BEST PRACTICE IN SMART CITY APPLIED RESEARCH IN SMALL AND RURAL MUNICIPALITIES

COMMON CHALLENGES AND OPPORTUNITIES FOR COLLABORATION BETWEEN RESEARCH AND PUBLIC SECTOR IN NORWAY AND THE CZECH REPUBLIC

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Executive Summary

The Czech-Norwegian bilateral exchange focused on the common challenges that hamper the development of small Czech and Norwegian cities towards technologically advanced and sustainable "smart cities". Furthermore, we specifically selected those challenges that can be addressed with joint capacities of R&D centers and municipalities, i.e. sustainable construction, public buildings and public space assessment, energy efficiency, stakeholder engagement and access to expert know-how.

While we work with the terminology of the smart cities concept it is important to acknowledge that for the small cities in the Czech Republic it is more often the basic services that require the attention of the municipal authority than advanced technological solutions. To quote one small municipality head of investment: "for the next twenty years we will be mostly coping with necessary repairs of degrading infrastructure instead of investment into town's technological upgrade". This illustrates the point of departure not only for the Czech small municipalities but also for many small rural places in Norway.

Following report was prepared for local municipalities and regional and national authorities. Its purpose is to serve as a source of best practice and recommendations for implementation of smart and sustainable measures in small cities and towns in the Czech Republic and Norway. It further shows how the local authority may make use of closer collaboration with public research and development sector.

Results of exchange between University Centre for Energy Efficient Buildings and Western Norway Research Institute are summed up in six sections describing areas of:

1. Attractiveness of public space and its livability,
2. Planning for access to renewable energy sources,
3. Electromobility,
4. E-health and assistive technology,
5. Human resources.
6. Stakeholder engagement.

1 Basic information about institutions

1.1 Western Norway Research Institute (Vestlandsforsking)

VESTLANDSFORSKING

Western Norway Research Institute (WNRI) is a non-profit research institute contributing to innovation and development of policy in areas of sustainable development, climate policy, energy, transport, tourism and innovative technologies with close relation to public and private sector in the Sogn and Fjordane region. The institute has been active in national and international projects for over 25 years with special focus on EU projects. Implementation of such projects has also led to regeneration of the region, economic growth and creation of jobs in business sectors like IT, tourism and agriculture.

Together, WNRI and the regional campus of Western Norway University of Applied Sciences constitute a collective specialist community, with approximately 200 academic posts. Researchers from the College also participate in projects carried out by WNRI and have competence in the academic fields of social studies, natural sciences, technology and the humanities. The institute works closely in partnership with local and regional authorities as well as private companies actively involved in relevant business sectors.

1.1.1 Main areas of applied research

The main areas of applied environmental research are local and regional environmental and climate policy, sustainable tourism, sustainable mobility and Life Cycle Assessment (LCA) analysis of products and services. WNRI has also experience on developing ICT based analysis and training tools relating to environment and climate issues; e.g. individual ecological footprint tools and transport emission calculators.

1.2 University Centre for Energy Efficient Buildings (CTU UCEEB)

University Centre for Energy Efficient Buildings (UCEEB), a part of the Czech Technical University in Prague (CTU), is a research center focused on applied innovations in buildings. Main goal of the center is to produce knowledge in the field of energy efficiency of buildings and implementing this knowledge in practice through close cooperation with industry and municipalities. UCEEB liaise with industry and municipalities in over 40 collaborative research projects and more than 100 contract research collaborations per year. UCEEB offers complex research programs that help to prepare high quality applied research for practice. Their knowledge supports competitiveness of small and medium enterprises. UCEEB building was officially opened in May 2014 with 20 laboratories that offer state of the art equipment.

1.2.1 Main areas of applied research

Laboratories are joined into five research programs: (1) Architecture and the environment, (2) Energy systems of buildings, (3) Indoor environmental quality, (4) Materials and structures, (5) Control and monitoring of intelligent buildings.

Across the five-research programs the main topics pursued in international research projects at UCEEB are sustainable construction, sustainable building assessment and technologies for smart cities.

In its four years' history UCEEB has produced several innovative technologies which are now in different stages of commercialization. To mention several prominent examples:

- **Envilop** is a new type of environmentally friendly light façade system. The technology is designed to replace obsolete curtain wall systems still widely used especially in Eastern Europe.
- **Wave CHP** is a small combined heating and power unit based on organic Rankine cycle powered with biomass or waste heat. The technology allows its users to run decentralized micro power plant, thus increasing their energy resilience.
- **Moisture guard** is a sensor system for monitoring moisture in critical spots of the timber constructions. Using this technology, the user can prevent irreparable damage to buildings such as family houses and other timber based structures.

2 Mapping the challenges and best practice in small and rural municipalities

European Commission supports development of smart cities across Europe through its innovation actions. So far EU focused on medium to large urban areas. This is best demonstrated on the distribution of partner municipalities based on their size in so called lighthouse projects (H2020 SCC-1 calls). SCC-1 projects are following the principle of leading by example where less developed followers learn to accommodate best practice from the lighthouse or pilot cities.

The figure below shows that under the H2020 program only one city below 50,000 inhabitants (or 2%) was involved as a partner in any of these projects while no city below 20,000 took part. The average size of the lighthouse city was 1,2 M people while average-sized follower had around 450,000 inhabitants (EC Open Data Portal).

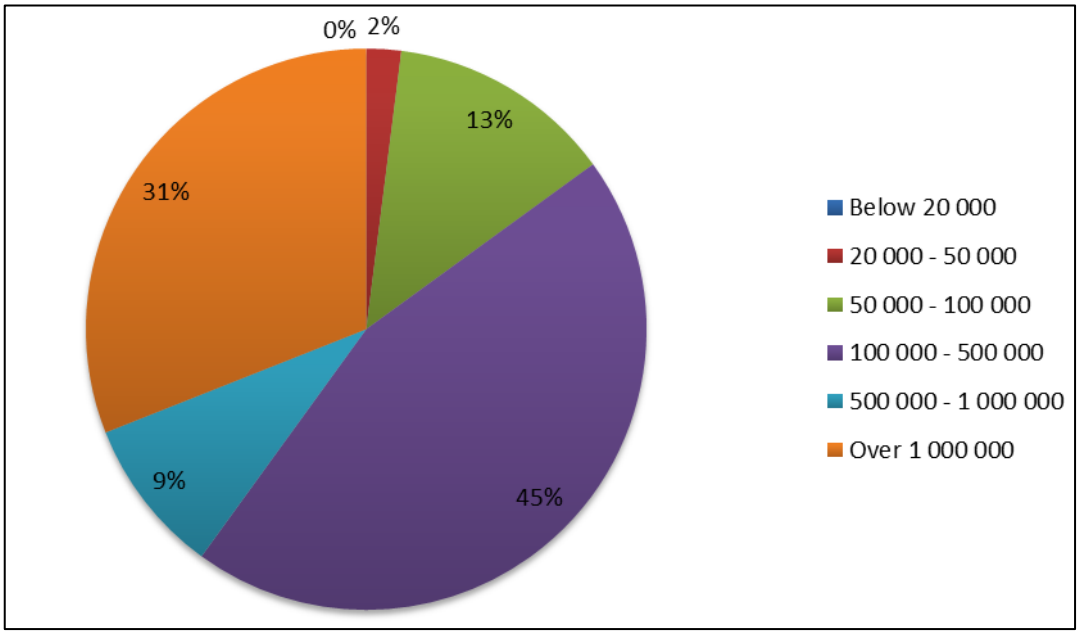

Figure 1: Distribution of lighthouse (pilot) and follower (early adopter) cities in H2020 SCC-1 projects based on their population size (as of 4/2017)

Even if we acknowledge the importance of the European metropolitan centers for the economic performance of the EU as a whole and its competitiveness, small cities should not be left apart. Between 20 and 40 % of European countries' population lives in small and rural municipalities, therefore they represent a significant component of the EU's urban landscape and economy. It is also in these areas where the gap between needs and resources could endanger sustainable development and adoption of new technologies. Therefore, we looked closer on the small city segment and its developmental challenges.

This report aims to highlight challenges and problematic areas of small-sized cities and rural places development. Our aim is to show where the differences from more dense and bigger cities lay with a focus on technological development, especially in the field of construction and energy while other issues such as citizen engagement are taken into consideration.

The report provides overview of best practices and recommendations for municipalities that are in line with the regional development policy. Recently the Central Bohemian Innovation Centre decided to support the development of implementation of Smart City concept in Central Bohemia region, where UCEEB is located.

2.1 Defining Smart and Sustainable Rural Cities

In order to increase the terminological clarity, we need to define the key categories we are dealing with both in Norway and the Czech Republic.

While in Norway we sometimes talk about "Smart rural cities" or "Smart rural places", in the Czech Republic the term applied in this report would be "Small smart cities". Nevertheless, for best practices exchange, we identified several common challenges in both countries.

Smart rural cities (SRCs): In line with the terminology of past projects conducted by WNRI, SRCs represent a concept which relates to smaller cities located outside of the central areas of the country. Their population is between 1,000 and 15,000 inhabitants and they represent approximately 20 - 30% of the whole population. This definition was applied by several Nordic research institutes and universities e.g. SINTEF, WNRI, Linköping University, VTT and Helsinki University.

Small smart cities (SSCs): The only criteria applied for the definition by UCEEB for this report is the population interval between 2,000 and 20,000 inhabitants for the small cities. This limit is anchored in Czech Statistical Office methodology. The group constitutes over 30% of the Czech municipal structure (CZSO 2016). Therefore, the SSCs are small cities belonging to this group where smart city concept may be applied. The parameter of distance from central areas is not stipulated. Thus, this group includes both rural and suburban areas with their own set of specific challenges.

2.2 Common developmental challenges for Czech and Norwegian small and rural municipalities

The Czech-Norwegian bilateral exchange focused on the common challenges that hamper the development of small Czech and Norwegian cities towards technologically advanced and sustainable "smart cities". Furthermore, we specifically selected those challenges that can be addressed with joint capacities of R&D centers and municipalities, i.e. sus-

tainable construction, public buildings and public space assessment, energy efficiency, stakeholder engagement and access to expert know-how. While we work with the terminology of the smart cities concept it is important to acknowledge that for the small cities in the Czech Republic it is more often the basic services that require the attention of the municipal authority than advanced technological solutions. To quote one small municipality head of investment: "for the next twenty years we will be mostly coping with necessary repairs of degrading infrastructure instead of investment into town's technological upgrade". This illustrates the point of departure not only for the Czech small municipalities but also for many small rural places in Norway.

For the identification of key challenges we used two-stage approach. In the first stage the researchers from WNRI and UCEEB classified the challenges into two categories that are broken down into six groups:

- Planning, technological investments and maintenance of infrastructure
  - Attractiveness of public space and its livability,
  - Planning for access to renewable energy sources,
  - Electromobility,
  - E-health and assistive technology,
- Management and administration
  - Human resources,
  - Stakeholder Engagement.

In the second stage, we verified our assumptions with the towns of Buštěhrad (CZE; 3,000 people), Postřekov (CZE; 1,000 people), Eid (NOR; 6,000 people) and Sogndal (NOR; 7,500 people). UCEEB and WNRI teams visited towns of Buštěhrad and Sogndal and held talks with representatives of Postřekov and Eid. Following municipality representatives took part in the exchange:

- **Buštěhrad:** Mayor Ing. arch. Daniela Javorčeková; Head of Investment Mr Vavruška;
- **Postřekov:** Mayor Ing. Jan Kreuz;
- **Eid:** Municipal Administrative Manager Elin Leikanger, Energy Expert, Trond Haavik from Segel, business consulting firm specialising in strategy and business development, internationalization, marketing innovation and project management
- **Sogndal:** Mr. Aase, a representative of the local energy company Sognekraft, Investment Manager Per-Odd Grevsnes from Sognnæring.

Each of the observations we made for individual challenges are structured in three subsubsections:

- Description of the state of art in general and specifically for the Czech Republic and Norway,

- Best practices observed in Norway and/or the Czech Republic and,
- Recommendations for public sector, including local municipalities and regional and national actors, such as ministries for regional development and environment.

2.2.1 Attractiveness of public space and its livability

"The common goal of all municipalities is to remain attractive to their citizens and to offer livable public space. In some of the small cities such common space is missing or it lacks "pedestrian friendliness".

The definition of public space does not necessarily mean the same as 20 or 50 years ago, what serves as a common public space heavily depends on many factors nowadays. It is not as straightforward as it used to be, when the town citizens used to gather around for example market space. Nowadays it is important to define what actually public space is for local community."

Czech Republic:

Livability measures in a SSC are different to those in big cities due to the vicinity of nature, low urban density and lower traffic. Specific for the Czech Republic are the urban sprawl and for instance interventions into urban fabric during communist times.

Public space in the Czech municipalities embodies the legacy of communism era when public space was not a place to be used, formed and enjoyed by citizens rather than a tool to shape and control the citizens by the regime. This approach influenced both the appearance of the spaces and the relationship to them. The result is that many authorities do not know how to treat and maintain their public space in conceptual and consistent way. This goes together with insufficient financial resources. However, some positive development in the relationship towards public space is palpable especially among younger generations.

Norway:

In Norway, only two percent of the area is developed (Regjeringa.no 2017). Majority of the area is comprised of mountains, woodlands and agricultural areas. The overall plans for municipalities comprise of agricultural, nature and outdoor activities as well as reindeer husbandry. This brings specific challenges for areal planners while planning for common areas due to substantial spreading of rural places along vast areas. In comparison, those living or working in a dense development area with a wide variety of activities, have shorter journeys, use more collective means of transport, go and cycle more than others, and have lower greenhouse gas emissions than those in a more dispersed area.

Figure 2: Sogndal, Norway

Often it is not obvious where the public common space should be situated in the less dense areas. This leads to new challenges for areal planners but it also opens up to new opportunities for more innovative approach. Whereas in the cities the strategy is to accommodate all needs within small area and dense population, in rural places the aim is to avoid outflow of inhabitants and make the place more attractive for newcomers - especially younger people. Hence, a more attractive center in the village is an important factor in relegating young people and new inhabitants, and therefore essential for reducing the emigration flow towards the towns. One example to achieve this goal is linked to integrating nature-based value creation within planning for urban development. Attracting tourists to spend more days in nature near rural areas is one of the current examples.

Figure 3: Guided tour at the Sognekraft power station providing heating to Fosshaugane Campus , Sogndal, Norway

Best practices:

First example from Norway is Folderid (800 inhabitants), where municipality put their efforts on creating social arena around a store. The shop joined the Merkur pilot program called "The store as a social arena" in 2012. The store itself is expanding, and a meeting and dining room has been built up to accommodate around 60 people. Here, local people and travelers can buy both dinner and coffee. The store is now a popular gathering place for the village. The other example of best practice is Lom municipality (2,360 inhabitants) that anchors nature-based value creation in their social part of the municipal plan.

Sogndal (7,500 inhabitants) is another case that presents an alternative to traditional city square as a social arena. Here, stadium linked with college campus brings together private sector (SMEs and startups) and research & development sector (researchers). Sogndal center represents the so called “five-minute city” concept where all major services are nearby (kindergartens, schools, town hall, police, health services, elderly home, cultural center, restaurants and shopping center). While this solution creates conditions for livable city center in a small town, it has also its drawbacks. Some people reacted by increasing the car use outside the five-minute perimeter. Therefore, this behavioral change should be considered.

Best practice of very well treated public space in the Czech Republic is represented by middle or smaller sized towns like Znojmo (33,000 inhabitants) or Litomyšl (10,000 inhabitants). Both municipalities managed to revitalize and develop their public space and succeeded in work with their historical districts. This was possible thanks to a strong position of planning department and systematic and enlightened approach of specific individuals in their management. However, this is not a common practice due to the instability in municipal politics and administration which is strongly connected to the political turbulences. This instability and lack of experience with public space are big obstacles for creation of attractive and livable public space.

Recommendations:

Promoting non-traditional centers of public life such as stores, stadiums, and natural monuments is functional way for urban planning. Public space is created where motivation and interests of people lie. Behavioral effects of public space planning need to be considered.

Provision of strategic long-term planning should be managed by experts together with public. This requires courage, time and sufficient human and financial resources. The municipality should seek the state of art knowledge in urban planning. It is important to think about how the plan impacts the development in the next 100 years. Mistakes are expensive.

It is important to employ bottom-up approach while planning for public space. What is the center of community should be defined by community itself and not outsiders.

2.2.2 Planning for access to renewable energy sources

"Functional link between national strategic and local planning is a pre-condition of successful transformation into high-efficiency and low carbon economy. However, the local sustainability policies are vague and energy efficiency policies are not fully implemented or they are missing."

Czech Republic:

Czech Republic is equipped with reliable electricity grid with 3rd lowest energy prices within the EU28. The overall energy mix is based mainly on the coal and nuclear power generation with only 16% share of renewable energy sources. The room for integration of renewables is enormous. The electricity grid is widely using quite old (but well accepted) system of distribution demand control. This system is missing any smart grid functionality and does not encourage renewable production on local level integrated into the grid.

The overall motivation to integrate renewables is rather low despite ongoing subsidy programs for citizens as well as for companies. Subsidies encourage the beneficiaries mainly to change the heat sources (i.e. New Green Savings Program, Boiler subsidy). Citizens in small towns are using local heat production (mainly non-renewables) or in some cases district heating (which has quite long tradition from former era). Czech energy market does not allow feed-in tariffs, it suffers from missing net-metering and it is using three-phase systems in 98% of installations. Residents in the town of Buštěhrad and Postřekov are mostly using gas local heating systems or in some cases solid fossil fuel heating.

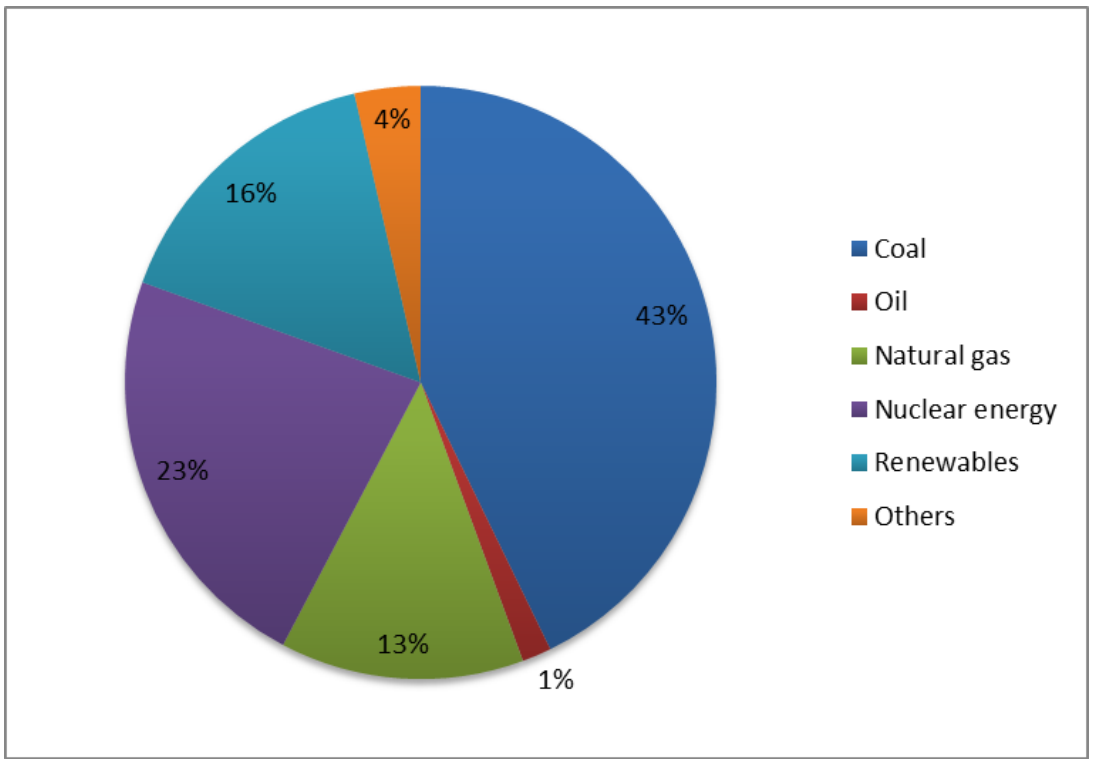

Figure 4: Energy mix of the Czech Republic

Norway:

In Norway, the main electricity source is hydropower. Norwegian electricity production totaled 134 TWh in 2013 out of this, approximately 96% (129 TWh) was produced in hydropower plants, 1% (1.9 TWh) in wind power plants and 2% (3.3 TWh) in gas-fired power plants and other thermal power plants. The average electricity production has been approximately on the same level over the last 15 years.

Prices of electricity in Norway are below EU28 average, which has its consequences in relatively high electricity usage at the household level and electricity being a main heating source for households.

Norway supports development of energy efficient and climate friendly technology for households. The body responsible for helping to enable those solutions at household and individual business level is ENOVA, owned by the Norwegian Ministry of Petroleum and Energy. ENOVA provides subsidies for investments such as PV solar panels, solar heat collectors, heat pumps and house insulation. The amount of subsidy depends on the specific type and price of measures applied. The subsidy is between 30% and 50% of the investment costs. In Norway, only few households are connected to feed-in tariffs but this measure is yet to be further developed in upcoming years. This also creates potential for development of renewable energy solutions linked not only to buildings but also to mobility in remote places.

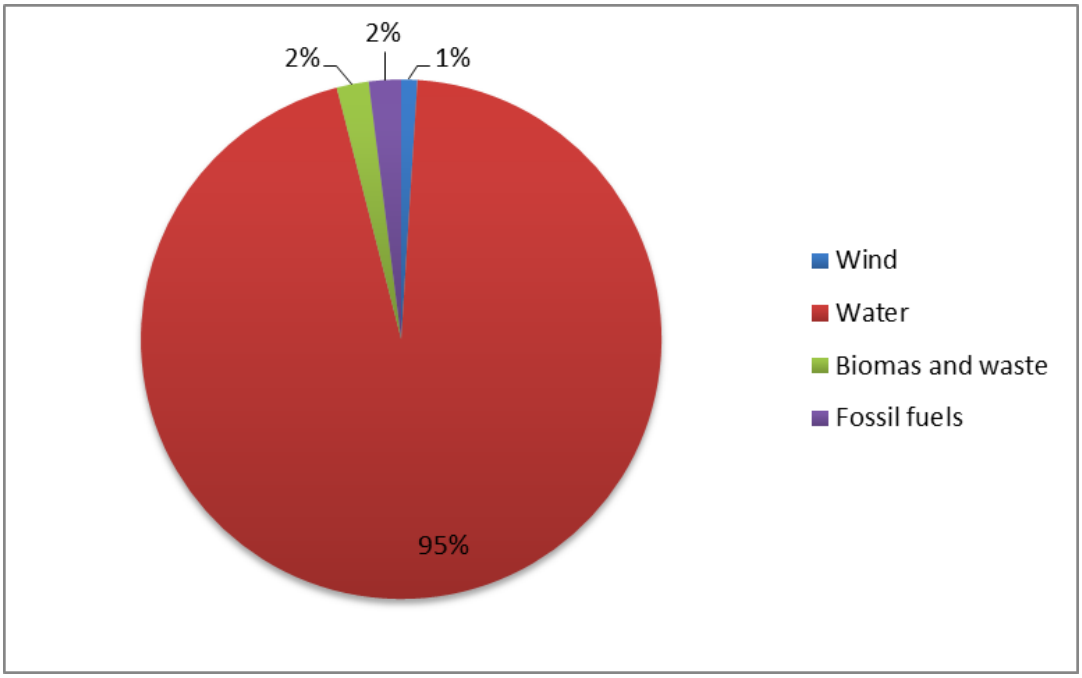

Figure 5: Energy mix of Norway

Best practices:

Based on information given by Elin Leikanger, Eid (5,920 inhabitants) in Western Norway is using stable temperature of water (8 ºC) from the local fjord. The system provides district heating for local municipal buildings, i.e. hospital, and households. The investment was supported by the government and currently it sustains itself by using payments from users of the system. The infrastructure of this district heating is owned by the municipality while the district heating system is operated by a private company. Residents are encouraged by the municipality to connect to the system. They receive advice and guidance on how to change their private house heating systems.

Kněžice (500 inhabitants) is one of the best examples of central heating system in the Czech Republic based on biogas power plant produced from biodegradable waste (from

agriculture and municipalities). Kněžice won the 2007 European Energy Award for the innovative use of biogas district heating. The biogas production plant contains a 180 m^3 homogenization tank, a waste cleansing line with a daily capacity of 10 tones, a 2,500 m^3 heat digester, a Combined Heat and Power (CHP) unit and two 6,500 m^3 storage tanks for residual liquid. It provides heat to town's households and public buildings.

Recommendations:

There is a lack of consciousness about the renewable energy benefits and challenges among citizens of smaller cities. The municipalities should encourage dissemination of pilot "green projects" and introduce incentives such as subsidy programs on local level.

In Norway, there is not much pressure on energy-efficiency measures, but the focus is linked to other topics within energy sector, i.e. electrification of transport. Measures like PV panels and feed-in tariffs should be given higher priority at the governmental level while small municipalities should play a role of advocates for change.

2.2.3 Electromobility

"Electromobility (e-mobility) is not typically a challenge for the small city both in the Czech Republic and Norway, but it is an opportunity to be exploited in coming years. The industry will change the culture of mobility both in big cities as well as in small municipalities. Even if the rate of growth varies a lot in various countries the change to e-mobility already started. The question is only how fast it will be in different EU countries. The municipalities should cope with growing trend and include it into planning for charging infrastructure, parking places combined with charging stations, electricity grid capacity etc. Furthermore, for e-mobility to be clean, the energy consumed needs to come from renewables."

Czech Republic:

Czech municipalities are at the beginning of e-mobility transformation. Charging infrastructure is currently under development and the density is not sufficient for wide use of electro-vehicles (EVs). The map of charging stations is shown in the figure bellow. Subsidy programs for EVs (both to increase demand and to build infrastructure) are active since 2017. Municipalities can use these subsidies for purchasing EVs for public services and to start building local infrastructure for charging. There are approximately 1,100 EVs registered in the Czech Republic (CTK 2017) which counts for 0.02%.

The consequences for Czech electricity network should be considered also in terms of current electricity grid refurbishment and demand response services. Peak load capacity and charging control pattern will play substantial role in grid stability.

Small towns and villages are not much interested in e-mobility and do not think that they should care within coming years. Use of EVs in public services is negligible. The push to combine EVs with local renewable energy production is missing almost completely.

Figure 6: Map of charging stations for electric vehicles in the Czech Republic (Elektromobilita.cz)

Norway:

In the recent years one can observe rapid increase of electric vehicles in Norway. By the end of 2015 the number of electric cars constituted 2.6% of the total stock of passenger vehicles. The number of passenger EVs increased from 38,600 to 69,100 (Statistisk sentralbyrå 2015). In total, 2.6 million passenger cars were registered at the end of 2015, which is 2.1% more than the year before. E-vehicle chargers are available all over Norway including small municipalities and rural areas.

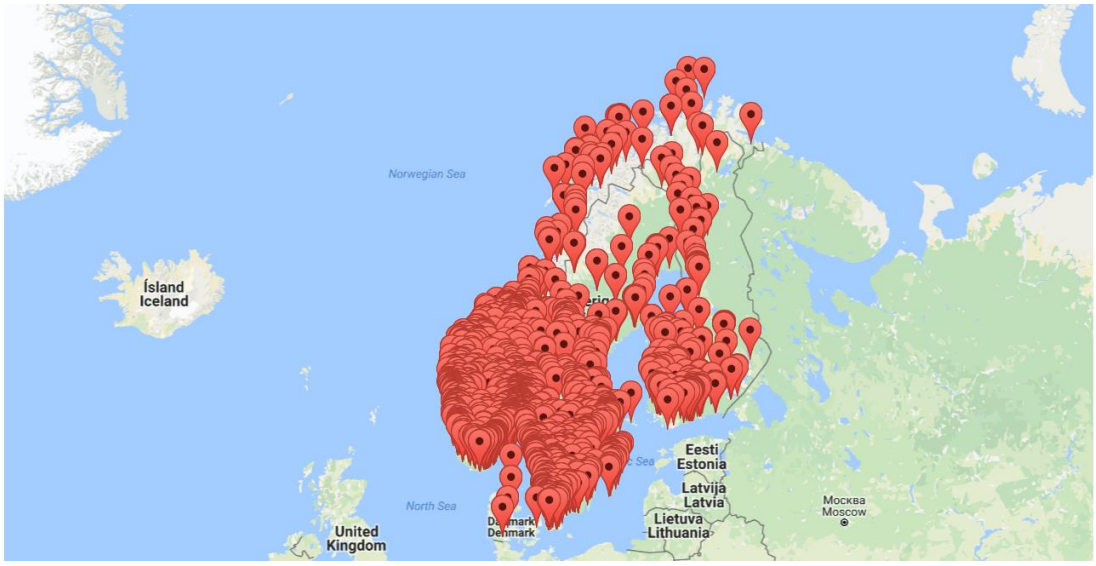

Figure 7: Map of charging stations for electric vehicles in Nordics (Inegi, Orion-Me 2017)

Best practices:

Norway with its countryside charging infrastructure could be taken as an e-mobility driver country in Europe with the highest percentage of newly registered EVs. The charging infrastructure is well developed and does not block the using of the EVs on nationwide scale. The other advantage is that due to the Norway energy mix the EVs are supplied with mostly renewable energy which is very good approach to replace oil based fuels by renewables in transportation.

Recommendations:

Even if the municipalities itself are not the main drivers in the change they can provide e-mobility support in many aspects by giving incentives to EV users such as free parking, reserved places or free/discounted charging stations. Municipalities should consider leading by example by promoting e-mobility in public services.

Municipal energy planning should consider future electricity consumption trend relating to e-mobility. The municipalities should encourage green (renewable) electricity both with regard to new EVs support schemes and to support local renewable energy production.

2.2.4 E-health and assistive technology

"The increasing share of elderly in the population is one of the most pressing social challenges worldwide. Every country in the world is experiencing growth in the number and proportion of older persons in their population. Population ageing is poised to become one of the most significant social transformations of the twenty-first century, with implications for nearly all sectors of society, including labor and financial markets, the demand for

goods and services, such as housing, transportation and social protection, as well as family structures and intergenerational ties (UN 2015)."

Czech Republic:

Demographic predictions for year 2065 show that percentage of citizens aged 65+ will almost double from 17.7% in 2015 to 32.2% in 2065. This represents big challenge for transformation of health and social care. Big topic in the Czech Republic is a concept of integrated care for aging population that would effectively combine social care with healthcare, stressed prevention and supported community care and informal care givers. The visions are considering the opportunity of modern technology. There are examples of good practice from emergency care systems for elderly in several Czech cities and the interest of municipalities, companies, universities and care providers in assistive technology is on increase. The biggest obstacle for integrated care to be fully developed is lack of integration of social care and healthcare. There are two disconnected systems each of them with their own legislation and funding scheme. Municipalities can play key role as a local integrator of health and social care.

Norway:

Scenarios in Norway show that within the next 15 - 20 years almost one third of the population living in Norwegian rural municipalities will be aged 67 or more. Partly it is resulted by the post-second world war baby boom combined with a reduction in birth rate in the later years. Therefore, the number of young adults seems to be low compared to the elderly population in the first place. Secondly, we can observe young adults leaving rural municipalities for studies, and not returning until they are in their forties, or not returning at all (NOU 2016, Telenor 2013).

Due to the shortage of young adults, there is also a shortage of skilled health workers and "warm hands" in the municipal health care services. Many of the nurses within this range of work today are part of the aging population and this profession is facing high numbers of retirement within the next 10 – 15 years (NOU 2016, Telenor 2013).

Best Practices:

An example of good practice is introduction of safety technology within Norwegian homes. Norwegian municipality close to Sogndal, provides assistive technology for patients suffering from mild dementia or cognitive challenges. The basis of assistance for elderly people are sensors that warn family members or municipal health care staff in case the user leaves his house or wanders through the house at night. Such technology enables patient to live in her own house for a longer time. A "house kit" of various sensors might be able to postpone institutionalizing the patient for months or years. This saves the municipality approximately 80.000 NOK per patient per month, and gives the patient higher quality of life causing less confusion and allows the patient to be able to

control their own life to larger extent than when being institutionalized (NOU 2016, Telenor 2013).

The innovation potential does not only lie in new technologies being developed but mainly in new processes that can support them. Ministry of Health of the Czech Republic introduced new eHealth strategy and Czech Technical University in Prague launched Ecosystem for Integrated Care in 2016. Pilot projects dedicated to implementation of new solutions for health and social care are being prepared.

Recommendations:

New assistive technology in health care services is a vital part of the solution for the coming challenges regarding the aging population. Numbers presented in the Norwegian report (NOU 2016) estimate that an average Norwegian municipality might reduce their costs by 25 M NOK per year by 2030, through changes in health care services and the introduction of the E-health technology.

Most rural municipalities in Norway will achieve smaller saving than the estimated amount though savings could still be massive if changes are done wisely. In addition, such technologies may not only lead to public cost savings but also bring better quality of life to older citizens and their families.

2.2.5 Human resources

„To plan and implement investments into smart city the municipality needs considerable capacity in terms of specialized technological expertise and legal capacity to manage demand driven public procurement. The challenge to small cities is related to insufficient quality of available specialists as well as their number.

The process for strategic and land use planning depends on dedication of people, their experience and on specific local circumstances. Due to the lack of human resources the planning phase is often not followed in systematic way but relies on random inputs such as particular interests or involvement of insufficiently qualified consultants. "

Czech Republic:

In small municipalities in the Czech Republic the legal advisory capacity is often basic, usually employed on ad hoc basis. This situation became even more striking after the introduction of new public procurement law in 2016 (Law 137/2006 Coll.). The main aim of the reform was to encourage public authorities to organize tenders based on quality criteria instead of tenders based on price criteria. Since the new law has been introduced it brings challenges in implementation for public authorities. Quality based tendering requires certain skills and experience both in legal terms and in technological sense which is often not available to small cities.

In addition, small cities do not have access to technology expert capacities. While large cities may afford to employ city architect, energy manager or specialist in citizen engagement, small cities need to procure these specialized services on ad hoc basis. These services could be provided by public research institutions. However, due to limits set by procurement law, even public-public partnership between municipalities and research companies is limited in both scope and time. As a result, small cities do not have easy access to longer-term and independent consulting provided by research organizations.

Norway:

Municipal sector in Norway struggles with inability to obtain sufficient competence within social area and land use planning. Almost 90% of municipalities nowadays need to recruit more human resources to cover for the positions within land use planning for the next five years. Furthermore, municipalities face competition with consultant companies to get the qualified workforce. The worst situation is in the small municipalities with low number of inhabitants, but large in terms of administered area.

One of the solutions to this problem is seen in the municipal reform introduced recently in Norway. Its aim is to merge together smaller municipalities to provide stronger cooperation and management between them.

The use of external competence in form of research institutes or private consultant companies is also challenging as it requires competence from the municipal side to decide what kind of expertise is needed and how it should be provided.

Best practices:

Cooperation between Bustehrad and UCEEB is an example of a working long-term relation between municipality and research institute. Between 2015 and 2017 the institute had been involved in the school expansion project where helped the town to manage participatory design process and define architectural and energy standards for the construction project. Furthermore, Bustehrad provided needs assessment feedback on specific communication technology that were under development by UCEEB where the institute also runs a local LoRa network covering the town.

The examples of best practice in Norway involve competent and active stakeholders on the both municipal and research institution sides. Eid managed to make use of research and development programs offered by government. The strong push on projects related to innovation made it possible for Eid to develop their ideas for district heating and be part of the wider Energy center platform that gathers public and private business.

Recommendations:

The municipalities should clearly define what capacity they are lacking and whether it

makes sense for them to develop it in-house or procure externally. Most needed are positions of city land use planners, architects, energy managers and experts on stakeholder engagement.

Pooling human resources with other small municipalities may be an efficient strategy to increase the municipal expert base. It can be either through establishing joint public companies or "borrowing" experts from one another.

Research organizations usually offer services that are independent from commercial interests and thus provide good partner to small cities. Municipalities should push for greater collaboration in all possible forms with preference to longer-term arrangement.

2.2.6 Stakeholder engagement

„Every municipality has potential lying in local institutions, organizations, private companies and citizens. Together, they have capacity to drive change towards sustainable and livable city. Municipality can facilitate dialog with its stakeholders to understand their needs, set common goals and engage them into projects. Municipality should adopt tools and strategies enabling sustainable engagement of stakeholders into governance, strategic planning and individual investments. It is important to combine formal and informal platforms for collaboration and support information exchange and collaboration between organizations and informal groups in the city. Specific goal of stakeholder engagement is to achieve a transparent collaboration with private sector."

Czech Republic:

Most municipalities lack personal and organizational capacity to handle stakeholder engagement well. We can see some isolated examples of tools and techniques of stakeholder or citizen engagement being used in the Czech municipalities. Sometimes external agencies are being deployed to facilitate communication. It happens mostly with projects that are potentially controversial and the goal of the agency is mainly to prevent conflict and to protect interest of few key actors. There is quite a lot of municipalities using participatory budget and some pilot projects using ICT tools for citizen feedback (e.g. for reporting on litter in public space and damages to public infrastructure). There are good examples of community planning in social services based on regular meetings with service providers and service recipients.

Norway:

Following the Planning and Building act, local authorities are obliged to facilitate a minimum level of stakeholder engagement in all local planning processes; i.e. land-use planning and the municipal master plan. The way this obligation is handled varies among

municipalities with respect to both size (number of inhabitants) and political and administrative culture. Small municipalities with respect to number of inhabitants (and thus, the size of public administration) will normally have fewer and less extensive ways of formally engaging local stakeholders. On the other hand, the extent of informal inclusion (e.g. when your neighbor is the local planner at Mayor's office) may to some extent compensate for formal engagement. Some municipalities, independent of size, may have a tradition of extensive stakeholder engagement, especially in case of housing development projects financed by the government, the EU or other external funding.

Best practices:

Agenda 21 has a quite long tradition of supporting the engagement of key stakeholders in creating sustainable development plans. The Ministry of Environment of the Czech Republic supports implementation of Agenda 21 on local municipal level in the so called Local Agenda 21. There are organizations supporting cities in planning process including citizen engagement. Municipalities following Local Agenda 21 are united in association Healthy Cities of the Czech Republic. The association promotes stakeholder engagement and collects cases of best practice across the country.

Figure 8: Discussion between municipality representatives and scientists on Smart Cities transformation

Further activities focus on educating municipalities and providing guidelines for citizen participation. For example the **PAKT project** supported by EEA Grants delivered a short guideline "Standards for Successful Citizen Participation" (Pakt participace 2017).

Stakeholder engagement is applied in participatory design of public buildings. UCEEB developed **methodology for complex design of public buildings**. The methodology is applicable for both new buildings and refurbishments engaging experts from research and key stakeholders into the design process to increase the technical quality and energy efficiency of the building as well as the user satisfaction. This methodology was successfully applied in **Buštěhrad** and **Postřekov**.

In the **Eid municipality** in Norway local authorities have started cooperation with private businesses and research institution. The goal was to share know-how in implementation of innovative projects. One of the joint EU projects established local cooperation between various small private businesses and craftsmen including plumbing companies, carpenters, electricians and private house owners. The goal was to create efficient platform for renovating single family houses that would make the renovation management easier for the house owners. Thanks to the platform different professions communicate with one another without additional coordination effort from the owner.

Recommendations:

Small cities should analyze their current capacity in the area of stakeholder engagement and create strategy for further development. City can use external agencies to facilitate the process in more complex projects or develop their own dedicated personal capacity.

Municipality needs to play proactive role, not just passively gather occasional inputs from stakeholders. The processes in stakeholder engagement need to be transparent with clear objectives and defined responsibilities. The results also should be published. Municipalities may work together with research institutes focusing on participatory planning.

Small cities should learn to lead pre-commercial dialogue to create transparent framework for collaboration with private sector. Structured platform of local business may help to create conditions for such cooperation.

3 Practical collaboration between R&D institutes and small and rural municipalities

3.1 Practice in the Czech Republic (experience from UCEEB)

UCEEB works with municipalities on strategic and project level. In 2017 share of UCEEB's research contracted by municipalities and their public service companies is expected to reach between 5 and 10% of the total contract research. Around half of these projects focused on small cities below 20,000 inhabitants. UCEEB further worked with municipalities in several collaborative research projects (e.g. Milevsko in the H2020 MORE-CONNECT project). Typical collaboration consisted of strategic technological guidance for Smart City, integration of renewables into municipal energy system, energy balance of the new heat power source, waste-to-heat management and renovations of public buildings such as schools. UCEEB also developed an assessment tool called SBToolCZ for complex evaluation of school buildings. These projects together with number of conference appearances helped to increase awareness of the possibilities for collaboration with the research institute among Czech municipalities.

Remaining important barrier is the complicated procurement environment where the research institute must compete with other private companies in order to enter into contract collaboration with municipalities. Current procurement law does not account for differences between public research institutes and for instance consulting companies. On one hand research institute is not price competitive due to higher overheads that are required to run its research non-commercial activities. On the other hand, the institute provides independent expertise that is especially important in the Smart City development to ensure interoperability of systems from different vendors. Unfortunately, it is nearly impossible for the municipality to make a long-term arrangement that would bring necessary expertise to the city and could cover the costs of the research institute. Therefore, we suggest looking for new framework that would foster stronger and long-lasting link between municipalities and research.

3.2 Practice in Norway (experience from WNRI)

WNRI works with private as well as public stakeholders. For the last 15 years, the share of contracted research on the topic of "environment" has been as follows: Local public authorities 3%, regional public authorities 10%, national public authorities 11%, private businesses 10%, EU 13% and Norwegian research council 53%. The distribution of environmental research topics has for the last 15 years been as follows, measured as share of total contracted research: Local and regional environmental policy 36%, sustainable tourism 29%, sustainable energy 15%, sustainable mobility 17%. The focus within the

topic “local and regional environmental policy” has been on rural areas (e.g. the county of Sogn og Fjordane and the local authorities in that county) and climate mitigation and adaptation policy, with a particular focus on land-use planning and the management of physical infrastructure. WNRI developed in 1996 the first web accessible footprint tool in Norway on household GHG emissions (http://vfp1.vestforsk.no/miljokalk/) and has also produced a web accessible database with life cycle emission factors for different means of transportation and different types of fuel (http://transport.vestforsk.no/). WNRI has also produced web accessible training tools on energy use (http://meirennbank.no/energiguiden/) and climate change adaptation (http://prosjekt.vestforsk.no/trainingforadaptation/).

Norway faces some of the same structural barriers as the Czech Republic (and many other countries) with respect to establish long-lasting knowledge building cooperation between research institutes and public authorities, still, the arrangement “Regional Research fund” has improved this situation. A regional research funding system is established to cover all Norwegian regions. The funding arrangement is designed to help local and regional authorities as well as small and medium sized private businesses to become more involved in research, and it is nearly 10 years that WNRI has benefitted from this arrangement. The arrangement also allows for international cooperation, although with rather limited budgets for such activities.

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