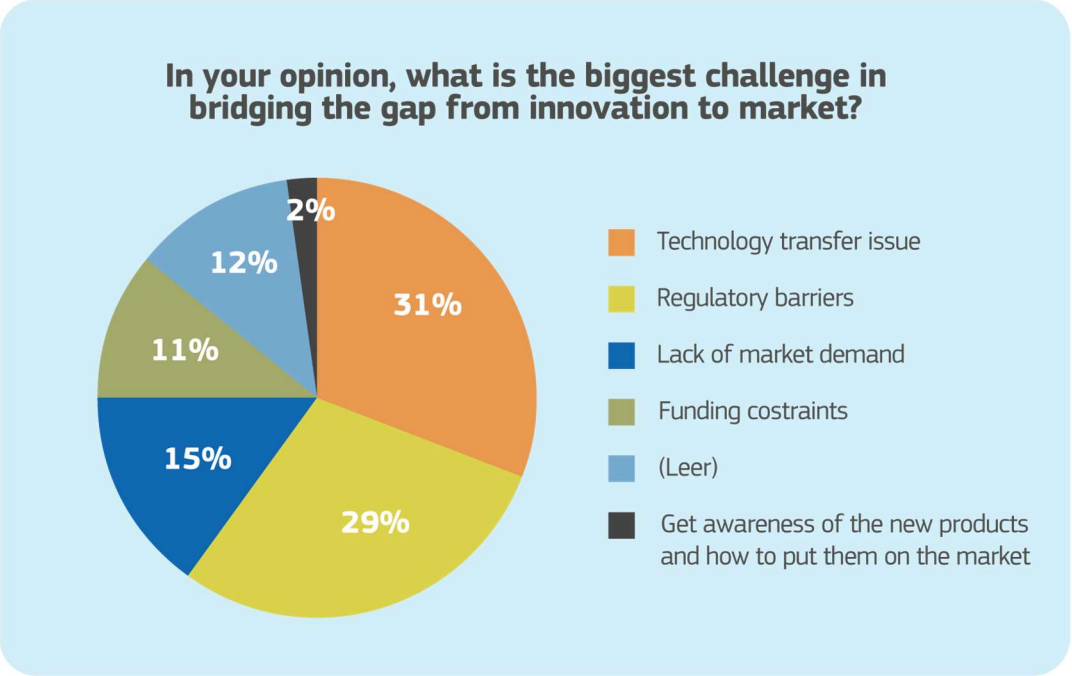

Figure 8 Survey results: biggest challenge in bridging the gap from innovation to market (view of researchers)

3.2. Regulatory Hurdles

Regulatory challenges present a significant barrier to the market implementation of energy-related public-funded research projects. This was amongst others discussed in[33]. Energy researchers have to navigate a complex landscape of approvals and compliance measures before their new energy technologies can be introduced onto the market. The time-consuming and costly nature of regulatory processes can delay market entry and commercialisation, adding further strain to already resource-constrained energy projects. Overcoming these regulatory hurdles demands a concerted effort to streamline processes, enhance transparency, and provide tailored support to facilitate the transition from energy research to market.

Regulatory hurdles were most often mentioned as barriers for getting new solutions in the market by project leaders. All energy systems, whether vertically integrated or deregulated, have regulation or some form of market oversight. Some of these regulations have been in place since the beginning of the 20th century. Due to the latest developments in the energy system with decentralised and volatile renewable energy sources, with consumers who have also become producers (prosumers) and numerous new market roles (aggregators), new regulatory structures need to be tested. Such regulatory experimentation zones (Sandboxes) can support the integration of advanced smart grid technologies and business models

[33] Sovacool, B. K. (2019). "The precarious political economy of energy research and development." *Energy, 179, 964-971. doi:10.1016/j.energy.2019.03.099.*

and ultimately allow for the introduction of these technologies and methods in application [34] [35, 36]. Apart from these regulatory barriers, also other standards and regulations need to be fulfilled or their changes discussed. The already established funding of regulatory innovation zones like regulatory sandboxes is a significant step in this direction [37] [38] [39].

The regulatory hurdles can vary depending on the jurisdiction and regulatory environment. Some of these challenges that projects face during market implementation were discussed as follows:

- **Compliance with standards and regulations**: Energy projects often need to comply with a range of technical standards, safety regulations, environmental requirements, and building codes. Ensuring that the technology meets all relevant standards and regulations can be a complex and time-consuming process that requires technical expertise and resources.

- **Permitting and licensing:** Energy projects may require various permits and licences from regulatory authorities to operate or deploy the technology. Obtaining these approvals can involve navigating a complex regulatory landscape, engaging with multiple agencies, and meeting specific requirements related to land use, emissions, noise, and other factors.

- **Interconnection and grid integration:** Energy projects that involve grid-connected technologies, such as renewable energy systems or energy storage, may face challenges related to interconnection with the existing grid infrastructure. Ensuring seamless integration with the grid, complying with grid codes, and addressing technical issues related to grid stability and reliability are critical regulatory considerations.

- **Market access and competition:** Public-funded energy research projects may need to navigate market access barriers, competition rules, and procurement regulations to enter the market. Compliance with antitrust laws, fair competition practices, and public procurement requirements can impact the commercialisation and deployment of innovative energy technologies.

- **Tariffs and incentives:** Energy projects may be subject to tariffs, taxes, or fees that affect their economic viability and competitiveness. Understanding and navigating the regulatory framework for energy pricing, incentives, subsidies, and tax credits is essential for maximising the financial benefits of the technology and attracting investment.

- **Data privacy and cybersecurity:** Energy projects that involve data collection, monitoring, or control systems may need to address data privacy and cybersecurity regulations to protect sensitive information and ensure secure operation. Compliance with data protection laws, cybersecurity standards, and industry best practices is critical for maintaining trust and mitigating risks.

- **Environmental and social impact assessments:** Energy projects may be required to undergo environmental impact assessments, social impact assessments, or other regulatory reviews to evaluate the project's potential environmental and social impacts. Addressing these regulatory requirements and engaging with stakeholders can help mitigate risks and ensure sustainable development.

Navigating these regulatory hurdles requires a comprehensive understanding of the regulatory landscape, proactive engagement with regulatory authorities, stakeholders, and industry partners, and strategic planning to address compliance challenges effectively. Collaboration with legal experts, regulatory consultants, and industry associations supports market implementation of energy-related research projects results.

[34] Kubeczko et al Policy messages on Innovative Regulatory Approaches with Focus on Experimental Sandboxes to Enable Smart Grid Deployment
[35] Veseli, A., Moser, S., Kubeczko, K., Madner, V., Wang, A., & Wolfsgruber, K. (2021). Practical necessity and legal options for introducing energy regulatory sandboxes in Austria. *Utilities Policy*, *73*(101296). https://doi.org/10.1016/j.jup.2021.101296
[36] IEA ISGAN Innovative Regulatory Approaches with Focus on Experimental Sandboxes (2019) Report. Web: http://www.iea-isgan.org/wp-content/uploads/2019/05/ISGAN_Casebook-on-Regulatory-Sandbox-A2-1.pdf (2020-11-24)
[37] Regulatory Sandboxes are already funded by the commission: e.g. AI regulatory sandboxes: EU-level coordination and support
[38] EU FRAMEWORK FOR EXPERIMENTATION - EBF,
[39] DIGITAL-EUROPE-SANDBOXING-THE-AI-ACT_FINAL_WEB_SPREADS-1.pdf

3.3. Technological Readiness

The readiness of energy technologies for market implementation is usually quantified by the Technology Readiness Levels (TRL). These levels, firstly defined for the race to the moon by NASA[40], have been widely discussed (e.g., ISGAN Working Group on Energy Transitions [41]) concerning their relevance in the application to a system of systems such as the energy system and smart energy grids. However, as it is widely used and well established, in the survey this report is based on, the TRL level has been used to quantify the market readiness of projects.

The projects answering the survey had an average TRL of 6.7. This level seems too low for market implementation with regard to research projects (see Figure 7). In many cases the funding rate goes down as the TRL goes up. This is true not only for industry partners but also for research organisations. This could make high TRL-projects unattractive for research and technology organisations and thus hinder market access. The risks of a market adoption and system integration of TRL 6.7 solution is still too high.

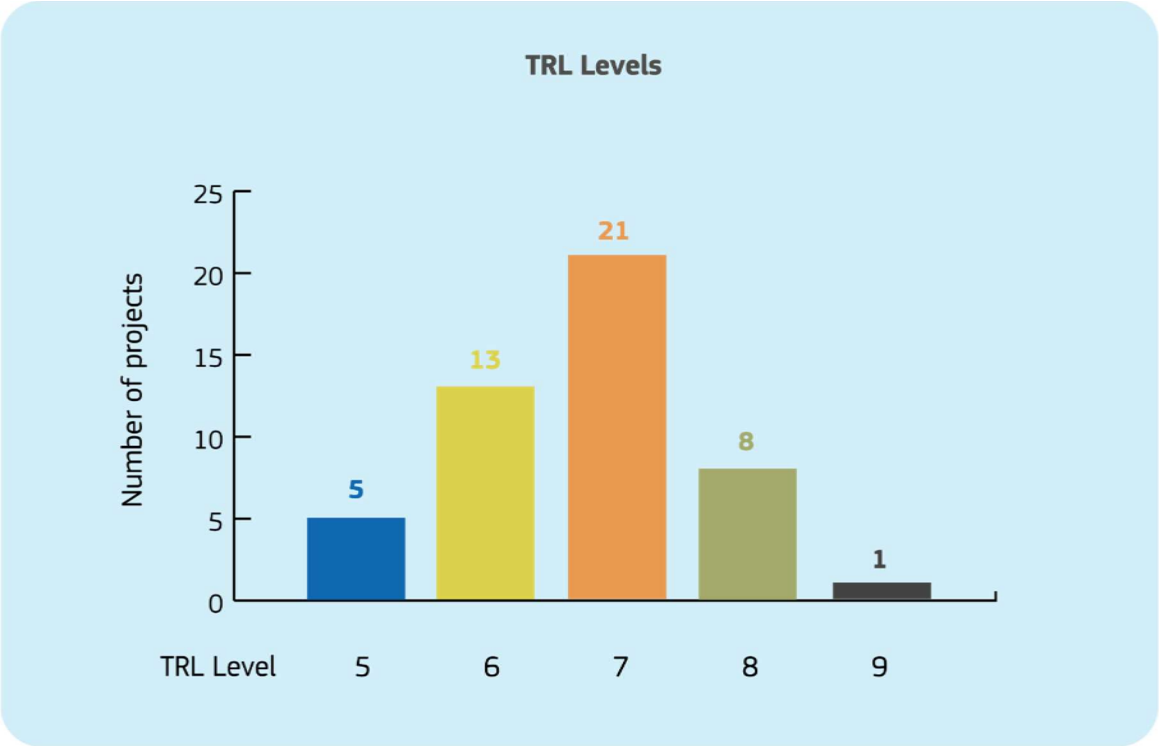

Figure 9 Survey results: TRL Levels of research projects answering the survey

Like all research projects, those in the energy and electrical power systems sector often encounter challenges in reaching the technological readiness required for successful market implementation. Transitioning from the research and development phase to a market-ready product or service requires overcoming technical hurdles, optimising performance, and ensuring scaleability as well as a valid business case. As mentioned above, combining several high TRL technologies in the complex energy system does not automatically lead to high system readiness levels[42].

Strong collaboration between researchers, industry partners, policymakers and funding agencies are essential for overcoming these barriers. By offering targeted support, resources, and incentives to bridge the innovation-to-market gap, stakeholders can enhance the commercialisation prospects of public-funded research projects and maximise their societal and economic impact.

Further challenges discussed in relation to technological readiness:

- **Complexity and Maturity of Technology:** The technological complexity and maturity level of energy and power system research projects can impact their readiness for commercial deployment. If the technology is highly

[40] NASA Systems Engineering Handbook." NASA/SP-2007-6105 Rev 1, December 2007
[41] ISGAN. All Rights Reserved. - Transitions - https://www.iea-isgan.org/our-work3/wg_7/
[42] https://doi.org/10.1016/j.respol.2018.12.007

intricate or in the early stages of development, it may not be suitable for market implementation. The lack of proven performance and maturity could discourage potential investors, partners, or customers from adopting the technology.

- **Compatibility and Integration**: Energy technologies emerging from research projects must align with existing infrastructure, systems, other technologies and market standards to ensure seamless integration. If significant modifications or integration efforts are necessary for the technology to operate effectively within current and future systems, it can create barriers to adoption and implementation. In particular in critical infrastructure, like the energy system.

- **Cost and Investment**: Implementing energy technologies that are not technologically mature can be financially burdensome. Additional investments may be required to further develop, test, or optimise the technology for commercial use, increasing deployment costs and hindering market acceptance.

- **Performance and Reliability**: The performance and reliability of energy and power system research projects are pivotal for gaining market acceptance. If the technology fails to meet industry standards, performance criteria, or reliability expectations, it may face scepticism from potential users or buyers, limiting its market potential.

- **Regulatory Compliance**: Technological readiness is essential for ensuring compliance with regulatory requirements and safety standards in the energy sector. Failure to meet regulatory criteria or address environmental, health, and safety concerns could lead to regulatory obstacles that impede market implementation.

- **Skills and Training**: New and advanced energy technologies often demand specialised skills and training for operators, maintenance personnel, and end users. If the technology lacks user-friendliness, adequate training resources, or requires a high level of technical expertise, it can present challenges in effectively deploying it in the market.

- **Market Acceptance and Demand:** The ability of energy and power system research projects to meet market demands and address consumer needs is critical for successful market implementation. If the technology does not offer significant benefits, cost savings, or competitive advantages over existing solutions, it may struggle to gain acceptance and demand in the market.

Addressing technological readiness barriers requires further research and development, testing, validation, demonstration, and pilot projects to enhance the maturity, performance, reliability, and compatibility of energy technologies. Collaboration with industry partners, technology providers, and end users in an early development stage can help to identify and address technological gaps, accelerate technology and system readiness levels, and facilitate the successful market implementation of energy public-funded research projects.

3.4. Limited Industry Collaboration

In addition to financial constraints, energy research projects often encounter hurdles in **establishing collaborations with industry** stakeholders. Industry engagement is seen as extremely important for 87% of researchers in the survey (Figure 10). Researchers also mentioned that one of the barriers for market implementation is “Making the results known by potential adopters”. Thus, the limited interaction between public-funded energy researchers and industry partners can hinder the effective transfer of knowledge and technology, impeding the alignment of energy research outcomes with market needs. Without robust industry collaborations, energy research projects may struggle to navigate the complexities of commercialisation and miss out on valuable opportunities to leverage industry insights and support.

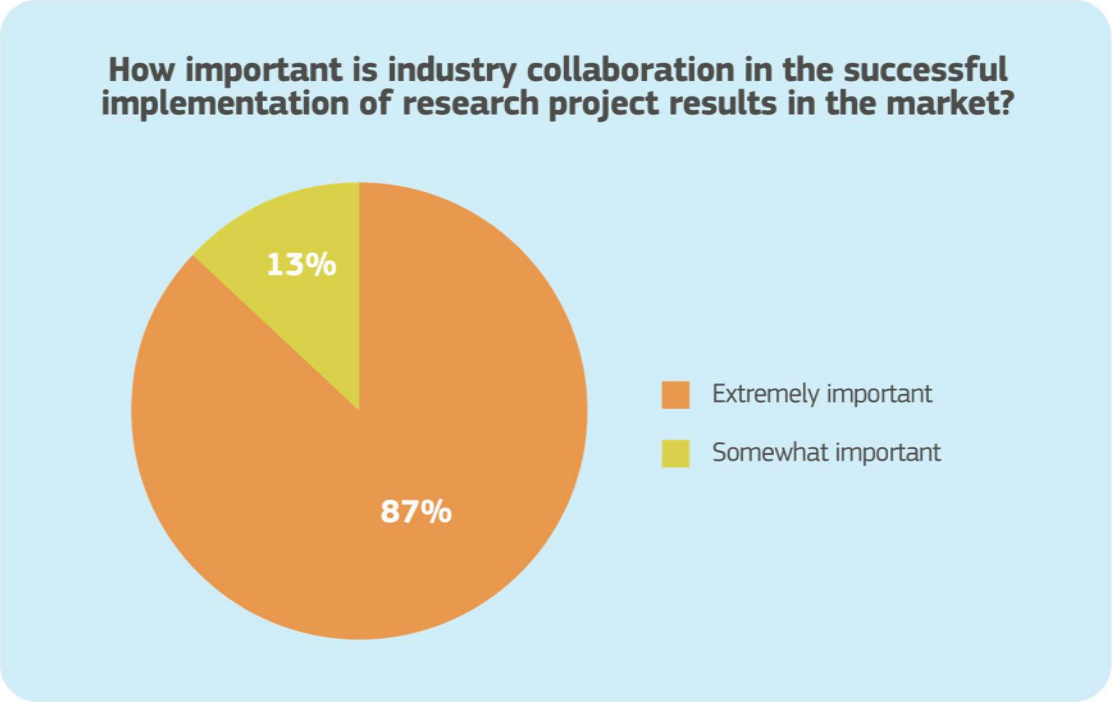

Figure 10 Survey results: researchers' answers on the importance of industry collaboration from the survey

Public-funded research projects sometime have difficulties in establishing partnerships and collaborations with other industry stakeholders (except for those within the projects) who can provide additional expertise, resources, and market access. From a research project perspective, a shift from research push to industry pull is beneficial.

Industry can help address the lack of funding for high TRL energy projects and support their market adoption through various means. In return industry can benefit from participations in inventions and patents probably filed together with the researchers of the market-ready solutions. Firstly, industry players can provide crucial financial support by investing in high TRL energy projects, enabling them to scale up and reach the market effectively. Collaboration with research institutions, startups, and government agencies can also facilitate resource and expertise sharing to accelerate the development and commercialisation of innovative energy solutions. Additionally, industry associations and organisations can establish funding programmes to provide grants, loans, or other financial incentives (Mission Innovation being such an example[43]). By facilitating technology transfer, industry partners can help commercialise high TRL energy projects more efficiently. Industry can provide market validation and support by becoming early adopters or partners, demonstrating the viability and value of these solutions in real-world applications. Lastly, industry can advocate for policies and funding initiatives that support high TRL energy projects, creating a conducive environment for innovation and investment in the energy sector.

3.5. Lack of Funding

Despite receiving initial funding for research and development (please refer to the various funding programmes of the European Commission[44]), public-funded projects face challenges in securing additional funding for commercialisation and market implementation.

The transition from the laboratory to the marketplace requires substantial resources to refine, test, and deploy energy innovations at scale. Securing funding for pilot projects, demonstration facilities, and initial production runs is crucial for showcasing the viability and scalability of energy innovations to potential investors, customers, and industry partners.

The absence of sufficient funding for market implementation can limit the reach and impact of energy research projects, constraining their ability to transform our energy systems, reduce greenhouse gas emissions, and create new opportunities for businesses and consumers.

[43] https://mission-innovation.net/about-mi/overview/
[44] Funding opportunities - European Commission - https://research-and-innovation.ec.europa.eu/funding/funding-opportunities_en

One of the key challenges that arise from insufficient funding is the limited scalability of these projects. Without adequate financial support, high TRL energy projects may struggle to expand to commercial production levels, hindering their ability to meet the demands of a larger market. This limitation can impede the widespread adoption of the solution, as it may not be readily available or accessible to a broad range of consumers and businesses. A set of very comprehensive policy recommendations for funding agencies and policy makers was published by the International Smart Grid Action Network in 2019 [45]. Detailed information on the lack of funding for distribution grids can be found in the report Assessing EU Funding priorities – Connecting the missing pieces to solve the DSO funding puzzle, published by E.DSO in November 2023[46]. For this report a survey amongst DSOs was conducted. Their results identified major obstacles related to proper guidance by Member States, burdensome administrative processes, a lack of transparency, disproportionate competition, unfavourable regulatory treatments, or unrealistic timelines.

The lack of funding during the transition or introduction phase from one technology to another can result in higher development and production costs for high TRL energy projects. This can make the solution less cost-competitive compared to existing technologies, deterring potential customers from adopting it, even though it would contribute to reaching the European 2050 goals [47]. Higher costs can also pose a barrier for smaller companies or startups looking to enter the market, further limiting the reach and impact of high TRL energy projects.

In addition, insufficient funding can restrict marketing and promotional efforts for high TRL energy projects. Without adequate resources to raise awareness and educate potential customers about the benefits of the solution, these projects may struggle to gain visibility in the market. This lack of awareness can slow down the adoption rate of the solution, as potential customers may be unaware of its existence or potential advantages.

Navigating regulatory requirements and obtaining necessary approvals can be more challenging without sufficient funding. High TRL energy projects may face delays in commercialisation and market entry due to regulatory hurdles that require financial resources to address effectively. This can further hinder the market adoption of the solution and limit its potential impact on the energy sector and the broader economy.

To overcome the challenges posed by the lack of funding for energy research projects, concerted efforts are needed to mobilise resources, foster collaboration, and create supportive funding mechanisms tailored to the specific needs of energy innovations close to market implementation. Public-private partnerships, venture capital investments, and targeted grant programmes can play a crucial role.

3.6. Intellectual Property issues

Issues related to intellectual property rights, including ownership, protection, and licensing, can present barriers to market implementation of public-funded research projects[48,49]. Unclear or restrictive intellectual property arrangements can deter potential investors and industry partners from supporting commercialisation efforts. Intellectual property (IP) issues can play a significant role in the market implementation of energy public-funded research projects. Some of the main IP issues that may arise include:

- **Ownership of IP rights:** Determining the ownership of intellectual property rights generated from energy public-funded research projects is a crucial issue. In many cases, the funding agency or institution providing the research grant may claim ownership of the IP, while researchers or collaborating partners may also have rights to the IP. Clarifying ownership rights and establishing clear agreements on IP ownership can help avoid conflicts and facilitate commercialisation.

- **Protection of IP**: Protecting the intellectual property generated from energy public-funded research projects through patents, copyrights, trademarks, or trade secrets is essential to prevent unauthorised use or exploitation by third parties. Securing robust IP protection can enhance the value of the technology, attract investment, and enable the technology to be licensed or commercialised effectively.

[45] https://www.iea-isgan.org/wp-content/uploads/2019/12/ISGAN-Policy-Messages-on-Upscaling_November2019-1.pdf
[46] https://www.edsoforsmartgrids.eu/content/uploads/2024/05/2023_EDSO_Report_Assessing_EU_Funding_Final.pdf
[47] The European Green Deal - European Commission
[48] https://www.kauffman.org/wp-content/uploads/2019/12/IP_PolicyDigest_040715.pdf
[49] Heidi L. WilliamsJournal of Political Economy, Volume 121, Number 1, February 2013, DOI: https://doi.org/10.1086/669706

- **Licensing and technology transfer:** Licensing IP rights to third parties for commercialisation or technology transfer is a common strategy to bring energy public-funded research projects to market. Negotiating licensing agreements, determining licensing terms, and ensuring compliance with IP laws and regulations are critical steps in the commercialisation process. Clear licensing arrangements can help maximise the impact of the technology and generate revenue for further research and development.

- **Collaboration and joint ownership**: Energy public-funded research projects often involve collaboration between multiple partners, such as research institutions, industry partners, and government agencies. Joint ownership of IP rights, collaborative research agreements, and technology-sharing arrangements can raise complex IP issues related to ownership, exploitation, and commercialisation. Establishing clear agreements on IP rights, responsibilities, and revenue sharing can help manage IP issues in collaborative projects.

- **Enforcement of IP rights**: Enforcing intellectual property rights through legal action against infringement, counterfeiting, or unauthorised use is essential to protect the value of the technology and maintain a competitive advantage in the market. Monitoring the market for potential IP violations, taking timely legal action, and enforcing IP rights effectively can deter infringement and safeguard the technology's commercial success.

- **Open innovation and IP management:** Balancing the need to protect intellectual property with the principles of open innovation and knowledge sharing can be a challenge for energy public-funded research projects. Adopting IP management strategies that promote collaboration, technology transfer, and knowledge dissemination while protecting valuable IP assets can support innovation, market adoption, and societal impact.

3.7. Customer acceptance

In many cases technologies for the energy system are already developed; however potential customers may not adopt them which can hinder their implementation in the market. This fact was investigated in numerous publications[50,51,52] over the past year and recently discussed at the ENTSO-E event Future of our Grids: Accelerating Europe's energy transition, September 2023[53]. Conclusions from these discussions can be summarised in the following challenges:

- Building grids is not only about the technology aspects but local and regional communities need to be taken into account.

- Benefits and impacts are not evenly distributed. Impacts e.g., in rural areas need to be considered to ensure a fair and just transition.

A thorough whole-system analysis of the energy transition in the UK was done in the publication [54]. In this paper the whole system reconfiguration of production, transmission and consumption for low-carbon transition is discussed, including the view of the consumers.

[50] ISGAN_CaseBook_ConsumerEngagement-Empowerment_2017.pdf (iea-isgan.org)
[51] Isa Diamant, 2023 Methods-for-customer-dialogue_FINAL_230220.pdf (iea-isgan.org)
[52] Friedrichsen, N., Brandstätt, C. & Brunekreeft, G. The need for more flexibility in the regulation of smart grids – stakeholder involvement. Int Econ Econ Policy 11, 261–275 (2014). https://doi.org/10.1007/s10368-013-0243-x
[53] Microsoft Word - 230907_Discussions and Conclusions_Session IV_FINAL.docx (eepublicdownloads.blob.core.windows.net)
[54] McMeekin, A., Geels, F.W., Hodson, M., 2019. Mapping the winds of whole system reconfiguration: Analysing low-carbon transformations across production, distribution and consumption in the UK electricity system (1990–2016). Research Policy 48, 1216–1231. https://doi.org/10.1016/j.respol.2018.12.007

4. Industry Benefits and Support for Implementation of Project Results

In today's rapidly evolving energy landscape, industry collaboration emerges as a cornerstone for the successful market adoption of research project results and solutions. As highlighted in previous sections, partnerships between academia, industry, and policymakers are essential for aligning research outcomes with real-world needs. Survey data indicates that a significant majority of projects recognize industry collaboration as "extremely important" (see Figure 10), underscoring its critical role in accelerating the transition from innovative ideas to market-ready solutions.

By engaging industry stakeholders early in the development phase, policymakers and funding agencies can enhance the relevance and applicability of research outcomes, ultimately fostering a smoother path to market integration. The survey results reveal that 60% of industry participants have successfully implemented results from publicly funded projects, showcasing the tangible benefits of such collaborations. These implementations span a wide array of outcomes, including tailored business strategies, advanced distribution grid technologies, and innovative energy management systems.

However, the journey from research to market is not without its challenges, often characterized by the notorious "Valley of Death," where promising technologies struggle to achieve commercial viability. Encouragingly, over 50% of industry stakeholders express readiness to contribute to the final development phase of high Technology Readiness Level (TRL) projects, highlighting a willingness to invest in the last mile of innovation. This chapter delves into the vital importance of industry collaboration, examining its multifaceted benefits and the mechanisms through which it can significantly enhance the successful implementation of research results in the energy sector. By understanding and leveraging these collaborative efforts, stakeholders can create a more conducive environment for innovation, ultimately driving the adoption of sustainable energy solutions.

4.1. Importance of Industry Collaboration

As identified above, industry collaboration is crucial for successful market adoption of project results and solutions. Most projects answering the survey rated industry collaboration as “extremely important” (see Figure 10). By fostering these partnerships already in the development phase, policymakers or funding agencies can improve alignment of research solutions with the needs form industry and thus accelerate market update of research results.

From industry stakeholders answering the survey 60% have implemented project results from public funded projects (see Figure 5). The implemented results include:

Tailored business strategies (e.g., Energy communities’ creation) and our IPs (SPT, ECOOP, EVYLOR).
Leveraging the outcomes and lessons learned from publicly funded collaborative research projects (H2020, Horizon Europe, LIFE and ERA-Net projects) to foster and support the development of Energy Communities in Spain.
Finalisation of collaborative R&D projects together with customers, incl. Prototype application, demo plants / first market deployments.
Technology and concept solutions.
Hardware and software solutions for advanced distribution grid operation.
Operation software/technology for distribution system operators: live-monitoring, state estimation, steering/controlling of end-customer devices.
Knowledge in engineering services, developments in own smart energy systems.
Mobile app for energy consumption monitoring.
Tools, Architectures and Methodologies.
Smart monitoring capabilities.
Flexibility Register (INTERRFACE Project), ESTHESIS iot Platform (BENEFFICE Project).
Our Energy Management System has been partially developed thanks to publicly funded collaborative research

projects.
Concrete offshore wind turbine.
Design system improvements for gas turbines.
The underlying standardisation of our Product (reference is the NR+ non-cellular 5G Radio interface standard).
Engagement strategies for energy communities and energy market actors.

As is well known, overcoming the Valley of Death[55,56] in the development phase is a great hindrance for newly developed technologies and methods. Thus, in the survey industry stakeholders were asked about their readiness to contribute to the final development phase of innovative project results. The result shows that more than 50% are ready to do so.

Figure 11 Survey results: willingness of industry to fund the last mile for high TRL project results to market implementation

68% of respondent industry stakeholders have already implemented results of publicly funded research projects in their company. Further comments received to the questions were:

- Some stakeholders answered that this depends on the technology readiness or the market readiness.
- One participant gave concrete information: Our Energy Department is already working on implementing in the Spanish market the project solutions developed by our R&D and Innovation Departments under the scope of high-TRL EU-funded projects (with a 70% funding rate).

Market Insights and Needs Identification: Researchers often operate within a primarily academic environment, which may not fully capture the realities and complexities of the energy market. Industry partners bring valuable real-world expertise to the table:

- Market Needs and Demands: Understanding industry pain points and unmet technological needs helps researchers tailor their innovations to address specific market challenges.
- Commercial Viability: Industry partners can assess the economic feasibility of an innovation, considering factors

[55] W.G. Biemans, K.R.E. Huizingh, Rethinking the Valley of Death; an Ecosystem Perspective on the Commercialisation of New Technologies, Technovation, forthcoming (2020)
[56] S.K. Markham: Moving technologies from lab to market, Res. Technol. Manag., 45 (6) (2002), pp. 31-42

like production costs, scaleability, and potential return on investment.

- Regulatory Landscape: Industry players are well versed in navigating complex regulations related to energy technologies.

Insights into Research Results: On the other hand, it is time consuming and thus costly for industrial stakeholders to find and process the results of research projects to the right level of detail. It is therefore particularly important for commercial users to make this information available on a customised basis.

On the level of distribution Grid Operators (DSO), E.DSO has established an information product, the Technology Radar [57] in order to inform DSOs on new technologies that are possibly ready for market uptake in the power grid. Such publications are an excellent way to bring innovations to market. This document has been published for the second time this year and provides tailor-made information for DSOs.

For transmission system operators (TSO) ENTSO-E provides information on the publicly funded projects, ENTSO-E is directly involved in[58] providing first-hand information on latest developments relevant for TSOs.

Resource Sharing and Expertise Exchange: The development and commercialisation of innovative energy technologies often require a diverse skillset and significant resources. Industry partners can contribute:

- Technical Expertise: Industry engineers and technicians can collaborate with researchers to refine prototypes, improve manufacturability, and ensure the technical feasibility of the innovation.

- Financial Resources: Industry partners can co-invest in research projects, providing additional funding for pilot testing, market research, and commercialisation efforts.

- Marketing and Distribution Channels: Industry players have established networks for marketing and distributing new technologies, which can significantly accelerate market penetration for research-derived innovations.

Risk Mitigation and Investment Attraction: Investors are often hesitant to fund innovations that haven't been validated or tested in a real-world setting. Industry collaboration can help mitigate risks by providing:

- Industry Validation: Positive feedback and collaboration from industry players signal the potential viability of an innovation, making it more attractive to investors.

- Shared Investment Risk: Sharing the financial burden of research and development can incentivise industry partners to invest in promising innovations.

- Proof of Concept: Pilot projects conducted in collaboration with industry partners can serve as a valuable proof of concept, demonstrating the innovation's effectiveness and marketability.

By working together, researchers and industry players can create a more compelling case for investors, increasing the likelihood of securing funding for commercialisation efforts.

Accelerating Innovation and Market Adoption: Effective industry collaboration can lead to faster innovation cycles and swifter market uptake of new energy technologies. Industry partners can:

- Provide Feedback and Guidance: Collaboration allows for continuous feedback from industry stakeholders throughout the research process, leading to more commercially relevant innovations.

- Facilitate Pilot Testing and Demonstration: Industry partners can provide access to test sites and infrastructure for pilot projects, allowing researchers to validate their innovations and demonstrate their capabilities to potential customers.

[57] https://www.edsoforsmartgrids.eu/content/uploads/2024/06/E.DSO-Technology-Radar-v2.pdf
[58] https://www.entsoe.eu/research-and-innovation/#projects

- Streamline Regulatory Processes: Industry experience can be invaluable in navigating regulations and obtaining necessary approvals for new technologies, accelerating their market launch.

Through collaboration, the time it takes for promising energy research projects to reach the market can be significantly reduced.

4.2. Readiness Assessment for Market Implementation

A readiness assessment for market implementation involves evaluating the preparedness of an innovation, technology, or product for successful commercialisation and market entry. A review of readiness assessment tools can be found in [59]. This assessment helps identifying strengths, weaknesses, opportunities, and threats related to the innovation-to-market transition and informs strategic decision-making, resource allocation, and commercialisation planning.

The responses to the question regarding the readiness of research project results for market implementation reveal a nuanced understanding of the various factors that contribute to successful commercialisation in the energy sector.

The fact that 34% of respondents prioritise TRL assessment indicates a strong recognition of the importance of evaluating the maturity of technology before it can be effectively commercialised. TRL assessments provide a structured framework for determining how close a technology is to being market-ready, encompassing stages from basic research to full deployment. This aligns with the policy paper's emphasis on ensuring that innovative solutions are not only technically feasible but also robust enough for practical application. A focus on TRL can help identify potential technical barriers early in the process, allowing for timely interventions and adjustments to enhance market readiness.

The significant proportion of respondents (32%) who consider industry feedback crucial reflects a recognition of the value of real-world insights from potential users and stakeholders (see Figure 12). Engaging with industry experts and potential customers can provide valuable perspectives on usability, scaleability, and the practical applications of research outcomes. This aligns with the policy paper's call for enhanced collaboration between researchers and industry partners to ensure that innovations are developed in response to actual market needs. Industry feedback can also help validate the assumptions made during the research phase and inform necessary adjustments to the technology or business model.

The 18% of respondents who highlighted market analysis as a key factor emphasises the necessity of understanding market dynamics, customer needs, and competitive landscapes. Conducting thorough market analysis helps stakeholders assess the demand for a particular technology, identify target customers, and determine pricing strategies. The policy paper underscores the importance of aligning research outcomes with market demands. This response suggests that while technology is crucial, understanding the market context in which the innovation will operate is equally important for ensuring its success. The responses categorised as "other," which include combinations of TRL assessment, market analysis, and industry feedback, indicate a holistic approach to evaluating market readiness. Stakeholders recognise that a focus on one aspect may not be sufficient; instead, a comprehensive evaluation that incorporates multiple dimensions—such as stakeholder feedback, cost-benefit analyses, and business model assessments—is essential for a well-rounded understanding of readiness. This perspective reflects the complexity of the commercialisation process and the need for integrated strategies that encompass technical, market, and user considerations.

[59] Sudarsan, A., Kurukkanari, C. & Bendi, D. A state-of-the-art review on readiness assessment tools in the adoption of renewable energy. *Environ Sci Pollut Res* **30**, 32214–32229 (2023). https://doi.org/10.1007/s11356-023-25520-9

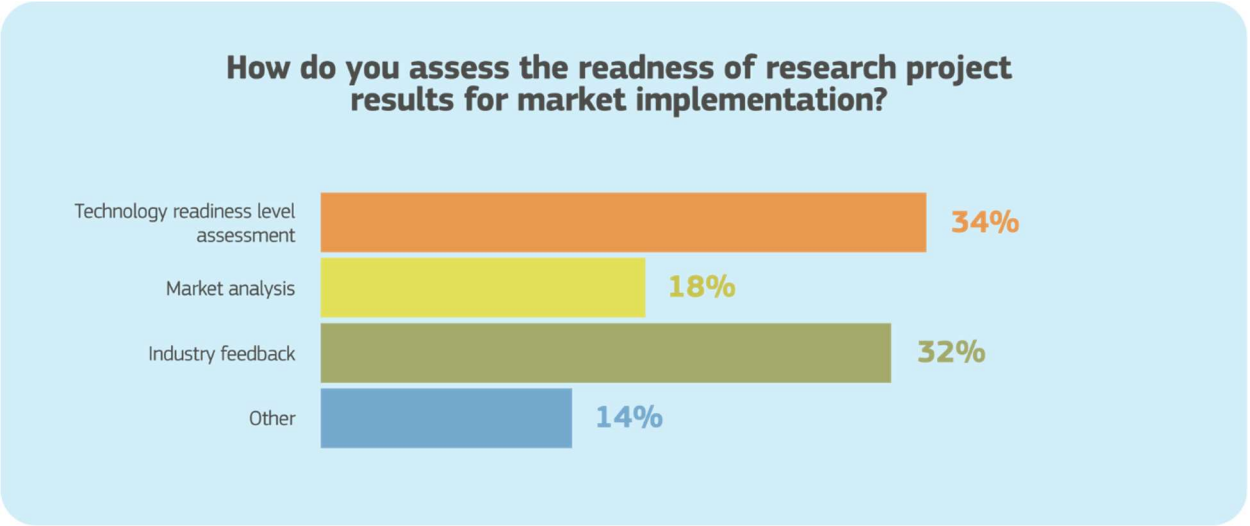

Figure 12 Survey results: assessment of market readiness

By adopting a comprehensive assessment strategy, stakeholders can better navigate the challenges of bringing research outcomes to market, ultimately contributing to a more sustainable and competitive energy landscape in Europe.

Key components of a readiness assessment for market implementation:

- **Technology Readiness Level (TRL)**: Assess the technology readiness level of the innovation based on its maturity, scaleability, and performance. Evaluate the technical feasibility, prototype development, testing results, and validation data to determine the readiness of the technology for market implementation.

- **Market Analysis**: Conduct a comprehensive market analysis to identify target markets, customer segments, competitors, and market trends. Evaluate market demand, size, growth potential, and competitive landscape to assess the market readiness and opportunities for the innovation.

- **Value Proposition:** Define the value proposition of the innovation by articulating its unique selling points, benefits, and competitive advantages. Identify the value proposition for customers, stakeholders, and end users to communicate the value of the innovation in the market.

- **Business Model**: Evaluate the business model, revenue streams, pricing strategy, and go-to-market approach for commercialising the innovation. Assess the business feasibility, profitability, and sustainability of the business model to ensure alignment with market needs and objectives.

- **Regulatory Compliance**: Evaluate the regulatory requirements, standards, and compliance obligations relevant to the innovation and its market entry. Assess the regulatory landscape, approval processes, and legal considerations to ensure compliance with industry regulations and standards.

- **Market Validation**: Validate the innovation through market testing, pilot projects, customer feedback, and user validation to confirm market acceptance and demand. Evaluate the product-market fit, customer satisfaction, and market validation results to assess the readiness for market implementation.

- **Commercialisation Strategy**: Develop a commercialisation strategy that outlines the market entry plan, distribution channels, sales and marketing tactics, and partnership opportunities. Define the commercialisation roadmap, milestones, and key performance indicators to guide the implementation process.

- **Resource Assessment**: Evaluate the resources, capabilities, and infrastructure required for successful market implementation. Assess the funding needs, talent requirements, partnerships, and operational support necessary to scale the innovation and drive market adoption.

- **Risk Assessment**: Identify potential risks, challenges, and barriers to market implementation, such as competition,

regulatory hurdles, funding constraints, and technology limitations. Conduct a risk assessment to mitigate risks, develop contingency plans, and address challenges proactively.

4.3. Measuring Impact in the Market

Measuring the impact of innovative ideas, technologies, and products in the market is essential for evaluating the success, effectiveness, and value of commercialisation efforts. Impact measurement helps assess the outcomes, benefits, and contributions of innovations to the market, economy, society, and environment.

The responses to the question regarding how stakeholders measure the impact of research project results in the market provide valuable insights into the key metrics and indicators that are prioritised within the context of the policy paper. Each response category—market penetration, revenue generation, customer feedback, and other measures—reflects different dimensions of impact assessment that are crucial for evaluating the success of innovative energy solutions (Figure 13). The fact that 38% of respondents identify market penetration as a primary measure of impact highlights the critical importance of assessing how widely an innovation is adopted in the market. Market penetration serves as a direct indicator of the success of a technology in reaching its intended audience and achieving commercial viability. This aligns with the policy paper's emphasis on the need for effective market deployment of innovative solutions. A strong market presence not only signifies acceptance by consumers and businesses but also reflects the potential for scaling and broader economic impact. This response underscores the necessity of strategies that facilitate entry into the market and promote widespread adoption.

The significant proportion (30%) of respondents who prioritise customer feedback as a measure of impact indicates a recognition of the value of user insights in evaluating the effectiveness of research outcomes. Customer feedback provides qualitative and quantitative data on user satisfaction, usability, and the perceived value of an innovation. This aligns with the policy paper's advocacy for stakeholder engagement throughout the commercialisation process. Understanding customer perspectives can inform continuous improvement of products and services, ensuring that innovations are aligned with market needs and preferences. This emphasis on customer feedback also suggests that successful commercialisation goes beyond initial adoption; it requires ongoing dialogue with users to foster loyalty and long-term success.

The 21% of respondents who consider revenue generation as a key measure of impact reflects the importance of financial sustainability in assessing the success of research project results. Revenue generation serves as a tangible indicator of the economic viability of an innovation and its ability to contribute to the overall financial health of a company or the sector. This response aligns with the policy paper's focus on creating an environment that supports the economic growth of the energy sector through the successful commercialisation of innovative technologies. Revenue generation is crucial not only for the sustainability of individual projects but also for attracting further investment and fostering continued innovation. The responses categorised as "other," which include a mix of the above metrics, the number of exploitable results, potential economic and technical impact, and pilots feedback, indicate a comprehensive approach to measuring impact. This reflects an understanding that no single metric can fully capture the multifaceted nature of innovation success. By considering a combination of quantitative and qualitative measures, stakeholders can gain a more holistic view of the impact of research project results. This aligns with the policy paper's call for integrated strategies that encompass various dimensions of evaluation, including technical feasibility, market readiness, and economic potential. The inclusion of pilot feedback as a measure further emphasises the importance of real-world testing and validation in understanding the practical implications of research outcomes.

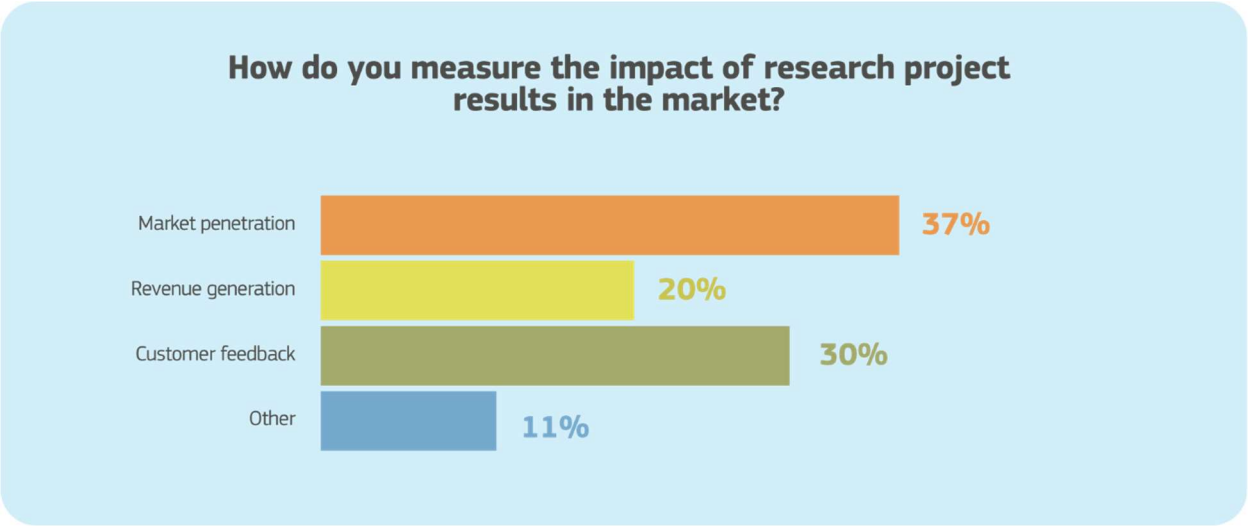

Figure 13 Survey results: measure the impact of research project results on the market

Evaluating the impact of EU-funded energy research projects in the market requires a multi-faceted approach, considering both economic and environmental benefits. Here are some key metrics to consider:

Economic Impact:

- **Market Penetration:** Measure the percentage of the target market that has adopted the technology developed by the research project. This can be tracked through sales figures, market share analysis, or customer adoption rates.
- **Revenue Generation:** Track the total revenue generated by the commercialisation of the research project's innovation. This can be a direct indicator of its economic success.
- **Job Creation:** Estimate the number of jobs created throughout the value chain due to the commercialisation of the innovation. This includes jobs in manufacturing, installation, maintenance, and related services.
- **Investment Attracted:** Measure the total amount of private and public investment attracted by the research project after its technology reached the market. This indicates the broader economic impact and potential for further scaling.
- **Cost Reduction:** Analyse the cost savings achieved by energy consumers or businesses due to the adoption of the research project's innovation. This could be related to reduced energy bills, improved energy efficiency, or lower maintenance costs.

Environmental Impact:

- **Energy Savings:** Measure the total amount of energy saved through the adoption of the innovation. This can be expressed in units like Megawatt-hours (MWh) or Gigawatt-hours (GWh).
- **Greenhouse Gas Emission Reduction:** Estimate the reduction in greenhouse gas emissions achieved by the widespread adoption of the innovation. This can be expressed in tons of CO2 equivalent (CO2e).
- **Improved Air Quality:** Assess the positive impact on air quality metrics like particulate matter (PM) or nitrogen oxides (NOx) resulting from the utilisation of the innovation.
- **Resource Conservation:** Analyse the potential for resource conservation, such as reduced water usage or fewer raw materials required, due to the adopted technology.

- **Sustainability Indicators:** Consider broader sustainability metrics like lifecycle assessment (LCA) to evaluate the environmental impact of the innovation throughout its entire lifecycle, from production to disposal.

Additional Considerations:

- **Long-Term Impact:** Track and analyse the lasting impact of the research project, considering factors like sustained market penetration, continuous energy savings, and ongoing job creation over time.
- **Innovation Spillover:** Evaluate whether the research project has spurred further innovation in the energy sector, leading to the development of new technologies or applications.
- **Societal Benefits:** Consider broader societal benefits, such as improved energy security, increased access to clean energy for communities, or positive impacts on public health.

By using a combination of these economic and environmental metrics, policymakers and researchers can understand the impact of EU-funded energy research projects in the market. This information can be used to assess the effectiveness of funding strategies, identify areas for improvement, and inform future research priorities.

Data availability and collection methods will vary for each metric. Collaboration between research teams, industry partners, and government agencies is crucial to ensure robust data collection and reliable impact assessment.

In conclusion, the responses to the question about measuring the impact of research project results in the market highlight a diverse and layered approach to impact assessment. The emphasis on market penetration, customer feedback, and revenue generation underscore the need for stakeholders to evaluate both the commercial viability and user acceptance of innovative energy solutions. This aligns with the policy which advocates for comprehensive evaluation frameworks that support the successful commercialisation of research outcomes. By adopting a multifaceted approach to measuring impact, stakeholders can better navigate the complexities of the energy market and enhance the overall effectiveness of their innovations.

4.4. Factors Influencing Industry Adoption

In the context of the policy paper, understanding the factors influencing industry adoption of innovative solutions is crucial for maximising the benefits of public-funded research projects. The survey results reveal that a significant 78% of industry stakeholders are engaged in high TRL public-funded research projects (see Figure 14). This strong participation underscores the critical role of public funding in facilitating access to advanced technologies and fostering innovation within the energy sector. Furthermore, the fact that 72% of respondents indicated they would not have pursued the same projects using their own company funds highlights the essential support that public funding provides (see Figure 15).

This subchapter will explore the various factors that drive industry adoption, including the influence of funding mechanisms, the importance of collaboration with research institutions, market dynamics, and the alignment of project outcomes with industry needs. By identifying and analysing these factors, stakeholders can better understand how to enhance the successful implementation of project results and ensure that innovative solutions achieve widespread market acceptance.

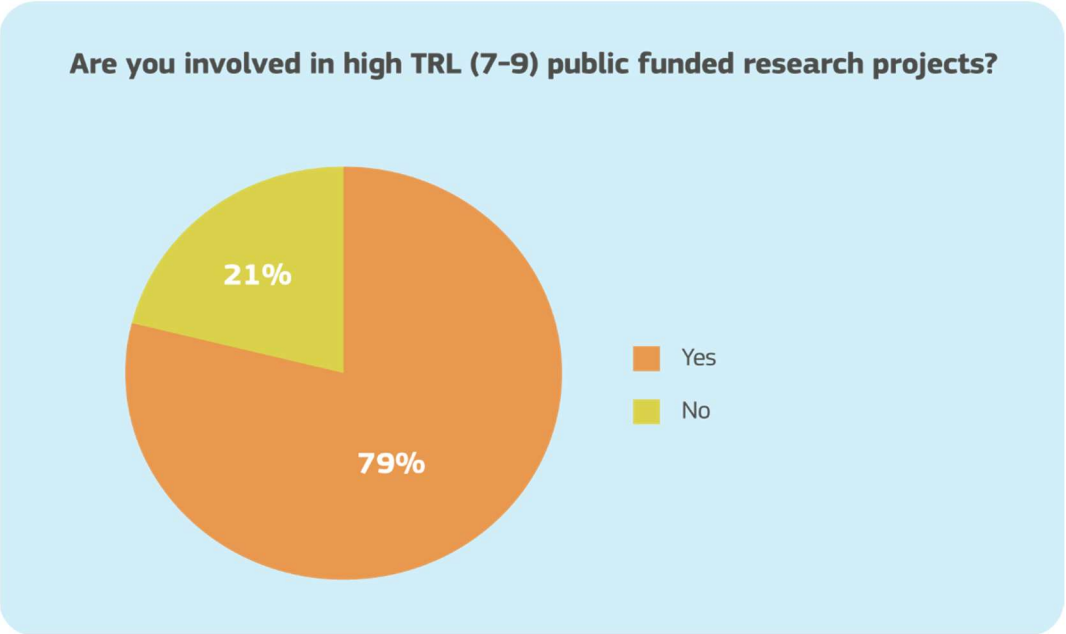

Figure 14 Survey results: involvement in high TRL research projects

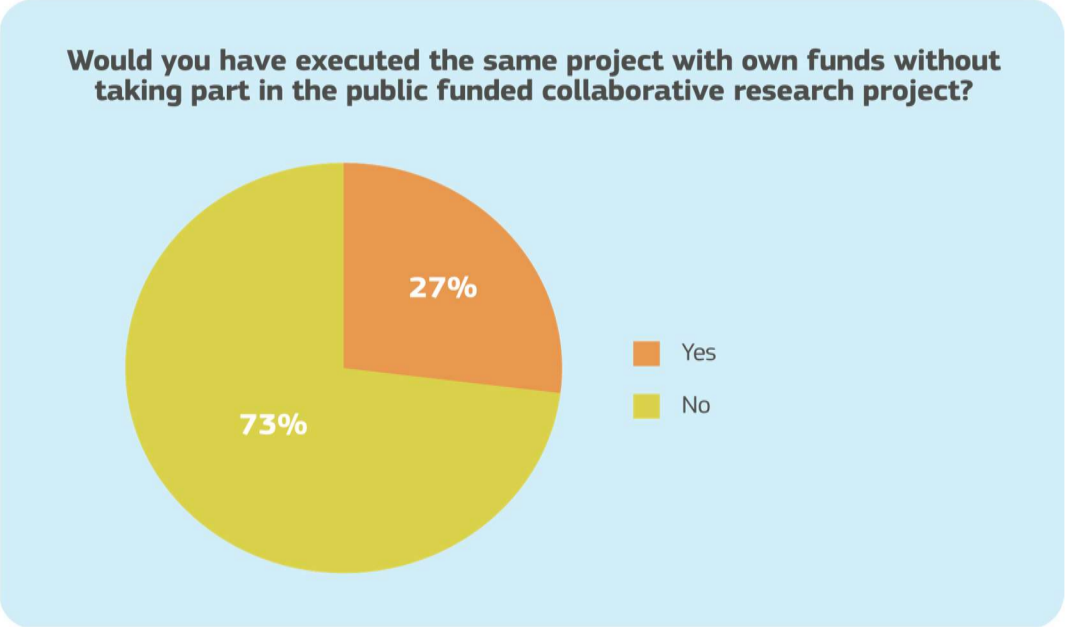

Figure 15 Survey results: impact of funding on hight TRL projects

Half of the industry stakeholders answering the survey are ready to invest in high TRL projects to financially cover "the last mile" to market implementation of the project results. However, 23 % of research partners see the lack of industry adoption as the main obstruction for bringing their results to the market. A conclusion from this result is that fora should be organised where the interested industry partners should be brought in contact with researchers presenting their project results.

Key factors that influence industry adoption:

- **Market Demand**: The level of market demand, customer needs, and industry trends in the energy sector play a critical role in influencing industry adoption. Innovations that address pressing energy needs, such as renewable energy solutions, energy efficiency technologies, and grid modernisation, are more likely to be adopted by industry stakeholders.

- **Value Proposition**: The value proposition, benefits, and competitive advantages of energy innovations are key factors that influence industry adoption. Industry stakeholders assess the value, return on investment (ROI), and impact of energy innovations in terms of cost savings, environmental benefits, energy security, and strategic advantages.

- **Technology Readiness**: The readiness, maturity, and scaleability of energy technologies or innovations influence industry adoption in the energy sector. Industry stakeholders evaluate the technical feasibility, reliability, and compatibility of energy innovations with existing energy systems, infrastructure, and regulatory frameworks.

- **Regulatory Compliance**: Regulatory requirements, standards, and compliance obligations in the energy sector impact industry adoption of energy innovations. Innovations that meet energy regulations, address compliance requirements, and contribute to sustainability goals are more likely to be adopted by industry stakeholders.

- **Market Validation**: Market validation, customer feedback, and user acceptance are important factors that influence industry adoption of energy innovations. Industry stakeholders look for evidence of market validation, user satisfaction, and fit with energy market needs to assess the viability and acceptance of energy innovations.

- **Risk and Uncertainty**: The level of risk, uncertainty, and perceived barriers associated with energy innovations influence industry adoption in the energy sector. Industry stakeholders evaluate the risks, challenges, and potential obstacles of adopting energy innovations, such as technology risks, market risks, and implementation risks.

- **Competitive Landscape**: The competitive landscape, market dynamics, and industry competition impact industry adoption of energy innovations. Industry stakeholders assess the competitive positioning, differentiation, and market advantage of energy innovations compared to existing energy solutions, competitors, and market alternatives.

- **Resource Availability**: The availability of resources, funding, expertise, and infrastructure influences industry adoption. Industry stakeholders consider the resource requirements, investment needs, and operational capabilities needed to adopt and implement the innovation effectively.

- **Partnerships and Collaboration:** Collaborative partnerships, industry alliances, and technology transfer opportunities can facilitate industry adoption of energy innovations. Industry stakeholders look for collaboration opportunities, strategic partnerships, and co-development initiatives that enhance the adoption and implementation of energy innovations.

- **Change Management:** The readiness for change, organisational culture, and change management processes within industry stakeholders impact adoption. Industry stakeholders assess their capacity for change, organisational readiness, and internal alignment to support the adoption and integration of the innovation.

- **Training and Support**: The availability of training, support, and technical assistance can influence industry adoption. Industry stakeholders look for training programs, technical support, and implementation assistance to facilitate the adoption, deployment, and utilisation of the innovation. Training Industry partners to gain necessary skills related to the project results could also be a task of researchers. A dedicated “innovation to market” funding instrument could include such a training phase.

- **Sustainability and Impact:** The sustainability, long-term impact, and societal benefits of energy innovations can influence industry adoption in the energy sector. Industry stakeholders consider the environmental impact, social responsibility, and long-term value proposition of energy innovations in their adoption decisions to drive a more sustainable energy future.

5. Significance of Research and Technology Organisations in Market Adoption

Research and Technology Organisations (RTOs) play a key role in helping turn complex research outcomes into viable products and services.[60]

One of the primary functions of RTOs is to act as intermediaries between research institutions (like universities) and the market. Many research projects yield valuable insights and breakthroughs, but without the proper channels for commercialisation, these innovations can remain confined to academic circles. RTOs help bridge this gap by providing the necessary expertise and resources to guide researchers through the process of bringing their innovations to market. They work closely with researchers to identify potential applications, target markets, and pathways for commercialisation, ensuring that research outcomes are not lost to obscurity[61].

A critical aspect of RTOs' work is technology transfer.[62] RTOs specialise in this process, helping to license technologies, establish partnerships, and navigate the complexities of commercialisation. By providing a structured approach to technology transfer, RTOs increase the likelihood that research findings will be adopted by industry and ultimately benefit society.

Navigating the regulatory landscape is another significant challenge that RTOs help overcome. Many sectors, particularly healthcare and technology, are subject to stringent regulations that can delay or even derail the commercialisation of innovations. RTOs often possess the expertise needed to guide projects through the necessary regulatory approvals, ensuring compliance with relevant laws and standards. This support is invaluable, as it can significantly reduce the time and resources required to bring a product to market, making it more attractive to potential investors and partners.

Capacity building is a fundamental part of the RTO mandate. They often provide training and development programmes for researchers and entrepreneurs. This training can cover various aspects, including business development, marketing strategies, and understanding market dynamics. By fostering a culture of entrepreneurship and innovation, RTOs empower researchers to take ownership of their findings and pursue commercial opportunities confidently.

Additionally, RTOs facilitate pilot programmes and prototyping initiatives that allow researchers to test their innovations in real-world settings. By evaluating the effectiveness and feasibility of research outcomes in practical applications, RTOs help researchers make necessary adjustments, thereby increasing the chances of market success.

RTOs play a vital role in the dissemination of knowledge. They actively share research findings through workshops, conferences, and publications. This dissemination is crucial for raising awareness about new technologies and research outcomes, which can generate interest and demand in the market. By promoting dialogue and collaboration among researchers, industry stakeholders, and policymakers, RTOs contribute to a more informed and dynamic innovation ecosystem.

5.1. Technology Development

In high TRL energy projects, strategic planning for technology development is pivotal for bridging the gap between innovation and market implementation. Stakeholders should adopt a structured and systematic approach and consider

[60] Rincón Díaz, C. A., & Albors Garrigós, J. (2017). Research and technology organisations' mobilizers of the regional environment: Competitive strategies. *European Journal of Management and Business Economics*, 26(2), 113-126. https://doi.org/10.1016/j.ejme.2017.05.001

[61] https://joint-research-centre.ec.europa.eu/system/files/2015-12/JRC97781.pdf

[62] Hilkenmeier, F., Fechtelpeter, C. & Decius, J. How to foster innovation in SMEs: evidence of the effectiveness of a project-based technology transfer approach. *J Technol Transf* (2021). https://doi.org/10.1007/s10961-021-09913-x

the following:

- **Advanced Prototyping and Validation**: Prioritising advanced prototyping, pilot testing, and validation of energy technologies enables stakeholders to showcase the performance, reliability, and feasibility of the innovation to potential investors, partners, and customers. Through advanced prototyping, the value proposition, features, and functionalities of energy technologies can be effectively demonstrated, instilling confidence, and generating interest in the market.

- **Performance Optimisation**: Fine-tuning the performance, efficiency, and functionality of energy technologies enhances their competitiveness, market appeal, and value proposition. By optimising the technology based on user feedback, testing results, and market validation, stakeholders can address energy market needs, user requirements, and industry standards, thereby increasing the likelihood of market adoption.

- **Regulatory Compliance and Market Validation**: Addressing regulatory compliance requirements and conducting market validation activities are crucial to ensuring that energy technologies meet legal, safety, and quality standards, as well as market demands and user preferences. Compliance with energy regulations and alignment with market needs are essential for gaining market acceptance, building trust, and facilitating market entry.

- **Scale-up and Commercialisation:** Planning for scale-up, production, and commercialisation of energy technologies involves developing a robust commercialisation strategy, go-to-market plan, and partnership opportunities. By identifying distribution channels, sales channels, and commercialisation pathways, stakeholders can accelerate the market uptake, adoption, and impact of energy technologies.

- **Technology Transfer and Collaboration:** Facilitating technology transfer, knowledge exchange, and collaboration with industry partners, stakeholders, and end users accelerate the market uptake and deployment of energy technologies. Collaborating with industry stakeholders enables energy innovators to leverage industry expertise, resources, and market insights to drive successful commercialisation and market penetration.

- **Documentation, Training, and Risk Management:** Providing comprehensive technical documentation, user training, and support resources enhances the understanding and effective utilisation of energy technologies by users, customers, and stakeholders. Effective documentation, training, and support contribute to enhanced user adoption, satisfaction, and engagement, thereby driving market uptake and success. Additionally, implementing robust risk management strategies, contingency plans, and mitigation measures helps address technical, market, and operational risks that may impact the successful commercialisation of energy technologies.

5.2. Testing and Validation

Testing and validation play a crucial role in bridging the gap between innovation and the market by providing evidence, assurance, and validation of the innovation's technical feasibility, performance, and market readiness, and mitigate risks associated with technology development a nd commercialisation. Please find a summary of very relevant publications in this field under the following link https://www.iea-isgan.org/our-work3/wg_5/resources/ provided by the Smart Grid International Research Facility Network (SIRFN)[63], a network of smart grid researchers with test-bed facilities in countries participating in the Implementing Agreement for a Cooperative Programme on Smart Grids (ISGAN)[64]. SIRFN empowers participating countries to assess pre-competitive technologies and system approaches across various Smart Grid implementation scenarios and geographies using standardized testing procedures. The research conducted within each member country leverages the unique capabilities and environments of partner nations. Test data is made public to expedite the progress of Smart Grid technologies, systems, and policies.

Testing and validation can help in advancing innovation within the energy sector, particularly in the development of power grids and the electric power industry. Here are some of the benefits:

- **Confirm Technical Feasibility**: Testing and validation activities are instrumental in confirming the technical feasibility, functionality, and performance of innovative energy technologies. Rigorous testing, simulation, and

[63] http://www.iea-isgan.org/our-work/annex-5/about-sirfn/
[64] http://www.iea-isgan.org/

verification processes help validate that the technology operates as intended, meets technical specifications, and aligns with the requirements of the power grid and electric power sector.

- **Ensure Quality and Reliability:** Testing and validation procedures ensure that energy innovations meet stringent quality standards, reliability requirements, and performance expectations. By subjecting the technology to various conditions, scenarios, and operational tests, stakeholders can assess its reliability, robustness, and resilience in real-world power grid environments.

- **Validate User Requirements**: Testing and validation help validate user requirements, user experience, and user acceptance of energy innovations within the power grid sector. Through user feedback, usability testing, and validation sessions, stakeholders can ensure that the technology meets the specific needs, preferences, and expectations of grid operators, energy providers, and end users, enhancing its market appeal and adoption.

- **Address Regulatory Compliance**: Testing and validation activities are crucial for addressing regulatory compliance requirements, safety standards, and industry regulations within the electric power sector. By testing the innovation for compliance with legal, safety, and quality standards relevant to the power grid and energy industry, stakeholders can ensure that the technology meets regulatory requirements and is prepared for market entry and adoption.

- **Identify and Mitigate Risks**: Testing and validation help identify and mitigate technical risks, performance issues, and operational challenges that may impact the successful integration of energy innovations within the power grid. Through risk assessments, failure mode analysis, and performance testing, stakeholders can proactively address potential risks, optimise performance, and enhance the readiness of the technology for grid implementation.

- **Optimise Performance and Functionality**: Testing and validation activities play a key role in optimising the performance, functionality, and features of energy innovations tailored for the power grid and electric power sector. By iteratively testing, refining, and validating the technology based on user feedback, testing results, and market validation, stakeholders can enhance its competitiveness, usability, and alignment with industry requirements.

- **Build Credibility and Trust:** Testing and validation processes build credibility, trust, and confidence in energy innovations targeted at the power grid and electric power industry. By providing evidence of rigorous testing, validation, and verification, stakeholders can instil trust in potential investors, grid operators, energy providers, and customers, fostering greater acceptance and adoption of the technology within the energy sector.

- **Facilitate Market Entry**: Testing and validation activities facilitate the market entry, adoption, and commercialisation of energy innovations within the power grid and electric power industry. By validating the technology through comprehensive testing, validation, and verification processes, stakeholders can accelerate its integration into the grid infrastructure, drive adoption among energy stakeholders, and create value for end users and the broader energy ecosystem.

5.3. Industry Engagement and Support

Industry partners offer invaluable expertise, resources, market insights, and collaboration opportunities that are essential for the successful commercialisation of innovative energy solutions. They often have access to valuable resources, facilities, and infrastructure that can support the development, testing, and deployment of energy technologies. By engaging with industry stakeholders, energy innovators can leverage these resources to accelerate the commercialisation process, reduce costs, and enhance the scaleability of their solutions. Additionally, industry stakeholders provide a crucial perspective on market demand, user requirements, and competitive landscape in the energy sector. By building relationships with industry partners, energy innovators can access new markets, distribution channels, and commercialisation pathways, as well as foster innovation ecosystems that support technology development and adoption. Industry stakeholders can provide valuable insights into regulatory requirements, policy frameworks, and compliance standards in the energy sector.

Key strategies for effectively engaging industry stakeholders in the energy and power sectors include:

- **Identify Key Stakeholders:** Identify relevant industry stakeholders in the energy, power grid development, and electric power sectors, such as energy companies, grid operators, technology providers, investors, and regulatory bodies, who can contribute to the commercialisation of your energy innovation.

- **Communicate Value Proposition**: Clearly communicate the value proposition, benefits, and market potential of your energy innovation to industry stakeholders. Articulate how your innovation addresses energy challenges, enhances grid reliability, and offers sustainable solutions for the electric power sector.

- **Collaborative Partnerships:** Explore collaboration opportunities with industry stakeholders in the energy and power sectors to co-develop, pilot, test, or commercialise your energy innovation. Seek strategic partnerships, joint ventures, licensing agreements, or technology transfer opportunities aligned with the goals of grid modernisation and energy transition. Testing and validation, in particular using approaches like Hardware in the Loop (HIL), can reduce development time as well as time to market. Valuable for industrial partner, to compete with industry from other global regions.

- **Seek Feedback:** Solicit feedback, input, and insights from industry stakeholders on your energy innovation, market strategy, and commercialisation plan. Incorporate stakeholder feedback to refine your innovation, address energy market needs, and enhance market readiness in the power grid development sector.

- **Participate in Industry Events:** Attend energy industry events, power grid conferences, exhibitions, and trade shows to showcase your energy innovation, network with industry stakeholders, and stay informed about energy trends, opportunities, and challenges in the electric power sector.

- **Provide Value-Added Solutions:** Demonstrate how your energy innovation can provide value-added solutions, enhance grid efficiency, and contribute to sustainability goals in the electric power industry. Highlight the benefits, ROI, and performance improvements that your energy solution offers to potential partners and customers in the power grid development sector.

- **Customise Solutions:** Tailor your energy innovation, grid solutions, or services to meet the specific needs, requirements, and preferences of industry stakeholders in the power grid and electric power sectors. Customise solutions, pricing models, and deployment strategies to align with industry standards and energy market expectations.

- **Showcase Success Stories:** Share success stories, case studies, testimonials, and use cases that illustrate the impact, benefits, and outcomes of your energy innovation for industry stakeholders in the power grid development and electric power sectors. Highlight real-world examples of how your energy solution has addressed energy challenges, optimised grid operations, and delivered value to customers.

5.4. Key Areas

With regard to researchers several key areas can also be addressed, which can be strongly supported with measures by the European Commission.

1. **Interdisciplinary Collaboration**: The complexity of smart grids necessitates interdisciplinary research, integrating knowledge from fields such as engineering, data science, economics, and social sciences. Researchers should seek collaborative opportunities to ensure that technological advancements are aligned with economic and societal needs.
   Support: The European Commission can facilitate interdisciplinary collaboration by funding research consortia that bring together experts from diverse fields and by creating platforms for cross-disciplinary exchange.

2. **Focus on System Resilience and Security**: As smart grids become more integrated and data-driven, it is paramount to ensure the resilience and security of these systems against cyber threats. Researchers should prioritise the development of robust cybersecurity measures, alongside strategies for rapid recovery and resilience in the face of disruptions.

Support: The European Commission can allocate dedicated research funding for cybersecurity in smart grids, encouraging the development of advanced tools and frameworks to safeguard these systems.

3. **Innovation in Energy Storage and Management**: The effective management and storage of energy, particularly from renewable sources, are pivotal for the success of smart grids. Researchers should explore new materials, technologies, and algorithms for energy storage solutions that are both cost-effective and efficient. Additionally, innovative approaches to demand response and energy management should be developed to optimise energy use across the grid.
   Support: The European Commission can support these efforts by launching calls for research proposals focused on breakthrough technologies in energy storage and management.

4. **Scaleability and Integration**: As smart grid technologies evolve, it is essential to ensure their scaleability and seamless integration with existing infrastructure. Researchers should focus on developing modular and flexible solutions that can be easily adapted to different scales and regions. This includes the standardisation of protocols and interfaces to ensure interoperability across different systems and devices.
   Support: The European Commission can help by promoting the development of European standards for smart grid technologies and providing funding for projects that focus on scalable solutions.

5. **User-Centric Design and Acceptance**: The success of smart grids also hinges on user acceptance and engagement. Researchers should investigate user behaviour, preferences, and barriers to adoption, developing user-centric designs that encourage participation and support from the public. Understanding the social dynamics at play will be key in fostering broad acceptance and effective use of smart grid technologies.
   Support: The European Commission can sponsor social science research on consumer behaviour and can promote public engagement campaigns based on research findings.

6. **Policy Support and Alignment**: Finally, researchers should actively engage with policymakers to ensure that their work is aligned with regulatory frameworks and policy objectives. By providing evidence-based insights and recommendations, researchers can help shape policies that support innovation while addressing the economic, social, and environmental impacts of smart grids. This includes contributing to the development of standards and best practices that will guide the deployment of smart grid technologies.
   Support: The European Commission can establish advisory committees that include researchers, ensuring that scientific insights directly inform policy decisions and regulatory developments.

By taking these strategic measures the European Commission, as well as national policymakers, and researchers can ensure that Europe has a financially competitive energy system at the forefront of smart grid innovation, ultimately leading to a more sustainable, efficient, and secure energy system for all its citizens.

6. Conclusions and Policy Recommendations for Accelerating Market Uptake of Project Results

Implementing strategic policy recommendations that support innovation, entrepreneurship, and commercialisation efforts, strongly contribute to accelerating the market uptake of proven technology derived from concrete project results. These policy recommendations should remove barriers, drive market adoption of innovative projects and generally provide an incentivising framework.

To the stakeholders: By advocating for and implementing these policy changes and the enabling framework, you aim to shift the focus from merely overcoming obstacles to promoting investment, fostering innovation-driven entrepreneurship, and creating a supportive ecosystem. This approach will accelerate the adoption of sustainable energy solutions.

At a systemic level, the successful commercialization of innovative projects is paramount. Creating an environment rich in opportunities can cultivate a competitive, dynamic, and innovative economy. This foundational shift not only facilitates the integration of new technologies but also encourages further investment and calculated risk-taking, ultimately bridging the gap between innovation and market success.

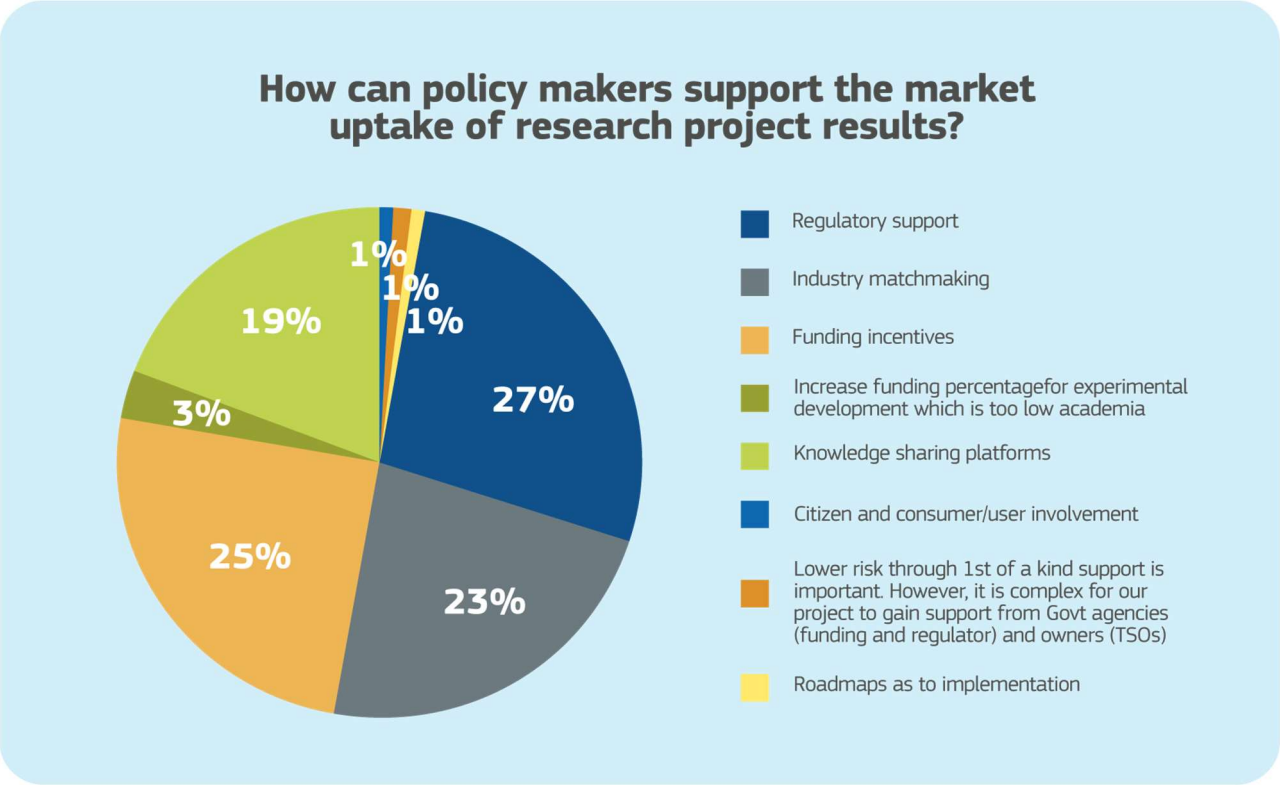

Figure 16 Survey results: ways policymakers can support the market uptake of research project results

To support the successful market uptake of research project results, policymakers can implement several strategies. According to the survey, **25%** of respondents emphasize the importance of providing funding incentives, while another **27%** highlight the need for regulatory support. Additionally, **23%** of respondents suggest that industry matchmaking is crucial for connecting researchers with industry partners. Knowledge-sharing platforms are also significant, with **19%** of respondents recognizing their value in disseminating research findings. A small percentage (**5%**) have other unique ideas.

By focusing on these key areas, policymakers can effectively bridge the gap between innovation and practical application.

The following section describes ten key policy recommendations for accelerating market uptake of projects results, namely:

- Energy Innovation Incentives
- Public-Private Partnerships in Energy
- Regulatory Reform for Energy Innovation
- Energy Technology Transfer Programs
- Energy Market Access Initiatives
- Startup Support in Energy Innovation
- Industry Collaboration for Energy Innovation
- Energy Skills Development
- Energy Market Intelligence
- Evaluation and Monitoring of Energy Projects

Energy Innovation Incentives

: (1) Energy innovation incentives, including grants, and funding programs, to stimulate research, development, and commercialisation of innovative energy projects. (2) Financial support and resources to promote innovation-driven entrepreneurship and technology adoption in the energy sector, power grid development, and the electric power industry.

The European Commission is actively working to promote energy innovation through various programs and initiatives. Here are some key measures[65]:

- **Innovation Fund:** This is one of the world's largest funding programs for the deployment of innovative net-zero and low-carbon technologies. It is financed by revenues from the EU Emissions Trading System (EU ETS) and aims to help businesses invest in clean energy and bring technologies to market that can decarbonize European industry[66].
- **Horizon Europe**: The EU's research and innovation funding program, which succeeds Horizon 2020, invests around €5.6 billion in research and innovation to support the European Green Deal. This includes funding for projects in the areas of energy efficiency, renewable energy, power grids, and interconnectors.
- **Connecting Europe Facility (CEF): This funding instrument supports investments in EU infrastructure** networks for energy, transport, and digital infrastructure. The CEF has a budget of €42.3 billion for 2021-2027, with €8.7 billion allocated to energy projects.
- **European Investment Bank (EIB):** The EIB provides loans and other financial instruments to finance energy projects, focusing on renewable energy, energy efficiency, and power grids. The EIB also launched the European Investment Advisory Hub to provide advice and expertise on project development.
- **European Fund for Strategic Investments (EFSI):** This joint initiative between the EIB Group and the Commission aims to mobilize private investment in strategically important projects, including those in energy efficiency, renewable energy, and power grids.
- **European Regional Development Fund (ERDF):** The ERDF finances programs to reduce economic and social disparities between EU regions, including investments in energy projects that benefit the environment.

These measures collectively aim to stimulate research, development, and commercialization of innovative energy projects, promote entrepreneurship and technology adoption in the energy sector, and support the development of power grids and the electric power industry.

Recommendations for further promoting Innovation and Research. Innovation is at the heart of electric energy system

[65] https://energy.ec.europa.eu/topics/funding-and-financing/eu-funding-possibilities-energy-sector_en
[66] https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/innovation-fund_en

development. European institutions, therefore, need to continue investing in research and development (R&D) to drive technological advancements in this field. The establishment of **innovation hubs**, where academia, industry, and government can collaborate, is a strategic approach to bridge the gap between research and market-ready solutions.

To further promote innovation and research, it is essential to emphasize **the urgency of accelerating the time-to-market for innovative solutions.** Given the rapid evolution of the energy sector's needs and the swift pace of digital technological developments, this is particularly critical. Implementing agile funding mechanisms that enable companies to quickly respond to market changes is imperative. By prioritizing fast-track funding and streamlined processes, we can ensure that new technologies and solutions are developed and introduced to the market in a timely manner, meeting the sector's demands and fostering continuous advancement.

In addition, the European Commission should increase funding for **pilot projects** that demonstrate the viability of new technologies in real-world settings. These pilot projects not only serve as testbeds for innovation but also help build the business case for wider deployment.

To further enhance energy innovation incentives, the European Commission could consider implementing the following concrete measures:

- **Expand Innovation Fund**: Increase the budget and scope of the Innovation Fund to support a wider range of innovative projects, especially those focusing on emerging technologies.
- **Support for Startups**: Create dedicated funding programs and incubators for startups in the energy sector to help them scale up their innovative solutions.
- **Cross-Border Collaboration**: Encourage cross-border collaboration on energy projects to share knowledge, resources, and best practices across EU member states.
- **Regulatory Sandboxes**: Expand regulatory sandboxes to allow for testing and development of new energy technologies in a controlled environment with regulatory oversight.
- **Market Access Support**: Provide support for market access, helping innovators navigate the complexities of entering new markets and scaling their solutions.

Energy innovation incentives include grants and funding programmes. These incentives focus on the power and electric grid sector as it undergoes a paradigm shift and they accomplish the following:

- They provide financial support, resources, and incentives, which stimulate research, development, up to commercialisation of innovative energy projects.
- They support research collaboration, knowledge exchange, and technology transfer initiatives; fostering collaboration between research institutions, industry partners, and technology developers, drives innovation, technology adoption, and market implementation of innovative technologies, solution and systemic approaches.
- They accelerate the commercialisation process, by targeting various steps in the process, for example specifically facilitating the transition from laboratory to market.
- They enable innovators to scale up solutions, attract investment and secure market adoption even in the transitioning energy sector.
- They promote entrepreneurship and technology adoption, by specifically incentivising startups, small business, and innovators developing and commercialising energy solutions.
- They reduce the financial burden on the innovator, attract investment and mitigate the risk in the development and the commercialisation process, thus making it attractive for stakeholders to invest in energy innovation and technology adoption.
- They create a vibrant framework to attract more innovation in the power grid development and electric power industry, even as it undergoes a paradigm shift.
- They drive market uptake of innovative energy solutions, by making these technologies more competitive, affordable and accessible in the energy sector; thus, encouraging energy consumers, businesses, and utilities to adopt innovative technologies, accelerate market penetration, and drive widespread adoption of energy innovations in the power grid development and electric power industry.

Public-Private Partnerships in Energy (PPP): *(1) Public-private partnerships to encourage collaboration between government agencies, industry stakeholders, research institutions, and startups in the energy sector. (2) Platforms for knowledge sharing, technology transfer, and collaborative projects to drive innovation, market uptake, and economic growth in energy and power grid development*

Facilitating Public-Private Partnerships. The scale and complexity of smart grid deployment necessitate collaboration between the public and private sectors. Public-private partnerships (PPPs) can leverage the strengths of both sectors, combining public oversight with private sector efficiency and innovation.

The European Commission supports public-private partnerships through various industrial alliances to bridge the gap between innovation and the market by bringing together stakeholders to collaborate on research and innovation projects.[67] Notable alliances include the European Clean Hydrogen Alliance, which focuses on hydrogen technologies; the European Battery Alliance, aimed at making Europe a leader in sustainable battery production; the European Raw Materials Alliance, which addresses the supply chain for rare earth and magnet materials; and the European Solar Photovoltaic Industry Alliance, which enhances the resilience and strategic autonomy of the solar PV value chain. These alliances facilitate joint action, resource pooling, and knowledge sharing to drive innovation and bring new technologies to market more efficiently[68].

The European Commission should encourage the formation of PPPs by providing a *framework* that facilitates these collaborations, *including guidelines* for risk-sharing and return on investment. By doing so, the Commission can help ensure that the necessary resources and expertise are mobilised to bring smart grid projects to fruition.

General Partnership Role: By working together, public, and private sector partners can accelerate the development and commercialisation of innovative energy solutions, addressing market needs, and driving sustainable growth. Energy sector Public-Private Partnerships (PPPs)[69] foster collaboration between government agencies, industry stakeholders, research institutions, and startups.

These partnerships create a conducive environment for knowledge sharing, technology transfer, and collaborative projects while maintaining a view on the pipeline from innovation, market uptake, to economic growth.

PPPs help bridge the gap from innovation to market by leveraging the strengths and capabilities of each partner as follows:

- Government agencies provide funding, regulatory support, and policy guidance to incentivise innovation and streamline the market entry framework and conditions.
- Research institutions contribute cutting-edge research, technical expertise, and innovation know-how to develop and test new energy solutions.
- Industry stakeholders bring industry insights, market knowledge, and commercialisation expertise to the partnership, helping to identify market opportunities, validate technology solutions, and drive adoption in the energy sector.
- Startups bring agility, creativity, and entrepreneurial spirit to drive innovation and disrupt the market with novel technologies.

PPPs establish platforms for:

- Collaboration, knowledge sharing, and technology transfer that enable stakeholders to co-create, pilot, and scale

[67] https://research-and-innovation.ec.europa.eu/research-area/transport/public-private-partnerships_en
[68] https://single-market-economy.ec.europa.eu/industry/industrial-alliances_en
[69] https://www.eib.org/attachments/lucalli/20230009_epec_market_update_2022_en.pdf

up innovative energy projects.

- Facilitating the exchange of ideas, best practices, and lessons learned among partners.
- Creating opportunities for joint research projects, technology demonstrations, and pilot initiatives that showcase the feasibility, performance, and market potential of innovative energy solutions, attracting investment, and driving commercialisation in the energy and power grid development sectors.
- Driving innovation and accelerating the market uptake of energy technologies.

PPPs unlock synergies, align incentives, and mobilise resources to address energy challenges, drive competitiveness, and promote sustainable energy solutions. These partnerships enable the development of a vibrant ecosystem of energy innovators, startups, and industry players that collaborate to drive innovation, accelerate market uptake, and create value for society, the economy, and the environment.

Regulatory Reform for Energy Innovation: *(1) Streamlined regulatory processes, minimised administrative burdens, and innovation-friendly regulatory frameworks to support the commercialisation of energy projects. (2) Regulatory reforms to facilitate market entry, technology adoption, and entrepreneurship in the electric power sector while ensuring consumer protection and safety in energy innovation.*

The European Commission is actively working on regulatory reforms to support energy innovation:

- **Streamlined Regulatory Processes**: The Commission has been working on simplifying regulatory processes to reduce administrative burdens. This includes revising several pieces of EU legislation, such as the Electricity Regulation, the Electricity Directive, and the REMIT Regulation. These reforms aim to create a more innovation-friendly regulatory framework that supports the commercialization of energy projects[70].
- **Facilitating Market Entry and Technology Adoption**: The Commission has introduced reforms to the electricity market design to make it easier for new technologies and market players to enter the market. This includes provisions for long-term contracts for clean power production, which help stabilize prices and reduce risks for both consumers and suppliers. Additionally, the reforms empower consumers by giving them more choices and clearer information before signing contracts.
- **Ensuring Consumer Protection and Safety**: The regulatory reforms also focus on protecting consumers. Measures include better protection for vulnerable consumers and energy-poor households, ensuring they are not disconnected from power during crises. The reforms also aim to reduce the risk of supplier failure and strengthen consumer protection by requiring suppliers to manage their price risks more effectively.

These efforts are part of the broader European Green Deal objectives and the REPowerEU plan, which aim to make energy more affordable, secure, and sustainable[71].

The Net-Zero Industry Act (NZIA) supports regulatory reforms by creating a framework to boost the competitiveness of EU industry and technologies crucial for decarbonisation. It aims to enhance European manufacturing capacity for net-zero technologies and their key components, addressing barriers to scaling up production.[72] The Act simplifies the regulatory framework, attracting investments and improving market access for clean tech in the EU. It also sets ambitious goals, such as ensuring that at least 40% of the EU's annual deployment needs for net-zero technologies are met by 2030. This supports the clean energy transition, improves energy resilience, and creates quality jobs[73].

Strengthening Regulatory Frameworks. A critical step for policymakers is to enhance existing regulatory frameworks to better support the integration and deployment of smart grid technologies. This includes the establishment of comprehensive standards for interoperability, data privacy, and cybersecurity. These standards are essential to fostering

[70] https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_23_6602/IP_23_6602_EN.pdf
[71] https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/research-and-innovation-repower-eu-2022-05-18_en
[72] https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en
[73] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en

consumer trust and ensuring that different systems can work seamlessly together, reducing barriers to the widespread adoption of smart grid solutions. The European Commission should play a leading role in harmonising these regulations across Member States to prevent market fragmentation. By creating a unified regulatory environment, the Commission can encourage investment and facilitate the scaling of smart grid technologies across borders.

Regulatory reform can drive innovation, accelerate market uptake, and foster economic growth in the energy industry. The European Commission's Joint Research Centre (JRC) report on regulatory experimentation highlights the role of regulatory tools like sandboxes and pilot projects in facilitating the energy transition. It emphasises the need for regulatory frameworks that can adapt to fast-changing environments while protecting consumers[74]. The Council of European Energy Regulators (CEER) report on regulatory frameworks for European energy networks discusses the importance of efficient regulatory regimes and the need for innovation-friendly policies to support energy projects[75]. The CEER report also covers new incentive mechanisms and regulatory adjustments aimed at fostering entrepreneurship and technology adoption in the energy sector.

The introduction of a market-based system (the system on Guarantees of Origin of renewable energy supply), along with government-led economic incentives did support increasing the uptake of renewable energy in domestic energy consumption in a Member State (i.e., the Netherlands) but that the system was subjected to heavy criticism. Consumer representatives and NGOs openly criticised the system for "cheating green electricity". A study revealed the important role of consumer organisations, NGOs and public opinion in the implementation process, as well as the flaws and national politics interests that impede sound harmonised implementation across EU Member States.

Streamlining regulatory processes:

- enables energy innovators to navigate complex regulatory requirements, obtain necessary approvals, and bring their technologies to market more efficiently.
- reduces administrative burdens, minimises bureaucratic hurdles, paperwork, and delays that can impede the commercialisation of energy projects, enabling innovators to focus on developing and scaling their technologies.

Creating innovation-friendly regulatory frameworks:

- supports the commercialisation of energy projects, which fosters a conducive environment for innovation, entrepreneurship, and technology adoption in the electric power sector.
- includes establishing clear guidelines, standards, and incentives that promote innovation and market uptake, and encourages energy stakeholders to invest in new technologies, adopt innovative solutions, and drive sustainable growth in the energy industry.
- ensures consumer protection and safety in energy innovation which is crucial for building trust, credibility, and confidence in new technologies.
- addresses consumer concerns, safety risks, and regulatory compliance requirements, regulatory reform, which enhances market acceptance, adoption, and deployment of innovative energy projects, safeguarding consumers and promoting the responsible use of technology in the electric power sector.

Energy Technology Transfer Programmes:

(1) Technology transfer programmes, technology commercialisation offices, and innovation hubs to transfer research outcomes, intellectual property, and technology know-how from energy research institutions to industry partners. (2) Technology transfer initiatives to accelerate market uptake and deployment of innovative energy projects.

Energy technology transfer programmes facilitate the commercialisation of innovative energy projects by providing a structured framework for technology transfer, knowledge exchange, and collaboration between academia and industry. In the USA for example The Department of Energy (DOE) offers various programmes: the Technology Commercialisation

[74] https://ses.jrc.ec.europa.eu/publications-list/making-energy-regulation-fit-purpose-state-play-regulatory-experimentation-eu
[75] https://www.ceer.eu/publication/report-on-regulatory-frameworks-for-european-energy-networks-2023/

Fund (TCF), Energy I-Corps, and the Energy Program for Innovation Clusters (EPIC)[76]. They also facilitate the transition of research innovations from the lab to the market and invite industry partners to adopt cutting-edge technologies[77].

The European Commission has several initiatives and programs aimed at facilitating technology transfer and commercialization in the energy sector. One of the key programs is the **Strategic Energy Technology Plan (SET Plan)[78]:**

- **Energy Research Institutions**: The SET Plan helps coordinate national research efforts and aligns them with EU-wide goals, ensuring that cutting-edge research findings are translated into practical solutions.
- **Technology Commercialization Offices**: The European Technology and Innovation Platforms (ETIPs) support the implementation of the SET Plan by bringing together EU countries, industry, and researchers to promote market uptake of key energy technologies.
- **Innovation Hubs**: The SET Plan includes Implementation Working Groups (IWGs) that focus on key technologies and foster collaboration, entrepreneurship, and technology adoption in the energy sector.

Several measures to improve Energy Technology Transfer Programmes can be taken:

- **Enhance Coordination and Collaboration**: Strengthen the coordination between technology transfer programmes, technology commercialisation offices, and innovation hubs. This can be achieved by creating a unified framework that facilitates seamless collaboration and knowledge exchange among these entities.
- **Promote Industry Partnerships**: Foster partnerships between energy research institutions and industry players through matchmaking initiatives, networking events, and collaborative projects. This can help bridge the gap between research and market implementation.
- **Develop Knowledge-Sharing Platforms**: Establish and enhance knowledge-sharing platforms where researchers, industry professionals, and policymakers can exchange information, best practices, and innovations. These platforms can include online databases, conferences, and forums.
- **Create Regional Innovation Clusters**: Develop regional innovation clusters focused on energy technology, where research institutions, startups, and established companies can collaborate closely. These clusters can benefit from shared resources, infrastructure, and networking opportunities.
- **Strengthen International Cooperation**: Foster international cooperation and exchange of best practices in energy technology transfer. Collaborating with other countries and international organizations can bring new perspectives and enhance the effectiveness of programmes.
- **Support the Development of Energy Ecosystems**: Develop comprehensive energy ecosystems that include a range of stakeholders, from research institutions and startups to large corporations and government agencies. These ecosystems can foster collaboration, knowledge exchange, and the commercialization of new technologies.

Startup Support in Energy Innovation: *Energy-focused incubators, accelerators, mentorship programs, and funding opportunities to support energy startups, entrepreneurs and SMEs. Ecosystem to incentivise entrepreneurship, innovation, and energy startups driving market uptake of innovative energy projects*.

Support for energy innovation startups comes in the form of energy-focused incubators, accelerators, mentorship initiatives, and funding opportunities[79]. The goal is to provide a reliable framework and supportive ecosystem that nurtures entrepreneurship, fosters innovation, and accelerates the role energy startups as driving the market uptake of innovative energy projects.

The European Commission has several initiatives to support energy startups, entrepreneurs, and SMEs:

[76] https://www.energy.gov/technologytransitions/office-technology-transitions
[77] Sink, C.H., Easley, K. The basis for U.S. Department of energy technology transfer in the 1990s. *J Technol Transfer* **19**, 52–62 (1994). https://doi.org/10.1007/BF02371413
[78] https://setis.ec.europa.eu/about-set-plan_en
[79] https://www.startus-insights.com/innovators-guide/energy-startups/

- **EIC Fund (European Innovation Council Fund)**: This program provides grants and equity investments to promising startups and SMEs, helping them to develop their innovations and scale up operations.
- **Innovation Fund**: While it supports a broad range of organizations, including large-scale projects, it also offers funding opportunities that can be beneficial to startups developing innovative net-zero and low-carbon technologies.
- **New European Innovation Agenda**: This agenda focuses on deep-tech innovation and startups, providing measures to support private investment, experimental spaces, and regional innovation valleys.
- **Horizon Europe**: Through various calls for proposals, Horizon Europe supports innovative projects from startups and SMEs that contribute to energy independence and sustainability.

These programs create a supportive environment for energy-focused startups, helping them bring their innovations to market and drive the energy transition forward but are not dedicated programs to encourage start-ups development.

Tailored support and provision of resources to energy startups will help early-stage ventures navigate the challenges of technology development, commercialisation, and market entry in the energy sector.

- **Energy-focused incubators** provide startups with access to workspace, mentorship, networking opportunities, and industry connections that are essential for developing and scaling their energy innovations.
- **Accelerator programmes** offer intensive support, coaching, and guidance to assist startups in fine-tuning their business models, validating their technologies, and preparing for market entry, accelerating the growth and market uptake of innovative energy projects.
- **Mentorship programs** pair startups with experienced industry professionals, entrepreneurs, and mentors who provide guidance, advice, and support to help navigate the complexities of the energy sector, drive innovation, and overcome challenges in bringing energy technologies to market.
- **Targeted funding opportunities**, such as grants, seed funding, and investment programs, provide critical financial support to energy startups, enabling them to develop prototypes, conduct pilot projects, and scale up their innovations for commercialisation in the energy industry.

Energy Market Access Initiatives

: Market access initiatives, export promotion programmes, and market development strategies to spur innovative energy projects into new markets, to expand their geographic reach, and to drive market uptake on an international scale. Support in market entry, market validation, and market expansion to enhance global competitiveness of innovative energy projects.

Supporting Market Adoption. To ensure that innovative smart grid solutions reach the market, policymakers must create an environment that encourages early adoption. This could involve offering subsidies, tax incentives, or other financial mechanisms to reduce the upfront costs for businesses and consumers. Moreover, public awareness campaigns are crucial for educating stakeholders about the benefits of smart grids, such as increased energy efficiency and enhanced grid reliability. The European Commission can support these efforts by coordinating campaigns at the EU level, ensuring a consistent message across all member states.

Energy Market Access Initiatives provide essential support and resources to help innovative energy projects navigate the complexities of entering new markets, expanding their reach, and driving international market uptake in the energy sector. For example, the European Union has already developed cooperation structures for European Network Transmission Systems Operators (ENTSOs) for electricity, gas, and hydrogen, which create detailed network access rules and technical codes[80].

These initiatives cover a range of strategies, including the development of market access initiatives, export promotion programmes, and market development strategies.

[80] https://www.europarl.europa.eu/factsheets/en/sheet/45/internal-energy-market

Energy market access initiatives focus on supporting market entry, market validation, and market expansion efforts. They do so by supporting innovative energy projects in overcoming barriers and challenges in accessing new markets, thereby enhancing their global competitiveness. The framework allows to navigate regulatory requirements, understand customer preferences, and build partnerships with local stakeholders, all of which are critical for successful market entry and expansion. The framework provides guidance and support by enabling innovative energy projects to establish a foothold in new markets, to build credibility, and to gain traction among customers and investors.

Export promotion programmes are key to enable innovative energy projects tap into international markets. For example, the energy export initiative by Deutsche Energie-Agentur (dena) supports companies in the renewable energy and energy efficiency sectors by providing marketing materials, information on overseas markets, and reference projects worldwide[81]. Export promotion programmes help innovative energy projects showcase their products and services to international audiences, build brand awareness, and establish a presence in target markets.

Market development strategies are essential for the growth and of innovative energy projects; they provide a roadmap for innovative energy projects to navigate market dynamics, assess competition, and position their products and services effectively in target markets. The DOE's Office of Technology Transitions (OTT) announced investments in clean energy projects through the Technology Commercialisation Fund (TCF). These projects aim to address commercialisation challenges and accelerate the development of promising technologies, thereby enhancing market entry and expansion efforts[82]. The International Energy Agency (IEA) report on technology innovation highlights the importance of market development strategies in tracking trends, developing analysis, and providing recommendations on innovation in the energy sector. This helps innovative energy projects navigate market dynamics and position their products effectively[83]. The World Economic Forum (WEF) discusses various global energy efficiency projects that reflect the importance of these strategies in both policy and innovation. These projects showcase how identifying market opportunities and implementing market expansion efforts can drive the adoption of innovative energy solutions[84].

Industry Collaboration for Energy Innovation: *(1) Industry collaboration, technology partnerships, and cross-sectoral initiatives to promote technology adoption, industry uptake, and market diffusion of innovative energy projects. (2) Collaboration between industry stakeholders, research institutions, and startups to co-develop, pilot, and commercialise innovative energy solutions.*

Harmonising Standards and Best Practices. A coordinated approach across Europe is essential for the successful implementation of smart grids. The European Commission should lead efforts to harmonise standards and best practices, drawing on successful examples from individual member states. This includes standardising technical specifications, regulatory requirements, and market frameworks to ensure that smart grid solutions are interoperable across different countries and regions.

Industry collaboration fosters partnerships, knowledge sharing, and technology transfer among industry stakeholders, research institutions, and startups. This streamlines efforts and pragmatically increases effectiveness in expanding into new markets. Industry collaboration comes in the form of:

- **Technology partnerships**, and **cross-sectoral initiatives**, whereby organisations leverage collective expertise, resources, and networks to accelerate the adoption, uptake, and diffusion of innovative energy projects in the market. Specifically, it enables organisations to access new markets, expand their reach, and scale their operations, as well as to facilitate the transfer of know-how, intellectual property, and innovative solutions between partners, ultimately enhancing the competitiveness and market readiness of energy projects, then accelerating jointly their path to commercialisation and market uptake.

[81] https://www.dena.de/en/projekte/projects/renewable-energies/energy-export-initiative/
[82] https://www.energy.gov/technologytransitions/fiscal-year-2024-climr-projects-transforming-clean-energy-technologies-0
[83] https://www.iea.org/reports/technology-innovation-to-accelerate-energy-transitions
[84] https://www.weforum.org/agenda/2023/01/energy-efficiency-projects-innovations/

- **Strategic alliances, joint ventures, and technology licensing agreements**, through which companies can leverage each other's capabilities, market and regulatory framework knowledge, and customer base to drive the adoption of innovative joint energy projects.
- Co-development, piloting, and commercialisation of cutting-edge energy solutions that address market needs, drive innovation, and co-create value for stakeholders across the energy value chain, by, among others, developing new products effectively in new markets, tapping into the expertise of each partner, with a system-wide approach due to the partnership.
- **Knowledge exchange and technology transfer** among industry players, can accelerate the development and deployment of innovative energy technologies, reducing time-to-market and enhancing the competitiveness of energy projects.
- **Joint research projects, technology demonstrations, and pilot programmes** enable industry stakeholders to leverage complementary strengths, pool resources, and de-risk investments.
- Advocating for a **larger CAPEX component in innovation funding** can significantly foster industry collaboration for energy innovation by supporting technology partnerships and cross-sectoral initiatives. This increased investment can promote the adoption and market diffusion of innovative energy projects by enabling companies to invest in testing and demonstration infrastructures, as well as cutting-edge equipment and software. By encouraging collaboration between industry stakeholders, research institutions, and startups, these investments will facilitate the co-development, piloting, and commercialization of new energy solutions, ultimately enhancing the competitiveness of European industry and positioning it at the forefront of global innovation.

Collaboration across different sectors such as energy technology, finance, and policy organisations to leverage diverse perspectives, expertise, and resources to overcome barriers to market entry, drive investment, and stimulate demand for innovative energy solutions.

Enabling diverse stakeholders to identify market opportunities within the energy sector, to co-create solutions, and develop business models that address market needs and deliver sustainable impact across sectors.

Fostering industry stakeholders to unlock new growth opportunities, drive market uptake, and accelerate the transition to a clean, sustainable energy future through the market diffusion of innovative energy projects. The exercise of developing a joint project helps tackle and overcome market barriers and developing a constructive regulatory and market framework.

Energy Skills Development: *Investment in (1) energy skills development, workforce training, and talent acquisition programs to build a skilled workforce capable of driving innovation, technology adoption, and market uptake of energy projects and (2) training in emerging energy technologies, digital skills, and innovation management to support the implementation of innovative energy projects.*

A skilled workforce is the backbone of any industry. Not only is the energy sector affected by an ageing workforce, but the skills needed for the energy industry are increasing in complexity, volume and reach. Therefore, investing in workforce training, talent acquisition programmes, and skill development initiatives is a need in the energy sector for both governments and businesses. However, the transition presents an opportunity to cultivate a skilled workforce capable of driving innovation, technology adoption, and market uptake of energy projects.

Organisations can accelerate the commercialisation and successful market entry of new technologies by focusing on building a workforce equipped with the necessary skills, knowledge, and awareness to support the implementation of innovative energy projects. Investing in energy skills development involves providing training in emerging energy technologies, digital skills, and innovation management.

To accomplish this, the following is needed.

- Provide training in emerging energy technologies, such as renewable energy systems, energy storage, and smart grid technologies, to ensure these technologies are being proficiently deployed and maximising their potential in the market. This technical expertise is essential for overcoming barriers to market entry, demonstrating the value proposition of innovative energy projects [85].
- Enhancing workforce capabilities in digital skills, data analytics, and technology integration, which are critical for leveraging digitalisation and automation in energy projects. These skills harness the power of digital technologies to optimise energy operations, improve efficiency, and drive innovation in the market. This digital acumen enables organisations to adapt to changing market dynamics and capitalise on emerging opportunities for growth and expansion.
- Building expertise in innovation management, entrepreneurship, and market analysis to support the successful commercialisation of energy projects. Innovation management training helps organisations innovate more effectively and position their new products and services where they are needed, ultimately increasing revenue.
- Build skills not only on the level of academics, but also empower the workers in the energy system with the relevant skills to build the actual infrastructure needed for the energy transition.

The European Commission is actively promoting energy skills development through several key initiatives:

Pact for Skills: This flagship initiative under the European Skills Agenda aims to mobilize resources and incentivize partners to take concrete action to upskill and reskill the workforce in key industrial ecosystems, including the energy sector. The Commission has established partnerships under the EU Pact for Skills to boost skills development in the energy sector. These partnerships bring together stakeholders from industry, research organizations, and educational institutions to design and implement specialized training program.[86]

Net-Zero Industry Act: This act proposes actions to ensure a skilled workforce in the cleantech sector to support the transition to a net-zero economy. It focuses on identifying skill needs and developing appropriate training programs.[87]

Erasmus+ and Horizon Europe: These programs support education and training in emerging energy technologies, digital skills, and innovation management. They fund projects that develop curricula and training programs to ensure a skilled workforce capable of driving innovation and technology adoption.

Energy Market Intelligence: *Development of market intelligence, technology scouting, and industry analysis capabilities to obtain insights into market trends, customer needs, and competitive landscapes in the energy sector. Focused market intelligence to develop market entry strategies, product positioning, and commercialisation plans as it drives successful market uptake of energy projects.*

Energy Market Intelligence provides strategic insights and a comprehensive understanding of the market dynamics. It also identifies opportunities for innovation and growth. This intelligence allows companies to identify target markets, assess market demand, and develop tailored approaches to penetrate new markets effectively. This includes identifying regulatory requirements, understanding customers and their preferences, and building partnerships with local stakeholders to establish a strong presence in target markets. By aligning market entry strategies with market intelligence, organisations can minimise risks, optimise resources, and increase the likelihood of successful market uptake of energy projects.

Energy Market Intelligence covers:

- **Technology scouting**, which involves identifying emerging technologies, trends, and innovations that have the potential to disrupt the energy sector. Monitoring technological advances and industry developments let

[85] IEA (2023), Electricity Grids and Secure Energy Transitions, IEA, Paris https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions Licence: CC BY 4.0

[86] https://energy.ec.europa.eu/news/commission-promotes-strategic-partnership-skills-advance-digitalisation-energy-system-2023-12-14_en

[87] https://energy.ec.europa.eu/news/commission-launches-large-scale-skills-partnership-energy-intensive-industries-2023-05-10_en

organisations stay ahead of the curve and capitalise on new opportunities for innovation and market expansion. Identifying potential partners, collaborators, and investors let companies accelerate commercialisation of energy projects and drive market uptake.

- **Industry analysis capabilities** to assess the competitive landscape and identify key players, market trends, and potential risks in the energy sector. With industry analysis companies benchmark their products and services against competitors, identify gaps in the market, and develop strategies to differentiate themselves and capture market share. This information is critical for informing market entry strategies and product positioning that resonate with customer needs and preferences, ultimately driving successful market uptake of energy projects.
- **Using artificial intelligence (AI)** in energy market intelligence to enhance the efficiency and effectiveness of market analysis, technology scouting, and industry insights. AI technologies can analyse vast amounts of data, identify patterns, and generate actionable insights that help organisations make data-driven decisions and optimise their market strategies. By leveraging AI-powered tools and platforms for market intelligence, organisations can gain a competitive edge, accelerate market uptake of energy projects, and drive innovation in the energy sector. AI technologies also enable organisations to automate repetitive tasks, streamline processes, and improve decision-making, ultimately enhancing their ability to bridge the gap from innovation to market successfully.

The European Commission is providing several resources to be used as inputs by Energy Market Intelligence tools:

Market Analysis Reports: The Commission produces quarterly reports on EU gas and electricity markets, analyzing market data to examine trends and challenges. These reports provide insights into market prices, consumption patterns, and competitive landscapes.[88]

Electricity 2024 Report: The European Climate, Infrastructure and Environment Executive Agency publishes reports like "Electricity 2024: Analysis and Forecast to 2026," which provide comprehensive insights into market developments and future forecasts.[89]

Evaluation and Monitoring of Energy Projects: *(1) Evaluation mechanisms, performance indicators, and monitoring frameworks to track the progress, impact, and outcomes of energy projects in driving market uptake. (2) Tracking system of policy effectiveness via assessments, evaluations and reviews of policy interventions to continually improve the process and to tweak future strategies to accelerate and strengthen market uptake of energy projects in the energy sector, power grid development, and the electric power industry.*

Evaluation and monitoring of energy projects helps ensure that pioneering solutions reach the market and thrive there. Failure to evaluate and monitor such projects may result in wasted resources and lost opportunities. The European Union Agency for the Cooperation of Energy Regulators (ACER) publishes annual market monitoring reports that include detailed frameworks for tracking the progress and impact of energy innovations. These reports highlight the importance of continuous monitoring to adapt to market changes and external factors[90]. A good example for policy effectiveness tracking is the Energy Policy Tracker: This platform provides detailed analysis of public finance flows and policy measures across major economies. It tracks the effectiveness of different energy policies, including subsidies, tax incentives, and regulatory frameworks[91].

Evaluation Mechanisms, Performance Indicators, and Monitoring Frameworks. To effectively track the progress, impact, and outcomes of energy projects, it is essential to establish comprehensive evaluation mechanisms and performance indicators tailored to the unique characteristics of the energy sector. These frameworks should encompass a range of quantitative and qualitative metrics that assess not only the technical performance of energy projects but also their

[88] https://energy.ec.europa.eu/data-and-analysis/market-analysis_en
[89] https://managenergy.ec.europa.eu/publications/electricity-2024-analysis-and-forecast-2026_en
[90] https://www.acer.europa.eu/electricity/market-monitoring-report
[91] https://www.energypolicytracker.org/policies-analysis/

economic viability, social acceptance, and environmental sustainability. For instance, performance indicators could include metrics such as the reduction in greenhouse gas emissions, cost savings for consumers, and the scaleability of innovative technologies. By systematically collecting and analysing data on these indicators, stakeholders including policymakers, investors, and project developers can gain valuable insights into which projects are succeeding and why, as well as identify those that may require additional support or intervention. Moreover, continuous monitoring frameworks are vital for understanding the dynamic nature of energy markets and the external factors that influence the success of energy innovations.

Tracking System of Policy Effectiveness: In addition to evaluating individual projects, it is crucial to implement a tracking system that assesses the effectiveness of policy interventions aimed at fostering innovation and market integration in the energy sector. This system should involve regular assessments, evaluations, and reviews of existing policies to determine their impact on the development and deployment of energy technologies. By systematically analysing the outcomes of various policy measures - such as subsidies, tax incentives, regulatory frameworks, and public-private partnerships - policymakers can identify best practices and areas for improvement. This iterative process not only helps to refine current policies but also provides a foundation for developing future strategies that are better aligned with market needs and technological advancements.

The **BRIDGE** initiative (Building an Energy Data Infrastructure for the European Union) significantly enhances the evaluation and monitoring of energy projects across the EU by fostering collaboration among various research and innovation projects in smart grids, energy storage, and digitalization. Its goal is to foster discussion on the real challenges faced in demonstration projects, identify solutions to overcome obstacles to innovation, share knowledge, and deliver recommendations to facilitate the energy transition. BRIDGE is structured with four permanent working groups representing the main areas of interest, enabling collaborative efforts to influence future policy, technology developments, and the application of project results.[92]

Key Impact Pathways: Horizon Europe, the current research and innovation funding program, uses a modernized approach called Key Impact Pathways to capture and communicate the impact of research projects. his approach aligns with the ambition to boost the diversity of impact from EU research funding.[93]

[92] https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/
[93] https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/evaluation-impact-assessment-and-monitoring/horizon-europe-programme-analysis_en

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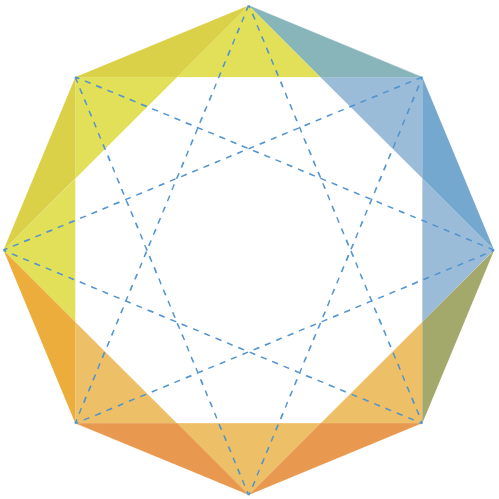

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