FinEst Centre
for Smart Cities

SMART CITY CHALLENGE 2025
Solution idea for the city challenges

Solution Idea Title – Resiliency-Based Urban Grid Planning

Planned pilot project duration – 24 months

Main contacts –

- Vahur Maask, vahur.maask@taltech.ee, +372 620 3703, TalTech, Department of Electrical Power Engineering and Mechatronics
- Tarmo Korõtko, tarmo.korotko@taltech.ee, +372 620 3708, TalTech, Department of Electrical Power Engineering and Mechatronics

1. Which urban challenge or problem are you planning to provide a solution to?

Stable Energy System in Crisis

2. The solution you are proposing

Electricity supply in cities is provided by distribution system operators (DSO), who are responsible for ensuring a secure and sufficient power supply. Cities rely on DSO planning and operating procedures to improve the resiliency of their power systems. Most DSO-s operate in multiple cities and plan their investments at least two years in advance. This results in cities having limited say and means to prepare for crises or adverse events.

We propose municipal electric grids for power system reconfiguration and redundancy. Most municipalities own and operate power systems through public streetlighting. For DSO-s, it is already common to plan and implement redundant, or N-1 (ensures the system continues to function even if one component fails), distribution grids and use operational reconfiguration of the system to ensure optimal loading of the grid. Our solution proposes that **municipalities build and own relevant grid infrastructure to achieve grid redundancy**. Aside from improved resiliency, network reconfiguration can create energy islands, enabling behind-the-meter energy sharing among municipal assets such as municipal buildings, public EV charging stations, PV plants and energy storage systems (ESS). The proposed solution relies on established technologies but applies an innovative approach to asset ownership and operations. As a result, municipalities receive practical and proactive measures to improve their energy supply resilience and optimise the self-consumption of locally produced renewable energy.

To realise the proposed solution, cities require tools for optimised planning of the redundant municipal grid. Within the project, we propose to **develop and pilot a GIS-based urban grid planning tool** that enables municipalities to **easily design and optimise redundant grid infrastructure** for improved resiliency through network reconfiguration and operation as local energy islands. This digital planning environment supports cities in creating resilient energy systems by integrating dynamic and static information across multiple domains, including power system assets (production, consumption, storage), existing grid infrastructure (substations, transformers, and feeder ratings), and geospatial information. The tool will enable planning, analysis, simulation, and validation of municipal grid layouts. Applications include determining cabling routes and types (overhead lines or buried cable; low- or medium-voltage; etc.), evaluating optimal locations for PV, wind, or cogeneration plants, estimating balancing/storage needs, and planning autonomous energy islands for critical loads. By providing a unified geospatial model for infrastructure, consumption, and renewable potential, the solution directly addresses the described need for a stable, crisis-resilient, and decentralised energy supply system.

3. Innovation and piloting of your pilot solution.

Today, several classes of tools already support parts of the challenge:

- **Distribution grid planning tools** can optimise cable layouts, substation sizing and reinforcement, but they target a centralised grid operator (DSOs) with homogenous asset ownership and direct control of assets.
- **GIS platforms for utilities** allow mapping of existing assets and basic routing, but they do not integrate energy flow or renewable energy potential analysis.
- **Microgrid design and optimisation tools** can model local energy islands and storage, but are mainly applied to single sites rather than a citywide network of assets with DSO and municipal distribution systems.

Our solution is innovative in four main ways:

1. **Municipal alternative-grid focus,** where instead of optimising the existing private DSO network, the tool is explicitly designed to help the city design a parallel, municipality-owned distribution network and local energy islands.
2. **Integrated geo-energy optimisation,** where we combine GIS layers with energy data in a single software environment. This allows cities to jointly optimise routes for new lines, locations for renewable energy sources and storage, and the topology of energy islands.
3. **Resilience- and crisis-driven planning,** where the tool is built around scenario-based resilience analysis covering blackout scenarios, partial grid destruction, and emergency islanding for critical services.
4. **Governance and co-existence** by design, where we explicitly model the co-existence of municipal and DSO networks, and operational modes (e.g. connected, limited exchange, fully islanded).

To pilot the solution in Vinnytsia (and in one Estonian city), the following prerequisites are required:

- **Access to existing IT systems and data:**
    - GIS data of the city administrative boundaries, land use, building footprints, protected zones, flood/earthquake risks (if available), etc.
    - Documented existing electrical infrastructure, including geospatial data and functional parameters about existing cable lines, transformer substations, generation plants, etc., for the DSO grid and municipal street-lighting grid.
    - Time-series consumption and load data for the relevant municipality assets and infrastructure.

- **Availability of local partners:**
    - Active and open cooperation with the local DSO to pilot procedural innovation for joint operation of the DSO and municipality grids.

The project is led by the Microgrids research group of TalTech, which covers the following competencies:

- **Distribution system planning,** including the modelling of radial and meshed distribution networks and microgrid islanding strategies. Experience with integrating RES, cogeneration, and storage into distribution networks.
- **Optimisation, data analytics, and decision support.** Development of multi-objective optimisation models (cost, resilience, emissions, coverage). Scenario analysis, sensitivity analysis, and visual analytics for non-expert decision-makers.
- **Framework for deployment.** Development of a documented framework assisting municipalities in managing procedural and buerocratic hurdles during the deployment of the solution.

Additional capabilities that are covered by project partners:

- **Spatial analytics** (potential TalTech partners: Road Engineering and Geodesy, Energy Economics, and Information Systems Research Groups; open for cross-institutional cooperation)
    - Spatial optimisation for routing, siting, and zoning of energy islands.
    - Software and information systems prototyping. Initial UI/UX preparation.
- **Software development and user interfaces** (potential partners: AlphaGIS OÜ, AS Datel, Regio OÜ)
    - Creation of robust, modular software for commercialisation beyond the pilot.
    - Software preparation for deployment. Integrating with companies' existing products and into their product portfolio.
    - UI/UX refinement for intuitive mapping and dashboard interfaces.
    - Prepare replication guidelines for other Ukrainian and EU medium-sized cities.

4. Expected impact of your pilot solution.

The proposed solution strengthens urban energy resilience, sustainability, and citizen well-being by enabling cities to plan decentralised, renewable-based energy islands that reduce dependence on a vulnerable centralised grid. By optimising the placement of new municipal lines, solar and wind generation, and storage through a GIS-based tool, the city can reduce CO_2 emissions, improve air quality, and lower long-term energy costs. Critical services such as hospitals, water infrastructure and schools gain reliable power even during crises, while citizens benefit from fewer outages, improved public health, and opportunities to participate in local energy communities. Overall, the solution accelerates the transition toward a cleaner, more efficient, and crisis-resilient urban energy system.