SCALABILITY & REPLICABILITY SELF-ASSESSMENT CHECKLIST

SCOPE OF THE QUESTIONNAIRE

This checklist is intended for use in Research and Innovation (R&I) projects that aim to accelerate the clean energy transition. Its primary purpose is to help project teams systematically identify gaps and opportunities for improvement regarding the scalability and replicability of their solutions. Rather than providing a definitive assessment, the checklist guides users in reflecting on key factors and potential barriers, supporting the design and execution of more robust and impactful projects.

By completing this questionnaire, R&I projects can ensure that considerations for scaling up and replication are embedded "by design," increasing the likelihood that innovative solutions will achieve large-scale impact in the energy sector.

- **Scalability** refers to the ability of a solution, system, or process to expand in size or range (without compromising performance or efficiency).
- **Replicability** refers to the ability to duplicate the solution in a different location, sector, or time (under different conditions, or within new organizational or regulatory frameworks).

Both dimensions are essential for achieving large-scale impact and ensuring that innovative solutions can contribute meaningfully to energy system transformation.

TYPES OF PROJECTS AND DEMONSTRATIONS

This checklist is most relevant for:

- **Technical demonstrations showcasing energy system solutions** (e.g., smart grids, sector coupling, flexibility solutions).
- **Technology pilots that aim for market readiness and deployment**.

The structure—organized into main criteria and sub-criteria—guides users systematically considering all relevant dimensions of scalability and replicability, helping to identify strengths and weaknesses.
The checklist can also provide useful insights for:

- **Early-stage research & Technology proof-of-concept activities** (low TRL, e.g., component validation, lab-scale prototypes).
- **Digital platforms and tools** supporting energy management, forecasting, or optimization.
- **Business models and services** designed to enable clean energy adoption.
- **Cross-sectoral initiatives** involving energy, mobility, industry, and buildings.

In these cases, not all criteria may be applicable; **some questions may be out of scope, while others may require interpretation and adaptation**. The checklist is flexible and can be tailored to different project types and stages.
Projects at different stages of development can benefit from this assessment, especially during proposal design or demonstration planning, to keep scalability and replicability in focus and maximize project impact.

HOW TO USE THIS CHECKLIST

- Apply each section of the checklist to your overall project or to individual demonstrations within a larger R&I project, ensuring that all dimensions of scalability and replicability are properly considered.
- For every question, provide an honest, evidence-based self-assessment and assign a score from **1 to 10**:
    - 1 = The aspect is not addressed in your project.
    - 10 = The aspect is thoroughly and comprehensively addressed.
- Whenever you assign a low score, provide a brief justification explaining the gaps, barriers or issues encountered.

  This helps you:
    - Identify specific areas where improvements are needed.
    - Make your assessment more transparent and actionable.
    - Guide targeted actions for strengthening your project.
- **Discuss the results and justifications with your team** to prioritize improvements and integrate them into your project planning.
- Repeat the assessment at key stages of the project (e.g., proposal drafting, demonstration planning, periodic updates) so that scalability and replicability remain embedded "by design" throughout development.

TIPS FOR USERS:

- Agree on the assessment scope before scoring.
- Use scores to trigger discussion, not as final judgments.
- Look beyond technical performance to non-technical barriers.
- Document assumptions, gaps and open questions for follow-up.

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Criteria	Sub-criteria	Concept	Question	Rate 1-10
1 Technical Framework	1.1 System architecture & Modularity	Ability to scale without major redesign	1.1 To what extent does the project architecture enable straightforward technical scaling up by adding resources/components, while addressing potential technical limitations? Example: A wind farm where adding turbines is straightforward and does not disrupt existing components (10), vs. a coal power plant that requires extensive redesign to increase capacity (1).	
		Standardized, modular design adoption	1.2 To what extent does the project adopt modular designs to facilitate easy scaling and replication? Example: A solar panel kit with interchangeable components and modular connectors (10), vs. a tailor-made energy storage system requiring custom engineering for each deployment (1).	
	1.2 Technical Maturity & Readiness	Maturity of technology before scaling	1.3 To what extent does the project include a structured plan for achieving technical maturity and operational readiness before entering target markets? Example: The project includes a well-defined plan for achieving maturity and readiness before deployment (10), vs. the project lacks a clear roadmap for technology validation, scalability, and deployment prior to market entry (1).	
		Future-proofing for tech advances	1.4 How well is the project structured to incorporate future technological advances for addressing operational challenges as it scales? Example: A solar farm management software with scalable architecture to handle increased data as more panels are added (10), vs. a basic monitoring system that crashes with minor data increases (1).	
	1.3 Deployment Flexibility & Integration	Deployment across diverse environments	1.5 How flexible is the project's architecture in view of deployment and integration across various environments, with minimal need for customization? Example: A district heating substation that can be connected to different heat sources with standardized interfaces (10), vs. a heat pump system that requires extensive site-specific modifications (1).	
		Integration with legacy systems	1.6 How effectively does the project address integration challenges with existing/legacy systems or infrastructure? Example: An open-standard energy storage system (10), vs. a proprietary grid system requiring exclusive hardware (1).	
		Compliance with interoperability standards	1.7 To what extent does the project align with standards for data integration and interoperability? Example: A project that fully adopts IEC 61850 and integrates seamlessly with existing grid systems (10), vs. a project that uses a proprietary format with no support for standard data protocols (1).	
		Minimizing local infrastructure dependency	1.8 To what extent does the project minimize reliance on the availability or expansion of local infrastructure, whether physical or digital? Example: A mobile solar unit that does not depend on local infrastructure (10), vs. a large power plant requiring significant infrastructure expansion (1).	
		Ease of integrating with other systems	1.9 How easily does the project integrate with various energy networks/sectors (e.g., electricity, gas, water, heating and cooling, mobility)? Example: An EV charging station network compatible with solar PV (10) vs. an isolated, incompatible diesel generator setup (1).	
	1.4 Technical Robustness	Reducing vendor lock-in	1.10 How well does the project mitigate vendor or technology dependencies that could limit deployment? Example: A renewable energy management system that easily connects with existing SCADA and analytics tools (10), vs. proprietary energy management system that cannot connect to any third-party platforms, requiring complete replacement for integration (1).	
		Performance stability at large scale	1.11 How well does the project maintain efficiency and performance under scaled operations? Example: A microgrid system that optimizes energy distribution efficiently as more users are added (10), vs. a battery storage system that experiences significant efficiency losses at higher capacities (1).	
		Required technical expertise	1.12 How effectively does the project consider the technical expertise required for scaling or replicating in different locations? Example: A modular solar system that local technicians can install and maintain (10), vs. a nuclear reactor requiring extensive specialized skills (1).	
	Explain your low rates			

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Criteria	Sub-criteria	Concept	Question	Rate 1-10
2 Economic & Financial Viability	2.1 Deployment & Operational Costs	Cost-efficient deployment across regions	2.1 To what extent does the project enable cost-efficient and straightforward deployment in diverse locations? Example: A standardized solar PV system that is easily deployed in diverse regions with minimal additional setup costs or specialized tools (10), vs. a large centralized power plant with high setup costs in different locations (1).	
		Long-term cost-benefit considerations	2.2 How well does the project account for future changes impacting cost-benefit balance and leverage economies of scale as it grows? Example: A wind project planning for decreasing technology costs (10), vs. a coal plant with high fixed costs unaffected by technological advances (1).	
	2.2 Resource Efficiency & Cost Considerations	Resource efficiency & sustainability	2.3 To what extent does the project optimize resource efficiency (e.g., technological, or human resources) and incorporate cost-effective strategies to function effectively in resource-constrained environments? Example: A solar PV system with diverse deployment options and efficient low-light performance, allowing it to scale across different regions with minimal resource dependency (10), vs. a hydropower plant that requires highly specific river flow conditions, making it viable only in a limited number of locations (1).	
		Critical resource dependencies	2.4 How effectively does the project assess and mitigate risks related to the availability and sourcing of critical inputs (e.g., raw materials, specialized components, technological infrastructure, or proprietary software) required for scaling? Example: A wind project with multiple sourcing options for critical materials (10), vs. a solar project with panels dependent on a single rare mineral source (1).	
	2.3 Financial Flexibility & Business Model	Profitability adaptability across markets	2.5 How well does the project maintain its profitability in the economic conditions of other countries/regions, independent of regulatory barriers and competitive responses while replicating? Example: A solar pay-as-you-go model with flexible pricing mechanisms that adapt to both high-income and low-income regions without relying on subsidies (10), vs. A fossil fuel project entirely reliant on regional government subsidies, making it unviable in countries without similar financial incentives (1).	
		Diverse funding models for financial flexibility	2.6 To what extent does the project minimize financial resource dependency and incorporate funding strategies (e.g., cost-sharing, subsidies, or partnerships) to support scaling or replication? Example: A pay-as-you-go solar model that enables rapid scaling with minimal upfront costs, supported by partnerships with microfinance institutions (10), vs. A large-scale nuclear project requiring massive initial investments with no financial flexibility for scaling (1).	
		Regulatory & market adaptability	2.7 To what degree is the project's business model flexible to accommodate diverse regional regulatory and market conditions? Example: An off-grid solar solution with flexible pricing (10), vs. a heavily subsidized coal project viable in only specific markets (1).	
	2.4 Lifecycle Cost Optimization	Lifecycle cost optimization	2.8 To what extent does the project evaluate and optimize its total lifecycle costs, including development, implementation, operation, maintenance, and eventual phase-out? Example: A wind farm includes a comprehensive lifecycle cost analysis, with plans for cost-efficient maintenance and recycling of turbine materials (10), vs. A bioenergy plant lacks a maintenance plan and has no decommissioning strategy, leading to high future costs (1).	
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Criteria	Sub-criteria	Concept	Question	Rate 1-10
3 Market Viability	3.1 Market Barriers & Competitiveness	Addressing market barriers	3.1 How effectively does the project address anticipated market barriers for implementation in the target regions? Example: Smart grid implementation with regulatory alignment and utility cooperation to overcome market fragmentation (10), vs. geothermal project facing high initial costs and lack of market incentives. (1)	
		Competitive positioning for mass adoption	3.2 How well does the project position itself competitively in the market for scalable growth? Example: A solar power startup offers competitive pricing, strong partnerships, and a flexible business model that easily adapts to different markets, positioning it well for rapid scalability (10), vs. A biofuel project offers high-cost energy with limited market differentiation and a rigid business model, making it unlikely to scale competitively (1).	
	3.2 Industry Collaboration & Local Supply Chain	Industry partnerships for large-scale rollout	3.3 How effectively does the project establish partnerships with industry players, public authorities, or local stakeholders to support its expansion or replication? Example: A rural electrification project that collaborates with local utilities and governments to ensure smooth deployment (10), vs. a fossil fuel project with no partnership strategy for new locations (1).	
		Supporting local supply chain growth	3.4 How well does the project ensure that local supply chains and manufacturing capacity support its scaling up or replication? Example: A solar project sources components locally and trains the workforce, ensuring scalability (10), vs. A geothermal project depends on a single foreign supplier, hindering scalability (1).	
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Criteria	Sub-criteria	Concept	Question	Rate 1-10
4 Policy & Regulation Framework	4.1 Compliance with Standards & Regulations	Compliance feasibility with different regulations	4.1 How well does the project consider the aspects of compliance with standards in the perspective of scaling up or replication? Example: A microgrid system customizable to local standards (10), vs. a specialized control system needing expensive adaptations (1).	
		Certification & validation requirements	4.2 To what degree does the project plan include provisions for obtaining external validation or certifications for compliance with local standards, such as third-party assessments, to ensure that the project is replicable? Example: The project includes comprehensive plans for obtaining external validation or certifications before replication (10), vs. no plans for external validation or certifications are included (1)	
	4.2 Regulatory & Legal Considerations	Adherence to data protection laws	4.3 How well does the project ensure compliance with data protection laws and privacy regulations when scaling up or entering new markets? Example: A solution that automatically meets GDPR compliance and other regional data protection laws without requiring additional efforts (10). A system that needs extensive modifications and legal consultations for each new region to comply with data privacy laws (1).	
		Overcoming regulatory barriers globally	4.4 How effectively does the project address regulatory challenges, including both policy barriers, permitting, and other compliance requirements, when scaling up or replicating in new regions? Example: A renewable project that is adaptable to different policy landscapes and meets global compliance standards with minimal modifications (10), vs. a project dependent on rigid national regulations, requiring extensive legal and technical adjustments for each new location (1).	
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5 Social & Environmental Impact	5.1 Social Acceptance & Community Involvement	Managing societal & behavioral challenges	5.1 How well does the project anticipate and address societal, or behavioral challenges that could hinder its acceptance while scaling up or replicating? Example: The project includes detailed strategies for aligning with societal norms and gaining public acceptance (10), vs. the project overlooks societal priorities or public concerns in its planning (1).	
		Community engagement & inclusion	5.2 How well does the project ensure inclusive benefits for local communities in its scaling strategy? Example: A mini-grid project creates local jobs, offers affordable energy, and supports local businesses (10), vs. A hydro project displaces local communities with no plans to benefit them (1).	
		Anticipating cultural/political barriers	5.3 To what extent does the project foresee and mitigate implementation challenges, and actively disseminate knowledge to facilitate replication to other sectors or regions? Example: The project includes a dissemination plan to share lessons learned and facilitate smoother international adoption (10), vs. the project provides no strategy for sharing knowledge beyond its initial scope (1).	
		Building public trust & awareness	5.4 How well does the project address the importance of building trust among end users through its solutions in future deployments? Example: The project includes well-thought-out plans to build user trust, with mechanisms for engagement and reliability (10), vs. the project provides little consideration for user trust or lacks mechanisms to build confidence in the solution (1).	
	5.2 Sustainability & Resilience	Long-term sustainability	5.5 How thoroughly does the project address long-term sustainability and impact across diverse markets, regions, or technological environments? Example: A bioenergy project that includes lifecycle assessments and sustainability metrics tailored for each deployment area (10), vs. a coal plant without any sustainability considerations (1).	
		Resilience to disruptions	5.6 How well does the project build resilience to withstand any kind of disruptions (e.g., extreme weather, market fluctuations, technological issues, resource shortages, and workforce disturbances) and ensure long-term stability? Example: A solar farm designed with structural reinforcements to withstand extreme weather conditions (10), vs. a project highly vulnerable to climate variations with no contingency plans (1).	
		Adopting circular economy principles	5.7 To what extent does the project incorporate circular economy principles, including resource efficiency, waste heat utilization, and sustainable materials? Example: A district heating system reuses waste heat and uses recyclable materials (10), vs. A coal plant has no waste heat recovery and relies on non-recyclable materials (1).	
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<table>
<tr><th>Criteria</th><th>Sub-criteria</th><th>Concept</th><th>Question</th><th>Rate 1-10</th></tr>
<tr><td rowspan="7">6 Risk Management & Organizational Scalability</td><td rowspan="3">6.1 Risk Mitigation & Expansion Planning</td><td>Managing risks tied to scaling</td><td>6.1 How effectively does the project identify and address risks associated with scaling up, including financial, regulatory, operational, technological, and resource supply challenges, while proposing actionable and comprehensive mitigation strategies?
Example: A modular energy storage solution with a detailed risk management plan for each stage of scaling (10), vs. a project with no risk planning beyond initial setup (1).</td><td></td></tr>
<tr><td>Evaluating risks across locations</td><td>6.2 To what extent does the project evaluate location-specific risks and propose strategies for mitigating challenges in replicating the project in new regions?
Example: A wind energy project with country-specific risk assessments for international expansion (10), vs. a nuclear plant with significant location-specific risk and limited replicability planning (1).</td><td></td></tr>
<tr><td>Cybersecurity considerations</td><td>6.3 How effectively does the project implement cybersecurity measures, such as encryption and secure protocols, to protect against cyber threats during scaling or replication?
Example: A system with built-in encryption, secure APIs, and regular security audits to safeguard data and infrastructure across all deployments (10). A system with no security measures or plans for scaling, vulnerable to cyber threats as it expands (1).</td><td></td></tr>
<tr><td rowspan="3">6.2 Pilot, Prototyping & Growth</td><td>Pilot testing before large-scale deployment</td><td>6.4 How widely does the project use pilot testing to assess its feasibility and performance at scale before widespread deployment?
Example: The project includes robust and strategic pilot testing initiatives designed to validate scalability (10), vs. pilot testing is absent or poorly planned for scalability validation (1).</td><td></td></tr>
<tr><td>Organizational capacity to grow</td><td>6.5 To what extent does the project address the impact of scaling or replication on the organizational structure and capacity of the team developing it?
Example: The project includes a clear strategy for organizational scaling, such as training and capacity-building plans for teams, and aligns roles and processes to support growth effectively (10), vs. The project overlooks the impact of scaling on the organization, leading to confusion in roles, lack of capacity, or inefficiencies as it grows (1).</td><td></td></tr>
<tr><td>Open data, public repositories use</td><td>6.6 To what extent does the project leverage or contribute to public repositories (e.g., software, datasets, regulatory comparisons, test models, and tools) to support scalable and replicable business models?
Example: The project actively uses and shares open-source tools, datasets, and models, enhancing accessibility and collaboration (10), vs. the project relies solely on proprietary resources, offering no contributions or access to shared repositories (1).</td><td></td></tr>
<tr><td>Explain your low rates</td><td colspan="3"></td></tr>
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