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Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

Replication board feedback as deliverable of task 15.6 EURICA

Deliverable D15.6

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Abstract

This document provides a comprehensive overview of the EURICA project, focusing on its integrated landscape, innovative business model, user empowerment strategies, validation methodology, and capacity building efforts. The document explores two distinct business model cases in Burkina Faso and Madagascar, highlighting business opportunities, market potential, and partnership prospects, while also introducing the concepts of "FlexEnergy-as-a-Service" and "PVEnergy-as-a-Service". EURICA's commitment to user empowerment and validation methodology are detailed, and capacity-building constraints and mitigation strategies are discussed. The document also outlines communication and dissemination strategies and concludes by summarizing key insights and contributions from the EURICA project. In response to the project's evolving demands, this document also delves into the project's potential for replication beyond the pilot phase. It discusses the investigation of synergies with other stakeholders and DSOs in Africa. The report concludes by summarizing key insights and contributions from the EURICA project.

Keyword list

business model, top-down, bottom-up, capacity building, communication, dissemination

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1.0	29/09/2023		1st version, ready for last review/submission
1.0	06/10/2023		1st official version

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List of abbreviations

Abbreviation	Term
BRPs	Balance Responsible Parties
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
DSO	Distribution System Operator
EV	Electric Vehicle
FaaS	FlexEnergy-As-A-Service
GSM	Global System for Mobile Communications
Home-EMS	Home Energy Management System
HW	Hardware
ICT	Information and Communications Technology
KPI	Key Performance Indicator
LoRa	Long Range
NB-IoT	Narrow Band Internet of Things
OGS	Off-Grid Solar
OPEX	Operating Expenditure
PAYG	Pay-As-You-Go
PV	Photovoltaic
SHS	Solar Home System
SIM	Subscriber Identity Module
SW	Software
TSO	Transmission System Operator
VPS	Virtual Power System
Wifi	Wireless Fidelity
XaaS	Everything-As-A-Service

1 Introduction

1.1 About the deliverable

This document represents an important milestone in the broad spectrum of EURICA results. Its main focus is on clarifying synergies arising from top-down and bottom-up pilot initiatives. In addition, it delves into the details of the related business plans for the two pilots, offering a detailed analysis of their commonalities and points of convergence.

Furthermore, this paper expands its scope to include valuable insights into user empowerment, clarified through a thorough review of the entire documentation set. It builds on the foundation laid in deliverable D15.2, which initially addressed regulatory issues and identified existing gaps in the context of capacity building.

This document essentially summarizes a critical phase in the EURICA project, provides a comprehensive overview of how the two pilot initiatives are aligning and succeeding, and continues to address the key aspect of capacity building within the project, addresses regulatory concerns and seeks to bridge existing gaps in this essential area.

As the EURICA projects' technologies and approaches continue to evolve, this document extends its focus to investigate synergies with stakeholders across the African landscape. Building upon these experiences, it delves into exploring the lessons learned and the project's potential for replication. This comprehensive section provides invaluable insights into how empowering communities beyond technical aspects, employing context-sensitive approaches, and fostering trust for energy justice have shaped the project's trajectory.

1.2 Scope of the document

The document is the sixth deliverable (D15.6) of the EURICA work package, titled "Replication board feedback as deliverable of task 15.6". The scope encompassing several key aspects integral to the project's success:

- Business Models for both approaches: A detailed exposition of the business models for both the top-down and bottom-up approaches is presented. Each approach distinct business model is meticulously described, shedding light on their respective strategies and approaches.
- Capacity Building Constraints Continuation: Building on the foundation laid in the preceding D15.2 document, this deliverable continues the exploration of capacity building constraints. It takes a closer look at the challenges and limitations faced in this critical aspect, providing valuable insights for addressing these constraints.
- Empowering Users through User Documentation: The document also places a strong emphasis on user empowerment by elucidating the significance of the complete documentation set. It highlights how comprehensive user documentation plays a pivotal role in empowering users to make the most of the EURICA project's offerings. Communication and Dissemination of EURICA Project: Another vital facet covered in this deliverable pertains to communication and dissemination strategies employed within the EURICA project. It delves into the methods and channels used to effectively convey project updates, findings, and outcomes to relevant stakeholders and the wider community.
- Investigating synergies with stakeholders and DSOs in Africa: This document also delves into the wider African context of the project. It underlines the EURICA project's commitment to exploring synergies with stakeholders across the African landscape, recognizing that sustainable energy solutions transcend borders.

2 EURICA integrated landscape

2.1 The collaborative approach

In their quest to maximize synergies between two distinct business models, the EURICA partners recognize the importance of considering the unique value propositions each model brings to the table.

The urban project, with its focus on flexible energy solutions, is dedicated to resolving electricity blackouts due to constraints on the low voltage network in densely populated areas. This model emphasizes adaptability, real-time response, and reliable access to electricity for urban consumers. It represents a critical response to the growing energy demands of urban centres and their vulnerability to power disruptions.

Conversely, the rural project centres around deploying interconnected photovoltaic solutions to gradually establish electricity grids in regions lacking a national grid. This initiative champions sustainability by harnessing abundant solar energy in rural environments to provide clean and consistent power. It not only enhances the quality of life for rural populations but also promotes economic growth and social development in underserved areas.

The integration of these two models presents a unique opportunity for synergy. By merging the flexible energy solutions of the urban project with the photovoltaic infrastructure of the rural project, the EURICA partners can create a comprehensive and adaptable energy ecosystem. This unified solution has the potential to address the diverse energy needs of both urban and rural areas, offering reliable power, reducing blackouts, and promoting clean and sustainable energy practices.

In doing so, the organization not only bridges the urban-rural energy divide but also paves the way for a more sustainable and resilient energy future. This collaborative approach ensures that the strengths of each model enhance the other, resulting in a more robust and inclusive energy solution for all.

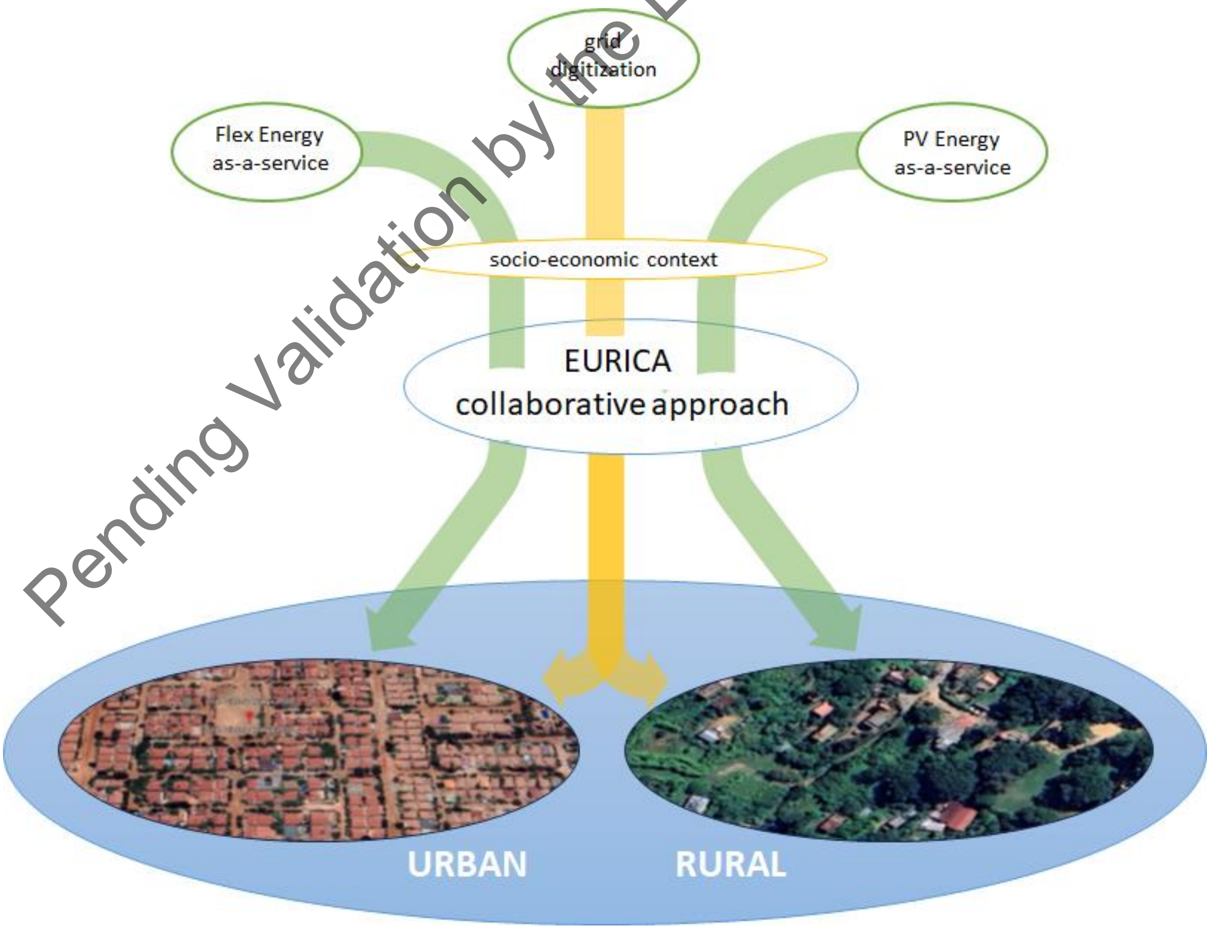


Figure 1: EURICA collaborative approach

2.2 The project toolbox

In their quest to maximize synergies between two distinct business models, the EURICA project's partners recognizes the importance of considering the unique value propositions each model brings to the table. Within this comprehensive approach, the project utilizes a versatile set of tools and strategies to accomplish its mission:

- **FlexEnergy-as-a-service:** This approach, primarily employed in the urban project, focuses on providing flexible energy solutions tailored to the dynamic energy demands of urban centres. It emphasizes adaptability, real-time response, and reliable access to electricity for urban consumers, effectively addressing electricity blackouts in densely populated areas.
- **PVEnergy-as-a-service:** In contrast, the rural project centres around the deployment and interconnection of photovoltaic solutions, harnessing abundant solar energy in areas lacking a national grid. This initiative champions sustainability by providing clean and consistent power to rural populations, simultaneously promoting economic growth and social development in underserved regions.
- **Grid Digitization:** The integration of digital technologies into energy infrastructure ensures a better-informed planning and operation thus leading to efficient energy management and distribution. Grid digitization plays a pivotal role in optimizing the performance of both urban and rural energy projects, enhancing the understanding of asset's real operating conditions, which improves reliability and reduces outages.
- **Socio-Economic Context:** The success of the EURICA collaborative approach is rooted in a deep understanding of the socio-economic context in which it operates. Recognizing the unique needs and challenges of urban and rural areas allows for tailored and effective energy solutions that uplift communities and drive sustainable development.

3 EURICA business model

3.1 Burkina Faso "top-down" case

The EURICA "Top-down" solution stands apart from alternative flexibility-oriented business models through its unique platform that facilitates flexible collaboration among diverse market participants. This platform employs a market-based pricing mechanism, automatically determining prices based on supply and demand according to predefined requirements. Importantly, the pricing aspect is distinct from the actual execution of flexibility activation. This separation between pricing and execution reflects the project's core philosophy. EURICA was not conceived as a mere marketing strategy, but as a practical solution to real-life challenges aimed at improving people's lives. This philosophy led to the adoption of an extended socio-economic approach, recognizing that addressing energy flexibility requires a holistic perspective that considers not only market dynamics but also the broader socio-economic impact. Therefore, the pricing mechanism's separation from execution ensures that the project remains focused on delivering tangible benefits to communities and individuals, aligning with its mission to enhance the quality of life through sustainable energy solutions.

The individual components and business cases, subjected to rigorous testing at demo site, must demonstrate both technical functionality and economic viability. However, the full potential of the platform, capable of supporting broader market development, emerges when considering additional business cases and developments that are currently hindered by various factors such as regulations, time constraints, resource limitations, and market access barriers.

Irrespective of the framework devised for the necessary role of a market operator in facilitating flexibility trading—analogous to the role of a data manager—the central question remains: Is it valuable to invest in and operate a decentralized flexibility market? Furthermore, are there identifiable objectives that guide the adaptation and progression of the business model?

Drafted at the 30-month mark of the project, the recent completion of the technical rollout phase has yielded insights primarily focused on customer interaction and the technical intricacies of establishing a functional system at pilot sites. Therefore, this deliverable outlines our approach to evaluating business opportunities, with a specific emphasis on the socio-economic context aimed at addressing critical electricity blackout and grid congestion scenarios.

3.1.1 Understanding business opportunities for flexibility

The utilization of intermittent and decentralized renewable energy sources is poised to transform the energy system, though there remains considerable debate on the precise evolution of this transition. One inevitable development is the increasing prominence of decentralized power generation, which will necessitate a more localized management of the energy infrastructure capable of accommodating local generation, consumption, and grid demands.

Furthermore, it is evident that flexibility in energy supply and demand will assume a pivotal role in this impending energy paradigm shift. Flexibility is likely to be treated as a distinct and tradable product, a trend already observed in today's open flexibility market, such as the power reserve market.

The growing reliance on renewables also presents heightened challenges for distribution grids. To contain investment costs in grid infrastructure, grid operations must increasingly align with the dynamics. . A prime example of this challenge is evident in the islanding mode of a distribution grid, where the entire system, including generation, consumption, and grid requirements, must be meticulously balanced.

The EURICA "top-down" toolbox offers a comprehensive suite of solutions tailored to the emerging decentralized system. The top-down approach taken, involving smaller local facilities to test and demonstrate all facets of the solution while supporting them in implementing diverse business models, appears promising. It's a prudent strategy to generate initial revenue streams from established TSO-centric services like reserve power, but this is just the beginning.

One notable departure from conventional components is the local flexibility market based on local Flex-Offers, a concept validated and demonstrated during the project's duration. Determining the ideal implementation of the EURICA toolbox in the market post-demonstration is a challenge. Collaborating through other R&I projects focused on a decentralized energy market and collectively reshaping paradigms, market models, and regulations seems a prudent path forward.

Currently, locally produced renewable energy lacks a commercial advantage compared to centrally generated energy, despite its reduced grid resource usage. This dynamic could change in the future, potentially bolstering the business models of local energy communities and virtual power plants centered around renewable energy sources. The present grid paradigm operates as a "copper plate," connecting generators and consumers wherever they are located, but the remuneration structure for DSOs often fails to account for costs averted through actions like preventing blackouts, congestion, or grid expansion, not to mention compensation for performing islanding mode. This lack of incentives is also due to the absence of visibility and far-sighting on such issues. Developing the tool allowing, through grid digitization, to identify these issues and valorise such "avoided costs" form the cornerstone of the EURICA business models.

Addressing the requisite changes in markets, regulations, and energy paradigms is an ongoing challenge. During the project, identifying and engaging with small and medium-sized facilities, such as households and small businesses, interested in transforming their consumer base into prosumers or leveraging local generation potential to integrate it into a localized energy system was a wise strategy. These smaller utilities are well-positioned to thrive in a decentralized energy landscape, having already established local credibility. In this emerging system, they will play a pivotal role in balancing energy supply and demand, along with local grid requirements, with the support of their local communities. The EURICA tools empower them to progress in this direction.

When assessing the unique market and regulatory frameworks across European countries, Switzerland emerges as the most promising, followed closely by France, Belgium, Great Britain, Ireland, and Finland. This context underscores the significance of flexibility as a tradable product and its role in mitigating issues related to blackouts and congestions as the energy landscape evolves.

3.1.2 The importance of offering energy and volume

On the flip side of the market platform, an array of diverse flexibilities is presented. The top-down solution holds the capability to seamlessly integrate various types of flexibilities via its Home-EMS. Through the aggregation of these discrete flexibilities, the nuances that distinguish them become indiscernible to potential buyers. However, additional factors can influence pricing, such as transfer costs – e.g. transferring to other DSO, market platform, etc. An algorithm is employed to discern which flexibilities best align with specific demands, thereby refining the matching process.

The ongoing analysis will pivot toward exploring the impact of scale. Is there an economic advantage in offering flexibilities without immediate monetary compensation? For instance, take the case of air-conditioners, where the owner prioritizes cooling over reduced energy consumption at any given moment. The compensation in this context might encompass non-monetary advantages rather than financial gains. Nevertheless, these smaller-scale flexibilities, like air-conditioners, stand in contrast to the magnitude of flexibilities exhibited by industrial operations, power plants, or the energy required for charging electric vehicles. As a result, a considerable number of minor devices need to aggregate their impact to approximate the scale achieved by factories or power plants. From a business standpoint, the effort and investment required to collect myriad minor loads must be comparable to the effort expended for a few substantial ones.

In the future, as the market platform matures, a more comprehensive examination will incorporate insights related to diverse criteria. Factors like longevity, reliability, and precision of the offered flexibilities will be scrutinized to enrich our understanding and decision-making processes.

Considering additional questions and thoughts:

Addressing how our solution generates revenue is pivotal. Will revenue be derived from subscription fees, advertising, transaction charges, or alternative avenues? Evaluating these aspects becomes vital to shaping our business model. This financial underpinning will play a significant role in the sustainability and success of the approach.

3.1.3 Cost benefit analysis

The Cost Benefit Analysis (CBA) is a methodical process used to calculate and compare the advantages and costs associated with a decision or project. In the case of EURICA, the primary goal of the CBA is to determine the feasibility of an investment or decision by examining whether the benefits it brings outweigh the incurred costs, and to what extent. In this scenario, "benefits" are quantified by the revenue generated from customers utilizing the specific service.

However, it is crucial to recognize that EURICA stands apart from typical commercial projects due to its strong social mission, aiming to resolve electrical congestions and blackouts for improved citizen's access to electricity, economic growth and social development. Consequently, evaluating EURICA worth extends beyond mere financial considerations to encompass its broader social impact and significance.

3.1.3.1 Costs & benefits

There were two main cost categories to be assessed:

- Fixed costs

  These are fixed costs, which remain constant regardless of the quantity of goods or services produced. An illustration of this cost category would be the expenses incurred in establishing a market platform for flexibility. The development costs for this platform remain unchanged, regardless of the number of market actors utilizing it.

- Variable costs

  These costs fall under the category of variable costs, meaning they fluctuate in proportion to the volume of goods or services produced. An example of this cost category would be the expenses directly associated with providing access to markets for prosumers. Each prosumer requires specific equipment and software, and the costs for these resources vary depending on the number of prosumers involved.

3.1.3.1.1. Hardware optimization

In the context of EURICA, the flexibility platform underwent a significant redesign and enhancement when compared to a prior projects, most notably the renowned GIFT project[1]. EURICA's primary aim was to decrease customer-side expenses while simultaneously simplifying hardware intricacies.

The majority of the efforts were concentrated on the Home-EMS and the associated home equipment.

Home-EMS:

- Transitioned from employing multiple hardware instances to a solitary cloud instance.
- Upgraded to incorporate multi-user support in place of the previous single-instance-per-user setup.

[1] https://www.gift-h2020.eu/

- Streamlined hardware, replacing customized hardware setups and cabinets with standardized cloud instances.

End-user equipment:

- Emphasized easy installation procedures.
- Introduced novel technologies to both Distribution System Operators (DSOs) and end users.
- Minimized disruptions to existing house electrical installations, ensuring a smooth integration process.

Similarly, the Grid Digitization software is designed to run on cloud instances with a containerized approach enabling deployment, scaling and management with a cost adjusted to the scale of the analysed area.

Table 1: EURICA Home-EMS

	Old Home-EMS	EURICA Home-EMS
Cloud	/	Virtual instance on site (DSO)
Hardware	N x prosumers (3500 EUR per instance)	N x prosumers (LoRa TIC = 150 EUR, LoRa socket= 60 EUR, Optional LoRa IR set = 200 EUR
Software	N x prosumers (3500 EUR per instance)	1x3500
Installation	N x prosumers (500 EUR per instance)	/
Total	N x (HW + SW + Installation)	SW + N x (LoRa equipment)

3.1.3.1.2 LoRa communication network and equipment

The Home-EMS system established a basic form of communication with end users using wireless technology, given the absence of wired internet infrastructure in the demonstration setting. Additionally, this setup served as a proof of concept for potential future projects in similar environments.

Among the available wireless technologies, namely GSM, WiFi, and LoRa, LoRa was selected as the most suitable option in terms of cost-effectiveness and performance for the specific conditions in Ouagadougou, see [Table 2].

Table 2: Wireless technologies

Technology	WiFi	GSM	LoRa
Internet gateway	N x Home routers *required wired connectivity	Mobile base station	LoRa gateway
SIM cards	N x Home routers *if no wired internet connectivity: Mobile router	N x controlled devices *NB-IoT not available, only GSM	1 per gateway *max 2 gateways
Mobile data	Medium *in the case of mobile routers	Medium *sum of all SIM cards	Low data consumption
Reliability	Variable	Variable	Fixed bandwidth
Communication range	Low	Long range	Long range

Power Consumption	Medium	Low	Low

3.1.3.1.3 Smart metering infrastructure

The grid digitization solution relies on the smart metering infrastructure providing the required set of data to compute the model and identify the places where congestion and/or voltage excursions will appear and require mitigation measures. In the framework of EURICA the whole solution benefited from an already deployed infrastructure.

In European countries, the deployment of smart metering infrastructures has been analysed and justified by other use cases mainly centered on the contractual aspect such as billing, change of energy supplier, remote change of subscribed electrical power, remote closing of the delivery point, customer information. In the African context, similar case including features like prepayment are under study, even though smart metering projects are not yet on a nationwide scale.

The replication strategy consists in exploiting such existing infrastructure to bring additional benefits to an already made investment. The marginal cost related to the grid digitization use case is then limited to the higher data requirement compared to simple billing reading and imply an increase in communication costs at Data Concentrator Unit level. In EURICA's case, this increase is localized in one sim card per secondary substation, therefore four sim cards on the demonstration site, as the communication technology between smart meter and DCU is Power Line Communication.

3.1.3.1.4 Cost optimization

While the solution has been extensively reconfigured to align with Burkina Faso's total cost considerations, there is still untapped potential for improvement in comparable future projects. Here are some possibilities:

- Smart Meter Integration with LoRa: Instead of employing standalone LoRa sensors that are connected to smart meters, an alternative approach involves utilizing smart meters that come with built-in LoRa communication capabilities. This approach has the potential to significantly reduce costs and eliminate the need for additional installations.
- Exploring Cost-Effective LoRa Communication Modules: The existing LoRa modules used for various components such as sensors and smart sockets are priced at around 10-20 EUR. Exploring options for local research and development of these modules could lead to more cost-effective alternatives.
- Tailored End-User Monitoring/Control Modules: The selection of LoRa user equipment was deliberately chosen to facilitate easy installation and avoid disruption to existing household systems. However, there are numerous other modules available that could be integrated into the solution, offering lower costs. Integrating these modules might require additional effort during the installation phase within households.
- In places where electronic but not communicating meters have been deployed, the study of adding a communication module rather than proceeding to a full upgrade of the meters could enable to address new geographies.

By considering these opportunities for optimization, future projects could benefit from cost savings, streamlined installations, and enhanced functionality.

3.1.3.2 Revenue streams

There are various approaches to creating revenue streams within EURICA "Top-down" business models, all of which require careful evaluation.

- Asset Sale:

The most widely recognized revenue stream involves selling ownership rights to a physical product. In the context of solution, this revenue stream can be applied to the sale of equipment (such as PV systems, EMS, and batteries) to prosumers. This empowers them to enhance their self-consumption capabilities and participate in flexibility trading.

- Lending/Renting/Leasing:
  This revenue stream is generated by temporarily granting exclusive usage rights of a specific asset for a predetermined period in exchange for a fee. Lenders benefit from recurring income, while renters or lessees enjoy the advantage of avoiding the full ownership costs. Within solution, utilities can apply this concept by renting out equipment (e.g., PV panels, batteries, EMS) to prosumers, possibly as part of a tariff model akin to mobile phone plans.
- Usage Fees:
  Revenue is derived from the utilization of a particular service, with customers paying based on their usage. In solution, this revenue stream can be associated with the use of the flexibility trading platform by market participants, with fees paid per transaction. It also applies to actors purchasing flexibility from others.
- Subscription Fees:
  This revenue stream arises from selling continuous access to a service. For example, in the context of market actors gaining access to the flexibility platform, subscription fees could be structured as monthly or yearly payments.
- Licensing Fees:
  Revenue is generated by granting customers permission to use protected intellectual property in exchange for licensing fees. Licensing allows rightsholders to generate income from their intellectual property without the need to manufacture a physical product or commercialize a service.

3.1.3.3 Benefits from use cases

Four sources of potential benefits are identified as follows:

- Congestion avoidance / reduction in investment costs as grid centric use case
- Customers' peak shaving / contracted power compliance as customer centric use case
- Balancing energy reduction as BRP centric use case
- Tertiary reserve as TSO centric use case

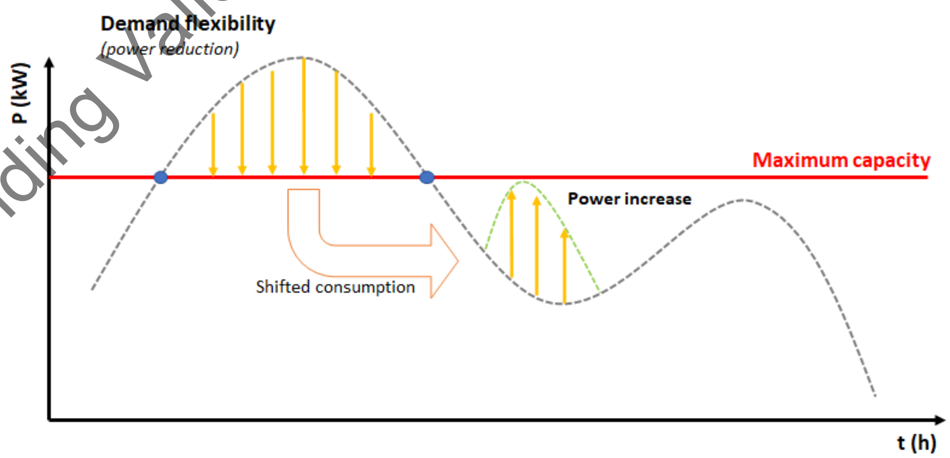


Figure 2: Energy shifting

The "top-down" platform, intended primarily for congestion mitigation by Sonabel (DSO), is designed in such a manner. It is important to highlight that mitigating or eliminating congestion also has a positive impact on voltage stability on a network that went through the rebalancing activities suggested by the Grid Digitization.

With only minor adjustments, the entire solution could similarly be applied to the other three benefit sources. The ensuing table delineates the employment scenarios and the requisite alterations for achieving specific functionalities, see Table 3.

Table 3: Benefits of use cases

	Today's situation	**Possible implementation**	**Additional equipment required**	**Additional SW required**
Congestion avoidance	✓ implemented	implemented	implemented	implemented
Peak shaving	✗	✓	✗	VPS Peak-EMS module
Balancing energy reduction	✗	✓	✗	BRP interconnection for direct demands
Tertiary reserve	✗	✓	✗	TSO interconnection for direct demands

3.1.3.4 Potential available flexibility

Table 4 presents an estimation for 160 consumers, which can be extrapolated to a larger population of 1000 individuals residing in the demonstration area. These consumers were categorized into four groups based on their rated power consumption:

- Group 1: Rated power less than or equal to 4 kW.
- Group 2: Rated power less than or equal to 24 kW.
- Group 3: Rated power less than or equal to 37 kW.
- Group 4: Rated power equal to 56 kW.

For each group, specific assumptions were made regarding the availability of flexible appliances with power ratings of 1 kW, 2 kW, 4 kW, and 8 kW.

An analysis of this data revealed the relationship between the flexible power capacity and the house rated power. It was found that using the flexible platform, approximately 18% of the flexible power capacity could be effectively utilized. Furthermore, during periods of reduced power demand, the flexible platform has the potential to achieve approximately 18% in power savings. This suggests that the platform can play a valuable role in optimizing power usage during times when power consumption needs to be curtailed.

Table 4: Potential available flexibility

Number of prosumers	**Rated power (kW)**	**Available flex power (kW)** (flex appliances)	**Ratio between flex and rated power (%)**	**Total flex power (kW)**	**Percentage of People (%)**
91	<= 4	1	25	91	56

24	>= 12	2	16	48	15
37	>= 23	4	17	148	24
8	= 56	8	14	64	5
160	approx. **2000**	/	approx. **18**	approx. **351**	100

3.1.4 Exploring regional flex-market viability

Based on the assumptions surrounding demand and supply within the flexibility market, we can derive a trading volume estimate. However, at this juncture in the project (M30), a multitude of uncertainties persist, and the available data is insufficient to conduct a comprehensive business case analysis or formulate a robust business model.

It's clear that the value of flexibility is on the rise within the energy sector. Yet, it's imperative to acknowledge the existence of alternative markets and products that could potentially pose as competitors to the top-down solution. These alternatives wield considerable influence over the pricing dynamics, often acting as thresholds to prevent scarcity from driving prices to excessive levels.

However, it remains plausible that a regional flex-market could generate a substantial trade volume, rendering investment and operation economically viable. The pivotal determinant in this context is the required expenditure. Despite the competitive landscape, the prospect of sufficient regional trade activity could counterbalance the costs, thus making the endeavour financially viable.

3.1.5 Key activities

The pivotal actions involved in cultivating a flexible energy market, encompassing the identification of target DSOs and the active engagement of consumers.

Flexibility Trading and Market Development:

Flexibility trading presents a unique challenge reminiscent of the chicken and egg scenario, where the availability of flexibility providers and potential flexibility users are intertwined. Without flexibility providers, there is no supply for potential users, and without users, the business model for flexibility providers remains unviable. To tackle this challenge:

- Identifying Target DSOs: The first step is to identify distribution system operators (DSOs) grappling with congestion problems who are open to adopting this innovative congestion mitigation tool and have a smart metering infrastructure fitting the requirements of the Grid Digitization tool or are willing to invest into such infrastructure.
- Onboarding Flexibility Providers: Crucial to success is enlisting an ample number of flexibility providers such as prosumers, producers, industries, asset managers or tertiary sector which are willing to participate.
- Aggregator Enablement: Empowering aggregators or local BRPs to aggregate FlexOffers from various customers, including smaller ones, is essential.
- Establishing Common Standards: Actively participating in efforts to establish universally accepted standards such as the FlexOffer[2] protocol, which is vital for market development.

Local BRP Activities and Consumer Engagement:

[2] https://flex-community.eu/

Local balancing responsible parties (BRPs) play a pivotal role in the flexibility ecosystem, primarily focusing on consumer engagement and conversion into flexible consumers or prosumers. This pivotal activity prepares the ground for various other actions:

- Expanding Consumer Base: Identifying and recruiting new consumers, prosumers, and generators interested in becoming part of the flexibility community.
- Supporting Smart Appliance Vendors: Collaborating with vendors of smart appliances, such as PV systems, batteries, and electric vehicles (EVs), to initiate activities within the region.
- DSO Collaboration: Establishing contact with local DSOs to gauge their interest in procuring local flexibilities and launching related initiatives.
- Market Participation: Collaborating with other market operators to participate in reserve markets and build a robust portfolio capable of meeting pre-qualification requirements for power reserves and local markets.

3.1.6 *FlexEnergy-as-a-Service: A flexible solution for energy needs*

Just as with the concept of XaaS (Everything as a Service), which encompasses a range of services such as Hardware as a Service, Infrastructure as a Service, Platform as a Service, and Software as a Service, FlexEnergy-as-a-Service (FaaS) can be similarly defined within this framework.

FaaS represents an innovative approach that provides on-demand access to flexible energy resources. From the perspective of distribution system operators (DSOs), FaaS serves as an add-on service seamlessly integrating within the existing DSO ecosystem. This versatile solution empowers DSOs to enhance grid management and stability by improving the understanding of grid's operating conditions and harnessing flexible energy assets. FaaS can be directly integrated into the current infrastructure, offering DSOs a valuable tool to optimize grid performance, accommodate renewable energy sources, and ensure efficient energy distribution.

Expanding on this service, it can be roughly categorized into the following components:

- Hardware as a Service
- Observability as a Service
- Flexibility Platform as a Service
- Infrastructure as a Service
- User Software as a Service

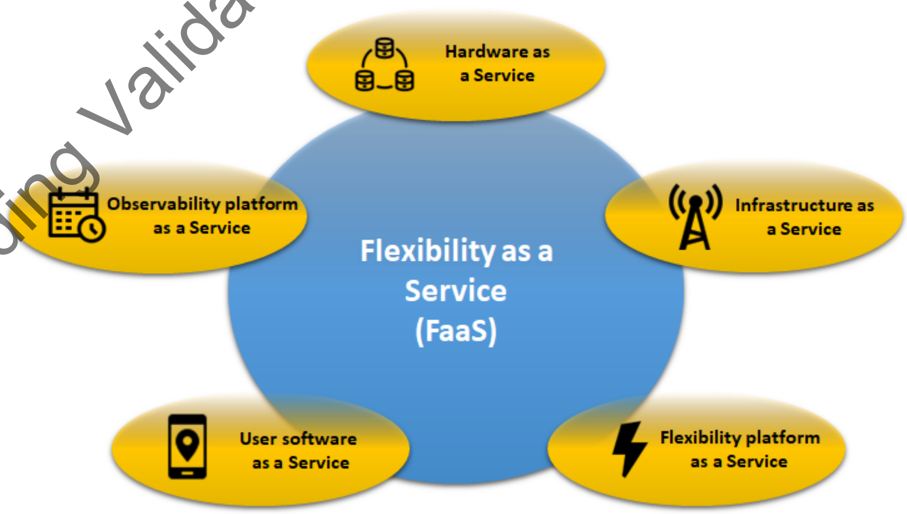


Figure 3: Flexibility as a Service

3.2 Madagascar "bottom-up" case

3.2.1 Business opportunities

With a theoretical potential of annual solar PV generation of more than 660,000 TWh of electricity, Africa is the continent with the largest solar energy resource. However, despite this enormous potential, Africa possesses less than 1% of the global PV installed capacity and constitutes the continent with the most extensive access deficit to electricity, with over 600 million people still left out. Despite a positive trend during the last two decades, the pace of progress in access to electricity for rural areas has slowed in recent years. Partly due to external shocks like COVID-19 and high inflation caused by the war in Ukraine but mostly due to the increasing complexity of reaching those hardest to reach, new connections to electricity are not expected to outpace the population growth in most African countries by 2030.

In this context, it is likely that no incremental progress of the technological, financial or regulatory landscape of the African rural electrification sector will allow to modify this trend and that a radical rethinking of the current practices in the field is urgently needed to reach universal access to clean and affordable energy as stated in the UN SDGs[3].

The ambition of the bottom-up case experimented during the project is to open a new power infrastructure development path for the rural area of the African continent taking up its two main energy challenges:

- The short-term challenge of universal energy access. This challenge is to quickly provide basic and affordable energy services able to rapidly improve the living conditions of the largest share of its currently off-grid population, and
- The long-term challenge of sustainable development. This challenge is to participate in the progressive building of the XXIst century decentralized, decarbonized and smart power infrastructures needed to put the continent on a green growth trajectory.

Although this may sound like an obvious ambition, none of the rural electrification approaches historically deployed in Africa actually manage to make both these challenges compatible and usually only tackle one of them at the expense of the other. Indeed, current rural electrification practices can be broadly divided in two categories: Grid solutions in one hand (including national grid extension as well as autonomous mini-grid or microgrid) and individual solutions (including solar home systems, solar lanterns, gensets, etc) on the other hand that not only differ from technological, marketing, business model and regulatory standpoints but also differ from their targeted stake:

- Grids are heavy solutions that can have a tremendous and sustainable impact on local development in the rural villages in which they are deployed but their slow diffusion during the last 20 years despite high subsidization rates has proven their inability to tackle the energy access emergency for most of the remaining off-grid population. Due mainly to their extremely high capital-intensity (CAPEX of 750 – 2 000 €/user[4]) compared to the payment capabilities of their typical beneficiaries (15 – 60 €/year/user) but also to slow and complex deployment processes, their large-scale development potential is limited to over 300-500 households' dense and economically dynamic villages in fairly stable and financially supportive countries. This is unfortunately not the typical place where most off-grid Africans live today, confining these solutions to a small perimeter of the energy access problematic.
- Individual solutions on the other hand and Solar Home Systems in particular have proven during the last decade their ability to cope with the short-term energy access challenge.

[3] https://sdgs.un.org/fr/goals

[4] http://documents.worldbank.org/curated/en/569621512389752401/Benchmarking-study-of-Solar-PV-mini-gridsinvestment-costs-preliminary-results

Thanks to their affordability (50 – 250 €/user) and easy deployment in almost all kind of rural settings, they managed to quickly improve the living conditions of millions of households across Africa. They have however been able to do so only by giving up on the long-term sustainability and developmental challenges. These stopgap solutions are indeed sustainable neither technically (3-4 years lifetime), nor economically (not able to power productive uses of energy), nor socially (not helping final users to climb up the energy ladder), nor even environmentally (generating enormous amounts of disseminated dangerous battery wastes that distributors are largely unable to collect).

The inherent limits of these two conventional rural electrification models calls for the emergence of a third model drawing on lessons learned from their respective advantages and drawbacks, hybridizing their technological and organizational features to combine a quick and cost-effective access to basic electricity services to the largest share of the unelectrified rural population in the short-term and the progressive building of modern, flexible and resilient infrastructures able to support the socio-economic uplift of their communities in the long-term.

This is the ambition of the bottom-up electrification concept that has been experimented in the project. It is an agile process of progressive extension of the energy services delivered to the end-users (from Tier 1 to Tier 4 in a few years) by quickly diffuse and successively interconnect basic smart units of solar power generation, storage and distribution (named solar nano-grids).

This novel approach bridging the two conventional individual and grid solutions not only combines their respective merits in the short and long-terms but also conveys the potential to surpass them in many ways. Indeed,

- Contrary to standalone Solar Home Systems, the constitution of swarm grids allows that the energy produced, but not used by one system, can be exploited by another system whose production or storage level do not structurally or conjecturally meet the local consumption. The service is therefore improved for all users, while the capital expenditure in production and storage capacities can be better optimized at the individual and community levels. The energy service can consequently be not only more flexible but also more affordable to all.
- Compared to conventional AC distribution microgrids, in addition to being far cheaper, the plug & play expandability of swarm grids makes their development far less risky by breaking down large capital expenditures in small successive investments with short paybacks performed on the basis of largely metered demand instead of declared demand. Their flexibility and the possibility to freely remove or add new production and storage capacities connected to the swarm grid at any time to optimize the production-consumption equilibrium is a game changer in microgrids economics. Among many of other advantages, bottom-up grids are highly scalable, generate less distribution losses, do not require to artificialize areas of land for building of large power plant, enable progressive increase in the consumption levels of end-users and overall present drastically lower CAPEX and OPEX costs than conventional microgrid and national grid extension while offering higher inclusivity to low-income end-users.

3.2.2 Market potential and relevant costs

Real financial data on costs and revenues of solar nano-grids deployment and of their successive interconnection to form village-wide microgrids have been collected during the pilot implementation in the village of Ambohimena in Madagascar in order to assess the business case and market potential of the two first steps of this bottom-up electrification concept.

Nanogrid economics

As shown in the graph below, the average CAPEX of the 25 nano-grids deployed in Ambohimena amounts to 667 €/nano-grid, representing an average connection cost of 143 €/user which is equivalent to the cost of an SHS delivering a less flexible and extended energy service (Tier 1-2 compared to Tier 1).

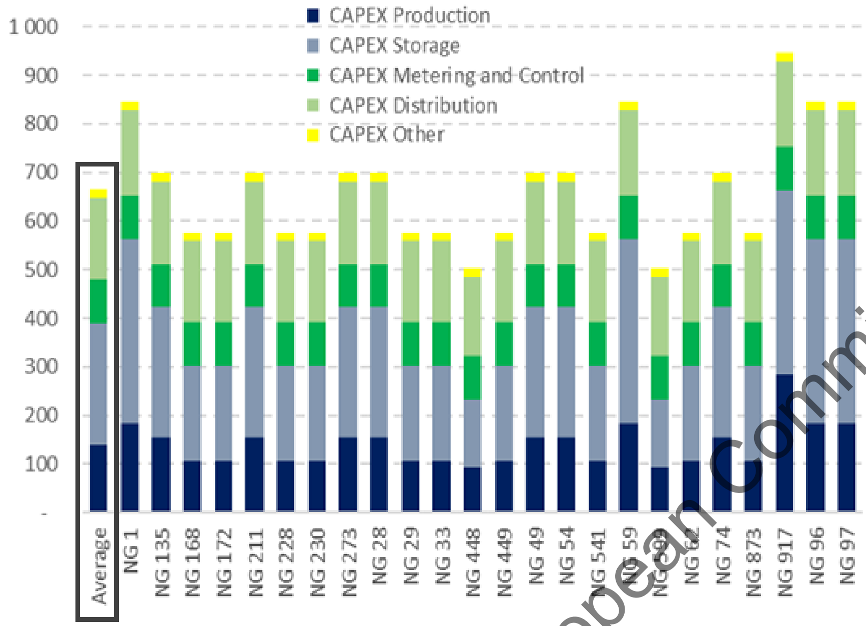


Figure 4: Nano-grid economics

The average monthly revenue generated by the PAYG sale of energy service to the 108 domestic users connected has reached 4,7 €/month/user during the field test period. With average operational expenses of 0,5 €/month/NG, the average nano-grid CAPEX will be paid back in 32 months and the IRR would be 6% at 3 years and 43% at 10 years.

This demonstrates the economic viability of the nano-grid solution.

Microgrid economics

The following table synthetizes the real costs of the nano-grids interconnection operation implemented in Ambohimena as part of the pilot constituting an additional CAPEX of 112 €/user. The total cost of such a system is therefore 255 €/user which is less than a quarter of the CAPEX of centralized solar AC microgrids deployed by other operators in Madagascar.

Materials	Unit Cost (€)	Qtty	Total Cost (€)
Interconnection Modules			**5 558**
Interconnection Modules 750 W	*200,00*	*21*	*4 200*
Interconnection Modules 1500 W	*250,00*	*4*	*1 000*
Breakers 16A	*13,33*	*25*	*333*
*Cable 2 *6 mm2 Cu for connection*	*0,98*	*25*	*25*
Distribution			**6 538**
8m Wood Poles	*80,00*	*25*	*2 000*
*Aerial Cable 2*16 mm2 Alu - Pole to Pole*	*1,49*	*2475*	*3 684*
*Aerial Cable 2*16 mm2 Alu - Pole to house*	*1,49*	*300*	*447*
Grid connectors	*1,35*	*90*	*122*
Cable Anchoring	*1,00*	*260*	*260*
Miscellaneous hardware	*1,00*	*25*	*25*
Other			**767**
Labor	*4,44*	*50*	*222*
Transportation cost			*545*
TOTAL CAPEX			**12 862**

Figure 5: Microgrid economics

Moreover, data collected during the field test showed than, thanks to the mutualization of the production and storage capacities of the 25 nano-grids of the village, an excess energy of 6-8 kWh/day could be used to power productive users.

Interviews conducted in the field with an existing diesel-run video shop, a hair salon, a mill operator and the mayor of the municipality allowed us to design new energy services adapted to these needs (AC power / 48V power with larger energy allowances, etc) that will be offered in the next few months and expected to generate an additional revenue of 287 €/month. With average operational expenses of 10 €/month, the interconnection operation CAPEX will be paid back in 47 months and the IRR would be 14% at 5 years and 31% at 10 years.

Business case and market potential

The figures above demonstrate strong business cases for the two first steps of the proposed bottom-up electrification approach. By breaking down large capital expenditures with long paybacks of classic AC microgrids in small successive investment operations with short paybacks, these technologies put rural electrification at the financial reach of small local entrepreneurs (even without subsidies!) and offer their infrastructure the possibility to closely follow the evolution of the local demand by seamlessly adding or removing new solar panels and batteries in a plug & play manner everywhere in the network.

This constitutes a game changer in the energy access sector and call for a rapid scaling of this solution. To do so, Nanoé has already launched a deployment plan of 10 000 nano-grids in the North of Madagascar by 2025 and is currently developing ad hoc planification tools and raising funds to finance the building of up to 100 microgrids in villages in which it already operates.

The company is also actively seeking to build partnerships with international energy operators to replicate this approach in other African countries. Indeed, according to GOGLA 2022 off-grid solar market trends report, in 2022, 775 million people were still without access to electricity, of this 298 million are in nascent OGS market (see segmentation below).

Based on the cumulative sales penetration of off grid products and recent sales growth of Solar Electricity Kits (SEK) since 2016		
Type	**Description**	**Examples**
Nascent	• (298 Mn) >5% of the country's population still lacks electricity • <10% sales volume of the market potential (2 mn SEK sales) • Ability of household to pay is very limited • Weak enabling environment. High fragility and conflicts	Angola, Burundi, CAR, Chad, Congo, DRoC, Gambia, Guinea, Haiti, Madagascar, Mauritania, Mozambique, Namibia, Niger, Sudan, South Sudan, Yemen, Zimbabwe, Pakistan
Emerging	• (305 Mn) atleast 5% of the population still lacks access to electricity • Atleast 10% of the market potential (~12 Mn SEK sales since 2016) • Some degree of stability to support market expansion	Burkina Faso, Benin, Cameroon, Cote d'Ivoire, Ethiopia, Liberia, Malawi, Mali, Sierra Leone, Somalia, Tanzania, Togo, Zambia, Nepal, Cambodia, Myanmar
Mature	• (71 Mn) <5% of the population still lacks access to electricity • Minimal sales volume >10% of the market potential (~14 mn SEK) • Accounted for 34% of the total off grid sales over last 3 years • Supportive financing is the key for further expansion	Kenya, Ghana, Papua New Guinea, Rwanda, Senegal, South Africa, Uganda, Vanuatu
Peaked	• Showing signs of unit sales declining. However, though declining the absolute sale is still large • 33 Mn people without access to electricity • Minimal sales volume >40% of the market potential (12.5 mn SEK)	India, Bangladesh, Guatemala, Indonesia, Philippines, Thailand, Peru

Figure 6: Market segmentation

However, the PV-based products had seen high traction. Off-grid solar product market is worth USD 2.8 bn annually (2021 data including sale of solar energy kits and Off-grid appliances). Moreover, there is substantial capital flow/ investments (USD 2.3 bn) in the off-grid solar between 2012 and 2021. The yearly investment has reached to USD 450 mn in 2021 and the sector is projected to raise USD 7.8 billion between now and 2030.

3.2.3 PV Energy-as-a-Service: Revenue streams for PV deployment

Although marginal variations may exist within each of them, only two value propositions to the final energy users and two business models for the energy access providers are currently implemented in the African rural electrification landscape.

- The conventional Utility business model where the energy access providers develop, build, own and operate the power production, storage and distribution assets up to the final users' meters and sell them electricity (in €/kWh) usually complemented by an upfront connection fee and sometimes a monthly fixed fee (in €/month).
- The conventional Retail business model where the energy access providers design, manufacture and distribute to the final users the power production and storage equipment as well as the appliances to be powered. The kit is bought by the final users cash or in leasing via Pay-As-You-Go.

The first model is extremely risky for the energy access providers since its value proposition (selling produced kWh) is largely disconnected from its cost structure (high CAPEX/low OPEX). This situation is considerably aggravated in case of renewable energy production (marginal production cost close to zero) in the African context of high capital cost and low labor cost. This equation leads to the necessity for the energy access providers to "stimulate the demand" or, in other words, promote "energy inefficiency".

The second model transfers the risks of under-consumption of energy to the final user. It also transfers a lot of other risks that are usually taken by the energy provider like material thefts, breakdowns or under-performance of the system. Its main limit however is that its deployment creates very limited economic opportunities for local players in Africa since the local added value creation is limited to the distribution of equipment largely designed in the USA and manufactured in Asia.

Beyond this status quo, two innovative business models and value propositions are made possible by the technological specificities of the bottom-up electrification model developed and tested in Madagascar:

- A Prosumer business model where the energy access providers only develop, build and operate the microgrid interconnecting several solar systems (solar nano-grids or Solar home systems) that are owned by their final users allowing them to buy or sale energy to each other. The value proposition being a combination of the sale of solar equipment and appliances to the final users and a commission on energy sold peer to peer among them.
- A Franchising business model where solar nano-grids and the microgrids interconnecting several of them are developed, owned and operated by local entrepreneurs under a franchising model guaranteeing quality and interoperability of their systems, the value proposition to the final users being the combination of the sale of energy-efficient appliances and an energy service (fixed daily fee corresponding to a maximum power and a maximum daily energy consumption).

If only the second one has been experimented so far in the project (see Deliverable 15.4), both approaches offer unique business and marketing solutions able to generate new revenue streams for PV deployment in rural Africa.

3.2.4 Partnership opportunities

Given the dynamics of the off-grid solar market, many partnerships opportunities exist to deploy this bottom-up approach in other African countries.

Based on a thorough market analysis of existing or previous partnerships between different energy access players in Africa, the figure below provides a mapping of potential partnership model for the diffusion of the bottom-up technologies developed and demonstrated by Nanoé in Madagascar in other African countries.

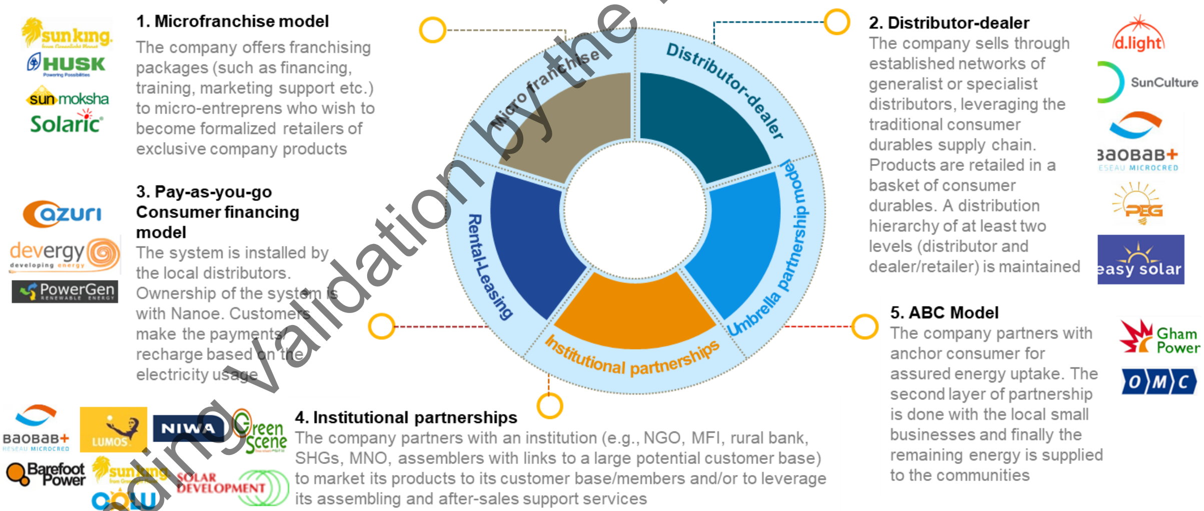


Figure 7: Partnership opportunities

4 Empowering users

Through documentation package users are empowered and equipped with the knowledge and tools to effectively adopt and use the solution. The following set of documentation plays a significant role in empowering users:

- Deployment guides
  These guides provide step-by-step instructions for deploying the solution. They cover topics such as system requirements, installation, configuration and troubleshooting tips.
- User guides
  User guides offer detailed information on how to use the solution. They provide an introduction to the solution, guide users through its features and functionality, explain user roles and permissions, and offer tips and best practices.
- Implementation plans
  Implementation plans outline the activities and phases involved in successfully implementing the solution.
- Support and training documentation
  Provides users necessary resources to troubleshoot and resolve issues independently. The following elements could be included:
  - *Troubleshooting guides*
  - *Frequently asked questions*
  - *Knowledge Base articles*
  - *Training and educational material*
- Solution description and use cases
  Solution description provides an overview and understanding the solution itself.

Table below [Table 5] serves as a repository that includes a comprehensive collection of documentation related to the EURICA project. In this table you will find a comprehensive list of document titles. It is important to note that all user manuals that are integral to the functionality and usability of the project have been thoughtfully considered and included in the scope of the previous work package tasks. These user guides are thoughtfully integrated into the report findings, ensuring that their content and relevance are immediately accessible to interested parties. In particular, both handouts, D15.4 and D15.5, have been carefully designed to include all relevant user manuals, providing a consolidated and comprehensive resource for project stakeholders.

Table 5: List of documentation

Document Type	Burkina Faso (top-down)	Madagascar (bottom-up)
Solution description and use cases	• D15.2: Capacity building plan and local flexibility market specification WP15 • D15.3: Grid digitization tool specification and mock-up WP15 • D15.4: Report of bottom-up pilot as deliverable of task 15.4 • D15.5: Report of top-down pilot as deliverable of task 15.5	
Implementation plans	• WP15.5 Deployment plan for Burkina Faso (part of Deliverable D15.5)	• Lateral electrification deployment plan (Annex - 9.2)
Deployment Guides	• User guide for equipment deployment (part of Deliverable D15.5)	• "Plan de passation Micro-réseau 2022" (Confidental)
User Guides	• User guide for system administrators • User manual for mobile application (part of Deliverable D15.5)	• "Module d'interconnection - Mode d'emploi" (Confidential) • "Module d'interconnection - Montage" (Confidential) • "Module d'interconnection - Software à installer" (Confidential) • "Module d'interconnection - Charges communales" • (Confidential)
Support and Training material	• LoRa description document • User manual for LoRa Field tester (part of Deliverable D15.5)	• Eurica presentation (Annex - 9.3)
Dissemination material	• Commercial flyer for Ouagadougou, Azimmo 2000 residents (Annex - Table of contents9.1)	

5 Validation methodology

The EURICA project established several Key Performance Indicators (KPIs) to assess and evaluate the project's impact. These KPIs have been categorized into the following distinct groups:

- Project management
- Sociologic and Economic
- Grid digitization and Observability
- Nano-grid and micro-grid interconnection
- Flexibility activation

This document outlines the Key Performance Indicators (KPIs) for both Project Management and Sociological and Economic groups, while all other topics are covered in earlier documents, namely D15.3, D15.4 and D15.5.

5.1 Project management

5.1.1 Project milestones completed on time

Definition:

Project milestones completed on time. Whether or not assignments or tasks are completed by a given deadline. As reported in D15.1, the WP15 milestone were the following:

Number	Title	Verification mean	Due Date	Responsible
MS1	Sociological and technical outcome	Submission of D15.2 and D15.3	M18	Odit-e
MS2	Report on pilot sites and replicability	Submission of D15.4 and D15.5 and D15.6	M30	Odit-e

Calculation method:

Counted at the end of a project.

Value:

At the end of the project, it is determined that the first milestone has been achieved with the publication of D15.2 and D15.3 on the EC portal on 5th of April 2022.

The second milestone is yet to reach with the publication of D15.4, D15.5 and D15.6 on the EC portal during the month of Octobre 2023. With the extension of the WP to M37 and the updated deliverables' due date on M36, this milestone has been changed accordingly.

5.1.2 Percentage of deliverables submitted on time

Definition:

Completed deliverables on time. Whether or not submitted deliverables by a given deadline.

Calculation method:

Counted at the end of a project.

Value:

Out of the seven deliverables, three have been published already with minor delay, four are to be published in early October 2023.

5.1.3 Project risks

Definition:

The number of realized risks on the project, the risk table identifies in D15.1 is the following:

Number	Risk description	Risk mitigation	Proba	Impact
1	Unforeseen extra costs	(C). Apply the rules set in the Consortium agreement for possible budget reshuffling	2	4
2	Difficulties with deployment, data acquisition	(P). Involve local partners early. Coordinate the deployment. (C). Deploy additional sensors if existing equipment doesn't exist or is unsuitable. Use simulated data.	2	3
3	Difficulties with acquisition of prosumers	(P). Start the acquisition process at the beginning of the project. Inform potential stakeholders. (C). Scale the pilot.	3	2
4	Technical problems to obtain relevant technical and economical results	(C). Possible redefinition of the expected results to conduct the cost benefit analysis	2	2
5	Lack of DSO engagement in the testing of the solution	(P). Apply appropriate customer engagement measures – recruitment campaign	3	2
6	Travel restriction due to the COVID pandemic	(P). Most meetings performed online. (C). Delay of field work and modification of the planning	4	2
7	Travel restriction due to the security situation	(P). Most meetings performed online. (C). Delay of field work and modification of the planning	3	3

Calculation method:

Counted at the end of a project.

Value:

In reflection upon the concluded project, it's worth noting that two predefined risks were anticipated and duly acknowledged. These risks pertained to ongoing challenges related to travel, particularly security issues in Burkina Faso, and persistent difficulties associated with the acquisition of prosumers. Despite these predicted risks, the project has successfully come to its conclusion.

5.2 Sociologic & Economic

5.2.1 Number of visits and interviews

Definition:

The number of remote or on-site visits, interviews, and presentations conducted to gain insights into the views and experiences of specific populations.

Calculation Method:

Counted at the end of the project.

Value:

67 interviews were conducted across Burkina Faso, Madagascar, and Cameroon in the winter and spring of 2022. These interviews were qualitative in nature and involved various stakeholders, including academia, business interests, consumers, suppliers (including “illegal” suppliers in Cameroon), regulators and government officials.

5.2.2 Recognized added value

Definition:

The level of engagement and positive reception of the project's key events, as evidenced by metrics such as impressions, reactions, and participation rates, can serve as an indirect measure of the recognized added value of the project's solutions.

Calculation Method:

Metrics are collected from key events like TRIAE and the IFDD webinars, focusing on the level of engagement and participation.

Expected Objective:

To achieve high levels of engagement and positive reception, as evidenced by social media metrics and participation rates.

Value:

For the TRIAE event, posts related to the event received 19,133 impressions, 394 reactions, and 84 reposts mainly on LinkedIn, indicating a high level of engagement and interest.

For the IFDD webinar, out of 1,095 registrants, 361 participated live. IFDD labelled this turnout as "very good" for an event of this type. The diverse participation from government institutions (24%), private companies (21%), and students (18%) suggests that the project's solutions are resonating across different sectors.

While these metrics do not directly measure the added value recognized by the participants, the high levels of engagement and diverse participation can be considered indicative of the project's relevance and potential impact.

5.2.3 Women empowerment

Definition:

The extent to which women are included and empowered in the project's activities, particularly in key events like TRIAE and IFDD webinars. This includes their representation as speakers, participants, and the focus of dedicated panels or discussions.

Calculation Method:

Metrics are collected from key events, focusing on the gender distribution of speakers and participants, as well as the content and takeaways from gender-focused panels.

Expected Objective:

To achieve a balanced gender representation among speakers and to address gender-specific issues in the energy sector through dedicated panels or discussions.

Value:

At the IFDD webinar, 50% of the speakers were women, although women accounted for only 16% of the participants.

The International Round Table (TRIAE) event featured a dedicated panel on women in the energy sector, discussing the barriers they face and the need for their inclusion in decision-making processes. The panel included experts like Sara BAGRE, Ines NANEMA, and Fatoumata DIALLO, who are actively involved in clean energy projects in Africa. Key takeaways emphasized the need to break gender stereotypes and cultural constraints that limit women's participation in STEM fields, particularly in the energy sector.

These metrics and qualitative insights indicate a concerted effort to empower women through the project's activities, although there is room for improvement in increasing female participation among the general audience.

6 Capacity building constraints (gaps)

Theoretical stress analysis of the capacity building constraints and issues identified in deliverable 15.2 was confirmed in the following project steps. The successful implementation of the capacity building plan requires a nuanced understanding of the challenges at hand, which encompasses not only the technical and infrastructural dimensions but also the regulatory, social, and trust-related aspects that significantly influence the engagement and participation of communities in the energy transition.

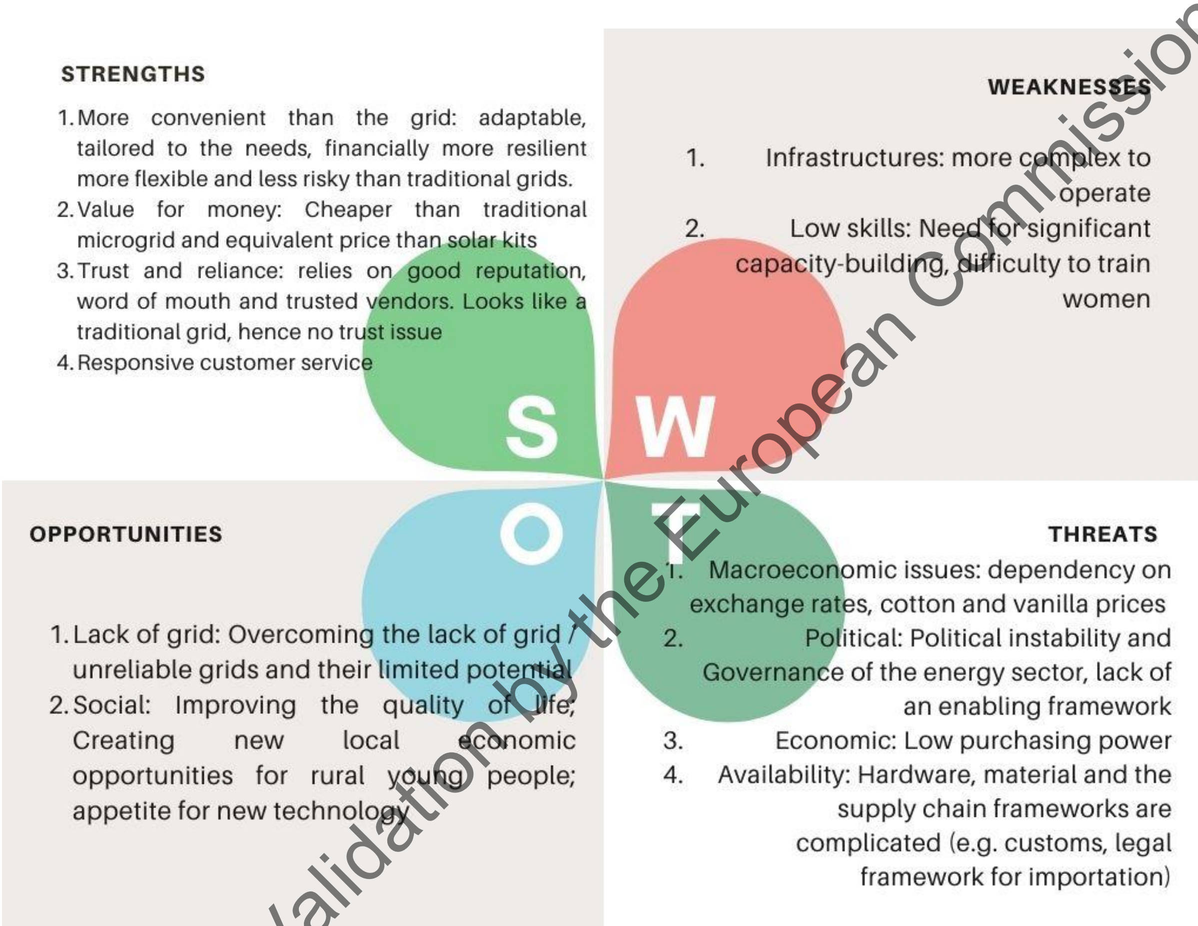


Figure 8 - SWOT Analysis - Madagascar (updated)

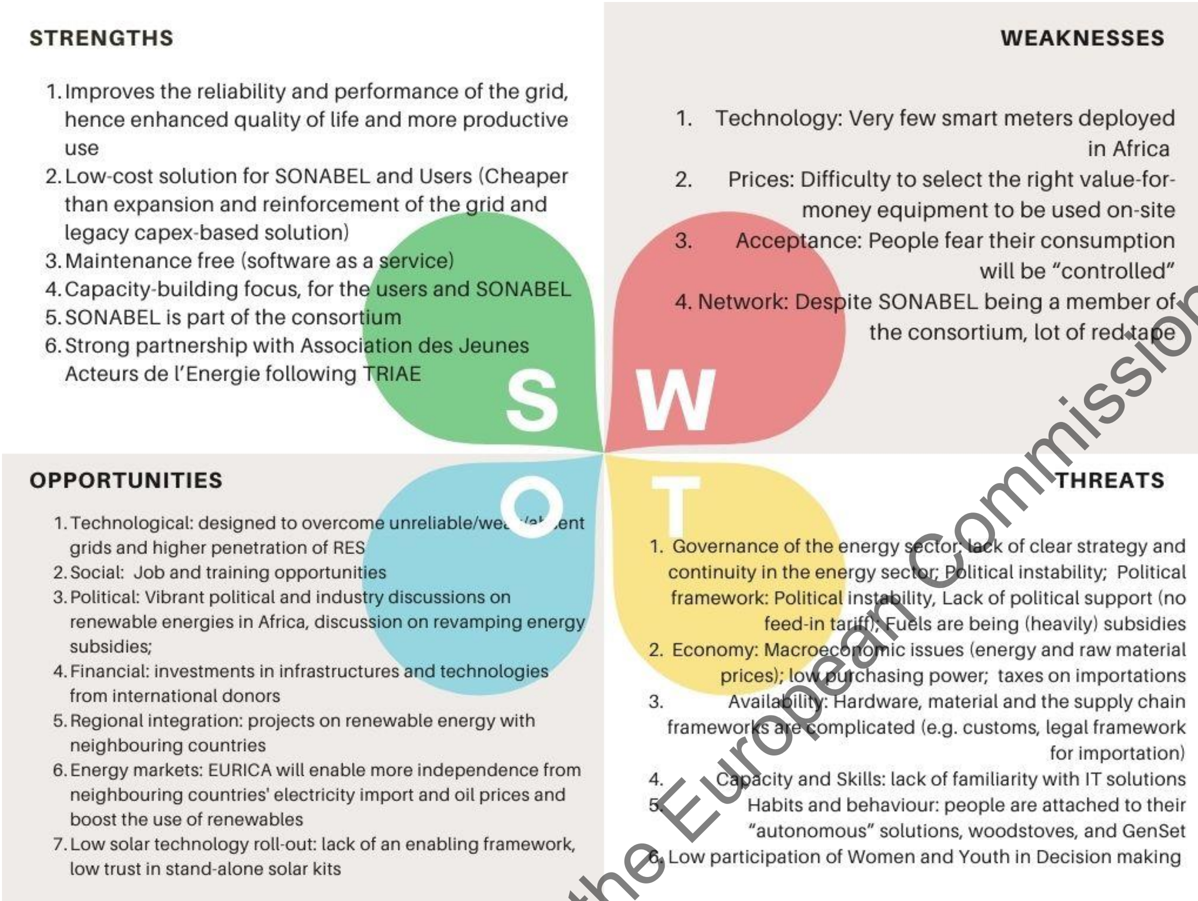


Figure 9 - SWOT Analysis - Burkina Faso (updated)

6.1 Understanding gaps and issues

6.1.1 Regulatory issues

In the Sub-Saharan African context, the regulatory landscape presents a complex terrain for effective engagement and participation in energy initiatives. The prevailing centralization of energy systems, often controlled by state-owned monopolies and international players, contrasts with the vision of democratized and distributed energy promoted by EURICA. This discrepancy is further exacerbated by a perceived or real lack of transparency and accountability within these centralized structures. While progressive energy models such as peer-to-peer and prosumer networks are demonstrating effectiveness in developed nations, they face hurdles in under-resourced communities due to inadequate policy frameworks and institutional support.

In the context of the EURICA project's efforts to enhance energy access and justice in Burkina Faso and Madagascar, we encounter a multifaceted set of constraints that hinder effective capacity building and the realization of inclusive energy transition goals. One critical aspect pertains to regulatory challenges, which intersect with barriers to customer engagement, cultural considerations, and geographical dimensions.

Regulatory frameworks to oversee decentralized energy setups and innovative business models, as well as incentives for consumer and community engagement, are often lacking or inadequately implemented.

This dearth of regulatory support diminishes the potential impact of bottom-up energy justice approaches. Moreover, struggling national utilities may lack incentives to invest in smart-grid projects, and the fear of income loss can deter the expansion of demand response initiatives and distributed generation programs. Additionally, the scarcity of comprehensive sector data and large-scale smart metering complicates the scenario further.

6.2 Mitigating strategy

To address these regulatory challenges, a multi-faceted approach is essential. This includes advocating for the development and implementation of regulatory frameworks that empower local communities and promote democratized energy systems. This is why the digitalisation topic was so prominent in the International Energy Round Table event EURICA organised with the Burkinabè Young Energy Actors association in March 2023 (more information on this flagship event below).

EURICA has sought to prioritise collaborative efforts between stakeholders, including governments, regulatory bodies, and local communities, as field work have demonstrated how crucial this kind of collaboration is to ensure that policy advice aligns with the needs of these communities. In addition, capacity-building initiatives has included training on navigating regulatory processes and advocating for favorable policy changes, for instance through the online seminar organised in July 2023 with the Institut de la Francophonie pour le Développement Durable.

Hence, to address these regulatory challenges and barriers to customer engagement, a comprehensive mitigating strategy is essential. This strategy should encompass several dimensions:

1. **Policy and Regulatory Reform:** Collaborative efforts between governments, international organizations, and local stakeholders should focus on developing and implementing coherent regulatory frameworks that support decentralized energy systems. These frameworks should encourage innovative business models, incentivize community participation, and ensure transparent decision-making processes.
2. **Capacity Building and Awareness:** Capacity-building initiatives targeting regulatory authorities, local utilities, and communities are crucial. Workshops, training programs, and knowledge-sharing platforms can raise awareness about the benefits of decentralized energy systems and empower stakeholders to navigate regulatory landscapes effectively.
3. **Cultural Sensitivity and Geographic Customization:** Recognizing the diversity of cultural norms and geographical variations across regions is vital. Regulatory frameworks and engagement strategies should be tailored to accommodate these differences, ensuring that they resonate with local communities.
4. **Technology Localization:** Fostering partnerships for technology localization can facilitate the adoption of appropriate digital solutions. Collaborations between local innovators, international tech companies, and regulatory bodies can lead to contextually relevant and effective solutions.

6.3 Lessons learnt and potential for replication

Reflecting on the implementation of the action plan within the EURICA project, tangible insights have emerged that can guide future endeavours with a specific focus on the unique contexts of Burkina Faso and Madagascar. These insights shed light on the intricate interplay between regulatory challenges, trust-building, and energy justice in these regions.

6.3.1 Empowering Communities Beyond Technical Aspects: Burkina Faso and Madagascar

In both Burkina Faso and Madagascar, the significance of empowering communities goes beyond technical aspects. While technical knowledge is vital, the lessons from the EURICA project emphasize that regulatory literacy is equally essential. Communities must be equipped not only with the skills to navigate technological solutions but also with the ability to engage with regulatory bodies. This empowerment enables them to advocate for their energy needs and ensures that policies align with the principles of energy justice.

6.3.2 Context-Sensitive Approaches: Localized Wisdom in Action

Replicating successful strategies requires a nuanced understanding of local contexts. The experiences in Burkina Faso and Madagascar underscore the significance of tailoring approaches to the specific cultural, geographical, and socio-economic nuances of each community. Context-sensitive solutions, rather than generic interventions, are pivotal for success. Lessons from both regions show that a one-size-fits-all approach is unlikely to yield optimal outcomes.

For example, the Ouagadougou case study illuminated the potential of local flexibility as a remedy for grid congestion. However, this potential hinged upon acknowledging real-world situations and counteracting rebound effects. In brief, relying solely on digitalization falls short of achieving significant and rapid reductions in resource needs and environmental effects. The potential rebound effect of smart homes could diminish the expected energy savings, raising questions about accountability among hardware manufacturers, software developers, energy providers, and oversight bodies. Despite the promoted efficiency improvements, digitalization frequently leads to higher energy usage due to the production, usage, and disposal of information and communication technology (ICT), ultimately outweighing any sector-specific changes.[5]

These findings highlight the importance of customizing solutions to address the unique challenges and opportunities present in each region.

6.3.3 Building Trust for Energy Justice: The Burkina Faso and Madagascar Perspective

Energy justice, a pivotal concept in the energy transition journey, emphasizes the fairness and equity dimensions of energy production and consumption. It encompasses aspects of availability, affordability, transparency, and accountability. Trust plays a foundational role within the realm of energy justice.[6] Building trust among electricity users, utility providers, and governing bodies overseeing the energy sector is essential for the success of any transition initiative. Trust is closely linked to the acceptance of renewable energy sources, reflecting the connection between knowledge acquisition, social awareness, and sustainable energy practices.

[5] T. Santarius, J. Pohl, and S. Lange, "Digitalization and the Decoupling Debate: Can ICT Help to Reduce Environmental Impacts While the Economy Keeps Growing?" Sustainability, vol. 12, no. 18, Sep. 2020, doi: 10.3390/SU12187496 and S. Lange, J. Pohl, and T. Santarius, "Digitalization and energy consumption. Does ICT reduce energy demand?" Ecological Economics, vol. 176, Oct. 2020, doi: 10.1016/J.ECOLECON.2020.106760

[6] A. Ambole, K. Koranteng, P. Njoroge, and D. L. Luhangala, "A Review of Energy Communities in Sub-Saharan Africa as a Transition Pathway to Energy Democracy," 2021, doi: 10.3390/su13042128.

Conversely, energy poverty erodes trust, highlighting the interplay between financial challenges, discrimination, and housing difficulties in undermining confidence. Recognizing this, efforts to enhance energy access must prioritize building and nurturing trust. Trust serves as a cornerstone within communities, forming the basis for productive relationships and resilient energy practices, particularly for energy-poor households.

In Burkina Faso and Madagascar, the experiences confirmed the essential role of trust in fostering successful energy transitions. In Burkina Faso, portraying consumption as 'monitored' rather than 'controlled' led to greater receptivity. Trust in data management emerged as central, highlighting the importance of cybersecurity. Similarly, in Madagascar, the element of trust played a pivotal role in the user-nano grid relationships. Families' confidence in Nanoé's supply quality contrasted starkly with past disillusionment caused by underperforming mainstream products.

Both Burkina Faso and Madagascar display a gap in consumer protection. Therefore, building trust emerges as a paramount goal in the evolving nexus of the energy transition. Trust acts as a fulcrum that bolsters the resilience of energy-poor households and serves as a foundation for inclusive energy transitions.

6.3.4 Stakeholder Engagement and Inclusivity: Burkina Faso and Madagascar in Focus

The Quintuple Helix model, involving political, educational, economic, civil society, and environmental subsystems, is a guiding framework for stakeholder engagement.[7] This model gains particular relevance in Burkina Faso and Madagascar, where diverse participation is pivotal. Acknowledging the role of women and girls as consumers and drivers of economic growth and political leadership is particularly vital within this framework.

In Madagascar, for instance, the absence of specific legislation governing consumer protection underscores the need for strong leadership and comprehensive regulations. In Burkina Faso, efforts to enhance consumer well-being must consider the high illiteracy rates and complex market dynamics. In both cases, inclusive discussions involving various stakeholders, especially women, are pivotal for driving effective and equitable energy transitions. This is why women participation and empowerment was so central within the TRIAE roundtable. One of its takeaways is that gender parity, women and youth's involvement in the energy transition are key to better serve people's aspirations and needs. Including women's perspectives in decision-making can lead to more relevant innovations and better technology transfer.

Conclusion: Navigating Unique Pathways for Energy Justice

In conclusion, the lessons garnered from the EURICA project's implementation in Burkina Faso and Madagascar offer invaluable insights for navigating the intricate landscape of energy justice. By tailoring

[7] V. González-Carrasco, R. Robina-Ramírez, D.-E. Gibaja-Romero, and M. Sánchez-Oro Sánchez, "The Quintuple Helix Model: Cooperation system for a sustainable electric power industry in Mexico," Frontiers in Sustainable Energy Policy, vol. 1, p. 1047675, Feb. 2023, doi: 10.3389/FSUEP.2022.1047675. and E. G. Carayannis, T. D. Barth, and D. F. Campbell, "The Quintuple Helix innovation model: global warming as a challenge and driver for innovation," Journal of Innovation and Entrepreneurship 2012 1:1, vol. 1, no. 1, pp. 1–12, Aug. 2012, doi: 10.1186/2192-5372-1-2.

strategies to specific contexts, fostering trust, and ensuring inclusivity, capacity-building efforts can lay the foundation for meaningful and sustainable energy transitions. The experiences in these regions highlight that the road to energy justice is not uniform; rather, it is a dynamic journey that demands context-sensitive approaches and active stakeholder engagement. Through this lens, we can pave the way for inclusive, equitable, and resilient energy transitions in Sub-Saharan Africa and beyond, embodying the principles of energy justice.

7 Communication and dissemination

7.1 Project identity and public image

A logo based on the LEAP-RE graphic charter was created for this project. This enables EURICA to be firmly anchored in the LEAP-RE ecosystem, while giving it its own identity.

Figure 10 - EURICA logo

The team did not create a dedicated website, but instead relied on the platform provided by LEAP-RE that can be found here https://www.leap-re.eu/eurica/.

As for social media, the consortium used the hashtag #EURICA.

On the occasion of the first International Energy Players Round Table (TRIAE), EURICA created a playlist on YouTube, hosted by Next Energy Consumer and accessible here:
https://youtube.com/playlist?list=PLX79ciNSwhsTXue5Ayu6Z4MX_VOSXs7fs&si=1MvMyuIhzksJnASp

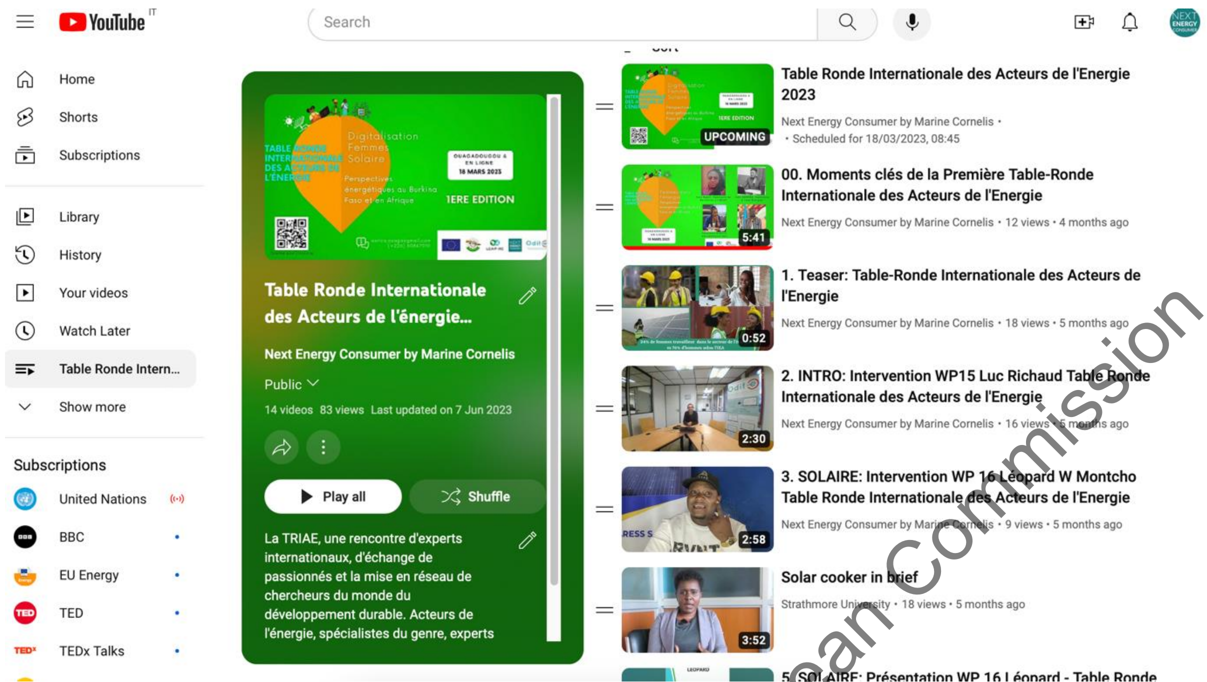


Figure 11 - Screenshot of YouTube playlist

7.2 Communication and dissemination strategy

7.2.1 Communication activities

EURICA established a detailed communication plan at the beginning of the project. Most of the planned activities and publications took place. Others were added as opportunities arose.

Table 6: Initial Communication plan

Date / timeline	Topic	Audience / Target	Medium / Type	Purpose/goals	Persons in charge	Extra (e.g. link, example)	Status / Next steps	Comments July 2022	Status (September 2023)
Q3 2023	impacts of the digitalisation of electricity in developing countries	Academic	Peer-reviewed publication	Scientific recognition	Nanoé, NEC, ISDK		Find the review, submit an abstract	TBD by September 2022	Published by Routledge. Book Chapter: "Demand-side flexibility to address household energy poverty in Sub-Saharan Africa: The Case of Burkina Faso and Madagascar" by Cornelis, M., Mballa Elanga, E., and Richaud, L. in Living with Energy Poverty: Perspectives from the Global North and South:
Q4 2022		Energy professionals	General publication	Information sharing, publicity	NEC	Enlit Europe	NEC contacted ENLIT		NEC chaired the "energy democratisation" hub at ENLIT 2022
Q2 2023	Community energy, empowerment, eradicating poverty, energy justice	**Social justice / NGO professionals**			NEC		Find the right organisations, get in touch, propose an abstract / presentaiton		Book Chapter: Energy digitisation as a consumer empowerment tool: opportunities and risks in ESCOP4GREEN (Coordinated by the University of Camerino): Cornelis, M., to be published in 2023 (Q4)
			Event (presentation/ panel)	Dissemination – high level peer to peer		Africa Climate Week, SE4ALL, Development Days, Africa Europe Foundation	Find the right stakeholders		EURICA was presented by NEC at CEER - Energy Regulators conference on Digitalisation and consumer rights in May 2023
Jan/Feb 2023, Ouagadougou	Energy round tables – next steps – best	Energy sector in BF	Event (organisation)	Capacity building, knowledge	ODT, NEC, association Les				TRIAE : The first International Energy Players Round Table (TRIAE), took place in both Ouagadougou and online on 18 March 2023, and

	practices in Africa			sharing, lobbying	Jeunes Acteurs de l'Energie				was organized by EURICA in partnership with the local youth association Les Jeunes Acteurs de l'Energie.
Q1 2022	Podcast on Digitalisation	All	Podcast Energ'Ethic	Knowledge sharing	NEC	https://podcasters.spotify.com/pod/show/energethic/episodes/E12---Developing-decentralised--decarbonised-and-smart-electricity-access-in-Africa---Nicolas-Saincy--Nano-e1dh7r6	Recorded with Nicolas Saincy in January 2022		Episode 12 of Energ'Ethic: Developing decentralised, decarbonised and smart electricity access in Africa, with Nicolas Saincy, Nanoé Madagascar
August 2023	Webinar / course	African energy professionals	IFDD	Capacity-building	NEC	https://formation.ifdd.francophonie.org/innovation-digitale-pour-un-avenir-electrique-lelectrification-amelioree-a-madagascar-et-au-burkina-faso/		Could be a case study end 2022/early 2023 (on digitalization or other topics). 1h / 1h30, presentation + Q&A	Capacity-building effort which included ODT, Nanoé, NEC and Burkinabè association Les Jeunes Acteurs de l'Energie, in the framework of SELF IFDD, 13 July 2023
	Op-ed on digital tools for devoping economies	European Policymakers	EurActiv	knowledge sharing, lobbying	NEC, ODT, Nanoé?		Check political agenda – when would be the right moment	November 2022	/
Deadline 15/7/2022	*Boosting prosumerism: State of play of the best practice to inform and boost individuals, communities and other relevant stakeholders*.	Energy professionals, policymakers	EUSEW 2022	Knowledge sharing	NEC	https://sustainable-energy-week.ec.europa.eu/news/lets-boost-prosumerism-models-and-state-play-2022-09-02_en			Published on 2/9/2022. Online: Boosting prosumerism: State of play of the best practice to inform and boost individuals, communities and other relevant stakeholders, by Cornelis, M.
November 2022	Explainer on Energy & digitalisation	General	IPPI	Knowledge sharing	NEC		Waiting for approval		/

October 2023		Energy professionals	ECEEE		NEC		Check if interested/when	Summer study beginning of June. In 2024, summer study. Abstract for September 2023 ?	TBC
October 2022	RESchool	PhD and Master students							RESChool, October 2022, Pretoria: Demand-Side Flexibility: what does it mean for consumers?

Key messages

The key messages used in the communication strategy of the project emphasize the importance of digitalization in improving the quality of distributed electricity and optimizing existing resources, which in turn enhances human satisfaction and serves as a powerful tool in combating energy poverty. The messages also highlight the need for innovative solutions in rural electrification that prioritize qualitative employment and reduced capital intensity. Local entrepreneurship is recognized as a driving force in disseminating such innovations, while the synergies between energy and digitalization support the principles of lateral electrification (the core principle of the bottom-up approach in Madagascar). Flexibility within an already connected electrical network, as it is the case in Ouagadougou, Burkina Faso, is crucial for optimizing assets and distributed production sources, as well as prioritizing essential uses. Lastly, digitalization is seen as an indispensable tool in understanding and enhancing the resilience of networks, acting as true drivers of the energy transition and sustainable development of the African continent.

What	Concept	Keywords	Relevance for…
Who we are	3 African countries, 2 demonstrations sites 1 bottom-up (Madagascar), 1 top-down (Ouaga) Multidisciplinary team with relevant geographical and gender balance	Multidisciplinary, geographical repartition, and gender-balance	All
Broad context of energy in developing countries	Electricity "brightens life". It is an empowerment tool, especially for women, when it serves their professional and personal aspirations (e.g. store food to eat & sell, charge their phone, watch TV).	Development, empowerment, productive uses, SDG7, poverty reduction	International donors, NGOs
From energy user to consumer	When people start to pay for an electricity service, they want it to be reliable, affordable and easy to use – they want to understand what they are paying for. It's one of the reasons why solar seems so appealing: once it's installed, people get electricity (in theory).	Consumers, affordability, grid, solar	Project leaders, regulators, policy-makers
EURICA solution	Digitalisation is an enabler of a better electricity service, as it permits to make the most out of the electricity grid, whether the main one (Ouaga) or nano-grids (Ambanja), while not increasing costs.	Demand-side response, energy efficiency, energy sufficiency	Energy companies, Project leaders, regulators, policy-makers
Next steps/discussions	Testing the performance of digital tools in real-life; trigger discussions around the social impacts of electricity; discuss how energy consumers can be shielded against rising energy costs and better protected against poorly performing energy companies	consumers	Project leaders / donors

Communication and dissemination channels:

EURICA team used a combination of tools, from participating to events, delivering speeches, or presenting research paper, to organising webinars and onsite events and recording podcasts. Social media has also been largely utilised. Bellow is a list of material used for communication purposes:

Photo 1: EURICA webinar advertising slide, 13 July 2023

Events organisation:

- TRIAE: The first International Energy Players Round Table (TRIAE), took place in both Ouagadougou and online on 18 March 2023, and was organized by EURICA in partnership with the local youth association Les Jeunes Acteurs de l'Energie. The primary objective was to unite a diverse range of individuals and organisations, each with their own visions and projects in the energy sector, to facilitate cross-communication and coordination. https://www.nextenergyconsumer.eu/2023/04/26/first-international-energy-players-round-table/
- SELF IFDD: Innovation Digitale Pour Un Avenir Electrique A Madagascar Et Au Burkina Faso (Digital Innovation For An Electric Future In Madagascar And Burkina Faso): This online seminar, organised on 13 July 2023 with the support of the Institut de la Francophonie pour le développement durable, looked at the lessons and opportunities offered by digitalisation for a successful energy transformation, based on the two EURICA case studies: a small-scale nano-grid project in Madagascar and grid stabilisation in an electrified urban area in Burkina Faso. https://formation.ifdd.francophonie.org/innovation-digitale-pour-un-avenir-electrique-lelectrification-amelioree-a-madagascar-et-au-burkina-faso/
- International Energy Poverty Action Weeks 2022 and 2023: The International Energy Poverty Action Week is an online grassroots event series focused on the solutions aiming to address energy and fuel poverty at local and international levels. Next Energy Consumer, a subcontractor partner of EURICA, organized and moderated two sessions building on the lessons learned throughout EURICA. One providing context on energy poverty in Africa (2022), inviting several members of LEAP-RE (watch: https://youtu.be/0UI4J2br2-Y?si=_USKSW1FwVwzdTK3); and another in 2023 on youth engagement, involving the president of with the local youth association Les Jeunes Acteurs de l'Energie, met during the course of EURICA (watch: https://youtu.be/JxenLrhu-R8?si=wAJnV5JRL9BFV5eg).

Publications:

- Book Chapter: Energy digitisation as a consumer empowerment tool: opportunities and risks in ESCOP4GREEN (Coordinated by the University of Camerino): Cornelis, M., 2023

- Report on the first International Energy Players Round Table (TRIAE): https://drive.google.com/file/d/1kGHQcr-Mbjf4YCAq3-ZyGtr7we2xERI7/view?usp=share_link
- Book Chapter: "Demand-side flexibility to address household energy poverty in Sub-Saharan Africa: The Case of Burkina Faso and Madagascar" by Cornelis, M., Mballa Elanga, E., and Richaud, L. in *Living with Energy Poverty: Perspectives from the Global North and South*, Routledge 2023
- From Blackouts to Flexibility: case study from Burkina Faso at CIRED: Ursic S., Cornelis, M., and Richaud, L.
- Electrification latérale Vers Un Nouveau Modele d'électrification Pour L'Afrique by Saincy, N. https://www.academia.edu/36892599/Electrification_lat%C3%A9rale_VERS_UN_NOUVEAU_MODELE_DELECTRIFICATION_POUR_LAFRIQUE
- Boosting prosumerism: State of play of the best practice to inform and boost individuals, communities and other relevant stakeholders, by Cornelis, M. EUSEW 2022 (2 September 2022): https://sustainable-energy-week.ec.europa.eu/news/lets-boost-prosumerism-models-and-state-play-2022-09-02_en

Videos:

- Orange: Nanoé - Start-up Stories Saison 2 https://www.youtube.com/live/0y7snYz6ZtI?feature=share
- Nanoé - Electrification décentralisée (VF) https://www.youtube.com/watch?v=s-AHSwHYF6k&ab_channel=Nano%C3%A9-Electrificationd%C3%A9centralis%C3%A9e
- Nanoé Madagascar - Djao Mazava (Clip officiel) https://www.youtube.com/watch?v=qAFy_2jLbOg&ab_channel=Nano%C3%A9-Electrificationd%C3%A9centralis%C3%A9e
- Playlist: Table Ronde Internationale des Actuers de l'Energie (2023) https://www.youtube.com/watch?v=0y7snYz6ZtI&list=PLX79ciNSwhsTXue5Ayu6Z4MX_VOSXs7fs
- https://youtu.be/aF1mKl8RuBI
- Friday at IEPAW 2023: Addressing energy poverty in the context of climate change - youth ambitions https://youtu.be/JxenLrhu-R8?si=wAJnV5JRL9BFV5eg
- Friday at IEPAW 2022: International Energy Poverty Action Week - Day 5: Africa https://youtu.be/0UI4J2br2-Y?si=_USKSW1FwVwzdTK3
- Digital Innovation for An Electric Future In Madagascar And Burkina Faso Webinar with IFDD https://youtu.be/0UI4J2br2-Y?si=QxqX6nDhnrBLvEff

Event participation and Speeches

- EURICA at EUSEW, June 2023
- The solution of interconnection module of Nanoé has won the Grand Prize at 2023 IEEE Empower a Billion Lives Global Final in March 2023: https://empowerabillionlives.org/winners/
- EURICA presented at CEER - Energy Regulators conference on Digitalisation and consumer rights in May 2023.
- Keynote Speaker, Foro Espanol de Energia Limpia, January 2023
- Chair of the Democratisation Hub, ENLIT Europe, November 2022
- Keynote Speaker, MEDREG Consumer Protection Working Group, October 2022;
- Speaker, Webinar "Facilitating Sustainability via Consumers: The Perspective of Energy Law", University of Groningen, June 2022 ;
- Panel leader and Moderator, ECEEE Summer Study: Panel 3. Policy, finance and governance, June 2022

- Speaker, Ombudsman Energia Mexico: Madagascar: la experiencia del consumidor de energía, 26 May 2022
- Speaker, Consumidores Energéticos: El Caso de Burkina Faso, Ombudsman Energia Mexico, 17 March 2022

Podcasts:

- Episode 12 of Energ'Ethic: Developing decentralised, decarbonised and smart electricity access in Africa, with Nicolas Saincy, Nanoé Madagascar https://podcasters.spotify.com/pod/show/energethic/episodes/E12---Developing-decentralised--decarbonised-and-smart-electricity-access-in-Africa---Nicolas-Saincy--Nano-e1dh7r6

7.2.1.1 Event campaigns

EURICA regularly shared news about the progress of the project on the LinkedIn and X (formerly Twitter) social networks, such as the trips to Madagascar, Burkina Faso and Pretoria for the LEAP-RE Stakeholder forum and General Assembly. EURICA specifically organised two campaigns for its outreach and capacity-building activities, namely the first International Energy Players Round Table (TRIAE) in March 2023 and the Digital Innovation for An Electric Future In Madagascar And Burkina Faso Webinar organised with IFDD in July 2023.

In both cases, to communicate, EURICA relied on the institutional profiles of the consortium members (including the service provider on sociology, organisation and capacity building Next Energy Consumer); on the partners of the actions, namely the Association des Jeunes Acteurs de l'Energie for the TRIAE and the IFDD for the Digital Innovation for An Electric Future In Madagascar And Burkina Faso Webinar; and on the personal profiles of EURICA members.

Specifically, regarding the TRIAE, before, during and after the event, the organisers mainly communicated and advertised via professional social channels, including the profiles of the two most influential people in the group, Dimitri Tientega (JAE) and Marine Cornels (Next Energy Consumer). Most engagements came from LinkedIn. The figures given are as of 22 March 2023. Their posts received 19133 impressions; 394 reactions and 84 reposts.

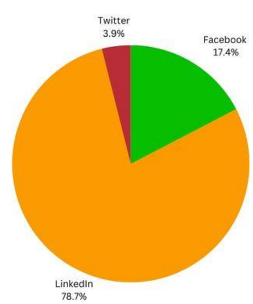


Figure 12 - Source of the engagement for the TRIAE. Source: EURICA, 2023.

Figure 13 - Example of social media campaign - extract from EURICA's TRIAE report

Interested parties registered via Eventbrite to follow the registrations and to be able to write to the participants in a GDPR-compliant way. Two events were created via this platform, one for face-to-face participants and one for online participants. Seventy-eight people registered to participate online, 40 on-site (maximum room capacity).

Most registered online and face-to-face participants came from Burkina Faso. Still, the international footprint is confirmed by registrations from many African countries (such as Kenya, Mozambique or Benin), Europe (Switzerland, France, Italy), and the American continent (Canada, Mexico). The room was packed for the live debates, while 20 online participants stayed logged in for the whole duration of the event.

More information regarding the campaign and outreach of the TRIAE can be found in the TRIAE report in Annex [9.4].

Regarding the Digital Innovation for An Electric Future In Madagascar And Burkina Faso Webinar with IFDD, an offshoot of the Organisation Internationale de la Francophonie, sent EURICA some outputs of the webinar. Out of 1,095 registrants, 361 participated live, which the IFDD said was "very good" for an event of this type. 24% came from government institutions (ministries, local authorities, etc.), 21% from private companies and 18% from students. Despite a perfect gender balance among the speakers, women accounted for only 16% of all registrants, reflecting trends in the sector. The participants were fairly young, as 55% were aged between 18 and 35.

18% of registrants came from countries targeted by EURICA: 161 from Burkina Faso and 35 from Madagascar.

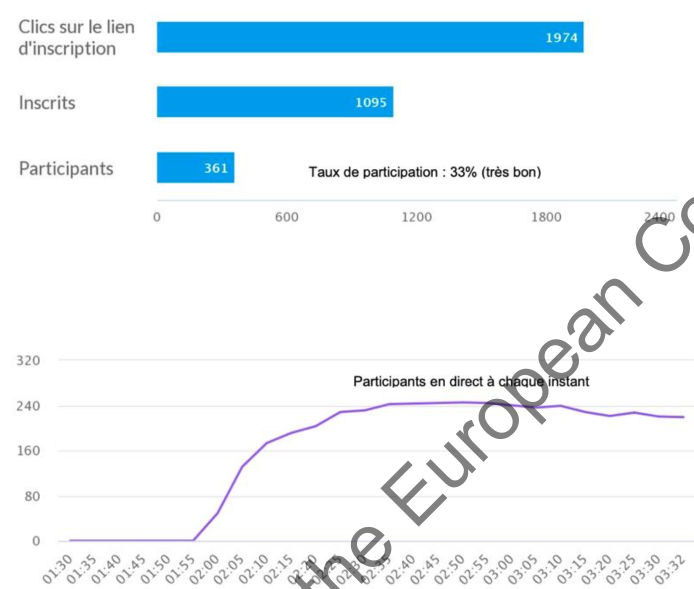


Figure 14 - Registered participants and live participation. Source: IFDD, 2023

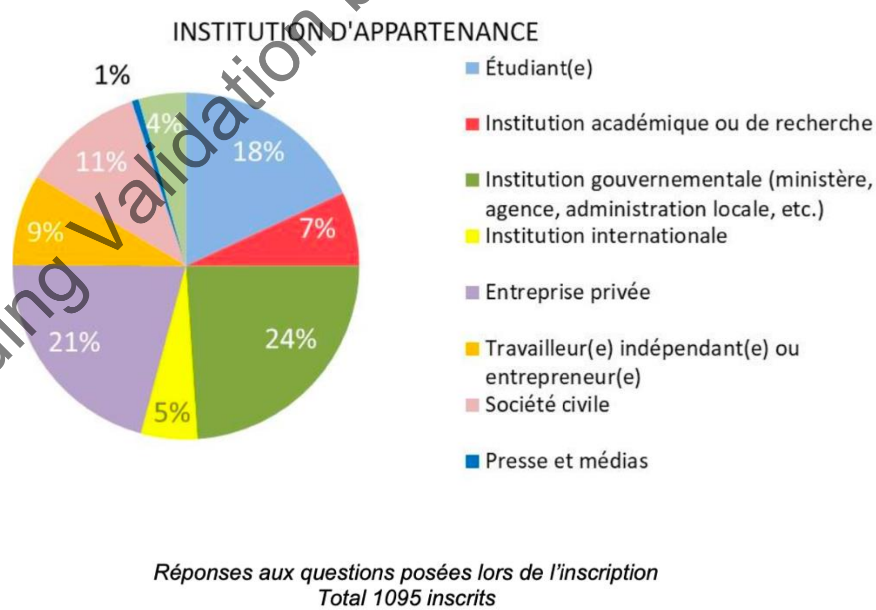


Figure 15 - institutions of origin of webinar registered participants. Source: IFDD, 2023

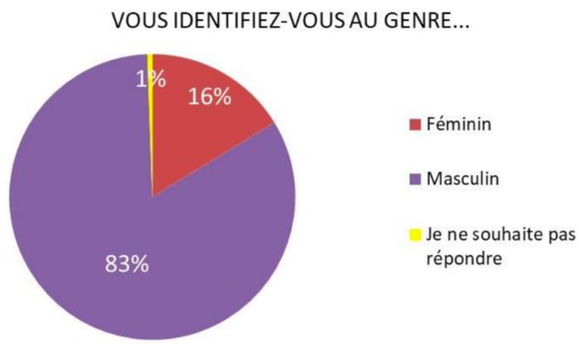


Figure 16 - Proportion of women and men among registrants. Source: IFDD, 2023

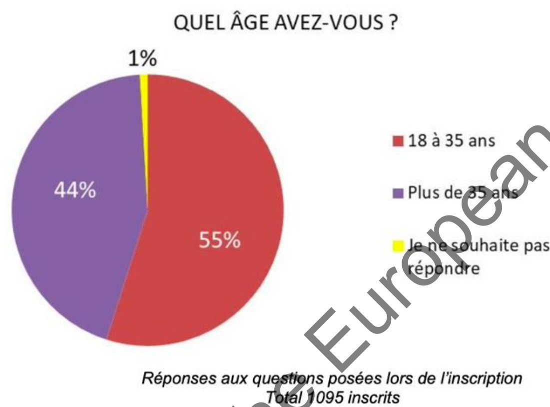


Figure 17 - Age groups of participants. Source: IFDD, 2023

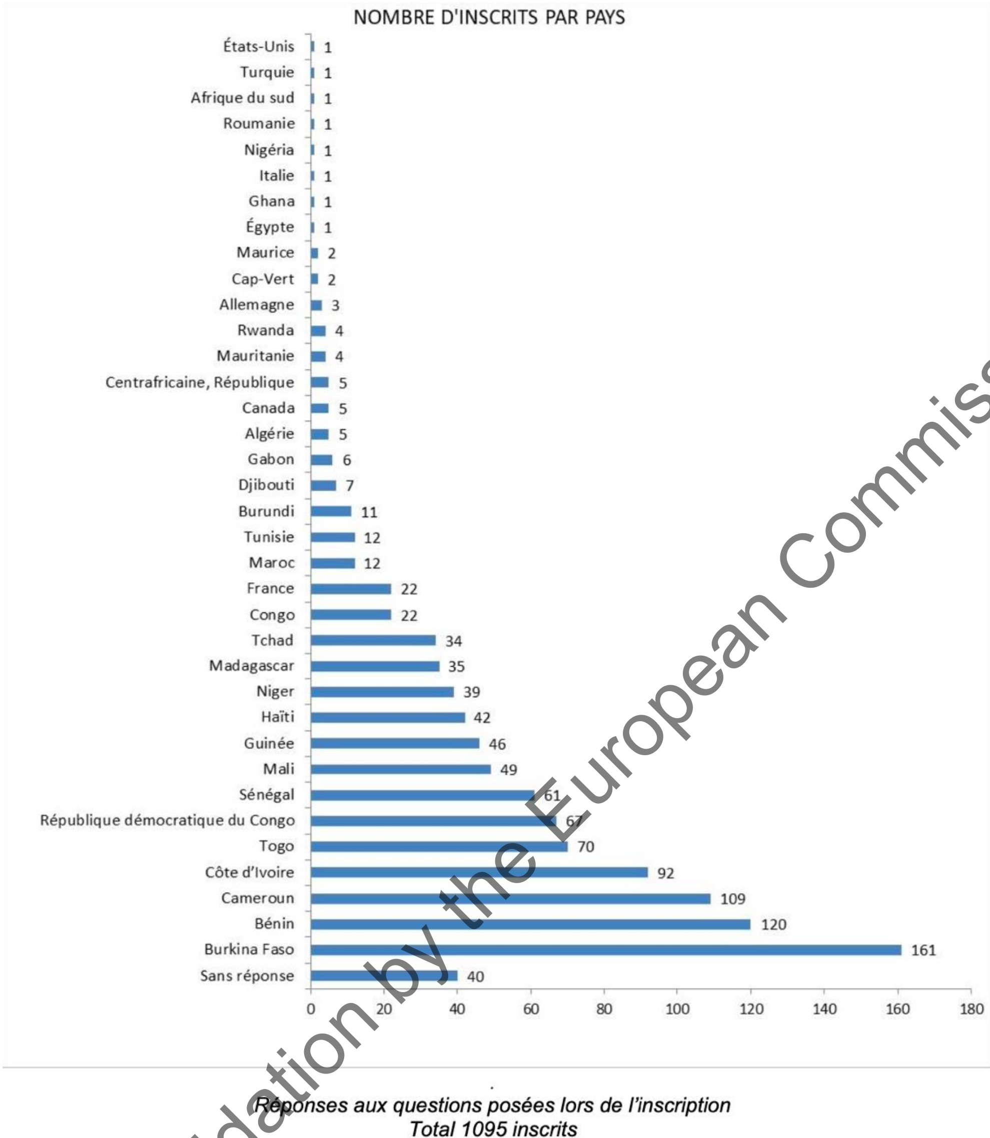


Figure 18 - Country of origin of the webinar registered participants. Source: IFDD, 2023

7.2.2 Assessment & lessons learnt

The EURICA project, with its focus on the transformative power of digitalization in the energy sector, has made significant strides in both local and international arenas. The key messages, emphasizing the role of digitalization in enhancing the quality of distributed electricity, optimizing resources, and combating energy poverty, resonated deeply with a diverse audience. These messages underscored the importance of innovative solutions in rural electrification, the potential of local entrepreneurship, and the synergies between energy and digitalization, particularly in the context of lateral electrification, a core principle in Madagascar. In Burkina Faso, the emphasis on flexibility within connected electrical networks highlighted the potential for optimizing assets and prioritizing essential uses. The overarching narrative was clear: digitalization is not just a tool but a catalyst for the energy transition and sustainable development in Africa.

The project's outreach was vast and varied. The first International Energy Players Round Table (TRIAE) in Ouagadougou, organized in collaboration with the local youth association Les Jeunes Acteurs de l'Energie, was a testament to the project's local impact. The packed room and the significant online participation demonstrated a keen interest in the energy sector's future, with a majority of participants hailing from Burkina Faso. Yet, the international footprint was undeniable, with attendees from across Africa, Europe, and the Americas. The subsequent online seminar with a partner as prestigious as the Institut de la Francophonie pour le Développement Durable, an offshoot of the Organisation Internationale de la Francophonie, "Innovation Digitale Pour Un Avenir Electrique à Madagascar Et Au Burkina Faso," further solidified the project's global reach, with a commendable turnout and significant participation from the target countries.

The project's communication strategy was multifaceted, leveraging various platforms from webinars, podcasts, and social media to on-site events and research presentations. The International Energy Poverty Action Weeks in 2022 and 2023, organized by service provider Next Energy Consumer, further emphasized the project's commitment to addressing energy poverty, with sessions focusing on the African context and youth engagement. The extensive list of publications, videos, event participations, and speeches further attests to the project's comprehensive outreach and its success in disseminating its key messages.

The project's success in convincing a broad audience of its key messages is evident not just in the numbers but in the depth and breadth of engagement. From the Grand Prize at the 2023 IEEE Empower a Billion Lives Global Final to the insightful episodes of the Energ'Ethic podcast, the EURICA project has left an indelible mark on the discourse surrounding energy, digitalization, and sustainable development in Africa and beyond.

Incorporating the lessons learned from the project can guide future initiatives in the energy sector, ensuring that they are impactful, sustainable, and aligned with the needs and aspirations of the communities they serve. Drawing from the extensive outreach and impact of the EURICA project, here are some lessons learned:

1. Adaptability is Essential: The diverse contexts of Madagascar and Burkina Faso, from lateral electrification to network flexibility, highlight the need for solutions that are adaptable to local challenges and opportunities.
2. Diverse Communication Channels Enhance Outreach: The project's multifaceted communication strategy, encompassing webinars, podcasts, on-site events, and a variety of social media, highlighted the importance of using varied platforms to reach and engage different audience segments.
3. Localized Engagement is Crucial: The success of the TRIAE event in Ouagadougou, in collaboration with Les Jeunes Acteurs de l'Energie, underscores the importance of partnering with local organizations. Such collaborations ensure that interventions are culturally sensitive, relevant, and effective.
4. Youth Engagement is Vital: The energy transition requires the involvement of the next generation. Engaging with youth, as seen in the 2023 session on youth engagement of the IEPAW and the collaboration with the association Les Jeunes Acteurs de l'Energie, ensures that the transition is sustainable and forward-looking.
5. International Collaboration Amplifies Impact: While local impact is paramount, the international footprint of the project, with participants from across continents, emphasizes the value of global collaboration and knowledge exchange.

6. Empowerment Through Knowledge: Publications, from book chapters to case studies, played a crucial role in disseminating knowledge. They serve as lasting resources that can inform and guide future initiatives.
7. Feedback Mechanisms Enhance Effectiveness: The commendable turnout and feedback from events like the "Innovation Digitale Pour Un Avenir Electrique A Madagascar Et Au Burkina Faso" seminar indicate the importance of real-time feedback. Such mechanisms allow for course corrections and ensure that interventions remain relevant and effective.
8. Celebrating Successes Drives Momentum: Recognitions, like the Grand Prize at the 2023 IEEE Empower a Billion Lives Global Final, serve as morale boosters. They validate the efforts of all stakeholders and inspire continued dedication to the cause.
9. Digitalization as a Catalyst: The project reaffirmed that digitalizing energy assets isn't just a tool but a transformative force in the energy sector. It can optimize resources, enhance the quality of distributed electricity, and play a pivotal role in combating energy poverty.
10. Consumer Empowerment is Key: The project's emphasis on consumer empowerment, especially through digitalization, underscores the importance of placing consumers at the centre of the energy transition. Empowered consumers can drive change from the grassroots level.

7.3 Establishing the replication strategy

7.3.1 Identification of potential stakeholders

Establishing a replication strategy with the right stakeholders is crucial for scaling the impact of successful projects. EURICA has worked with the below types of organisations at various levels to challenge its approach and investigate potential synergies with other relevant stakeholders in Africa. Such collaboration enabled to gather replicability potential feedback and assess the possibilities for further adoption of demonstrated technologies:

1. International Development Agencies: Organizations like the World Bank, UNDP, Organisation Internationale de la Francophonie and others can offer funding, technical expertise, and a global network of partners.
2. Local Governments and Municipalities: These entities have a vested interest in improving energy infrastructure and can provide regulatory support, permits, and potential funding.
3. Energy Providers and Utilities: They can offer technical expertise, infrastructure support, and can integrate new solutions into existing grids.
4. Private Sector and Investors: Businesses in the energy sector, as well as impact investors, can provide funding, technical solutions, and scale-up support.
5. Local Entrepreneurs: They can drive innovation, offer localized solutions, and ensure that interventions are sustainable in the long run.
6. Research Institutions and Universities: They can provide data analysis, research support, and innovative solutions. Collaborations can also lead to pilot projects and case studies.
7. Local NGOs and Community Organizations: These groups can provide on-the-ground support, community engagement, and ensure that interventions are culturally and contextually appropriate. Among them, Consumer Advocacy Groups play a particularly critical roles, as they can offer insights into consumer needs, challenges, and can boost consumer education and empowerment. Youth Organizations are also key enablers to steer future sustainability, increase potential skills and brings fresh perspectives and innovative solutions.
8. Media and Communication Entities: They can help in disseminating information, raising awareness, and garnering public support.

7.3.2 Replication possibilities

To effectively replicate the successes of the EURICA project, a multifaceted approach is essential. Initiating pilot projects in new regions can serve as a litmus test, allowing for real-time adjustments before full-scale implementation. However, instead of reinventing the wheel, synergies with existing energy initiatives in target regions can be explored, integrating the project's proven components, and enable a better customization. Customization, while maintaining the project's essence, ensures interventions resonate with the socio-cultural and economic fabric of new areas.

To make replication possible, knowledge-sharing forums and digital events can enable stakeholders from different regions to exchange insights and best practices and perhaps foster collaboration. Digital platforms are critical as they offer a medium for knowledge dissemination, stakeholder coordination, and continuous learning. However, local training and capacity-building workshops are also necessary to empower local stakeholders, ensuring they possess the requisite skills for project execution. Lastly, public awareness campaigns can set the stage, ensuring community buy-in and laying the groundwork for successful project replication.

Maintaining the contact with the potential stakeholders described in the previous paragraph to keep gathering replicability opportunities and provide strategic oversight can ensure fidelity to the project's core principles while allowing for regional customization. Robust monitoring and evaluation mechanisms are indispensable, providing a feedback loop for continuous improvement. Securing funding is pivotal, and dedicated mechanisms, possibly through collaborations with financial institutions or public-private partnerships, can underpin the replication efforts.

8 Conclusion

The EURICA project stands as a testament to successful collaboration and innovation in the realm of energy solutions. With a comprehensive approach to addressing diverse energy needs, the project has demonstrated its effectiveness in bridging the urban-rural energy divide.

The project began with a clear understanding of its scope and objectives, guided by the pursuit of delivering tangible value to both urban and rural communities. Through the development of a collaborative approach and the strategic use of a versatile project toolbox, EURICA has harnessed the strengths of "FlexEnergy-as-a-Service" and "PVEnergy-as-a-Service" models.

In analysing the project's business models, it is evident that the "Top-Down" approach in Burkina Faso and the "Bottom-Up" initiative in Madagascar have not only identified business opportunities but have also laid the groundwork for sustainable revenue streams. These models have been tailored to meet the unique energy challenges of their respective regions.

The project's commitment to empowering users and the validation methodology employed underscore its dedication to making a meaningful impact. Socio-economic benefits, technical achievements, and milestones have all been accomplished in a timely manner.

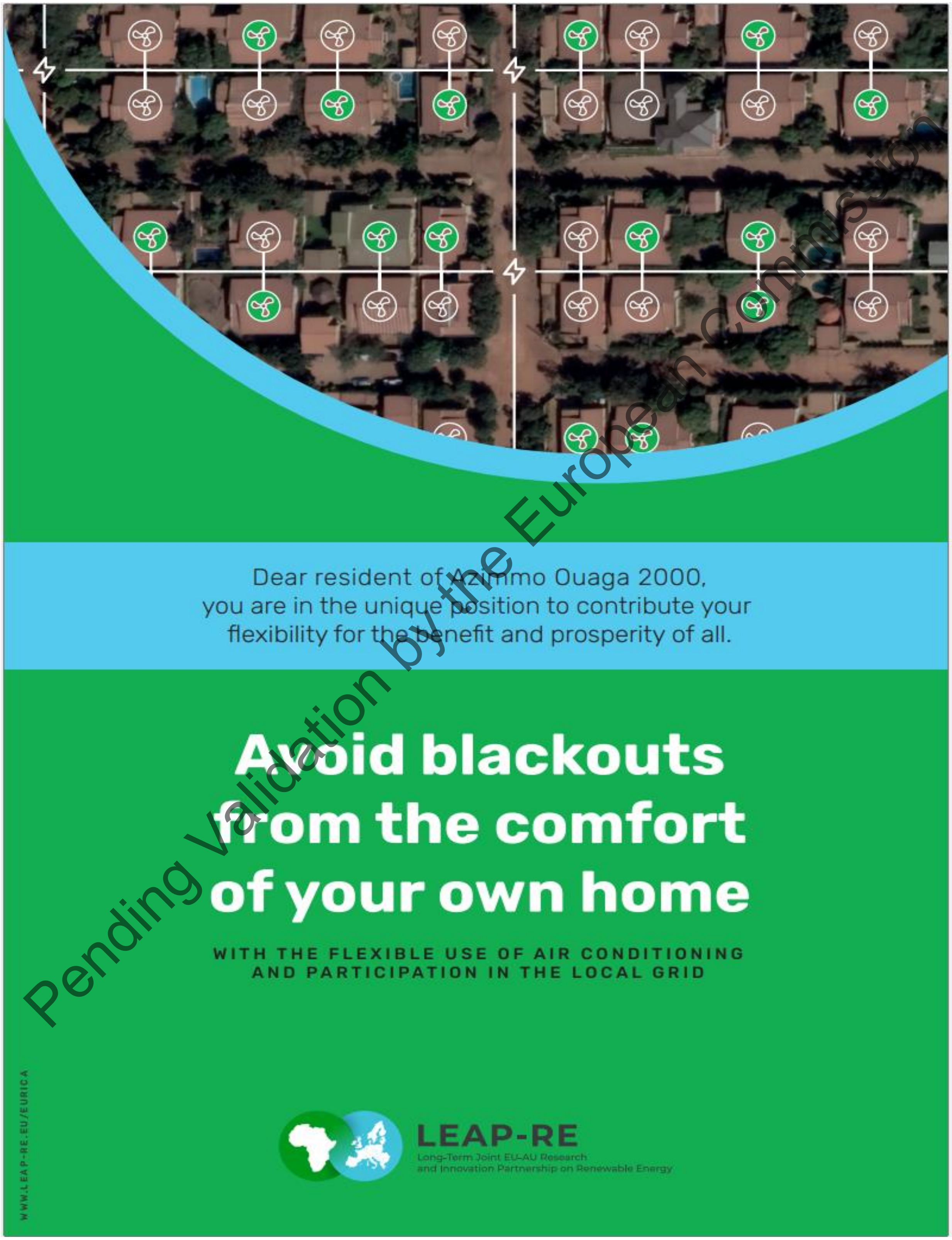
However, it's important to acknowledge that the project has not been without its challenges. Capacity building constraints and regulatory issues have been addressed systematically, providing valuable insights into mitigating strategies and lessons learned.

In terms of communication and dissemination, EURICA has succeeded in establishing a strong project identity and a well-thought-out strategy. The groundwork for potential replication has also been laid, emphasizing the project's commitment to extending its impact beyond its current scope.

In conclusion, EURICA emerges as a successful project, bringing together innovative business models, user empowerment, effective project management, and a strategic approach to communication and replication. As it continues to bridge energy gaps and foster sustainable development, EURICA sets an example for future endeavours in the field of energy solutions and socio-economic development.

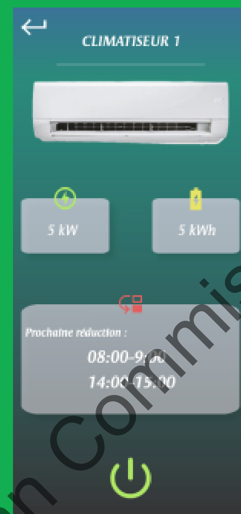
9 Annexes

9.1 Prosumer flyer



One hour a day makes all the difference

During times of peak consumption, turning air conditioners off for an hour can mean that more critical devices like refrigerators can stay on continuously without having to turn on diesel generators, saving you time, money, and noise.



Total control via mobile app

Know exactly what is happening at home using the LEAP-RE mobile app. See when your devices will be turned on and off in the app and monitor how much energy you contributed this way.

It will always be your choice

Your air conditioner will be turned off automatically when a time of grid instability is approaching - but only if you want it to. We will never turn off your devices against your will and you can always turn it on and off yourself.

Contact SONABEL to join the AU-EU project!

SONABEL

(+226) 25 30 61 00
infos@sonabel.bf

9.2 Lateral electrification deployment plan

LATERAL ELECTRIFICATION DEPLOYMENT PLAN

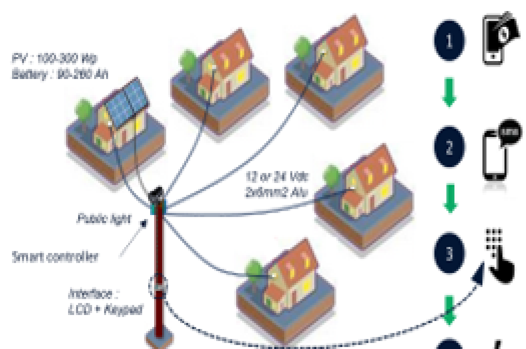
Concept summary

Despite the United Nation Sustainable Development Goals of ensuring universal access to basic and modern electricity services by 2030, up to 770 million people still lack access to electricity, mostly in rural places of Sub-Saharan Africa and South-East Asia. At the same time, developing countries are struggling with unemployment and poor local economic development. A new electrification model is needed to answer simultaneously both greatest challenges the African continent is facing nowadays. Conventional ways to tackle rural electrification challenges fail to do so. Based on this observation, Nanoé, a young French-Malagasy social company created in 2017, develops the Lateral Electrification model, based on the progressive building of decarbonized and decentralized electric infrastructures in a bottom-up manner and the training of a myriad of local electric operators and developers.

TECHNOLOGIES

The Lateral Electrification model proposes an agile process of progressive extension of the energy services delivered to the end-users (from Tier 1 to Tier 4) by diffusing and then aggregating basic smart power units regrouping solar power generation, storage and distribution.

Nanoé has already successfully developed in-house the nanogrid, an expandable and collective DC solar system composed of solar panels, lead-acid batteries and a proprietary smart controller, powering 4 to 6 households up to Tier 2 access.



The successful field-testing has enabled to complete the proof-of-concept of the second step of the Lateral Electrification model. A village-wide 72 V DC microgrid has been installed in Madagascar to interconnect 24 nanogrids. In addition, the microgrid enables productive use of energy, either through AC inverters connected on the 72 V DC bus or through 48 V high-power DC agro-processing machines. The microgrid is operating satisfyingly since December 2022. This new technological development is a game-changer for Nanoé, now ready for accelerating on the second phase of its electrification model.

1

BUSINESS

Marketing approach

The Lateral Electrification model relies on an exhaustive service offer from power production and grid operation to appliance supply and domestic electrification. Indeed, remote rural environments do not favor vertical specialization as each market segment fails to be sufficiently large to be economically viable on its own. Therefore, the Lateral Electrification business model rests on an hybrid commercial offer with an initial fee for device and then a fee for service. This tariff structure offers many advantages:

- **Flexibility** for the clients who only pay when they consume,
- **Assessment** by the operator of the motivation and financial health of the end users through the initial fee for device,
- **Better cost-reflectiveness** than selling kWh in an energy situation where reliability and safety are equally important than the power and energy rating of the electric services delivered.

Fee for device		Fee for service	
Device	Initial fee (in $)	Service	Daily fee (in $/day)
3W	10 $	10 Wp 50 Wh/day	0,15 $/d
4W	~ 10 $	18 Wp 90 Wh/day	0,23 $/d
USB 5W	~ 10 $	30 Wp 150 Wh/day	0,30 $/d
8W	~ 15 $	42 Wp 210 Wh/day	0,45 $/d
PL 12W	~ 30 $	66 Wp 330 Wh/day	0,60 $/d
15W	~ 100 $	100 Wp 500 Wh/day	0,91 $/d

Revenue sharing scheme

The revenue of each nanogrid is automatically and securely shared through mobile payments between Nanoé (20%), the franchised entrepreneur who built and operates it (20%) and the owner who financed it (60%). The rationale of this approach is three-fold:

IMPACT

Optimize the local economic impact of the electrification process by enabling local actors to invest in the development of their community and by offering new job opportunities to community-members;

SCALING

Maximize the scaling potential of the solution by concentrating efforts on local capacity building through technology and knowledge transfer and new markets and financing circuits structuration to leverage local entrepreneurs' motivation and community know-how.

SUSTAINABILITY

Guarantee the sustainability of the service by concluding with decentralized and often remote operators a "franchiser-franchisee" relationship in which both parties economical interests are better aligned than in an "employer-employee" relationship.

Business model

The recent field-testing has enabled to collect real financial data on costs and revenues of nanogrids and microgrid deployment to assess and consolidate the business model of both solutions.

The CAPEX of the field-test microgrid amounts to **255 €/user**, of which **143 €** comes from the nanogrid costs and **112 €** from the interconnection costs. This is less than a quarter of the averaged CAPEX of centralized AC microgrids deployed by other operators in Africa.

In addition, the average monthly revenues generated by the PAYGO sale of energy services on the nanogrids already enable a **payback period of 32 months**.

Materials	Unit Cost (€)	Qtty	Total Cost (€)
Interconnection Modules			**5 558**
Interconnection Modules 750 W	*200,00*	*21*	*4 200*
Interconnection Modules 1500 W	*250,00*	*4*	*1 000*
Breakers 16A	*13,33*	*25*	*333*
*Cable 2*6 mm2 Cu for connection*	*0,98*	*25*	*25*
Distribution			**6 538**
8m Wood Poles	*80,00*	*25*	*2 000*
*Aerial Cable 2*16 mm2 Alu - Pole to Pole*	*1,49*	*2475*	*3 684*
*Aerial Cable 2*16 mm2 Alu - Pole to house*	*1,49*	*300*	*447*
Grid connectors	*1,35*	*90*	*122*
Cable Anchoring	*1,00*	*260*	*260*
Miscellaneous hardware	*1,00*	*25*	*25*
Other			**767**
labor	*4,44*	*50*	*222*
Transportation cost			*545*
TOTAL CAPEX			**12 862**

Based on data collected on the field and interviews with end-users, new energy services are being developed for the microgrid users and the expected payback period for the interconnection operation is expected to be **47 months**.

2

IMPACT

On communities

Nanoé already offers reliable and affordable energy services up to Tier 2 to more than **6000 end-users** through **1500 nanogrids** in more than **300 villages** in the North of Madagascar. The quality, simplicity and quick availability of the nanogrid services as well as the flexible payment option facilitate the technology acceptance by the communities. Very low maintenance delay and good customer relationships are ensured thanks to the revenue sharing scheme and the incentives for the entrepreneurs to maximize the use of the nanogrids services.
In addition, more than 35 health facilities and 100 communal buildings (city halls, schools, churches, mosques) have been electrified and public lighting is provided in most villages, which definitely improve health, safety and well-being of communities.

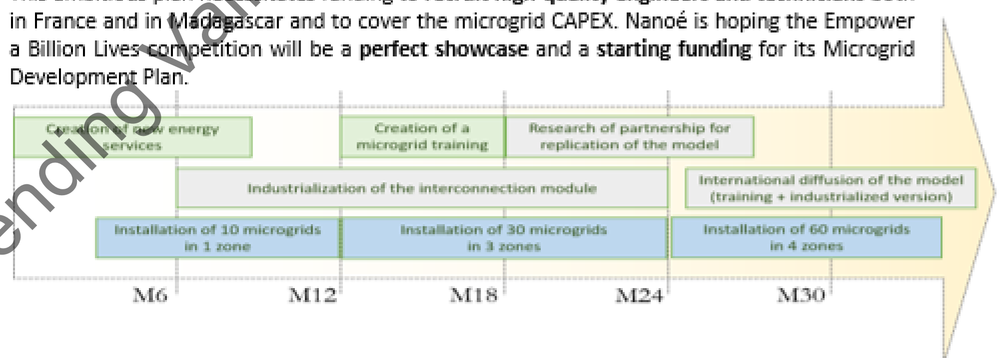
On local economy

One objective of the Lateral Electrification model is to boost local economy. Thanks to the company organization, this is a success with the training of 9 different generations of entrepreneurs in 4 different geographical areas, empowering up to **100 locally recruited entrepreneurs** to participate and benefit from the energy revolution of their region. In addition, Nanoé employs more than **50 persons** for field-support, entrepreneurs training, marketing and R&D activities.
The energy services provided by Nanoé already enable end-users to enhance their income, for instance through freezers or improvement of working conditions. Yet, soon there will be a significant increase on the local economy impact with future microgrid deployments and **productive use of energy**. The new energy services will range from AC consumption points (hair salon, multimedia kiosk, etc.) to DC agro-processing and craftsmanship machines (flour mill, rice huller, cold room, wood saw, etc.).

MICROGRID DEVELOPMENT PLAN

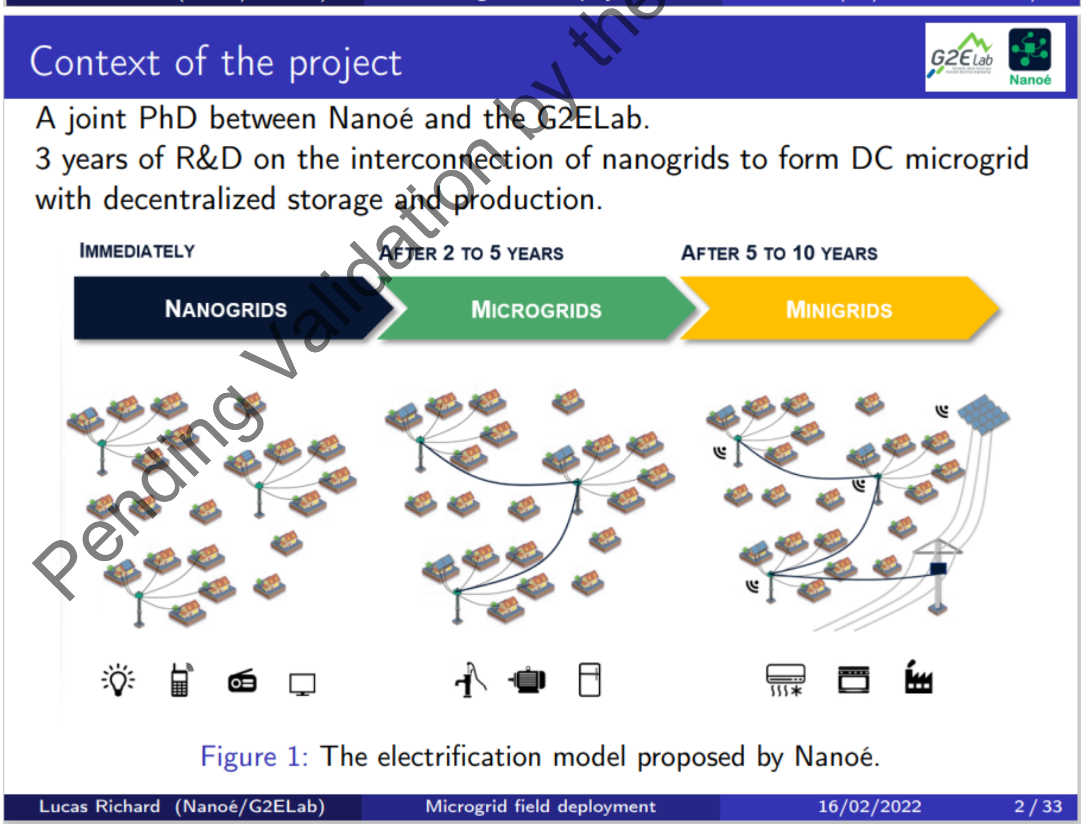
In complement to its already launched and funded **Nanogrid Development Plan** of installing **10 000 nanogrids** and opening **4 new offices** in Madagascar by the end of 2025, Nanoé is now ready for a **Microgrid Development Plan** and is seeking funding to launch it in 2024.
This ambitious 3-year plan firstly aims to install between **60 and 100 microgrids** in the North of Madagascar. The site locations are already identified within the 300 villages where Nanoé intervenes, a huge advantage of the Lateral Electrification model where no time-consuming and often difficult partnership with other electric operators are needed in the first place.
Secondly, the Microgrid Development Plan includes a **challenging R&D part**, with the industrialization of the interconnection module, at the heart of the microgrid concept. Its industrialization is needed for international replicability of the Lateral Electrification model, whether it is by Nanoé or through partnership with local electric operators. The goal is to provide a **turnkey hardware and software solution** for the first two steps of the Lateral electrification model, from the nanogrid to the microgrid.

This ambitious plan necessitates funding to **recruit high-quality engineers and technicians** both in France and in Madagascar and to cover the microgrid CAPEX. Nanoé is hoping the Empower a Billion Lives competition will be a **perfect showcase** and a **starting funding** for its Microgrid Development Plan.



3

9.3 EURICA presentation – Madagascar



The DC microgrid to develop

A low-voltage DC microgrid, with decentralized communication-free control of the nanogrids.
Development of a DC-DC bidirectional converter and its control algorithm.

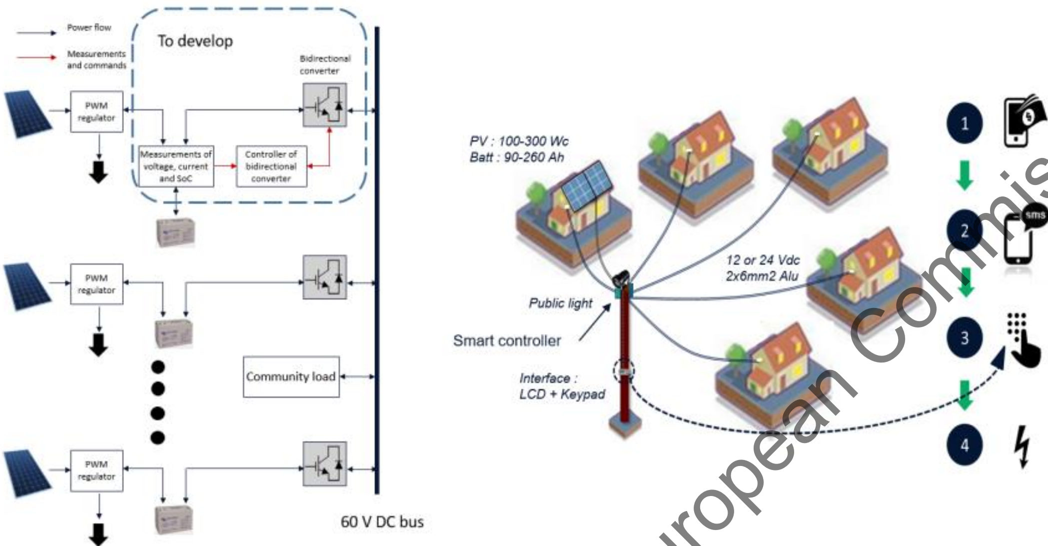


Figure 2: Interconnection of nanogrids.

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Main objectives of the microgrid

- Battery "rescuing" between NGs. For instance, if one NG is undercharged, it can be charged by the other NGs enough charged.
- Improving the lifetime of batteries.
- Powering community loads such as water pump, rice huller, by all the NGs.
- Installing NGs without batteries.
- Using less hardware resources for the same level of electric services by mutualising the battery and solar panel parks.

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The simulated microgrid

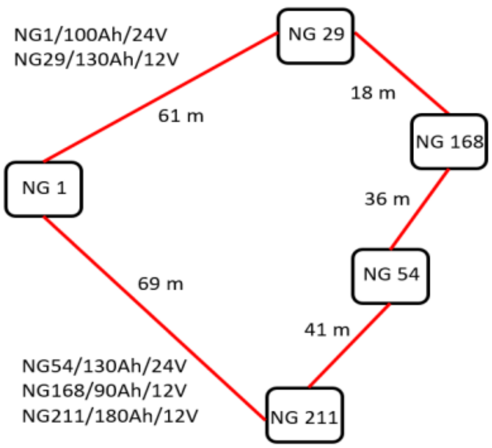

Figure 3: Topology of the simulated MG.

- Simulation needed to tune and validate the control algorithm.
- Analyse of the power flow on the MG over many days.
- Real data are used (PV production, NG consumption) but NG consumption of NG 29 and 168 are artificially doubled.

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Control algorithm of the MG

The control algorithm, decentralized and communication-free, relies on local measurement of the SoC of the battery and the DC bus voltage.

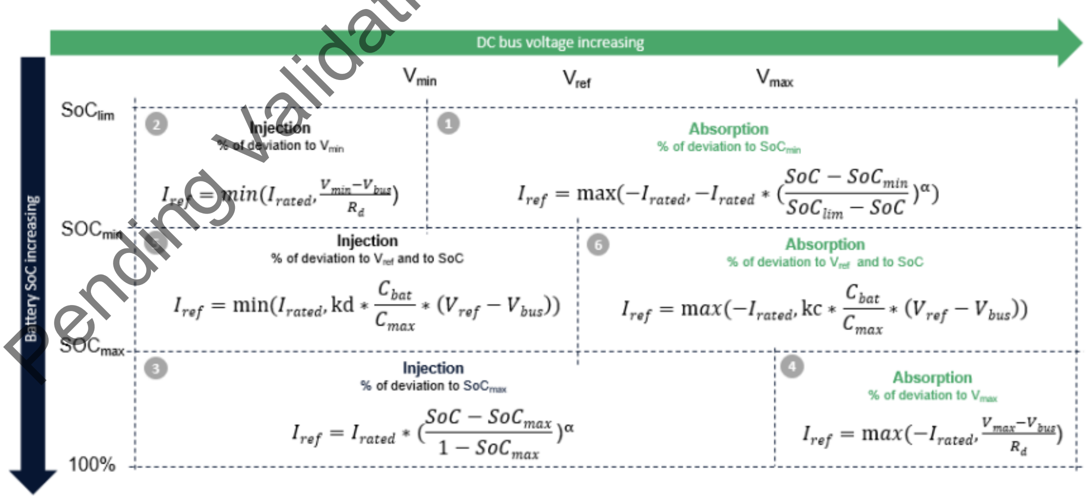

Figure 4: Control algorithm based on logic modes.

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Simulation results - SoC evolution

G2Elab Nanoé

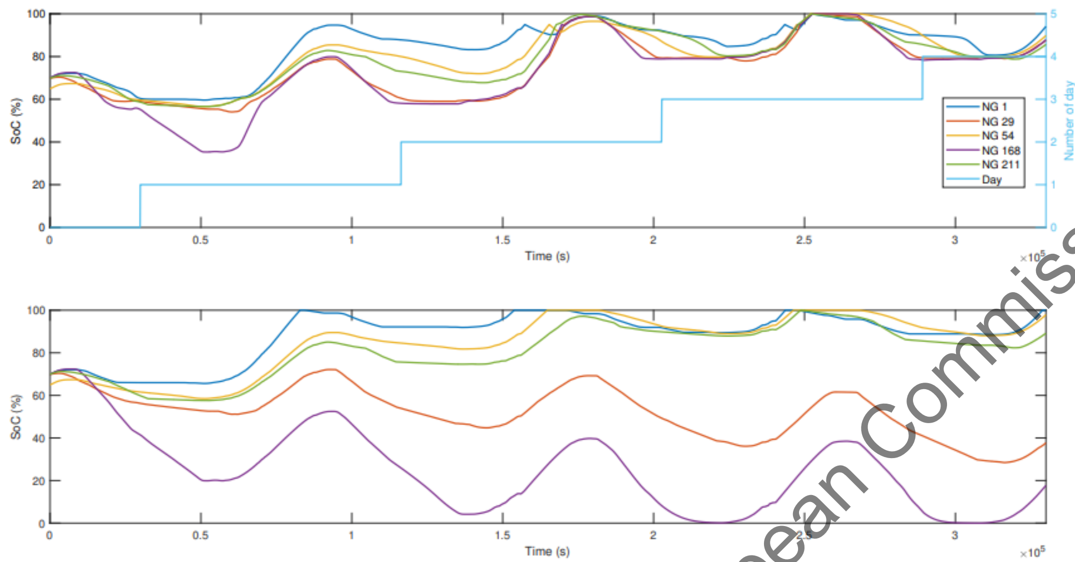

Figure 5: Evolution of the SoC of the NGs with and without a MG.

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Simulation results - Voltage and current evolution

G2Elab Nanoé

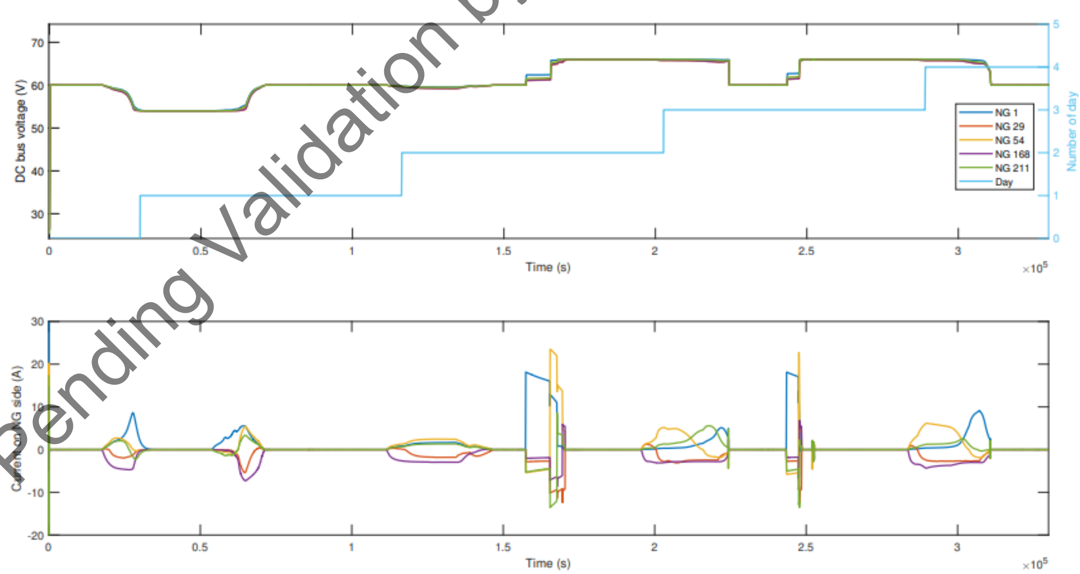

Figure 6: Evolution of the voltage and the current exchanged between NGs.

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From simulations to lab testing

3 bidirectional DC-DC converters linked by RL lines. All datas (current, voltage, etc.) are recorded every 25 ms.
Tuning and validation of the proposed control algorithm.

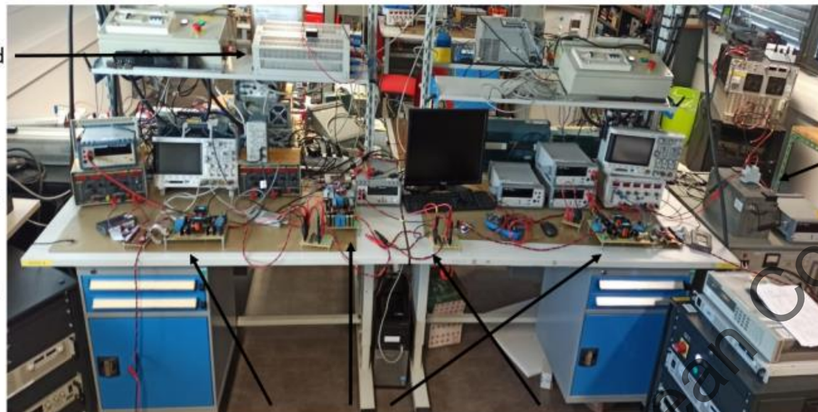

Figure 7: Test bench of the microgrid developed in the lab.

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Voltage, SoC and current exchanged

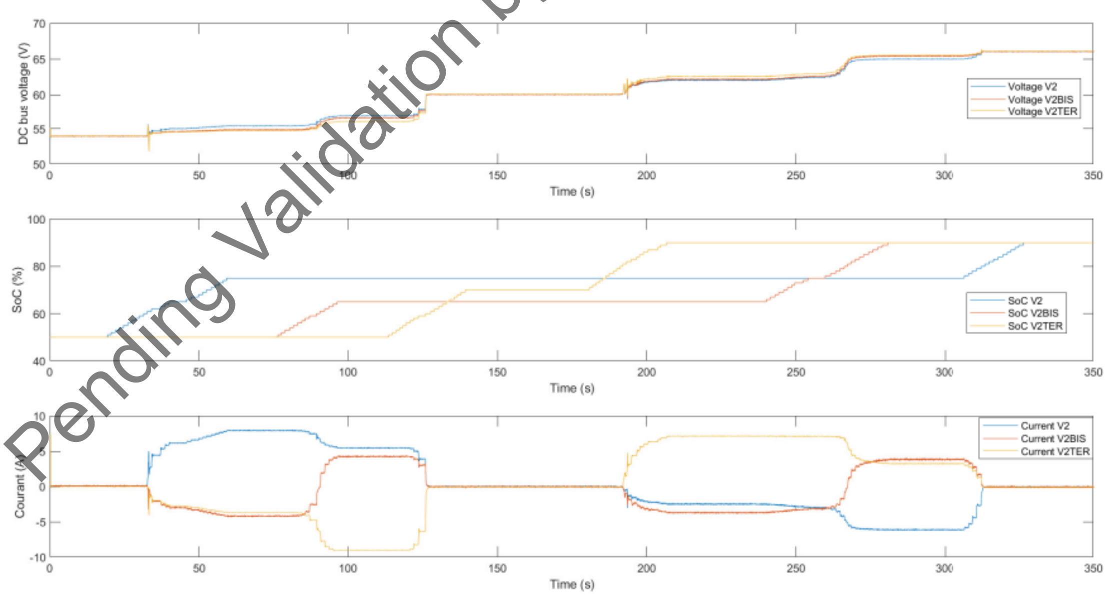

Figure 8: Evolution of the DC bus voltage, the SoC of the NGs and the current exchanged.

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Ambohimena, test-village

27 NGs, a battery park of 3560 Ah, 4570 W of PVs. 3 24V NGs and 24 12V NGs.

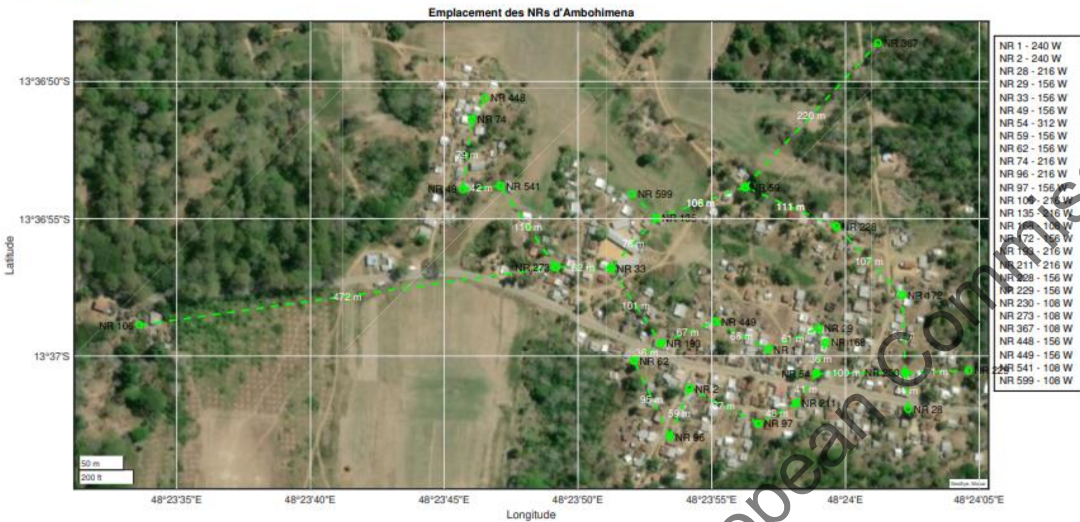


Figure 9: Geographical distribution of the NGs of Ambohimena.

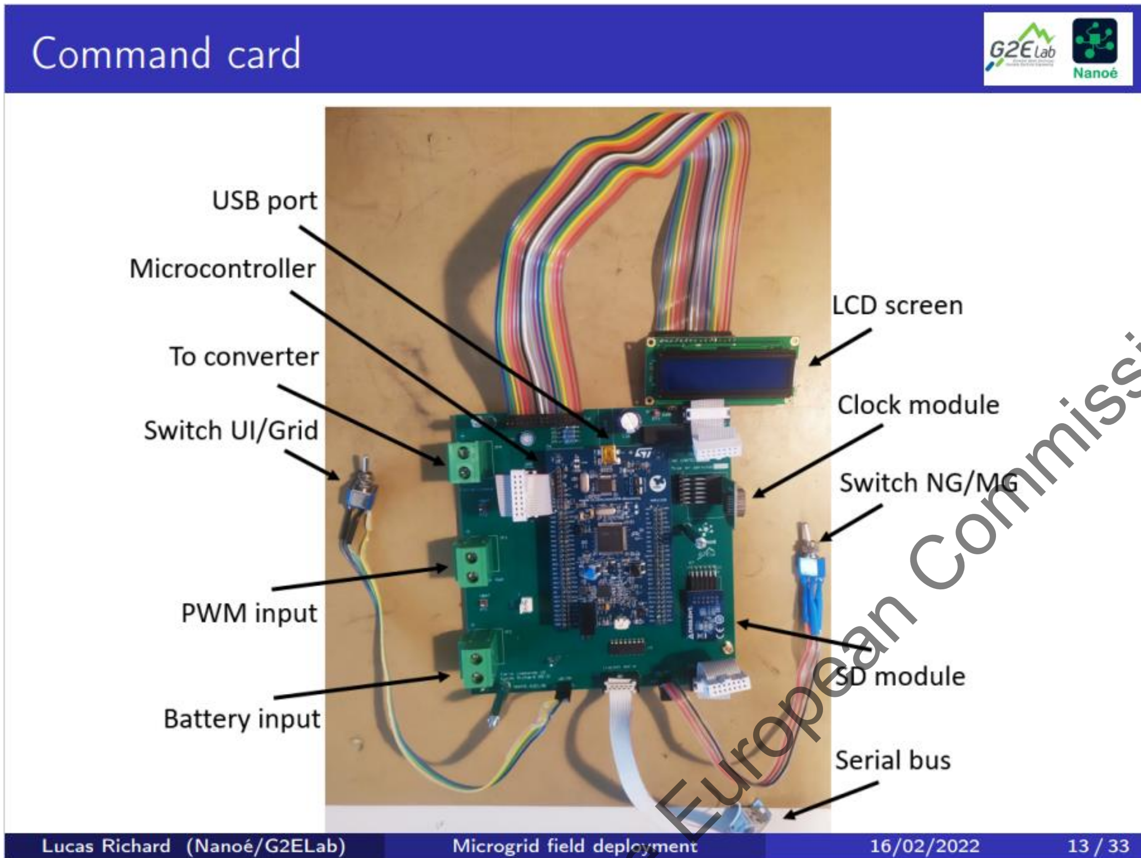
The interconnection module

The interconnection module is composed of:

- A command card, which contains a LCD screen, a clock, a SD module, a USB port, a serial port, switches, and which controls the power card.
- A power card, which is a 500 W DC-DC bidirectional boost converter.

The interconnection module has 3 modes of operation:

- UI mode: it is the User Interface Mode, where the interconnection module is controlled by someone through a computer communicating to the module by the serial bus.
- NG mode: the interconnection module works only for the NG, it saves data, estimates the SoC of the battery, etc.
- MG mode; the interconnection modules works in MG, it exchanges energy through the power card, with the other NGs depending on its SoC and the SoC of other NGs.


Command card
G2ELab
Nanoé
USB port
Microcontroller
To converter
Switch UI/Grid
PWM input
Battery input
LCD screen
Clock module
Switch NG/MG
SD module
Serial bus
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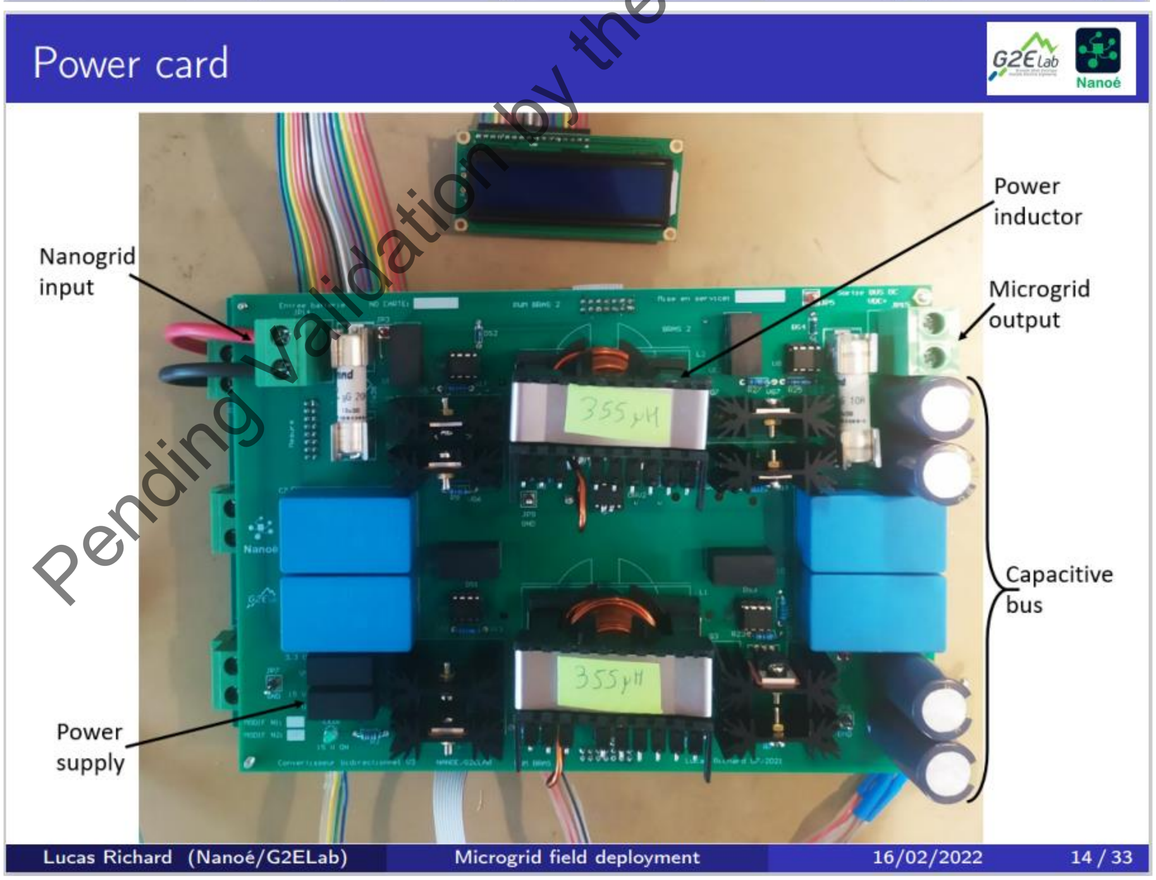
Power card
G2ELab
Nanoé
Nanogrid input
Power supply
Power inductor
Microgrid output
Capacitive bus
355 µH
355 µH
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Mounting, installation of the interconnection module
G2ELab
Nanoé
Nanoé
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Work in progress - electric poles and cables
G2ELab
Nanoé
Lucas Richard (Nanoé/G2ELab)
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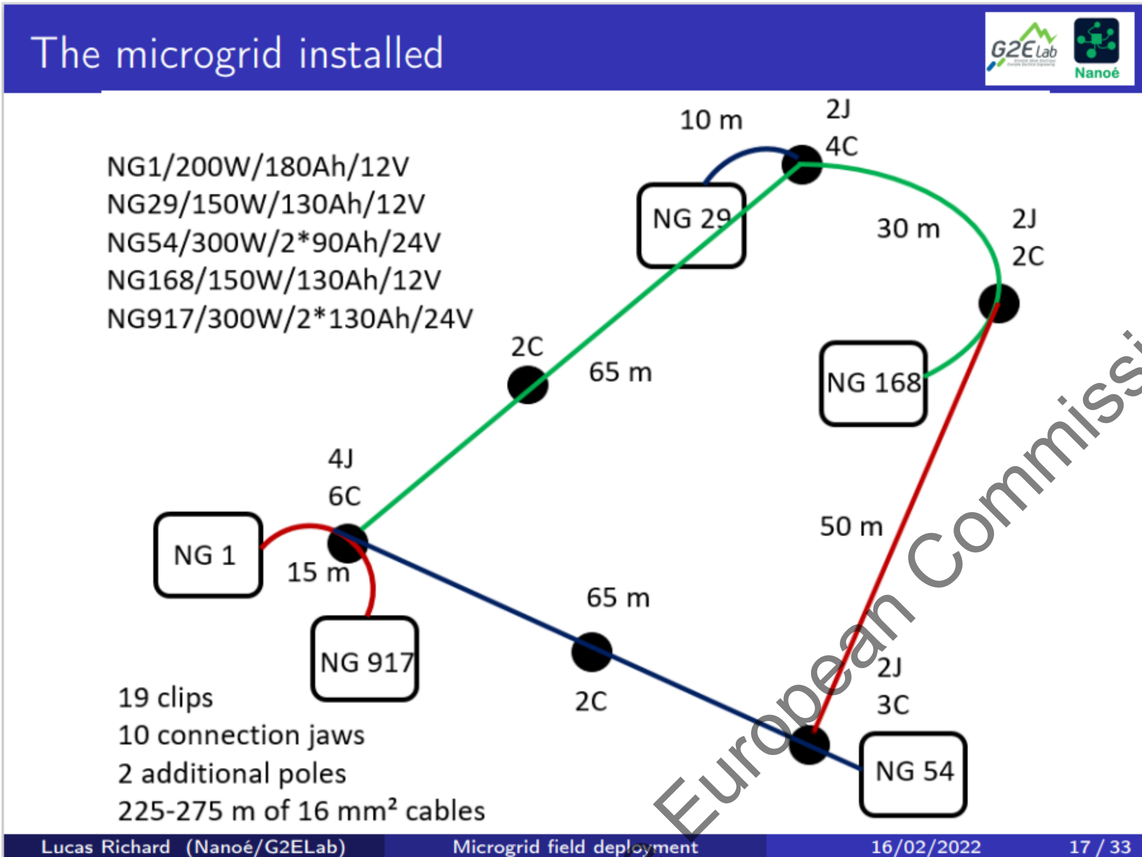
The microgrid installed
NG1/200W/180Ah/12V
NG29/150W/130Ah/12V
NG54/300W/2*90Ah/24V
NG168/150W/130Ah/12V
NG917/300W/2*130Ah/24V
10 m
2J
4C
NG 29
30 m
2J
2C
2C
65 m
NG 168
4J
6C
NG 1
15 m
50 m
65 m
NG 917
2J
3C
19 clips
10 connection jaws
2 additional poles
225-275 m of 16 mm² cables
2C
NG 54
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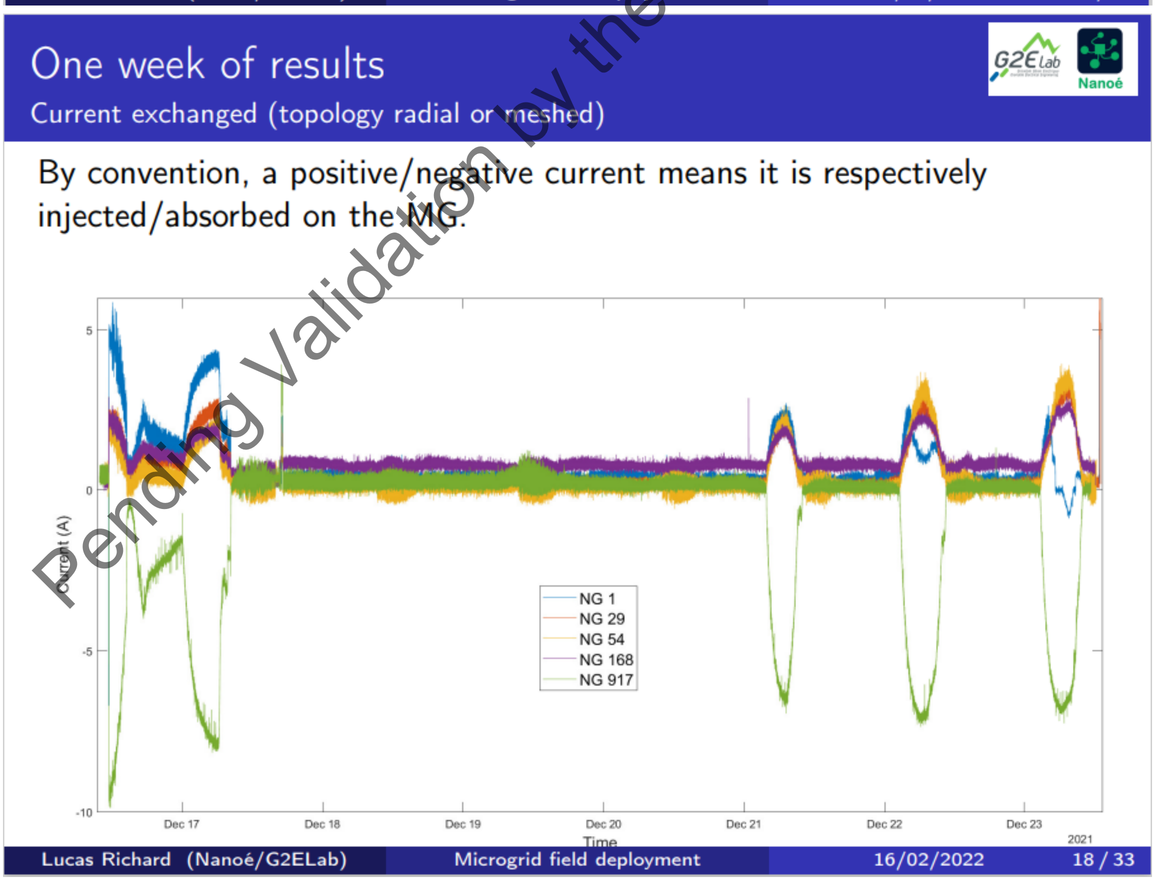
One week of results
Current exchanged (topology radial or meshed)
By convention, a positive/negative current means it is respectively injected/absorbed on the MG.
Current (A)
NG 1
NG 29
NG 54
NG 168
NG 917
Dec 17
Dec 18
Dec 19
Dec 20
Dec 21
Dec 22
Dec 23
2021
Time
Lucas Richard (Nanoé/G2ELab)
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One week of results

Evolution of the SoCs

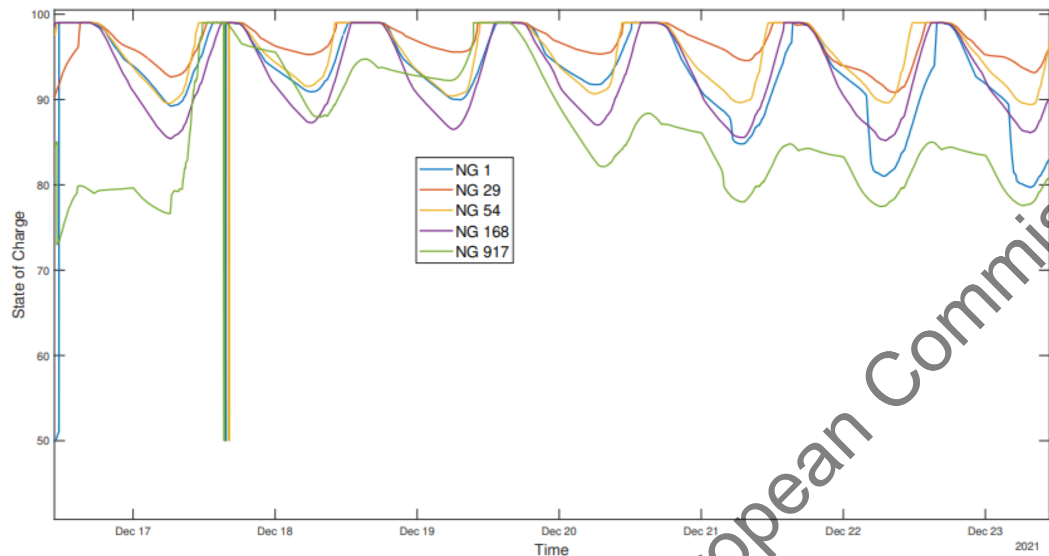

Figure 10: Evolution of the SoCs of the NGs.

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One week of results

DC bus voltage

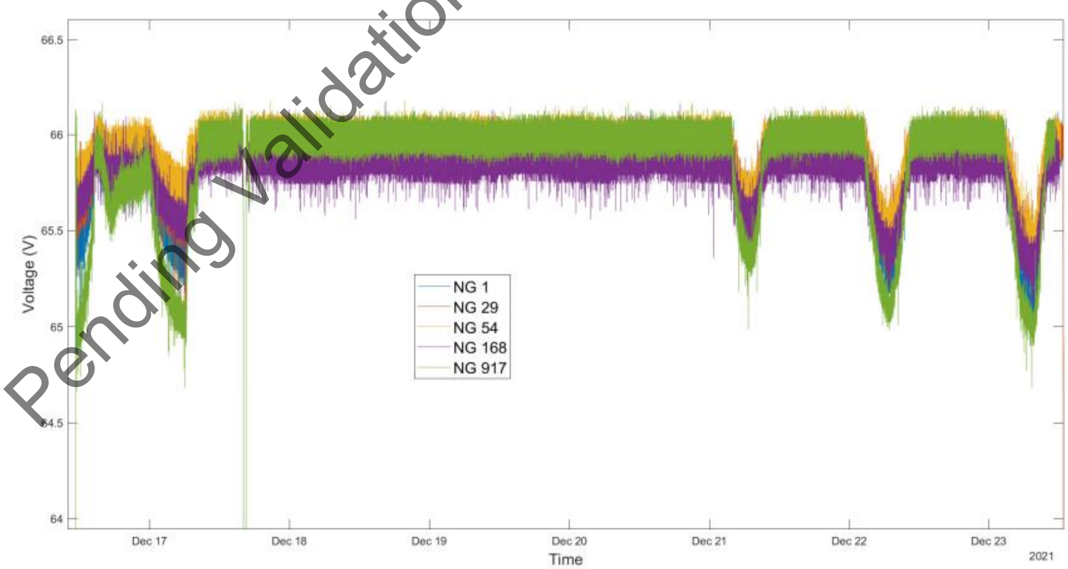

Figure 11: Evolution of the DC bus voltage at each interconnection module.

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Difficulties, tests and improvements

Tests

- NGs without solar panel.
- Meshed or radial topology.
- Communal load, with a simple resistor.
- One NG has broke due to misconnection => all the MG reacted safely

Difficulties

- SoC gauge => imprecise and not user-friendly.
- Data recording => SD card hard to access and a few bugs.
- Imprecise calibration of interconnection modules makes the voltage oscillate.

Improvements on the field

- Starting procedure and management of errors improved.
- Data collection and code uploading eased on the field.

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Feedback

Installation and deployment work

- Installation work lasted 3 days.
- Maximal distance between 2 poles: 50 m.
- In total, 15 round-trip to Ambohimena over 20 workdays.
- One-month mission a bit short.
- More than 2 months of operation without major issues.

Acceptation of the technology

- Nanoé employees excited about the project.
- Good support from the employees on the mounting of the interconnection modules and the installation work.
- Willingness to do more MGs from employees and nano-entrepreneurs.
- Good feedback from the inhabitants of Ambohimena.
- Interesting discussion about communal loads and the needs of the inhabitants.

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Future works - 2022

A V2 of the interconnection module

- Smaller, less expensive, more user-friendly, better performance.
- Improving the SoC estimator.
- Use of the interconnection module for real communal loads (multimedia, AC load, agro-processing machine, NG without battery).

Decision aids for MG planning

Development of an algorithm to help choosing where to put additional poles, cables, where to put/remove batteries or solar panels, etc.

Planning

Second mission for microgrid deployment at the end of 2022, with a greater number of NG connected (>20) and communal load testing.

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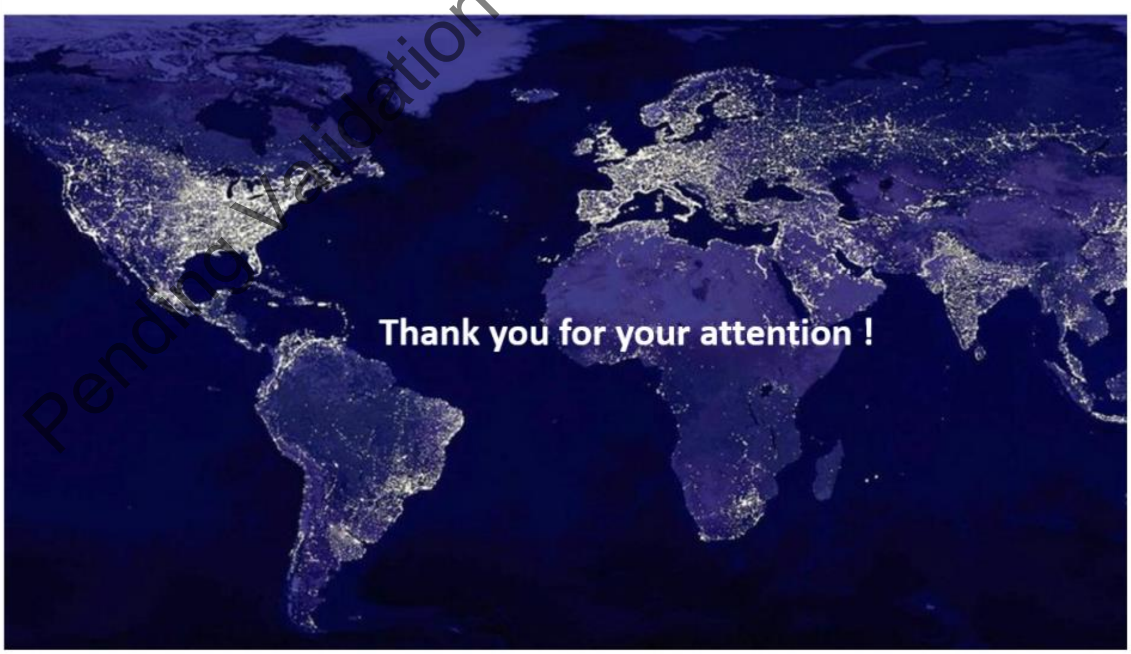
Any questions ?



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9.4 TRIAE report


TABLE RONDE INTERNATIONALE DES ACTEURS DE L'ÉNERGIE

Digitalisation
Femmes
Solaire

Perspectives énergétiques au Burkina Faso et en Afrique

1ERE EDITION

OUAGADOUGOU & EN LIGNE
18 MARS 2023

MARCH 2023

First International Energy Players Roundtable Report

PREPARED FOR:

EURICA (WP 15, LEAP-RE, EU GA 963530) & Association des Jeunes Acteurs de l'Energie (JAE)

AUTHORS

Marine Cornelis
Anne-Carole Kindadoussi
Luc Richaud
Dimitri Tientega
Raouf Coulidiati

LEAP-RE

NEXT ENERGY CONSUMER

Odit-e

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the LEAP-RE grant agreement n°963530.

10 TAKEAWAYS FROM THE FIRST INTERNATIONAL ENERGY PLAYERS ROUNDTABLE

60% of the best RES resources are in Africa, yet only 1% of the world's installed capacity are on the continent

Africa must create its own definition of the energy transition, tapping into collective intelligence and aligning various social, environmental and economic objectives

7 AFFORDABLE AND CLEAN ENERGY

43% of Africans live without electricity

3/4 of the jobs in the energy sector are filled by men

The quality of the electricity supplied imports as much as the quantity.
Digitalisation is crucial to integrating renewables, anticipating outages and grid instability, and allocating resources more efficiently

Large & small scale electricity plants are equally important to fill Africa's energy needs

Africans have everything to gain in becoming empowered, active prosumers engaged in the energy and climate transitions

Gender parity, women and youth's involvement in the energy transition are key top better serve people's aspirations and needs.
Including women's perspectives in decision-making can lead to more relevant innovations and better technology transfer

Politicians need to create and enforce the right regulations and incentive frameworks to foster the resilience of the energy systems

Education is the game-changer to bridge the gaps and accelerate the deployment of renewable energies

Above: the round table on gender and women in the energy sector, led by Raouf Coulidiati, with Inès Nanema, Sara Bagre and Fatoumata Diallo.
Below: Participants listen to a presentation.
18 March 2023. Credit: Boudou Ouedraogo

LEAP-RE
Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

CONTENT

6 LIST OF ACRONYMS

AU	African Union
CEB	Communauté Electrique du Bénin (Benin Electric Community)
EU	European Union
GDPR	General Data Protection Regulation
JAE	Association Internationale Jeunes Acteurs de l'Energie (International Young Energy Actors NGO)
LEAP-RE	Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy
LV	Low voltage
NGO	Non-governmental organisation
PV	Solar photovoltaic
RES	Renewable energy sources
SONABEL	Société Nationale d'électricité du Burkina Faso (National Electricity Company of Burkina Faso)
STEM	Science, technology, engineering and mathematics

7 ABOUT

The International Energy Players Roundtable

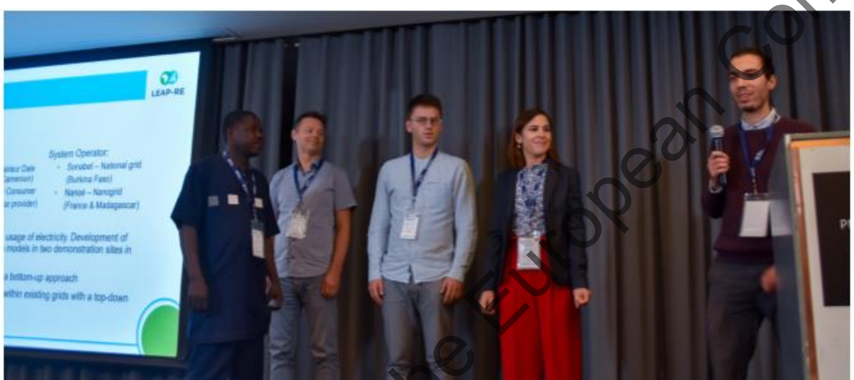
Table-Ronde Internationale des Acteurs de l'Energie

The International Energy Players Roundtable (TRIAE) was held in Ouagadougou and online on 18 March 2003. It is the result of a partnership between the "Association des Jeunes Acteurs de l'Energie" (JAE) and EURICA (LEAP-RE WP15).

This event brought together national and international energy actors, humanities experts and civil society representatives. This event allowed for high-level discussions on the present and future of energy in Africa around digitalisation, the place of women and solar energy.

LEAP-RE

From 2020 to 2025, the LEAP-RE programme builds long-term partnerships between African and European stakeholders in a quadruple helix approach: government (programme owners and funding agencies), research and academia, private sector and civil society. It aims to reduce fragmentation by aligning existing bilateral and multilateral frameworks. LEAP-RE jointly develops and implements research, innovation and capacity building activities. LEAP-RE is a programme that has received funding from the European research and innovation programme Horizon2020 under grant contract No 963530.



EURICA partners' representatives present the project at LEAP-RE's Stakeholder Forum, Pretoria, October 2023. From left to right: Camille Bayanma (SONABEL), Sebastijan Ursic (INEA), Lucas Richard (Nanoé), Marine Cornelis (Next Energy Consumer), and Luc Richaud (ODIT-E). CREDIT: LEAP-RE.

EURICA

EURICA is a project focused on green electrification in Africa to serve the productive use of electricity. It involves the development of digitisation tools, methodologies and new business models in two demonstration sites in Burkina Faso and Madagascar to enable the interconnection of existing small-scale microgrids and promote demand-side response via a local flexibility market within existing grids, as well as in-depth work on understanding the social and economic issues and developing the capacity of local partners.

The partners are:

- Digital technology provider: Odit-e (France) & INEA (Slovenia)
- Sociology and Capacity building: Institut Supérieur Dale Kietzman (Cameroon) & Next Energy Consumer (Italy - Service provider)
- Operators: Sonabel - National grid (Burkina Faso) & Nanoé - Nanogrid (France & Madagascar)

Association Internationale Jeunes Acteurs de l'Energie - JAE (Ouagadougou, Burkina Faso)

The Association Internationale Jeunes Acteurs de l'Energie (International Young Energy Actors NGO) is a non-profit organisation created in 2019 in Ouagadougou (2021-0024/DGPLAP/DOASOC/Ouaga). It intervenes in energy, environment, education, vocational training and addressing climate change.

Dimitri Nentega (JAE), Marine Cornelis (Next Energy Consumer) and Luc Richaud (ODIT-E) launching the preparatory work for the roundtable on 1 June 2022 in Grenoble. (credit: ODIT-E)

Odit-e (Meylan, France)

Odit-e develops innovative solutions for LV networks operation and planning: by digitalizing LV networks, Odit-e enables operation optimization, losses reduction, or impact prediction for renewable productions or demand response.

Next Energy Consumer (Turin, Italy)

Next Energy Consumer is a policy consultancy focused on the social aspects of the energy and climate transitions.

Anne-Carole Kindadoussi and Luc Richaud (ODIT-E) present the EURICA project at the roundtable on 18 March. YouTube

Next Pages: the flyers shared to promote the event


TABLE RONDE INTERNATIONALE DES ACTEURS DE L'ÉNERGIE
1ERE EDITION
Digitalisation
Femmes
Solaire
Perspectives énergétiques au Burkina Faso et en Afrique
22etsix Space à Ouagadougou & EN LIGNE
18 MARS 2023
eurica.ouaga@gmail.com
(+226) 60847010
ITAOUA SERVICE Sarl INTERNATIONAL
LEAP-RE
NEXT ENERGY CONSUMER
Odit-e

La digitalisation des réseaux permet de réduire les pertes de 5 à 10%

24% de femmes travaillent dans le secteur de l'énergie vs 76% d'hommes

60% des meilleures resources solaires sont en Afrique mais aujourd'hui, le continent ne représente qu'1% de la capacité installée du monde entier!

18 mars 2023

8H30 - 12H

Session d'ouverture

Débats sur thème du Solaire, du Genre, et de la Digitalisation

Présentation des entreprises sponsors

Scanne pour t'inscrire

L'association des Jeune Acteurs de l'Énergie est une organisation à but non lucratif crée en 2019 à Ouagadougou (2021-0024/DGPLAP/DOASOC/Ouaga). Elle intervient dans l'énergie, l'environnement, l'éducation, la formation professionnelle et la lutte contre les changements climatiques.

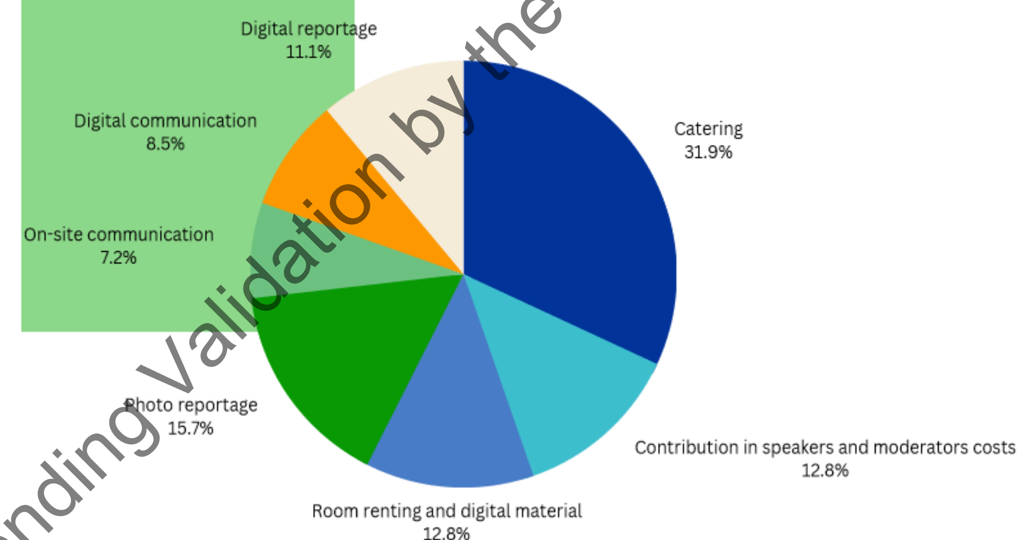
LEAP-RE (EU Grant Agreement 963530) est un écosystème de projets de recherche et d'innovation financés par l'Union européenne, qui compte une centaine de partenaires, dont la moitié sont africains.

12 BUDGET

The venue was kindly made available by the event space 22andSix, which considerably reduced the costs of organising the activity. However, the room was not adequately equipped for the live broadcast, which meant that the organisers were required to bear the costs of ensuring that the event took place in the best possible conditions.

The salaries of the organisers are not included in the below breakdown.

The organisers would like to thank the generous contribution of the company ITAOUA Services.



13 AGENDA

The full agenda for 18 March 2023 was as follows

Topic	Description	Panellists	Videos
Opening session	Welcome of the guests, Presentation of the LEAP-RE programme, Presentation of the NGO Jeunes Acteurs de l'Energie	Dimitri TIENTEGA, JAE	Luc RICHAUD, Odit-e
Debate on Solar	Questions: • Why does the African continent represent only 1% of the world's capacity when 60% of the resources are there? • What are the key actions to be taken? • Who are the stakeholders?	Ange SEBEGO, DGTE/MEMC Ahmadou DIALLO, Ingénieur Énergie et Finance Cheick FOFANA, ITAQUA Services	Video intervention WP 16
Video screenings	Screening of WPs 10 & 16 project videos		
Debate on Gender	Questions: • Does Energy have a gender? • How can we move towards greater parity in the energy sector? • What would society gain from a more gender-balanced energy sector?	Inès NANEMA, TotalEnergies Sara BAGRE, IRSAT Fatoumata DIALLO, Green Entrepreneur	Video interventions: • Amandine GAL, Econoler • WP 10 • MWE - Mozambique Women of Energy • Norbert KINDADOUSSI, CEB
Video screenings	Screening of WP 13 & WP 15 videos		
Debate on Digitalisation	Questions: • What do you know about digitalisation in the energy sector? • How can digitisation serve the deployment of solar energy? • What role can digitalisation play in the gender issues of the energy sector?	Romuald OUEDRAOGO, Young minister of Digital transition Charles BAZIE, Président de Youth Open Data Burkina Malik LINGANI, Président de Beog Néré	Pang il wilfried DIARRA, General Manager 22etsix Space (Présentiel)
Summary of the workshops			

14 INNOVATIVE USE OF DIGITAL TOOLS: CREATION OF A DEDICATED YOUTUBE PLAYLIST

The organisers opted for a hybrid event, live in Ouagadougou, Burkina Faso and via the Zoom platform. This format allowed the international dimension of the whole project to be firmly anchored, allowing people who could not physically join the event to join in the discussion.

Screenshot of the YouTube playlist

Recognising that the internet connection is not always optimal, the organisers asked international experts, some of whom are LEAP-RE project leaders, to pre-record their videos.
These are now available on a YouTube playlist hosted by Next Energy Consumer.

The roundtable recording will also be made available on this platform. This will allow interested parties to access the proceedings at a later stage, even after the event.

15 VIDEO

Take a look back at the key moments of the First International Energy Players Roundtable, a relevant and informative event for the entire energy sector in Africa and beyond:

16 PARTICIPATION

Indicative map showing that registrations for the online broadcast came in from all over the world.

Interested parties registered via Eventbrite to follow the registrations and to be able to write to the participants in a GDPR-compliant way. Two events were created via this platform, one for face-to-face participants and one for online participants.

Seventy-eight people registered to participate online, 40 on-site (maximum room capacity).

Most registered online and face-to-face participants came from Burkina Faso. Still, the international footprint is confirmed by registrations from many African countries (such as Kenya, Mozambique or Benin), Europe (Switzerland, France, Italy), and the American continent (Canada, Mexico).

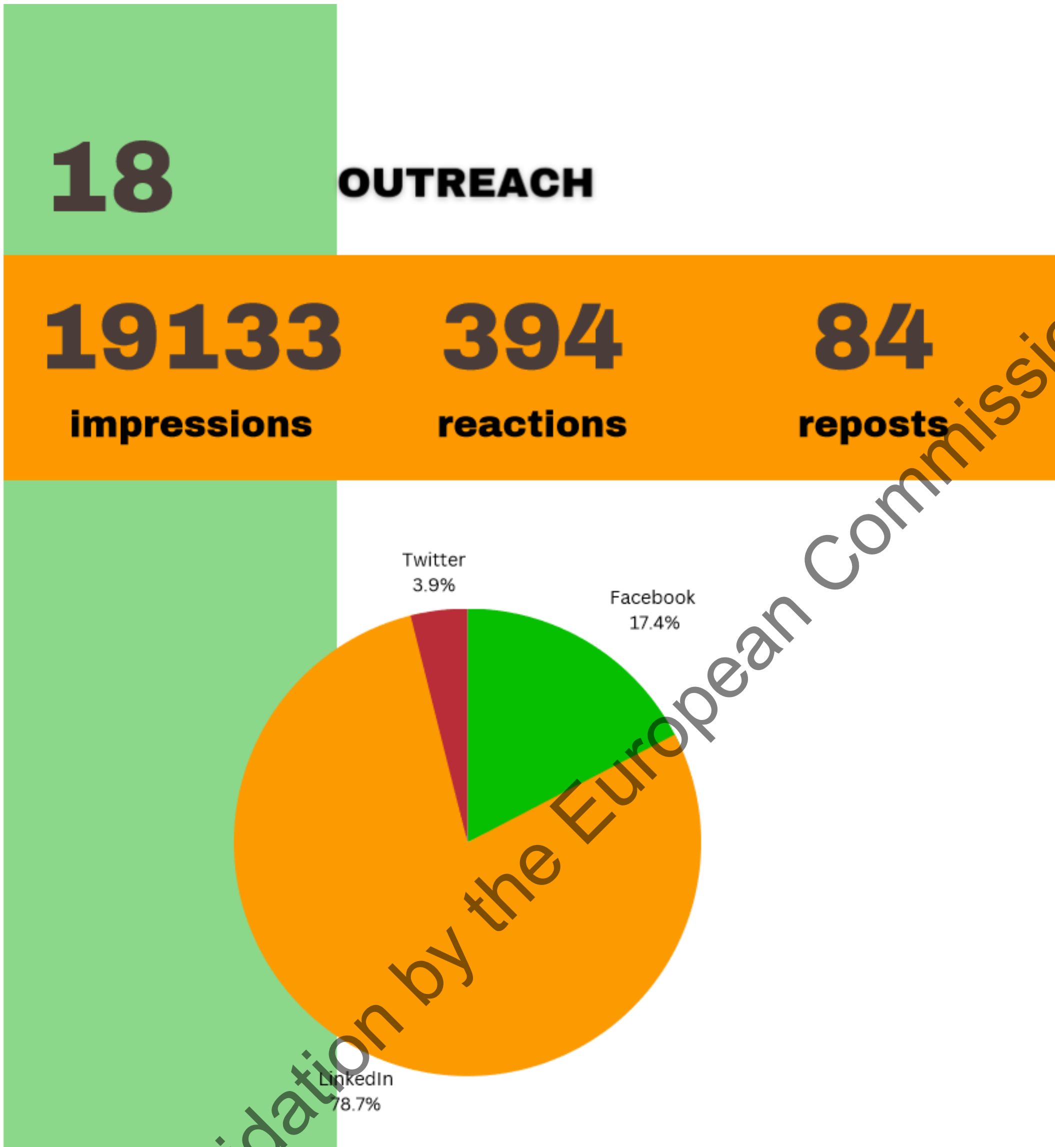
The room was packed for the live debates; while 20 online participants stayed logged in for the whole duration of the event.

On-site participants, 18 March 2023. Credit: Boudou Ouedraogo

The pre-recorded YouTube videos posted as a playlist for the occasion were viewed 71 times on 21 March 2023.

The organisers were aware of the risk of limited turnover associated with holding the event on a Saturday morning, an unusual time for a professional audience in Burkina Faso or Europe but one that is relatively common among Burkinabe students. The day was chosen in view of coordinating these activities with the JAE Energy Debates. Providing material following the event, notably via social networks, will help fill any participation gaps.

Digital automated interpretation tools (subtitles) have helped to overcome language barriers.



Most engagements came from LinkedIn

Before, during and after the event, the organisers mainly communicated and advertised via professional social channels, including the profiles of the two most influential people in the group, Dimitri Tientega (JAE) and Marine Cornelis (Next Energy Consumer). Most engagements came from LinkedIn. The figures given are as of 22 March 2023.

Examples of social media campaign engagement (Source: JAE's Facebook page and Marine Cornelis' LinkedIn profile)

20 MEDIA COVERAGE

The Burkinabè press was invited and reported on the exchanges, as shown in this screenshot from iFaso media.

iFaso

Vous informer, notre raison d'être

HOME BURKINA MONDE POLITIQUE ECONOMIE OPINION SPORT TECH CULTURE LIVE

A LA UNE BURKINA TECH

1ère édition de la TRIAE : un rendez-vous international sur la digitalisation, la femme et le solaire

OUEDRAOGO 19 HEURES AGO 2 MIN READ

La première édition de la Table Ronde Internationale des Acteurs de l'Energie (TRIAE) s'est tenue ce samedi 18 mars 2023 à Ouagadougou sous le thème : « Digitalisation, femme, solaire : défis et perspective énergétiques au Burkina Faso et en Afrique ».

21 FEEDBACK

Feedback from live participants and virtual parties was extremely good, as evidenced by the following messages, shared publicly via Facebook, LinkedIn and Twitter.

It was a great pleasure to attend and discuss around this topic

We can note that Digitalization is the key technology to facilitate energy accessibility at scale

Ab-so-lu-te-ly Marine!

Africa has to define its legitimate & feasible path to world NetZero, via all its inhabitants' access to modern energy

Exactly like India, Africa will do it on its own way, serving its inhabitants 1st, and 2nd all humanity.

Félicitation Presi. Une activité très riche en connaissance dans le domaine du solaire et des perspectives pour une transition énergétique réussie au Burkina Faso. Merci encore à l'ensemble des panelistes pour le partage d'expérience

"Congratulations president. An extremely rich activity in terms of knowledge in the field of solar energy and perspectives for a successful energy transition in Burkina Faso. Thanks again to all the panelists for sharing their experience".

Une plus grande parité du secteur énergétique au Burkina et en Afrique, un levier majeur de l'essor de se secteur.

Nos panelistes sur la thématique du genre n'ont pas fait dans la dentelle.

"Greater parity in the energy sector in Burkina Faso and Africa, a major lever for the development of this sector.
Our panelists on the theme of gender were very pointed."

Merci aux trois intervenants d'avoir bien voulu répondre à mes questions. Merci Marine Cornelis Anne-Carole KINDADOUSSI Wendpayangdé Dimitri TIENTEGA pour cette belle initiative!!

"Thanks to the three speakers for answering my questions. Thank you Marine Cornelis Anne-Carole KINDADOUSSI Wendpayangdé Dimitri TIENTEGA for this great initiative!"

22 ROUNDTABLE TAKEAWAYS

Dimitri Tientega (JAE), opening the TRIAE, 18 March 2023. Credit: Boudou Ouedraogo

This first roundtable proved that it is possible to bring together international experts, students, and researchers from the world of energy and sustainable development and discuss in very practical constructive ways the energy challenges faced by Africa and the potential of renewable energy sources, digital tools and gender being critical enablers.

Our collaboration comes from the firm belief that addressing energy poverty and building reliable and resilient energy systems in the face of climate change requires bringing bright and innovative minds from Europe and Africa to discuss the future of energy and the planet.

The social and economic challenges Africa faces are immense. Climate change and a lack of reliable infrastructure make it urgent to build more resilient societies. According to the International Energy Agency (IEA), 600 million people, or 43% of the African population, lack access to electricity, most of whom live in sub-Saharan Africa. However, countries like Ghana, Kenya, and Rwanda are on track to achieve full access by 2030, providing success stories for other countries to follow.

Indeed, the continent is abundant in (untapped) renewable energy sources such as solar energy, which can be harnessed to provide clean energy and improve the lives of millions. Almost two-third of the best solar resources are in Africa, but today, the continent represents only 1% of the world's installed capacity. The roundtable emphasized that combining small and large-scale solutions such as solar kits, mini-grids, and larger public solar power plants can enable Africa to become energy independent.

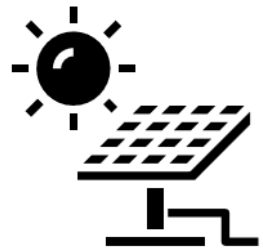
Hence, the roundtable unfolded and shared alternative perspectives on the energy transition, to design fair and inclusive solutions, from policies to simple appliances, that combine respect for the environment with human aspirations. The speakers stressed that achieving those goals require different and complementary skills and worldviews. The ideas of young people, whether students, entrepreneurs or employees, should be encouraged. They are the leaders of tomorrow. The topics we selected, digital technology, solar energy, and women's involvement were confirmed to have tremendous potential. This will involve in-depth work to facilitate regulation, access to finance for entrepreneurs and public authorities, training of stakeholders and dissemination of good practice at every level.

Gender parity and women's involvement in the energy transition will be instrumental in genuinely serving people's aspirations and needs. Including women's perspectives in decision-making can lead to more relevant innovations and better technology transfer. Women remain under-represented in the energy professions: 24% of women work in the energy sector compared to 76% of men, a trend that is visible worldwide. Fostering girls' and women's education in STEM is central for Africa to achieve its potential.

Digital technologies go hand in hand with social development, as they help to integrate renewables, anticipate outages and grid instability, and allocate resources more efficiently. Digitalisation of networks can reduce losses by 5 to 10%. This is particularly important in Africa, where energy needs often exceed availability. Digital is emerging as a key lever to meet human, economic and ecological needs. Africans have everything to gain in becoming empowered prosumers.

The solar energy roundtable and on-site participants, 18 March 2023. Credit: Boudou Ouedraogo

TOPIC 1: SOLAR ENERGY



Description of the Workshop

60% of the best solar resources are in Africa, but today the continent represents only 1% of the world's installed capacity. This discussion aimed to understand what drives or prevents solar energy development today in the context of increasing energy needs and climate change. The panellists had to reflect on the stakeholders involved and the key actions to be taken.

The conversation was led by moderator Inès NANEMA, Energy Engineer at TotalEnergies, joined by leading experts Amadou DIALLO, Cheick FOFANA from ITAOUA and Ange SEBEGO.

LEAP-RE working groups 10, 13 and 16 brought their international perspectives.

Key takeaways

Africa needs to build its own definition of energy transition and support the development of an alternative model, simultaneously supporting human needs and economic growth while respecting natural resources and addressing the challenges of climate change.

In practice, the continent must combine small and large-scale solutions (solar kits and mini-grids, often supported by the private sector; and larger publicly funded solar power plants) to be energy independent and meet its needs.

This requires substantial work in terms of regulation, access to finance, training, and dissemination of good practice.


TABLE RONDE INTERNATIONALE DES ACTEURS DE L'ÉNERGIE
Thème: Solaire
L'Afrique doit définir sa propre transition énergétique en soutenant un modèle alternatif respectueux des ressources naturelles, répondant aux défis du changement climatique tout en favorisant la croissance économique et les besoins humains.

TOPIC 2: GENDER

Description of the Workshop

Currently, 24% of women work in the energy sector versus 76% of men. The workshop aimed to reflect on the articulation of gender and energy issues. The panellists had to reflect on the current obstacles. They were asked to assess the opportunities greater gender parity in the sector would represent for African societies' economic and social development. Panellists were also invited to consider possible avenues for moving towards greater gender parity in the energy sector.

The panel of experts included Sara BAGRE from IRSAT, Inès NANEMA from TotalEnergies and Fatoumata DIALLO, who are working on projects related to clean energy and energy innovations in Africa.

Amandine Gal, MWE - Mozambique Women of Energy and Norbert KINDADOUSSI shared their international perspectives.

Abdul Raouf Soandamba COULIDIATI led the conversation

Key takeaways

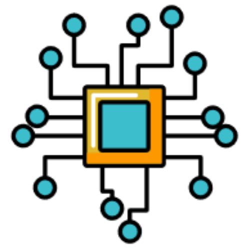
"What we want is to live our passion for science."

Gender stereotypes and cultural constraints create a glass ceiling that weighs heavily on the presence of women and girls in the engineering professions. But the better representation of women at all levels is needed to meet climate, economic and human objectives. Their perspective and inclusion in decision-making allow for more relevant innovations and better technology transfer. It is, therefore, essential to change the narrative, showing that STEM is not necessarily a physical profession but, first and foremost, an intellectual one.

For example, women are literally "at the mill and by the oven" in Africa. In rural communities, they are responsible for collecting raw materials and cooking them. Thus, if they are directly involved in the design of clean cooking solutions, their direct participation allows for creating products better adapted to their realities. These solutions help to improve their daily lives and address the healthcare and energy poverty challenges.


TABLE RONDE INTERNATIONALE DES ACTEURS DE L'ÉNERGIE
Thème: Genre
Vivre notre passion pour les sciences nécessite une meilleure représentation des femmes dans les métiers d'ingénierie malgré les stéréotypes de genre et les pesanteurs culturelles.
Leur inclusion dans la prise de décision favorise l'innovation et des transferts de technologies.
Il est crucial de changer la narration des STEMs en soulignant leur dimension intellectuelle plutôt que physique.
ITAOUA SERVICE Sarl INTERNATIONAL
LEAP-RE
NEXT ENERGY CONSUMER
Odit-e

TOPIC 3: DIGITALISATION



Description of the Workshop

Digitisation of networks can reduce losses by 5 to 10%. Panellists were asked to reflect on how digitalisation can serve the deployment of clean energy in Africa and what is holding back the adoption of digital solutions.

The speakers included Charles BAZIE, R. Romuald OUEDRAOGO and Malick Lingani. Dimitri TIENTEGA moderated the discussion.

LEAP-RE's Work Packages 13 and 15 brought their international perspectives.

Key takeaways

Digital represents a range of solutions to meet energy needs, from greater integration of renewables to anticipating outages and grid instability, as well as better allocation of resources to different users. This is particularly critical in the African context, where energy needs exceed availability.

By optimising energy, investment and grid reinforcement and by empowering consumers, digital technology is emerging as a critical lever to meet human, economic and ecological needs.


TABLE RONDE INTERNATIONALE DES ACTEURS DE L'ÉNERGIE
Thème: Digitalisation
Le digital permet de répondre aux besoins énergétiques en Afrique, en intégrant les énergies renouvelables, anticipant les coupures et instabilités du réseau, et en répartissant efficacement les ressources entre utilisateurs.
Alors que les besoins en énergie dépassent leur disponibilité, le digital est un levier essentiel pour répondre aux besoins humains, économiques et écologiques en optimisant l'énergie, l'investissement et le renforcement du réseau, tout en donnant plus de pouvoir aux consommateurs.

30 CONCLUSIONS

The major challenge of this roundtable was to bring together a multitude of people, ambitions and projects that are still struggling to talk to each other and coordinate their actions.

However, as the climate crisis affects Africa in particular and as various economic, social and demographic pressures increase the need for clean energy, stimulating such dialogues is essential.

This made the first International Energy Stakeholders' Roundtable a resounding success and a critical milestone in the global energy transition conversation.

Looking ahead, we look forward to the possibilities for future International Energy Stakeholders' Roundtables. These dialogues are essential for fostering collaboration and building a brighter, more sustainable future for all. By continuing to work together and share our experiences and expertise, we can achieve our shared goal of a more sustainable and inclusive world.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the LEAP-RE grant agreement n°963530.