Distributed platform for multi-model co-simulations in smart grids

PhDMAN

Oral Presentation

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Smart Grid

Main characteristics

- Shift from hierarchical architecture
- Bidirectional flows of data and energy

Objectives:

- Improve service reliability by increasing automation and monitoring capabilities
- New kind of actors
- Multi-energy approach

Challenges

- Manage data exchange (IoT)
- Manage Renewable Energy Resources (RES)

Research topic

Models for the co-simulation

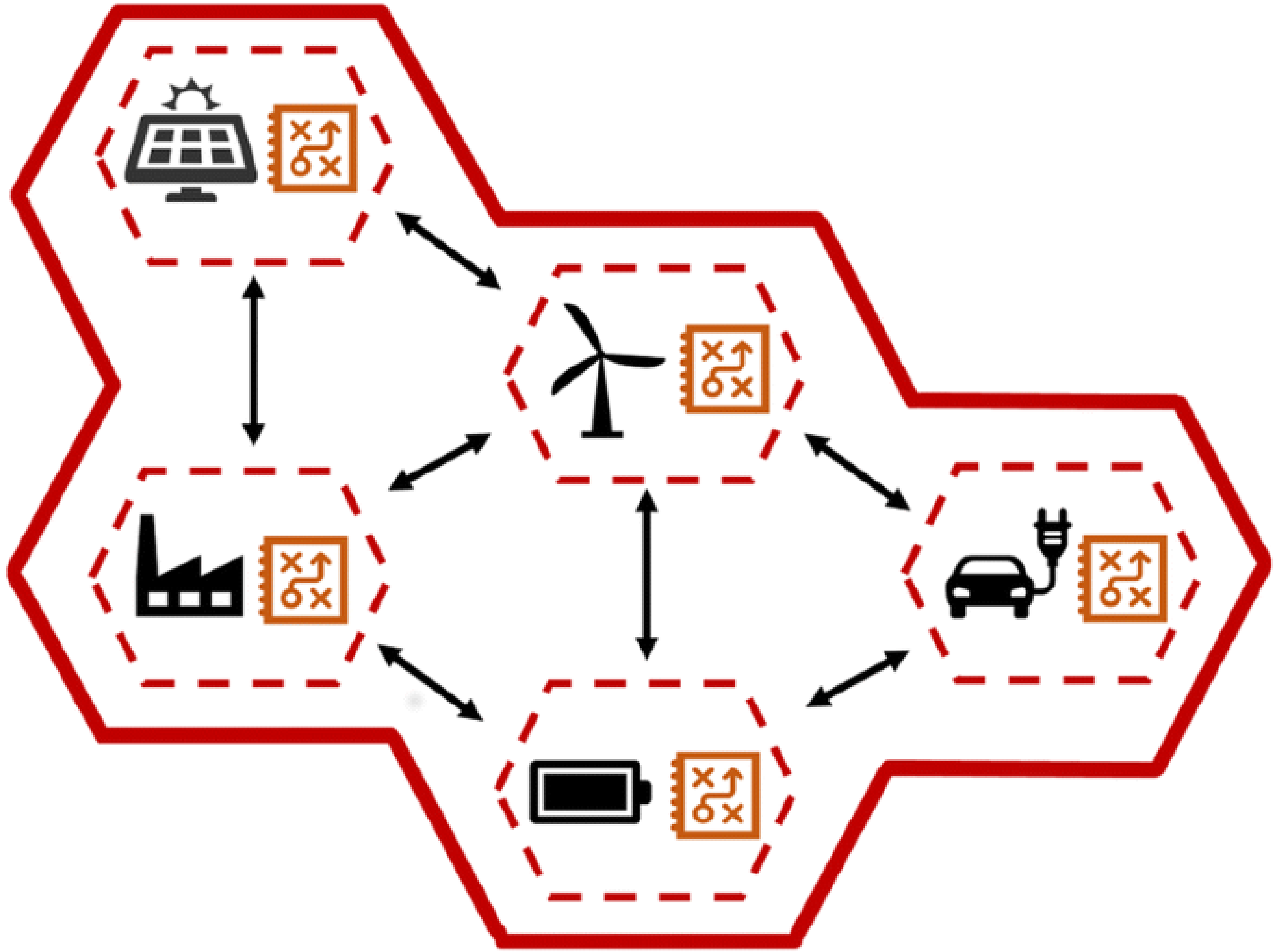
In order to reach these objectives to develop models that can seamlessly work together in different combination. Nowadays there is a lack of tools that enable to do so, the research is mainly focused on studying scenarios that include few models that most of the time are developed ad hoc to work with each other

The objective is study an create **models** for the smart grid scenario which can work in **co-simulations** infrastructure. This kind of research is needed to explore the possible scenarios that may appear in the shift towards the smart grid and find the best way to manage it.

Case studies for Smart Grid

State of the art

- Distribution network management (smart building, microgrid…)
- Transmission network management(**FDIR**,**metering** …)
- Distributed energy resource (**PV panels**, wind turbine…)
- Smart grid communication (protocol, **latency**…)



Metering and automation

State of the art:

- Meters are mainly used for building and distribution network
- Centralized evaluation of the state of the grid
- Low automation

Objective:

- Smart meter for transmission network
- Automation of outage management (self-healing grid)
- Provide a communication infrastructure

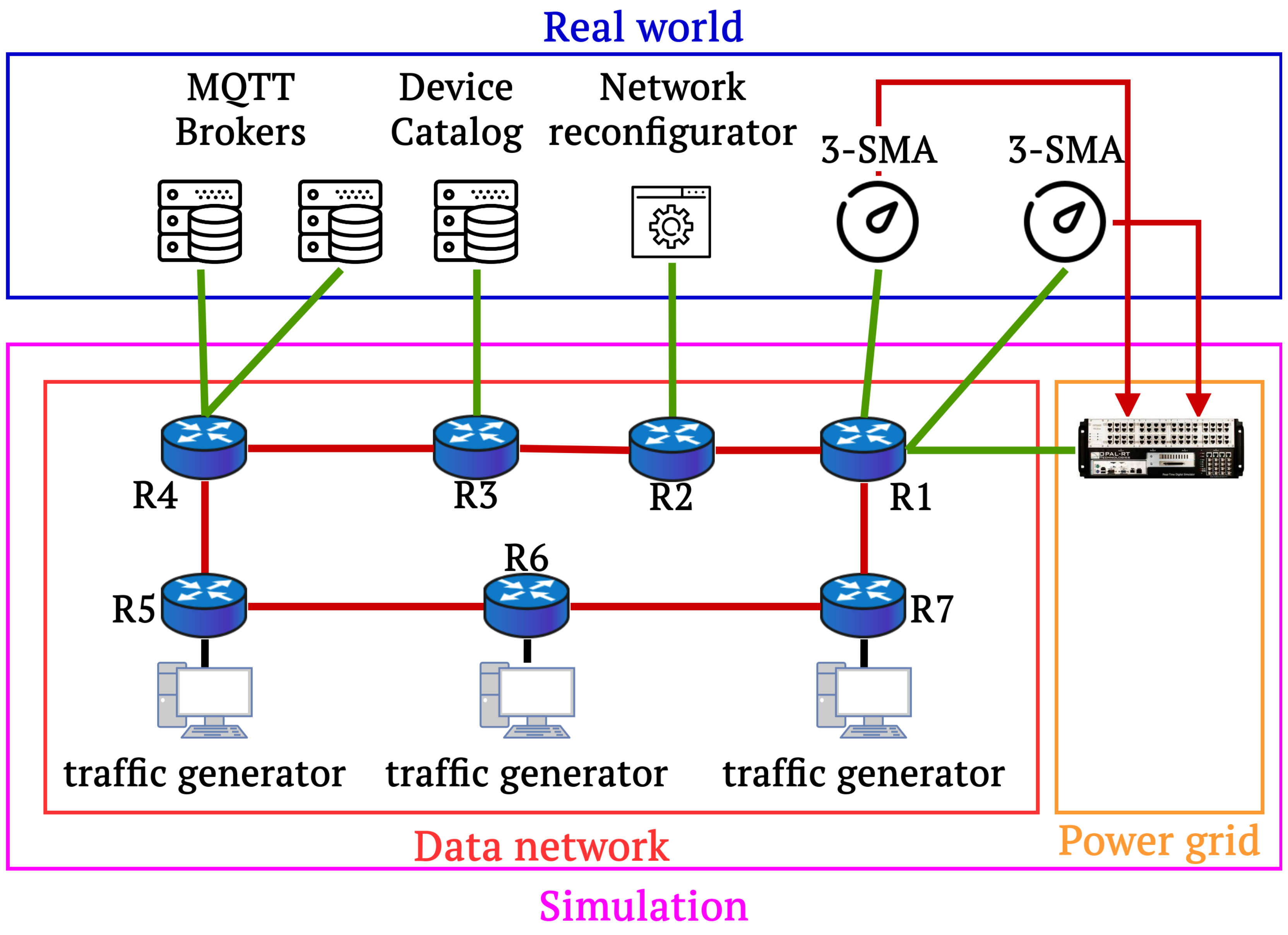
Challenges:

- Algorithms for grid management can be computational expensive
- Outages needs a lot of time to be solved and human intervention is needed to restore the service

3-phase Smart Metering Architecture

Proposed solution

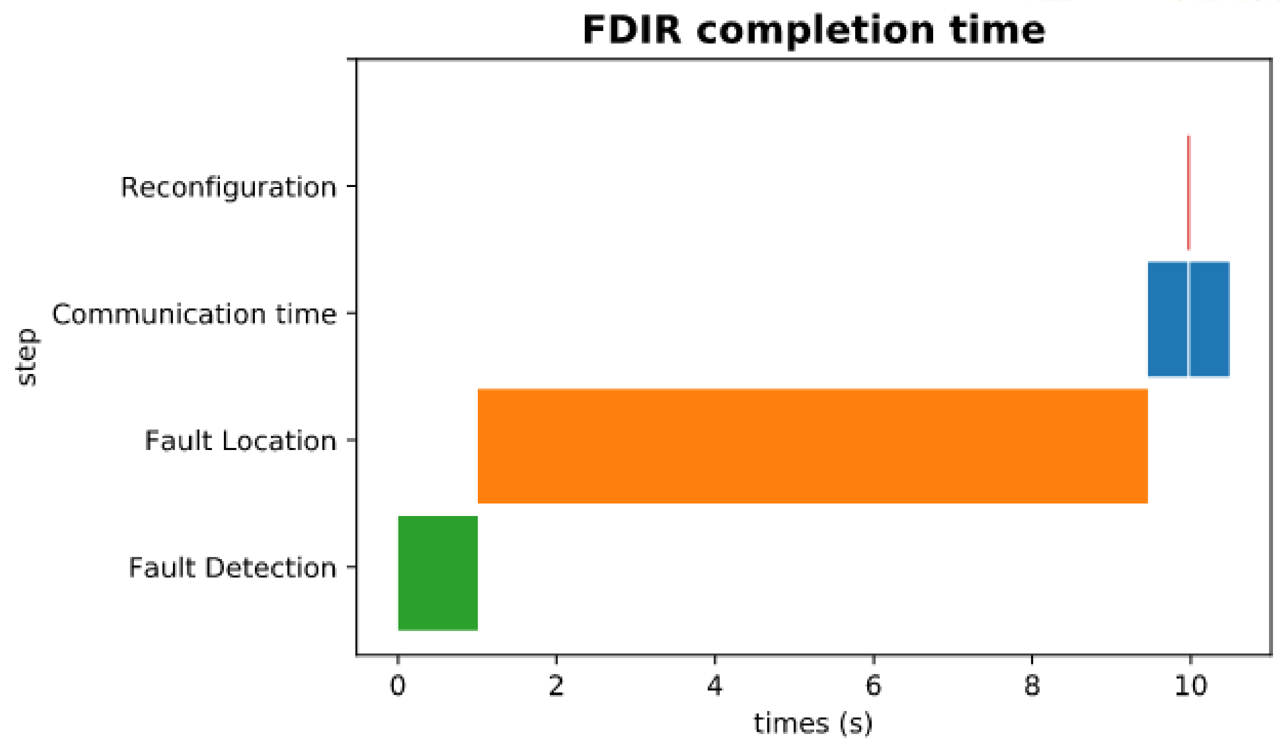
- 3-phase smart meter prototype with RTS
- Communication infrastructure (REST+MQTT)
- Self-configuration and auto-update of the devices
- On board algorithms (FD,FL, SE)
- External service (network reconfiguration)
- IoT actuators have been simulated

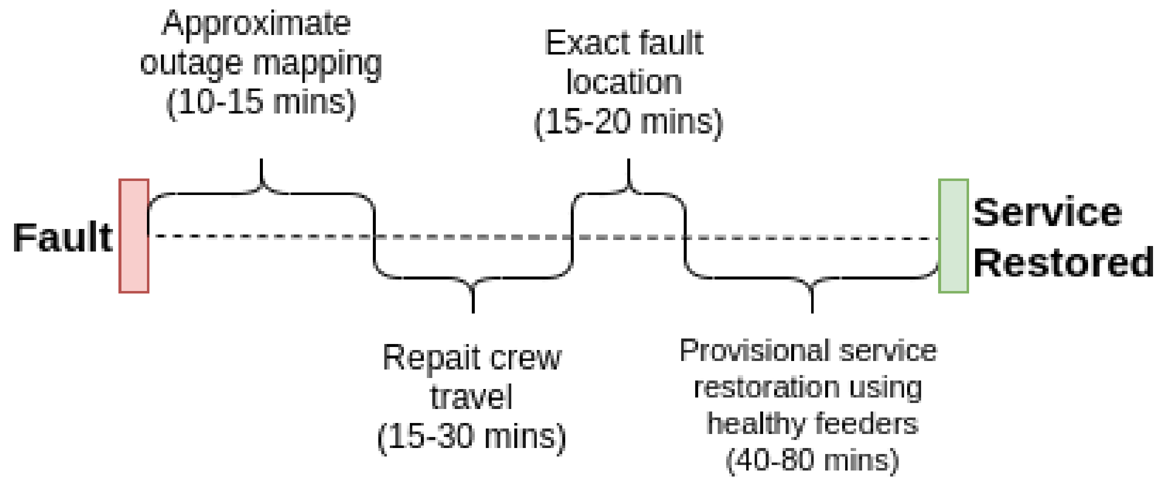


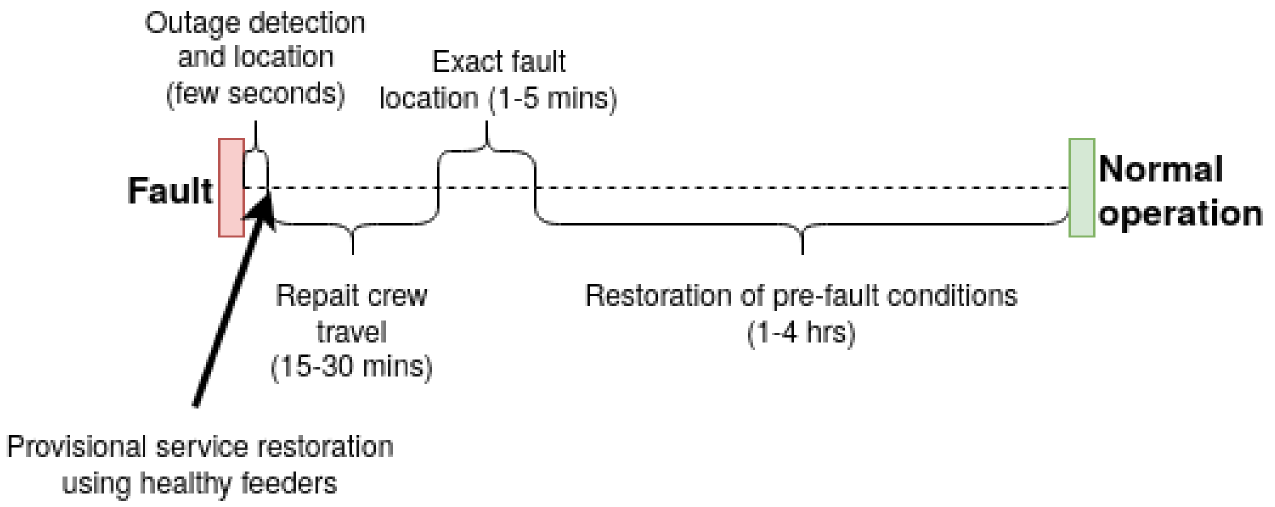
3SMA

Results

- State estimation capability
- Fast fault detection and location
- Restore of the service in a short amount of time
- Resilience to network congestion







"A Novel Internet-of-Things Infrastructure to Support Self-Healing Distribution Systems," 2018 International Conference on Smart Energy Systems and Technologies (SEST), 2018, pp. 1-6, doi: 10.1109/SEST.2018.8495717.

"A Smart Meter Infrastructure for Smart Grid IoT Applications," M. Orlando et al.,in IEEE Internet of Things Journal, vol. 9, no. 14, pp. 12529-12541, 15 July15, 2022, doi: 10.1109/JIOT.2021.3137596.

"Hybrid SiL and HiL Multi-model Co-simulation Infrastructure for Multi-Energy Systems" Work in Progress

RES and new actors

State of the Art:

- Shift from fossil fuel and decreasing cost of PV panels
- Appearance of new actors in the smart grid scenario (prosumers, renewable energy community)

Objective & novelties:

- Economic analysis of PV systems installation
- Analysis of multiple possible panels configuration

Challenges:

- Size of the data needed for a fine estimation of the production
- Shading effect of PV panels

Previous works

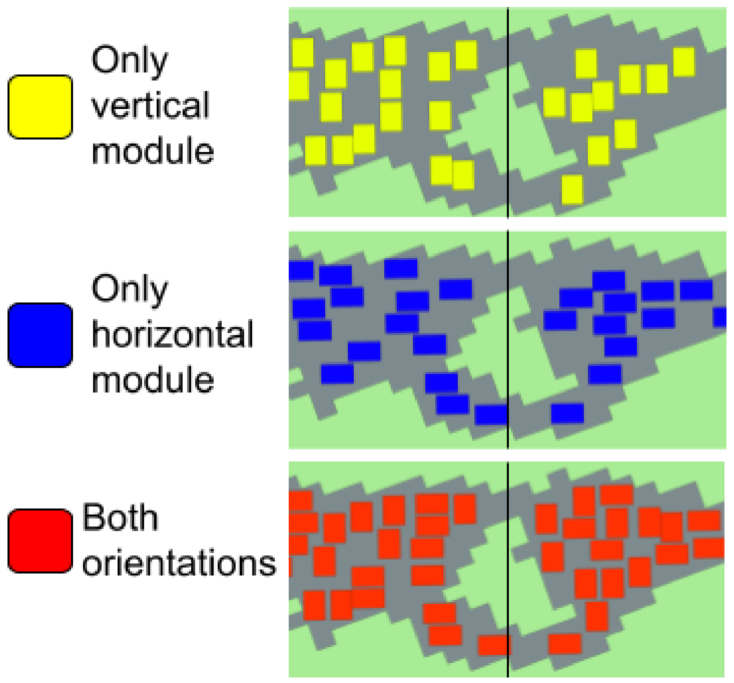
Design of District-level Photovoltaic Installations for Optimal Power Production and Economic Benefit.

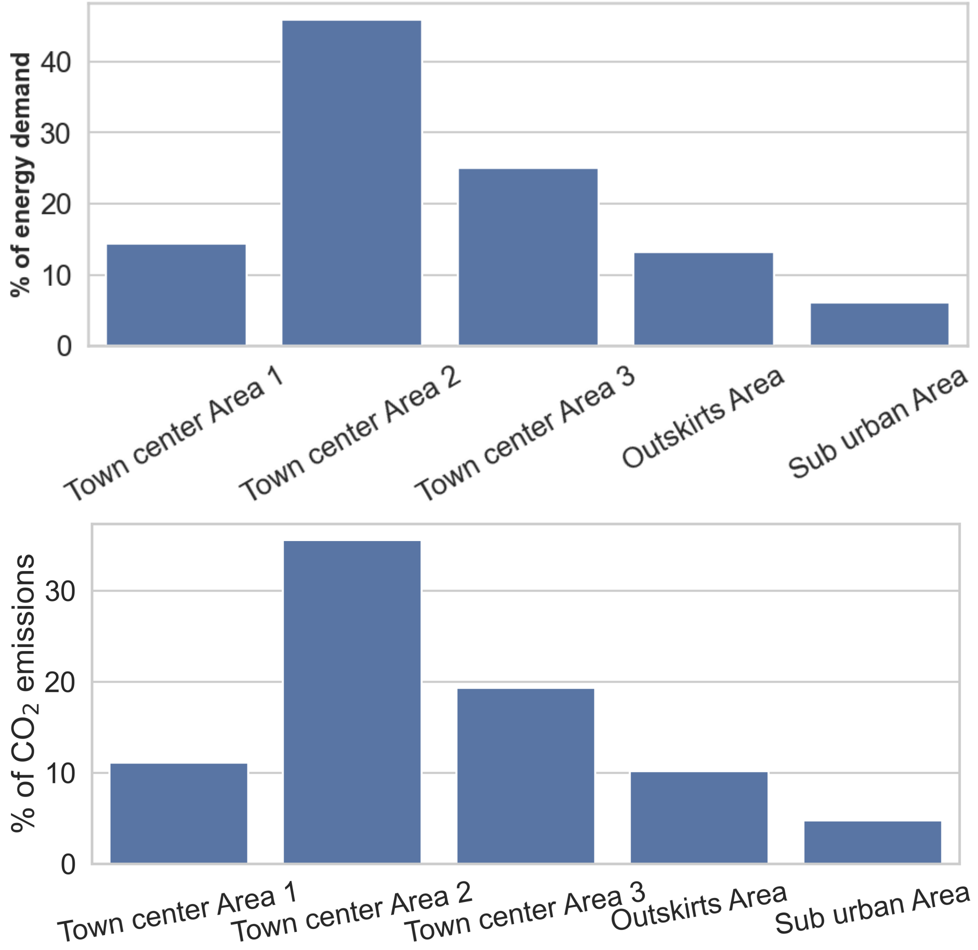
M. Orlando et al. "Design of District-level Photovoltaic Installations for Optimal Power Production and Economic Benefit," 2021 IEEE COMPSAC

A framework for economic and environmental benefit through Renewable Energy Community

Obtained result

- Possibility to evaluate systems with different panel orientation (also mixed)
- By simulating the consumption of a realistic population we can realistically evaluate the benefit of a REC
- reduction due to usage of renewable energy



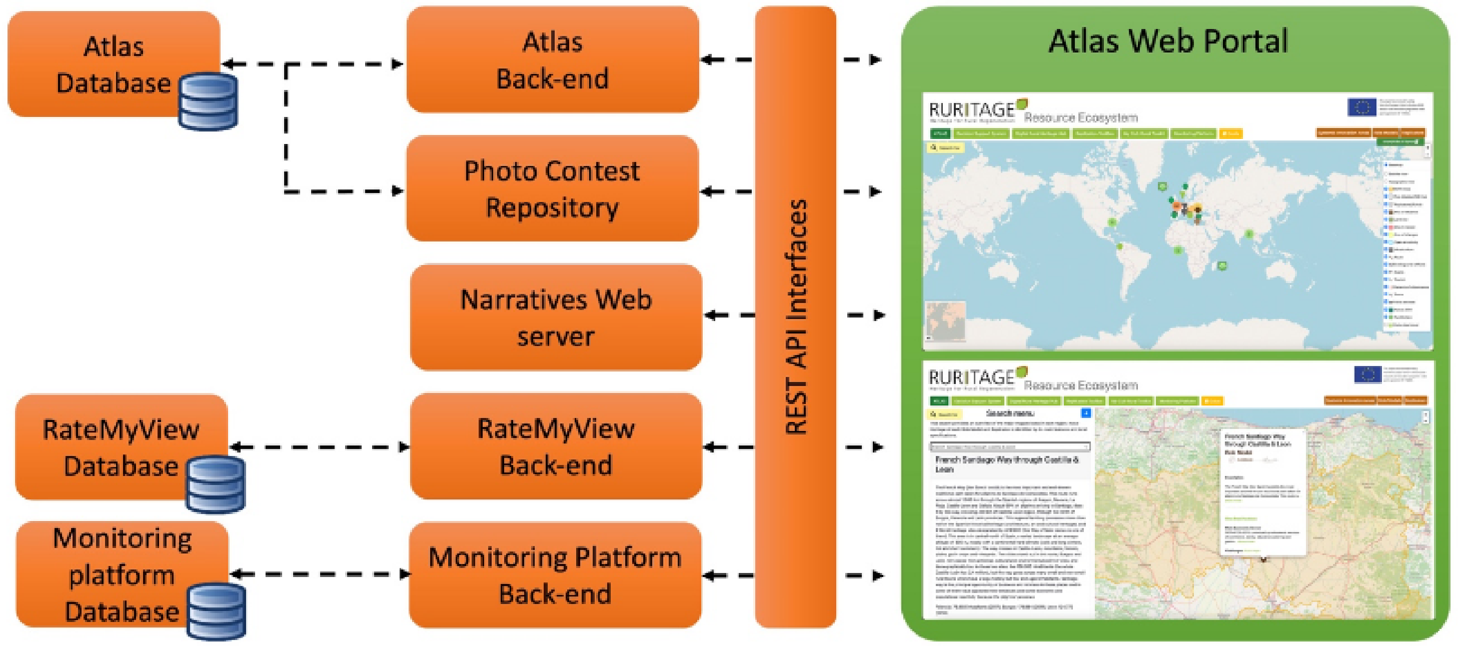


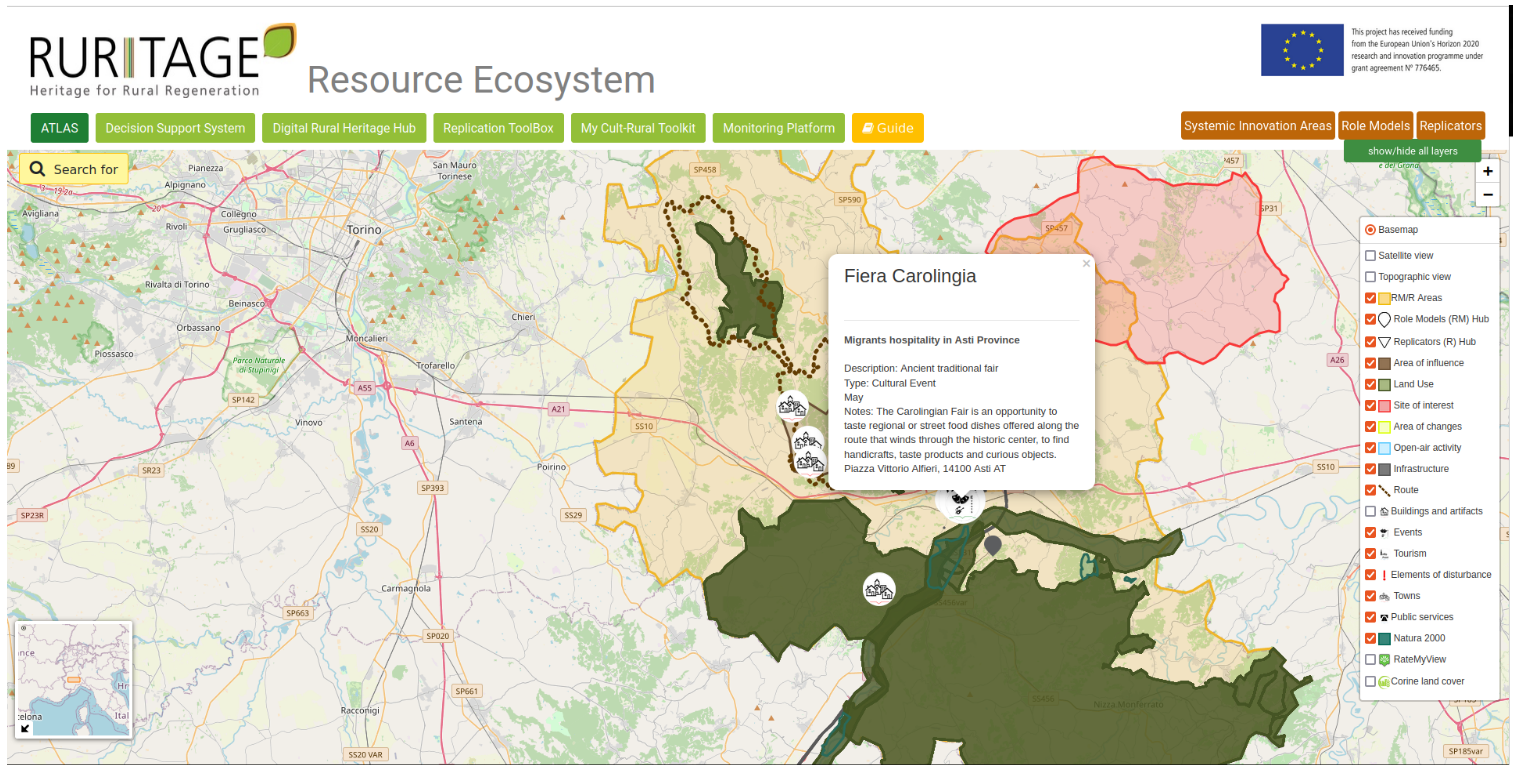
A framework for economic and environmental benefit through Renewable Energy Community" Matteo Orlando et al. IEEE Systems Journal , under review

Ruritage

Rural regeneration through heritage

This project gave me the opportunity to work in a multidisciplinary team that involves various professionals from different Academias and companies in Europe. My tasks were related to web programming and API integration





Tamborrino, R., Dinler, M., Patti, E., Aliberti, A., Orlando, M., De Luca, C., ... & Pavlova, I. (2022). Engaging Users in Resource Ecosystem Building for Local Heritage-Led Knowledge. Sustainability

Tamborrino, R., Patti, E., Aliberti, A., Dinler, M., Orlando, M., de Luca, C., ... & Pavlova, I. (2022). A resources ecosystem for digital and heritage-led holistic knowledge in rural regeneration. Journal of Cultural Heritage