

SPARCS

SPARCS Survey: Opportunities of 5G for the Mobility Sector

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About SPARCS

Sustainable energy Positive & zero cARbon Communities demonstrates and validates technically and socioeconomically viable and replicable, innovative solutions for rolling out smart, integrated positive energy systems for the transition to a citizen centred zero carbon & resource efficient economy. SPARCS facilitates the participation of buildings to the energy market enabling new services and a virtual power plant concept, creating VirtualPositiveEnergy communities as energy democratic playground (positive energy districts can exchange energy with energy entities located outside the district). Seven cities will demonstrate 100+ actions turning buildings, blocks, and districts into energy prosumers. Impacts span economic growth, improved quality of life, and environmental benefits towards the EC policy framework for climate and energy, the SET plan and UN Sustainable Development goals. SPARCS co-creation brings together citizens, companies, research organizations, city planning and decision making entities, transforming cities to carbon-free inclusive communities. Lighthouse cities Espoo (FI) and Leipzig (DE) implement large demonstrations. Fellow cities Reykjavik (IS), Maia (PT), Lviv (UA), Kifissia (EL) and Kladno (CZ) prepare replication with hands-on feasibility studies. SPARCS identifies bankable actions to accelerate market uptake, pioneers innovative, exploitable governance and business models boosting the transformation processes, joint procurement procedures and citizen engaging mechanisms in an overarching city planning instrument toward the bold City Vision 2050. SPARCS engages 30 partners from 8 EU Member States (FI, DE, PT, CY, EL, BE, CZ, IT) and 2 non-EU countries (UA, IS), representing key stakeholders within the value chain of urban challenges and smart, sustainable cities bringing together three distinct but also overlapping knowledge areas: (i) City Energy Systems, (ii) ICT and Interoperability, (iii) Business Innovation and Market Knowledge.

Partners





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1. INTRODUCTION

The development of smart city solutions is central within the SPARCS project, the Espoo development strategy, and the transformation towards carbon-neutrality in general. These smart city solutions aim at the improvement of city functions, such as healthcare, security, and energy, while providing a foundation for sustainable digital services. To enable the implementation of new smart city solutions, development of communication technologies is needed. One often mentioned technology in this regard is 5G and, in the future, 6G and beyond. 5G, as a new more effective mobile communication technology, can aid in the development of smart city solutions in several sectors. One sector where 5G can be of benefit is transport and mobility.

Different development and research projects within Finland and the City of Espoo have been implementing innovative pilots in the field of 5G. These pilots are testing 5G communication, physical small cell infrastructure and connected operation models needed for a smart city. During the SPARCS project, the Espoo project team aimed to engage project representatives of different smart cities projects especially on the mobility sector. To achieve this, a survey on 5G and mobility was conducted. This report will present the results of this survey and following conclusions.



2. RELEVANCE OF 5G IN SPARCS

Within the Grant Agreement, the Kera demonstration area is explained as follows:

“The goal of the demonstration block is to act as a testbed for co-creation and infrastructure building towards a resilient, sustainable and smart energy positive area. Infra solutions will include a bidirectional electricity grid, 5G platform, emission-free energy, and open district heating system (heating energy consumers acting as prosumers). Kera is also planned to become a testbed for a 5G network based on sensors and antennas installed in lampposts and already being tested in the northern parts of the area.”

As can be seen, 5G has been specifically mentioned as a possible building block for Kera to emerge as a resilient, sustainable, and smart Positive Energy District (PED) in the future. The possibilities of 5G within Kera is looked at in intervention E12 – ICT for Positive energy blocks within the Kera interventions and is closely linked to two actions: E12-1, looking into 5G and smart infrastructure and E12-2, looking into 5G and mobility.

Figure 1 below shows the detailed plan devised to meet action E12-2 from deliverable D3.1. The action focuses on opportunities offered by the local district 5G network pilot in Kera towards smart mobility solutions. The aim is to investigate and document these opportunities for possible future use within Espoo and elsewhere.

Action E12-2	5G as service enabler. Developing new service models for autonomous transport and e-mobility linked to the local 5G network, solutions enabling the use of car batteries as energy reserve and the operation of autonomous transport. (ESP, stakeholders)
Detailed plan	Identify smart infrastructure requirements for autonomous transport and e-mobility. Open discussion with smart city Kera area development, relevant stakeholders and ongoing projects developing autonomous transportation and 5G technologies in Kera (including LuxTurrim5G+ / Neutral Host Pilot -project; Six Cities: Low-carbon transport in mobility hubs -project). Estimate car battery capacity available for energy reserves in different scenarios.
Targeted outcome	Car batteries and smart charging can improve power balance and reduce emissions and costs. 5G technologies can support the use and operation of autonomous transportation and enable e-mobility in local networks.
Roles and responsibilities	ESP: Main responsibility.
Schedule	M3-12 Opening discussion with relevant stakeholders. M12-36 Assessment of car battery solutions. Assessment of local 5G network in the operation of autonomous transportation.
KPIs	Battery storage capacity available. Service models for autonomous transport / e-mobility.

Figure 1: Detailed plan of action E12-2



3. 5G AND MOBILITY: A SURVEY

This section will be looking into the 5G and mobility -survey conducted within SPARCS, which will give insights on the role of the city in creating new service models for 5G within smart cities, with a focus on the mobility sector. The survey was sent to stakeholders of different Finnish development projects linked to 5G via email. The projects included:

- *LuxTurrim5G*
- *Neutral Host Pilot*
- *SPARCS*
- *5G-Safe-Plus*
- *Smart and Clean Kera*
- *5G-Force*
- *5G Finlog*
- *ARPA*
- *Smart Otaniemi ecosystem*

The fully anonymous survey received a total of 12 responses. The number of responses was low compared to the approximately 60 recipients of the original e-mail. However, as this was an expert survey, it was still deemed beneficial to analyze the provided answers. This analysis will be provided in the following chapters.

3.1 How important would you say the implementation of a local 5G network is for the advancement of mobility services?

The aim of this question was to gain preliminary information on the importance of 5G for the mobility sector. The analysis ranged from “Not at all important” (a value of 1) to “Very important” (a value of 4). The number of answers in each bracket and the percentages are provided in *Figure 2*. As can be seen, most of the answers were fairly positive, as over 80% of the responders believed that 5G would be at least somewhat important for mobility.

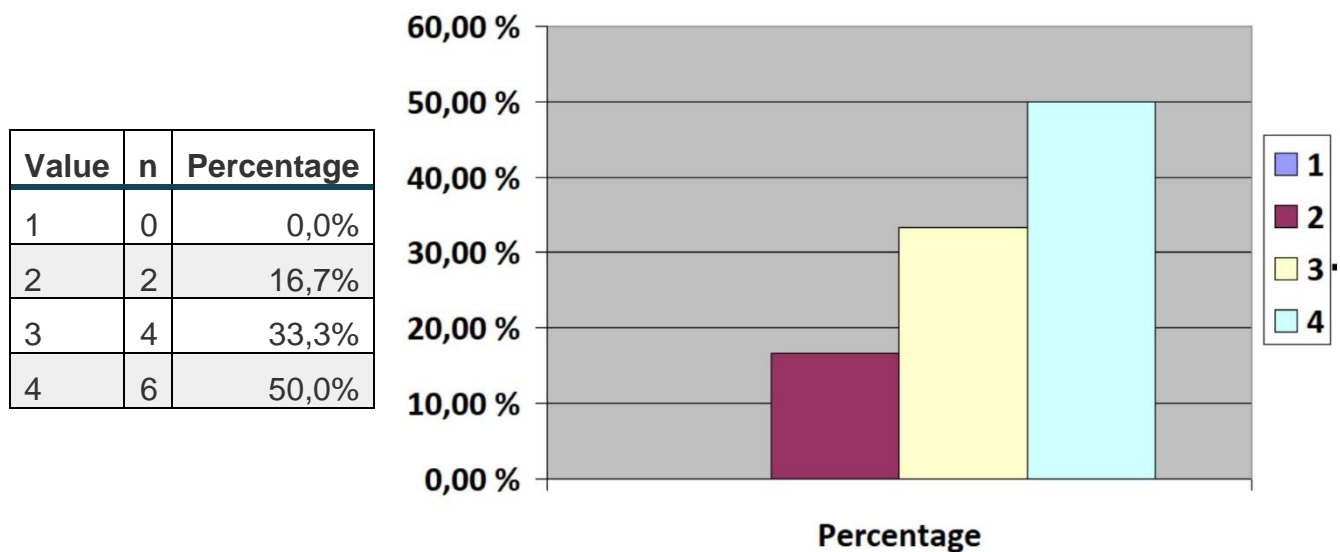


Figure 2: Importance of 5G for the advancement of mobility services as a value from one to four



3.2 Within this question, you can freely add your thoughts on the role of 5G within the development of mobility in the near future

In this question, the responders were given an opportunity to elaborate on the value given in the first question, while also voicing their opinion further. The main insights given under this question are provided below in [Table 1](#), grouped based on theme.

Table 1: Thoughts on the role of 5G within the development of mobility in the near future

Insight
5G can provide a solution for the need for fast, reliable, high capacity and low latency communication
5G can enable autonomous mobility solutions
5G can enable a situational awareness of urban mobility in real time, leading to situational control.
5G can aid in providing more optimized, sustainable, and safer mobility services
5G can aid in providing more personalized services for citizens

As can be seen in the table, 5G was seen as an enabler for autonomous mobility solutions, with reliable, high capacity and low latency communication seen as a main benefit that 5G can provide to enable this transition. In addition, 5G as an enabler for real-time situational control, sustainable mobility, and personal service was mentioned. In short, autonomous mobility and enabling effects for autonomy were seen as 5G's main benefits towards mobility, while 5G can also enable other benefits on the side to further enhance mobility services.



3.3 What are the major benefits that a local 5G network could bring to the providers of mobility services?

In this question, the responders were asked to give their opinion on the benefits that a local 5G network could bring to the providers of mobility services. With a local 5G network, this question means a small cell network similar to the one piloted within Kera. The benefits given in Table 2 are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the benefit in the first column, when compared to the full number of provided responses.

Table 2: Benefits brought by a local 5G network to the providers of mobility services

Benefit	Percentage
Real time solution	25 %
High capacity and low latency	42 %
Benefits to autonomous mobility and remote control	50 %
Benefits to data collection and usage within mobility services	42 %
Benefits to the safety of mobility services	17 %

As can be seen in Table 2, the main benefits that 5G was seen to provide were towards the enablement of remote and autonomous control and better usage of data. The respondents envisioned that the high capacity and low latency of 5G technology can aid in real time communication, providing new service opportunities especially in the autonomous or remotely controlled mobility sector. A heavy focus can also be seen on better use of data within mobility services, which can relate to traffic planning or navigational services as well.

In short, 5G can be seen as either a prerequisite technology or a key aid in the provision of new mobility services. The need for real-time communication to ensure the safety of new services is a key issue to solve, as autonomous vehicles need to operate as a safe part of the transportation system. Upgraded mobile services are integral to ensure constant functioning communication between autonomous vehicles, the environment, and each other.



3.4 What are the major benefits that a local 5G network could bring to the users of mobility services?

In this question, the responders were asked to give their opinions on the benefits that a local 5G network could provide to the users of mobility services. With a local 5G network, this question means a small cell network similar to the one piloted within Kera. The benefits given in [Table 3](#) are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the benefit in the first column, when compared to the full number of provided responses.

Table 3: Benefits brought by a local 5G network to the users of mobility services

Benefit	Percentage
More personal services	9 %
Savings in time and money, smoother services	45 %
More flexible mobility services	9 %
More reliable mobility services	27 %
Increased safety	18 %
New mobility services	36 %
Better connectivity for users	36 %
Real time data for easier travel	45%

As can be seen in [Table 3](#), the main benefit provided by the responders was the better usage of data for easier and more affordable travel. Easier and more affordable mobility solutions can stem from the increased reliability and additional flexibility provided by new last-mile solutions or a portfolio of new mobility services provided more personally to customers. In addition, 5G can provide better connectivity while travelling, providing better options for working during the commute.

The answers seem to agree on the fact that 5G can make travel easier and smoother in many ways for customers. Still, concrete examples of these new services are needed before the full benefits of 5G for consumers can be concretized.



3.5 What are the major benefits that these mobility services enhanced by 5G could bring to the cities and to the built environment?

In this question, the responders were asked to give their opinion on the benefits that a local 5G network could provide to the city and the built environment. With a local 5G network, this question means a small cell network similar to the one piloted within Kera. The benefits given in Table 4 are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the benefit in the first column, when compared to the full number of provided responses.

Table 4: Benefits brought by 5G-enhanced mobility services towards cities and the built environment

Benefit	Percentage
Effective collection and sharing of information	33 %
Real time situational picture of urban mobility	25 %
Optimization of mobility for more fluid transport	33 %
Increased safety	8 %
Aiding in achieving city sustainability targets and other environmental benefits	33 %
Better opportunities of citizen mobility	25 %
Better knowledge of citizen mobility	8 %
More modern and trendier city environment	8 %
Economical savings	17 %

As can be seen in Table 4, the three main benefits provided by the responses were more effective collection and sharing of data and information, more optimized transport and aiding in achieving the city sustainability targets. Providing a real-time situational picture of the urban mobility system was also mentioned, in addition to the economical savings that the optimization of urban mobility would bring. As in the last questions the role of 5G in enhancing real-time data collection and use was preferred in answers, including a real time picture of mobility at a larger scale. Achieving more fluid and optimized mobility through this collection and use of real time data can in turn lead to environmental benefits and aid in the achievement of sustainability targets. However, it must also be noted that new mobility services can increase the use of transportation solutions especially in the last-mile section of travel. This can increase emissions if cycling and walking is replaced by these solutions.



3.6 What are the major risks to take into account when implementing a local 5G network?

In this question, the responders were asked to give their opinion on the risks that need to be considered when implementing a local 5G network. With a local 5G network, this question means a small cell network similar to the one piloted within Kera. The risks given in Table 5 are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the risk in the first column, when compared to the full number of provided responses.

Table 5: Major risks to take into account when implementing a local 5G network

Risk	Percentage
Monetary needs, especially regarding expensive investment requirements	58 %
Regulation and licensing	25 %
Cybersecurity	33 %
Ownership model still relatively unknown	8 %
The need for services using the 5G infrastructure	25 %
Lack of knowledge on technology	8 %
Increased vehicular travel	8 %

As can be seen in Table 5, the main identified risk was the capital investment needed. Several of the answers also mentioned the problem often found with new and innovative infrastructure solutions. Infrastructure providers would like to ensure that providers of services already exist before making the investment, as a majority of revenue would come from these providers. Meanwhile, the service providers would like to ensure that the infrastructure already exist before locking in to service development. This may lead to a situation where the infrastructure does not move further. Other mentioned risks include regulation, licensing, cybersecurity and a lack of knowledge.

In short, the main risk identified on most answers was the investment needed, but the answers related to the lack of services is heavily connected with the investment needs, as it is hard to explain a high capital investment in infrastructure if there are no services to use this infrastructure. In addition, risks related to regulation and cybersecurity can lead to less investment interests as well.



3.7 What kind of mobility services and type of businesses could be developed in connection with local 5G at this time?

In this question, the responders were asked to give their opinion on the different mobility services that could be developed in connection with a local 5G network currently. With a local 5G network, this question means a small cell network similar to the one piloted within Kera. The services given in Table 6 are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the service in the first column, when compared to the full number of provided responses.

Table 6: Possible mobility services and businesses in connection with local 5G at this time

Services	Percentage
Autonomous mobility solutions	64 %
Personal and contextual services	9 %
Real time situational awareness, control and optimization	64 %
Safety services	18 %
Air quality and weather data	18 %
Logistics	27 %

As can be seen in Table 6, most of the responses mentioned autonomous mobility solutions and real time control and optimization as the main services linked to 5G currently. Other services that emerged in the forefront were logistics solutions, air quality, and safety services. According to the respondents of this survey, these services are already possible as 5G communication technology is implemented. However, several respondents noted that at the moment these services would still be in pilot phases and work should focus in constructing the basis for large-scale use as technology moves forward.



3.8 What about in 30 years, what are the possibilities after further development of the technology?

In this question, the responders were asked to give their opinion on the different mobility services that could be developed in connection with a local 5G network in the future. With a local 5G network, this question means a small cell network similar to the one piloted within Kera. The possibilities given in [Table 7](#) are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the possibility in the first column, when compared to the full number of provided responses.

Table 7: Possible mobility services and businesses in connection with local 5G in 30 years

Possibility	Percentage
Autonomy on a larger scale	75 %
Fully optimized mobility for more fluid traffic	25 %
Real time video aiding in mobility	8 %
Personal solutions for different users	8 %
Large scale drone fleets	17 %
Fully interactive city environments	8 %
Everything communicating with everything seamlessly through more efficient use of data	17 %
Moving forward to 6G and even 7G	17 %

As can be seen in [Table 7](#), the main vision of the future provided by the responders was an implementation of autonomous mobility on a larger scale, combined with additional optimization services for more fluid traffic. In the future, fleets of drones can handle parts of logistics duties, in addition to other suitable services. The increased collection and more efficient use of data will allow everything in the mobility sector to communicate seamlessly with everything. In combination with each other, these visions of the future aim to create a smart mobility environment for local residents.

When compared to the survey as a whole, provided answers are in line with the proposed timelines and benefits as given in the responses to the previous questions. Autonomous solutions gain the most benefits from 5G when considering possible mobility services. In the near future, autonomous pilots and use of autonomous solutions in a small scale is possible, while larger implementation is possible within 30 years. As operational models and technology evolve, data-based solutions as mentioned in the previous responses can be implemented in more detail, realizing the benefits mentioned in sections 3.3 to 3.5. However, we must note that communication technologies are constantly evolving, making visioning future possibilities and advances difficult, especially in relation to possible timelines.



3.9 What new actors or working procedures do we need to advance the development of 5G within smart cities even further?

In this question, the responders were asked to give their opinion on the change in working procedures that is needed to advance the use of 5G in smart cities even further. The insights given in [Table 8](#) are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the insight in the first column, when compared to the full number of provided responses.

Table 8: New actors and working procedures needed to advance the development of 5G within smart cities

Insight	Percentage
Operator of autonomous transport	8 %
Owner and operator of smart pole infrastructure	58 %
Data marketplace owner and market operators	25 %
Businesses providing smart city services	50 %
Participation of mobile network operators (MNO's)	17 %
Participation of the city	17 %
Regulators	17 %

As can be seen in [Table 8](#), the responders saw the lack of service providers as the main issue currently, and voiced a need for new and innovative businesses in this area. Another main issue was the ownership model of the infrastructure and the linked data platform and marketplace. A need for new working procedures to enable the implementation of a local 5G network was identified. Responders also identified the municipality, mobile network operators (MNO's) and regulators as actors whose participation in development could be increased. Answers within section 3.9 are linked to the risks identified within section 3.6, as solving the working procedures and operational models in relation to local 5G infrastructure and enticing service providers to design and implement services could alleviate some major risks identified within 3.6.



3.10 What is, in your opinion, the city's role in developing the local 5G network and connected mobility services?

In this question, the responders were asked to give their opinion on the role of the city in this development. The roles given in [Table 9](#) are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the role in the first column, when compared to the full number of provided responses.

Table 9: The city's role in developing the local 5G network and connected services

Role	Percentage
Enabler through e.g. the use of public spaces as testbed	67 %
At least partial funder	25 %
Setting the vision and following its implementation	8 %
Ensuring impartial use of data	17 %
Participation in the planning of infrastructure	25 %

As can be seen in [Table 9](#), an overwhelming majority of responders thought of the city as mainly an enabler for the infrastructure development, while a fourth of answers also saw the city as a funder for the infrastructure as well. Responders view the city as a major recipient of many of the benefits of an enhanced 5G network. In addition to new smart city services that can be utilized by municipalities themselves, these 5G networks enable the expansion of the municipality as a smart city business environment. Thus, it is important for the city to encourage research, development, and investment activities to enable the innovation of new infrastructure and solutions. For example, public spaces could be used as a testbed for new 5G-based solutions.

The city should also participate in the planning process of infrastructure development, to set the large-scale vision for development and ensure impartial use of data. A local 5G network could be seen as a natural monopoly, and thus the participation of the municipality and other regulators is important to ensure impartiality.



3.11 What do you think the role of the city could be in the future, once the local network has been developed and is being utilized for smart mobility services?

In this question, the responders were asked to give their opinion on the role of the city in the future. The roles given in [Table 10](#) are grouped based on main themes identified in the responses, while percentages in the second column indicate the number of responses aligning with the role in the first column, when compared to the full number of provided responses.

Table 10: The city's role in the future, once the local network has been developed

Role	Percentage
Driving towards a vision	20 %
Enabler	10 %
At least partial funder	20 %
Steering or overseeing development, ensuring impartiality	30 %
Facilitator and/or ecosystem leader	20 %
Operation & Maintenance	20 %
User	10 %

As can be seen in [Table 10](#), the answers to this question were quite diverse. Most of the responders saw the role of the city as quite similar in the future as well, including enablement, funding and ensuring the impartiality of data use. Some saw the city as a leader of the ecosystem that would form around the smart city infrastructure, while some saw the city's role as merely a user of the infrastructure.



4. CONCLUSION AND THE WAY AHEAD

This SPARCS-produced survey provides an expert overview on the opportunities that 5G can provide towards the mobility sector. Within section 3, each questions and respective answers where analysed, providing information on the following topics:

- *The importance of 5G for the mobility sector.*
- *Major benefits that 5G can provide to different actors.*
- *Major risks to be taken into account during implementation.*
- *Different services that can be implemented now and in 30 years.*
- *Possible new actors and working procedures to be taken into account.*
- *The city's role in the development of 5G technology and infrastructure in the near and far future.*

The major importance of 5G can be seen in the development of autonomous mobility across the mobility sector, from autonomous personal vehicles to fleets of autonomous drones. Enhanced mobile communication is needed to ensure the safe and reliable operation of autonomous vehicles at all times. Mobile solutions are especially important due to the mobile nature of planned services.

Another major possibility of 5G is seen in the large-scale situational awareness and optimization of mobility. 5G provides opportunities for the collection and use of large amounts of data, which can be used for real-time services and optimization. One possibility of 5G-enhanced digital solutions is the construction of a city-wide digital twin of the mobility sector, which shows a digitalized copy of the local transportation environment.

As noted in the major benefits of local 5G solutions, possible services center around autonomous mobility and real time control and optimization. For local customers and residents, 5G-enhanced services can provide a smoother everyday life through more reliable, cheaper and flexible transportation, while also providing opportunities for more sustainable travel through the use of new autonomous solutions instead of a personal vehicle. Fleets of autonomous vehicles may also decrease emissions of the transport sector through more optimized travel.

Major risks within the implementation of new smart city infrastructure solutions such as local 5G include the high investment needs to achieve full urban coverage. For this coverage to be attainable, a portfolio of services is needed to provide monetary value for investment. To set the vision of this smart city infrastructure in fruition, a functional operational model for the infrastructure is needed in addition to a healthy collection of service providers. MNO's, municipalities and regulators should actively participate in development and implementation.

Municipalities can serve as an enabler of 5G research and development. Municipalities should focus on their own goals in relation to sustainability and smart city activities, and steer large-scale development plans towards the achievement of these goals. In this way, impartial planning and use of future infrastructure and services can be ensured. In addition, municipalities should support development financially based on their own means. The role of the municipality remains similar during the whole lifecycle, as continuous steering and overseeing activities are needed. In addition, municipalities are a user among others as infrastructure and services are implemented.



In addition to this small-scale survey, a separate feasibility study on the role of 5G within the mobility and energy sectors was produced during the SPARCS project. Concurrently, Espoo has remained as a major hub for companies and other actors within the smart city sector, and piloting of solutions continues. The City of Espoo should continue to follow this work and collaborate with local actors in establishing living labs for experimentation, with an aim for future commercial solutions that will increase local business opportunities.

