BACKGROUND DOCUMENT #4
Version 1.0

PRE-LEAP-RE

Outputs from the PRE-LEAP-RE Ecosystem Analysis – Building the PRE-LEAP-RE Research & Capacity Building Agenda

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This Background Paper is part of a series of background papers for the development of the forthcoming African- European joint programme on renewable energies – LEAP-RE. It is a document in progress, like all Background Papers, which will form the basis for the discussion with committed stakeholders, who wants to contribute to the joint programme LEAP-RE and who may want to become even a consortium member or associated partner. Feedback and suggestions for this document are welcome. The intention with the Background Papers is to foster an inclusive process as much as possible. The Background Papers series will be finalized next year after PRE-LEAP-RE #2 Strategic Workshop.

The current Background Papers:

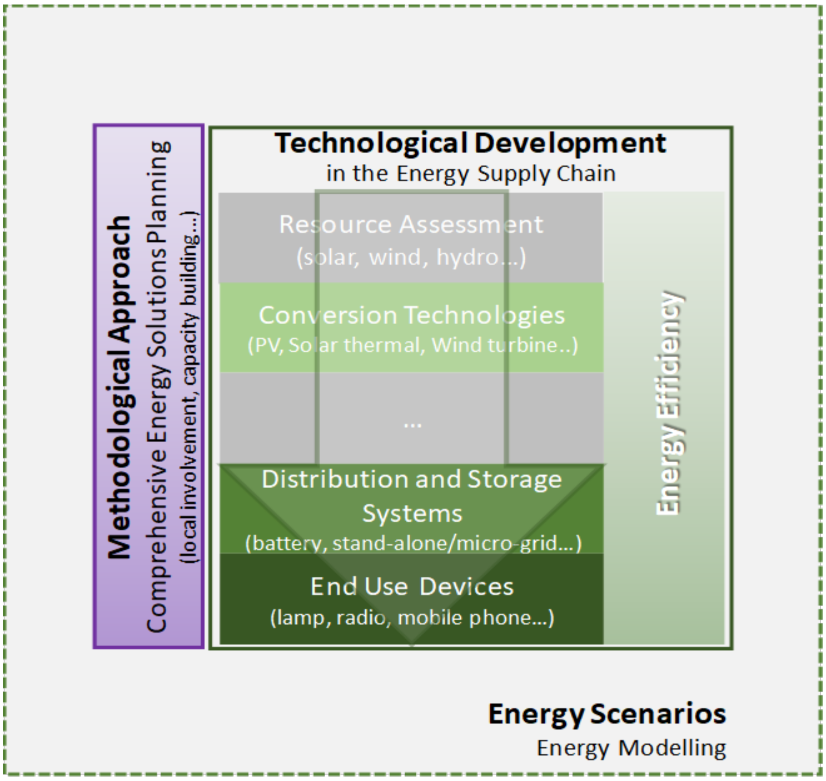
- Research & Innovation and Human & Institutional Capacity Building Agenda
- Funding Concept
- Outcomes from the PRE-LEAP-RE Ecosystem Analysis – Building the PRE-LEAP-RE Research & Capacity Building Agenda
- Management & Implementation Concept
- Private Sector Concept
- Position Paper - Open Philosophy & IRP
- Monitoring & Evaluation

Summary

Renewable energy (RE) is important in tackling the global challenge posed by climate change and providing reliable energy access to millions of people worldwide. Therefore, there is a need to increase investment in renewable energy innovation, research, human and institutional capacity in RE. In this regard, PRE-LEAP-RE is a project funded by the European Union to prepare a joint programme (LEAP-RE) in the area of RE.

This Background Paper aims to support the work undertaken by the PRE-LEAP-RE team to prepare topics for future joint action. The recommendations may be schematically offered by the infographic below, where the ***Seeds of the PRE-LEAP-RE Multidisciplinary Frame for Research and Capacity Building Agenda*** are presented and schematically described:

1) the **Technological Development** needs to be deepened along all the phases of the energy supply chain, keeping a constant eye on energy efficiency as a cross cutting issue along it.
2) Technological development cannot walk alone and concurrently a **Methodological Approach** needs to be developed in both research and capacity building mostly to guarantee long-term sustainability of energy technologies and solutions.
3) A renewed attention to **Energy Scenarios & Policy** is mandatory to understand the context where technologies and energy solutions will be developed to avoid lock in solution or unforeseeable side effects.



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1 Introduction

This Background Paper is a synthesis of the main outcome and recommendations that came from a report prepared by the PRE-LEAP-RE Consortium, which provided an overview of the initiatives and networks working on EU-AU collaboration in the RE sector. The report analysed the opportunities, gaps, and trends of this collaboration; and identified potential opportunities for cooperation. At the same time, the report aimed to help define coherence and synergy with other existing initiatives, to avoid duplication of efforts within the Europe-Africa ecosystem, and support the development of a future research, innovation, and human and institutional capacity building agenda for the forthcoming European Joint Programme (EJP) Cofund, LEAP-RE. The report is based on information given by PRE-LEAP-RE consortium members (such as main collaboration in the field of RE between Europe and Africa in the past 10 years) and relevant international literature. A summary of the main outcomes from this report is included in this paper.

1.1 Methodological approach for the Ecosystem Analysis

The analysis conducted was built in a sequential manner, with the outcomes from each analytical section supporting the analysis to be conducted in the next section. The first action aimed to undertake an identification of the major initiatives and networks, both past and present, and to compile their outcomes and recommendations. Due to the substantial volume of actors and projects in this area, the search also referred, when available, to existing studies having undertaken a similar synthesis task (i.e. the 2015 Study on Renewable Energy and Research and Innovation Capacity of Sub-Saharan Africa, produced by ECORYS).

As the main output an *Initiatives & Network Matrix* was built with 89 selected initiatives respecting given criteria like geographical relevance with African regions involvement; temporal coherence as potential synergic initiative; framework coherence as part of AU-EU cooperation programs. Data was then analysed accordingly by categories like: types of programme, kinds of actors involved, objectives, activities, project results/achievements, energy source, final energy use, comprehensive energy planning steps beyond technical sizing and nexus with other sources.

1.2 Potential for Building a Broad Partnership Network for LEAP-RE

The analysis shows that most of the initiatives are funded by the European Union, national instruments, or development banks. As the political relationship between Europe and Africa is changing from one based on the more traditional donor-recipient one, to one based on mutual interest, ownership, and design and investment, it is worthwhile to consider the opportunities for developing large-scale cooperation instruments with these principles. Encouraging the development and exploitation of synergies between European Union (EU) and African Union (AU) countries in the area of Renewable Energy (RE) is important for Africa and Europe's development.

The AU and EU countries have complementary strengths within the RE thematic area. Africa has considerable untapped potential in RE innovation, research and capacity and the EU has a host of skills and technologies to help tap into this potential. Synergy building within the AU-EU partnership in RE should operate in such a way that maximises the capabilities of both regions, and of the initiatives involved. It is within this context that PRE-LEAP-RE should organise itself in a manner that not only stimulates the AU-EU Research &Innovation and Human and Institutional Capacity Building (HICB) partnership in RE, but also proposes new forms of collaboration and funding mechanisms that will result in bi-regional ventures. Moreover, building collaboration in the area of skills and technology transfer, applied research, manufacturing and use of local technologies are areas of potential synergy in research, innovation, and human and institutional capacity.

The forthcoming partnership should be inclusive of various stakeholders including but not limited to philanthropists, public sector, small businesses, venture capitalists, and other non-traditional stakeholders. These stakeholders should be considered as potential funders of the projects, all of which might be reached through strategic synergy building. The general conception is that PRE-LEAP-RE should adopt an inclusive approach. The potential impact of this approach can lead to RE initiatives that yield practical solutions to shared RE challenges.

As per the matrix below, the Actors and Donors most frequently occurring in the analysis have been selected and reported in Table 1.

Table 1 Summary – Most Recurrent Actors and Donors

Most Frequently Occurring European Actors	Most Frequently Occurring African Actors	Most Frequently Occurring Donors*	Most Frequently Occurring European Countries	Most Frequently Occurring African Countries	Most Frequently Occurring Initiatives All-African Regions
GIZ	ECOWAS Center for Renewable Energy and Energy Efficiency (ECREE) Gender and Energy Program	African Development Bank	Germany	Kenya	Africa-EU Energy Partnership (AEEP)
Austrian Development Agency	Kenya Electricity Generating Company Limited (KenGen)	European Development Fund	France	Egypt	Africa Renewable Energy Initiative (AREI)
CEA	Common Market for Eastern and Southern Africa (COMESA)	European Investment Bank	Italy	Burkina Faso	ACP-EU Energy Facility
German Federal Ministry for Economic Cooperation and Development (BMZ)	Southern Africa Development Community (SADC)	Kreditanstalt für Wiederaufbau (KfW)	United Kingdom	South Africa	ESMAP
French Development Agency (AFD)	Alexandria University (Egypt)	French Development Agency (AFD)	Spain	Tanzania	EU Africa Infrastructure Trust Fund

** EC is not reported in this list even if it is the most present donor*

The current PRE-LEAP-RE consortium includes either directly (or is directly connected to) most of the players. Nevertheless, connections with the missing actors and countries should be developed further to ensure the footprint needed to engage in a large-scale EU-AU initiative. More direct connections with the Regional Economic Communities in Africa, and their centres for renewable energies, is important to pursue, as is partnerships with the high-level initiatives and partnerships identified in the matrix. In addition to the actors and donors mentioned in the table, a number of countries and actors in both regions have developed their interest, activity, and investment in the field. Cooperation should be sought with these emerging players and considered a priority for building the LEAP-RE partnership.

2 Recommendations for the PRE-LEAP-RE Research, Innovation, and Human and Institutional Capacity Building Agendas

As a result of the review and analysis of the existing landscape of cooperation and activities in the field of Renewable Energies, a set of suggestions were developed for research and capacity building needs in the area of technological development, methodological approaches, and energy scenarios analysis. These suggestions could serve as the basis for the further development of research, innovation, and human and institutional capacity building agendas for LEAP-RE.

2.1 Technology Development

Research on technology development for energy systems based on **renewable energy** can be confirmed, as highlighted in the High Level Policy (HLPD) Roadmap on CCSE (Climate Change and Sustainable Energy) and in the ECORYS, as one of the solutions to support Africa in the energy transition that is needed to promote leapfrogging, cost-effective, locally adaptive and sustainable energy systems. In this framework, drivers and barriers are still present for different renewable energy technologies development in Africa and requires further research. By matching the recommendations coming from the HLPD Roadmap on CCSE with the results of the PRE-LEAP-RE review, some key elements emerge and may represent the seed of the PRE-LEAP-RE Roadmap.

Solar Photovoltaics Energy and Solar Thermal Heat research is confirmed to be pivotal. Attention should be paid to lifetime, behaviour and adaptation of solar panels in extreme conditions and related maintenance and energy storage systems. Furthermore, photovoltaic systems for agriculture, mining operations, environmental applications, solar heating & cooling, and concentrated solar power should be taken into consideration for research purposes. Indeed, the majority of the initiatives within the PRE-LEAP-RE review are related to solar energy for its potential as source for both electricity and thermal heat.

This is confirmed by the fact that 50% of the initiatives collected in the matrix were reported to have focused on solar technologies for electricity generation (i.e. PV technology). The growing interest in some areas on solar thermal is recent. This predominance, despite the relatively higher cost of PV compared to the other alternatives, is mainly linked to the global diffusion in the continent of solar radiation, which makes it a reliable source of energy.

Wind Power Research is also recognized as crucial, with 25% of the initiatives mapped in the present study including wind power. Particular attention should be paid on the development of decentralised generation and stand-alone systems, including energy storage. Furthermore, additional research needs to be carried out in fields that go beyond the technological aspects, as will be better addressed in the next paragraph.

Hydro Power is the cheapest resource that may be used for power production, despite the competition over water and the transboundary problems in managing the water basin, which has led to privileging small-hydro power run of river solutions rather than big dams. Despite this, less than 20% of the initiatives are devoted to hydro power, the HLPD Roadmap on CCSE and ECORYS study, as well as the Agenda 2063 of the Africa Union, confirm that this is a space where research and innovation should keep on working in terms of choice of technologies and configurations which need to be adapted to local conditions.

Geothermal energy is characterised by large-scale activities, which make the implementation complex and dependant on local policy and governmental actions and funds. In terms of research, the many issues related to geothermal exploitation are a fruitful area for future cooperation, and particularly exploring the environmental implication in areas with existing potential for geothermal activities. Some attention should also be given to geothermal cooling with special reference to food and beverage.

Bioenergy is used both for power generation, in the case of big size power plants, and also for domestic needs, such as for cooking. Both aspects need to be deepened in terms of research and innovation: mainly on the sustainability of the supply chain and adaptation to local context through the introduction of new fuels from urban solid waste, agri-food processes and combustion chamber design, improved cookstoves and other alternatives to traditional and unhealthy domestic cooking systems. Attention must always be paid to the competition between bioenergy and food needs when dealing within the sector.

Few initiatives are dedicated to **marine energy** where research is still needed at the level of Resource Assessment, site localization and exploitation.

Looking at technology development within the **energy supply chain**, from the perspective of single source renewable energy systems, it also becomes evident that efforts need to be mostly focused on Conversion Technologies and End Use Devices.

Resource Assessment is still crucial for marine energy and for a full assessment of the mini-hydro potential.

Distribution is an important area for research and innovation when dealing with integration of renewables via smart **hybrid mini grid**, either in their **off-grid configuration** or when considering their long-term **integration within the national grid**. This is one of the most attractive areas of research where leapfrogging can be done by leveraging innovation with the **digital revolution** that is currently taking place in the continent.

Indeed, from the PRE-LEAP-RE review, an emerging interest in **resource integration** is envisaged in line with the HLPD Roadmap on CCSE and other grey literature from reference institutions[1,2,3]. Roughly 15% of the projects are dealing with "All Renewables" thus it is clear that more research efforts should be placed on the effective integration of different sources in a way that could lead to overall grid stability, cost saving, technological advantages (reduce use and better life time for batteries), and non-technological opportunities (like local job creation and better exploitation of resources).

There is an urgent need for more R&I for **storage systems** and alternative solutions to traditional backup diesel generators (like CSP/biomass hybrids with high temperature thermal storage, stationary fuel cell etc.), as evidenced by the discovery that more than 95% of the projects involving "All Renewables" are indeed testing distribution systems (the remaining being associated to stand alone devices): half in mini-grids and half in grid-connected configurations, as reported in Fig.2.

From the HLPD Roadmap on CCSE, it is clear that renewable energy and technological development need to go side-by-side with **energy efficiency** as a cost-effective strategy for the energy transition that is needed to promote prosperity in Africa.

As stated by the AEEP: "*enhancing energy efficiency in Africa plays a crucial role and induces high impact opportunities, providing the same economic services with a reduced consumption of primary energy, or more services with the same consumption of primary energy. Indeed, the International Energy Agency (IEA) recognizes the twofold role of energy efficiency: first, it is a key to ensure a safe, reliable, affordable and sustainable energy system for the future; secondly, it can be seen as one type energy resource that every country possesses in abundance, and it is the fastest and probably least cost way of addressing energy security, environmental and economic challenges…*"

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[1] http://www.euei-pdf.org/sites/default/files/field_publication_file/annex_5_aeep_mapping_of_energy_initiatives_overview_of_initiatives_0.pdf

[2] http://www.euei-pdf.org/sites/default/files/field_publication_file/mapping_of_initiatives_final_report_may_2016.pdf

[3] http://www.irena.org/DocumentDownloads/Publications/IRENA_Africa_2030_REmap_2015_low-res.pdf

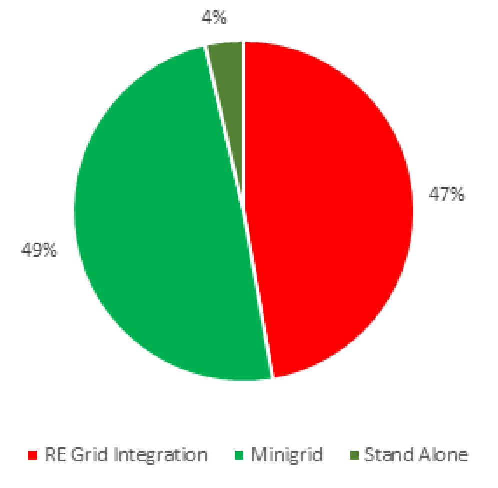

Figure 1 RE Grid Integration, Mini-grid and Stand-alone solutions share

Nevertheless, less than 10% of the initiatives analysed involve, partially or fully, energy efficiency with an equal distribution between Demand Side Efficiency and Supply Side Efficiency. This reduced attention is a recognised gap that needs to be further supported in any future Roadmap, as also concluded by the AEEP report on Energy Efficiency in Africa[4]

Technology development with specific reference to integration of different sources for off-grid or on-grid solutions, heat applications (process heat, cooling etc.) as well as energy efficiency are areas where **capacity building** and **local empowerment** need to be designed in order to create the enabling environment to promote more long term and equitable native innovation.

2.2 Methodological Approach

Besides the well-recognized importance of technological aspects described above, another crucial aspect is related to the **methodological approach** that needs to be investigated in research and innovation projects. The approach widens from the evaluation for the *needs*, that are at the base of any load curve creation, to the analysis of the *expected impact*. Indeed, technology development and design need to be completed by a more **comprehensive design,** which includes society, market evaluation, business models for long-term sustainability as well as impact on development. This approach is strongly needed to guarantee the long-term social, economic and environmental sustainability of the technologies developed in research and innovation projects as well underlined by the HLPD Roadmap on CCSE for R&I in the renewable sector.

The need for more research and innovation with the frame of **comprehensive energy solutions planning** is also evidenced in the ECORYS study, where economic, social and environmental impacts of RET uptake is analysed concluding that renewable energy in itself is not necessarily positive or negative for the economy, society and environment of the specific context, but it depends on how the energy technology is designed, built, operated, financed and maintained (e.g. thorough project preparation, solid business models, engagement of local expertise and population, etc.). The study also shows evidence of a current gap in the impact assessment work related to RE technology deployment.

The aspects highlighted in the HLPD Roadmap on CCSE and ECORYS studies are confirmed by the PRE-LEAP-RE review. The gap evidenced by ECORYS is confirmed by the number of projects where a

[4] AFRICA-EU ENERGY PARTNERSHIP, Enhancing energy efficiency in Africa, AEEP Energy Efficiency Workstream, Final report, **ISBN** 9788894122657, 2018

methodological approach beyond technological development is not applied at all (approx. 20% of the projects). On the other hand, it can be positively observed that when the project goes beyond the technological development, it includes almost all the steps that are relevant for the Comprehensive Energy Solutions Planning. This can be therefore formalised with further dedicated methodological research confirming the importance given to the inclusion of non-pure technological aspects in the analysis and application of the energy systems to ensure their long-term sustainability in both research and innovation projects.

It is also evident, as underlined by ESAMP in the special feature report of the Sustainable Energy Annual Report[5] (2017), that multidisciplinary and holistic **capacity building** is strongly needed for promoting innovation with the frame of the Comprehensive Energy Solution Planning: cross fertilisation among disciplines and competences may increase the chance of breakthrough innovation even along non-technological pathways.

2.3 Energy Scenarios and Policy Analysis

The Technological Development and Methodological Approach described above must be included in a more general framework directly related to the capacity of understanding and designing energy scenarios at the local, country, and global levels. Middle and long-term sustainability of energy scenarios, as well as the assessment of the needs and potential resources at country or regional levels is also needed to be able to understand the potential implication of technology or energy solutions with the local boundary conditions (economic, environmental and even cultural).

There is a strong need for supporting further research and capacity building on **Energy Scenario Analysis**, which include all modelling approaches and tools aimed to support policy and decision makers to build a long-term plan for energy systems development at the country level.

Specifically, the HLPD Roadmap on CCSE indicates the development of models and tools in order to achieve a systemic view on energy demand, energy access, energy security and sustainability is one of the five main action fields. This is also confirmed by the fact that the UN system[6] and the IEA are approaching and promoting a new programme for research and capacity building on energy scenario and modelling as a fundamental element at the country level to set up technological roadmap and energy solutions trends.

The importance of this aspect, even if well-recognized in the main objectives of most of the *Mapping Report* and *High Level Initiatives* analysed in the present PRE-LEAP-RE review, is not converted into specific studies and analysis. The aspect is present as the main activities in a very limited number of analysed Initiatives (less than 8% of the total) evidencing a potential gap in the present *Research & Innovation Initiatives*, thus giving some space for further research cooperation between AU-EU.

2.4 PRE-LEAP-RE infographic as input for building agendas

The final aim of this section is to support the work undertaken by the PRE-LEAP-RE team to prepare topics for future joint action. It is important to note that this table should be seen only as a guide for further action – ultimately the definition of a research, innovation, and human and institutional capacity building agenda is dependent on numerous factors, including the interest of funding parties. In order to give a structured vision to these recommendations the PRE-LEAP-RE consortium offers an infographic reported in Figure 3 ***Seeds of the PRE-LEAP-RE Multidisciplinary Frame for Research and Capacity Building Agenda*,** which is explained below.

[5] Colombo, Emanuela; Mattarolo, Lorenzo; Politecnico di Milano; Bologna, Stefano; Masera, Diego. 2017. The Power of Human Capital Multi-Level Capacity Building for Energy Access. State of Electricity Access Report. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/104731494940162971/The-power-of-human-capital-multi-level-capacity-building-for-energy-access

[6] https://un-modelling.github.io/modelling-tools/#energy-systems

1) The **Technological Development** needs to be deepened along all the phases of the energy supply chain, keeping a constant eye on **energy efficiency** and **quality assurance** as cross cutting issues.
2) Technological development cannot walk alone and concurrently a **Methodological Approach** needs to be developed in both research and capacity building mostly to guarantee long-term sustainability of energy technologies and solutions.
3) A renewed attention to **Energy Scenarios & Policy** is mandatory to understand the context where technologies and energy solutions will be developed to avoid lock in solution or unforeseeable side effects.

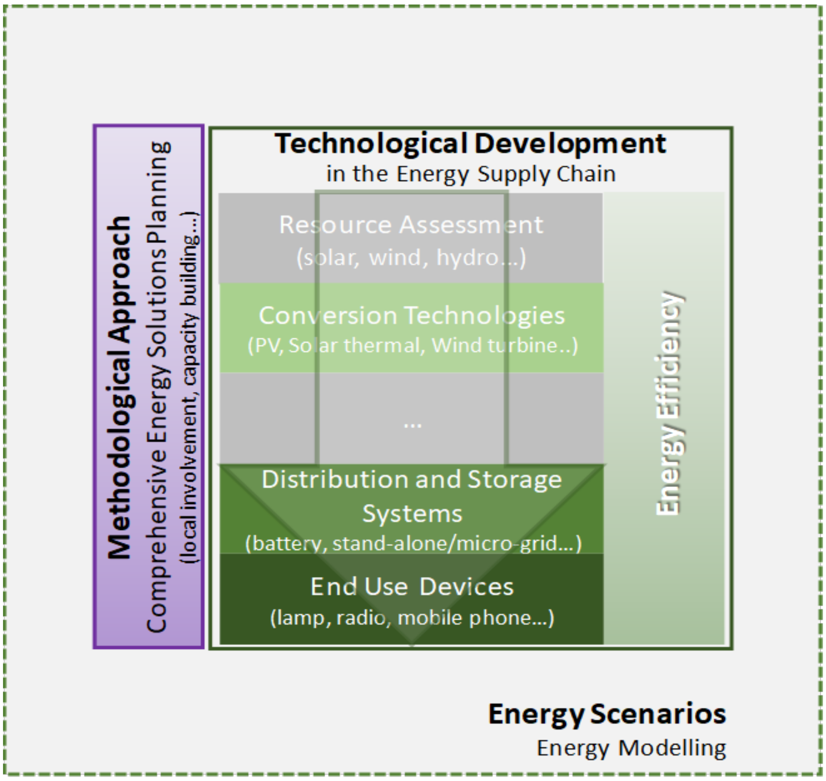

Figure 2 Seeds of the PRE-LEAP-RE Multidisciplinary Frame for Research and Capacity Building Agenda.

In this picture, the **technological development** that is needed within the **energy supply chain** is underlined with most of the attention dedicated to Conversion Technologies and End Uses Devices and to energy efficiency as a backbone of the overall chain. Aside from Technological development, as reported in the HLPD Roadmap on CCSE, ECORYS and within the most relevant grey and scientific literature on renewable energy penetration, there is need to couple technological development with a more structured **comprehensive energy solutions planning** methodology. The methodology is activated by <u>needs assessment</u>, including business model definition for technology sustainability and <u>impact evaluation,</u> which is strongly envisaged and suggests a more **multidisciplinary approach** to energy research and innovation.

This is consequently linked to the urgency of promoting a new asset of capacity and competence for local empowerment and ownership, which are needed in both the AU and EU. Technology development and the **multidisciplinary approach** need to be developed within a frame where research is also made in order to understand the potential and feasible **energy scenarios** that may be developed in a country or region to promote technological innovation that complies with local endowment, contains support for **policy makers,** and enables prosperity at local level, both for people and the planet as anticipated within Agenda 2030 and the Agenda 2063.

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