



From Fragmentation to Interoperability: A Collaboration Framework for Open-Source Energy Access

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1. Introduction

The term collaboration refers to the act of [working together toward a shared goal, built on trust, cooperation, and mutual understanding](#). In the context of the Sustainable Development Goals (SDGs), collaboration plays a key role in driving collective progress. As challenges, particularly in areas such as energy access and health, become more complex, professionals and stakeholders increasingly rely on one another. This growing interdependence highlights the need to better understand and strengthen interprofessional collaboration to address these challenges effectively.

Collaboration in Open Source for Energy Access Tools tackles the challenges of improving energy access and bridging gaps in collaboration among tool developers, data providers, users, and donors. Over the past decade, geospatial data and technology have transformed decision-making in the energy access sector. Open-source solutions have driven this progress by offering cost-effective, data-driven approaches that reduce reliance on technical expertise. Despite the wealth of available solutions, limited collaboration among tool developers creates confusion for end users and beneficiaries. This fragmentation hinders interoperability, renders the solutions less comprehensive, and ultimately impedes user satisfaction and progress toward universal energy access. To address these issues, we developed a collaboration framework to foster alignment and integration across the sector.

The framework originated from an ideation challenge held during the final two days of the 2024 Open Source in Energy Access Symposium (OSEAS) in Abuja, Nigeria. This challenge brought together open-source software providers and users to improve collaboration within the open-source community in the energy access space. Through open discussions and problem-solving, participants identified key barriers and laid the foundation for a unified approach.

This framework represents the culmination of those deliberations and aims to foster a cooperative environment for open-source solution providers, users, and donors in the energy access space. By breaking down barriers and encouraging stronger partnerships, it seeks to enhance coordination, resource sharing, and innovation, which are critical steps toward ensuring reliable, affordable, and sustainable energy access for all. The framework is grounded in a shared vision, mission, values, and guiding principles. It incorporates processes and identifies factors that can either support or hinder the success of collaboration, ultimately shaping its outcomes.



The framework can also act as a diagnostic tool to evaluate progress, track advancements in the field, and facilitate the growth of collaborative groups. This framework was created through the joint efforts of open-source energy access tool developers who have participated in OSEAS including experienced researchers and specialists in the energy access domain.

1.1 Purpose

This collaboration framework responds to the [challenges identified at OSEAS](#), such as duplicated efforts, fragmented solutions, and delayed decision-making. Its purpose is to:

- **Develop Interoperable, User-Centered Tools:** Coordinate among developers, planners, and end users to build open-source tools that are streamlined, accessible, and designed around real-world needs.
- **Reduce Fragmentation through Shared Standards:** Promote alignment of tools, data, and workflows by establishing common standards, processes, and goals to enhance interoperability and improve user experience.
- **Enable Inclusive Co-Creation:** Foster a platform where tool developers, energy planners, local communities, NGOs, and private companies collaborate to design context-specific, innovative solutions.
- **Ensure Local Relevance and Ownership:** Engage all stakeholders throughout the development process to build trust, ensure solutions meet local needs, and promote long-term commitment.
- **Monitor Progress and Adapt Continuously:** Use the framework as a diagnostic tool to identify gaps, measure progress, and guide iterative improvement of tools and collaboration strategies.

By addressing these objectives, the framework aims to ensure a unified, efficient, and impactful approach to solving energy access challenges through open-source tools and collective action.

2. Principles of Collaboration

The checklist for the collaborative framework covers the following:

- **Align with a Shared Vision:** Unite all stakeholders (developers, planners, communities, and NGOs) around the goal of reliable, affordable, and sustainable energy access, with clear roles and a shared purpose.



- Foster Inclusive, Transparent Co-Creation: Promote open communication, knowledge sharing, and co-development of solutions. Ensure diverse voices are heard and respected throughout the process.
- Ensure Interoperability and Flexibility: Use open standards, shared data formats, and modular designs to enable seamless integration across tools, while remaining adaptable to changing technologies and local needs.
- Build Local Capacity and Ownership: Empower communities with the skills and knowledge to use, improve, and sustain tools. Strengthen local engagement for long-term impact.
- Maintain Accountability and Drive Continuous Improvement: Track progress, evaluate effectiveness, and iterate collaboratively. Foster trust and lasting partnerships through mutual respect and learning.

3. Scope of Collaboration

The framework calls for collaboration among data providers, solution providers, end users, and donors. Each group's role in this process is shown in the Venn diagram below (Figure 1).

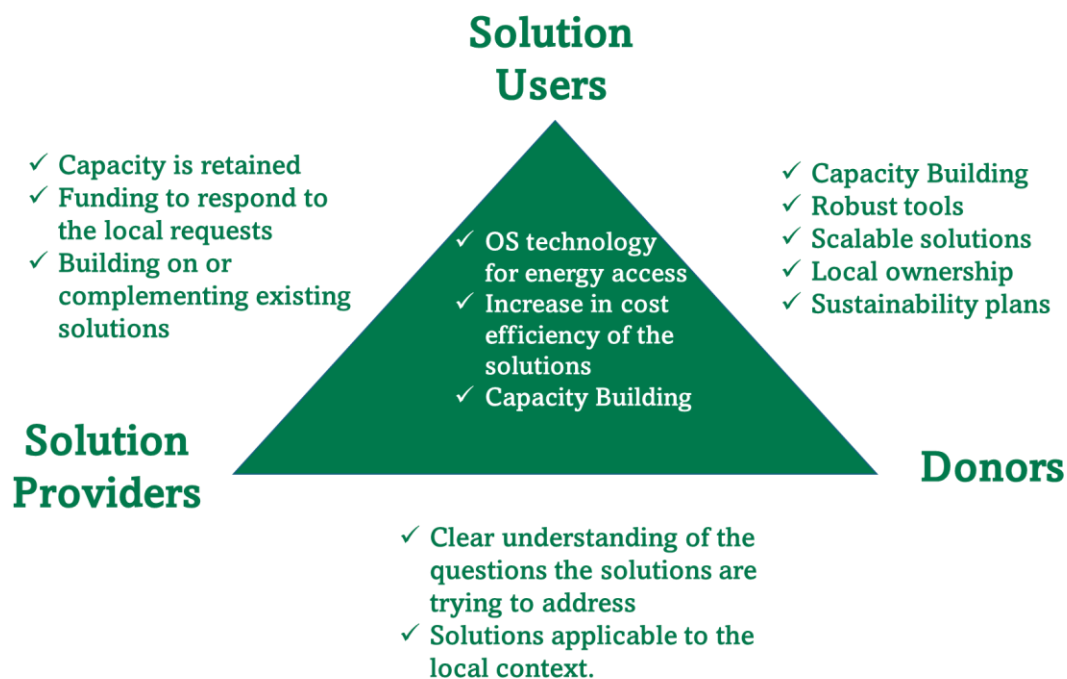


Figure 1: Collaboration between solution providers, data providers, end users and donors



Funders and donors play a crucial role in fostering collaboration by providing financial resources, strategic guidance, and incentives necessary to ensure that partnerships in the energy access sector follow key collaboration principles. By embedding the principle of collaboration into their funding processes, funders and donors can encourage tool developers, energy planners, NGOs, communities, and governments to work together more effectively and sustainably.

Table 1: How funders can support collaboration

Collaboration Principle	How funders can support
Shared vision and goals	Fund alignment workshops and maintenance of a database of all software in energy access. Encourage consortium arrangements where organizations work together rather than individually. Support open standards in tool development and mandate tool compatibility and interoperability.
Inclusivity and participation	Prioritize multi-stakeholder projects promoting equity.
Open innovation and co-creation	Fund co-creation workshops and incentivize joint projects. Funders can also include collaboration in their grantees' key performance indicators (KPIs).
Flexibility and adaptability	Offer flexible funding that supports iterative approaches. Provide multi-year funding that supports tool maintenance.
Capacity building and empowerment	Fund local training programs and capacity building for community-led initiatives. Support long-term partnerships.
Accountability and evaluation	Require regular reporting on collaboration through independent evaluations.

From the perspective of solution providers (such as open-source tool developers and technology companies), the scope of collaboration in the energy access sector involves working closely with stakeholders across the ecosystem to develop, integrate, and improve tools and services. This collaboration helps create scalable, user-friendly, and impactful solutions that address the challenges of energy access while ensuring interoperability, inclusivity, and long-term sustainability.



Table 2: How solution providers can support collaboration

Area	Scope of Collaboration	Example
Tool development and co-creation	Co-design solutions with users and other solution providers. Ensure that the solutions are modular and that the code is well documented and stored on GitHub. Regularly scan for similar tools that are already available in the IEA's database. Before collaborating with developers to add new functionalities to tools, conduct a literature review and have discussions with peers.	Development of new features based on user feedback
Data integration	Ensure interoperability and collaborate on open data standards.	Integration of outputs from planning tools such as OnSSET and RAMP into Energy Access Explorer (EAE).
Knowledge sharing	Co-organize training programs, build local capacity, and improve documentation.	Conducting workshops for energy planners, such as the Energy Modelling Platform by CCG.
Governance	Participate in governance frameworks to set common standards.	Development of a community of practice and governance structure around OSeMOSYS.
Scaling	Work with different solution providers to scale tools and ensure long-term adoption.	Scaling of EAE across regions with local working groups
Joint fundraising	Co-write proposals to develop tools or link the different open-source tools to one another.	Consortia: Strathmore and WRI Africa worked on joint funding to support development of an open-source toolkit
Joint communications	Co-branding and shared messaging; organizing joint	OSEAS was jointly organized by the EnAccess



	webinars and conferences; sharing success stories	Foundation and the World Resources Institute (WRI)
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Data providers play a pivotal role in fostering collaboration in the open-source energy access ecosystem. By offering relevant, high-quality, and accessible data, they enable tool developers, energy planners, policymakers, and communities to design, implement, and evaluate sustainable energy solutions.

Table 3: Different ways by which data providers can support collaboration

Areas of support	Actions	Examples
Open data accessibility	Provide free and open access to datasets under open licenses. Develop user-friendly platforms or APIs for data access and integration.	Global horizontal irradiance or world population data
Promote interoperability	Use open data formats and standards for compatibility with various tools. Standardize metadata to enhance usability and interoperability.	Sharing data in commonly used formats
Encourage capacity building	Offer training in collaboration with solution providers so that users understand the data and learn how to use it.	Methodologies and datasets published in peer-reviewed journals, such as distance to health facilities.
Foster transparency	Share data sources, methodologies, and limitations to promote transparency. Enable peer reviews to validate datasets and improve quality.	CCG energy planning roundtable

Open-source tool users, including energy planners, NGOs, policymakers, and researchers, play an important role in fostering collaboration. Their active involvement helps ensure tools are user-centric, interoperable, and impactful. Their uptake of the tools also drives



local adoption and continuous evaluation, which supports long-term sustainability and keeps the tools relevant and organic.

Table 4: Ways by which users can promote collaboration

Area of Support	Actions users can take	Example
Promote interoperability	• Advocate for tools that integrate seamlessly with other platforms or datasets. • Share experiences of using multiple tools together to highlight gaps in interoperability. • Share success stories of the tools and collaboration.	Participation of users in the ideation challenge at OSEAS
Provide Feedback	Share detailed feedback on the usability, functionality, and relevance of the tools, such as suggesting improvements or new features based on practical experience.	Reporting bugs or recommending mobile-friendly versions of the tools.
Participate in the design process	• Collaborate with developers during the tool design and development process. • Share insights on local challenges to ensure tools are tailored to specific contexts. • Participate in online forums, user communities, and feedback platforms for tools. • Contribute directly to open-source projects by improving documentation or testing features	Providing data on local energy needs to improve tool accuracy for rural electrification planning



Advocate for collaboration	Encourage the adoption of collaborative tools within organizations or projects.	Promoting the use of interoperable and open-source tools for government energy initiatives.
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4. Governance Structure

For the collaboration framework, which is voluntary, the governance structure needs to be flexible, inclusive, and efficient to accommodate the diverse stakeholders involved while ensuring effective decision-making and coordination. We propose a hybrid model with distributed leadership supported by a steering committee led by a community manager. The community manager can bring everyone together and keep the group true to the spirit of collaboration. The structure would be as follows:

- Stakeholders meet once every four months to discuss collaboration stories and opportunities for collaborating more effectively.
- At least one “Collaborator Champion” is assigned from each tool. There can be a secondary champion as well, who supports the collaboration process.
- Conduct consultations with available tool developers/owners and user researchers before developing new tools.
- Regularly scan existing databases for energy access tools to understand the current landscape.
- Donors can ask for collaboration among their grantees or other tool developers.
- Maintain regular communication among users, tool providers, donors, and data providers.

5. Resources

Collaboration in open-source tools for energy access requires more than just goodwill and enthusiasm. It depends on the availability of resources to ensure the process is effective, inclusive, and sustainable. Resources are critical at every stage of the collaboration, from development and integration to scaling and long-term sustainability. We recommend the following resources:



- Securing grants from organizations or donors to support collaborative development.
- Champions from the collaborating organizations to coordinate tasks, manage timelines, and ensure collaboration stays on track.
- Volunteers or staff to moderate discussions, address questions, and guide contributors.
- Develop resources for co-organizing hackathons, workshops, or training sessions.
- Establish coding standards, data standards, and collaboration guidelines to ensure consistency.
- Ensure tools and datasets are compatible and can integrate seamlessly.
- Create comprehensive user guides, contributor manuals, and training modules.
- Encourage documentation on how developers can contribute, including coding standards, branch naming conventions, and pull request workflows.
- Share stories of successful implementations to guide new users and developers.
- Set up online spaces where users and developers can interact, share ideas, and resolve issues.
- Resources for raising awareness about the tool and its benefits to attract more contributors and users.
- Platforms for users and developers to provide feedback on features, bugs, and usability.

6. Licensing and IP

Choosing the right licensing and intellectual property (IP) approach is critical to fostering collaboration, innovation, and sustainability in open-source tools for energy access. Open licenses such as MIT, Apache 2.0, or Creative Commons not only make contributions accessible to a global audience but also encourage transparency, interoperability, and broad adoption. Clear IP policies ensure that contributors are credited, their work is protected, and the tools remain open and adaptable for future advancements.

Table 5: Recommendations for Licensing and IP

Resource	Recommended License	Rationale
Software code	Apache 2.0 or MIT	Encourages collaboration and broad adoption while



		protecting contributors from patent claims.
Data	Creative Commons (CC-BY or CC0)	Ensures open access with attribution for data providers.
Documentation	CC-BY-SA or GFDL	Enables free sharing and adaptation while ensuring proper credit.
Training materials	CC-BY or CC-BY-SA	Encourages reuse and customization for community needs.
Branding/Logo	Trademark Registration	Protects the tool's identity and prevents unauthorized use.

The table above summarizes the licenses appropriate for different types of resources in open-source tools. Collaborators can jointly decide under which license they want to share their resources.

7. Monitoring and evaluation

Monitoring and evaluation in [open source](#) collaboration for energy access ensures that the framework remains transparent, effective, and impactful. By tracking metrics related to participation, outputs, outcomes, and long-term impacts, stakeholders can identify successes, address challenges, and continuously improve the collaboration process. This structured approach ensures that the tools developed contribute meaningfully to energy access goals and foster a sustainable, collaborative ecosystem.

- Measure the number and diversity of contributors (developers, users, data providers, donors) actively engaged.
- Assess the frequency, quality, and inclusivity of communication among stakeholders.
- Evaluate whether tools are designed to integrate seamlessly with other platforms and datasets.
- Use tools like GitHub license scanning to ensure contributions follow the chosen licensing terms.
- Track the creation of shared datasets, documentation, and training materials.
- Assess whether features or improvements are based on user feedback and needs.



- Evaluate whether the collaboration framework is self-sustaining and continues to attract contributors.

8. Communicating

Effective communication is essential to foster collaboration in open-source energy access tools. By establishing clear channels for internal, external, technical, and community communication, stakeholders can align their efforts, share knowledge, and ensure the tools remain impactful and user-centric. A robust communication strategy not only enhances engagement but also ensures long-term sustainability and scalability of the collaboration framework. Below is an outline of the communication efforts required to foster collaboration:

- Share the overarching goal of improving energy access and how collaboration drives this.
- Use success stories and testimonials to demonstrate how collaboration has solved real-world energy challenges.
- Co-publish articles, white papers, or blogs to share the collaboration's impact and attract more stakeholders.
- Communicate with organizations, governments, and donors to build partnerships.
- Regular virtual or in-person meetings to discuss progress and challenges when collaborating.
- Inform stakeholders about tool updates, new features, or collaboration opportunities.
- Co-host events to bring the community together for brainstorming, learning, and co-creation.
- Regular updates acknowledging contributions and highlighting active members.
- Comprehensive guides for using, contributing to, and maintaining the tools.
- Regular reports on milestones, tool performance, and collaboration metrics.

Collaboration lies at the heart of solving complex challenges such as achieving universal energy access. This framework aims to provide a structured approach to foster meaningful partnerships, align diverse efforts, and create impactful, open-source solutions. By enabling transparency, inclusivity, and shared ownership, the framework aims to bridge



gaps among stakeholders (developers, users, data providers, and donors) and ensure that tools are interoperable, scalable, and user-centric.

The success of this framework depends on everyone's involvement. Whether you are a developer contributing code, a data provider sharing critical insights, a donor funding innovation, or a user offering valuable feedback, your contribution plays a vital role in building sustainable energy solutions for communities worldwide. Together, we can create a collaborative ecosystem where ideas thrive, challenges are overcome, and the energy access gap narrows.

The journey to collaboration starts with every stakeholder coming together, because the solutions we build today will empower the generations of tomorrow. Let's collaborate and innovate for a sustainable future.

Participants:

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Disclaimer:



This framework is a synthesis of ideas and discussions from the Open Source in Energy Access Symposium (OSEAS) ideation challenge and collaboration sessions. It does not represent the formal review, endorsement, or individual views of the contributors listed above, nor of the organizations they are/were affiliated with. It reflects collective input from the sessions and should be attributed to the collaboration process rather than to any specific individual or organization.

ⁱ Open source, as defined by the Open Source Initiative, refers to software whose distribution terms comply with specific criteria ensuring free redistribution, access to source code, allowance for modifications and derived works, and non-discrimination against persons, groups, or fields of endeavor.