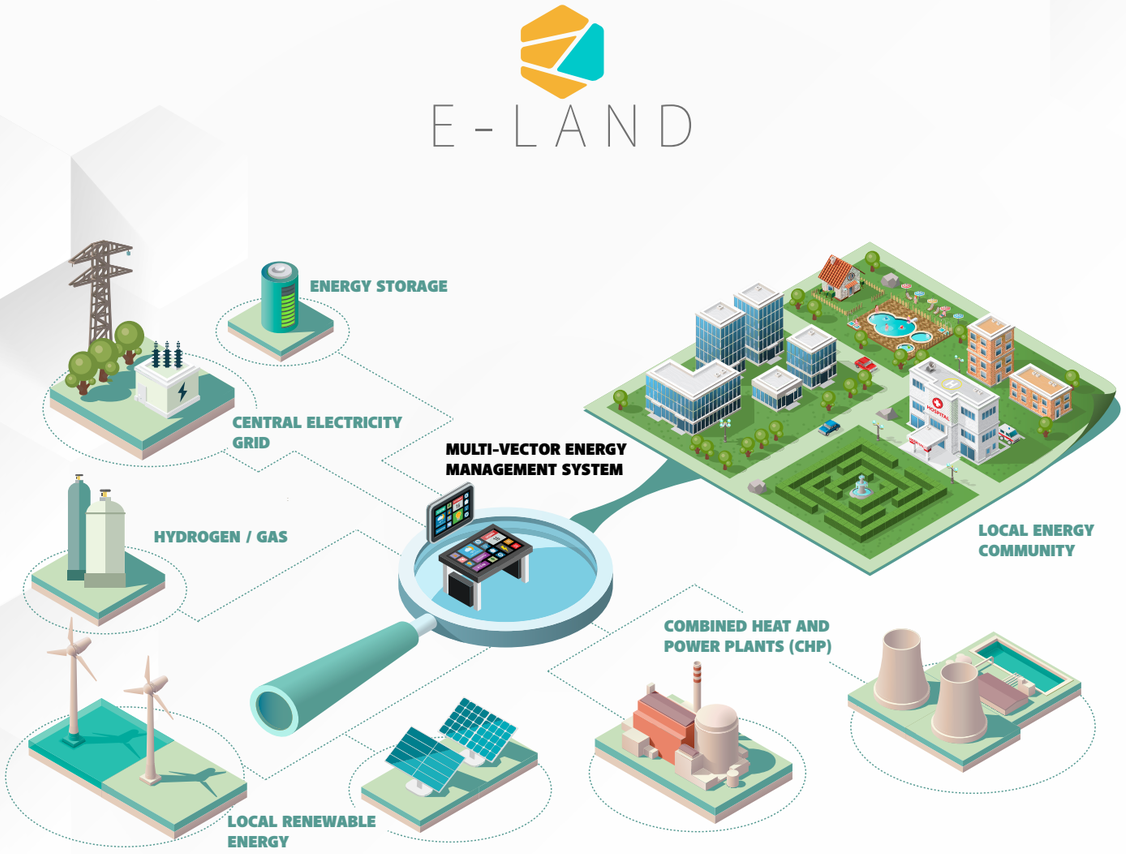
E-LAND

Toolbox Description and Replication Guidelines

This project has received funding from the **European Union's Horizon 2020** Research and Innovation programme under Grant Agreement **No 824388**

CONTENT



1. E-LAND Introduction

Description of the project

Why E-LAND?

The goal of the European-funded H2020 project E-LAND is to provide a synergistic solution between technological, societal, and business challenges that the energy sector faces

Develop and integrate the needed technology tools to change the role of the Energy Island into an actor providing services to the grid.

Create new business opportunities for different storage technologies, including the potential for seasonal storage and cross-vector storage optimization.

Understand how the dynamics of existing communities can be explored and further developed to secure impact and longevity of the introduced solutions.

Develop multi-vector energy optimization algorithms that take into account the current and future value of energy storage and end-user flexibility.

Increase the use of the current and most advanced innovative business models for energy communities and key energy market players .

Achieve an economically viable system that will be self-sustaining after project termination.

Implement a modular toolbox composed of technology, business, and community engagement-related tools, and validate the viability and impact of these tools in three regions in Europe and one region in India with different geography, demography, sociography, and maturity.

How does E-LAND create an impact on society?

1. Relevant, compatible and supportive with the broad **EU energy policy** context
2. Contribute to the **2030 Climate & Energy objectives**: 40% GHG reduction (with respect to 1990) and at least 27% of renewables by 2030
3. Validate **solutions for decarbonisation** of the local energy system – taking advantage of the availability of local renewable resources – while ensuring a positive impact on local economy, social aspects, and air quality
4. Enhance the **involvement of local energy consumers** and producers and test new business models
5. Validate approaches to a **safe and secure local energy system** that integrates significant shares of renewables (electricity, heating, cooling, water, wastes, etc.)
6. Benchmark technical solutions and **business models that can be replicated** in many local regions and that are acceptable to local citizens
7. Reduce loneliness through **collaboration** within the energy community
8. Develop an **associative economy**
9. Design a **cellular energy structure**

Who are the partners involved in E-LAND?

IFE

REINER LEMOINE INSTITUT

Universitat de Girona

Schneider Electric

UNIVERSITATEA VALAHIA din TÂRGOVIȘTE 1992

BORG HAVN

Inycom

SMART INNOVATION NORWAY

INTRACOM TELECOM

Auroville Consulting

University of St.Gallen

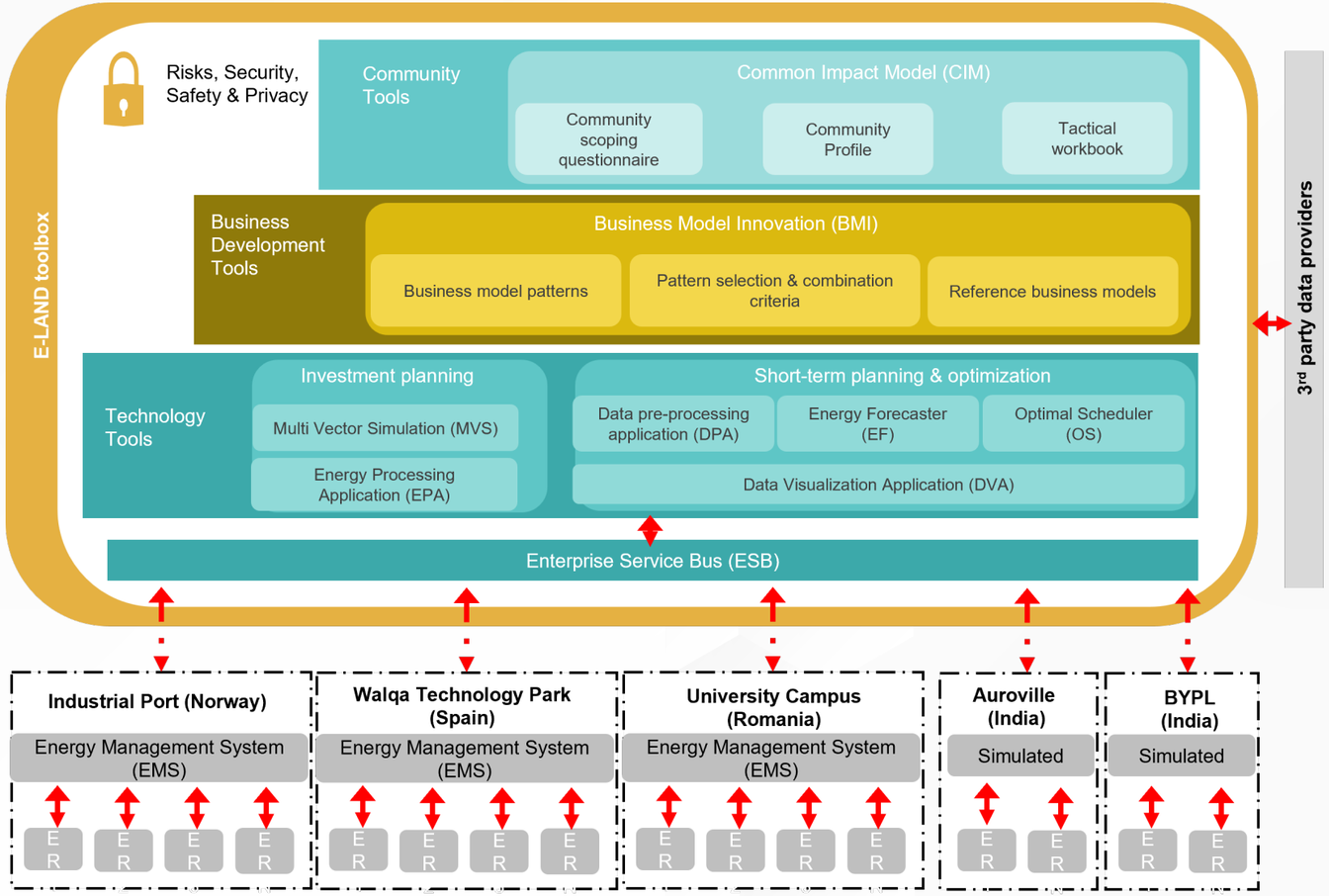
CREESC

BSES
BSES Yamuna Power Limited

2. E-LAND Modular Toolbox

Description of the E-LAND toolbox

What is E-LAND project as a whole?



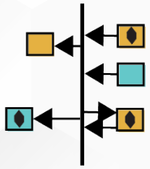
What are the tools developed in E-LAND?

Community Building Tools

The **Common Impact Model** establishes a three-step process for building community acceptance. Complimentary tools have been designed to facilitate the user at each step, including a modular community scoping questionnare, community profile dashboard, and tactical engagement workbook.

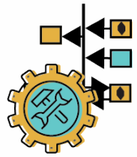
Business Development Tools

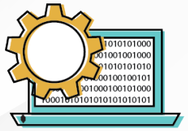
The **Business Model Innovation Tool** is the first of its kind tool tailored to the needs of energy communities under multi-vector settings. It includes a package of building blocks, i.e. business model patterns, as well as a complete framework for tailoring and configuring them to develop eorking business models.



The **Multi-Vector Simulator** performs investment planning and evaluation of localsector-coupled energy systems that include the energy carriers electricity/ heat/gas or others. It allows for adaptive energy system topologies, and optimizes all sectors in an integrated manner.

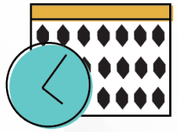
The **Energy Planning Application** was developed to the open-source optimization tool Multi-Vector Simulator. It guides the end user through system design, data input, simulation and optimisation results, including economical, technical and dispatch information.





The **Data Pre-Processing Application** is a tool that detects/corrects missing, corrupt or inaccurate (outliers) data, re-samples them, if needed, and gets energy load profiles (daily, weekly). This is a necessity to exploit these information by other tools (forecasting, optimization, planning).

The **Energy Forecaster Tool** provides hourly forecasting of electrical/loads and Photovaltaic / wind generation. Two forecasting horizons are provided: intra-day and day-ahead. forecasts are based on weather data, characteristics of generation assets, and contextual information.



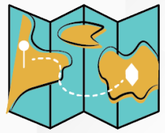
The **Optimal Scheduler Tool** provides an hourly scheduling of storage (when store or consume) and controllable assets (when switch on/off) in order to maximise the use of renewable energy resources. It is based on the forecast production/consumption in the Local Energy System (LES).

The **Enterprice Serving Bus** is a software solution (middleware) enabling the integration of applications in the Smart Grids domain, offering compatibility with domain standards (e.g. IEC 61968). It interconnects the technological tools of the toolbox with the Energy Management System of the LES.

Data Visualization Application is a web application presenting the project's Key Performance Indicators and operational data of local energy assets; providing useful insights to ELAND's pilot owners and the local communities.

Additional Resources

Need guidance in carrying out your own project? The **Replication Toolkit** gathers usable resources for you to utilise the E-LAND tools. It also includes guidelines and insights from experience in the E-LAND project.



The **Risk Management** handles risks for the project and the final product. The risk regarding safety, security and privacy as well as cyber risks

Common Impact Model (CIM)

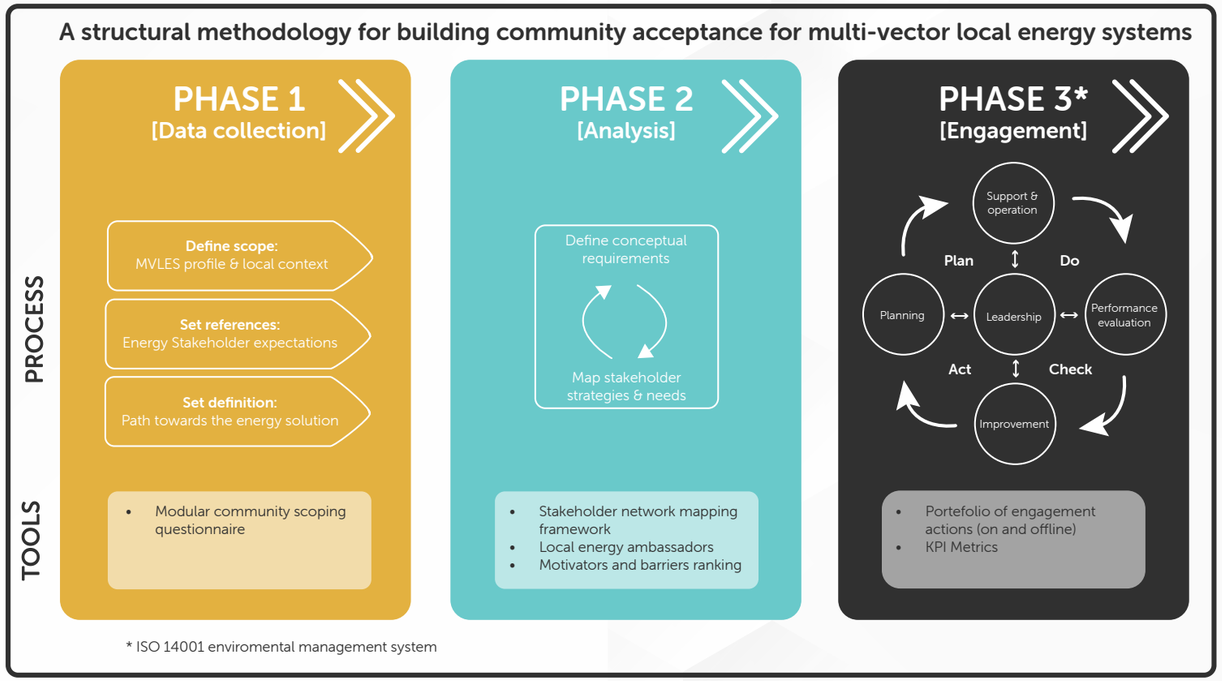
How do we build community acceptance?

Today, communities can increasingly rely on clean and locally produced energy to satisfy their power, heating and mobility needs. However, this requires engaging may actors. The Common Impact Model is the first structured process to facilitate and manage acceptance of community energy solutions among all stakeholders.

Contextually responsive

The Common Impact Model has been successfully applied to markedly different environmental, cultural and economic contexts - a sea port, a technology park, and a university campus – and has built acceptance for solutions that generate locally clean energy for their community members.

How does the CIM help build community acceptance for the multi-vector LES?



What are the key features of using CIM?

Community scoping tools that allow for energy islands to be holistically studied from the perspective of the technical, cultural and theoretical status of the community.

Community analysis frameworks that identify the players in each community and map the community's opportunities and barriers towards change and acceptance.

Engagement implementation processes that utilize leanings from previous engagement activities to inform future initiatives via feedback loops.

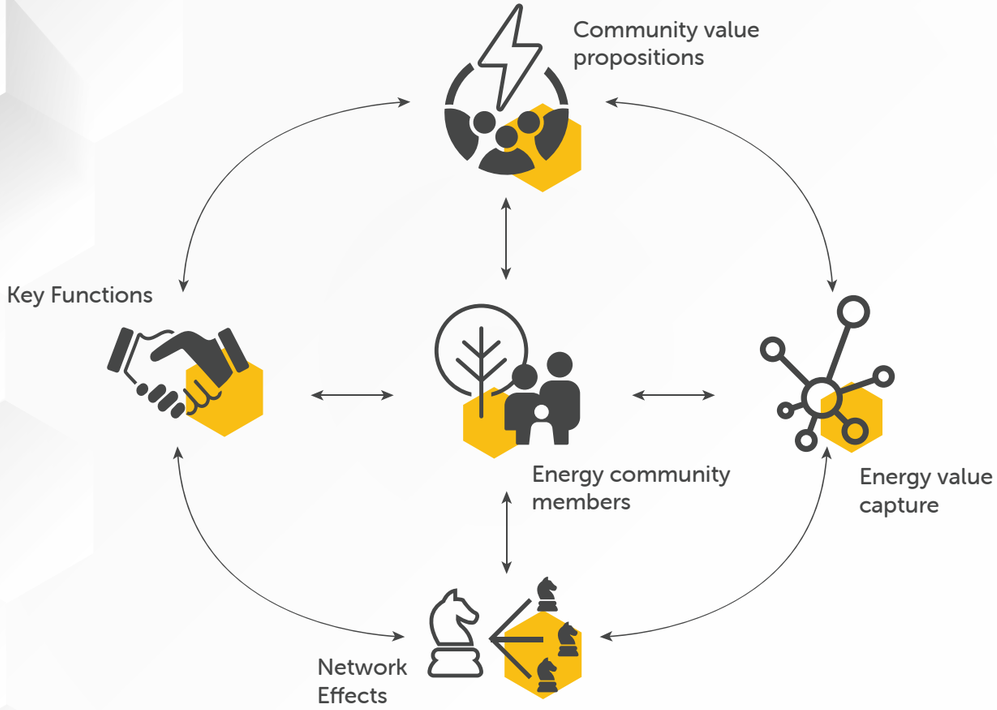
What are the benefits of using CIM?

Complete a holistic community assessment and contextualized, multidimensional mapping of the energy community

Utilize an agile framework designed to adapt to changing community dynamics and evolving phases of engagement

Benefit from the standardized and replicable process for building and maintaining community engagement

Business Model Innovation (BMI)



What are the key features of CIM?

Reasons to get engaged

- Create and test innovative business model for local energy system in a guided process.
- Get inspired from successful business models from pioneers and related domains.
- Un-lock the power of the community to decarbonize your energy needs.
- Learn from the E-LAND pilot sites and their unique set-ups.

What are the key benefits of the BMI tool?

Key Benefits

- Allows companies to be agile, modify business model rapidly and react to changing local market needs
- 25 business model patterns dedicated for energy communities nder multi-vector settings.
- Manage the value network in the energy community.
- Develop strategies to initiate and reinforce network effects.
- Supports new market entrants to launch new offers in the energy market with robust business models.

Multi Vector Simulator (MVS)

REQUIREMENTS

Basic energy planning knowledge

✓

Data describing local energy systems

- ✓ Demand profiles
- ✓ Current generation capasities
- ✓ Energy supply cost

Data describing future potential investments

- ✓ Asset type
- ✓ Technical parameters or expected performance data
- ✓ Investment and operation costs

INPUTS

Project description
- General Data
- Economic Data

Energy consumption
- Electricity Demand
- Thermal demand
Hydrogen Demand

System configuration
- Technical Data
-Asset Cost

Meteorological data (e.g., irradiation)

SYSTEM MODEL

MVS Simulation

with oemof-solph python library

1. Economic dispatch problem that allocate the total emand among generating units so that the production cost is minimised

2. Investment model that optimizes near-future investment in generation and storage and storage assets so that the least-cost of supply for electricity and heat is obtained

⋮

Linear programming
- Decision variables
- Objective function
Equality/inequality constraints

OUTPUTS

Economic
- LCOE (electricity)
- LCOH (heat)
- LCOH2 (hydrogen
- Net present value
- Upfront investment cost

Technical
- Optimized capacity
- Renewable coverage factor
- Assets dispatched (time series/slots
- Degree of autonomy
- Degree of sector coupling

Enviromental
- CO2 emissions

WHAT ARE THE KEY FEATURES AND BENEFITS OF MVS?

Key Features

Evaluation of the current energy system's operation and performance, to determine its costs, efficiency and renewable share.
Planning future investments into power generation or storage assets to achieve least-cost supply of electricity.

Planning the integration of emerging technologies also helps to meet sustainability goals and decrease adverse climate effects, e.g. through high renewable energy shares or electric mobility.

Key Benefits

Quick pre-feasibility analysis: Provided with the system parameters, potential investment options can be explored with low effort.
Capacity estimation: Trajectory of future assets capacities, necessary for sales inquiries.

Avoiding costs: Internalizing the pre-feasibility analysis the decision process within a company to invest into future supply options is sped up, while costs otherwise necessary to pay for an external review are skipped.

Reasons to get engaged

Low-effort and low-cost pre-feasibility analysis of investment options for complex sector-coupled energy systems.

Determine your CO2 reduction potential and possible renewable share of your energy island.

Which are the target groups for using the MVS?

Energy System Planners employed at the end user site | Energy system planners for consulting | Research | NGOs for green transition

Energy Planning Application (EPA)

REQUIREMENTS

Basic energy planning knowledge

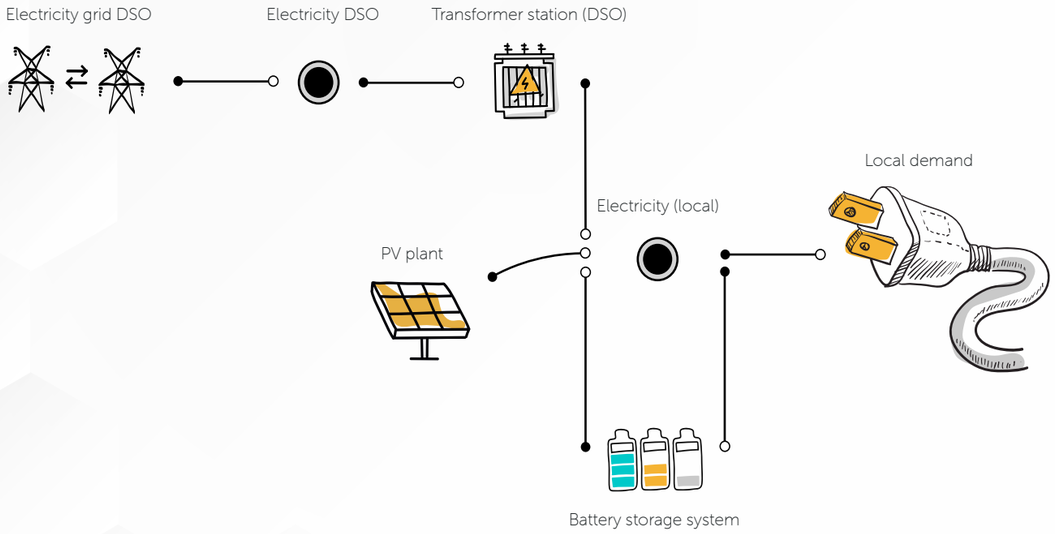
✓

Data describing local energy systems

- ✓ Demand profiles
- ✓ Current generation capasities
- ✓ Energy supply cost

Data describing future potential investments

- ✓ Asset type
- ✓ Technical parameters or expected performance data
- ✓ Investment and operation costs



WHY SHOULD YOU USE EPA?

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Energy System Planners employed at the end user site | Energy system planners for consulting | NGOs for green transition

Data Pre-processing Application (DPA)

PRODUCT HIGHLIGHTS

Ensure that gathered data have the best quality detecting and correcting inaccurate/missing records so they can be exploited by the Energy Forecaster Tool

Energy profiles provided by Data Pre-processing Application Tool may be used by the Multi-Vector Simulator Tool

WHAT ARE THE KEY FEATURES AND BENEFITS OF DPA?

Key features

- Outliers detection
- Missing values/outliers - data imputation
- Re-sampling
- Energy profiling

Key benefits

Guarantee that the metered data in the LES can be used in E-LAND toolbox although there exist some problems with their quality or the metering configuration does not fit with the requirements of other tools.

Reasons to be engaged

There is not a direct profit from this tool but it guarantees that other tools may work more accurately and final results may be more accurate.

Who is the target audience for DPA?

Local energy system operators and facility/energy management

Energy Forecaster (EF)

FORECAST YOUR CONSUMPTION AND GENERATION TO MAXIMIZE YOUR BENEFIT

The tool provides forecasting for different energy vectors: electrical and thermal loads; photovoltaic and wind generation.

Data provided to the Energy Forecaster Tool are first pre-processed by the Data Pre-processing Application Tool in order to ensure their quality.

Forecasting results are provided to the Optimal Scheduler Tool in order to calculate the optimal scheduling of assets.

WHAT ARE THE KEY FEATURES AND BENEFITS OF EF?

Key Features

- Production/consumption forecasting
- Day-ahead forecasting: hourly forecasting of the next day.
- Intra-day forecasting: hourly forecasting of the remain of the day.

Key Benefits

- Estimation of the expected generation/consumption in different time horizons.
- The tool can be exploited separately (for example, detection of faulty/non normal consumption behaviours) or together with Optimal Scheduler tool (provides information needed by OS)

Reasons to get engaged

Estimate your costs based on your expected production/ consumption.

More efficient management of your local energy system.

Who is the target audience for EF?

Local energy system operators, aggregators, DER operators, facility and energy management

Optimal Scheduler (OS)

PRODUCT HIGHLIGHTS

Optimal scheduling of multi-vector energy assets.

Day-ahead and intra-day hourly scheduling.

Requirements/ Expectations

- State of operation (storage, Building Energy Management System, indoor conditions)
- Controlling assets (storage, loads) available
- Energy costs available
- Weather data available

OPTIMIZE THE USE OF YOUR DISTRIBUTED ASSETS TO MAXIMIZE YOUR BENEFIT

WHAT ARE THE KEY FEATURES AND BENEFITS OF OS?

Key Features

- Innovative and intelligent algorithms
- OS thermal and electrical storage
- Shift loads
- Storing excess of generation in thermal network
- Optimal management of electric vehicles

Key Benefits

- Balance different forms of supplies (renewables, conventional sources and direct imports from the main grid)
- Use energy storage devices to temporarily store the surplus energy
- Take profit of curtailable or reschedulable loads
- Optimise the time for purchasing electricity from or selling excess electricity back to the eligible energy markets.

Reasons to get engaged

Decission tool that improves the use of renewable resources: C02 reduction, costs reduction.

Who is the target audience for OS?

Local energy system operators, aggregators, facility and energy management.

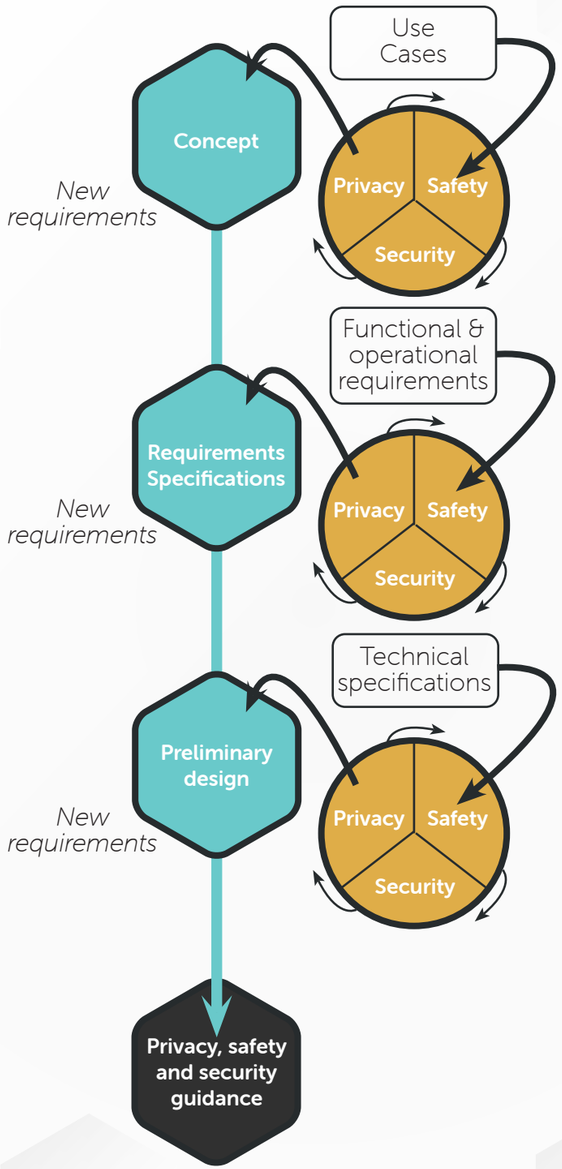
Risk assesment method

Internal and external factors that can impact the quality of the project and the final product are specifically addressed.

The project defines risk management as the process of identifying, analyzing, and then responding to any risk that arises over the life cycle of a project. These requirements may not cover all scenarios caused by unwanted and unexpected incidents. These gaps are addressed through the technical risk assessment.

The Risk Management handles risks for the project and the final product. The risk regarding safety, security and privacy as well as cyber risks have been assessed through the following steps:

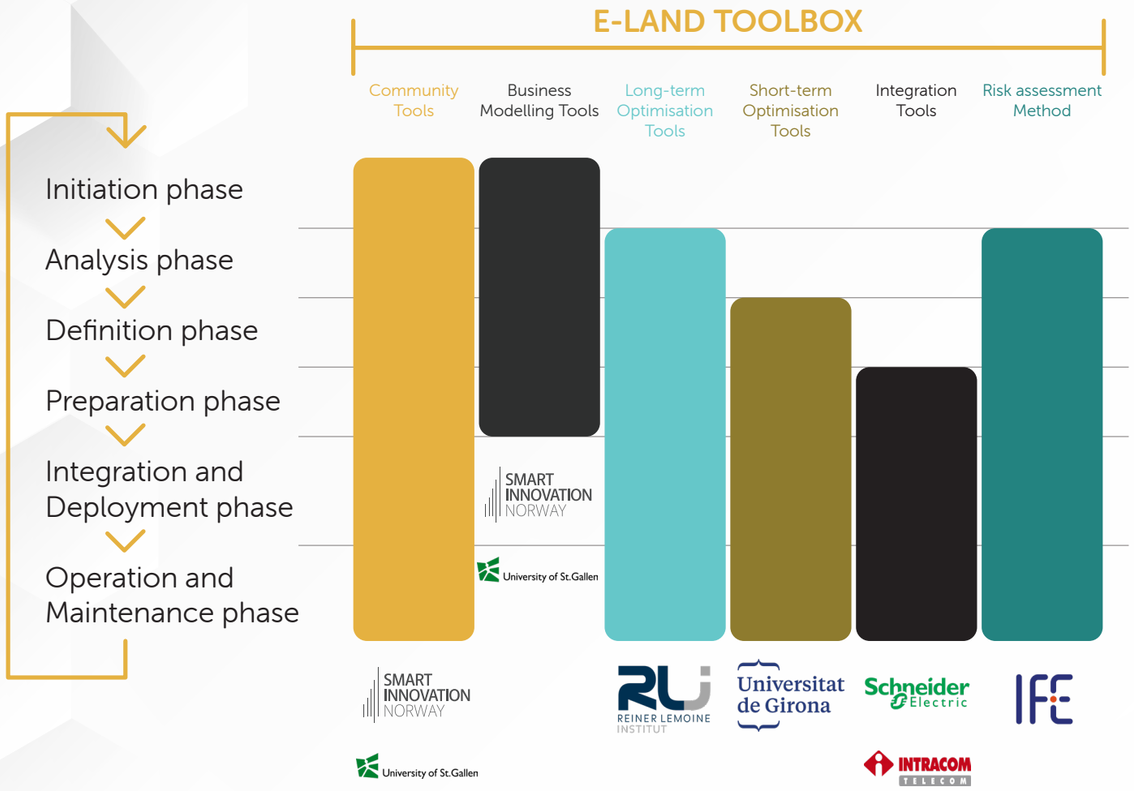
- Studying high-level Use Cases and business model
- Knowledge on relevant standards and guidelines
- Providing a list of mitigations and technical specifications
- Support in analysis and decisions making
- Following the implementation of the solution.



3. E-LAND Replication Toolkit

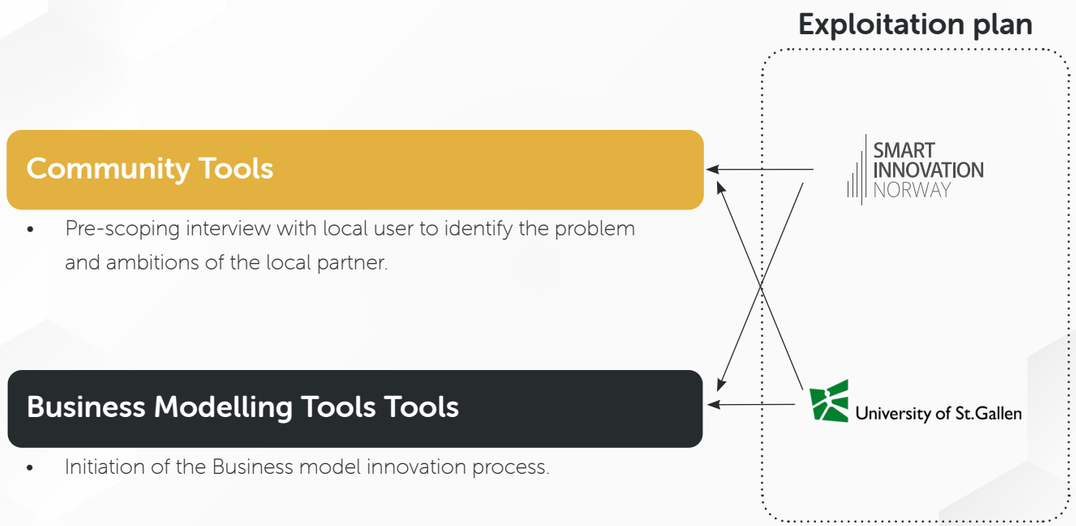
Description of the replication phases

E-LAND replication toolkit



Initiation phase

Low-threshold phase to set start with the energy community



Analysis phase

Analyzing the existing assets with regards to business, community, and technology aspects. On the other hand, this phase should identify the needs and objectives of the community

Exploitation plans

Community Tools

- Stakeholder mapping.

SMART INNOVATION NORWAY

Business Modelling Tools

- Integration phase of Business Model Innovation (BMI) tool with first Business Model (BM) configurations

University of St.Gallen

Long-term optimization Tools

- Identify the location of the energy system
- Map the current energy system (status quo) and initiate data measurements (e.g. demand)
- Discuss and define the stakeholders' future goals

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Risk Assessment Method

- Gain knowledge and ownership of the risks in the processes

IFE

Definition phase

Input collected in the analysis phase is used to formulate an offering for the community, which answers to their ambitions and needs and fits to their existing ecosystem

Exploitation plans

Community Tools

- Exploring the stakeholders' interest towards the solution (surveys, interviews, focus groups etc.)
- Updated version of the stakeholder analysis
- Information condensed into community profile and solution

SMART INNOVATION NORWAY

Business Modelling Tools

- Finetuning of BM configuration + implementing consideration laid down

University of St.Gallen

Long-term optimization Tools

- Define all scenarios to be considered + relevant KPIs

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Short-term optimization Tools

- Definition of the optimization scenario

Universitat de Girona

Risk Assessment Method

- Identify the main assets of the infrastructure to prepare the risk assessment method

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Preparation phase

The preparation phase is executed across various planes

Exploitation plans

Community Tools

- Co-creation of engagement recommendations with user

Business Modelling Tools

- Selection of 1-2 suitable business models

Long-term optimization Tools

- Gather all input data (technical, financial, environmental)

Short-term optimization Tools

- Training of DPA, EF models, adjustment of OS to the defined scenarios

Integration Tool

- Tools implementation and/or adaptation to fit the user needs

Risk Assessment Method

- Checklists for risk assessment

Integration and Deployment phase

Various technical components are fine-tuned to the site needs and end-to-end testing is conducted. The communication interfaces, data quality, and operational challenges are resolved. The community interactions and feedback are received, while the cost analysis is conducted for the business models.

Exploitation plans

Community Tools

- Engagement recommendation implementation and evaluation
- Assessment of stakeholder acceptance and participation

Long-term optimization Tools

- Run the multi-vector simulations

Short-term optimization Tools

- Communication/data interchange, assessment of first DPA/EF results

Integration Tool

- Tools integration, testing and deployment

Risk Assessment Method

- Risk monitoring

Operation & Maintenance phase

Local Energy System is fully operational from technology point of view. Business model testing is executed, community functions independently within the defined roles. Feedback loop to other steps to expand system

Exploitation plans

Community Tools

- Engagement recommendation implementation and evaluation
- Another input round from stakeholders (continuous calibration/ feedback loops)

Long-term optimization Tools

- Evaluate results (KPIs and energy system dispatch)

Short-term optimization Tools

- Assessment of OS results; retraining EF models, adjustments of OS

Integration Tool

- Operation monitoring and users' support

Risk Assessment Method

- Gain knowledge and ownership of the risks in the processes

SMART INNOVATION NORWAY

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Universitat de Girona

INTRACOM TELECOM

Schneider Electric

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Early adapters of the E-LAND replication toolkit

Auroville

LOCATION

Auroville
Chennai

India

ENERGY

The rising temperatures in the region together with growing energy consumption, are placing huge stress on its on-site energy assets and state-owned distribution transformers feeding Auroville.

VISION

Auroville aims to be a self-sufficient energy community by developing a robust energy system within the area that can operate in an islanded mode.

PILOTING

E-LAND toolbox will help Auroville in simulating the investments and optimization needed for Auroville to implement the vision of the islanding mode of operation.

IMPACT

By becoming self-sufficient for energy needs, Auroville can be a truly net zero emission community in India

BYPL

LOCATION

New Delhi

India

ENERGY

BYPL is licensed to supply and distribute electricity in central and north of Delhi. The industry actors are for example food industries, incinerators, recycling plants, care providers, and companies within energy production, storage, and distribution

VISION

With new government initiatives on promoting EVs, BYPL wants to be prepared in a cost-effective way to fulfill this additional electricity demand.

PILOTING

The piloting will be conducted using the simulation tools part of E-LAND toolbox, giving a long-term investment plan for pilot site and also day-ahead schedules for Multi Vector sources

IMPACT

The local pockets which are constrained by transformer capacity limits will be enhanced, which in turn increase value for 1.6 million customer

4. E-LAND Pilot Case Studies

Description of the pilot case studies suitable for each replication phase

Pilot sites

Pilot sites

Walqua Technology Park
A sustainable tech park pioneer in developing an Energy Community to show that local energy markets can be viable and replicabale.

The Energy Community
A small township-based community with 3000 residents that explores the most cost efficientways ofachieving carbon neutrality by 2030.

The Industrial port
An industrial harbour working on reducing peak usage in the hopes of becoming an energy hub by providing carbon free energy to ships and land transport.

The Industrial Metropolitan
Licensed to supply and distribute electricity in the north and central Delhi, BYPL aims to reduce space constraint and manage the peak demand in the grid in an effective manner.

The University Campus
An aspiring carbon neutral University campus working on minimizing CO2 footprint and increasing stakeholder awareness on energy efficiency.

The University Campus

LOCATION

Târgoviște

Romania

ENERGY

The local electrical energy grid at campus site includes various Renewable Energy Sources (RES) and storage. Currently they are covering the energy need of the research institute building.

VISION

In the interest of technology and research, UVTgv has a vision to increase the amount of RES on campus and maximize efficiency towards a Zero-Energy Campus.

PILOTING

The pilot will test the use of electrical batteries and Thermal Storage along with optimization of various building assets for increasing RES penetration in a multi-vector approach.

IMPACT

A step closer to carbon neutral campus by enhancing the Energy Management System and engaging local/external stakeholders towards a better understanding of their energy usage impact over the climate.

The Industrial Harbour

LOCATION

Fredrikstad

Norway

ENERGY

The harbor would like to reduce peak energy usage, increase self-consumption by producing emission-free energy and to utilize energy resources well.

VISION

The harbor works towards a vision and ambition of becoming CO2 neutral, by developing into an energy hub that will help reduce the emissions, with E-LAND enabling this transformation.

PILOTING

Intelligent control of battery storage, thermal heating and EV chargers, along with optimized schedule for harbor loads.

IMPACT

By developing Port of Borg to a green energy hub, reducing emissions from ship and land transport through the harbor and share results with other harbors.

The Technology Park

LOCATION

Huesca

Spain

ENERGY

The technology site is located in one of the limits of the Spanish electricity system, with various Renewable Energy Sources (RES).

VISION

The Spanish pilot aims to bring different technologies together and manage the united infrastructure in a coordinated way.

PILOTING

Increase in monitoring and intelligent control of various DERs, including HVAC system, Electrolyzer for Hydrogen production and EV charging infrastructure.

IMPACT

A showcase of green technologies and raise awareness among stakeholders of energy savings behaviours, promoting the economic growth of a rural area.

E-LAND

elandh2020.eu

Design: Smart Innovation Norway