LEAP-RE

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

OASES

Part of the LEAP-RE Programme

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Development and Demonstration of a Sustainable Open Access AU-EU Ecosystem for Energy System Modelling: Open-Source and Data Strategy Report

Version 1.0

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Abbreviations and Acronyms

Acronym	Description
AU	African Union
DOI	Digital Object Identifier
EU	European Union
LEAP-RE	Long-Term Joint EU-AU Research and Innovation Partnership on RE
OASES	Open Access AU-EU Ecosystem for Energy System Modelling
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Source
WP	Work Package

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Summary

This report provides a comprehensive overview of the strategies and implementations used by the OASES consortium to ensure the transparency, accessibility, and effective dissemination of its results within the African-European renewable energy community. As part of the LEAP-RE initiative, the project focuses on the development of a sustainable AU-EU ecosystem using open-source software and data strategies, fostering long-term collaboration in energy systems modelling between African and European partners.

The main objectives of this project include the dissemination of project results through various open-source platforms and the creation of a comprehensive model chain for renewable energy (RE) system detection, time series generation and energy system modelling. The measures taken to achieve it are described in detail in the following report.

Open-Source data and dissemination

To promote transparency and foster collaboration, the OASES consortium utilizes several platforms to disseminate its data and results:

- GitHub: The project's source codes and scripts are systematically organized and published on GitHub. This platform facilitates collaboration between developers, researchers, and other stakeholders and ensures that all project developments are transparent and accessible for real-time updates and peer reviews.

- Zenodo: In addition to GitHub, Zenodo is used to archive and distribute important datasets, models, and other project results. Zenodo, a general-purpose open repository developed under the European OpenAIRE program and operated by CERN, allows researchers to deposit research papers, datasets, research software, reports, and other research-related digital artifacts. Zenodo's secure and reliable infrastructure ensures long-term access and citation. Participation in the Zenodo LEAP-RE community extends the reach of the project and connects it to a wider network of renewable energy research initiatives.

- LEAP-RE platform and newsletter: The LEAP-RE platform serves as a central hub for the African-European energy community, where project news and updates are regularly shared. This platform fosters connections, facilitates collaboration, and promotes mutual learning among members. In addition, the LEAP-RE newsletter is an important channel to promote the progress and achievements of the project and to reach a wide audience in the renewable energy sector.

- Partner websites: Dedicated project pages on the websites of the OASES project partners (Fraunhofer IEE, University of Kassel and VTT) provide important entry points into the thematic landscape of the project. These pages ensure visibility and accessibility, direct visitors to key resources and increase the impact of the project.

- Additional outreach activities: The OASES project organizes and participates in workshops, actively contributes to the LEAP-RE Stakeholder Forum, and presents at international scientific conferences. These activities aim to share knowledge, foster collaboration, and promote innovative solutions within the African-European energy community. By engaging directly with stakeholders and the scientific community, the project enhances its visibility, receives valuable feedback, and contributes to the global dialogue on sustainable energy.

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Model Chain

An important outcome of the OASES project is the development of a comprehensive model chain to support renewable energy systems in Africa and Europe. This model chain consists of the following components:

- Renewable Energy Source (RES) detection: the generation of open data on currently installed renewable energy systems. This is crucial for accurate resource assessment.
- Time series generation of energy data: The generation of high-resolution wind and photovoltaic (PV) energy time series data with a spatial resolution of at least 1 km x 1 km and a temporal resolution of at least 1 hour. This data is standardized for integration into the IRENA FlexTool.
- Modelling of energy systems: The IRENA FlexTool is chosen for modelling energy scenarios as it provides an accessible workflow that is applicable at local, national, regional, and continental scales. Six case studies are developed and documented, demonstrating the tool's adaptability and utility in different contexts in Africa and Europe.

Conclusion

This report highlights the findings in the overall context of the OASES project and illustrates how the use of open-source platforms and tools has enabled effective dissemination and collaboration. By ensuring that all data, models, and tools are accessible and transparent, the project not only contributes significantly to the advancement of renewable energy research, but also sets a standard for best practice in open science. The comprehensive modelling chain developed by the consortium, combined with strategic dissemination efforts, strengthens the project's role as a key player in promoting sustainable energy solutions within the African-European energy community.

Keywords

LEAP-RE, Open-Source, AU-EU Collaboration, Data Dissemination, Energy System Modelling, Energy Scenarios, IRENA FlexTool, Renewable Energy Sources, Renewable Energy Potential, Time Series Generation, RES Detection, Zenodo, GitHub

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1. Introduction

One of the main objectives of OASES project is to develop and demonstrate a sustainable AU-EU ecosystem utilizing established open-source software and open data strategies and ensure accessibility and transparency. The concepts of open data and open-source underpin the capacity-building initiatives. The goal is that both European and African partners can run the models on their own including Renewable Energy Sources (RES) detection, resource assessment, spatial distribution of RES, time series generation and scenario analysis. The adoption of open-source principles aims to foster long-term collaboration between African Union (AU) and European Union (EU) countries, leading to future joint efforts in energy system modelling.

As the OASES consortium, we are fully dedicated to the goals stated above. As scientists and individuals, we are dedicated to advancing open-source software and open data as key pillars of our project. We believe that this approach empowers AU and EU stakeholders to independently utilize tools for Renewable Energy Sources (RES) detection and analysis, supporting long-term joint efforts in energy system modelling. The publication of our comprehensive model chain and data demonstrates our commitment to transparency, sustainability, and future cooperation beyond the project's lifespan.

Accordingly, we want to ensure that all source code, data, and the complete model chain created within the OASES project are accessible to everyone. The comprehensive model chain and data from Work Package (WP) 2: "*Detection of renewable energy sources based on Earth observations*", WP3: "*Generation of time series for renewable energy sources*", WP4: "*Modelling of energy systems for different spatial scales*" and WP5: "*Dissemination, demonstration and capacity building*" will be published in compliance with this long-term strategy so that they can be fully used by all interested parties. This deliverable is part of Task 5.2 "*Open-source data and software dissemination"* and delivers a sustainable open-source and open-data strategy that is used to publish the project results.

2. Open-Source and Data Dissemination

Within the OASES project, open-source data and effective dissemination are key to ensuring transparency, accessibility, and collaboration within the African-European energy community. By utilizing platforms such as GitHub, Zenodo, the LEAP-RE platform and partner websites, the project has made great strides in making its results and resources accessible to a wide audience. The following section describes the various methods and tools used to share project progress, achievements, and data to foster a collaborative environment that favours innovation and continuous improvement.

2.1 GitHub

To ensure the transparency and accessibility of the OASES project results, relevant source codes, scripts, and documentation are systematically organized and published on GitHub. These resources will remain accessible to the global community even after the project concludes, ensuring their sustainable use and further development.

The use of GitHub not only democratises access to project resources, but also facilitates a continuous cycle of feedback and improvement through a diverse user community. This platform enables developers, researchers, and other stakeholders to collaborate, contribute and utilise the available resources. By applying open-source principles on GitHub, all project developments are transparent, enabling real-time updates and peer reviews. This commitment to openness not only increases the validity and reliability of results, but also fosters a collaborative environment in which innovation can thrive.

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The GitHub repository includes:

- Source code: All scripts and programs used in the project, from data collection to analysis and visualization.
- Documentation: Detailed instructions for setting up environments, running scripts and interpreting the results. This includes comprehensive README files and separate instructions for each major component of the project.
- Issues and Contributions: An area where users can report issues, request features, and contribute to the project by submitting pull requests. This collaborative approach ensures that the project can evolve and improve over time.

Links to the repositories:

IRENA FlexTool
https://github.com/irena-flextool/flextool

IRENA FlexTool Documentation
https://irena-flextool.github.io/flextool/

Multi-Resolution Segmentation of Solar Photovoltaic Systems Using Deep Learning
https://github.com/Kleebaue/multi-resolution-pv-system-segmentation

2.2 Zenodo

In addition to the GitHub repository, the OASES project has also utilised Zenodo for archiving and disseminating important datasets, models, and other results. Zenodo is an established platform for preserving and sharing research results, ensuring long-term access and citation. It provides a secure and reliable repository for research as it stores data securely at CERN's data centre. Trusted and operated by CERN and OpenAIRE, it supports the principles of Open Science, enabling researchers worldwide to participate and contribute. Each upload is assigned a Digital Object Identifier (DOI), which makes it citable and traceable, increasing the visibility and credibility of research. In addition, Zenodo offers flexible access options that allow open sharing of data.

By participating in Zenodo's LEAP-RE Community, the OASES project joins a larger collaborative project that already brings together over 30 different pieces of work from different projects and promotes a synergistic approach to renewable energy research.

The OASES project benefits from Zenodo's robust and reliable infrastructure, which ensures the longevity and accessibility of our research results, as well as from the network of the LEAP-RE community on Zenodo, which increases the reach of the research work and thus represents an important multiplier. In addition, the integration with GitHub facilitates the seamless preservation of our repositories, while the ability to version datasets ensures that the most up-to-date data is always available. Usage statistics provide valuable insights into how often the research is accessed and by whom, helping to measure its impact.

These resources are freely available for download to promote transparency and enable other researchers to build upon the work conducted within the OASES project. Although not all the OASES project's outputs are available on Zenodo at the time of this report's publication, the following overview offers an initial point of access to the platform.

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- Main entry point for the LEAP-RE community on Zenodo https://zenodo.org/communities/leap-re/

- Publication explaining workflow to train models for PV-Segmentation: "Multi-Resolution Segmentation of Solar Photovoltaic Systems Using Deep Learning" https://zenodo.org/records/10361245

- Model for PV-Segmentation: "Multi-Resolution Segmentation of Solar Photovoltaic Systems Using Deep Learning - DeepLabV3 ResNet101 Model" https://zenodo.org/records/10036926

2.3 LEAP-RE Platform

The LEAP-RE platform (https://leap-re.app) is the online hub for the African-European energy community. It provides a safe space for initiatives, projects, organisations, and individuals who are pioneers in the field of renewable energy. The portal was set up as part of the LEAP-RE programme. Its main objective is to foster connections, facilitate co-operation and promote mutual learning among members of the African-European Energy Community, with a focus on sustainability and renewable energy.

A key feature of the LEAP-RE platform is the ability to share project news directly with the LEAP-RE community, allowing for immediate updates and engagement. The platform enhances connections between AU-EU renewable energy practitioners and creates a dynamic environment for the exchange of ideas and experiences. Users can share knowledge, collaborate on common opportunities, and participate in discussions that move the community forward. The portal also serves as a central hub for accessing information and data on the projects in the LEAP-RE portfolio. Members can participate in forums, virtual meetings and events and join groups to overcome geographical barriers and foster a sense of community and solidarity. This comprehensive approach ensures that the platform not only connects people, but also facilitates meaningful interactions and partnerships in the renewable energy sector. As part of the OASES project, progress and interim results were shared with the community multiple times via the app to ensure active engagement and feedback.

2.4 LEAP-RE Newsletter

The LEAP-RE Newsletter serves as a vital channel for promoting the work, progress, and achievements of the projects within its portfolio. Featuring our project in the newsletter provides an excellent opportunity to showcase the accomplishments made so far to a wide audience. The information submitted will be published as news articles on the OASES project page and will be found on the LEAP-RE website, in the news section of the website, in the newsletter itself, and across LEAP-RE's social media platforms. This extensive dissemination helps increase visibility, engagement, and recognition of the project's efforts within the broader renewable energy community.

The following overview summarizes the various contributions made by the OASES project and provides links to the respective newsletters:

- **Towards a Carbon-Neutral Electrification of Africa**: This article discusses the overarching goals and initial steps taken by the OASES project to achieve carbon-neutral electrification across Africa. https://www.leap-re.eu/2022/09/05/oases-towards-a-carbon-neutral-electrification-of-africa/

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- **Latest Achievements and Progress**: This update highlights the significant milestones and progress made by the OASES project as of March 2023. https://www.leap-re.eu/2023/03/23/oases-latest-achievments-and-progress/

- **Downscaling Climate Data to Upscale Climate Action**: This article details the project's efforts in downscaling climate data to enhance climate action and support decision-making processes. https://www.leap-re.eu/2023/12/07/oases-downscaling-climate-data-to-upscale-climate-action/

- **Solar Photovoltaic System Segmentation Research Results Published**: This publication shares the findings of the research on solar photovoltaic system segmentation, contributing valuable insights to the field. https://www.leap-re.eu/2024/02/23/oases-solar-photovoltaic-system-segmentation-research-results-published/

- **Improved IRENA FlexTool Offers Easy-Access Energy System Modelling in Africa and Beyond**: This article introduces the enhancements made to the IRENA FlexTool, facilitating easier and more accessible energy system modelling for users in Africa and globally. https://www.leap-re.eu/2024/07/03/oases-improved-irena-flextool-offers-easy-access-energy-system-modelling-in-africa-and-beyond/

These articles not only highlight the OASES project's advancements but also provide a platform for sharing knowledge and engaging with a broader audience through the LEAP-RE Newsletter.

2.5 Own Webpages

Lastly, the partners of the OASES project have each created dedicated pages on their respective websites to describe the project. These pages serve as essential entry points into the project's thematic landscape, ensuring that visitors are directed to the previously mentioned central sites. The following overview provides a summary of these partner project pages:

- **Fraunhofer IEE**: This page offers a comprehensive overview of the OASES project, highlighting its objectives and achievements. https://www.iee.fraunhofer.de/en/research_projects/search/2022/oases.html

- **University of Kassel**: This page provides a general description of the OASES project, detailing its research activities and contributions. https://www.uni-kassel.de/eecs/en/e2n/our-research/projects

- **VTT**: This page outlines the development and demonstration of a sustainable open-access AU-EU ecosystem as part of the OASES project. https://cris.vtt.fi/en/projects/development-and-demonstration-of-a-sustainable-open-access-au-eu-

These online platforms are crucial for disseminating information and maintaining transparency, with links to the central resources to ensure comprehensive access to all relevant project details.

2.6 Additional outreach activities

In addition to the dissemination activities described above, the OASES project has undertaken various outreach activities to increase visibility, promote collaboration and

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share knowledge within the project consortium and the African-European energy community. These activities include:

- Workshops: The project team organises and participates in several workshops to share knowledge, discuss challenges, and find innovative solutions in the field of renewable energy. These workshops provide a platform for interactive learning where project results and methods are shared with both academic and societal stakeholders.

- LEAP-RE Stakeholder Forum: The OASES project repeatedly makes active contributions to the LEAP-RE Stakeholder Forum, an important event that brings together experts, policy makers and practitioners from both continents. This forum is an important venue to share insights from the project, receive feedback and engage in high-level discussions on the future of energy in Africa and Europe.

- Scientific conferences: Participation in international conferences has been a key strategy to disseminate the results of the OASES project to a wider audience. Presentations at these conferences focus on technical aspects of the project. These events not only raise the profile of the project, but also create an exchange within the scientific community.

Through these diverse efforts, the OASES project has contributed significantly to the global dialogue on sustainable energy and ensured that its findings and innovations reach a broad and influential audience.

3. Model Chain

We have developed a tool chain to create an open dataset of time series for wind power and photovoltaic (PV), with spatial resolution of at least 1 km by 1 km and temporal resolution of at least 1 hour, for potential RES sites in Africa and Europe. This tool chain can be used for creating realistic time series for both existing and future wind and PV installations. The format of the generated timeseries is standardized for integration into the IRENA FlexTool.

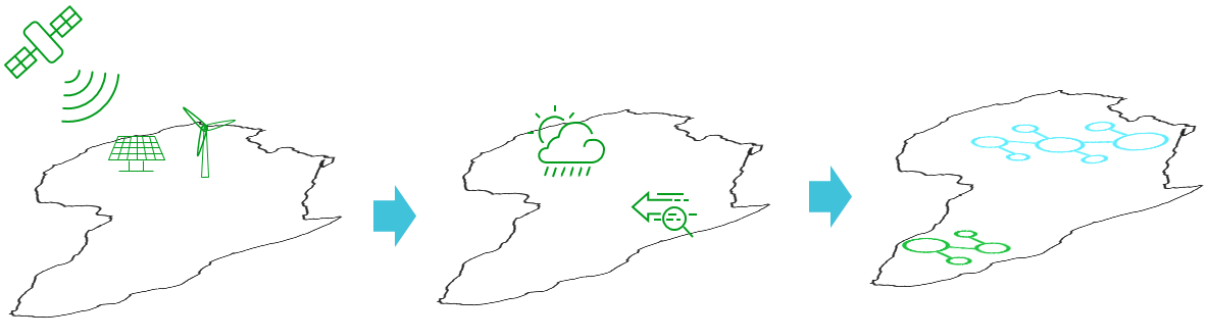

Fig. 1: The three steps of the modelling chain are illustrated. The process starts with renewable energy detection, where data on already installed renewable energy systems from different sources is collected and aggregated. The next step is the generation of time series, where high-resolution temporal datasets for wind and PV are created, enabling accurate simulations of both current and potential future energy yields. Finally, the energy scenario modelling workflow integrates these time series into comprehensive energy models that enable scenario analysis at local, national, regional, and continental levels using tools such as the IRENA FlexTool. This workflow facilitates informed decision-making and strategic planning for sustainable energy solutions.

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3.1 RES Detection

To create datasets that aggregate already installed renewable energy systems in relevant study areas, a variety of approaches are available. Users can, for instance, leverage existing datasets from sources such as IRENA, OpenStreetMap, or national energy operators before utilizing the energy system modelling workflows. When it comes to estimating the capacity of PV installations, the project-developed workflows for PV system segmentation and subsequent capacity estimation based on the spatial extent can be utilized. As described in Chapter 2, these workflows are made available through platforms like Zenodo and GitHub. Upon project completion, a comprehensive workflow description will also be provided.

Below are links to the already published workflows, models, and tools.

- Publication explaining workflow to train models for PV-Segmentation: "Multi-Resolution Segmentation of Solar Photovoltaic Systems Using Deep Learning" https://zenodo.org/records/10361245
- Model for PV-Segmentation: "Multi-Resolution Segmentation of Solar Photovoltaic Systems Using Deep Learning - DeepLabV3 ResNet101 Model" https://zenodo.org/records/10036926
- Deep Neural Remote Sensing (Deepness) Plug-in for QGIS to use the model within the model zoo without any programming knowledge https://github.com/PUTvision/qgis-plugin-deepness

3.2 RES Time Series Generation

The generation of open time series data for wind and solar energy is a crucial component of the OASES project model chain. This process involves the creation of high-resolution time series datasets that reflect the potential energy output of renewable energy systems (RES) in our local, national, and regional Case Studies. The time series are created with a spatial resolution of at least 1 km by 1 km and a temporal resolution of at least 1 hour to ensure that the data is both detailed and relevant to different scales of energy analysis.

To achieve this, we have developed a robust tool chain that synthesizes data from multiple sources, including meteorological data, satellite data and existing energy system datasets. The generated time series are useful not only for assessing the performance of existing plants, but also for simulating the potential performance of future wind and PV plants. The standardized format of these time series allows for seamless integration into energy modelling tools, such as the IRENA FlexTool, facilitating comprehensive scenario analyses and enabling stakeholders to explore different energy futures.

By making these time series openly available, the project supports broad accessibility and promotes the adoption of renewable energy modelling techniques on both continents. The data and tools provided will improve the ability of local, national, and regional planners to make informed decisions about renewable energy investments and infrastructure development. Publishing these datasets on platforms such as Zenodo and GitHub ensures that they are easily accessible to researchers, policy makers and industry professionals, promoting transparency and collaboration within the global renewable energy community.

3.3 Energy Scenario Modelling Workflow

With IRENA FlexTool, we have further developed an accessible energy scenario modelling workflow applicable at local, national, regional, and continental scales. Example case

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studies across these various spatial scales have been created and documented. These studies are designed to be easily run, copied, and modified by third parties, promoting widespread use and adaptation. Based on this workflow of IRENA FlexTool, we have showcased six case studies, led by VTT together with African partners CDER, CSIR and University of Venda. The case studies include:

- The local case study in Egypt simulated an Egyptian design of a solar water pump connected with the electricity system of a village in Egypt. Model and dataset can be found from Zenodo: https://zenodo.org/records/13318686.
- Local case study in Algeria optimised new RES investments for PIAT isolated network in southern Algeria.
- National case study in South Africa analysed how to decrease the load shedding and ensure security of supply while diversifying the electricity generation mix, becoming less dependent on coal-fired power plants, and adding more renewable generation.
- National case study in Egypt analysed the impacts of planned photovoltaic (PV) and wind integration to the existing power grid of Egypt. Model and dataset can be found from Zenodo: https://zenodo.org/records/13304369.
- Regional case study in Algeria and Northern Africa and Southern Europe to analyse how Algeria's large renewable potential could benefit from the export of electricity and/or hydrogen to European market.
- Continental case study in Africa integrated PyPSA-Earth's Africa data to IRENA FlexTool.

More detailed descriptions of the case studies can be found in Deliverable 5.2 "*Case study report":* Report describing the calculation and results of the national case studies from Egypt, Algeria, and South Africa. The workflows for the case studies will be available on Zenodo after completion. Workflows are available for download and can be run in IRENA FlexTool verbatim.

4. Conclusion

This report provides an overview of the various strategies and implementations deployed across a portfolio of platforms to ensure the effective dissemination and accessibility of the OASES project's outputs. From the organisation of source code and documentation on GitHub to the secure archiving of datasets on Zenodo, each platform plays a critical role in promoting transparency and collaboration within the African-European energy community. The OASES project's participation in the LEAP-RE platform and newsletter extends its reach and allows the project to share its progress and achievements with a wider audience. In addition, the creation of dedicated pages on partners' websites increases the visibility of the project and provides important access points for stakeholders. Through these extensive dissemination efforts, the OASES project not only contributes to the advancement of renewable energy research but is also an example of best practice in open science and collaborative innovation.

In addition, the development of a comprehensive model chain as part of the project has been instrumental in improving the accuracy and applicability of renewable energy system analyses. By creating open datasets of time series for wind and PV energy with high spatial and temporal resolution, the project has ensured that these resources can be utilised for both current and future RE installations. The integration of these datasets into the IRENA FlexTool enabled the creation of accessible workflows for modelling energy scenarios that have been successfully applied at different scales - local, national, regional, and

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continental. The documented case studies demonstrate the practical utility of these tools and provide a basis for further research and application in renewable energy planning and policy development.

In summary, the combination of robust dissemination strategies and the development of a versatile modelling chain underlines the contribution of the OASES project to the promotion of sustainable energy solutions and long-term cooperation between African and European partners in the field of renewable energy.

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