Brno's Pilot Smart City Project Špitálka Takes Inspiration from European Lighthouse Cities

Ivana JAKUBOVA

Brno University of Technology, Technická 12, 616 00 Brno, Czechia

jakubova@vut.cz

Abstract. *Under the EU project RUGGEDISED (*Rotterdam, Umea and Glasgow: Generating Exemplar Districts in Sustainable Energy Deployment*) several European cities are formulating, implementing and sharing their innovative solutions. As a part of this project, the city of Brno has chosen the unused land of the western part of the heating plant Špitálka to be its replication area and the future pilot smart district. Nowadays Špitálka serves as a testbed for replicating successful solutions and verifying modern technologies and approaches for their possible expansion all over the city. This article considers some of the selected solutions from the RUGGEDISED project and reflects on the conditions for possible replication within the Špitálka project.*

Common Way to Sustainable Development and Resilience

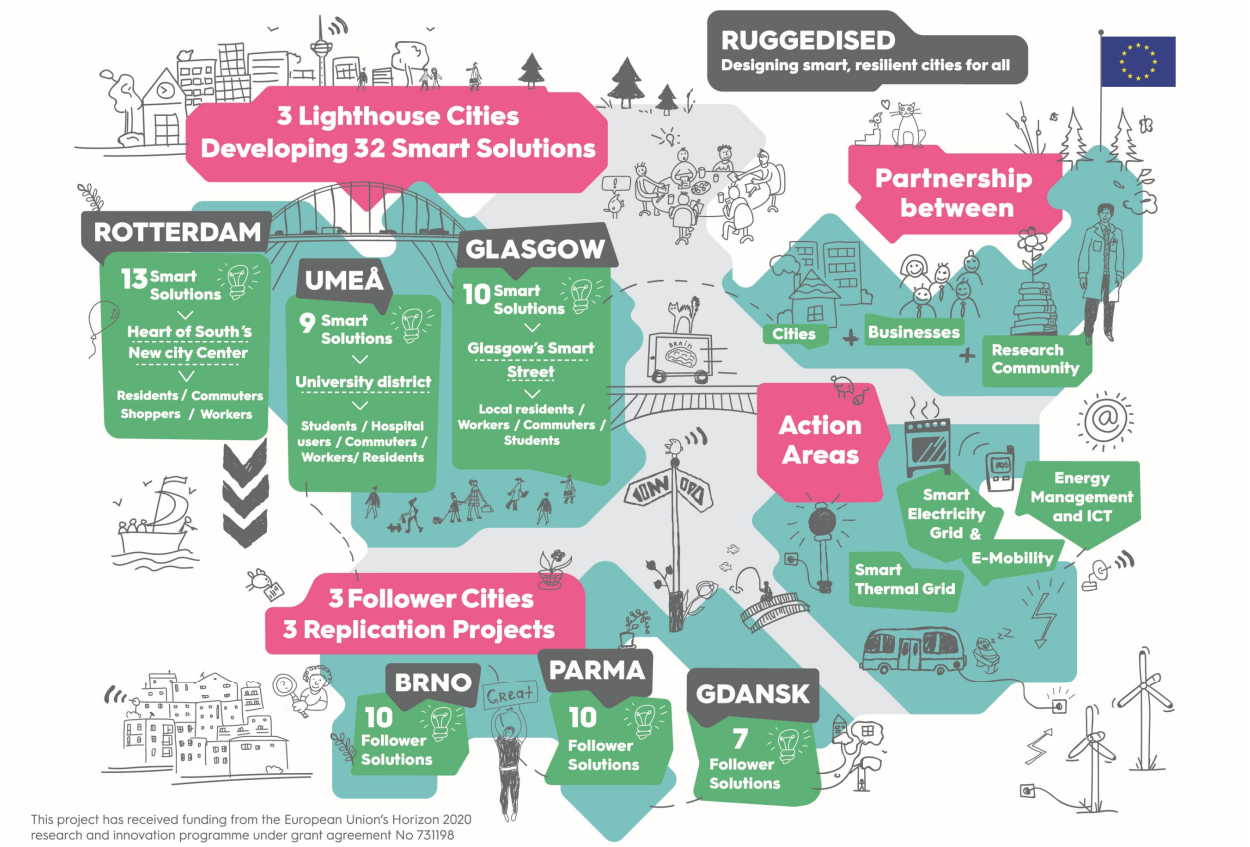
In recent years, the European Union has placed increasing emphasis on sustainable development and resilience based on advanced environmentally friendly technologies. Numerous meetings and negotiations preceded the adoption of the final documents binding on all EU members. It is not surprising that agreements on such a complicated subject, which includes not only technical, but also strong economic and social aspects, are by no means easy. Not only the legal obligations of EU countries, but perhaps even more so the unmistakable signs of climate change, pandemic and political turbulence have awakened the interest of many institutions, municipalities and individuals in the application of modern technologies in everyday life. The effort for decreasing the carbon dioxide emissions and weakening the fossil fuel consumption becomes one of the leading factors of recent innovations.

It is clear that innovative solutions are associated with a certain degree of risk which could be suppressed by mutual exchange of practical experience of similar subjects. Since 2014, Lighthouse projects have been funded which are driven by the same challenges that EU cities are facing to ensure secure, affordable and clean energy, smart electro-mobility and smart tools and services, always showcasing their economic viability towards ensuring their replication potential in other cities. RUGGEDISED is one such project that works to demonstrate the processes, technologies and business models to transform their ecosystems into smarter and more sustainable places (ruggedised.eu). The project RUGGEDISED received the support under the call Smart and Sustainable Cities of the HORIZON 2020 program.

Rotterdam in the Netherlands, Umea in Sweden, and Glasgow in Scotland are so called "lighthouse cities" that are not only trying to implement their own innovative solutions but simultaneously sharing their experience with so called "fellow (or follower) cities". The group of fellows includes Parma in Italy, Gdansk in Poland and Brno in Czechia.

34 project partners, namely city councils, research institutions, universities, industrial enterprises and companies, the Brno City Municipality and Brno University of Technology among them, formed a consortium and have started dealing with the complex issues. Each of lighthouse cities has formulated its own solutions, has implemented them and offers the obtained experience to the fellows not only in published partial and summary implementation reports, but also in specialized discussions during face-to-face and online meetings and study visits. Certainly, individual solutions must differ as they are prepared to meet individual needs and conditions of each city, but the palette of individual solutions in all the cities always covers the main groups of closely interrelated issues: energy (both electric and thermal, its production, storage and consumption), mobility (especially E-mobility and public transport), and data acquisition and usage for various purposes.

The pioneer nature of the innovative solutions causes that unusual steps should be done, nevertheless economic and social points of view require preliminary testing and limited scale verification. For that reason, even in lighthouse cities innovative solutions are applied only in selected districts: Heart of South in Rotterdam, George Street and Duke Street in the center of Glasgow, and University District in Umea. Typically, these are not sites that are upscale and representative, but rather neighborhoods that are in need of redevelopment, are inhabited by common people, include many diverse businesses or places for community activities, or have a connection to education and health care.



Infographic (RUGGEDISED project).

Brno's Replication Area Špitálka

According to their own needs and intentions, the fellow cities can choose some of the offered solutions for replication. In the city of Brno, innovative solutions are planned to be replicated in a selected part of the district of Špitálka. The Špitálka district is directly linked to the historical center of the city and is part of the protection zone of the city's heritage conservation area. In the 19th century, Brno was called the Moravian Manchester and the town still bears the stamp of its industrial past. Brownfields with dilapidated buildings of former factories must be rebuilt and revitalized. With regard to the preservation of the historical context and genius loci, the Špitálka project aims to transform the former industrial area in the western part of the heating plant of the company Teplárny Brno into a modern smart district.

In 2017, the Brno City Council decided to use the land as a replication site for the RUGGEDISED project. As the first step, it was necessary to determine the urban design for the new function of the site. Therefore, an International Urban Planning Competition was organized for the wider area, and a Zoning study was prepared as the primary document to change the city zoning plan. Later, an urban architectural proposal of the future smart district, the so-called Master Plan, was prepared.

Innovative trends that could be exploited during construction were not only inspired by the RUGGEDISED project but also researched and discussed within a series of six expert roundtables organized by the city of Brno together with Brno University of Technology. The outputs from them were incorporated into the so-called White Book – a document that contains specific conditions for the implementation of the construction and complements the previously presented Master Plan in terms of the use of innovative technologies and approaches.

The final stage of the project RE: Špitálka, currently underway, focuses on the preparation of project documentation and the search for a strategic investor who will bring the reconstruction of Špitálka to a successful conclusion. During this stage, also experience of lighthouse cities in

Current state of the locality (The Brno City Chief Architect's Office).

creation and modelling of suitable business plans in selected fields can be useful. Construction of the Špitálka Smart District is planned by the end of 2025 and will be completed in 2028.

Heat and Cold Production and Exchange

Each of the RUGGEDISED cities, both lighthouse and fellow cities, strives to support the use of local renewable energy sources, to achieve as much independence from fossil fuels and to reduce carbon dioxide emissions as efficiently as possible. Naturally, conditions in all the cities differ from each other, namely due to different location, climate, and also social and economic circumstances. A great advantage of Špitálka is that this smart district is still in the planning phase and can incorporate the use of innovative technologies into the emerging project documentation in advance.

The total energy consumption for heating and cooling can be decreased as the passive standard is required for new buildings and the Nearly Zero Energy Building Standard (NZEB) for refurbished buildings. Similarly as in lighthouse cities, thermal pumps and geothermal heat/cold storage are intended as a substantial part of the district's thermal grid. The total energy balance of the smart district will be preferred to the balance of individual buildings, thus mutual exchange of heat and cold is a necessity. It appears that Špitálka does not have aquifers which enable Rotterdam's Heart of South to store large amounts of thermal energy and its Ahoy Centre to become completely independent of fossil fuels. On the other hand, lighthouse cities' solutions offer other interesting innovative possibilities, such as use of surplus heat from different facilities (bakeries, breweries, servers and data centres, etc.), collecting of heat from waste or surface waters, from asphalt pavements, etc.

Electricity from a Renewable Source

As in all the lighthouse cities, photovoltaic panels are planned to be the crucial source of electricity. Špitálka project is guided by the principle: People over technologies, which is reflected in the whole process of building the smart district. The green roofs of the buildings will be connected with a unique trail in the clouds (skywalk) and will be used for leisure time activities, including sports and community gardening. Green roofs substantially reduce the heat island effect, improve the local climate and help create a lively and modern neighborhood where people can comfortably live, work and spend their leisure time. Such vegetable roofs can be used for installation of photovoltaic panels only to a limited extent (transparent panels at "bio-solar" roofs). Thus, most photovoltaic panels are to be installed on facades of new buildings or as shading elements in public spaces. Due to this limitation, Špitálka probably will not be able to cover all its consumption from PVE sources.

The nature of photovoltaic electricity production requires energy to be stored in batteries and then consumed with respect to preferred goals (peak shaving, cost savings, suppression of dependence on fossil fuels, etc.). For optimal usage of electricity from photovoltaic panels, lighthouse cities have created several different models which can be inspiration for the smart district of Špitálka.

Keeping in mind that electricity will be consumed not only inside (in flats, offices, cafes and restaurants, in a concert hall or gallery), but also outside, several smart solutions may be considered. In public spaces of Špitálka smart LED public lighting with automatic dimming and brightness control depending on time of day, amount of natural light and on ambient traffic is to be deployed. Here, Glasgow's experience could be useful where street lights columns with integrated charging units for e-cars and air-pollution sensors connected to the wireless communication network are tested.

E-mobility

In recent years, in order to combat global warming by significantly reducing greenhouse gas emissions, the European Union has strongly supported and promoted E-mobility. It became one of the essential features of the smart city concept, and no wonder that all the lighthouse cities have included e-mobility among their innovative solutions. As mentioned above, Glasgow has tested e-charging units integrated in street light pillars while Umea was working on building an e-charging hub and infrastructure in the Campus of Umea and near the hospital entrance. In Umea, both semi-fast (22 kW) and superfast (50 kW, 250 A) chargers are available for workers, students, public, e-taxis, etc. Available E-car chargers should enable both inhabitants and taxi companies to switch to a more environmentally friendly energy source - the goal being environmental benefits in terms of reduced exhaust emissions and also lower noise levels in the area. In Rotterdam's Heart of South, the plan to reduce peak loads by introducing smart charging at parking lots failed due to legal hurdles and its alternative version has wrecked on the intended usage of the private parking area of Ahoy for concerts and similar events. Even such a partial failure could serve as a helpful warning for fellow cities.

In the smart district of Špitálka, the circumstances are different. The smart district itself is relatively small in size and its connection to the city's wider transport network is still being planned. Furthermore, the new residential buildings form an imaginary ring with a central open space, the inner square, allowing a large number of visitors and users to meet. The buildings are designed to be deliberately 'open' to let visitors through towards the site, while allowing for the intimacy of the internal spaces. In such a district, the main support for e-mobility must include espe-

cially slow chargers (e. g. wallboxes) enabling inhabitants and workers to charge their e-cars, e-bikes and e-scooters during working hours or overnight. It is necessary to ensure sufficient and suitable space for the installation of the distribution transformer station and at the same time to consider sufficient power capacity to equip all parking spaces with this type and character of electric vehicle chargers. On the contrary, there is no need to install fast chargers inside Špitálka as this is solved within the realization of the total traffic connection in the surroundings. Coincidentally, the company Teplárny Brno, on whose unused territory the smart district of Špitálka is planned, is already building a network of public chargers in Brno, including also fast chargers up to 150 kW.

Smart Neighborhood Must-haves: Data and Wireless Network

Smart cities are characterized as technologically modern urban areas that use different types of electronic methods and sensors to collect specific data from citizens, devices, buildings and assets, process and analyze gained information and utilize it to monitor and manage e.g. traffic and transportation systems, power plants, utilities, water supply networks, waste, information systems, schools, libraries, hospitals, and other community services. Furthermore, smart data portals make the data available to the public and create a breeding ground in which anyone can use the city's data for their innovative projects, for research, control or to inform themselves about the current state of affairs in the city.

Obviously, just data, its acquisition, collecting, monitoring, analyzing and widespread use is a fundamental feature of smart cities.

All three lighthouse cities have paid close attention to data and its use for different purposes and with various degrees of generality. The Glasgow's intelligent street lights have been mentioned above.

Photovoltaic power plants cannot be efficiently operated without thorough measuring, data acquisition and sensible control of the operating regimes of power storage and consumption. Sophisticated models, both technologic and business, have been created in lighthouse cities aiming mainly to peak shaving, cost savings and decreasing the dependence on fossil fuels. It is worth noting that these models require long-term investigation of local conditions, users' behaviour and also economic circumstances, but after a suitable tuning their contribution may be decisive.

Very interesting design of intelligent building has been introduced in Umea. The city of Umea prefers improved utilisation of existing buildings instead of building new buildings for the increasing number of people and tries to decrease energy consumption using rather organizational (real occupancy, better booking, etc.) than technical means (better thermal insulation, airtightness, etc.) The energy usage and climate of the room can be optimally controlled, depending on human presence, solar radiation, internal load, outdoor temperature, weather forecast and other parameters. Automatic control for ventilation, heating, cooling and lighting, based on measured data, and combined with weather data analysis and prediction of the coming heat load, allow the heating supply of a building to be turned down for a while, which does not cause a noticeable drop of indoor temperature but brings surprisingly significant savings. Careful monitoring of occupancy in combination with weather forecast enables to use buildings (esp. of concrete, bricks) as thermal energy storage hubs in the way hot water tank storages are currently used. Thanks to that, district heating providers can avoid using peak load units. The system is even more effective if more buildings of mutually different operational modes are involved. Špitálka, where modular units in new residential buildings are adjacent to a large two-aisle event hall (old shed) and a cowork hub (old archive), is just a case. Thus the replication potential of the system of Umea could be substantial and should be considered.

In Špitálka, the smart system of energy consumption will be deployed. Electricity consumption of major appliances will be automatically shifted to off-peak hours. The system will be equipped with identification of low and high tariff, including the feedback to users (e.g. warning about excessive consumption during peak hours). Due to their planned nature, real consumption of many individual consumption points can be assumed as standard (low). Nevertheless, the intention of full on-site smart metering is reasonable not only because of rising energy prices, but also as a tool for deeper involvement of users in energy savings concerning environmental impacts.

Very inspirational are the attempts of lighthouse cities to create a digital twin of the district (Rotterdam, the Heart of South), or a smart open data Decision Platform & central management system (Glasgow, Umea). Collecting large volumes of data from various sources and making them freely available to all is a very complex task connected with many technical and legal challenges. The impact to business, living, decision making in the city can be strong. Undoubtedly, the existing data portal of the city of

Visualization of the future smart district (Atelier A8000).

Brno (https://data.brno.cz, launched in March 2018) will draw further impulses from examples developed in lighthouse cities and thus further contribute to improving the quality of life of inhabitants.

Conclusion

Both the general public and the professional public are watching the impressive pictures of the future smart district vision with interest. The pictures might look like castles in the air. However, behind them, there is a lot of complex business negotiation, careful planning, technical calculations, and among other things, inspiration from pilots of lighthouse cities. Nowadays, project documentation for obtaining zoning and building permits are being prepared. In 2023, these steps will be followed by market consultation and selection of a strategic partner, and in the following two years, by construction of transport and technical infrastructure. In 2025, the construction of the Smart District RE: Špitálka will begin, and in 2028 it should finish. As explained above, this pilot project benefits from innovative solutions of lighthouse cities, will verify the use of modern technologies and approaches for their possible expansion all over the city, and will outline the possibilities for future development of the broader area of Špitálka and the city of Brno.

Acknowledgement

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