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

Proceedings from general workshops

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Summary

Deliverable 4.5 (D4.5) compiles the proceedings of the three General Workshops (GWs) and associated Renewable Energy Schools (RESchools) organized within the LEAP-RE programme between 2022 and 2024. It serves as a comprehensive record of the LEAP-RE Stakeholder Forums (LRSFs), showcasing the scientific ambition, achievements, and collaborative spirit of the LEAP-RE community. This deliverable includes the updated state-of-the-art reports developed from the events held in Pretoria (2022), Kigali (2023), and Milan (2024), synthesizing project results, academic contributions, and capacity-building efforts across Africa and Europe. The document is structured into five key components: the 1st State-of-the-Art report from the Pretoria Stakeholder Forum and RESchool; the Kigali Forum's extended abstracts and Book of Proceedings (ISBN: 978-88-941226-6-4); a scientific and strategic overview of the Milan Forum; the concept note and programme of the 3rd RESchool; and a comprehensive annex with presentations, posters, and related materials. These contributions illustrate LEAP-RE's integrated approach to renewable energy research, its interdisciplinary synergies across Pillars 1, 2, and 3, and its efforts to strengthen science-informed policy dialogue and innovation partnerships in the AU-EU context. D4.5 reflects LEAP-RE?s commitment to inclusive knowledge sharing, long-term cooperation, and sustainable impact, and it stands as a key milestone toward building a common African-European research and innovation ecosystem in the field of renewable energy.

Approval

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LEAP-RE

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

Research & Innovation Action

October 2025

Deliverable 4.5 – Proceedings from the general workshop

State-of-the-art report from the General Workshops

Version N°1

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Abbreviations and Acronyms

Acronym	Description
WP	Work Package
RESchool	Renewable Energy School
MAR	Multi Annual Roadmap

Summary

Deliverable 4.5 documents the knowledge production and community-building that LEAP-RE has driven through its General Workshops—held alongside the LEAP-RE Stakeholder Forums (LRSF) and the Renewable Energy Schools (RESchools)—within the Joint EU–AU Research & Innovation Partnership on Renewable Energy (Grant Agreement 963530, 2020–2025). It situates these proceedings within the programme's broader mission to align African priorities and European support for a just energy transition through science, innovation, and policy dialogue.

Objectives. The deliverable captures, structures, and disseminates the scientific outputs, policy exchanges, and capacity-building activities from three cycles of LRSF/RESchool events. It provides state-of-the-art snapshots of LEAP-RE research across pillars, supports stakeholder engagement consistent with the AU-EU Innovation Agenda, and curates materials for reuse by researchers, policymakers, and practitioners.

Methods of development. The report compiles event programmes, abstracts, extended abstracts, presentations, and posters; synthesizes thematic and transversal workshop content; and archives learning outcomes from RESchools. The Pretoria (2022) and Kigali (2023) proceedings are summarized with structured annexes; the Kigali scientific sessions are additionally published as a standalone "Book of Proceedings" (ISBN 978-88-941226-6-4). The Milan (2024) section records agenda highlights—clustering, policy exchanges, and innovation showcases—completing a coherent multi-year record.

Results. In Pretoria (3–6 Oct 2022), the Forum convened AU–EU stakeholders, launched 13 Pillar 1 projects, reported Pillar 2 progress, and delivered a four-day RESchool on data collection and energy modelling; clustering meetings established synergy groups (data, modelling, capacity building). Activities progressed in line with the amended Grant Agreement. In Kigali (10–13 Oct 2023), the Forum expanded with scientific thematic sessions (minigrids, geothermal, modelling, technology for the transition), transversal workshops (business models, scientific writing, agriculture electrification), the kick-off of 10 additional Pillar 1 projects, and a second RESchool focused on methods and policy. Milan (8-11 Oct 2024) consolidated policy–science dialogue with institutional sessions, clustering, and a third RESchool, underscoring LEAP-RE's role in shaping just-transition practices.

Overall, D4.5 provides an integrated, citable record of LEAP-RE's scientific advances, training activities, and coordination outcomes across 2022–2024, demonstrating steady progress toward long-lasting AU–EU R&I cooperation and recommending broader external stakeholder participation to amplify impact in future forums.

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Keywords

Stakeholder Forum; RESchool, AU–EU Research & Innovation Partnership; Renewable-energy capacity building.

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1. Summary of the Deliverable

1.1 The LEAP-RE Stakeholder Forums and RESchools

The LEAP-RE Stakeholder Forum is the flagship event of the Long-Term Joint European Union – African Union Research and Innovation Partnership on Renewable Energy (LEAP-RE). Held annually or biennially, the Forum provides a unique platform where stakeholders from both continents—researchers, policymakers, innovators, funders, and community representatives—come together to shape the future of renewable energy cooperation between Africa and Europe.

As the LEAP-RE programme aims to establish a long-term and sustainable research and innovation collaboration, the Forum plays a pivotal role in ensuring that this vision is inclusive, multi-actor, and impact-driven. It does so by:

Showcasing scientific progress and results from projects funded under the LEAP-RE programme;

Enabling science-informed policy dialogue between EU and AU institutions;

Fostering collaboration between initiatives and communities across sectors and countries;

Training the next generation of researchers and practitioners, especially through its parallel RESchool programme.

The Forum is strategically embedded in the AU-EU Innovation Agenda, serving as a practical mechanism to operationalize its key pillars. These include advancing green transition, strengthening capacity for science, technology, and innovation, and building AU-EU synergies in policy and funding frameworks.

By bringing together science, innovation, and diplomacy under one roof, the LEAP-RE Stakeholder Forum not only tracks progress—it actively drives alignment between African priorities and European support instruments, ensuring mutual benefits and long-term impact..

1.2 Structure of the Deliverable

This Deliverable brings together the key outputs and documentation from the three General Workshops of the LEAP-RE (Long-Term Joint AU-EU Research and Innovation Partnership on Renewable Energy) community, spanning from Pretoria in 2022 to Milan in 2024. It provides a coherent narrative of the project's scientific progress, capacity-building efforts, and policy dialogue, as well as a structured archive of the events' proceedings.

The documents are presented in the following order:

Pretoria 2022 – 1st Stakeholder Forum and RESchool

The first volume comprises the proceedings and state-of-the-art report from the inaugural LEAP-RE Stakeholder Forum and Renewable Energy School held in Pretoria. This foundational event marked the kick-off of Pillar 1 projects and initiated cross-continental dialogues on renewable energy research and innovation.

Kigali 2023 – 2nd Stakeholder Forum and RESchool

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The second installment includes the extended abstracts and scientific contributions presented at the Kigali Forum. Structured as a scientific conference, it showcases progress from both Pillar 1 and Pillar 2 projects. Thematic sessions focused on minigrids, geothermal energy, energy modelling, and technological innovations. A parallel RESchool further enhanced skills in modelling, policy, and data-driven planning.

Milan 2024 – 3rd Stakeholder Forum and RESchool

The agenda of the Milan Forum outlines a rich programme of institutional discussions, innovation showcases, and policy exchanges within the AU-EU context. It captures the evolving strategic role of LEAP-RE in shaping the Just Energy Transition in Africa through science diplomacy and multilateral cooperation. A parallel RESchool further enhanced skills in modelling, policy, and data-driven planning. The sessions of the school continue the work begun in Pretoria and Kigali, with a focus on modelling for minigrids, economic analysis of energy projects, community engagement, and clean cooking technologies.

Kigali 2023 – Book of Proceedings – Published with ISBN: 978-88-941226-6-4

Complementing the state-of-art report, this separate volume collects the extended abstracts from the Kigali scientific sessions, offering deeper insight into the technical and methodological contributions of the LEAP-RE community.

Together, these four documents provide a structured overview of LEAP-RE's multi-year trajectory, highlighting its interdisciplinary approach, collaborative ethos, and commitment to supporting sustainable energy transitions in Africa through science, innovation, and policy integration.

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2. 1st State-of-the-Art report from the General Workshop and the RESchool in Pretoria

2.1 Introduction

Deliverable 4.5 (D4.5) constitutes the published record of the LEAP-RE general workshops, including abstracts of interventions or reports of papers presented by the LEAP-RE Community. The updated state-of-the-art reports of each general workshop (GW) are built on projects' activities, results, and outcomes. Three LEAP- RE State-of-the-Art reports will be produced based on the proceedings of the three LEAP-RE Stakeholder Forums (LRSF) to show the scientific ambition and achievements of the LEAP-RE programme. This document presents the 1st State-of-the-Art report from the General Workshop and the RESchool held in Pretoria, South Africa, from the 3rd to the 6th of October 2022.

The next section of the report will collect the abstracts received by the WP leaders that presented a contribution in the Pretoria forum, after having reported the programme of the SF and RESchool.

The third section of the report provides conclusion and an overview on the scientific achievements, ambition and committments of the programme, according to the state-of-art emerged in the forum.

The report concludes with an annexes section containing all the slides of the interventions held at Pretoria LRSF, explained in the previous sections.

2.2 Abstracts of the proceedings of the LRSF and RESchool

2.2.1 Summary of the events

The first LEAP-RE Stakeholder Forum has been held in Pretoria, South Africa, from 3 to 6 October 2022, in a hybrid format (Protea Hotel Fire & Ice! Pretoria Menlyn & online). The LEAP-RE Stakeholder Forum (LRSF) is an event organized every second year to enrich the LEAP-RE Community by addressing the following key objectives:

Create and expand an international multi-stakeholder community dealing with renewable energy, science-based policymaking, funding and research, innovation, monitoring, evaluation and learning, in Africa and Europe;

Identify, design, and implement the services and functions of LEAP-RE;

Foster collaboration between similar initiatives.

The 2022 LEAP-RE SF held in Pretoria sought to convene various stakeholders within the Consortium, as well as participating stakeholders with interests in the African Union-European Union (AU-EU) renewable energy Science, Technology and Innovation (STI) cooperation. The Forum has:

Featured the participation of high-level speakers involved in AU-EU cooperation

Hosted the kick-off of the 13 projects selected for funding by LEAP-RE (LEAP-RE Pillar 1)

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Presented the first results from the 8 projects developed within LEAP-RE (LEAP-RE Pillar 2)

Initiated the co-development of a long-term AU-EU platform for the multilateral AU-EU cooperation through workshops and other activities (LEAP-RE Pillar 3)

Hosted a Renewable Energy School (RESchool) for PhD students, young researchers, innovators, and entrepreneurs, as a parallel event of the SF

Provided clustering and networking activities.

Connection links to access the open sessions were included in the programme available on leap-re website at this link (https://www.leap-re.eu/2022/07/11/join-the-leap-re-stakeholder-forum-in-pretoria-in-october/). Participants to restricted sessions have received specific connection links for these sessions separately.

In parallel to the LRSF, the 1st LEAP-RE RESchool has taken place. This was organised as a blended Renewable Energy and Source School for PhD students; early career researchers and innovators will be held during the scope of the SF. The aim of the school was to support the development of early career researchers and innovators/entrepreneurs who are part of the LEAP-RE community. Based on the Synergy Groups existing inside the Pillar 2 (i.e., Data collection, Energy modelling) and the internal survey among the partners in Pillar 2, the general topics proposed for the RESchool were:

Data collection standards and tools.

Energy modelling capacity and tools.

Transversal socio-economic ancillary topics (Seminar event).

According to the specific topics and needs, preliminary materials have been shared and discussed before the onsite training using platforms for online (synchronous or asynchronous) sessions.

2.2.2 Programme Overview of the LRSF

3/10/2022

10:00 – 11:20	Opening session
11:20 – 12:30	Programme overview
13:30 – 16:30	Pillar 1 projects Kick-off
16:45 – 18:30	RESchool Day #1
16:45 – 18:30	Advisory Boards meetings
16:45 – 18:30	CCSE Working Group

4/10/2022

9:00 – 12:30	Pillar 2 Follow-up
14:00 – 18:00	Clustering Workshop
16:15 - 18:30	RESchool Day #2

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5/10/2022

9:00 – 12:30	LEAP-RE General Assembly meeting
13:30 – 15:15	LEAP-RE Roundtable
15:30 – 16:30	Twinning, Teaming and Matching Session
16:30 – 17:00	Closing Remarks
14:00 – 16:30	RESchool Day #3

6/10/2022

9:30 – 11:30	Vision Building Workshop #3
11:45 – 16:30	Programme Management Board meeting
9:00 – 17:00	RESchool Day #4

2.2.3 Contributions from the LRSF

2.2.3.1 Presentations of P1

Pretoria LRSF has hosted the kick-off meeting of the 13 projects selected for funding by LEAP-RE under LEAP- RE Pillar 1 (P1). Pillar 1 gathered Research and Innovation funding Agencies from Europe and Africa. It has selected 13 proposals for funding, with a global budget of 10,358,376 €. Out of this, 8,428,086 € comes from the funding agencies while 2,549,150 € comes from the European Commission. The selected projects involve 82 partners from 8 European countries (Belgium, France, Finland, Germany, Portugal, Romania, Spain, and the UK) and 9 African countries (Algeria, Egypt, Ethiopia, Morocco, Mozambique, Nigeria, South Africa, Togo, and Tunisia). The proposals span along the 6 multi-annual roadmaps (MARs) identified within LEAP-RE. All countries participating in Pillar 1 Call are involved in the funding of the selected proposals. Additionally, four African countries without funding agencies are participating in the selected projects, with a budget of 618,860 € dedicated to them. This demonstrates the commitment of the funding agencies to co-fund common Calls and foster collaboration between R&I partners from both continents towards achieving the goals of the Multi-annual Roadmaps.

The following table provides a full list of the presentations and the presenting institutions of P1 present at Pretoria LRSF. All the slides of the presentations held by the P1 projects' representatives are collected in **Annex A**.

MARs of reference	Title of the Project	Project Coordinator
#1 Renewable energy resources, mapping and modelling	OASES	Fraunhofer IEEST
	HyAfrica	Converge!, Lda

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#2 End-of-life and second-life management of RE components	RESTART	Ismael Saadoune Cadi Ayyad University (UCA)
	SIREVIVAL	Université catholique de Louvain (UCL)
3 Clean cooking and biomass transformation	PyroBioFuel	Cairo University
	SoCoNexGen	Aachen University of Applied Science
	SOLAR INDUCE	COPRECI S Coop
	SunGari	NRI Greenwhich
#5 New, more efficient PV cells and components	QDSOC	Université de Lorraine (UL)
	NANOSOLARCELL	NRS-CEMHTI
#6 Productive uses and new applications of solar energy	MG-FARM	Université de Lorraine (UL)
	LEDSOL	Centrul IT pentru Stiinta si Tehnologie
	SolChargE	TUM

Table 1: Summary of the interventions of the 13 projects of P1 at Pretoria LRSF

2.2.3.2 Abstracts and presentations of P2

The abstracts of the contributions of the WPs in P2, held during the follow-up of the second day of Pretoria LRSF by the WP leaders or their representatives, are reported in Table 2. Some of the abstracts are not reported for brevity but contained with all the slides presented in **Annex B**.

Title of the intervention	Presenter's Affiliation	Abstract
WP9	UNIFI	The Geothermal Atlas for Africa (GAA) project aims to provide a comprehensive overview of the low to high enthalpy geothermal resources on the African continent, suitable for electricity generation, plus a range of direct use applications. The key input data for the development of a comprehensive geothermal atlas are geoscientific information. This includes data on geological structures, tectonics, magmatic processes,

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		volcanic evolution, thermal anomalies, hydrothermal alteration, fluid chemistry, and hydrogeology. Data have been collected from existing databases and literature and will be used to categorize and assess resources, and to define geothermal provinces to be shown in the GAA. A team of engineers is working on this project to evaluate the energy potential of available geothermal resources. The objective is to develop a decision-making tool to select a range of suitable solutions in regards of energy, economic and environmental aspects for the sustainable utilization of geothermal resources, on the basis of the geothermal reservoirs' characteristics. Various combinations of energy systems were calculated using different conditions of the resource and considering thermodynamic, economic and environmental aspects (the latter by the means of Life Cycle Assessment). At the same time, the social science research group is committed to assess the socio-economic impact of geothermal development in Africa, in relation to the engineering investigated solutions. This is accomplished by using a methodology deployed into several steps: (i) Data collection tools; (ii) Reconnaissance Report on Homa Hills field visit and (iii) Literature review on the Socio-Economic context of geothermal energy in Africa. A framework was developed to collect information at different levels: continental, regional, countries, and country-local, within geothermal locations. Data were referred to several different databases including IRENA, UNEP and World Bank. Data collection tools have been prepared to include guides for Key Informant Interviews (KII) to collect data from expert opinions; Focus Group Discussions (FGDs) guide to target community groups' opinions and survey guide for structured interviews focusing on household energy users in geothermal countries have been setup. Using this amount of info, an assessment will be made of the geoscientific knowledge required to identify and successfully develop geothermal systems, factors enabling the construction of existing on-site plants (both high and low enthalpy), infrastructure constraints considerations, and social aspects of geothermal development. The foreseen final product is a website built mainly on open source technologies containing an interactive map, which provides insights into the African geothermal potential. Within the framework of LEAP-RE, GAA is willing to create a network of connections; therefore, capacity building plays a central role. Research mobility consisted in hiring many PhD students and researchers on different topics of geothermal energy. Participation to international conferences and submissions/publications in international scientific

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		journals have been the core of dissemination activity. Training needs were identified by surveys on existing training courses and schools for young researchers, students, technicians and operators in AU countries. Finally, as a clustering activity within Pillar 2, three synergy workgroups on data collection, energy modelling and capacity building were established in connection with other WPs.
WP10	SU	The Stakeholder Forum in October 2022 featured the WP10: PURAMS project, which focuses on developing a standalone solar cooking appliance for rural communities in Africa. The presentation highlighted various results, including the analysis of cooking habits, experimental campaigns using electric pressure cookers, and design metrics for photovoltaic (PV) cookers. The first iteration of the standalone solar cooker design was showcased, targeting road-side vendors for deep-frying meals and households/small cooking business owners for boiling, sautéing, and frying. Moreover, the optimization of the MECS eWant DC cooker design was presented. The presentation also emphasized the methodology for solar resource assessment, which was validated in Kenya and Mozambique and can be used in other African countries. It demonstrated the impact of the project, including the validation of the solar resource assessment methodology and identification of energy needs. The work package's ongoing efforts include the correlation between cooking hours and resource availability, profile analysis for the business plan, and cost breakdown analysis. Overall, the WP10: PURAMS project has made significant progress towards its objectives, with valuable results that can be leveraged to develop effective standalone solar cooking appliances for rural communities in Africa. The presentation showcased the project's impact and ongoing work, underscoring the team's dedication to improving the lives of people in rural Africa through sustainable energy solutions.
WP11	UL	-
WP12	IIASA	Irrespective of water resource abundancy, in sub-Saharan Africa (SSA) agriculture is predominantly

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		rainfed. Irrigation could offer vital support for coping with erratic rainfall and the hydrological impacts of climate change, supporting crop yields stabilization, income generation, and food security. Yet, a key barrier to its uptake is inadequate rural electricity supply. Here we devise a spatially-explicit integrated modelling framework (part of the LEAP-RE Pillar II WP12 RE4AFAGRI modelling platform) to show that two thirds of water requirements in rainfed cropland in SSA could be supplied with standalone solar PV irrigation systems that can be paid back by farmers within twenty years. To finance such capillary infrastructure deployment, we estimate a cumulative discounted investment requirement of $17 billion, in turn generating potential profits for farmers of up to $8 billion/year and significant food security and energy access co- benefits. Our analysis supports public and private stakeholders along the water-energy-food-economy nexus in targeting investments towards a synergetic achievement of the Sustainable Development Goals.
WP13	POLIMI	The SETaDiSMA project (LEAP-RE WP 13) has the objective of developing and applying energy system modelling to mini-grids, integrating digital technologies and socio- economic models. The main pillars of the project are therefore energy planning, technological design and digitalization research integrated with capacity building and dissemination activities. System design and planning activity, developed in task 13.1, has included a preliminary on-field mini-grid data collection campaign in Kenya and Rwanda targeted to operators and customers, the accuracy evaluation of solar and wind resource databases which consisted in a review of existing data sources and their validation against measured data, and the development of mini-grid design and planning models with a focus on load demand estimation at village scale. Modelling of mini-grid distribution system has been conducted as well with a first review of existing models and a selection of the most suitable approaches. The results achieved in technological development consisted in a review of solar technologies for electricity generation, the design of a micro-CSP plant (CSP4Africa II) and of an innovative solar

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		photovoltaic commercial solution ("Rural Energy Platform"). Research in digitalization, open innovation and entrepreneurship, conducted in task 13.2, has proceeded with the review of databases for digital technologies applied to mini-grids, the development of a database of actors of the African mini-grid sector and the mapping of digital technologies components and systems. Business models research (task 13.3), starting from a review of socio-economic models, has permitted to carry out an analysis of the actors in the rural mini-grid business, to develop a willingness-to-pay study and a methodology for investment plan evaluation and to analyze business models regarding productive uses support in mini-grids projects. The work has been conducted including case studies in Kenya and Rwanda in coordination with data collection activity of task 13.1. Finally, within capacity building and training activities of task 13.4, a workshop (RESchool 3-6 October 2022) targeted to LEAP- RE researchers has been held in Pretoria. The workshop has dealt with data collection methodologies, geothermal energy modelling, bottom-up and national modelling and GIS techniques.
WP14	UWasa	Villages in Africa have diverse sources of renewable energy, yet they neither utilise nor generate income from renewable energy. The objectives of the project are to map out different sources of energy found within a village and the various utilisation routes, to demonstrate that the village can generate sufficient energy at a commercial scale for use and sell the excess energy. The Energy Village (EV) concept, therefore, provides new types of energy infrastructure, energy access and energy market structures that keep the money flow within the region boosting its economy, employment and overall quality of life while enhancing the principles of bio- and circular economy. Further, the concept opens business opportunities for local and international companies. This concept involves the local communities and inhabitants in all stages up

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		to energy generation, thus giving them responsibility and ownership. Sixteen villages in Botswana, Ethiopia, Kenya, and Uganda are involved in this project. Teams from each partner visited the various villages for data collection using interviews and questionnaires. A common finding across the villages studied so far shows that the main sources of energy are firewood, charcoal, cow dung and LPG for cooking using the three stone method and kerosene and solar for lighting. Each village has shown potential renewable energy sources for utilisation. Langano village in Ethiopia has geothermal, biomass and solar energies as potential renewable sources. Cheboiwo village in Kenya has solar energy and agricultural biowaste for biogas generation has been identified as a feasible alternative to renewable energy. Based on the biowaste for the fields, an estimate of 30 kW can be generated. Kayanja village in Uganda has an installed 20kW microgrid initially designed to serve 90 households. However, currently, there are over 600 households connected to the system hence the increased load. This, therefore, implies that due to the increased demand, the current basic needs are not met by the system. Currently, only 30 households are served by the system. In this project, ongoing analysis to increase solar microgrids as well as utilising biowaste is proposed to the community. Reagants Hills school in Botswana has solar panels installed on the roofs. However, the daily fluctuations caused by sunrise and sunset, and the output from solar panels change suddenly due to clouds. The variability caused by clouds makes it more difficult for the school to go full renewable, therefore, buying on-grid electricity to accomplish the load-following phase. Biowaste and wind are being studied to provide a mix of sources of renewable energy that would complement the intermittency and uncertainty experienced with solar energy. Notwithstanding the challenge to quantify the amount of energy being consumed by each household, the estimation of potential renewable energy in the villages is ongoing. In the future, financial and SWOT analyses will be performed in at least one village per partner country showing the potential for self-sufficiency.

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WP15	Odit-e	-
WP16	-	-

Table 2: Abstracts of the interventions of P2 at Pretoria LRSF

2.2.3.3 Other

Pillar 3 (P3) presentation for the GA

A presentation by the project coordination (P3) WP leaders has been held in Pretoria to introduce the General Assembly (GA) meeting that took place on the 5th of October. The meeting has been structured as follows: Introduction, Quorum, Keynote, Afenda presentation, Code of conduct & consortium responsibilities, Amendments, Keypoint on Financial progress and a concluding keypoint on the Communication of LEAP-RE. The slides of the intervention are collected in **Annex C**.

Proceedings of the Capacity Building cluster meeting workshop

The LEAP-RE Capacity Building Cluster Meeting was held on Tuesday 4 October 2022 to discuss capacity building activities for different target groups and to define the role of the CB Synergy group in assisting with capacity building activities. The meeting was attended by representatives from various work packages.

The participants emphasized the need for diverse capacity building activities for different target groups, including researchers involved in the work packages, policymakers and government officials, manual technicians, and beneficiaries/end-users/communities. They proposed creating a common Google folder for LEAP-RE resources, such as video content and links to existing materials.

The participants identified the need for the CB Synergy group to clearly define target groups where there is synergy and where individual WPs can better provide their own dedicated capacity building activities. The group's energy should be best invested in assisting with capacity building activities for policymakers and researchers. On the other hand, individual projects are best equipped to deal with the capacity building activities concerning manual technicians and beneficiaries/end- users/communities. To support capacity building for researchers, the participants proposed a second RE School to join the trainings of each WP for greater impact. The RE School is recommended to be held in 2023, if possible, in synergy with the next in-person Stakeholder Forum. The budget for student scholarships comes from Pillar 3.

For policymakers, government officials, and implementing organizations, the participants proposed meetings as a support for capacity building activities. There is potential for Royal Academy of Engineering funding for five energy access policy trainings during 2023. The target for these meetings is researchers and government officials. The participants also discussed additional contacts and linkages, including with WP13, WP10, and WP12.

Overall, the LEAP-RE Capacity Building Cluster Meeting proposed various capacity building activities for different target groups and defined the role of the CB Synergy group in assisting with capacity building activities.

Proceedings of the Energy Modelling cluster meeting workshop

The cluster meeting on energy modelling was attended by various representatives from organizations and institutions interested in the field. The meeting covered topics related to

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energy modelling and provided an opportunity for attendees to share their ideas and opinions.

During the meeting, the group discussed topics related to North Africa, including WP10 & WP13, Pillar 1 MicroGrid Farms, and Pillar 1 Recycling PV. The meeting also covered smart grid topics such as data logging, real-time digital data sharing (including digital security), block chain for energy transmission (e.g.: ME-SOL-Share), and electricity security (damaging of appliances).

Many of the attendees expressed interest in load demand modelling, including both real-time and long-term forecasting. Additionally, the group showed more interest in minigrids than national systems. Some attendees were present "just to learn."

Overall, the meeting was productive and informative, with attendees sharing valuable insights and ideas related to energy modelling. The participants agreed to continue discussions on these topics in future meetings to further explore and develop the field.

Proceedings of the Data Collection cluster meeting workshop

Another cluster meeting workshop was held to discuss data collection. The data collection synergy group was managed by Sandra Banda (SU) and AESG (Rwanda), and it successfully coordinated different WPs on the topic. Attendees discussed the importance of collecting high-quality data for energy access and explored different methods for doing so. They proposed developing a set of best practices for data collection to be shared among the LEAP-RE community. Overall, the meeting was a success, with attendees providing valuable insights and ideas related to data collection for energy access.

Future actions of the clustering group may involve considerations on how to improve LEAP-RE data processing and visualization (beyond data collection per-se).

Other Green Deal projects presentations

Additional presentations have been taken by representatives of three related Green Deal Projects: ENERGICA, REFFECT-Africa and SOPHIA. The slides of the presentations are provided in **Annex D**.

2.2.4 Programme Overview of the RESchool

3/10/2022 - RESchool Day #1

16:15 – 17:00 Data Collection: The RDs in energy

17:00 – 17:45 Data Collection: Resource Assessment Criteria for selecting solar PV powered mini grids

17:45 – 18:30 Data Collection: Resource Assessment Criteria for selecting solar PV powered mini grids

4/10/2022 – RESchool Day #2

16:15 – 17:00 Energy modelling (introduction)

17:00 – 17:45 Energy modelling (models taxonomy and components)

17:45 – 18:30 Energy modelling (modelling geothermal technologies)

5/10/2022 – RESchool Day #3

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14:00 – 14:45 Data Collection: Qualitative data collection

15:00 – 15:45 Energy modelling: GIS for energy modelling

15:45 – 16:30 Energy modelling: GIS for energy modelling

6/10/2022 – RESchool Day #4

09:15 – 10:00 Seminar - Renewable Energy Communities

10:00 – 10:45 Seminar - Renewable Energy Communities

11:00 – 11:45 Seminar - Prosumers

11:45 – 12:30 Data Collection: Quantitative Data Collection

14:30 – 15:15 Energy Modelling: Hands On Session

15:15 – 16:00 Energy Modelling: Hands On Session

2.2.5 Contributions from the RESchool

2.2.5.1 Abstracts of the RESchool

Here follows an abstract description of the two streams of interventions held in the Pretoria RESchool, with related submodules and learning outcomes. The two streams have been planned according to the topics of interest identified. Two seminar events are also reported.

Data Collection

Responsible: SU

Abstract: The "Data Collection" session is designed to provide an in-depth understanding of both quantitative and qualitative data collection methods. Participants will learn about site selection and sampling, which are crucial steps to ensure that the data collected is representative of the population being studied. The development of effective questionnaires and tools will also be discussed, as this is a critical aspect of collecting accurate and reliable data. The session will cover data cleaning and quality, which is the process of identifying and correcting errors, inconsistencies, and inaccuracies in the collected data. Data storage and sharing will also be discussed, as this is an important aspect of data management. The case study based on Pillar 2 experience and coordination will provide participants with an opportunity to apply their knowledge to a real-world scenario. This will help them understand how to collect data in a practical setting and how to overcome challenges that may arise during the data collection process. Data methodology and interpretation for WP10 and WP13 will also be discussed, which will be beneficial for students who plan to use these methodologies in their research. An online assignment will be provided for students to apply their knowledge and skills. This will help them evaluate their understanding of the course material and identify areas where they may need further improvement. Upon completion of the workshop, students will be able to understand the fundamental principles of data collection formulation, distinguish between different data collection methods, and evaluate which method is best suited for their research topic. The evaluation of the learning outcomes will be based on the students' solution approach to a simple case study project. Overall, this workshop session is ideal for early career researchers interested in learning about data collection methods or those who wish to improve their data collection skills. It will provide a comprehensive overview

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of the data collection process and equip participants with the tools and knowledge needed to collect accurate and reliable data.

Energy Modelling

Responsible: POLIMI

Contributors: IIASA, UNIFI, POLIMI

Abstract: The module titled "Energy Modelling" covers a range of topics related to energy modeling at different scales. The workshop is divided into several sessions, each focusing on a different aspect of energy modeling. The first session, which spans two hours, covers the principles and taxonomy of energy modeling. Participants will learn about the different approaches to energy modeling and the various factors that need to be considered when modeling energy systems. The next two-hour session focuses on GIS-based energy models, with a case study providing hands-on experience. Participants will learn how to use GIS tools to model energy systems and analyze the results. The next one-hour session focuses on geothermal energy modeling, providing an overview of the principles and applications of geothermal energy modeling. In the subsequent session, participants will engage in hands-on case studies based on Pillar 2 experience. This will provide them with an opportunity to apply their knowledge and skills to real-world scenarios. The final two-hour session covers open- source demand and supply energy models. Participants will learn how to use open-source tools to model energy systems and analyze the results. By the end of the workshop, participants will have gained a comprehensive understanding of the fundamental principles and methodological approach to data gathering and energy modeling. They will also be able to prepare questionnaires for a data collection campaign and set up the reference energy systems for a region/area of interest. The hands- on sessions and case studies will provide participants with practical experience to better understand the topics covered, making them valuable assets in the field of energy. The evaluation of the learning outcomes will be based on an assignment given to the students on Day #4. The assignment will be carried out in small teams and will involve analyzing a questionnaire for data collection and implementing a simple case-study for energy modeling. This will help participants evaluate their understanding of the course material and identify areas where they may need further improvement

Renewable Energy Communities: a sustainable and inclusive way to ensure energy access in African countries (seminar)

Responsible: SSSA

Abstract: This 2-hour module will be a seminar event led by Professor Fabio Iannone from the Scuola Superiore Sant'Anna. The focus of the module will be on renewable energy communities and their potential to provide sustainable and inclusive access to energy in African countries. The seminar will not only explore the technical aspects of renewable energy communities but also the transversal socio-economic ancillary topics that are crucial for their success. Participants will learn about the benefits of renewable energy communities, including reduced carbon emissions, improved energy access, and increased community engagement. The module will also cover case studies of successful renewable energy communities in Africa and provide practical guidance on how to establish and operate such communities. Overall, this seminar is ideal for anyone interested in learning about renewable energy communities, their technical and socio-economic aspects, and their potential to provide sustainable and inclusive energy access in African countries.

From energy user to energy prosumer: Empowerment through flexibility (seminar)

This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

Responsible: NEC

Abstract: This seminar titled "From energy user to energy prosumer: Empowerment through flexibility" will be led by Marine Cornelis and will focus on the transition from energy users to energy prosumers. The seminar will explore the concept of prosumers, who are both energy consumers and producers, and how they can be empowered through flexibility. The seminar will cover various topics such as demand-side management, dynamic pricing, smart homes, energy storage, and vehicle-to-grid technology. Participants will learn about the benefits of becoming an energy prosumer, including reduced costs, increased energy independence, and greater control over energy consumption. The seminar will also provide practical guidance on how to become an energy prosumer, including the necessary technology and infrastructure. Overall, this seminar is ideal for anyone interested in learning about the transition from energy user to energy prosumer and how to become an empowered energy prosumer through flexibility.

2.2.5.2 Posters

A parallel session for poster presentation has been carried out alongside the RESchool. This has involved poster presentations of four PhD candidates or early career researchers from four different institutions. The posters are attached in **Annex E.**

2.3 Conclusion: overview on LEAP-RE state-of-art

The 1st LRSF held in Pretoria has been succesfully carried out and managed to provide a fruitful event for fostering collaboration between pillars and work packages.

The main activities of Pillar 1 have led to the execution of the first round of calls for proposals which was very successful. The selected 13 projects were kicked off during the forum and have received great interest from the audience. The eight Pillar 2 projects have progressed mostly along the lines of the Grant Agreement, despite some delays and deviations due to the pandemic and other geographical circumstances. The follow- up was held and technical interactions among partners fostered in the RESchool.

Overall, the progress of the activities is in line with the objectives of the project and what was foreseen in the amended grant agreement. The work has progressed within the timeline foreseen and the results are overall well in line with the grant agreement expectations. Most deliverables have been submitted on time or with minor delays of under 3 months.

The consortium has shown great scientific commitment, making LEAP-RE a scientifical and technologically relevant programme. The scientific products carried out have made a significant contribution to the objectives and impacts of the LEAP-RE programme. In particular, the project has made a significant progress towards creating long-lasting R&D cooperation in the energy field between EU and AU research organisations, both applicants and funding organisations.

As for future forums, the suggestion is to encourage greater participation from stakeholders external to the consortium, such that the R&D results can be disseminated and upscale their impact. Side events could be organized to facilitate this.

2.4 Annexes

The following annexes are reported:

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Annex A: P1 kom and project presentations, including the description of each project's consortium, the aim of the project and its relevance to the MARs, the expected results, outcomes, and possible contributions of each project to the AU-EU R&D cooperation.

Annex B: P2 follow-up presentations for every WP that presented.

Annex C: P3 General Assembly presentation

Annex D: other Green Deal project's presentations

Annex E: posters presented during the Pretoria RESchool

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3. 2nd State-of-the-Art report from the General Workshop and the RESchool in Kigali

3.1 Introduction

Deliverable 4.5 (D4.5) constitutes the published record of the LEAP-RE general workshops, including abstracts of interventions or reports of papers presented by the LEAP-RE Community. The updated state-of-the-art reports of each general workshop (GW) are built on projects' activities, results, and outcomes. Three LEAP- RE State-of-the-Art reports will be produced based on the proceedings of the three LEAP-RE Stakeholder Forums (LRSF) to show the scientific ambition and achievements of the LEAP-RE programme.

This document presents the 2nd State-of-the-Art report from the General Workshop and the RESchool held in Kigali, Rwanda, from the 10th to the 13th of October 2023.

The next section of the report will describe the events that have taken place. Then, the document summarises both the contributions of the LRSF and RESchool of Kigali, after having overviewed the programmes.

The last section of the report provides conclusion and an overview on the scientific achievements, ambition and committments of the programme, according to the state-of-art emerged in the forum.

The annex reports the LRSF Thematic Session extended abstracts, collected in a scientific conference format.

3.2 Abstracts of the proceedings of the LRSF and RESchool

3.2.1 Summary of the events

The second LEAP-RE Stakeholder Forum took place in Kigali, Rwanda, from 10 to 13 October 2023, utilizing a hybrid format across Serena Kivu, Four Points Muhabara & Gasabo, and online platforms. The forum aimed to foster the LEAP-RE community by engaging stakeholders, including other twin programs, facilitating knowledge exchange, and fostering networking opportunities. The event had several key objectives:

Cultivate an international, multi-stakeholder community focused on renewable energy, science- informed policymaking, funding and research, innovation, as well as monitoring, evaluation, and learning within Africa and Europe.

Define and expand the services and functions offered by LEAP-RE.

Promote collaboration among similar initiatives.

Particularly, the event has seen the participation of stakeholders with interests in the African Union-European Union (AU-EU) renewable energy Science, Technology and Innovation (STI) cooperation.

Here follows a brief summary of the events that have taken place during Kigali LRSF:

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1. Panel Discussions, featuring the participation of high-level speakers and officers involved in AU-EU cooperation. Topics:
    - Research to Policy;
    - CCSE contribution to the AU-EU Innovation Agenda;
    - CCSE – Climate resilience and adaptation.
2. Thematic Sessions organized in the form of a scientific conference moderated by experts, with selected papers presenting the techno-scientific innovations of P1 and P2 projects as well as other twin programs (EPICAFRICA, OnePLANET). Sessions:
    - Minigrids and Local Energy Systems;
    - Geothermal Energy;
    - Energy modelling;
    - Local Applications of Geothermal Energy;
    - The Role of Technology in the Transition – Clean Cooking, Advanced Materials and LCA.
3. The 2nd RESchool (Renewable Energy School) for PhD students, young researchers, innovators, and entrepreneurs, as a parallel event of the LRSF. Sessions:
    - Renewable Resource Assessment Methods and Data Sources;
    - Energy efficiency and demand side management;
    - Bottom-up electricity demand assessment;
    - Data collection, analysis and visualization;
    - Advanced energy modelling for mini-grids;
    - Geothermal power, sustainability of geothermal systems and BM specificities;
    - Policy and regulations.
4. Transversal Workshops for capacity building on the following topics:
    - Transversal workshop for business models for decentralized renewable energy;
    - Workshop for scientific writing and publication processes;
    - Interactive decision-making tools and business models for electrification of smallholder agriculture.

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5. General Assemblies for P1, P2 and P3, meetings and Project Management Board.

6. AfriLabs Annual Gathering, held in parallel with the LRSF.

7. Kick-off of the 10 additional projects selected for funding by LEAP-RE (P1).

8. Presentation of the first mid-term results from the 13 projects developed within LEAP-RE P1.

Clearly, as illustrated in the programme overview, some of these events had to be held in parallel sessions. Connection links to access the open sessions, including the RESchool and the Transversal Workshops, were included in the programme available on the event website at this link1. Participants to restricted sessions have received specific connection links for these sessions separately.

In parallel to the LRSF, the 2nd LEAP-RE RESchool took place throughout the 4 days of the fourm. This was organized by P2 and P3 as a blended Renewable Energy and Source School for PhD students, early career scientists and innovators within the LEAP-RE consortium. A total of 25 participants from Africa and Europe were selected and supported for in-presence attendance. The aim of the school was to support the development of early career researchers and innovators/entrepreneurs who are part of the LEAP-RE community. Based on the Synergy Groups existing inside the Pillar 2 (i.e., Data collection, Energy modelling) and the internal survey among the partners in Pillar 2, the general topics proposed for the RESchool (listed above) were in continuity with the 1st LEAP-RE RESchool held in Pretoria in 2022. According to the specific topics and needs, preliminary materials have been shared and discussed before the onsite training using platforms for online (synchronous or asynchronous) sessions.

3.2.2 Programme overview of the LRSF

10/10/2023

8:00 – 8:30	Registration
8:00 – 10:30	LEAP-RE Policy Introduction
10:30 – 15:00	Panel Discussions
15:00 – 18:15	CCSE and SEAB meetings
14:00 – 17:00	General Assembly
14:00 – 17:00	LEAP-RE 2nd RESchool Day #1
17:00 – 18:15	Transversal Workshop

11/10/2023

10:00 – 13:00	LEAP-RE 2nd RESchool Day #2
14:00 – 18:30	Transversal Workshops
14:00 - 17:30	LEAP-RE P1 kick-off event

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14:00 – 17:00	LEAP-RE 2nd RESchool Day #2
14:00b – 18:00	Thematic Sessions

12/10/2023

9:00 – 13:30	LEAP-RE P1 mid-term event
11:00 – 17:45	Thematic Sessions
9:00 – 17:45	LEAP-RE 2nd RESchool Day #3
14:15 – 17:45	LEAP-RE P1 mid-term event

13/10/2023

9:00 – 10:00	LEAP-RE P2 coordination meeting
10:00 – 10:45	SEAB meeting
9:00 – 13:00	LEAP-RE PMB
9:00 – 13:00	LEAP-RE 2nd RESchool Day #4
13:00 – 19:30	Site visit to Anne Heyman solar fields

3.2.3 Contributions from the LRSF

3.2.3.1 Thematic Sessions

Kigali LRSF hosted a series of thematic sessions organized in the form of a scientific conference. This allowed the participants to present the scientific results of the projects inside and outside LEAP-RE to a broader audience, receive questions and feedbacks and engage with the reference communities. The sessions was coordinated by P3 and the scientific coordination team of LEAP-RE, from their ideation (which started from the clustering initiatives within LEAP-RE) to their implementation and selection of moderators. The topics chosen for the thematic sessions stemmed from the synergy groups existing within LEAP-RE and from the Multi-Annual RoadMaps (MARs) of the LEAP-RE.

The process for the organization of the sessions included the following steps:

1. A first collection of short abstracts was performed through Google Forms between 7th of July 2024 and 7th of August 2024. A total of 36 short abstracts were received.

2. After a revision of the abstracts, 27 were considered eligible. Authors were asked to submit an extended version of the abstract (3-pager). Only the 3-pager abstracts received from the authors will be published as an annex to the present document.

3. Moderators were chosen among high-level participants to the forum.

The following table provides a full list of the presenters and moderators that animated the thematic sessions. The 3-pagers of the contributions received are available at Annex A , formatted as scientific conference book of proceedings.

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Title of the contribution	Contributors (institutions)	Abstract
Optimization of green microgrids/minigrids with solar and wind power production	LNEG, POLIMI	This work presents a methodology to determine the optimal share of variable renewable energy sources (vRES) in a selected minigrid and evaluate its capability to satisfy the electricity demand enabling to reduce the dependency on fossil fuel generators. The optimal share is identified based on a strategic exploitation of wind and solar photovoltaic (PV) synergies to attend the electricity demand, in this case, to replace the production of diesel generators. The use of non-energy optimal azimuth and inclination angles for solar PV systems as well as tracking systems to create an optimal system is explored. The preliminary results obtained highlight that is necessary to diversify the orientation of solar panels and explore wind power to avoid several periods of generation curtailment. Despite further work is needed, results support that the use of diesel generators can be significantly reduced especially during the daylight period.
Archetypes of Rural Users in SSA for Load Demand Estimation	POLIMI	In the realm of estimating electricity demand in rural regions, a series of representative user profiles are suggested to aid in the development of off-grid energy planning models. These profiles are tailored for residential consumers, educational institutions, and healthcare facilities, taking into account variations in latitude, climate, and socioeconomic status across Sub-Saharan Africa (SSA). These user archetypes are crafted to seamlessly integrate with both Energy System Optimization Models and Geospatial Electrification models. Within this study, they are employed in three distinct case studies focusing on off-grid system sizing in Nigeria, Kenya, and Mozambique, showcasing the versatility of this approach
Energy Village Concept Application in Africa	UV	The Energy Village (EV) project maps out the potential of a selected number of villages in Africa to act as Energy Villages, meaning being able to provide renewable energy for their use and also

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		for the surrounding area. There is a huge need for electricity in many parts of Africa and the solutions should be environmentally friendly and support energy transition. Energy balance altogether for 18 villages from Ethiopia, Uganda, Kenya, and Botswana was calculated. Two inspiring cases out of the 18 were chosen to be presented and to inspire others. Those are (1) the Addis Ababa Science and Technology University (AASTU) campus in Ethiopia and (2) the Bidibidi refugee settlement in Uganda. The total consumption of the AASTU campus is 12,572.03 kWh/day. The total renewable energy potential for the AASTU campus is estimated to be 14,032.23 kWh/day. Comparing the demand for energy with the potential energy there is more than 1500 kWh/day of renewable energy potential in the AASTU campus than what is needed. In the Bidibidi refugee settlement, the total energy consumption is 47,961.38 kWh/day. The current renewable energy potential estimate only from biogas, solar, and wind turbines is 20,379.8 kWh/day, which is much lower than the energy demand in the settlement and means that there is no excess energy to be used for the surrounding area. However, the renewable energy potential can replace about 40 – 50 % of the energy demand in the Bidibidi refuge settlement. All in all, these two inspiring cases represent how different situations can be in villages and not all of them can act as the same. The project has helped us to learn much about how to apply and what to expect while implementing the Energy Village Concept in Africa.
Bottom-up framework for estimating appliance adoption over time: Implications for energy demand evolution in rural mini-grids	LUT, SU	In the context of rural mini-grid (MG) projects, uncertain electricity load prediction can negatively impact the system performance and project sustainability. This study analy- ses appliance ownership of MG users, aiming to provide insights for better demand forecasting. The objectives of this work include: understanding the link between household electricity ac- cess duration and appliance ownership, and creating a framework for reliable energy demand predictions. The concept of appliance tier

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		framework is used to illustrate adoption patterns and demand evolution during initial project phases. Data employed for this study was collected from rural mini-grid users in Kenya.
Preliminary mapping of natural hydrogen resources in Morocco and South Africa	CONVERGE	Power supply in remote and isolated communities in African countries can benefit from standalone solutions relying on locally available energy resources. Natural hydrogen (also known as white hydrogen) has the potential for being one of those standalone solutions, since it is usually associated to geological environments that are common in Africa, and it is a constant primary energy source, replenished through continuous water-rock interaction. Project HYAFRICA has completed the first surveys for identifying and mapping natural hydrogen occurrence in two of its target regions: the Tendrara/Jerada municipalities in Morocco and the Mpumalanga district in South Africa. Remote sensing techniques were applied to identify potential hydrogen seeps, which were subsequently characterised by geochemical field surveys. Multiple occurrences of hydrogen were found at very shallow depth (<1.2 m), with concentrations slightly above 500 ppm in the Morocco target area, and up to 2500 ppm in South Africa. In both target areas, the connection between surface occurrence of hydrogen and its potential origin is studied through structural geology and geophysical methods. In Morocco, magnetic and gravimetric anomalies were identified and modelled, and seem to indicate that the hydrogen results from the serpentinization of ultramafic rocks. In the South Africa target, where similar geophysical anomalies were mapped, the most striking features are the structural controls that dictate the occurrence, orientation, and clustering of the natural hydrogen seeps. Subsequent stages of the project will aim at characterising the natural hydrogen system and the socio-economic impact of its use in standalone power supply systems.

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Table 2: Thematic Session 1 - Minigrids and Local Energy Systems, Moderator: Mott MacDonald

Title of the contribution	Contributors (institutions)	Abstract
Electrical conductivity and normalized chargeability tomograms, news tools to prospect geothermal resources	UL	The development of renewable energies in order to face the 21st century challenges will see geothermal energy taking a relevant and significant place in the production of carbon- free heat and electricity energy. Exploration of geothermal resources has its own specificities in terms of protocols and methods to characterize and model the most productive and suitable sites that will be chosen for such energy production. In this context, recent developments in induced polarization, integrated within the framework of geological mapping and geophysical modelling, allow for a characterization of alteration processes that undergo rock formations by the interaction between the hydrothermal fluid and the solid medium. This research explores the possibility of using electrical conductivity and normalized chargeability tomograms to image hydrothermal conduits thanks to their high cation exchange capacity. This information is of a precious importance in terms of structural control, intensity of the heat flow, and possible fluid flow intake estimation. The development of this new protocol allows for a quantification of alteration clay content and hydrothermal sulphide precipitation, which in consequence guides the most active targets for drilling operations at the same time it describes the overall geological background within the depth of investigation. This method has been applied to Lake Abhé, Djibouti, in the framework of the LEAP-RE consortium, and the results suggest a high potency of the method in the context of an intracontinental rift geothermal anomaly
Integrated Decision Support Tool for Optimal Exploitation of Geothermal Resource. A Thermodynamic,	UNIFI	Geothermal energy presents a promising and sustainable solution to address the growing global energy demand, and its potential is particularly relevant for the African continent. Africa has abundant geothermal resources, yet the

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Thermo-economic and Environmental assessment		exploitation of these resources has been relatively limited compared to other regions. Effectively harnessing geothermal resources in Africa requires a thorough evaluation of site-specific conditions and the identification of the most suitable exploitation approach. In this research, it has been introduced a novel decision support tool specifically tailored for the African context, aimed at assisting stakeholders and decision-makers in evaluating and determining the optimal utilization of geothermal resources on the continent. The decision support tool is designed as a user-friendly software application, incorporating thermodynamic and thermo-economic analysis of symplified system in order to evaluate the preliminary sizing for surface application and the economic feasibility of different exploitation strategies. Morover, to ensure sustainable geothermal development, the tool employs Life Cycle Assessment (LCA) techniques to evaluate the environmental impact associated with each exploitation option. This paper focuses on development of simplified model for the exploitation of low- and medium-enthalpy geothermal resources using thermodynamic and environmental models. The systems analysed are applications for cold production (ammonia- water absorption cycle) and heat production (high temperature heat pump).
African Geothermal play types a contribution to the Geothermal Atala for Africa (GAA)	Geo2D	Africa is still a continent where geothermal energy opportunities remain ill developed, and eventually unknown There is no specific geothermal system in Africa, but variety of systems and development perspective. 10 geothermal play-types are proposed, based on the relevant geodynamic environments encountered in Africa: 1: Eastern branch of the East African Rift System; 2: Red-Sea and Gulf of Aden including Afar; 3: Western branch of the East African Rift System and Southern Rifts; 4: Deep reservoirs from sedimentary basins; 5: North Africa (Mediterranean collision zone); 6: Oceanic and continental mantle plumes

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		(Comoros, Cap Verde, Darfur); 7: Oceanic fracture zones off-shore & on land (Cameroon line); 8: hot-springs & heat anomalies from basement discontinuities; In addition to Deep EGS (N°9) and Ground Heat Pumps (N°10) available everywhere. Each play-type, reported on the map of Africa, allow to illustrate the specific geothermal conceptual model defined by the corresponding geological parameters (volcanic, sedimentary, tectonic, etc…) characterizing each play type. Each play types also allows for a specific geothermal application, with rather different economic characteristics. The exploration strategy also differs for each play-type, and the same for the kind of development and technology to be considered. The social approach of each play type, and the kind of stakeholders and developers involved also need to be adjusted to each case. This contribution is aimed to help promoting ad-hoc geothermal development in Africa based on both the geothermal resource characteristics and the associated social demand at the surface. This is part of EU-AU LEAP-RE Project N°9 and is meant as an entrance to GAA data base.
Current assessment of the geothermal potential in Mozambique	UEM	Mozambique is geographically located on the southern end of the East African Rift System (EARS). It is well known that the EARS erupted 35 to 40 Million years and some of its fault systems are active to date. As one of the results of this rift phase in the Gondwana super continent, Mozambique registers several geothermal occurrences along the rift lineaments known in the provinces of Niassa, Tete, Zambezia, Manica and Sofala, well in line with the main fault lineaments of the Karoo and EARS rifts. Some or most of the geothermal springs are in areas of known seismicity thus related to the reactivation of Karoo faults and of faults of the EARS. This can be confirmed by the cumulative seismicity chart of Mozambique. The temperatures in some of the springs are well above one hundred degrees Celsius and could well be used for different purposes from leisure and medical cure to eventually power generation if enough potential could be

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		proved. Detailed studies are necessary to ascertain the full potential of the inventory of geothermal sources identified to enable the precise characterization of each source and thereafter determine the most adequate use of the existing geothermal potential. Geothermal energy in Mozambique is relatively unknown and underexplored, therefore only a few springs are artisanal explored for therapeutic treatment. The country energy sector is considering the installation of some small-scale geothermal power plants in some of the currently known springs in the future.
Capacity Building in Geothermal Energy Development in Africa – Successes and Challenges	DKUT	Over the years, the energy demand in Africa has steadily increased due to population and economic growth. In many countries, electrical energy is a major component in the energy mix. Geothermal Energy is being touted to improve generation capacity expansion of environmentally friendly sources, innovations and application of latest and appropriate technologies. Development of geothermal resources relies on a spectrum of professionals with varying technical backgrounds and experience. Two main reasons often quoted for lack of accelerated growth in geothermal energy exploitation despite its proved economic benefits are the large upfront costs and lack of adequate human expertise. Hitherto, no geothermal training institutions existed in Africa and the majority of geothermal energy professionals currently working in the continent have attended courses at various international geothermal schools, including the United Nations University in Iceland, the University of Iceland, Pisa University in Italy, Kyushu University in Japan and the Geothermal Institute of Auckland in New Zealand, utilising financial sponsorship of the host institutions, international and bilateral agencies. Kenya is leading in Africa in the development of geothermal resources, largely due to government commitment and well trained workers. Large investments have been made in training local personnel in geothermal exploration development and production activities. In this paper, we share some of the successes and challenges encountered

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		developing African geothermal resources. The review has used various reports on geothermal development in Kenya, Ethiopia, Djibouti and UN ARGeo project.
Exploring Current and Potential Locations and Utilization of Geothermal Energy in Egypt using Multi-Data Sources and Modelling	NARSSS	Energy represents the driving force behind global sustainable development, posing a significant challenge for many African countries, including Egypt. Despite being one of the largest consumers of oil and natural gas on the continent, Egypt struggles with limited power generation, resulting in an annual power generation of 31,600MW. To ensure a diversified energy portfolio that addresses that enhance and sustains power needs for economic growth, it becomes crucial to explore alternative energy sources. The potential for geothermal energy in Egypt is promising, with the capacity to play a substantial role as an energy source. However, its development and adoption are still in their early stages and not yet firmly integrated into future plans. Geothermal resources generally exhibit low to medium enthalpy, but certain high enthalpy locations show promise. To explore the potentiality of geothermal energy, the integration of models and various data sets (geology, structural geology, aeromagnetic, remote sensing, seismic, and tabular in-situ information) are harnessed in this study and consolidated into Geographic Information (GI) model (as part of the LEAP-RE project). This approach aids in mapping the most promising geothermal zones across the country. The outcome of this endeavour will be a national geothermal potential map, categorizing five potential zones based on their energy yield, ranging from poor to optimum. The study goes beyond technical considerations and delves into the social and economic aspects, including community utilization of geothermal resources. Moreover, the potential for power generation to meet electricity demands is also explored, adding an extra dimension to the assessment of geothermal energy's viability in Egypt.

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Table 3: Thematic Session 2 – Geothermal Energy, Moderator: SACREE

Title of the contribution	Contributors (institutions)	Abstract
AASTU energy village	AASTU	The ever-depleting nature of non-renewable energy resources has been and is a concern of researchers across the globe. Before the non- renewable energy resources are used up to a point of no return, it is a consensus of all to use renewable energy resources. This research, thus, studied the availability of renewable energy resources and quantified their potential at AASTU energy village. Besides, all forms of energy resources such as wood, charcoal, electricity etc., were identified and the consumption was determined. The statistical analysis of data gathered from the meteorological station installed in the village showed that the annual average solar intensity was 5.76 kW/m2/day and the most frequent wind speed was 7.2 m/sec at 50 m height. Based on the area available and efficacy of panels, about 13 MWh/day solar energy potential, and based on Weibull distribution model, 300 W/m2 wind power density were estimated. The wind rose analysis revealed that the village received most of its wind in the East direction. The biomass resources were pinpointed and the potential was quantified to be 2 ton/day of food waste and 2 ton/day human waste. Moreover, it was found that the aforementioned biogas could generate 1720 and 694 kWh/day respectively. Based on the data obtained from the university, AASTU energy village has consumed 1.3 m3 firewood, 13 Kg charcoal, 614 L fuel oil and 4 MWh per day which corresponds to energy consumption amount of 2 MWh/day, 108 kWh/day and 6 MWh/day respectively
Optimising Energy Pathways in the Eastern Nile Basin with Pumped Hydro Storage and Floating Solar Integration: towards Maximizing the Nexus of Water-	TUDelft (EPICAFRICA)	The Eastern Nile Basin in Africa is home to a rapidly growing population, leading to heightened competition for water resources. Over the last century, various large dams have been constructed along its rivers, with numerous large dam projects planned for the coming decades. However, the region's energy system

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Energy-Land Resources		remains underdeveloped, with low per capita electricity and clean energy consumption in upstream countries like Ethiopia. To tackle these water and energy challenges, as well as address land competition and transmission infrastructure costs, promising technologies at the water-energy-land interface, namely photovoltaic solar panels (FPV) and pumped hydro storage (PHS), are considered. We examine diverse techno- economic specifications, supply and demand dynamics, including variable renewable energy (VRE) integration, electrification of transport, residential, and cooking demands. For example, the energy demand in Ethiopia is expected to increase sevenfold with VRE expected to meet this demand; the incorporation of efficient energy storage solutions is then critical. With its established reliability, long operational life, high round- trip efficiency (80%), and stable cost trajectory, PHS is a viable option. The results demonstrate that PHS can be effectively integrated into Ethiopia's energy system under all scenarios covering Emissions Penalty, and Wind seasonality, revealing emergent diurnal and seasonal discharge patterns. Notably, incorporating PHS results in an average 10% increase in VRE capacity in 2050 compared to scenarios without storage. Pathways that include emission penalties show greater VRE penetration and electrification of residential cooking demand. By using GIS-based optimization of FPV locations within the Eastern Nile basin energy planning to 2050, we quantify the role of the technology to decrease the cost of solar integration, evaporation water losses, and land demand from energy near existing hydropower reservoirs across the basin. Through the incorporation of floating solar and pumped hydro storage technologies into the OSeMOSYS energy planning tool, we showcase their potential in achieving cost- effective integration of variable renewable energy, ultimately

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		paving the way for sustainable and resilient energy solutions in the region.
Open source Nexus modelling tools for Planning sustainable Energy Transition in Africa Energy Modelling call	SU (OnePLANET)	The ONEPLANET project, supported by the European Union, brings together African and European partners with the objective of clean energy generation and sustainable resource management while reducing socio-economic disparities. Within the LEAP-RE framework, this paper presents our research, highlighting potential synergies between ONEPLANET and LEAP-RE, and offering insights into our primary research question, methodology, and expected outcomes. In Africa, the water- energy-food (WEF) nexus is a complex interplay of factors. A substantial gap exists in comprehending this nexus in all its dimensions, including feedback loops, governance policies, and bottom-up perspectives. Our core research question, aligned with LEAP-RE's goal, asks: How can we craft a novel, context-sensitive WEF model for Africa, incorporating socio-economic dynamics and governance policies to optimise resource utilisation? ONEPLANET adheres to the LEAP-RE stakeholder engagement principles. We are developing and rigorously testing a Toolkit, grounded in established WEF Nexus models and methodologies. This Toolkit will facilitate scenario simulations, considering social, climate, economic, and biophysical constraints, thus enabling informed decisions for clean energy and resource management. Our forthcoming Knowledge Hub will be enriched with capacity-building resources and knowledge exchange activities, to empower not only our stakeholders but also those in the LEAP-RE community. While our project is ongoing, our focus on co- design and user engagement, guided by insights from local communities, promises a Toolkit customised to real-world challenges. The ONEPLANET Model, designed to incorporate feedback loops, socio-economic interconnections, and governance policies, is poised to enhance understanding of Africa's WEF nexus. This innovation will be pivotal for energy decision-makers, offering open- source tools, models, and materials that consider

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		social, economic, and environmental factors. Beyond technical advancements, ONEPLANET emphasises knowledge communities encompassing experts and future users from the EU and AU, leveraging the extensive networks of our partners, including UNESCO collaborations. By addressing gaps in WEF nexus modelling, capacity building, and stakeholder engagement, ONEPLANET commits to empowering African policymakers, researchers, investors, and citizens, aligning with the goals of LEAP-RE. Regarding the LEAP-RE Thematic Scientific Sessions, ONEPLANET's forum involvement will gather vital insights, identifying catalysts, challenges, and policy gaps for advancing WEF nexus initiatives globally and in Africa. Concise interviews and surveys will aid in this exploration among interested participants. Participating in a clustering session alongside OnePLANET sister projects focused on Energy Modelling (Workshop 1A.3) and joining a session on Renewable Energy resources, mapping, and modelling are two participation options that align with the purpose and themes of the LEAP PRE Stakeholder forum. This participation will bring together experts and prospective platform users from the EU and AU, leveraging existing networks and collaborating with institutions and organizations like Strathmore University, ECREEE, UKNZ, UNESCO initiatives, and AFRILABS.
SETadisma - Holistic Energy System modelling for minigrid planning	POLIMI (LEAP- RE)	SETadisma sets out to address the multifaceted challenges facing the African mini-grid sector, emphasizing both new (green-field) and existing (brown-field) projects that are being upgraded to incorporate renewable energy sources. The focus is on the technological advancements, energy planning, digitalization, and the crucial aspect of capacity building within the communities in Algeria, Kenya, and Rwanda. This comprehensive approach is structured around four key pillars: technological research, energy planning, digitalization, and capacity building, each playing a pivotal role in

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		the development and implementation of sustainable, efficient, and community-focused energy solutions. Throughout the SETadisma project, significant milestones were achieved across various objectives, beginning with the refinement and application of data collection methodologies, notably an additional campaign in Kenya. This project also saw the advancement of energy system modeling tools tailored for mini-grids and the initiation of a pilot Concentrated Solar Power (CSP) plant in Burkina Faso, highlighting the project's dedication to innovative energy generation technologies. Further efforts were dedicated to analyzing the current landscape and potential of digital technologies within the mini-grid sector, culminating in a comprehensive report and the organization of an Ideathon event aimed at fostering innovative solutions from the continent's youth. Additionally, the project undertook the evaluation of business, delivery, and socio-economic models to support local development, producing a detailed comparison of data from mini-grid systems in off-grid areas. Education and capacity building were also focal points, with the organization of RESchools in South Africa and plans for a subsequent event in Rwanda. These initiatives were designed to disseminate scientific findings from the project and involve postgraduate students in the research and development activities, thereby fostering a new generation of skilled professionals in the renewable energy sector The coordination and supervision of the project activities, along with the administrative and financial management and dissemination of results, were key components of the project's success during the project, ensuring the effective progression towards its overarching goals.

Table 4: Thematic Session 3 – European Projects encompassing Energy Modelling, Moderator: POLIMI, European Commission

Title of the contribution	Contributors (institutions)	Abstract

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The Geothermal Village (GV1) LEAP-RE WP11 – The Eraboru site (Afar Regional Stated Teru woreda, Ethiopia)	AGAP, Geo2D	At the foot of "Dabbahu" silicic peralkaline centre (1440m high) a wide geothermal field, named "Era'Boru (meaning "steaming crater") extends over several tens of square kilometres, in which hundreds of steam wells were engineered and are still currently operating. Fumaroles sites are numerous along the active volcanic ranges and centres as well as along faults and open fissures and have been engineered to recover water from the condensation of the steam. The device includes digging in the steam vent, removing rocks and clay that result from the alteration of the volcanic lava, allowing the steam to rise along the upper wall which is most frequently the fault plane. The branches of acacias, put over the steam vent ,will form a wet well, where steam will condensate along the branches and liquid water will fall in the impermeable basin shaped with the clay. Water is used for all kind of human consumption. These elements allow to elaborate a geothermal conceptual model supporting this exceptional field. Delayed due to the political unrest surrounding Tigray Regional State, further interdisciplinary research is now being engaged in the frame of the LEAP-RE project with the support of the community-based entity AGAP (Afar geothermal Alternative Power Cy). The paper describes the knowledge already acquired and the field and laboratory works being engaged in geosciences (IR and topographic drone survey, gas geochemistry and geophysics), social sciences and project engineering for production of both energy and water.
Geothermal Energy Communities and sustainable business model. Preliminary evidences from WP9 and WP11 activities	SSSA	Context: It is highly debated that Renewable Energy Communities-RECs, in Europe, could represent a way to promote ecological transition and be independent of the large energy suppliers. In Africa, moreover, RECs can be an epochal change in providing access to energy for all, especially in rural areas, delivering environmental and social benefits to local communities. Nevertheless, RECs, as meant in the global north, especially in Europe, are not yet a concept spread in the African context. Methodology: To explore the possibilities of their development, we

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		analyze the existing literature from 1985 to 2022 on RECs in Africa, adopting the framework from Bauwens et al. (2022), in order to identify elements of the RECs, and highlighting features of a sustainable management model. Results: The results tell us that RECs are still far to be realized in Africa, and a unique or prevalent management model is not present. Management and financial issues are under-analyzed in literature, that is focusing more on technological aspects related to decentralized renewable energies. Nevertheless, social and economic objectives are pursued and experiences of the involvement of local communities in the management do exist. Our study proposes a framework for better understanding the RECs phenomenon in Africa and future challenges and opportunities, both for further studies and for their practical development. Follow-up: Besides this desk research, we will present the preliminary results that are emerging from the field work done under WP11 Geothermal Village in two rural communities: Homa Hills (Kenya) and Lac Abbé (Djibouti).
Grid concepts for geothermal-based village energy systems	NORCE, SEPCO, Fraunhofer IEG, EHSSS, Geo2D	Baseload energy in the Geothermal Village (LEAP-RE WP11) is provided by shallow wells producing hot groundwater, as is found in hot-spring areas along the East African Rift. Wellhead temperatures 60-90°C will power drying sheds (grain, meat, timber); chillers, greenhouses; aquaculture (fish, biogas); sanitation; touristic spas; even pre-heating kilns (pottery, cement). Solar PV for pumps and controls. Above 90°C the thermal grid can power electric generation to drive the pumps, controls, lighting, refrigeration, cooking and workshops. The linked electric and thermal grids operate 24/7; capacities envisioned are several MW thermal power and several hundred kW electric power, relatively centralized. Integration with other RE is an advantage. Although smart-grid production- and load- controls are the ultimate goal for maximizing system efficiency, they must be appropriate to the economic and technological capacity of the operator:

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		fine for a technology company, whether rural or peri-urban, but where the operator is the rural community, a stepwise implementation, alongside capacity building, may better suit. Hence the energy-and- society question of what characterizes robustness in the village energy system. Smart load-management can facilitate, for example, electric cooking where electric capacity is insufficient for simultaneous use in all dwellings. An automated load control is at- the-cooker rapid time sharing. A less automated approach would be installing only communal electric cooking facilities, if socially acceptable (cook control). For refrigeration, water >60°C makes thermal cooling (e.g. adsorption) far more efficient than electro- mechanical, but would be limited to communal facilities unless hot water is available at each dwelling.
Selecting a site for a demonstration of the "Geothermal Village" concept	Geo2D and WP11	The LEAP-RE WP11 entitled "GV1" allowed to select 4 sites for in depth study of the "Geothermal Village" concept in eastern Africa, where geological conditions allow for geothermal resource found near surface. These are Homa Hills in Kenya, Mashyusa in Rwanda, EraBoru in Afar Regional Sate, Ethiopia and Abhé in Djibouti. All sites were subject to multidisciplinary studies including: geosciences, social sciences, engineering, aiming at selecting one of them for a demonstration. This implies in particular the quality of the resource, the social demand and organization on site, the technical capacity in the country, and the fulfillment of administrative conditions (leasing of the site by concerned authorities…). The quality of the resource appears quite variable. At Abhé, where numerous steam vents and thermal springs are found, we have the possibility to produce a fluid at a temperature sufficient for electricity production from an ORC, and also hot water for direct uses, as well as drinking water, highly demanded on site (desertic conditions). The same situation prevails at Homa Hills but the

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		geological conditions determine a highly salty high temperature fluid, which would raise costly productive conditions. Mashyusa site, with high flow rates but limited temperature, is suitable for a variety of direct uses but would not allow for electricity production. As a whole, the choice should also allow to demonstrate the best economic conditions, for the project construction and the resulting advantage for the population on site.

Table 5: Thematic Session 4 – Local Applications of Geothermal Energy

Title of the contribution	Contributors (institutions)	Abstract
Compositional engineering of highly emissive and widely tunable I-III- VI2 quantum dots (QDs) for photovoltaic applications	UL	Quantum dot-sensitized solar cells (QDSSCs) have emerged as candidate for the next- generation solar cells benefitting from distinct optoelectronic features of quantum dot (QD) light-harvesting materials. In QDSSCs, replacing heavy metal-based binary II-VI QDs such as PbX or CdX (X = S, Se or Te) with ternary I-III-VI2 counterparts is of high interest for environmental considerations while ensuring optimal device performance. In this context, CuInSe2 QDs are promising photon absorber for QDSSCs, due to their adequate direct band gap (Eg = 1.04 eV), large absorption coefficient, high stability and environmental-friendly composition. Our study describes an efficient and fast aqueous phase-based approach to produce bright and highly emissive core/shell CuInSe2/ZnS QDs (noted Cu-In-Zn-Se/ZnS QDs) of small size (ca. 2.20 nm). The prepared alloyed nanocrystals show wide and tunable photoluminescence (PL) emission from 618 to 765 nm by varying feed molar ratio of Cu, In and Zn precursors. The energy bandgap of the obtained QDs can also be tuned 1.73 to 2.12 eV. QDs prepared with a Zn:Cu molar ratio of 1:2 exhibit the highest PL quantum yield (54%). QDs-sensitized TiO2 electrodes were fabricated via magnetron sputtering and spin coating techniques to immobilize Cu-In-Zn- Se/ZnS QDs on TiO2. Photoelectrochemical measurements on tailored photoanodes were conducted.

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		The small and tight semi- circular shape of Nyquist plot of Cu-In-Zn-Se QDs-sensitized TiO2 compared to TiO2 electrodes indicates an improved charge transfer with minimal interfacial effects.
Design, development and functional testing of the LEDSOL disinfection unit	CIPSST SRL	In this work, we are presenting the disinfection unit of LEDSOL which is meant to provide a portable solution for producing safe water via a system based on UV/LED irradiation and powered by solar energy. Our design also considers various solutions that exist on the market for the accessories which comprise water pumps, mechanical filters and solar energy panels. Moreover, our model also takes into account the development of two systems, i.e., a laboratory prototype and a field prototype The laboratory prototype will be used to assess the performance of the UV/LED disinfection unit which we have developed within LEDSOL. For this purpose, the whole unit and its accessories need to withstand proper cleaning and disinfection between tests such as to avoid cross-contamination between experiments. For example, we have included in our design a special peristaltic water pump in which the contaminated water probe will only come in contact with a hoss made of Viton, a special material which is chemically resistant and can be disinfected with heavy solvents. The main drawback of such a pump is that it is heavy and expensive and is suitable only for laboratory testing. For the field prototype, we have considered accessories which are economically viable for our target price and users and which are also lightweight such as to ensure portability. Finally, we present here the functional tests performed for the disinfection unit and the accessories, i.e., power efficiency, flow rate, etc.
Understanding life cycle analysis for RE systems	UCLouvain	In the context of recycling end-of-life solar panels, it is key to understand the specificities and limitations of various life cycle analysis methodologies used to rationalize and optimize the process. Indeed, circular economy approaches and green manufacturing for renewable energy systems can be improved, in principle, by such software tools,

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		commercial and open-source. We have studied various life cycle analysis schemes related to processes studied in the SIREVIVAL project.
Quality of Household Electrical Appliances: A case study for Kenya	SU	The drive to improve uptake of modern cooking services is dependent on a number of socio-economic and technical factors like quality and affordability of cooking technology, availability of the fuel and other energy sources and willingness to consume. Emergence of electric cooking services promises to reduce problems related to traditional cooking technologies. However, there has been a slow uptake of these services in developing countries. The quality ecosystem of electrical cooking services is vital for diffusion of these services. This work presents results of a study to analyze the quality ecosystem of kitchen electrical appliances in Kenya. This work treated the quality ecosystem as a whole chain of activities, processes, services and stakeholders which affect the quality of cooking appliances in Kenya. Kitchen appliances on the other hand include all the electrical appliances that are used to assist the process of cooking. These included electric hotplates, EPCs? ovens, induction cookers, blenders, microwaves and coffee makers. The overall objective of this work was to map the electro-technical quality ecosystem of electrical cooking appliances in Kenya. To meet the objective of the work, two research approaches were used: qualitative and quantitative approach. The qualitative section of the work focused on published articles, key informant interviews and existing frameworks for improving the quality in the electrical cooking sector. This included review of standards, standards making procedures, enforcement and the agencies responsible. Quantitatively, the work carried out a survey of the stakeholders in the value chain of kitchen electrical appliances, to analyze the gaps and strengths in the quality ecosystem.

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Reconstructing life by improving the environment	UEM	The consequences of climate change are at our doorstep. Long periods of drought, heavy rains, violent cyclones and the spectrum of destruction of infrastructure, economies and displacement, associated with the loss of means or forms of production that include agriculture, fishing and livestock. The situation is worse in Mozambique, where for the last 48 years has been affected by floods, droughts or cyclones. The districts along the Limpopo valley in southern Mozambique are affected by a triple weather event, such that people are forced to cut down forests to earn a living. Currently, over half of Maputo city's population consumes coal from the Mabalane district. Given the nation's solar energy potential, the government has introduced measures to reduce and control deforestation and improve social conditions in communities, including solar cookers. However, eating habits, cultural significance and economic conditions pose challenges. The traditional cuisine of southern Mozambique has long cooking processes. Culturally dishes taste better when cooking in charcoal. Based on empirical evidence from my PhD training activity, bibliographical research, together with an analysis of measures aimed at introducing and massifying the use of solar cookers, this article explores the reasons behind the poor adherence to it. We affirm that existing solar cookers do not offer the conditions that communities want, in terms of time, technology and operating costs. In general, there is an urgent need to produce stoves that meet the needs and conditions of communities, given their relevance in reducing the impact of climate change and social living conditions.

Table 6: Thematic Session 5 – The Role of Technology in the Transition – Clean Cooking, Advanced Materials and LCA

As emerges from the summary, much space for scientific discussion was given to the participants both of P1 and P2. The sessions have taken place in a very satisfactory manner, with positive feedbacks received both from the presenters and the audience.

3.2.3.2 Transversal Workshops

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The transversal workshops at Kigali LRSF 2023 were planned to the scope of providing both scholars and practitioners with transversal skills within the RE sector. Three workshops, targeting precise intended learning outcomes (ILOs), were proposed by members of the consortium.

Title of the contribution	Contributors (institutions)	Abstract
Transversal workshop for business models for decentralized renewable energy	SSSA, TFE-Africa	This intervention aims to address two key projects within the LEAP-RE initiative: Geothermal Village and Geothermal Atlas of Africa. The Sant'Anna School of Advanced Studies (SSSA) is leading Task 11.2 of Geothermal Village and Task 9.3 of Geothermal Atlas of Africa, in collaboration with the University of Nairobi. To ensure comprehensive coverage, SSSA intends to gather additional information on the management of Decentralized Renewable Energies (DREs) in Africa, particularly for Task 9.3. They propose organizing an exchange of experiences among LEAP-RE partners working on management and business models. This exchange would involve partners such as Energy Village, Leopard, MG Farm, Purams, RE4AFAGRI, SOLAR INDUCE, and potentially other projects from both Pillar 1 and Pillar 2. The aim is to share relevant information and knowledge between partners. The proposed intervention consists of two steps: • The first phase will be an online meeting. The goal of this meeting will be to present each other activities (5-10 minutes per group) on the business/management research activities in the different projects, regarding business model and management in general. • A workshop in Kigali, Rwanda, where the identified solutions, challenges, drivers, barriers, and other pertinent topics can be discussed in depth. By facilitating knowledge sharing and collaboration among LEAP-RE partners, SSSA aims to enhance the understanding of effective management strategies for

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		DREs in Africa, benefiting all involved stakeholders
Workshop for scientific writing and publication processes	POLIMI	This interactive workshop delivered by POLIMI aims to provide participants with essential skills and knowledge for effective scientific dissemination and publication, based on the content delivered in the Scientific Dissemination Guidelines by WP3. Participants will explore the current practices in scientific dissemination, learn how to measure journal impact, understand journal publication guidelines, discover strategies for special issues and international conference participation, and gain insights into e-book publication guidelines. Additionally, participants will delve into the importance of scientific high-quality writing, focusing on key aspects such as clarity, organization, and effective communication. Throughout the seminar, participants will engage in discussions and activities to apply the concepts learned and foster their understanding of successful scientific dissemination practices. By the end of this workshop, participants should be able to: • Evaluate the significance of scientific dissemination and its role in advancing research and knowledge. • Apply principles of scientific high-quality writing, including clarity, organization, and effective communication of ideas. Synthesize key takeaways and best practices for successful scientific dissemination, including the importance of effective writing and adherence to publication standards.
Interactive decision-making tools and business models for electrification to smallholder agriculture through renewable energy	HEAS, TFE-Africa, IIASA	This interactive workshop brings together policy makers, renewable energy (RE) developers, farmers associations, and other stakeholders from sub-Saharan Africa to explore solutions for increasing agricultural output through RE electrification. Participants will have the opportunity to engage in discussions and

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		presentations facilitated by experts from TFE-Africa, IIASA, and HEAS. The workshop will focus on the presentation and exploration of an interactive decision-making tool and business models designed to assist stakeholders in implementing RE electrification for artificial irrigation and increased crop processing. The workshop aims to foster collaboration, knowledge sharing, and actionable plans among participants to drive sustainable agricultural development in the region.

Table 7: Summary of the Transversal Workshops

3.2.3.3 Other Events

Panel Discussions

Panel discussions featured the participation of high-level speakers and officers involved in AU EU cooperation, addressing various topics, including Research to Policy, the AU-EU Innovation agenda, and climate resilience and adaptation. These discussions served as platforms for exchanging insights and perspectives crucial for advancing renewable energy initiatives. These actively sought synergies with established groups and programs, aligning efforts with the AU-EU Innovation Agenda and the Climate Change and Sustainable Energy Partnership (CCSE). Engagement with LEAP-RE advisory board members and program beneficiaries played a pivotal role in shaping the future discussions, ensuring its relevance and effectiveness. By building on the outcomes of projects within the LEAP-RE Portfolio and fostering meaningful connections among researchers and other initiatives, the panel discussions aimed to establish a lasting endeavour dedicated to advancing renewable energy research and enhancing access to renewable energy sources.

LEAP-RE P1 kick-off event

The Forum witnessed the launch of 10 projects from the second LEAP-RE Call for Research and Innovation projects: D3T4H2S, MIDINA, OPTIMG, RCLIB, REPTES, SHE, SmartAPV-Fruit, SWITCH, BIOTHEREP and Vil2Bio. The new projects cover some of the LEAP-RE thematic priorities and MARs, including the Water-Energy-Food nexus, agrivoltaic solutions, green hydrogen, mini and micro-grids digitalization, and biomass transformation.

LEAP-RE P1 mid-term event

13 existing projects of P1 presented their mid-term results during Kigali LRSF. The projects are: SUNGARI, SOLAR INDUCE, SOCONEXGEN, PyroBioFuel, MGFarm, LEDSOL, SOLCHARGE, HyAfrica,

QDSOC, NANOSOLARCELL, OAESES, RESTART and SIREVIVAL. It must be noted that all the projects were also invited to contribute and take part to the thematic sessions, where some of them had the chance to show the preliminary results of their research to the broader audience of LEAP-RE stakeholders.

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3.2.4 Programme overview of the 2nd LEAP-RE RESchool

10/10/2023 2nd LEAP-RE RESchool Day #1

14:00 – 16:00 Renewable Resource Assessment Methods and Data Sources

16:00 – 17:00 Energy efficiency and demand side management

11/10/2023 2nd LEAP-RE RESchool Day #2

10:00 – 13:00 Bottom-up electricity demand assessment

14:00 – 17:00 Data collection, analysis and visualization

12/10/2023 2nd LEAP-RE RESchool Day #3

9:00 – 11:00 Advanced energy modelling for mini-grids pt. 1

14:15 – 15:15 Geothermal power

16:15 – 17:45 Advanced energy modelling for mini-grids pt. 2

13/10/2023 2nd LEAP-RE RESchool Day #4

9:00 – 10:45 Geothermal power, sustainability of geothermal systems and BM specificities

11:00 – 13:00 Policy and regulations

3.2.5 Contributions from the RESchool

Here follows an abstract description of the seven sessions held in the Kigali RESchool, with related submodules and learning outcomes. The sessions have been planned according to the topics of interest identified, corresponding to the priority topics of skill development within LEAP-RE. The sessions, proposed by P2 members, have been selected and structured together with LEAP-RE scientific coordination team (P3), identifying the Context, ILOs, teaching design and teaching methodologies employed and references for the students. A summary of the content of each session follows.

Renewable Resource Assessment Methods and Data Sources

Responsible: LNEG

Abstract: The first part of this session delves into solar energy resource assessment and data sources. Solar resource assessment is critical for determining the availability of solar radiation resources necessary for the development, deployment, and operation of cost-effective solar energy technologies. Participants will grasp the fundamental principles of solar radiation, including the Sun-Earth geometry, solar irradiance components, and their availability across different surfaces. Moreover, they will explore measurement equipment and associated data quality control methodologies. The session will also cover solar irradiance data sources, encompassing ground measurements, satellite information, and meteorological models. The second part focuses on wind energy resource assessment and data sources. It begins with an overview of wind characteristics and methodologies for

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wind resource assessment, primarily microscale models with a brief overview of mesoscale models. Participants will learn to perform wind resource assessments using microscale models, experimental data, and input data such as terrain and roughness maps. They will also discover the most commonly used data sources for obtaining wind data for modeling purposes. Furthermore, the session addresses environmental assessment for model input, including roughness, orography, and obstacles. The presentation will be delivered via slides, which will be accessible to participants along with recommended references for further reading to deepen their understanding. At the conclusion of the session, participants will have access to the presentation materials and recommended references to enhance their knowledge in renewable resource assessment methods and data sources. Equip participants with the tools and knowledge needed to collect accurate and reliable data.

Energy Efficiency & Demand Side Management

Responsible: PAUWES

Abstract: The potential for energy savings in Africa is substantial, with estimates ranging from 20% to 30% achievable through the implementation of energy efficiency measures. This session provides an overview of energy efficiency concepts, explores measures and technologies applicable across various sectors, and introduces participants to the energy auditing process. Structured as a 1-hour module, the session includes segments on energy efficiency fundamentals, sector-specific strategies, and auditing procedures. Utilizing visual slides and videos, the teaching methodology enhances understanding and engagement, empowering participants to grasp the importance of energy efficiency and its practical applications in Africa's energy landscape.

Bottom-up electricity demand assessment

Responsible: IIASA, POLIMI

Abstract: Planning electricity access infrastructure and allocating resources efficiently requires a careful assessment of the diverse energy needs across space, time, and sectors. Poorly representing the heterogeneity in the potential electricity demand across space, time, and energy sectors can lead to inappropriate energy planning, inaccurate energy system sizing, and misleading cost assessments. A more detailed spatio-temporal representation of the demand-side in large-scale electrification planning tools bears a potential for improving energy planning and policy. This session aims to: offering a background on electricity demand modelling in developing countries; highlighting the relevance of spatio-temporal and sectoral granularity; providing an overview and practical use cases of the M-LED (Multi-sectoral Latent Electricity Demand) geospatial data processing platform to estimate electricity demand in communities that live in energy poverty; devoting specific attention to the implications for water-energy-agriculture-development interlinkages. It will include introduction bottom-up energy demand modelling, crash course into the M-LED model and into the RE4AFAGRI dashboards. Teaching will be based on visual slides for the introduction part and on the RE4AFAGRI Github's wiki pages for the practical part, allowing students to access source code and input data to be in preparing a M-LED run.

Data Collection, Analysis and Visualization in Python (pt. 1)

This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

Responsible: SU

Abstract: This comprehensive data collection course is designed to equip participants with essential skills for effective demand side data collection in the context of rural access to electricity projects. Focusing on the significance of carrying out detailed data collection in off-grid system planning, the course draws upon insights gained from a field campaign conducted in Faza Island, Kenya in 2023. The primary emphasis lies in guiding participants through the three critical stages of the data collection process: preparation, execution, and preliminary data pre-processing for subsequent analysis.

The course unfolds with an exploration of the fundamental principles underlying demand side data collection, emphasizing its pivotal role in the success of rural electrification initiatives. Participants will gain an in-depth understanding of the unique challenges and considerations associated with gathering data for off-grid systems, setting the stage for a targeted and effective approach. The course will cover techniques for identifying and reaching remote communities, ensuring a representative sample, and overcoming logistical challenges. The course aims to equip participants with essential skills for effective demand data collection. The course will further facilitate a hands-on experience in executing the data collection process, encompassing survey design, fieldwork management, and the use of advanced technologies for efficient and accurate data gathering.

Data Collection, Analysis, and Visualization in Python (pt. 2)

Responsible: SU

Abstract: The session aims to provide participants with an introduction to Python and equip them with essential skills for data-related tasks in their research. Through a hands-on and interactive approach, participants will learn Python basics, data collection techniques, data analysis methods, and data visualization principles. They will have the opportunity to apply their knowledge to practical exercises and gain confidence in using Python for their research endeavours. By the end of the session, participants should be able to: Understand the basics of Python programming, Collect data using Python libraries and APIs, Perform data analysis tasks, including cleaning, transforming, and manipulating data, Visualize data effectively using Python libraries. The session will follow a hands- on and interactive teaching approach, allowing participants to actively engage with the material and apply concepts in practice. It will be divided into several modules, each focusing on a specific aspect of data collection, analysis, and visualization in Python. Throughout the session, participants will work on coding exercises and small projects to reinforce their understanding. The session will prioritise active learning, problem-solving, collaboration, and ongoing assessment. Participants will be presented with real-world research scenarios and problems throughout the session. They will be guided to analyse and solve these problems using Python, fostering critical thinking and problem- solving skills. Participants will be encouraged to collaborate with their peers during certain exercises and projects to promote peer-to-peer learning; allowing participants to share their insights, discuss challenges, and learn from each other's experiences. Additional resources will be provided, such as reference materials, tutorials, and online documentation, to support their continued learning beyond the session.

Advanced energy modelling for mini-grids

Responsible: POLIMI

This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

Abstract: This session introduces students to energy modelling and to the use of MicroGridsPy, an open-source optimization model for microgrid energy scaling and dispatch in remote areas. Developed by the University of Liege and POLIMI, MicroGridsPy utilizes Pyomo and features advanced capabilities such as multi-year formulation, capacity expansion planning, and multi-objective optimization. The session provides an overview on energy modelling glossary, then introduces the model's architecture and functionalities, emphasizing its application in optimizing microgrid operations in rural villages while considering techno-economic parameters and project constraints. Additionally, students engage in a hands-on exercise focused on Rutenderi village, Rwanda, using both endogenous and exogenous data to simulate real-world scenarios and explore the model's practical utility in sustainable energy development initiatives. Access to the MicroGridsPy documentation and GitHub repository facilitates further exploration and learning.

Geothermal power, sustainability of geothermal systems and BM specificities

Responsible: UNIFI

Abstract: This session delves into the study of Life Cycle Assessment (LCA) methodology as applied to geothermal power systems and other energy applications. Discussions revolve around the methodology's structure, relevant software, and databases for conducting LCA analyses. Additionally, insights into developing power plant models, data collection strategies, and interpreting results for potential improvements are presented. Further methodologies for data collection and model development are explored. Additionally, the session addresses geothermal energy and greener production opportunities, providing an overview of geothermal energy exploitation and evaluating emissions associated with geothermal fluid passing through cooling towers. Real data from sites in Italy, including Monte Amiata and Larderello, are showcased to contextualize the discussions and enhance understanding of geothermal energy applications.

Policy and Regulation

Responsible: SU

Abstract: This training aims to address the complexities of the energy market and the necessity for deliberate intervention to enhance access to affordable, reliable, and modern energy services. Participants will delve into the unique dynamics of the energy market, considering its conflicting aspects of safety, competitiveness, equity, environmental sustainability, and security of supply. Through a 3-hour module, attendees will identify the basic elements of electric energy systems, discuss the peculiarities of energy markets, and explore the interplay between competitiveness, safety, security of supply, equity, and sustainability. Furthermore, participants will gain insights into various energy policy tools and their practical applications through examples. The teaching methodology, which includes PowerPoint slides, anecdotes, and class discussions, facilitates comprehensive understanding and engagement among participants, equipping them with the knowledge and skills to navigate the complexities of the energy market and contribute to improving universal access to energy services.

3.3 Conclusion: overview on LEAP-RE state-of-art

The 2nd LRSF held in Kigali has been succesfully carried out and managed to provide a

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fruitful event for fostering collaboration between pillars and work packages.

The forum has been the occasion to share recent news from the LEAP-RE Community, including the latest results and insights from the 31 projects in our LEAP-RE Project Portfolio. The Forum witnessed the launch of 10 projects from the second LEAP-RE Call for Research and Innovation projects: D3T4H2S, MIDINA, OPTIMG, RCLIB, REPTES, SHE, SmartAPV-Fruit, SWITCH, BIOTHEREP and Vil2Bio. The new projects cover some of the LEAP-RE thematic priorities, including the Water-Energy-Food nexus, agrivoltaic solutions, green hydrogen, mini and micro-grids digitalization, and biomass transformation. Highlights from the Forum also include thematic sessions on several key topics (Minigrids and local energy systems, geothermal energy and its local applications, energy modelling, and the role of technology in the transition with a focus on clean cooking, advanced materials and LCA), and several workshops on scientific writing, business models and interactive decision-making tools. Another flagship part of the Forum was our second RESchool, which brought together some 25 students from both continents, with the aim to train tomorrow's researchers and provide them with a space to learn and share experiences together. A site visit to Anne Heyman Solar Fields, a solar plant powering the energy transition in Rwanda, was the final highlight of the forum. It was indeed a very rich and busy week for participants.

All these events, communicated through LEAP-RE platforms, have contributed to engage the consortium with the broader stakeholders of the programme. Kigali 2023 LRSF constitutes a milestone of LEAP-RE towards its end. In fact, many discussions and panels were conducted to try to understand the outreach of the programme beyond its end and boundaries, thus engaging with twin programs (OnePLANET, EPICAFRICA) and AU-EU high level stakeholders.

The main activities of Pillar 1 have led to the execution of the second round of calls for proposals which was very successful. The selected 13 projects presented mid-term satisfactory results during the forum and have received great interest from the audience. The eight Pillar 2 projects have progressed mostly along the lines of the Grant Agreement, despite some delays and deviations due to the pandemic and other geographical circumstances. The follow-up was held and technical interactions among partners fostered in the Thematic Sessions. These constitute a great outcome of the current state-of-art of the programme: beside the policy implications of LEAP-RE, the consortium is understanding and disseminating its scientific capital towards the communities of interest. In general, the consortium has shown great scientific commitment, making LEAP-RE a scientifical and technologically relevant programme. The scientific products carried out have made a significant contribution to the objectives and impacts of the LEAP-RE programme. In particular, the project has made a significant progress towards creating long-lasting R&D cooperation in the energy field between EU and AU research organisations, both applicants and funding organisations.

Overall, the progress of the activities is in line with the objectives of the project and what was foreseen in the amended grant agreement, with many P2 projects going to finalize in 2024. The work has progressed within the timeline foreseen and the results are overall well in line with the grant agreement expectations. Most deliverables have been submitted on time or with minor delays of under 3 months.

As for future forums, the suggestion is to encourage greater outreach, starting and engaging the participants on a deeper reflection on the Multi-Annual Roadmaps of the programme.

3.4 Annexes

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- Annex A: Book of Proceedings of LRSF 2023 - The Thematic Sessions of the 2nd LEAP-RE Stakeholder Forum, including the 3-pagers document that contributed to the thematic sessions, received by the editors: https://zenodo.org/records/17370476

- Presentations are not included in the annexes for brevity but available with recordings on LEAP-RE website at the page: https://www.leap-re.eu/2023/10/30/key-highlights-of-the-leap-re-stakeholder-forum-2023-in-kigali/

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4. 3rd State-of-the-Art report from the General Workshop and the RESchool in Milan

4.1 Introduction

Deliverable 4.5 (D4.5) constitutes the published record of the LEAP-RE general workshops, including abstracts of interventions or reports of papers presented by the LEAP-RE Community. The updated state-of-the-art reports of each general workshop (GW) are built on projects' activities, results, and outcomes. Three LEAP- RE State-of-the-Art reports will be produced based on the proceedings of the three LEAP-RE Stakeholder Forums (LRSF) to show the scientific ambition and achievements of the LEAP-RE programme.

This document presents the 3rd State-of-the-Art report from the General Workshop and the RESchool held in Milan, Italy, from the 8th to the 11th of October 2024.

The next section of the report will describe the events that have taken place. Then, the document summarises both the contributions of the LRSF and RESchool of Milan, after having overviewed the programmes.

The last section of the report provides conclusion and an overview on the scientific achievements, ambition and commitments of the programme, according to the state-of-art emerged in the forum.

4.2 Abstracts of the proceedings of the LRSF and RESchool

4.2.1 Summary of the events

The third LEAP-RE Stakeholder Forum took place in Milan, Italy, from 8 to 11 October 2024, across various venues at the Politecnico di Milano – Bovisa Campus. The event was held in a hybrid format and aimed to strengthen the LEAP-RE community by engaging a broad range of stakeholders and facilitating dialogue, knowledge exchange, and collaborative opportunities. The forum had several key objectives:

- Foster an international, multi-stakeholder community focused on renewable energy, science- informed policymaking, funding and research, innovation, and shared monitoring, evaluation, and learning across Africa and Europe.
- Enhance the services and functions offered by LEAP-RE and its continuity within a broader AU-EU innovation ecosystem.
- Promote synergies and cooperation with similar initiatives and research programs.

The event welcomed stakeholders engaged in African Union-European Union (AU-EU) Science, Technology, and Innovation (STI) cooperation in the renewable energy sector. Below is a summary of the main activities that took place during the Milan LRSF:

1. **Panel Discussions**, featuring high-level representatives from the AU, EU, national institutions, and academia, addressed:

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- Science Diplomacy and the AU-EU Partnership (including contributions from PAUWES, the European Commission, and Italian Ministries);
- Institutional capacity building and the role of research in the Mattei Plan;
- The Just Energy Transition "with" Africa: challenges and opportunities;
- Implementation and monitoring of the AU-EU Innovation Agenda on Green Transition;
- Mobilising stakeholders for innovation uptake in Africa.

2. **Clustering Sessions**, structured as scientific and methodological clusters and moderated by experts, showcased contributions from LEAP-RE P1 and P2 projects as well as affiliated initiatives. Topics included:

- Digital technologies, AI, and blockchain;
- Critical raw materials, end-of-life and circularity;
- Energy systems and modelling, including water-energy-food nexus;
- Local communities, capacity building, and gender in renewable energy projects.

3. **The 3rd RESchool (Renewable Energy School)** targeted PhD students, early-career researchers, and innovators. Sessions, organised as restricted trainings, covered:

- Renewable resource and demand assessment;
- Energy modelling;
- Energy technologies;
- Business models and financial modelling;
- Socio-economic impacts of energy projects.

4. **Workshops** for capacity building and twinning/teaming opportunities explored:

- AU-EU STI cooperation best practices and lessons learned;
- Green hydrogen, flexible generation, carbon capture, and renewable gases;
- Green construction and circularity;
- Experiences from LEAP-RE and synergies with LEAP-SE COFUND.

5. **LEAP-RE Pillar 1 Mid-Term Evaluation**, held on October 10, showcased presentations of project progress and results from funded projects under Pillar 1, such as BIOTHEREP, Vil2Bio, RCLIB, and others.

6. **Innovation Camp**, with dedicated sessions on innovation uptake and a demo-day pitch session featuring eight selected LEAP-RE projects (e.g., RE4AFAGRI, SolCharge, PURAMS, LEDSOL).

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7. **General Assembly (P1-P3)** and internal coordination and management meetings, including the **Kick- off of LEAP-SE COFUND** and **consultation on the long-term partnership**.

As illustrated in the programme overview, several sessions were held in parallel. Public access links were made available through the official LEAP-RE Forum webpage, while specific connection details were shared separately for restricted-access activities.

In parallel to the LRSF, the 3rd LEAP-RE RESchool was held as a structured training programme throughout the four days of the forum. Organized collaboratively by P2 and P3, the school was attended by selected PhD candidates and early-career professionals from Africa and Europe. The school supported their academic and professional development by delivering blended activities—onsite and virtual—based on the expertise of the LEAP-RE community and continuity with previous RESchool editions (notably, the 2nd edition in Kigali 2023 and 1st in Pretoria 2022). Training materials were shared prior to the event through both synchronous and asynchronous learning platforms.

The full agenda of the workshop is available here: Agenda LRSF Milano 2024

4.2.2 Programme Overview of the LRSF

08/10/2024

15:00 – 16:00 Welcoming Remarks & Keynote Speeches

16:30 – 17:30 Panel: Capacity for Science and Science Diplomacy in the AU-EU Partnership

17:30 – 18:30 Panel: Institutional Capacity Building and Research in the Mattei Plan

18:30 – 18:45 Debriefing & Launch of the Stakeholder Forum

18:30 – 20:30 Networking Aperitif

09/10/2024

9:00 – 1:00 Climate Change and Sustainable Energy Policy Conference

9:00 – 1:00 LEAP-RE 3rd RESchool Day #1

14:30 – 16:00 Innovation Camp: AU-EU Innovation Agenda Panel

14:30 – 16:00 Twinning & Teaming Workshop

14:30 – 16:00 LEAP-RE 3rd RESchool Day #1 (continued)

16:30 – 18:30 Innovation Camp: Project Pitching Session

16:30 – 18:30 LEAP-RE 3rd RESchool Day #1 (continued)

10/10/2024

9:00 – 1:00 LEAP-RE P1 Mid-Term Evaluation

9:00 – 1:00 LEAP-RE 3rd RESchool Day #2

14:30 – 18:30 Scientific & Methodological Clusters (Sessions 1–4)

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14:30 – 18:30 LEAP-SE COFUND Kick-off Meeting

11/10/2024

9:00 – 11:00 LEAP-RE General Assembly

9:00 – 11:00 LEAP-RE 3rd RESchool Day #3

11:30 – 13:00 LEAP-RE Consultation on the Long-Term Partnership

4.2.3 Contributions from the LRSF

4.2.3.1 Pitching Sessions

Moderated by PAUWES and, LGI

16:30 – 16:45 RE4AFAGRI

16:45 – 17:00 SolCharge

17:00 – 17:15 PURAMS

17:15 – 17:30 Sunsafe

17:30 – 17:45 LEDSOL

17:45 – 18:00 LEOPARD

18:00 – 18:15 SHE

18:15 – 18:30 Geothermal Atlas for Africa

4.2.3.2 LEAP-RE Pillar 1 Mid-Term Evaluation

Moderated by ANR and MESRS

9.00 – 9.05: Welcome and agenda, François Moisan, ANR, France

9.05 – 9.15: Monitoring and evaluation process, (UEFISCDI, Romania; LGI, France)

9.15 – 9.35: BIOTHEREP

9.35 – 9.55: Vil2Bio (Université de Nantes, France)

9.55 – 10.15: RCLIB (National Institute of Materials Physics, Romania)

10.15 – 10.35: REPTES (University of Cagliari, Italy)

10.35 – 10.55: SmartAPV-Fruit: (Fraunhofer Institute for Solar Energy Systems, Germany)

11.15 – 11.35: SWITCH (Technische Hochschule Ingolstadt, Germany)

11.35 – 11.55: MIDINA (Institut de Recherche en Energie Electrique Nantes Atlantique, France)

11.55 – 12.15: SHE: Dave Lello, Ekasi Energy, South Africa

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12.15 – 12.35: OPTiMG Reiner Lemoine Institut, Germany

12.35 – 12.55: D3T4H2S S VERTICAL, France

12.55 – 13.00: Conclusion and next steps (ANR, France)

4.2.3.3 Clustering Sessions

Title of the Session	Contributors (institutions and projects)	Abstract
Digital technologies, AI and Blockchain (Moderator: DSI)	UNIBO, Italy, SETADISMA AFD, France, OASES Fraunhofer, Germany, OASES CMCC, Italy RE4AFAGRI Nantes University, France, MiDiNA	The first clustering session focused on the transformative power of digital technologies in the renewable energy sector. The spotlight was on the Capacity optimization technology (and transition to renewable energy), Digital applications in the renewable energy sector and digitalization (tools and solutions), AI Integration in Renewable Energy (including automation, smart grids, smart cities). The session was dedicated to sharing experience on digital solutions developed among different LEAP-RE Pillar 1 and Pillar 2 projects and the Digital Energy Partnership (programme funded by the European Commission) aiming to support start up and utilities in innovative solutions for digitalization of energy sector. (programme funded by the European Commission) aiming to support start up and utilities in innovative solutions for digitalization of energy sector.
Critical Raw Materials, End of Life and Circularity (Moderator: SU)	STEAM Group and European Technology & Innovation Platform on Geothermal, Italy LNEG, Portugal, SETADISMA Restart Project, Morocco	This session gathered 3 speakers and a moderator to discuss the role of critical raw materials, end-of-life management, and circularity in renewable energy systems. The webinar addressed supply chain resilience, life cycle analysis, and recycling practices for technologies such as hydrogen, geothermal, solar, and wind. Emphasis was placed on circular economy principles to enhance the sustainability and long-term viability of renewable energy projects.
Energy Systems and Modelling with considerations to Water-Energy-Food	University of Energy and Natural Resources, Ghana	This session brought together 4 speakers and a moderator to discuss integrated energy systems and context- specific modelling approaches. The webinar addressed minimizing bias in energy

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Nexus (Moderator: 2iE)	University of Zagreb, Croatia, EMERGE Project KADI project: Knowledge and Climate Services from an African Observation and Data Aarhus University, Denmark RePower Project ONEPLANET Project	models, lessons from best practices, and the design of both on-grid and off-grid systems. It also highlighted the interlinkages between energy, water, and food systems, emphasizing the need for holistic, cross-sectoral planning in AU-EU cooperation.
Gender, Local Communities and Capacity Building (Moderator: Fraunhofer)	Géo2D, Geothermal Atlas for Africa (GAA) and Geothermal Village Next Energy Consumer Eurica SOLAR project: British University in Egypt Technische Universität Berlin, Germany DLR, Germany	This session gathered 5 speakers and a moderator to explore the social dimensions of renewable energy. Discussions focused on community involvement, gender equality, and capacity building as key factors in the success and sustainability of energy initiatives. The session highlighted strategies for inclusive engagement, community-led planning, and tailored training programmes, while emphasizing the importance of addressing gender-specific challenges and promoting women's empowerment in the energy sector.

Table 8 Summary of the Clustering Sessions

4.2.4 Progamme Overview of the 3rd LEAP-RE RESchool

09/10/2024 — 3rd LEAP-RE RESchool Day #1

16:30 – 17:30 Satellite data application to renewable energies assessment and validation

17:30 – 18:30 Bottom-up electricity demand modelling

10/10/2024 — 3rd LEAP-RE RESchool Day #2

9:00 – 11:00 Advanced energy modelling for mini-grids

11:30 – 13:00 Technologies for solar thermal energy

This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

11/10/2024 — 3rd LEAP-RE RESchool Day #3

9:00 – 10:00	Business models for decentralized renewable energy
10:00 – 11:00	Economic and financial modelling of an energy project
11:30 – 13:00	Socio-economic impacts on energy preferences and modelling
14:30 – 15:45	Clean cooking technologies
15:45 – 17:15	Biogas production for community development
17:15 – 18:30	Utilization of agricultural waste for biogas – Kenya's experience

4.2.5 Contributions from the RESchool

Here follows an abstract description of the five sessions, including the thematic workshop, held in the Milan RESchool, with related submodules and learning outcomes. The sessions have been planned according to the topics of interest identified, corresponding to the priority topics of skill development within LEAP-RE. The sessions, proposed by P1 and P2 members and members of EU funded partner projects, have been selected and structured together with LEAP-RE scientific coordination team (P3), identifying the Context, ILOs, teaching design and teaching methodologies employed and references for the students. A summary of the content of each session follows.

Satellite data application to renewable energies assessment and validation

Responsible: Laboratório Nacional de Energia e Geologia (LNEG), Portugal

Abstract: The solar and wind resource assessment is of utmost importance for the development of these types of renewable energy systems and require the use of experimental data. Although the development of experimental measurements campaigns is nowadays a common practice in the renewable energy sector, the associated costs are not insignificant. For planning purposes and/or studies that don't require a large detail, satellite data can be an asset and energy field. On the same way, satellites are a valuable source of information for the land occupation and orography suitable for the resource assessment models. In this sense, this session is dedicated to the identification of the satellites suitable for renewables' application, namely the introduction to the Copernicus Database, Copernicus Services for Solar (CAMS) and Wind (ERA5) data and the importance of a Reanalysis.

Bottom-up electricity demand modelling

Responsible: International Institute for Applied Systems Analysis (IIASA), Austria, and Politecnico di Milano (POLIMI), Italy

Abstract: Planning electricity access infrastructure and allocating resources efficiently requires a careful assessment of the diverse energy needs across space, time, and sectors. Poorly representing the heterogeneity in the potential electricity demand across space, time, and energy sectors can lead to inappropriate energy planning, inaccurate energy system sizing, and misleading cost assessments. A more detailed spatio-temporal representation of the demand-side in large-scale electrification planning tools bears a potential for improving energy planning and policy. This session aimed to: offering a background on electricity demand modelling in developing countries; highlighting the relevance of spatio-temporal and sectoral granularity; providing an overview and practical

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use cases of the M-LED (Multi-sectoral Latent Electricity Demand) geospatial data processing platform, as well as RAMP (Remote-Areas Multi-energy systems load Profiles) to estimate electricity demand in communities that live in energy poverty; devoting specific attention to the implications for water-energy-agriculture-development interlinkages. It included introduction bottom-up energy demand modelling, crash course into the M-LED model and into the RE4AFAGRI dashboards. Teaching is based on visual slides for the introduction part and on the RE4AFAGRI Github's wiki pages for the practical part, allowing students to access source code and input data to be in preparing a M-LED run.

Responsible: Politecnico di Milano (POLIMI), Italy

Abstract: The lesson touched on the basic principles and glossary of energy modelling, to provide the attendants with the tools to move in the complex and evolving world of energy system modelling, providing an overview of the basic mathematical principles, model categories and most relevant open-source models. The lesson closed with a specific discussion on energy modelling for minigrid sizing and analysis, through examples of state-of-the-art open-source models for optimal sizing of rural off-grid energy systems.

Renewable energy solutions for West Africa: the role of solar thermal technologies

Responsible: Institut International d'Ingénierie de l'Eau et de l'Environnement (2ie), Burkina Faso

Abstract: This lecture provided a comprehensive overview of solar thermal technologies in West Africa, with a focus on solar water heating (SWH) and concentrating solar power (CSP). We began by examining the current energy landscape in the region. Key topics included the principles, typology, and operation of non- concentrating solar power systems, thermosiphon vs. pumped systems, and global and regional trends. The lecture also covered existing systems in operation and main applications in West Africa. A historical perspective highlighted early developments since the 1960s, along with regional and national initiatives. In the context of CSP, we discussed the CSP4Africa project, which aims to develop cost-effective micro-CSP plants for rural electrification using locally sourced materials. The session explored the potential of solar thermal technologies to alleviate energy access challenges and reduce dependency on biomass and fossil fuels in the region.

A participatory community approach for the design and management of Geothermal Energy Communities in East Africa – Lessons learnt from the Geothermal Village project.

Responsible: Sant'Anna School of Advanced Studies (SSSA), Italy

Abstract: In this lecture, Fabio Iannone (SSSA) presented a participatory community approach for the design and management of Geothermal Energy Communities in East Africa, based on lessons learnt from the Geothermal Village project. Starting from a literature review and then through the focus group discussions and interviews with stakeholders in Kenya, Djibouti, Rwanda, and Ethiopia, participants learned about how to make us of qualitative methods and participatory processes to study the rural energy community design. Ideal for Ph.D. students and researchers interested in renewable energy community studies, regardless of the energy source. The cases discussed focused on geothermal energy, offering valuable insights into sustainable energy solutions in rural

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East Africa.

Economic and financial modelling of an energy project

Responsible: Cameroon Minister of Science Research and Innovation - National Technology Development Committee (CNDT-MINRESI)

Abstract: This lecture covered the criteria and tools for economic and financial evaluation of sustainable energy systems, with a focus on hydroelectric and solar mini-grids. With the aim of facilitating the work of young researchers and doctoral students in the design and evaluation of sustainable energy systems, this lecture presented an overview of economic concepts, tools and criteria generally used, cost modelling techniques and uses options that offer these criteria in the energy projects. The usual criteria and their relevance, the cost modeling techniques and applications were briefly introduced. The lecture also covered approaches to exploit these economic criteria for the evaluation and optimization of sustainable mini-grids. Some examples of studies carried out in Sub-Saharan Africa were presented, particularly on solar and hydroelectric power plants based on the activities carried out on Setadisma project. The session also explored theorical aspects of financial mechanisms applied on energy projects, currently used for energy systems in sub-Saharan Africa.

Governance and Socio-Economic Impacts on Energy Preferences and Modeling

Responsible: University of Nairobi, Kenya

Abstract: In this module, we focused to introduce the participant to critical perspective that governance and socioeconomic impacts have on energy modeling in rural-urban settings of Africa with case studies focusing on West, East, and South Africa. The social-economic aspects provide the basis for selection of energy preferences and their impact on human wellbeing and planetary health. Social factors for energy preferences are governed by availability, affordability, accessibility, and institutions for energy utilization. The lecture discussed clean energy technologies as a panacea to local employment, enhanced human and planetary health. Through this lecture, we provided an analytical tool for governance whose impacts control the economic outlook for rural-urban communities. Specifically, we focused on the governance lapses in energy modeling in considering preferences and their contribution to green energy transitions in addressing energy poverty. The nexus between policy, practice, and communities in modeling preferences that enhance environmental sustainability through renewable energy transitions that alleviate energy poverty in Africa.

4.2.5.1 Thematic Session on Bio-energy & Clean Cooking

Clean Cooking technologies - overview of the basic principles and technologies for clean cooking, configurations and materials, tests and regulations

Responsible: Laboratório Nacional de Energia e Geología (LNEG), Portugal

Abstract: In the past years, several studies have been conducted to evaluate the cooking habits in Africa, and the conclusions of these studies highlight the fact that, by 2023,

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several billion people still use highly polluting fuels to cook, which constitutes a severe public health problem and results in harm to the environment. The Sustainable Development Goal (SDG) 7 addresses this problem and calls for universal access to affordable, reliable and sustainable modern energy by 2030, including clean cooking technologies. This session addressed clean cooking technologies and made an overview of the basic principles on the sector. Also, examples of tests and an overview of the existing regulations and requirements used in this sector were presented. A demonstration of a cooker was also performed on-site.

Biogas production as part of a healthy community development (IBBK) & Utilization of Agricultural waste for Biogas Production: Kenya's Story (KIRDI)

Responsible: IBBK Fachgruppe Biogas (IBBK), Germany, and Kenya Industrial Research and Development Institute (KIRDI)

Abstract IBBK: This module focused on the services that biogas production can provide to individual households or farms as well as to larger communities. We looked at the feedstock side from sourcing to logistics and feedstock handling. Here participants learned how anaerobic digestion contributes to local waste management by channeling organic residues and side streams to the biogas system and thus relief the environment from uncontrolled waste decomposition. Beyond that we also looked into the product side of the biogas plant, where anaerobic digestion converts the feedstock into valuable biogas and organic fertiliser (digestate). We discussed options for using both products and the participants were able to take away how using biogas and digestate contributes to a healthy environment – be it in an individual household or in a larger community.

Abstract KIRDI: Kenya is committed to ensuring that its citizens enjoy access to modern bioenergy services, including 100% access to modern cooking services by 2028. To this end sustainable production and efficient use of biomass, waste to energy conversion and development of biofuels have been identified as key areas to help the county achieve this goal. Biogas technology is one key area highlighted under the Kenya's Bioenergy Strategy. This module introduced the participants with biogas ecosystem in Kenya including the policy, regulatory frameworks available as well as the success stories of how various enterprises have successfully utilized agricultural wastes for production of biogas production. The lecture also highlighted on the role of KIRDI and the current research being undertaken on utilization of various agricultural wastes as feedstock for biogas production.

4.3 Conclusions

The Milan 2024 Stakeholder Forum and 3rd RESchool marked a pivotal moment in the LEAP-RE programme, demonstrating the scientific, institutional, and strategic maturity achieved by the consortium. The events brought together researchers, policymakers, and innovation stakeholders from both Africa and Europe, reinforcing the collaborative spirit of LEAP-RE and its ambition to bridge continents through joint R&I actions in the renewable energy sector.

The clustering sessions showcased the thematic and disciplinary breadth of LEAP-RE projects, from digitalization and circularity to modeling approaches and social inclusion. The diversity of these discussions illustrates the capacity of the programme to serve as a platform for cross-sectoral innovation and knowledge sharing, increasingly aligned with the AU-EU Innovation Agenda. Notably, several LEAP-RE projects demonstrated tangible progress in their scientific outputs, technological development, and local implementation strategies, contributing to both Pillar 1 and Pillar 2 objectives.

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The 3rd RESchool further strengthened LEAP-RE's legacy of capacity building, empowering a new generation of African and European researchers. The school's training sessions, grounded in real-world project experiences and practical tools, reflect a clear commitment to long-term knowledge transfer and institutional partnership.

With most projects approaching their final year, the Forum in Milan offered a timely opportunity to take stock of LEAP-RE's scientific capital and operational achievements. The consortium is now equipped with lessons learned, strengthened partnerships, and a growing portfolio of scientific results that position it to influence future AU-EU collaboration in energy research. The upcoming final forum will provide a conclusive moment to consolidate these gains, celebrate the results, and reflect on sustainable paths forward for the partnership beyond the formal end of the programme.

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5. Conclusion

Across the three Stakeholder Forums—Pretoria (2022), Kigali (2023), and Milan (2024)—LEAP-RE has evolved from launch and coalition-building to a mature, impact-oriented platform that integrates science, capacity building, and policy dialogue between Africa and Europe.

The Pretoria Forum marked the operational take-off of the programme. Pillar 1's first call was successfully launched and its 13 projects kicked off; Pillar 2 advanced along the Grant Agreement despite pandemic-related constraints; and structured collaboration was reinforced via clustering and the inaugural RESchool. Deliverables progressed largely on schedule, signalling strong scientific commitment and early traction toward durable EU-AU R&I cooperation in renewable energy.

Kigali consolidated and broadened this momentum. The second call expanded the portfolio with 10 additional projects spanning priorities such as the water–energy–food nexus, agrivoltaics, green hydrogen, and digitalised mini-/micro-grids. Scientific dissemination deepened through thematic sessions on minigrids, geothermal, modelling, and technology roles in the transition; targeted workshops strengthened skills in scientific writing, business models, and decision-support tools. The second RESchool trained a new cohort and, together with a site visit to the Anne Heyman Solar Fields, connected learning to real-world systems. Progress remained aligned with objectives and timelines, and the consortium continued to demonstrate robust scientific output and collaboration. Looking ahead, participants called for stronger outreach and a deeper, community-wide reflection on the Multi-Annual Roadmaps (MARs).

Milan signalled programme maturity—scientific, institutional, and strategic. High-level panels on science diplomacy and the AU-EU Innovation Agenda framed LEAP-RE's role in the wider cooperation ecosystem. Clustering sessions showcased breadth across digital technologies and AI, circularity and critical materials, energy-system modelling (including WEF nexus), and community-centred dimensions such as capacity building and gender. The third RESchool focused on advanced training from resource and demand assessment to business models and socio-economic impacts, while the mid-term review of Pillar 1 and an Innovation Camp emphasised uptake and implementation pathways. With most projects entering their final stretch, Milan provided a stock-take of scientific capital, partnerships, and lessons that will shape the programme's legacy and its contribution to future AU-EU collaboration.

Cross-cutting insights.

1. **Science-to-impact pipeline**. The three Forums collectively demonstrate a functioning pipeline from competitive calls to collaborative research, demonstration, and dissemination. The growth from initial kick-offs to mid-term results and innovation pitches indicates that LEAP-RE's portfolio is not only producing peer-reviewable outputs but also maturing toward field-ready solutions and business models, particularly in minigrids, geothermal applications, clean cooking, and data-driven planning.

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2. **Capacity building as a backbone**. The RESchool series has been a consistent, practical lever for skills transfer and community formation. Its design—hands-on, model- and data-centric, and linked to live projects—has supported a new cadre of researchers and practitioners across both continents, reinforcing institutional partnerships and knowledge continuity.

3. **Policy alignment and diplomacy.** LEAP-RE has become a venue where science meets diplomacy. Through panels and coordination with AU-EU agendas, the Forums helped situate project-level outputs within policy priorities and funding dialogues, increasing the chances that results inform regulation, procurement, and programming.

4. **From themes to systems.** The clustering trajectory shows a move from discrete topics (e.g., resource assessment, individual technologies) toward integrated system perspectives (e.g., digital twins, circularity, WEF-nexus modelling, community and gender dynamics). This shift supports the translation of R&I into context-appropriate, bankable solutions.

Outstanding challenges and opportunities.

The Forums repeatedly underline the need to:

- **Widen outreach** beyond the consortium to accelerate diffusion, adoption, and scaling of results—via open events, side sessions, and partnerships with implementers and financiers.

- **Deepen MARs dialogue** with stakeholders to guide a focused final sprint, prioritising pathways with the highest development additionality and feasibility.

- **Systematise evidence for uptake,** packaging scientific outputs into decision-ready formats (guidelines, benchmark datasets, open tools, and business model playbooks) that align with regulatory and market realities surfaced in the Forums.

The road to closure—and beyond.

As the programme nears completion, LEAP-RE is positioned to conclude with a strong balance of scientific outputs, trained talent, and multi-actor alliances. The final phase should focus on: consolidating and curating the scientific corpus; strengthening open repositories, toolchains, and documentation; advancing pilots and demonstration cases toward investment readiness; and formalising bridges to AU-EU implementation mechanisms so that knowledge and communities built here continue to drive equitable, sustainable energy transitions. In doing so, LEAP-RE will leave more than a set of deliverables—it will leave a functioning cooperation architecture, a skilled cohort, and a portfolio of solutions capable of shaping policy and practice across the continent.

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