LEAP-RE

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

Research & Innovation Action

LEAP-RE 3rd RESchool

9rd –11th October, 2024

Programme and Syllabus

Version N°1

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Date, Venue & Format

Date: 9-11th October, 2024

***Venue*:** Politecnico di Milano, Milan – Italy; and online platforms

Online Venue: https://leap-re.app/event-398

Detailed Timetable

	Programme Feature	Link
Day 1		
16:30-18:30	Satellite data application to renewable energies assessment and validation (LNEG) Bottom-up electricity demand modelling (IIASA, Polimi)	https://leap-re.app/event-398
Day 2		
09:00-11:00	Advanced energy modelling for mini-grids (Polimi) Do's and dont's in interpreting energy system modelling results for policy support (KTH)	https://leap-re.app/event-400
11:30-13:00	Power-to-H2 and hydrogen technologies (Hassan II University of Casablanca) - online Technologies for solar thermal energy (2ie)	https://leap-re.app/event-400
Day 3		
09:00-11:00	Design and Management of DREs with local communities involvement - Business Models guidelines (Sant'Anna School of Advanced Studies) Economic and financial modelling of an energy project (CNDT-MINRESI)	https://leap-re.app/event-404
11:30-13:00	Socio-economic impacts on Energy preferences and modelling (University of Nairobi)	https://leap-re.app/event-404
14:30-18:00	Clean Cooking technologies - overview of the basic principles and technologies for clean cooking, configurations and materials, tests and regulations (LNEG) Design and production principles of pyrolysis cookstoves and biochar carbonizers & Laboratory and field testing of cookstoves and biochar carbonizers (KIRDI) - online Biogas production as part of a healthy community development (IBBK) Utilization of Agricultural waste for Biogas Production: Kenya's Story (KIRDI)	https://leap-re.app/event-404

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Syllabus

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)

Lecturers: Teresa Simões, Paula Costa

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) and Politecnico di Milano (POLIMI)

Lecturers: Giacomo Falchetta (IIASA), Nicolò Stevanato (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, 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 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.

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Energy Systems Modelling and Application to Minigrids

Responsible: Politecnico di Milano (POLIMI)

Lecturer: Nicolò Stevanato

Abstract:

The lesson will touch 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 will close 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 sytems.

Do's and dont's in interpreting energy system modelling results for policy support

Responsible: Sweden Royal Institute of Technology (KTH)

Lecturers: Francesco Gardumi

Abstract:

This section expands on the types of energy system modelling tools and practices that are commonly available, and it delves into how they may be used to deliver insights for long-term energy strategies. It starts from a refresher on why we create energy systems models and what types of modelling tools exist. It then focusses on concepts and ontologies (what terms to use and not to use when presenting an energy system model), on the links between results and assumptions (with examples of types of insights that can and cannot be extracted from model results), and on open-science practices to make the models FAIR (Findable, Accessible, Interoperable, Reusable). It also briefly touches upon aspects that deserve attention (and potentially re-thinking) when applying energy system modelling to developing contexts and contexts with potentially high shares of variable renewables.

Power-to-H2 and hydrogen technologies

Responsible: Hassan II University of Casablanca

Lecturers: Youssef Naimi

Abstract:

Power-to-Hydrogen (Power-to-H2) and hydrogen technologies are essential in the energy transition to a more sustainable system. It refers to the process of converting energy into hydrogen gas. This is typically done through electrolysis, where water is split into hydrogen and oxygen using an electric current from renewable energies.

There are several types of electrolysis technologies: Alkaline Electrolysis (AEL); Proton Exchange Membrane (PEM) Electrolysis; Solid Oxide Electrolysis (SOE); … Renewable energy sources like wind, solar, and hydroelectric power are used to produce green hydrogen and reducing carbon emissions.

The Hydrogen produced can be stored in various forms, such as compressed gas, liquefied hydrogen, or metal hydrides. Storage is critical for balancing supply and demand and enabling the use of hydrogen in different applications.

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Fuel cells are the best hydrogen technologies systems that utilize hydrogen as a fuel or energy carrier. The mature types of fuel cells are: Proton Exchange Membrane Fuel Cells (PEMFC; Solid Oxide Fuel Cells (SOFC); Alkaline Fuel Cells (AFC); …

The Hydrogen Refueling Infrastructure (HRI) are essential for the widespread adoption of hydrogen vehicles. This includes hydrogen production, distribution, and refueling stations.

Also, Hydrogen could be used in various industrial processes, such as ammonia production, refining, and steelmaking. Switching to green hydrogen can significantly reduce emissions in these sectors

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)

Lecturers: Kokouvi Edem N'tsoukpoe

Abstract:

This lecture provides a comprehensive overview of solar thermal technologies in West Africa, with a focus on solar water heating (SWH) and concentrating solar power (CSP). We begin by examining the current energy landscape in the region. Key topics include the principles, typology, and operation of non-concentrating solar power systems, thermosiphon vs. pumped systems, and global and regional trends. The lecture also covers existing systems in operation and main applications in West Africa. A historical perspective highlights early developments since the 1960s, along with regional and national initiatives. In the context of CSP, we discuss the CSP4Africa project, which aims to develop cost-effective micro-CSP plants for rural electrification using locally sourced materials. The session will explore 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)

Lecturer: Fabio Iannone

Abstract:

In this lecture, Fabio Iannone (SSSA) will present 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 will learn 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 focus on geothermal energy, offering valuable insights into sustainable energy solutions in rural East Africa.

Economic and financial modelling of an energy project

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

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Lecturers: David Tsuanyo

Abstract:

This lecture covers 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 will present 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 will be briefly introduced. The lecture also covers 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 will be presented, particularly on solar and hydroelectric power plants based on the activities carried out on Setadisma project. The session will also explore 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

Lecturers: Jane Mutune and Bessy Kathambi

Abstract:

In this module, we focus 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 will discuss clean energy technologies aa a panacea to local employment, enhanced human and planetary health. Through this lecture, we provide an analytical tool for governance whose impacts control the economic outlook for rural-urban communities. Specifically, we focus 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.

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)

Lecturers: David Loureiro

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, 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 will

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address clean cooking technologies and make an overview of the basic principles on the sector. Also, will present examples of tests and an overview of the existing regulations and requirements used in this sector. If the available time allows, a demonstration of a cooker will also be performed on-site.

Design and production principles of pyrolysis cookstoves and biochar carbonizers

Responsible: KIRDI

Lecturers: Benjamin Gituku

Abstract:
Design and production principles of pyrolysis cookstoves and biochar carbonizers
Resource use efficiency helps us mitigate and adapt to climate change. Currently in sub-Saharan Africa where biomass is the primary source of household cooking energy, the conversion of renewable biomass to charcoal fuel is an inefficient process that leads to immense energy losses. Recovery of this energy is possible through various circular economy models. Use of pyrolysis cookstoves and biochar carbonizers in Sub-Saharan Africa can save over 75% of the wood resource and enhance nutrient recycling. The session will introduce students to current research in optimizing pyrolysis cookstoves and biochar carbonizers aimed at efficient use of renewable biomass in sub-Saharan Africa. The session provides an overview on design principles to improve conversion efficiency of biomass to energy including fast and slow pyrolysis and heat recovery for various applications and role of fuel e.g. pellets/briquettes produced from industrial and agricultural wastes. The session will evaluate economic considerations for scaling-up production of pyrolysis technologies.

Laboratory and field testing of cookstoves and biochar carbonizers

Responsible: Kenya Industrial Research and Development Institute (KIRDI)

Lecturers: Mr Benjamin Gituku

Abstract:katrinTo estimate the impact of pyrolysis technologies in biomass resource use efficiency and climate change mitigation and adaptation, the prototypes should be subjected to various laboratory and field tests prior to promotion. This session will introduce students to standard performance testing methods including ISO 19867-1:2015 (The Standard Test Sequence for Emissions and Performance of Cookstoves) and field controlled cooking tests (F-CCT) that are currently being used including equipment used and sample results.

Since, performance measures vary in laboratory and field environments, the session provides an overview of the relationship between laboratory and field measurements e.g. correlation between laboratory thermal efficiency and field fuel savings. This relationship can help pyrolysis cookstove designers, promoters and regulators estimate expected fuel savings and accruing carbon credits basing on laboratory results. The sessions will also discuss correlation between laboratory and field measurements of cooking power and pollutant emissions of pyrolysis cookstoves and biochar carbonizers.

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) and Kenya Industrial Research and Development Institute (KIRDI)

Lecturer: Katrin Kayser (IBBK) and Joan Khalifa (KIRDI)

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Abstract IBBK:

This module focuses on the services that biogas production can provide to individual households or farms as well as to larger communities. We will look at the feedstock side from sourcing to logistics and feedstock handling. Here you will learn how anaerobic digestion contributes to local waste management by channeling organic residues and side streams to the biogas system and thus reliefing the environment from uncontrolled waste decomposition.

Beyond that we will also look into the product side of the biogas plant, where anaerobic digestion converts the feedstock into valuable biogas and organic fertiliser (digestate). We will discuss options for using both products and you will 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 will introduce 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 will also highlight on the role of KIRDI and the current research being undertaken on utilization of various agricultural wastes as feedstock for biogas production.

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