exPEDite

Enabling Positive Energy Districts through Digital Twins

Allowing for real-time monitoring, visualization and management of district-level energy flows

Positive energy districts for sustainable climate change

Cities consume 65% of the world's energy supply and are responsible for 70% of the CO^2 emissions, hence sharing a lot of the responsibility for climate change. We are faced with the challenge of redesigning our existing cities to make them more sustainable, resilient, inclusive and safe. Developing Positive Energy Districts (PEDs), is a breakthrough way to deal with the issue of urban emissions and applying adaptation and mitigation strategies to climate change, while ensuring that these urban areas generate an annual surplus of renewable energy and net zero greenhouse gas emissions. PEDs must address environmental, economic and social issues, providing solutions to energy consumption, production, emissions, transport & mobility and livability. By constantly monitoring and evaluating parameters through existing and/or novel sensor systems (e.g., renewable energy production/supply, transport conditions, air quality, energy demand, meteorological conditions, etc.), unconventional techniques may be applied to provide more sustainable options for the district's needs.

Objective

ExPEDite aims at creating and deploying a novel digital twin, allowing for real-time monitoring, visualization and management of district-level energy flows.

A suite of replicable modeling tools will enable stakeholders to analyze planning actions towards positive energy in a cost-effective fashion, aiding their evidence based decision-making process. The tools will be able to model the district's energy production and demand, optimize for flexibility and simulate mobility and transport. By employing gamification and co-creation approaches, the project will enhance public awareness and engagement in energy efficiency. The project will culminate in the publication of practical guidelines, reusable models, algorithms, and training materials to aid other cities to replicate the digital twin for their districts, fostering widespread adoption of sustainable energy practices.

ExPEDite's vision will be achieved by considering the four components that contribute to PEDs:

1. Building stock energy efficiency;
2. Renewable energy sources (RES);
3. Energy flexibility;
4. E-mobility & sustainable transport.

Consortium

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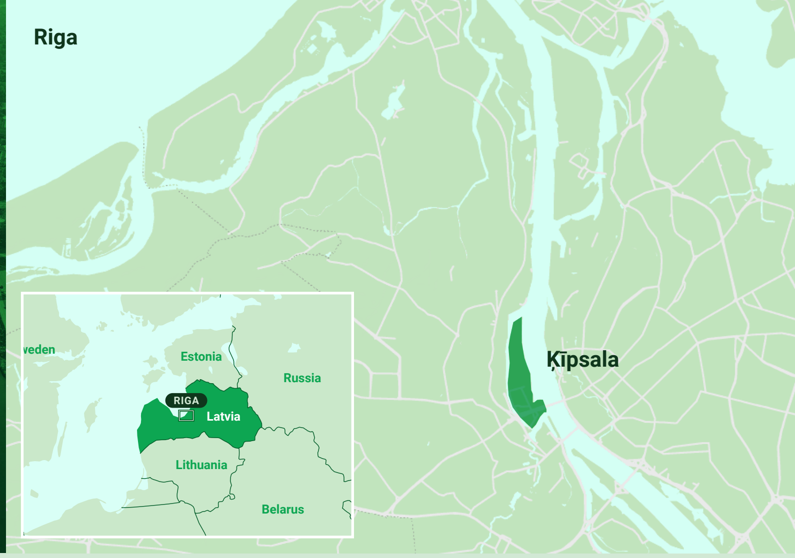

The pilot district

The ExPEDite **Digital Twin for Positive Energy Districts (PED)** will be deployed in the RTU smart student city, in Ķīpsala, Riga, Latvia, which covers an area of 17.5 ha. The district comprises 15 buildings with a total floor area of 119,264 m2:

- 12 faculty and laboratory buildings (maximum occupancy of 10,000 people)
- 2 dormitories (permanently housing 850 residents)
- 1 is an olympic-size swimming pool.

According to data from 2021, the smart city **electrical consumption** is ~5,000 MWh/year, while **thermal consumption** is ~8,000 MWh/year. The thermal consumption during the summer is mostly related to the supply of hot water. All buildings are either new or newly renovated, through an 80M€ investment.

The assets of the pilot district

In the pilot district the following assets are available:

- Conventional power generation: The university's heat supply is designed as a local centralized heat supply system.
- Electrical power, generated in combined heat and power (CHP) units, is delivered to the distribution network and sold to energy traders as regulated by local legislation and norms. There are two natural gas burners acting as heat sources (3MW and 6MW capacity), and two CHP units (1.6MW and 0.45MW thermal capacity). All heating is supplied from the CHP plants.
- Renewable Energy Sources (RES): a wind turbine (3.6 kW) and PV panels (11.7 kW) are connected to the faculty microgrid. In the future it is planned to power the campus entirely from local RES.
- Electrical storage: a commercial battery system is available (3.5kW power rating/ 60A/ 3.5kWh/70Ah) and an experimental prototype (144 40Ah lithium iron phosphate (LFP) cells, capacity of 18kWh). An interface converter can be used to connect to the grid. Installment of high-capacity storage for storing surplus energy from RES is planned.
- Mobility & Transport: The university operates a fleet of 13 electric vehicles (EV) (61kW power each). There are 5 EV charging stations on campus.
- Building Information Management Systems (BMS): 11 campus buildings have a BMS, following heating, domestic hot water production, air conditioning, ventilation and lighting functionalities. The efficiency classes of the BMS differ among buildings.
- Smart meters and other data collection: All campus buildings with a BMS are also equipped with sensors and smart meters for data collection (eg. temperature, CO^2, humidity sensors and sensors in the engineering systems). A weather monitoring station is installed in one building measuring wind direction, temperature, relative humidity, solar radiation, dew point, wind speed and gust speed. Electrical energy consumption data is available for each smart electricity meter from the DSO.

Expected outcomes

1
Increased number of (tangible) city planning actions for positive clean energy districts using the (proto-)PED design, development and management digital twin tools (based on pre-market research learnings) using open-standards based components which can be reused elsewhere.

2
Increased integration of existing smaller scale management systems (e.g. Building management systems) with open-standards based operational city platforms using sectorial data (e.g. building data, mobility, urban planning, etc.).

3
Enhanced data gathering approaches with identification of relevant multidimensional data sets (e.g. meteorological, load profile, social, geo-spatial, etc.) high-resolution real-time data streams (e.g. renewable energy production, energy consumption), and relevant forecasting data, drawing also on the work of common European data spaces.

4
Increased number of city planning departments / approaches using common data and (replicable) elements and processes.

5
Consolidated city sensor network specifications, complemented by appropriate data gathering approaches for soft data.

6
Improved performance of AI based self-learning systems for optimization of positive clean energy districts and bottom-up complex models.

7
Enhanced innovation capacity of local/regional administrations and accelerated uptake of shared, smart and sustainable zero emission solutions.

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