

Digitalization in Off-Grid Systems

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The Technical Report is available for download from the IEA-PVPS website www.iea-pvps.org.

Executive Summary

This report is intended for professionals and stakeholders in the off-grid energy sector who are either seeking to integrate digital tools into their projects or evaluating existing tools to enhance their system's performance. As off-grid energy systems expand to meet the needs of remote and underserved communities, the role of digitalization has become increasingly critical in optimizing their development, implementation, operation, and long-term sustainability. This report systematically explores the various digital tools available across each phase of the off-grid energy project value chain, offering valuable insights for decision-makers and practitioners.

The report is organized around four key phases of the off-grid energy project value chain: Development, Implementation, Operation and Maintenance, and Capacity Development. Each phase is analyzed in detail, with a focus on how digital technologies can be effectively leveraged:

1. **Development:** Tools such as Geographic Information Systems (GIS) and remote sensing are highlighted for their ability to optimize site identification and planning. These tools allow for precise assessment of spatial factors and local energy needs, ensuring that projects are technically viable and economically sustainable.

Subcategories:

- Site identification/Planning
- Economics
- Feasibility and Design

2. **Implementation:** Digital project management platforms and real-time tracking systems are explored for their role in streamlining procurement, logistics, and installation. These tools enhance coordination, ensure adherence to timelines and budgets, and support remote troubleshooting, particularly in challenging environments.

Subcategories:

- Construction
- Engineering
- Supply Chain and Logistics
- Procurement

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3. **Operation and Maintenance:** The report discusses the impact of IoT devices, sensors, and cloud-based platforms in facilitating real-time monitoring, predictive maintenance, and customer management. Additionally, advanced algorithms for dispatch and control, as well as digital financial tools like electricity price algorithms, are analyzed for their role in optimizing system performance and ensuring financial sustainability.

Subcategories:

- Customer management
- Monitoring and control
- Operations & maintenance management tool
- Reporting

4. **Capacity Development:** Recognizing the importance of human capital, the report emphasizes the need for digital literacy and technical training. Digital platforms that support knowledge sharing and capacity building are essential for empowering local communities and ensuring the long-term success of off-grid systems.

Subcategories:

- Online knowledge products
- Online trainings

To support the practical application of these insights, the report includes an annex that details over 60 different digital tools applicable to off-grid energy systems. Each tool is described in terms of its functionality, target application within the project value chain, and potential benefits. This comprehensive resource aims to assist readers in identifying the most suitable tools for their specific needs and project contexts.

To assess the innovation potential of every digital tool along the value chain, seven dimensions were set: Interlinkages to other digital tools; User interfaces; Process assistance; Flexibility; Transparency; Data Protection; Potential of including AI. An open access survey was designed to evaluate digital tools.

In conclusion, this report serves as a guide for off-grid energy practitioners who are looking to harness the power of digital technologies to enhance the effectiveness and sustainability of their projects. By providing detailed analyses and a curated list of digital tools, the report equips readers with the knowledge and resources needed to make informed decisions and drive successful off-grid energy initiatives.