# Methods and measures to enhance resilience against electrical power outage in urban vital societal functions

## Joint Final Project report

31.10.2019


dsb Norwegian Directorate for Civil Protection · City of Bergen · Dordrecht · Founded by European Union Civil Protection · Valmiera · City of Stavanger · Oslo

ISBN: 978-82-7768-492-5 (trykket utgave)

Grafisk produksjon: ETN Grafisk, Skien

# METHODS AND MEASURES TO ENHANCE RESILIENCE AGAINST ELECTRICAL POWER OUTAGE IN URBAN VITAL SOCIETAL FUNCTIONS

Joint Final Project report

31.10.2019

# TABLE OF CONTENTS


Society
On
Off

# 1 INTRODUCTION

MEREPUV (*Methods and measures to enhance resilience against electrical power outage in urban vital societal functions*) has addressed topics on urban resilience. The project has aimed at exploring vulnerabilities to electrical power outage in cities. Although it is unlikely that a whole city loses electricity over a longer period, the impact of such an event will be very high, thus preparation and increase of resilience is needed. Exploring the consequences of a suppositious power outage can reveal vulnerabilities and interdependencies, which are not included in other risk assessments.

Besides, recent events such as massive power outages on Manhattan in New York, Argentina and Uruguay summer 2019[1], clearly shows the relevance of the topic, as well as the importance of examining low-probability/high-impact scenarios.

The MEREPUV project has been funded by the European Commission (DG ECHO) Union Civil Protection Mechanism for prevention and preparedness projects in civil protection and marine pollution. The beneficiaries are stakeholders from Norway, the Netherlands, and Latvia:

- Norway: Norwegian Directorate for Civil Protection (DSB) (coordinator), City of Oslo, City of Bergen, City of Stavanger.
- Netherlands: Safety Region South Holland-South, City of Dordrecht
- Latvia: State Fire and Rescue Service, City of Valmiera

As a part of the project, the participating cities have conducted risk and vulnerability assessments of power outages. The national and regional authorities have then summarized the findings in a national working paper. This joint final report summarizes the main findings, recommendations and experiences from the project.

The general objective of the MEREPUV project has been to make cities more resilient to disruptions in power supply, by:

- improving knowledge of cities' role in protecting their vital societal functions from such disruptions,
- and by identifying efficient measures available at the local level for protecting citizens against severe consequences of power outage.

Operational urban critical infrastructures are essential in order to ensure the functioning of societal functions vital to citizens. Power supply is crucial in today's society, since almost all other vital societal functions rely on electrical power, and disruption can quickly lead to chains of negative impacts and severe consequences for citizens. Given the complexity characterizing critical infrastructures and services with regard to intra- and interdependencies, a central question has been to examine the municipalities' role in protecting urban vital societal functions.

The focus in the project has been risks related to power outage in cities. Further, the project has chosen to look at the vulnerabilities of such disruptions for three vital societal functions; namely the health services, emergency services and critical communication systems. The cities participating in the project have all conducted an assessment focusing on loss of electrical power supply as the adverse event (i.e. not focusing on the cause of the power outage itself). Each city has assessed direct and indirect consequences for one of the three vital societal functions mentioned. The aim has been to identify critical interdependencies and to outline the cities' role in protecting their citizens from consequences of failure in basic services. The effectiveness of existing preventive barriers, as well as new measures suitable for improving resilience in a long-term perspective, have been compared and outlined by the partners. The results of the project is documented in this final project report, whose purpose will be to share the gained knowledge with other participating states of the UCPM / European cities.

1 https://www.nytimes.com/2019/06/16/world/americas/power-outage-argentina-uruguay.html
https://eu.usatoday.com/story/news/nation/2019/07/13/manhattan-power-outage-widespread-power- outages-new-york-city/1726521001/

## 1.1 BACKGROUND AND CONTEXT

**A vital societal function** is here defined as a function of such importance that its loss or severe disruption could entail major risks for the life and health of the population, the functionality of society or society's fundamental values.

Vital societal functions and critical infrastructures are characterized by several intra- and interdependencies. This implicates that disruption in one critical function or infrastructure, quickly can lead to cascading effects also in other vital services and infrastructures. MEREPUV has chosen to focus on sufficient power supply, health services, emergency services (within police, health and fire) and operational electronical communication systems, which are all examples of vital societal functions.

Stable access to electrical power is crucial for modern societies, as all vital societal functions are dependent on electrical power in order to function. Failure could result in citizens being prevented from obtaining contact with the emergency services and can also lead to severe consequences for the health services such as hospitals and home care. Many of the challenges are related to the link between electrical power supply and electronic communication systems. MEREPUV has examined these chains of consequences and links in an urban context.

Council Directive 2008/114/EC called on Member States to identify and designate European infrastructures within the energy and transport sectors. In 2013, the Commission published a staff working document "on a new approach to the European Programme for Critical Infrastructure Protection. Making European Critical Infrastructure more secure". The document encourages a systems approach as basis for future work in the area. A systems approach treats infrastructures and vital societal functions as interconnected networks and takes into account close links between public and private actors at different levels. In line with this, MEREPUV has taken such an approach in the risk and vulnerability assessments conducted in the project by involving a broad spectre of public and private stakeholders into the work of assessing vulnerability to power outage.

In general, the same systems approach is evident throughout the Sendai Framework for Disaster Risk Reduction 2015 – 2030 (UNDRR). One of the seven main goals is to substantially reduce disaster damage to critical infrastructure and disruption of basic services, and to develop their resilience by 2030. Further, it concludes that it is necessary to empower local authorities and communities to reduce disaster risk. The latter is also highlighted through the UNISDR campaign "Making cities resilient". In line with this, MEREPUV has focused on the work with critical infrastructures and vital services at the local level.

Extensive scientific work in the field has been done by the European Commission's Joint Research Centre (JRC), covering a wide spectre of methodological approaches, including guidelines to vulnerability assessments of critical infrastructures and systems. We have reviewed several projects funded by the European Union's FP7 for research, technological development and demonstration of cascading effects, as examples of relevant earlier work. (CascEff, EMILI, CIPRNet, FORTRESS, PREDICT, ESENet, CIPRNet and SnowBall – see factbox).

Substantial work has been done and is ongoing at the national level regarding designation of national vital societal functions and critical infrastructures, and clarification of governmental responsibilities. MEREPUV focuses on the preventive work with vital societal functions at the local level, and aims at providing valuable bottom-up perspectives. Municipalities are responsible for providing their citizens with some of the services defined as vital. They are also hosting other critical functions and structures owned by state and private actors, and have a central role in responding in case of severe disruptions.

# OTHER PROJECTS OF RELEVANCE

The following EU funded projects have been explored and may provide information, which supplements the findings of MEREPUV:

**CascEff – Modelling of dependencies and cascading effects for emergency management in crisis situations**
Modern socio-technical systems are increasingly characterized by high degree of interdependencies. Whereas these interdependencies generally make systems more efficient under normal operations, they contribute to cascading effects in times of crises. The aim of the CascEff project was to improve the understanding of the cascading effects in crisis situations to reduce the consequences of escalating incidents in complex environments.

Website: http://casceff.eu/

**EMILI – Emergency management in large infrastructures**
The project EMILI was a capability project, which aimed at a new generation of data management and control systems for large infrastructures (CIs), including appropriate simulation and training capabilities. These control systems are needed in order to improve the security of large infrastructures like power grids and telecommunication systems. This is especially important in the case of emergencies and crises.

Website: https://www.emili-project.eu/

**PREDICT – Preparing for the domino effects in crisis situations**
The aim of the PREDICT project was to provide a comprehensive solution for dealing with cascading effects in multi-sectoral crisis situations covering aspects of critical infrastructures.
The PREDICT solution is composed of the following three pillars: methodologies, models and software tools. Their integrated use will increase the awareness and understanding of cascading effects by crisis response organisations, enhances their preparedness and improves their response capability to respond in case of cascading failures.

Website: http://www.predict-project.eu/objectives

**Snowball – Lower the impact of aggrevating factors in crisis situations thanks to adaptive foresight and decision-support tools**
The project's overall objective was to increase preparedness and response capacities of decision-makers, emergency planners and first responders in respect to amplifying hazards in large disasters. SnowBall consisted in a deep analysis of cascading effects and development of methods to anticipate them; and in a Decision Support System able to display current crisis monitoring and results of simulated decisions integrating cascading effects.

**Fortress – Foresight tools for responding to cascading effects**
Fortress has identified and explored cascading effects by using evidence-based information from a range of previous crisis situations, as well as an in-depth analysis of systems and their mutual interconnectivity and (inter-)dependency. FORTRESS has intervened in current crisis response practices by bridging the gap between the over-reliance on unstructured information collection on one side and a lack of attention to structural, communication and management elements of cross-border and cascading crisis situations on the other.

Website: https://cordis.europa.eu/project/rcn/185488/factsheet/en

**ESENET – emergency services in europe network**
The improvement of the European capability to respond to everyday emergencies and guarantee the safety and security of citizens in case of major emergencies and disasters requires a significant step forward in the integration of existing systems at several levels. The ESENet initiative aims at establishing a network of stakeholders in the Emergency Management domain that will identify, discuss and agree on needs, requirements, new technologies and best practices in responding to everyday as well as to major emergencies.

Website: https://cordis.europa.eu/project/rcn/106662/factsheet/en

**CIPRNet – critical infrastructure preparedness and resilience**
CIPRNet establishes a Network of Excellence in critical infrastructure protection (CIP). CIPRNet performs research and development that addresses a wide range of stakeholders including (multi)national emergency management, critical infrastructure operators, policy makers, and the society.

Website: https://ciprnet.eu/home/

## 1.2 OBJECTIVES

**General objective**
The general objective of the project has been to make cities more resilient to disruptions in power supply. This is done by improving knowledge of cities' role in protecting their vital societal functions from such disruptions, and by identifying efficient measures available at the local level for protecting citizens against severe consequences of power outage.

The long-term objective of the project is to have increased knowledge and awareness that will enhance European cities' understanding of risks and vulnerability related to critical infrastructures and vital societal functions. Furtheremore, their ability and capacity to protect their citizens against severe disruptions in such services and systems will be improved. Results from assessments of the selected cities will be transferable to other European cities. This will enable other cities to draw more or less directly upon experiences and evaluations made in the project in their own work with evaluations of effective barriers and municipalities' role vis-à-vis other stakeholders, when building resilient vital societal functions.

Testing and evaluating methodologies in order to assess chains of interdependencies and vulnerabilities is a further objective within this project. Beneficiaries have tested and evaluated within their own case studies. This provides methodological experience and insights that other participating states of the UCPM /European cities can build on in their further work in this area.

For national and regional civil protection authorities, the objective is a long-term effect, which will be improved understanding and awareness of the effectiveness of different governmental instruments available at the national level, such as regulation and cross-sector cooperation. Furthermore, a more closely connect European network in order to share knowledge between cities on prevention and preparedness efforts is an overall objective within MEREPUV, in order to build more resilient societies.

**Specific objectives**
The partners also defined a number of more specific objectives for the project:

1. **Improved understanding of and experience with methodological approaches for assessing vulnerability in societal functions with emphasis on interdependencies.** The cities have conducted risk and vulnerability assessments of direct and indirect effects of electrical power outage for three other urban vital societal functions. This has generated valuable experience and knowledge about vulnerability assessments among the partners, which will be of importance also in future work with similar assessments. In sum, the cities' assessments have served as pilots for testing, improving and developing existing methodologies.

2. **Improved knowledge of risks of severe power outage in the cities and efficient measures available at the local level.** The cities' assessments have revealed knowledge of the effectiveness and resilience of existing barriers and practices, as well as critical interdependencies between vital societal functions. The assessments constitute a basis for proposals of revised and/or new measures to better protect citizens against cascade effects due to disruption in electrical power supply. The findings are also expected to generate a spill-over effect, so that the cities may conduct similar assessments of other vital functions in the future.

3. **Better understanding of the municipalities' role vis-à-vis other stakeholders' responsibilities in preventing severe consequences of undesirable incidents hitting urban vital functions.** In the work with the cities' vulnerability assessments, many municipal and state actors, as well as private stakeholders, have been involved. This has contributed to an improved understanding of the interconnection between actors with different responsibilities in a chain of linked vital functions and services. We expect that this will lead to raised awareness of the different stakeholder's roles in such an interconnected network. We also expect that the importance of such cross-sectoral work will be recognized and used in further risk evaluations in the cities.

4. **Closer cooperation and sharing of experience nationally and internationally between cities and national authorities** in efforts aimed at improving urban resilience. The project documents the most important insights identified in the cities' assessments in this final project report, and participants will disseminate the findings nationally and internationally. We expect that the experiences and results from the project will be highly relevant for other cities in the participating countries, as well as other participating states of the UCPM / European cities, and thus leading to higher degree of cooperation and exchange of experiences and knowledge in this area, also in the future.

## 1.3 MAIN WORK PACKAGES IN THE PROJECT

The project is in line with the intentions of the adopted:

1. United Nations' Sendai Framework on Disaster Risk Reduction 2015-2030
2. The Council of the European Union's "Conclusions on a Community framework on disaster prevention within the EU", 2009
3. The Council of the European Union's "Conclusions on Further Developing Risk Assessment for Disaster Management within the European Union", 2011
4. Commission staff working document "on a new approach to the European Programme for Critical Infrastructure Protection. Making European Critical Infrastructure more secure", 2013.

The project builds on previous work carried out in the partner countries and the EU.

The partner countries have been responsible for one work package each. The activities herein has mainly taken place in the participating cities, and has entailed one vulnerability assessment per city, as well as one working paper from each partner country. In addition, there have been three joint workshops; one in Norway (May 2018), one in the Netherlands (June 2019), and one in Latvia (August 2019). The objectives for these gatherings have been:

- to share and discuss experiences and knowledge
- to build on other relevant findings from other EU-projects
- to compile the most important findings from the cities' assessments for the common final project report
- to develop a plan for dissemination of the results.

The main outputs and most important findings documented in the joint final report from the project was launched and presented on the project's final conference in Oslo 31 October 2019. Additional outputs from the project were also launched at the web pages of the partners, enabling other stakeholders to make use of the end products of the project.

## 1.4 STRUCTURE OF THE REPORT AND USE OF RESULTS BY OTHER PARTICIPANTS OF THE UCPM

MEREPUV has been carried out in three different countries located in the Baltic region, western and northern Europe. The partner countries are different regarding institutional and regulatory structures, risks and vulnerabilities, resources and prevention and preparedness strategies. This has opened up for a high degree of learning from each other during the project. Our hope is also that other participants of the European Union Civil Protection Mechanism (UCPM) can make use of the results generated in the project, since many of the European cities and countries are similar to at least one of the participating countries/cites in MEREPUV. Thus, we have chosen to include each of the partner countries' working paper in its entirety in the joint final report.

The joint final report from MEREPUV is structured as follows: chapter 2 gives a brief introduction to the joint analytical approach for the vulnerability assessments carried out in the project. Chapter 3 summarizes important findings from the project as a whole, in a comparative perspective. Chapter 4 gives a short description of the further dissemination plans for the partners of MEREPUV. Chapter 5 entails the three working papers.

# 2 A KNOWLEDGE-BUILDING PROJECT – JOINT METHODOLOGY

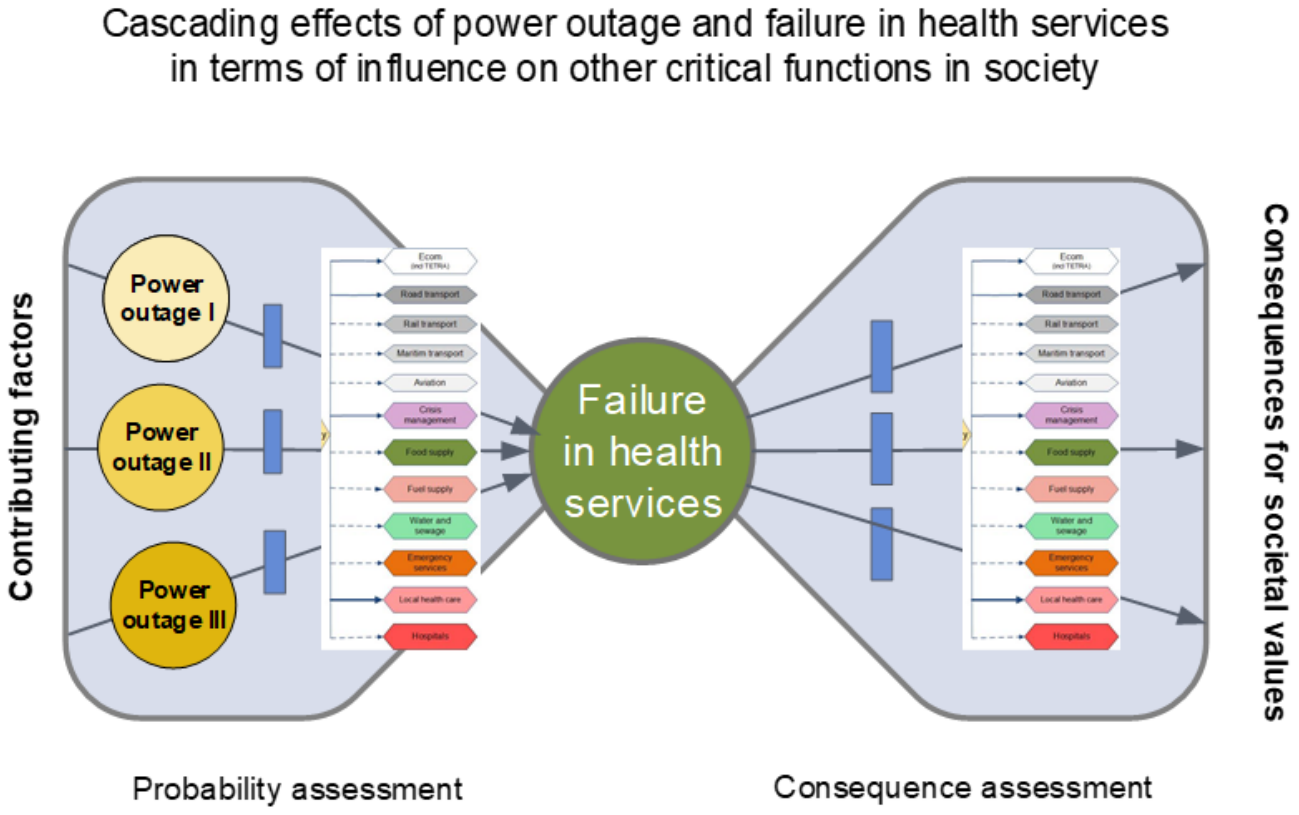
MEREPUV has been a knowledge-building project and the partners have used the same methodology in their analytical process.

The chosen method builds on the so-called bow tie model, and is adapted and specified on basis of purpose of this project and the main questions to be examined by the five cities. The chosen method is also scenario based, where a set of scenarios have been used as stressors for examining vulnerabilities. The following main elements have been emphasized in the cities' assessments:

- Assessment of how the scenarios affect critical input factors for health- / rescue- / electronical communication services
- Assessment of the overall impact of the scenario on health- / rescue- / electronical communication services, directly due to the power outage, and indirectly due to disruptions in critical input factors
- Assessment of how disruptions in health / rescue / electronical communication services affect other vital societal functions. Cascading effects
- Assessment of overall consequences of disruptions in health- / rescue- / electronical communication services on the societal values "life and health" and "social stability"

The partners agreed on two joint scenarios of electrical power outage to be assessed by all the five partner cities. The further specification of the scenarios was up to each partner country.

- Scenario 1: loss of electrical power for 24 hours
- Scenario 2: loss of electrical power for 72 hours




Figur 1. Risk and vulnerability assessment in four steps: 1) How do the scenarios affect other vital functions? 2) How does failure in such vital functions affect health services? 3) How does disruption in health services affect other vital societal functions (interdependencies) 4) What are the consequences for citizens and society?

A joint understanding of the term "vital societal function" has been important for the project, and as earlier mentioned, the following definition has been used in MEREPUV:

*"A vital societal function is a function of such importance that its loss or severe disruption could entail major risks for the life and health of the population, the functionality of society or society's fundamental values."*

Furthermore, the Norwegian framework "Vital functions in society" has been introduced to the partners as an illustration of the Norwegian approach to identification and operationalization of vital societal functions. In Norway, 14 such functions are identified as vital. "Power supply", "rescue services", "health and care" and "electronic communication network and services" represent four of the functions defined as vital in the framework. Each of the 14 vital functions are further broken down and detailed into capabilities.[2]

A more thorough presentation of the joint methodological approach used by the partners in MEREPUV is available in annex 1.

2 DSB June 2017 - Vital functions in society: https://www.dsb.no/rapporter-og-evalueringer/vital-functions-in-society/

# 3 OVERALL FINDINGS OF THE MEREPUV PROJECT

Five cities and three regional and national agencies, from three different countries, have participated in the MEREPUV project. Legislation, resources and institutional arrangements vary between the countries. Nevertheless, the project has revealed some common findings cutting across such differences between the partners.

## 3.1 LEGISLATION, ROLES AND RESPONSIBILITIES

There is a wide range of laws and regulations applying for the electricity sector in all three countries. In addition, there are sector laws requiring prevention and preparedness measures in the case of power outage within various services. The municipalities play an important role when it comes to the safety and well-being of the citizens in all three countries. In Norway, municipalities are required to carry out multi hazard risk assessments and develop plans accordingly. Latvian municipalities are required to conduct more limited risk and vulnerability assessments related to their areas of responsibility for providing heat and power. In Netherlands the safety regions have the responsibility to organize crisis management and conduct risk assessments. The safety region is an organization consisting of multiple municipalities, who fund the safety region and are ultimately responsible.

If a crisis occur in the Netherlands, the mayor will be in charge of crisis management. Although the police is national, fire services are regional and health services are largely private, the mayor will still be in charge during a crisis. If the crisis involves more than one municipality, the mayor who is chairman of the Safety Region is in charge. This system differs from the Norwegian and the Latvian system. In Latvia, the State offers assistance to the municipalities. In Norway, the county governor will have a coordinating role when several municipalities are affected. Furthermore, the police plays a key role in crisis management as coordinator for the emergency services.

Both the principle of responsibility and the principle of cooperation are central pillars in the civil protection systems in all three countries. Each stakeholder must take responsibility for their own vulnerabilities, but also identify other sectors that depend on it. The principle of responsibility entails that all stakeholders take their own responsibility, while the principle of cooperation requires that each stakeholder also identify interdependencies with other stakeholders, including other sectors. One experience is that owners of institutions that provide critical services will often look at this issue from a narrow business continuity point of view, rather than assessing the complexity of interdependencies and cascading effects.

## 3.2 PROBABILITY OF POWER OUTAGES IN CITIES

Although major power outages in cities are rare, all three countries have experience with power outage with similar duration as in the scenarios.

There seems to be some differences between the partner countries in how they evaluate the probability of such extensive power outages to occur. In Norway, for instance, the probability is considered to be very low, while in the Netherlands consider the probability of a power outage of 12 to 24 hours higher. This is due to different characteristics of the power systems.

The partners also differ in whether public authorities under certain circumstances can implement prioritizing mechanisms in favour of certain vital functions / end-users, for instance in deciding who should get power back first. In Norway, such prioritizing is possible, but regulated by law. In Netherlands, prioritizing certain users above others is not possible under any circumstances for the private organizations that maintain and manage the electricity network. In Latvia, the prioritizing is possible and the priorities are set by the municipality.

There is now a trend towards more diversified power supply, with the development of renewable energy, reinvestment in infrastructure, etc. This complicates the picture with regard to assessing the probability of power outage. Such a trend can both lead to a more resilient power system as well as new vulnerabilities. However, the project participants assume that more diversified energy supply offers an opportunity to strengthen the resilience of the power systems and its users.

## 3.3 VULNERABILITY TO POWER OUTAGE

### 3.3.1 GENERAL VULNERABILITIES

The consequences of power outages are considered severe in all three countries. All the countries have legal requirements for preparedness in case of power outages.

In general, cities become more and more dependent on well-functioning power supply, combined with ICT and electronic communication systems infrastructure. In addition, there is urbanization, and an increasing number of elders, changing the demographic patterns in cities over time. With more elders, there is a need for more patients to receive treatment at home, rather than overexploiting the capacity of hospitals and other health institutions. This is also closely connected to the increasing use of so-called welfare technology in cities.

Many of the identified vulnerabilities are common for the cities. Most services are for example dependent on electronic communications. If the power outage makes electronic communication fail, there will be widespread cascading effects. For example, rescue services will function only for a limited time, while the need for rescue services will probably increase – partly depending on what caused the power outage.

Limited access to fuel, shortage of staff and other resources are also mentioned as important potential consequences of power outage that can lead to further cascading effects.

There are uncertainties whether a situation with power outage will cause social unrest. Nevertheless, power outages will have widespread consequences among the population. For example, many will be unable to go to work, either because schools, kindergartens etc. are closed, or due to transportation and traffic problems.

The differences in the findings are mostly related to how the services are organized and the degree of privatization.

There is a need for spreading information to the public about what will actually happen in case of an evacuation. Hospitals will not function as evacuation centres; rather, they will send the least critical patients back home. People may not be aware that they will have to take care of their own elders and disabled relatives in a crisis situation.

There seems to be some differences between the countries when it comes to water production and infrastructure, and vulnerability to power outages. This may be a weaker spot in the Netherlands than in Norway. In Norway, the topography allows water supply to be driven mainly by gravity, while the Netherlands depend more on pump stations within high buildings for the upper floors. However, all countries rely on electricity to some extent, particularly for water purification, pump stations etc.

### 3.3.2 ELECTRICAL POWER OUTAGE AND ELECTRONIC COMMUNICATION SYSTEMS

The assessment of Stavanger revealed that electricity and electronic communications are so closely connected, that it is difficult to assess consequences of loss of electronic communication systems without also assessing consequences of power outage. Electricity is the most important impact factor for electronic communication services, and a power outage will have major impact on electronic communication services. . If communication systems don't fail immediately due to being overused, most electronic communication services will be unavailable after 2-4 hours unless they have reserve power. Since electronic communication systems are crucial for almost all other vital societal functions, disruptions of electronic communication systems will have huge impacts on society. Innovation and development of new services are largely based on support from telecommunications, which makes the society's dependence on electronic communications even stronger. Welfare technology is an example of this. The assessment emphasizes the need for increased awareness both within companies responsible for critical services, and among other stakeholders. In the context of the MEREPUV project, loss of electronic communication systems will have severe consequences, both for rescue services and for health services.

Suggested measures include reserve power, stronger collaboration between crisis management and other organizations, and identifying and developing alternative communication solutions.

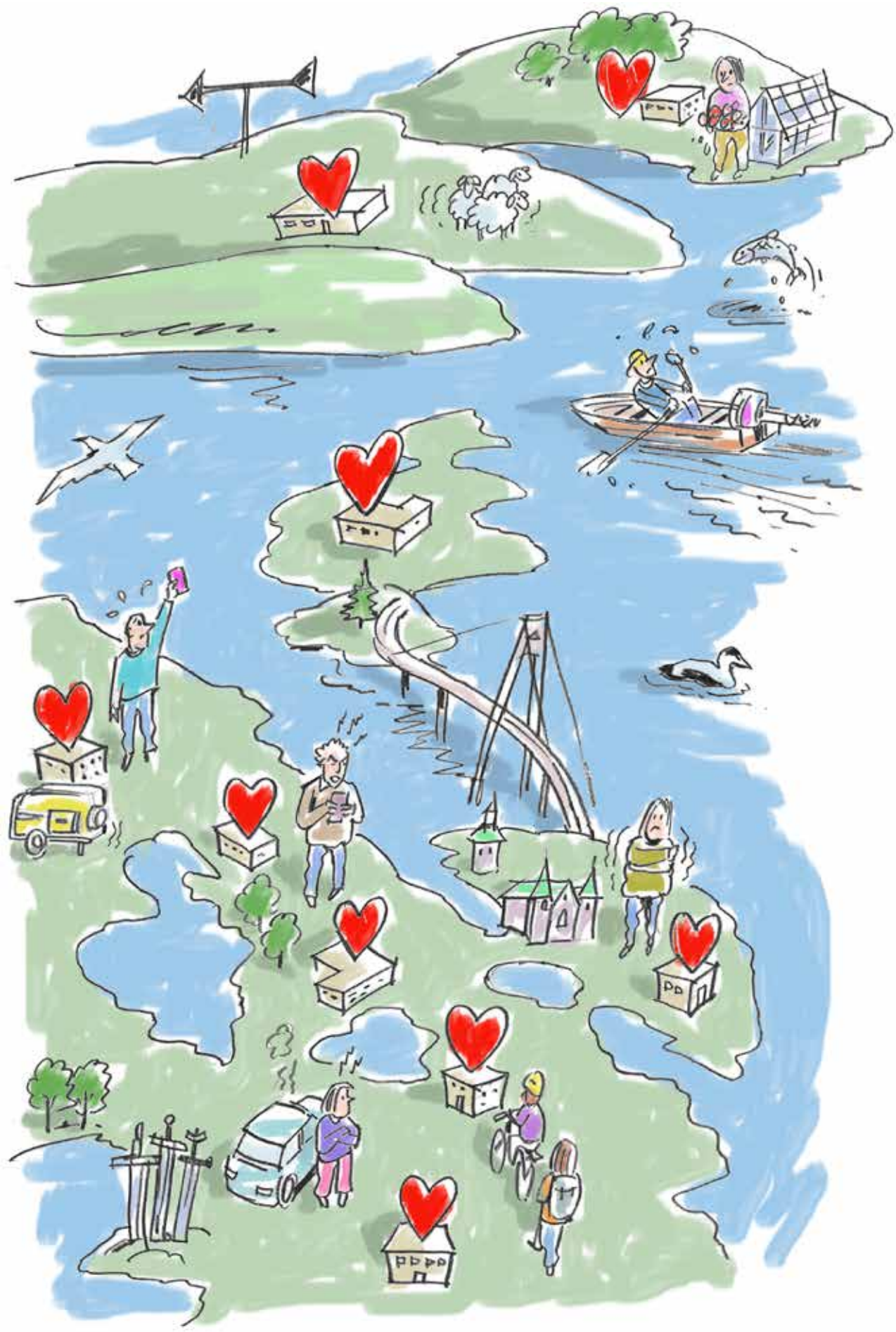
All project partners emphasize that electricity and electronic communication are basic functions, which have an impact on all other aspects of society, including life and health. Thus, electricity and electronic communication should be given special attention in risk and vulnerability assessments, societal planning and preparedness planning.

### 3.3.3 ELECTRICAL POWER OUTAGE AND RESCUE SERVICES

Electrical power outage will also lead to severe consequences for rescue services. The assessment from Oslo points at the close relation between power outage and electronical communication, and the rescue services' high dependency on both of these vital functions.

One of the most dangerous consequences of loss of electronic communication due to power outage, is that citizens in need of immediate help will have difficulties getting in contact with rescue services by phone. The assessment from Oslo underlines the need for the municipality to provide pre-identified locations where the public and rescue services can meet.  Rescue services will have to reassign their resources in order to be able to increase their detection capacity, and to enhance communication with the citizens.

The rescue services communications system, TETRA (Nødnett), makes it possible for the rescue services to communicate between them for a while, even during a power outage.



Depending on the duration of the power outage, this will enable some coordination. However, the ability to communicate will be even more important with reduced detection capacity.

The assessment underlines the importance of emergency power and redundancy emergency centres, but also the dependency of fuel supply. Rescue services need fuel supply both for reserve power and for vehicles.

Further, the assessment demonstrated the dependency of water supply for rescues services. In a worst-case-scenario, a hospital cannot receive patients if they cannot provide a clean environment, including clean textiles, ambulances, and buildings.

### 3.3.4 ELECTRICAL POWER OUTAGE AND HEALTH SERVICES

The health services are to some extent differently organised in the three participating countries. This has affected what health services Bergen, Valmiera and Dordrecht have chosen to include in their assessments. Whereas Valmiera chose to focus on the hospital located in the municipality, Dordrecht and Bergen chose to examine a broader spectre of health services, such as hospital, elderly homes, other institutions, home care, general practioners etc. Most of the findings have comparable elements across cities and countries, and at the same time some unique characteristics.

*Immediate effects*
The effects of a power outage starts to show almost immediately. Patients in institutions will be taken care of, while home nursing patients might need more assistance. This can for instance be a result of reduced heating and cooling capacity in private residences or the reduced ability to reach personnel by phone or safety alarms, etc. In general, a power outage will require more personnel to ensure the well-being of patients, but critical functions is expected to be taken care of.

Power outages that lasts more than approximately 12 hours are considered to be more critical and difficult to handle. The health services' own backup systems and the backup systems of critical supplies might not be designed to handle long lasting outages. Similarly, in all the assessments, most organisations would start evacuation within 24 hours. Around this time, it was deemed better to evacuate to surrounding regions, rather than to stay in areas without electricity.

*ICT/telecom and health services*
The increased use and reliance on ICT and telecom within the health sector is a shared characteristic among the partner countries, although on different levels. Ordinary communication, coordination and control in and between the different health services are mainly based on ICT tools and telecommunication, and will be reduced or lost in a power outage. Examples are access to patient journal systems, medicine lists etc. At the same time, the outage is expected to increase the need for effective communication. Although backup systems exist, these are not expected to have the same capacity or meet the increased demands. In short, many operations will have to be dealt with manually rather than digitally.

Another very important aspect is that few or no backup systems exists readily available to the public, leaving the public unable to contact the health care services – similar to what was described for rescue services.

*Home nursing patients*
It is becoming more common for patients to stay longer at home before being admitted into hospitals, or more quickly be discharged from the hospital and receive the care they need at home. The amount of people who are not able to be self-reliant without home care is increasing. These patients often rely on certain powered equipment for their health and need assistance to cope with power outages that lasts more than a few hours. The battery backup of these devices have limited duration. Also information on these patients and their needs is not always readily available, or not accessible in case of power outage. Creating a system in which this information can be accessed and/or shared with crisis organization would increase their ability to deliver critical assistance greatly.

*Infrastructure and critical supplies*
Healthcare buildings are in general equipped with emergency power systems, such as diesel generators or batteries. It is important to notice that these systems only have capacity to serve the core/ critical functions of the services with power.

Emergency power systems depend on steady resupply of fuel and maintenance to ensure continued operation. They also have to be tested to ensure that they will actually work during a power outage.

As mentioned, water supply is identified to be a critical supply for all the health services, and might be affected during long lasting power outages. Without water, the services have to close down and evacuate. It is important that water supply is included in the health services contingency plans.

*Complexity*
Crisis management and the flow of information is affected by how the services are organised. This applies both to public and private services (complexity of organisations).

The health services consists of a high number of organisations and systems. All these have a high dependency on ICT. The variety of designs and different backup power makes it difficult to plan for which services that will be available or not during a long lasting power outage.

### 3.3.5 OVERALL RECOMMENDATIONS

All the partners have identified several existing barriers established to avoid the occurrence of severe power outages, and to reduce the consequences if it occurs.

At an overarching level, all the cities have also evaluated the need for risk reducing measures and recommended implementation of new measures. Many of the proposals allow for implementation on basis of municipal decision making, or in collaboration with other local civil protection stakeholders located in the municipality. The proposals vary in scope as exemplified below.

*Emergency power systems*
Emergency power systems are vital to maintain operations during a power outage. Existing power systems should be maintained and tested to ensure their ability to operate during outages, and the systems' capacity and need for maintenance and resupply must be documented. There have to be plans for (re)supply of fuel for diesel-powered systems, and additional fuel backup for diesel-powered systems should be maintained. In addition to existing systems, the infrastructure must be prepared for the connection of emergency power (connection points). In the Netherlands, the ongoing energy transition is viewed as an opportunity to create more resiliency at a local level, as there will be large investments and changes into the overall energy network.

The principle of responsibility suggests that vital services dependent on undisrupted access to power at all times, should themselves have the responsibility to ensure sufficient emergency power systems within their services. In Norway, one of the main proposals from DSB, is a follow-up project to get a better overview of how this is dealt with in various sectors.

*Water supply*
Contingency plans to ensure water supply to the health services is important and should be coordinated with the health services' plans. This measure applies to power outages as well as other incidents.

*Advice and information to the citizens*
A major event of power outage will affect society and many people will be in need of help. If a larger part of the population is able to take care of themselves and those around during an emergency, immediate help is more likely to first reach those who need it the most. We recommend all households to take a few simple steps to improve their own emergency preparedness based on advice from the municipality.

Information to the public during an outage is also important. An example of a relatively modest measure proposal is Stavanger's suggestion to point out and communicate to citizens where they can go to get information in case of a long lasting disruption in electronic communication services.

*Cooperation between local stakeholders*
Another example is the proposal to initiate cooperation between relevant local stakeholders, in order to develop routines and procedures to ensure early warning in a situation with power outage. Such early warning mechanisms can ensure that important preparedness efforts are taken while electronical communication services and communication devices are still operational and not affected by the power outage. This includes planning for alternative communications, both within the services and between other stakeholders. In the Netherlands the need for a more closely connected health sector and crisis management organisations is needed. This network should especially encompass the smaller partners who have an (in) direct connection with patients, such as housing corperations and small scale home care organisations.

*Identify vulnerabilities in ICT-infrastructure*
One example of a proposed measure that is more extensive, yet fully possible to implement by municipal decision-making, is Bergen's proposal to go through the municipality's IT infrastructure with the aim to identify and strengthen critical elements at various levels.

*Plans for evacuation*
One of the key findings is that the need for evacuation can arise well within 24 hours with power outage. It is recommended that there are generic plans for this kind of evacuation.

Finally, there are also examples of suggested measures, which would require further assessment and decision-making at the central level. One example is Oslo, who addresses the question of whether more joint guidelines for preparedness against power outage should be considered for the police, fire and rescue and ambulance services.

The cities' identification of proposed measures illustrates that even if the topics addressed are complex and extensive, it is still possible to improve risk management by rather simple measures that are available locally, and not only by comprehensive and expensive measures managed at the central level.

The country and the cities reports explains the recommendations and measures in more detail.

## 3.4 METHODOLOGY AND PROCESS – EXPERIENCES FROM MEREPUV

**Joint model – increased understanding and awareness**
All the partners participating in the MEREPUV project have used the same analytical model developed in the project when doing their vulnerability assessment of power outage. The project developed a relatively detailed template attached in annex 1, where the analytical model was broken down to specific questions to answer in the five cities' assessments. All cities have conducted the vulnerability assessment, involved stakeholders and led local expert seminars.

The overall impression is that the cities have made substantial efforts in the work with the assessments, and gained new knowledge of vulnerabilities, cascading effects and measures related to power outage. The strength of the model is the structured approach towards the assessment and thus the possibility to compare results between the cities.

**Simple model – still complex and time consuming**
Even if the model was simple, and the questions quite specific, it was hard to get the full picture of the cascading effects of power outage. Therefore, the assessments mainly show effects at a very overarching and rudimental level when it comes to cascading effects. Anything more became too complex in this project.

Coordination and communication with the large group of stakeholders and departments within the municipality is demanding and requires a lot of effort. The more divided the responsibility for the service is, the more complex and difficult it becomes. Whether the service provider is private or public is not that important, but might be an issue when it comes to sharing sensitive information in a competitive environment.

All the cities have found it necessary to limit the scope of the original model to some degree. For example, the cities have seen the need to exclude some relevant critical input factors or cascading effects from the assessment in order to achieve a manageable scope. Furthermore, some adjustments of the questions addressed in the joint guide for assessments have also been made.

**Topics not assessed using the chosen model**
Some cities have pointed to some limitations with the analytical model. For example, the model does not contain an assessment of direct impact of power outage on life and health and social stability. The model focuses exclusively on effects of power outage on life and health caused by disruption in the rescue, health and electronical communication services. This can be a somewhat strange limitation since the citizens are expected to be heavily affected directly by the power outage, but is a chosen limitation to narrow the scope of the analysis.

**Conclusions regarding model**
There are strengths and weaknesses with all methodological approaches to risks and vulnerability assessments. The general impression in MEREPUV is that the partners found the chosen model as a fruitful method allowing for learning at an overarching level given the time frame and resources available for this project.

DSB considers the model as an adequate and relevant approach to consider in future vulnerability assessments conducted by DSB. SFRS argues that the methodological experience and learning from MEREPUV is expected to improve the quality of future multi-hazard risk assessments conducted by local / regional civil protection committees in Latvia. In Netherlands, the use of the model as a way to streamline the discussion has turned out as a fruitful method, though to go into depth additional tools have to be used. Not all consequenses and indepencies were known by the participating stakeholders themselves however (and some are still not completely discovered) but the model and additional tools gave them a good insight.

**Work process – stakeholder management**
During the work with the cities' vulnerability assessments, a large number of stakeholders have been involved and brought together in expert seminars designed to illuminate consequences and dependencies related to power outage. This has increased the understanding and awareness of dependencies and impacts from a broad perspective, not only among the partners, but also among the stakeholders involved.

The experience from the project is that this is a very exciting and fruitful approach when aiming at examining challenges that lies between different civil protection stakeholders. The strength of this way of working is the high degree of learning potential for all involved actors, as well as getting the possibility to examine civil protection challenges from a cross-sectorial and holistic societal perspective. The broad spectre of involved stakeholders also opens up for a more joint understanding of cross-sectorial challenges within the civil protection area.

The partners in MEREPUV are of the opinion that such cross-sectorial coordinating approaches can contribute to improved general civil protection work.

# 4 DISSEMINATION OF RESULTS

The results of MEREPUV will be disseminated in various ways. It has been an ambition of the project to develop knowledge and methodology which can be utilized at local, national and regional level and in other European countries. The project may have an impact on planning and decision-making in multiple sectors. The output of the cities' assessments highlight not only the need for cross-sector coordination, but also the need to look at impacts of power outage at regional (county) or even national level. Although the probability of such events is very low, the results of MEREPUV can provide knowledge and learning points which can enhance prevention and preparedness measures at all levels and in various sectors. Dissemination of the results is thus important in the years to come.

**Local level**

The cities' reports have already been utilized in all participating cities and constitute vital inputs for further planning, including holistic risk and vulnerability assessments, and prevention and preparedness planning at municipal level. The municipalities will be in the frontline in defining and implementing preventive measures within their own areas of responsibility and to further develop municipal contingency plans. They can also play a role as a driving force towards local private stakeholders and their work with prevention and preparedness efforts related to power outages

Each city participating in MEREPUV will ensure that the results of their own report becomes well known by the municipal administration and its political leadership, and that the reports will be used as basis for further planning at local level. Dissemination at local level will be done in numerous ways; in local seminars and workshops, in municipal planning processes, through local media, etc.

Further, as coordinating institutions for civil protection and emergency planning, the cities will make use of already existing networks, such as municipal emergency councils, to ensure that relevant stakeholders in each country will make use of the city reports.

**Regional and national levels**

All cities have benefitted from including regional stakeholders in their assessment process, such as county governors, regional suppliers of electrical power, regional health authorities, or other regional institutions. In Norway, the county governor is responsible for the coordination of civil protection and emergency planning at county level – similar to the municipalities' role at local level. The county governors have established regional emergency councils which may use the results of MEREPUV in their work. Both the cities and the Norwegian Directorate for Civil Protection (DSB) will be able to share results from MEREPUV to the county governors, and thus to the regional emergency councils throughout Norway. DSB will also ensure that other county governors will get information about results, findings and new methodologies developed in MEREPUV.

SRSHS includes the outcome of the MEREPUV project in the project *Self-resilience of the Safety Region*, which is a joint project with the municipalities within the region. The outcome will be input for further cooperation on this subject with the several stakeholders on the national and regional and local level in making aware of the interdependencies and finding ways to improve on all levels.

The national working papers will be available online (dsb.no), including links to, or information about, the cities' reports. This will simplify the dissemination to all stakeholders in civil protection and emergency planning, including national authorities, regional authorities, municipalities, the private sector, universities/research institutions, and NGOs.

The final conference (October 2019) of the project was open for relevant stakeholders from the participating countries as well as other European countries and institutions. Further, information about MEREPUV may be presented in the national conferences on societal safety, or at similar events.

The results of MEREPUV may make the basis for recommendations for further actions at various ministries and agencies. Thus, the outcomes and recommendations of MEREPUV may be presented to targeted ministries and other agencies.

**International level**
All project partners participate in a wide range of international arenas, including conferences, workshops, programmes and international projects. All partners will seek to disseminate the outcomes of MEREPUV where relevant, making use of already existing arenas.

Further, there is a potential for follow-up by developing new projects, based on the same concept and methodology developed in MEREPUV. There is a potential for exploring interdependencies between other societal functions than those covered in this project, or for going more into details in some of the analysed sectors.

**Website**
The national and regional participants have summarized their findings in three working papers, see annex 3-5. In addition, the assessment for each city have been summarized. The city assessment summaries can be downloaded at www.dsb.no.

*An ordinary Friday night in Stavanger*

*Electrical outage*

*4 hours without electricity*


*4 hours without electricity, with fuel supply*

*24 hours without electricity*

*72 hours without electricity*

*1 week without electricity*

*1 month without electricity*

# ANNEX

# ANNEX 1: TEMPLATE JOINT METHODOLOGI–CAL APPROACH MEREPUV

## 1.1 METHODOLOGY

## 1.2 ANALYTICAL MODEL

The assessment conducted is done within the framework of the so-called bow tie model. The model is adapted and specified on basis of purpose, analytical object and main questions to be examined in the assessments.

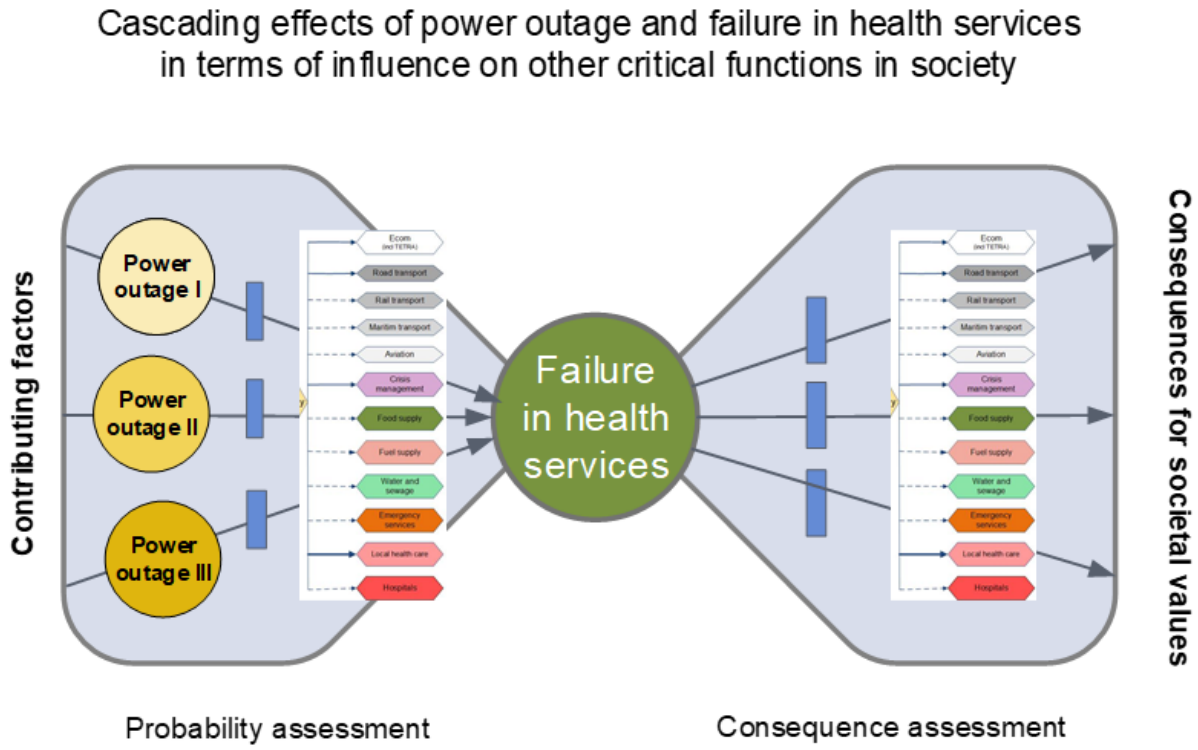
The following risk elements are assessed:

- Probability
- Vulnerability
- Consequences
- Uncertainty

In addition, two other elements are assessed:

- Steering ability: How manageable are the risk and vulnerability attached to the scenario? To what degree are there available measures which are likely to reduce risk and vulnerability?
- Transferability: To what degree can the results of the assessments be transferred to other cities?

Vulnerability in health services is the analytical object in the model.




Figur 2. Risk and vulnerability assessment in four steps: 1) How do the scenarios affect other vital functions? 2) How does failure in such vital functions affect health services? 3) How does disruption in health services affect other vital societal functions (interdependencies) 4) What are the consequences for citizens and society?

**Choice of scenarios**
Describe the choice of scenarios of power outage

**Assessment of probability – how likely is it that the scenario will occur?**
The probability assessment builds on results and insights from earlier risk and vulnerability assessments and other available existing knowledge and data material.

The probability intervals used are:

- Very low probability: 0-10 per cent likely in 50 years
- Low probability: 10-40 per cent likely in 50 years
- Moderate probablity: 40-60 per cent likely in 50 years
- High probability: 60-90 per cent likely in 50 years
- Very high probability: 90-100 per cent likely in 50 years

**How do the scenarios affect other vital functions?**
In the assessments we are examining whether and how the scenarios affect other critical input factors of which health services are dependent on in order to function.

**How are health services affected?**
In the assessment we are describing how the different scenarios affect health services, either directly or indirectly, due to failure or disruption in one or several other critical input factors for health services.

Furthermore, an overall assessment is made of how health services are affected in total. The assessment is based on a five-part scale from very low to very high degree.

**Cascading effects and consequences for other vital societal functions**
By examining other vital societal functions' dependency on health services, we get an impression of vulnerability in society related to failure in health services.

**Societal impact**
In this assessment we have chosen to assess consequences for society and citizens by focusing on the following societal values / types of impact:

- Human impact / life and health
- Societal stability / social impacts

The impact type "life and health" is further divided into two consequence categories: 1) number of deaths expected deaths and 2) number of severly injured or ill people.

The impact type "societal stability" is further divided into two consequence categories: 1) Social and psychological reactions and 2) Challenges in daily life.

**Uncertainty, steering ability and transferability**
Assessment of degree of *uncertainty* is related to an evaluation of the quality of exisisting knowledge used in the vulnerability assessment as well as an evaluation of to what degree the results are sensitive to changes in the conditions.

Degree of *steering ability* is evaluated by an assessment of whether efficient measures, of which can reduce the risk and vulnerability, exist and are well known. This is an important evaluation after the results of the risk and vulnerability assessment are ready and alternatives of measures are being adressed.

Degree of *transferability* is expressed by an assessment of whether results are transferable to other cities.

## 1.3 SYSTEM DESCRIPTION OF THE ANALYTICAL OBJECT (HEALTH SERVICES)

Describe the health services to be included in the assessment.

Describe the roles and responsibilities for the health services included in the assessment.

Describe legal framework regulating the services in terms of preparedness in case of power outage.

## 1.4 ASSESSMENTS OF POWER OUTAGE

**Example Scenario 1 – electrical power outage for 24 hours**

## 1.5 DESCRIPTION OF THE SCENARIO

**ELECTRICAL POWER OUTAGE 24 HOURS**

Sunday night 30 December 2019 the electrical power suddenly disappears in X municipality. The power outage affects all citizens in the municipality. It is cold outside with temperature between -5 and 0 degree celsius. After 24 hours all citizens have regained access to electrical power.

## 1.6 PROBABILITY

How likely is it that scenario 1 will occur in 50 years?

The probability intervals to be used are:

- Very low probability: 0-10 per cent likely in 50 years
- Low probability: 10-40 per cent likely in 50 years
- Moderate probablity: 40-60 per cent likely in 50 years
- High probability: 60-90 per cent likely in 50 years
- Very high probability: 90-100 per cent likely in 50 years

## 1.7 IMPACT ON CRITICAL INPUT FACTORS FOR HEALTH SERVICES

*Health services* are dependent on many input factors (other vital societal functions). All these input factors are more or less dependent on electrical power.

Describe the different input factors of which health services are dependent on, and how these input factors are affected by the scenario.[1] Describe and assess the barriers established within each of the input factors to prevent negative consequences from power out age.

For *health services* examples of such vital input factors are drinking water supply, sewage handling, fuel supply, ecom services, transport systems, supply of medicine, district heating supply etc.

## 1.8 IMPACT ON HEALTH SERVICES

Describe and assess existing barriers established to protect the *health services* against direct and indirect consequences of electrical power outage.

How does the power outage affect the different *health services*:

- Hospitals (included emergency medical care – doctors available 24 /7)
- Institutions for elderly and vulnerable groups
- Ambulances

Free to include other categories as:

- Home care services for elderly and vulnerable groups
- Psychiatric institutions
- other categories

Assess the overall impact on health services on a scale from very low degree to very high degree.

## 1.9 CASCADING EFFECTS AND IMPACT ON OTHER VITAL SOCIETAL FUNCTIONS

Describe and assess existing barriers established within other vital societal functions in order to protect citizens against disruption or failure in health services.

How are other vital societal functions affected by disruption / failure in health services?

1 Directorate for Civil Protection 2017: Vital functions in society (https://www.dsb.no/rapporter-og-evalueringer/vital-functions-in-society/)

In example emergency services, crisis management, law and order, water supply and sewage handling etc.[2]

## 1.10 CONSEQUENCES FOR SOCIETAL VALUES

The societal values focused in this assessment in terms of impact and consequences are:

- Life and health
- Societal stability
- Free to include others[3]

Disruptions / failure in health services may affect life and health and societal stability.

"Life and health" is operationalized in "number of deaths" and "number of severly injured or number of people with long lasting illness / injuries".

Societal stability is divided into two consequence categories: 1) societal and psychological reactions, and 2) challenges in daily life.

This chapter should also contain a (rough) assessment of the expected direct and indirect effects of the power outage on life and health and societal stability. For instance, is the demand for health services expected to be larger simultaniously with potential reduced capacity to deliver health services due to the power outage?

## 1.11 DEGREE OF UNCERTAINTY IN RESULTS OF THE ANALYSIS

The degree of uncertainty in results is expressed by an assessment of sensitivity and quality of the knowledge on which the analysis is buildt. Sensitivity is an evaluation of whether minor changes in the preconditions leads to a non-negligible change on the analysis results.

| ASSESSING UNCERTAINTY | |
|---|---|
| **Indicators for evaluation of quality in knowledge** | **Explanation** |
| To what degree is this type of incident a well known phenomenon? | |
| To what degree do we have access to relevant data and experience from equivalent scenarios? | |
| To what degree does the available knowledge provide high degree of consensus? | |
| **Sensitivity in results** | |
| To what degree do small changes in preconditions affect the assessment of probability and consequences? | |
| **Overall assessment of uncertainty** | |

Table 1. Assessment of uncertainty in results of the analysis.

2 Directorate for Civil Protection 2017: Vital functions in society (https://www.dsb.no/rapporter-og-evalueringer/vital-functions-in-society/)

3 European Commission, SEC (2010) 1626 Final: Commission Staff Working Paper – Risk Assessment and Mapping Guidelines for Disaster Management (p. 17)

## 1.12 STEERING ABILITY

Assessment of steering ability is being evaluated in terms of whether there are available, efficient and achievable risk reducing measures.

## 1.13 TRANSFERABILITY

To what degree can the results of the assessment be transferred to other cities?

## 1.14 IDENTIFIED VULNERABILITIES, EXISTING EFFICIENT BARRIERES AND PROPOSALS OF MEASURES

The following vulnerabilities has been identified in the assessment:

- ...
- ...

The following existing barriers seem to be efficient in reducing vulnerability against power outage

- ...
- ...

The following measures are proposed on basis of the risk and vulnerability assessment:

- ...
- ...

| ASSESSMENT OF STEERING ABILITY | |
|---|---|
| **Indicators on steering ability** | **Explanation** |
| To what degree can new effective measures be implemented? | |
| To what degree are areas of responsibility clear between other sectors and private actors? | |
| To what degree do the responsible sector authority have the possibility to decide and implement new measures? | |
| **Overall assessment of steering ability** | |

Table 2. Assessment of steering ability related to probability and consequences of the scenario.

# ANNEX 2: LIST OF PARTICIPANTS WORKING IN THE MEREPUV PROJECT

| Organization | Navn | Role |
|---|---|---|
| DSB | Dag Olav Høgvold | Project Coordinator / expert |
| DSB | Ragnhild L Kringen | Project member / expert |
| DSB | Knut Torget | Project member / expert |
| DSB | Marianne Isaachsen | Project member / expert |
| DSB | Ina M. Møller | Project member / expert |
| Oslo | Ann Kristin Brunborg | Project owner Oslo |
| Oslo | Osman Ibrahim | Project manager / expert |
| Oslo | Ian Gjetrang | Project member / expert |
| Bergen | Ivar Lunde | Project owner Bergen |
| Bergen | Jørgen Gullestad | Project manager / expert |
| Stavanger | Ida Elise Lundon | Project manager / expert |
| Stavanger | Torstein Nielsen | Project owner Stavanger |
| Stavanger | Åshild Steinberg Holmen | Project member / expert |
| State Fire and rescue Service | Rudolfs Azens | Project leader |
| State Fire and Rescue Service | Dmitrijs Dorožko | Project manager |
| State Fire and Rescue Service | Uldis Kevers | Project member / expert |
| State Fire and Rescue Service | Aleksandrs Jefimovs | Project member |
| State Fire and Rescue Service | Nora Lapina | Project member |
| Valmiera | Gints Bertins | Project manager / expert |
| Valmiera | Janis Berzinš | Project member / international focal point |
| Valmiera | Ricards Gailums | Project member / expert |
| Safety Region South Holland South | Nico Van Os | Project manager / expert |
| Safety Region South Holland South | Chi Brouwer | Project member / expert |
| Dordrecht | Rik Heinen | Project manager / expert |
| Dordrecht | Ronald Bosua | Project member / financial manager |

# ANNEX 3:
# EXPERIENCES FROM THE NORWEGIAN PART OF THE PROJECT

Norwegian Directorate for Civil Protection

MEREPUV

2017/PREV/783153

"Methods and measures to enhance resilience against electric power outage in urban vital societal functions"

MEREPUV - Norway

# Vulnerability to power outage in urban vital societal functions

## Main findings from Norway based on assessments from city of Oslo, Bergen and Stavanger

**Deliverable no: D2.4**

Funded by
European Union
Civil Protection

# Content

# 1 Introduction

## 1.1 Short introduction to the MEREPUV project

Power supply is crucial in today's society since almost all other vital societal functions rely on electrical power. Disruptions in power supply can quickly lead to chains of negative impacts or cascading effects, and thus negative consequences for citizens.

The project MEREPUV (*Methods and measures to enhance resilience against electric power outage in urban vital societal functions)* has as general objective to make cities more resilient to disruptions in power supply:

- by improving knowledge of cities' role in protecting vital societal functions from such disruptions, and
- by identifying efficient measures available at the local level for protecting citizens against severe consequences of power outage.

In addition, a set of more specific objectives has also been defined for the project. These are:

1. Improved understanding of and experience with methodological approaches for assessing vulnerability in societal functions with emphasis on interdependencies.

2. Improved knowledge of risks of severe power outage in the cities and efficient measures available at the local level.

3. Better understanding of the municipalities' role vis a vis other stakeholders' responsibilities in preventing severe consequences of undesirable incidents striking urban vital functions.

4. Closer cooperation and sharing of experience nationally and internationally between cities and national authorities in efforts aimed at improving urban resilience.

The project is partly funded by the European Commission (DG ECHO) Union Civil Protection Mechanism for prevention and preparedness projects in civil protection and marine pollution. The project partners are stakeholders from Norway, the Netherlands, and Latvia:

- Norway: Norwegian Directorate for Civil Protection DSB (coordinator), City of Oslo, City of Bergen, City of Stavanger.
- Netherlands: Safety Region South Holland-South, City of Dordrecht
- Latvia: State Fire and Rescue Service, City of Valmiera

The focus in MEREPUV has been on vulnerability of disruptions in power supply within the three other vital functions health services, emergency services and electronical communication services. The five cities participating in the project have all conducted an assessment focusing on loss of electrical power supply as the adverse event. Each city has assessed direct and indirect consequences for one of the other vital societal functions mentioned, and documented the findings in five English summaries.

The partners from each of the three participating countries have summarized the findings in three country reports. These reports, together with the cities summaries, will be used to document the overall results of the project in a final report, whose purpose will be to share the gained knowledge with other participating states of the UCPM / European cities.

**Knowledge building project - joint methodology**

MEREPUV has been a knowledge-building project and the partners have used the same methodology in their analytical process.

The chosen method builds on the so-called bow tie model, and is adapted and specified on basis of purpose of this project and the main questions to be examined by the five cities. The chosen method is also scenario based, where a set of scenarios have been used as stressors for examining vulnerabilities. The following main elements have been emphasized in the cities assessments:

- Assessment of how the scenarios affect critical input factors for health / rescue / electronical communication services
- Assessment of the overall impact of the scenario on health / rescue / electronical communication services, directly due to the power outage, and indirectly due to disruptions in critical input factors
- Assessment of how disruptions in health / rescue / electronical communication services affect other vital societal functions. Cascading effects
- Assessment of overall consequences of disruptions in health / rescue / electronical communication services on the societal values "life and health" and "social stability"

The partners agreed on two joint scenarios of electrical power outage to be assessed by all the five partner cities. The further specification of the scenarios was up to each partner country.

- Scenario 1: loss of electric power for 24 hours
- Scenario 2: loss of electric power for 72 hours

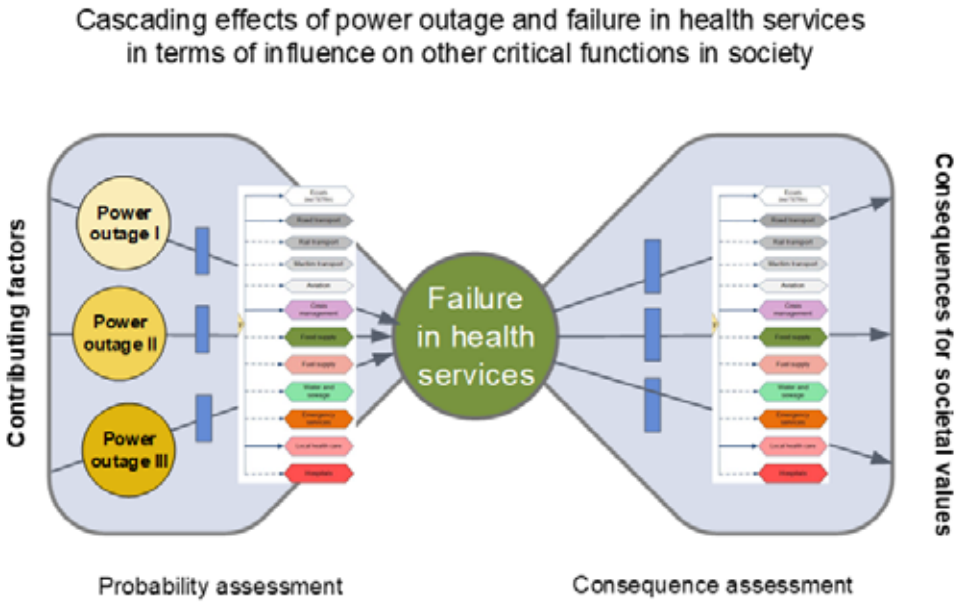



**Figure 3.** Risk and vulnerability assessment in four steps: 1) How do the scenarios affect other vital functions? 2) How does failure in such vital functions affect health services? 3) How does disruption in health services affect other vital societal functions (interdependencies) 4) What are the consequences for citizens and society?

A joint understanding of the term "vital societal function" has been important for the project, and the following definition has been used in MEREPUV:

*"A vital societal function is a function of such importance that its loss or severe disruption could entail major risks for the life and health of the population, the functionality of society or society's fundamental values."*

Furthermore, the Norwegian framework "Vital functions in society"[6] has been introduced to the partners as an illustration of the Norwegian approach to identification and operationalization of vital societal functions. In Norway, 14 such functions are identified as vital. "Power supply", "rescue services", "health and care" and "electronic communication network and services" represent four of the functions defined as vital in the framework. Each of the 14 vital functions are further broken down and detailed into capabilities. A more detailed description of the chosen methodology and vital functions and capabilities in the Norwegian framework, can be found in annex 1 and annex 2.

## 1.2 About the Norwegian part of the MEREPUV project

**Scenarios**

The scenarios agreed upon by the Norwegian project are briefly described in the table below. The city of Oslo has assessed consequences of the scenarios of power outage on rescue services, the city of Bergen consequences for health services, and city of Stavanger consequences for electronic communication services.

| **Description** |
|---|
| **Scenario 1 Electrical power outage 24 hours -** Sunday night 29 December 2019 the electrical power suddenly disappears in the City of Oslo / Bergen / Stavanger. The power outage affects all citizens in the municipality. It is cold outside with temperature between -5 and 0 degree celsius. After 24 hours all citizens have regained access to electrical power. |
| **Scenario 2 Electrical power outage 72 hours -** At 1900 o'clock Wednesday 9 January 2019 the electrical power suddenly disappears in the City of Oslo / Bergen / Stavanger. The whole muncipality are without power until 1900 o'clock Saturday 12 January. It is cold outside with temperatures between -5 and 0 degree celsius. |
| **Scenario 3 Electrical power outage for one week -** Tuesday morning 15 January 2019 the electrical power suddenly disappears in the City of Oslo / Bergen / Stavanger. The citizens in the municipality are without electrical power until Monday morning 21 January. It is cold outside with temperatures between -5 and 0 degree celsius. |

**Defining rescue, health and electronical communication services, critical input factors and cascading effects**

The Norwegian project has used the Norwegian framework mentioned above actively during process in order to:

- define which capabilities to include in when referring to "health services", "rescue services" and " electronical communication services"
- identify interdependencies between power outage and critical input factors for health / rescue / electronical communication services
- identify interdependencies between disruptions in health / rescue / electronical communication services and other vital functions.

**Involvement of stakeholders and consultations**

Broad involvement of stakeholders at different administrative levels has been an important objective for the project. Directorates and agencies at the national level have contributed to the project by

[6] DSB 2017b

sharing of their expert knowledge. They have also been invited to comment on the summaries of the cities assessments and the Norwegian Working Paper before finalizing these reports. An overview of involved stakeholders at the national level is given in annex 3.

The cities have also involved several important stakeholders from regional and local level in the work with their vulnerability assessments. Amongst others, the cities have arranged four expert seminars each, in order to collect data and expert knowledge. The cities have been responsible for ensuring that involved local stakeholders have had the opportunity to read and comment on the summaries before finalization.

**Structure of the Norwegian working paper**

This Norwegian working paper sums up the main findings of the Norwegian part of the project, with reference to the three Norwegian cities' assessments. The paper is structured as follows: chapter 2 gives a description of the Norwegian power system together with a rudimental expert evaluation of the probability of the three scenarios to occur in a Norwegian city. Chapter 3 gives a short description of the municipalities' roles and responsibilities for prevention and preparedness in Norway. Chapter 4 summarizes the main findings from the three vulnerability assessments from Bergen, Stavanger and Oslo. Chapter 5 aims at interpreting the findings from the cities in a wider context as well as outlining the overall findings from the Norwegian project as a whole. The final chapter 6 in the report, briefly describes how the findings from Norway will be shared and disseminated.

# 2 Background – The Norwegian power system

Norwegian households have among the world's highest consumption of electrical power, and electrical power is to a much larger extent than other countries, used as source for heating, light and hot tap water in buildings, as well as to operate electrical devices . Stable supply of electrical power for end users is thus crucial for civil protection in Norway, and the society's expectations of the security and continuity of power supply is increasing.[7]

## 2.1 Scenarios in MEREPUV – how likely in Norway? The Norwegian power system

**The security in electricity supply in Norway is evaluated to be very high. The Norwegian Water Resources and Energy Directorate (NVE) estimates the probability for all the chosen scenarios in MEREPUV to be very low for all the three Norwegian cities. Still, it is impossible to exclude the possibility that extensive power outage can occur.**

### *2.1.1 Production of power and the Norwegian electricity grid*

The Norwegian power grid is a monopoly and regulated by the state. The Norwegian Water Resources and Energy Directorate (NVE) regulates the system and grants licences for transmission and production of renewable energy.[8]

In contrast to European power systems dominated by thermal power production, 96 % of the Norwegian electricity production comes from hydro power. Norway is one of the world's largest producers of hydro power and the public owns around 90 % of the production capacity.[9]

The Norwegian production capacity is flexible in the sense that water can be stored in reservoirs or artificial lakes. Power can thus be produced in dry periods with little rainfall, as long as there is water in the reservoirs. Norway has half of Europe's hydro reservoir capacity.[10] Norway is also part of the European electrical power market, which enables import and export of power. Wind power currently accounts for a relatively modest share of the production capacity but dominates new investments, and production is expected to increase[11].

A secure electricity grid with sufficient transmission capacity is a pre-condition for high security in supply of electricity. The geographical distance between power production and consumer can be quite long in Norway. Thus, the electricity grid must be able to transport electrical power over long distances. In the planning and dimensioning of the electricity grid, Norway also faces challenges related to topography and areas highly exposed to weather events.

The Norwegian electricity grid consists of three levels: the transmission grid, the regional grid and the distribution grid. Most consumers are connected to the regional and distribution grids. Statnett is the

[7] Meld. St. 25 (2015-2016): s 8, OED 2015: s 34, 35, 43
[8] NVE 08/2018
[9] OED 2015:s 9, 18, 20, DSB 2016b: s87, https://energifaktanorge.no/norsk-energiforsyning/forsyningssikkerhet/,
[10] https://energifaktanorge.no/norsk-energiforsyning/kraftforsyningen/, Statnett 2014: s 21
[11] NVE 08/2018

Norwegian transmission system operator, and owns around 90 % of the transmission grid. Approximately 130 different distribution system operators (DSOs) operate the regional and distribution grids. The distribution grids are mostly owned by municipalities and county councils. NVE defines annual allowed income for each of the electricity grid operators.[12]

### *2.1.2 Security in electricity supply – short description of roles and central regulations*

In Norway security in electricity supply is defined as the power system's ability to continuously deliver power of a given quality to end-users.[13]

The Norwegian power sector is subject to extensive regulation in all of the value chain from production, transmission in the different levels of the electricity grid, and all the way to the end user. The regulations are amongst others aimed at contributing to an efficient administration of the energy resources and to ensure secure electricity supply.[14] The Norwegian energy Act[15], the Water Course Act[16] and the Norwegian Electricity Audit Act[17] are the most important laws in this regard.

NVE lies under the Ministry of Petroleum and Energy, and bears the overall responsibility for maintaining national power supplies. NVE is licensing authority and process licence applications for construction of power plants, dams and other installations in the water courses. They also process licence applications for major power lines and other energy installations that require permission according to the Norwegian energy Act.

DSB lies under the Ministry of Justice and Public security, and is the national authority for electrical safety in Norway. DSB administers the Norwegian Electricity Audit Act with affiliated regulations. Amongst others, the law contains regulations about technical security and safety of relevance for building, operating and maintaining high and low voltage installations. The law is thus important also for security and continuity in power supply.[18]

Both NVE and DSB are audit authorities with stakeholders within the Norwegian power sector, and the directorates collaborate closely in areas where their responsibilities are tangent to one another.[19]

The Norwegian power supply is based on the n-1 criteria. This means that the electrical grid and installations related to production of power must be operated in a way which ensures that no error in a single component can cause outages to an end user. However, it is not an absolute requirement that all spots in the electrical grid have n-1 supply. Decisions regarding new investments must also be made on basis of assessments of cost benefit-efficiency.[20]

[12] NVE 08/2018, OED 2015: s 21
[13] Meld. St. 25 (2015-2016): s 42
[14] DSB 2016 b: s88, OED 2015: s 9
[15] Lov om produksjon, omforming, overføring, omsetning, fordeling og bruk av energi m.m (energiloven)
[16] Lov om vassdrag og grunnvann ( vannressursloven)
[17] Lov om tilsyn med elektriske anlegg og elektrisk utstyr (el-tilsynsloven)
[18] DSB 2016b: s87, OED 2015: s 7,18
[19] DSB 2017a: s 50
[20] NVE 2018 / 60: s 37, Meld. St. 25 (2015-2016): s 183

When power outages occur, the severity of the outage depends on it's duration. NVE has developed a system called KILE[21], which gives financial incentives for the system operators to prevent long lasting power outages.[22] Furthermore, NVE has the responsibility to coordinate preparedness planning, and shall manage national supply of power during adverse events. NVE has developed a nation-wide preparedness organisation for this purpose consisting of stakeholders in the sector, such as producers of power, operators of transmission and distribution grids etc.[23] NVE also has the mandate to implement power rationing in situations where available energy in hydro reservoirs or through import is not sufficient to cover the consumption in the mid- to long-term.

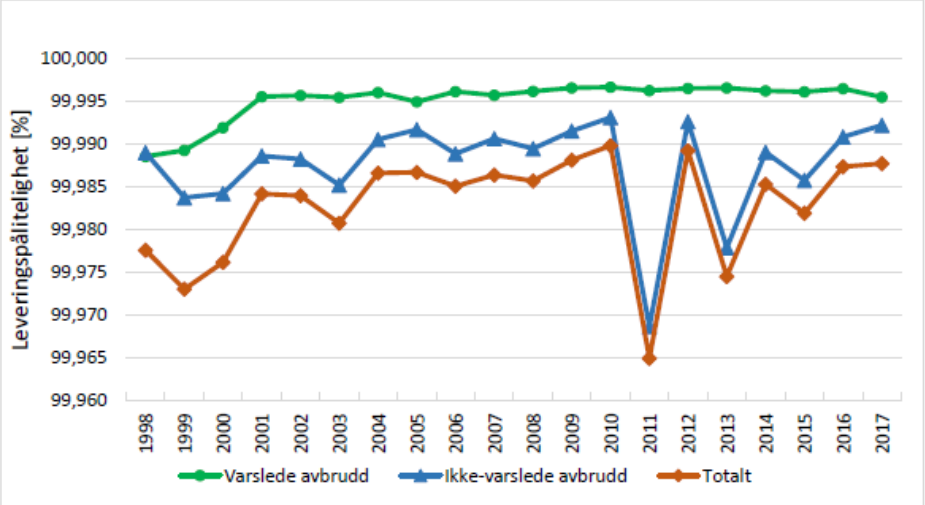
Even though many barriers are established to prevent and limit consequences of power outage, still an important principle is that absolute security against power outages cannot be achieved. This is amongst others evident in the Proposition about changes in the Norwegian Energy Act (2008-2009).[24] It is stated that a 100% guarantee of supply of power would barely be technically possible, and it would be extremely expensive for the society. The proposition concludes that those who are critically dependent on power are responsible for ensuring power back up systems with sufficient capacity.[25]

### *2.1.3 Continuity of supply*

Norway enjoys high security of electricity supply and the continuity of supply is close to 99,99% in years without extreme weather events. Consumers in Norway experience on average about two short interruptions and two long interruptions per year. The average duration is less than two minutes for short interruptions and around two hours for long interruptions. However, the security of supply varies from region to region, and is generally better at higher grid levels.[26]

Extreme weather events in the regions affect the statistics for continuity of supply at national level. Examples of this can be seen in NVE's figure 2 below, in the period 2011-2015.[27]

[21] Kvalitetsjusterte inntektsrammer ved ikke levert energi (KILE)
[22] NVE 2018 / 60: s 4
[23] Kraftforsyningens beredskapsorganisasjon (KBO)
[24] The largest of the two chambers in the Norwegian Parliament
[25] Ot. Prp. nr. 62 (2008-2009): s 15
[26] NVE 08/2018
[27] NVE 2018/ 60: s 4, 7, DSB 2016b): s 89




Figur 2: Leveringspålitelighet[6] for årene 1998-2017 (langvarig avbrudd > 3 minutter).

*Continuity of electricity supply, Norway 1998-2017. Percentage.*

*Green = notified disruptions*

*Blue = non notified disruptions*

*Red = total*

Overturned trees on power lines are among the most common causes of power outages with longer duration in Norway. Statistics also show that this is not only a challenge during extreme weather events, but also in years with normal weather, where snow and strong wind has to be expected.[28] Other causes can be related to outages in power lines caused by damaged ground cables due to digging (and crane) activity, slides or fallen pylons. Non notified disruptions can also be caused by maintenance taking place simultaneous to other incidents.

In addition to extreme weather events, NVE sums up the following causes as candidates that theoretically may cause severe and long lasting outages:

- *Technical failure of transformers*
- *Years with drought*
- *Solar storms / dangerous space weather*

### *2.1.4 Scenarios in MEREPUV – comparable events in Norway?*

In Norway, there are few examples of long lasting, extensive power outages in cities. NVE does not know of any incidents where Norwegian cities have been affected by power outage to the extent suggested in the scenarios in MEREPUV. Some examples of earlier events of power outage in Norway are listed below.

**The storm Dagmar 2011 (also called Patric)**

The storm Dagmar hit Norway night to 25 and 26 December 2011, causing high numbers of errors and failures in the electricity grid many places in Norway, leading to the immediate loss of power for many consumers. For the most heavily affected municipalities, examples of cascading effects due to the power outage were related to disruptions in landline telephone and internet, problems for health care services, water and sewage, fuel supply, crisis management and rescue services.

- 125 139 consumers were without electrical power for more than 12 hours.
- 35 639 consumers for more than 24 hours

[28] NVE 2012 /45: s 3

- The number of persons affected by the power outage is approximately 2,3 times higher than the number of consumers.[29]

**Steigen municipality 2007**
25-30 January 2007, a long lasting power outage due to extreme weather stroke Steigen, a small municipality in the county of Nordland. Steigen municipality experienced many of the same cascading effects as during Dagmar, and old and vulnerable people both in institutions and private residences needed more help as a consequence of the power outage.[30]

**Fire in a cable culvert at Oslo Central Station 2007**
In November 2007, a combination of failure due to constructional work in a ditch with high voltage cables, and fire in a culvert in the same area, lead to the cut off of all power supply to Oslo Central station. The station had to be evacuated and all train traffic were halted for around 20 hours, affecting approximately 80 000 travellers. The event also affected around 25 000 internet customers in addition to phone customers.[31]

### 2.1.5 Scenarios in MERPUV – conclusion

**The security in electricity supply in Norway is evaluated to be very high. The Norwegian Water Resources and Energy Directorate (NVE) estimates the probability for all the chosen scenarios in MEREPUV to be very low for all the three Norwegian cities. Still, it is impossible to exclude the possibility that extensive power outage can occur.**

A relevant question is if developing trends are expected to affect the probability of severe power outages in the longer run towards 2050. The Norwegian energy report from the Norwegian Cabinet to the Norwegian Parliament 2015-2016, concludes that uncertainty is high when trying to predict on basis of such developing trends. One example is climate change. On the one hand, it is assumed that climate change may have a positive impact on security in supply due to increased power production. On the other hand, it is assumed that climate change may represent more challenges for operational security of the power system as a result of increased strain due to more weather events.[32] The report concludes that it is necessary to build a broad knowledge base that allows for sufficient flexibility that can enable society to meet a broad set of possible future scenarios.[33]

## 2.2 Consumers of electrical power - requirements of preparedness in case of outages

Since it is impossible to completely exclude the probability of disruptions in power supply, it is crucial that users who are critically dependent on access to power at all times, ensure preparedness measures, such as alternative source of electrical power. Hospitals, health institutions and vulnerable

[29] NVE 2012:3: s 8, DSB 2012: s 80-81
http://www.hioa.no/extension/hioa/design/hioa/images/sifo/files/file79978_presentation_dagmar_homerisk_kick-off.pdf
[30] Norconsult 2014: s 11, 12
[31] https://www.tu.no/artikler/politiet-2006-strombrudd-lite-sannsynlig/323707
DSB 2008
[32] Meld. St. 25 (2015-2016): s 174
[33] Meld. St. 25 (2015-2016): s 170

groups living in their private residences, are examples of such users critically dependent on stable access to electrical power.[34]

Public authorities have repeatedly underlined that enterprises and services must assess their own vulnerability to power outage, and implement necessary measures for self-preparedness, such as for instance power back up solutions. Still, experience from previous events and exercises shows potential for improvement in this regard.[35]

Below we briefly describe some regulations of relevance when discussing requirements for back up solutions in case of power outage in various services and enterprises.

### *2.2.1 The Electrical Supervision Act[36] - with affiliated regulations*

In regulations related to this act it is stated that the owner and the user are responsible of ensuring that their electrical installations are in accordance with the relevant legal requirements. It is also stated that implementation of a safety power service system must be assessed wherever interruptions in the electrical power supply may cause loss of lives for persons or animals. In the guide to the regulation, hospitals, bigger hotels, institutions and private residences where life supporting electro medical devices are in use, are mentioned as examples where safety power services should be implemented.[37] For certain medical locations in hospitals, there are also detailed specific instructions on how safety power services shall be dsigned.[38]

The Norwegian Electrical Supervision Act[39] also requires that Norwegian grid operators shall carry out inspections and audits with low voltage electrical installations within their area of supply[40]. This is a specific system for Norway, called the Local Electrical Supervision Authority (DLE). DLE can carry out inspections in private residences, municipal and state services, as well as private enterprises. Annually, DLE conducts around 150 000 inspections and audits. The DLEs lie under the grid operators, but are instructed by DSB and financially managed by NVE.[41]

DLE uses risk assessments, a classification system as well as annual instructions from DSB, when defining objects to be prioritized for audits and inspections. In DSBs instructions for DLE, national, municipal and private health institutions are highlighted as services to be prioritized by DLE. Preparedness efforts related to power outage are among the check points that DLE can chose to examine during audits and inspections. DSB audits DLE, and also carries out audits in hospitals with high voltage licence.

[34] Ot.prp. nr 62: (2008-2009): s 15
[35] NVE 2012:03: s 14-16, NVE 49/2014, DSB 2018a), DSB presentasjon fagseminar MERPEUV aug 2018, NVE presentasjon fagseminar MEREPUV aug 2018, DSB 2013a,
[36] Full name of the law: The Norwegian Act relating to Supervision of Electrical Installations and Electrical Equipment
[37] DSB 2017a), Forskrift om elektriske lavspenningsanlegg §§ 9, 16, 31, veiledning
[38] NEK 400 – 5 – 560, NEK 400 – 7 - 710
[39] Se også Forskrift om det lokale elektrisitetstilsyn og sakkyndige som utfører oppgaver for netteier
[40] DSB 2017a
[41] DSB 2018c), DSB 2019d), DSB/NEK 2016/1

### *2.2.2 Sectoral regulations of self-preparedness in case of electrical power outages*

A recent project on electrical safety has concluded that there are considerable variation between different sectors when it comes to legal regulations and audit mechanisms in order to prevent adverse consequences of power outage.[42]

This also seems to find support in the MEREPUV project. Several stakeholders have been involved during the data collection in the project, including agencies at the central level. Involved national agencies have contributed with information about central legal regulations and audit systems of relevance within their areas of responsibility. Such sector regulations comes in addition to the already above-mentioned regimes of DSB. A brief summary of such sectorial regulations is given in the table below.

| Service | Regulation | Control mechanism |
|---|---|---|
| **Electronic communications** | Detailed requirements for minimum power backup capacity for base stations are laid out in the Decision on minimum requirements for backup power capacity in land-based mobile networks (reservestrømvedtaket) of 2014, with a legal basis in the Electronic Communications Act § 2-10.[43] | The Norwegian Communications Authority (Nkom) carries out audits and supervision of electronic communications providers with reference to the Electronic Communications Act § 10-1 and § 10-3. In due course, the Authority will also have a responsibility for audits and supervision in the electronic communications sector under the National Security Act. Audits and supervision include verification of power backup capacity. |
| **Fire and rescue** | The call centers and fire and rescue services must be operational at all times.[44] | DSB is auditing authority for fire and rescue services / fire call centers in Norway[45].<br>Consequences of power outage has been of the topics examined during audits towards fire call centers.<br>This has not been an explicit topic in audits towards fire and rescue services. |
| **Health services** | All health services must be able to continue and if necessary expand their services during crises situations.[46] | The Norwegian Health Audit and the County Governor (Chief county medical officer) audits health services. |
| | Regulations on safe use and maintenance of electrical-medical devices.[47] | The Norwegian Medicines Agency has recently taken over the responsibility for this area from DSB, including the responsibility for audits. |

[42] DSB 2017a): s 82

[43] Innspill fra NKOM 14.06.2019, Post og teletilsynet 6.juni 2014 (Reservestrømsvedtaket), Presentasjon fra NKOM i MERPUV fagseminar 28.august.

[44] Brann og eksplosjonsvernloven §§ 16, 9. Dimensjoneringsforskriften §§ 4-5, 4-7, 4-8 og 6-3

[45] Brann og eksplosjonsvernloven §§ 31a, 16, 9

[46] Helseberedskapsloven § 1-1. Se også §2-1

[47] Forskrift om håndtering av medisinsk utstyr §§ 7-12, 18

| Service | Regulation | Control mechanism |
|---|---|---|
| **Police** | The Norwegian National Police Directorate has the overall national responsibility for police preparedness, including requirements for back-up systems for the police emergency operation centers. | The police works continuously with police critical infrastructure and preparedness. Information are often not open for the public, and can be classified. |
| **Nødnett (TETRA network in Norway)** | Detailed requirements in contract with Motorola about minimum power back up capacity in base stations and transmission lines built for Nødnett.[48] Furthermore, the backup power has been improved compared to what the Nødnett-contract originally specified. | |
| **Water supply** | Regulations about reliability in supply towards public and private water. In guidance material emergency power is mentioned and required if the water work is dependent on power.[49] | The Norwegian Food Safety Authority carries out audits related to regulations on security of water supply. Preparedness measures in case of power outage can be topic in audits, in ex this was the case in 2016. |
| **Power plants and power grid** | Power plants and substations in the grid are classified based on importance, and all important stations are required to have back up for their own power supply. The capacity and redundancy of the required back-up is dependent on the importance of the station.[50] | NVE carries out audits related to regulations for preparedness in the power sector. |

[48] DNK 2014, Presentasjon fra NBK fagseminar 28. august 2018
[49] Presentasjon fra Mattilsynet i MEREPUV fagseminar 28. aug 2018, Drikkevannsforsrkfiten § 9
[50] Kraftberedskapsforskriften https://lovdata.no/dokument/SF/forskrift/2012-12-07-1157

# 3 Municipalities' responsibilities for prevention and preparedness

In Norway, the municipalities play a central role in civil protection. The municipalities are responsible for developing safe and robust local communities, for protecting the population, and for helping to maintain vital societal functions. This role is given through the regulation on municipal preparedness.

**Duty of Municipal Preparedness**
In accordance with the regulation on municipal preparedness, the municipalities shall integrate civil protection as a part of day-to-day activities in all relevant sectors, and follow a holistic approach for civil protection. The provisions also clarify the role of the municipalities as local coordinators in civil protection. This implies that municipalities should enhance:

- comprehensive and systematic civil protection
- a cross-sectorial perspective
- cooperation with other civil protection stakeholders

An essential part of the duty of municipal preparedness, is the development of a holistic risk and vulnerability assessment. The provisions on municipal preparedness provide minimum requirements to such assessments, such as the inclusion of challenges relating to critical societal functions and failures in critical infrastructure.

Due to its coordinating role, the municipality is imposed to take a leading role, inviting other civil protection stakeholders to participate in the process, to provide input for the assessment, and to make use of its results.

The holistic risk and vulnerability assessment should be followed up in an overall plan for civil protection, as well as a comprehensive contingency plan.

The aim of the duty on municipal preparedness is to ensure that the municipality:

- protects the population and helps maintain vital societal functions
- provides an overview, knowledge and awareness of civil protection challenges and the impacts these will have on population and local communities.
- reduces risk and vulnerability through preventive work.
- ensures good preparedness and crisis manageability.
- ensures cooperation and coordination with internal and external civil protection stakeholders in the municipality.

**Prevention and preparedness requirements towards municipalities in sector laws**
In addition to the coordinating role on civil protection, the municipality has the responsibility for civil protection in several other sectors, such as health and care, social services, fire and rescue services, acute pollution, planning and land use management, etc. There are also requirements for civil protection in services, in which the municipality can be the owner. This includes services such as schools and kindergartens and water supply. Further, there are several other stakeholders which are of crucial importance for the municipality's civil protection, such as energy and grid companies, dam owners, providers of telecom services, emergency medical services and hospitals, the police, etc. Emergency planning requirements are given in specific legislation for these stakeholders. The municipality, as coordinating body, will facilitate cooperation with and between them.

# 4 Identified findings and vulnerabilities from the city assessments

As earlier mentioned, each of the Norwegian cities have conducted one vulnerability assessment each of how power outage is expected to affect one other vital societal function. Bergen focused on impact for health services, Stavanger examined impact on electronical communication services and Oslo has assessed impact on rescue services.

In general, an overarching result is that although highly unlikely, a long lasting power outage in cities would have considerable impact on all societal functions examined in this project, as well as on others. In sum, this could also affect life and health of citizens. All the Norwegian cities conclude that the uncertainty related to their assessment is high, and that they have explored limited elements of the overall effects of power outage on society. Still, the assessments have revealed several vulnerabilities and interdependencies.

In the following a brief summary of the main findings from the cities work is given.

## 4.1 Bergen – vulnerabilities related to power outage in health services

In Bergen the following findings have been identified:

- Even if a long lasting city wide power outage is considered exceedingly rare, the consequences will be of such severity that several additional risk reducing barriers are needed to ensure the necessary resilience and function in the health care services.
- Whilst the specialist health care services are reasonably resilient in regards to power outages, the municipal healthcare services have a larger degree of vulnerability, increasing the less acute their service provisions are.
- There are some blind spots between the specialist health care services and the municipality health care services with regards to their responsibility of patients impacted by a power outage in their own homes.
- The necessary continuous fuel supply for electric generators is the major vulnerability with regards to the overall resilience towards a city wide power outage.
- The most severe consequences of a power outage in the health care services are expected to occur within the first 72 hours of a citywide power outage.

The identified vulnerabilities are as follows:

- *Communication between different health services:* Ordinary communication, coordination and control in and between the different health services are mainly based on ICT tools and telecommunication, and will be reduced or lost in a power outage, concurrent with an expected increase in the need for effective communication. Although backup-systems exist, these are not expected to meet the increased demands.
- *Public ability to contact health service:* As with the above, communication between the public and the health care services is mainly based on ICT tools and telecommunication. Few or no backup systems exist readily available in the public, leaving the public unable to contact the health care services.
- *Dependency on electro medical devices*: Home nursing patients depending on life supporting electro medical devices have few efficient barriers to be able to cope with electrical outages lasting longer than hours. Said patients are supplied with the equipment through the specialist health services, but are mainly seen on a day-to-day basis by home nursing staff. The operational limits (battery life) for the safe use of each patients equipment is

insufficiently communicated between the services, resulting in an expectation that not all patients will receive appropriate and timely intervention in case of a long-lasting power outage.

- *Health care services dependency on wireless technology:* Health care services have to a large degree replaced regular visits from health care personnel with different forms of wireless technology such as personal safety alarms, which is expected to lose functionality in a long lasting power outage.
- *Dependency fuel supply*: Healthcare buildings that are equipped with generators will be dependent on steady resupply of fuel and maintenance to ensure continued and safe core functions. Infrastructure remaining in operation during the longer scenarios will be dependent on steady resupply of fuel and maintenance to ensure continued functions.
- *Dependency on charging possibilities for cars:* The majority of municipal service cars (approx. 80%) is expected to be unavailable due to loss of charging possibilities in a power outage lasting longer than 24 hours. Home nursing and other services will need to reduce service or find alternative transports.
- *Access to potable water will vary* across institutions dependent on elevation level.

## 4.2 Stavanger – vulnerabilities related to power outage in electronical communication services

In Stavanger the following findings have been identified:

- The most critical input factor for electronical communication is power supply. Hence, a scenario with power outage will have major impact on electronical communication services.
- Electronical communication services is crucial in today's society. Almost all other vital societal functions rely on electronical communication services, and disruption can quickly lead to cascading effects and severe consequences for citizens.
- There is a need for increased awareness both within companies responsible for critical tasks, and among stakeholders who must collaborate to handle long-lasting events with potential to affect the whole society.
- Stakeholders must have knowledge of how an outage in electronical communication services will affect their ability to perform tasks. Furthermore, it is crucial that necessary measures to reduce vulnerability are implemented, and that stakeholders have a plan for how to handle the situation. The scenarios described in this analysis will affect the entire community and require a great deal of interaction. Good collaboration is crucial, both in the planning and handling phase. The cooperatives must use alternative communication solutions, with other limitations and possibilities than they are used to (such as satellite radios), or meet face to face to exchange information, coordinate and interact.
- More and more services and functions are being digitized and units are connected online (IoT). Welfare technology is an example of this. Innovation and development of new services are largely based on support from telecommunications, which makes the society’s dependence on electronical communication services even stronger.
- The work with this assessment has made the City of Stavanger more aware of what can happen in case of an outage of power and electronical communication services. Because of this, long-lasting loss of power and electronical communication services will be highlighted in the revised risk and vulnerability analysis

- The assessment has revealed several measures and topics that need to be followed up. The City of Stavanger will initiate follow-up projects and invite relevant stakeholders to participate. Several of the identified measures are applicable for other departments, stakeholders, companies and municipalities. The City of Stavanger has developed a plan for dissemination of the results to other cities and relevant stakeholders.

The identified vulnerabilities are as follows:

- *Knowledge and awareness regarding outage of power and electronical communication services*: Too low knowledge and awareness related to which consequences outages in power and electronical communication can have for different stakeholders and businesses
- *Alternative communication solutions*: A power outage will affect commercial electronical communication services to a very large extent. This addresses the need for alternative communication solutions
- *Information to the citizens:* In the event of an outage in electronical communication services, it will be challenging to provide information to the citizens
- *Cooperation:* 2-4 hours after loss of power, most of commercial electronical communication services will be unavailable. This will make the handling of the situation challenging and addresses the need for co-location for stakeholders who need to collaborate.
- *Dependency fuel services:* In case of a power outage, many stakeholders depend on fuel supply to maintain vital societal functions.

## 4.3 Oslo - vulnerabilities related to power outage in rescue services

In Oslo the following findings have been identified:

- Long lasting power outages will cause loss of electronical communication. The citizens will then have difficulties to make contact with the rescue services. The rescue services will have to reassign their resources to reinforce the operational personnel and equipment to increase detection capability, and enhance communication and accessibility for citizens. The analysis also underlines the need for the municipality to provide predefined locations where the municipality and the rescue services can provide information to the citizens, and to make the citizens able to reach the rescue services.
- The rescue services communication system, TETRA/Nødnett, makes it possible for the rescue services to communicate even during power outages and loss of commercial electronical communication services. TETRA/Nødnett is to some extent dependent upon the commercial networks, but have better emergency power. TETRA/Nødnett can also be used in "Direct Mode Operation", and emergency services can then communicate directly with each other and do not rely on network. The ability to communicate will be even more important with reduced detection capability due to power outage.
- The rescue services all need to be mobile to be able to reach out to the citizens. A long lasting power outage will affect traffic systems and normal fuel supply. There is limited experience and knowledge about how this will affect the rescue services' accessibility.

The identified vulnerabilities are as follows:

- *Importance of emergency power and redundancy emergency center*: Both the rescue services and their emergency centers are highly dependent on functioning emergency power if the normal power supply fails. During regional crises it might be necessary to draw on recourses from other districts, but there is no redundancy on the 110 emergency center for connection calls to other 110 centers.

- *Dependency of fuel supply*. The rescue services is dependent on fuel supply to maintain mobility. The rescue services do not have much own local storage of fuel, and are dependent that the fuel supply can be maintained even during power outages.
- *Dependency of water supply:* As a worst-case scenario the hospital cannot receive any patients if they cannot provide a clean environment. Further, the ambulance service are to some extent dependent on water supply for cleaning. If a power outage affects the water supply, it might affect the ambulances ability to operate safely. Especially the hospital has a very high usage of water.

# 5 Overall assessment of findings from the Norwegian project

In this chapter the aim is to outline and summarize some overarching and central findings from the Norwegian project as a whole. The chapter also aims to place and interpret findings from the project in a wider context.

The first part presents findings related to the chosen analytical model and work process. The second part of the chapter continues with lessons learned in terms of identified vulnerabilities and measures to reduce risk related to power outages in cities.

## 5.1 Analytical model and work process – coordination role and sectoral responsibilities

As mentioned in chapter three, Norwegian municipalities are required to conduct a holistic multi-hazard risk and vulnerability assessment, and they must involve other relevant regional and local civil protection stakeholders in the process.

In guidance material for the municipalities it is stated that an assessment is often made by using scenarios with triggering events, such as flooding, storm, accident etc. Such hazards are likely to affect several other vital societal functions. The municipalities *may* then continue by developing a new scenario based on identified failures caused by the triggering event. This scenario can be assessed using the same method as with the triggering event. [51]

The analytical model chosen in MEREPUV is similar to the latter form of assessment. Risk of disruption in a vital societal function is assessed in relation to one specific cause, namely power outage. The chosen model focuses on interdependencies and cascading effects, and emphasizes consequences more than probability.

**One model, three different city reports**
The project in DSB developed a relatively detailed template where the analytical model was broken down to specific questions to be answered in all three city assessments. Still, the project notices that the Norwegian city reports have turned out to become rather different end products. There are several reasons for this. The three cities represent three different organisations in terms of experience, culture and expertise, which affects how the task has been solved. The project has also to some degree been open for local adaptation of the template.

The strict adherence to frameworks versus local adaptation is a difficult balance that needs attention in work with guidance material for municipalities.

**Topics not assessed using the chosen model**
The Norwegian cities have pointed to some limitations with the analytical model, which have caused some challenges during the cities' work. For instance, the model does not contain an assessment of direct impact of power outage on life and health and social stability. This can be a somewhat strange limitation since the citizens are expected to be heavily affected directly by the power outage, but also indirectly due to disruptions in several other vital societal functions. As such, the model invites the cities to focus on a more limited part of the overall impact on life and health due to power

[51] DSB 2019b): s 27

outage. It focuses exclusively on effects of power outage on life and health and social stability caused by disruption in the rescue, health and electronical communication services.

Some partners have also experienced the analytical model to be rather rudimental in the sense that it represents a simplification of the real complexity in topics being addressed. Complex orders and cause-effect relations, as well as a precise estimation of impacts, are examples of topics mentioned as difficult during the process. At the same time, all the three Norwegian cities agree that the model, to a large degree, opens for a rudimental overview about cross-sectorial dependencies, and cross-sectorial blind spots.

**Apparently simple model, still complex and time consuming**
All three Norwegian cities have reported that even though the model and guide made for the assessments are quite rudimentary, the process of producing an assessment has nevertheless required a considerable amount of time and resources.

All the cities have found it necessary to limit the scope of the original model to some degree. For example, the cities have seen the need to exclude some relevant critical input factors or cascading effects from the assessment in order to achieve a manageable scope. Furthermore, some adaptations of the questions addressed in the joint guide for the assessments, have also been made.

To get an overview of a vast topic such as societal consequences of power outage, requires data gathering and expert knowledge from very many different fields. In addition, it might be difficult to find available information on some topics due to limited empirical data, and it can be difficult to sort out the most relevant information in the data gathered. The challenge in developing applicable tools and models to deal with the complexity at the appropriate level of detail is an important lesson learned in the project.

In risk assessments conducted by DSB, an assessment of a chosen scenario's impact on vital societal functions, is carried out as an integral part of all such scenario assessments. [52] This is also an ambition evident in regulations and guidance material for municipal holistic risk assessments.[53] Findings from DSB's annual survey towards municipalities seem to show a positive trend in the number of municipalities assessing their ability to maintain vital functions during adverse events.[54] The experiences from the project however, is that the cities do not seem to be as used to assessments of vulnerability and impact on vital societal functions as anticipated.

The project recommends that a further examination is undertaken of how vulnerability assessments and impact on vital societal functions are integrated in the work with municipal holistic risk and vulnerability assessments. The involvement of municipal sectors and other stakeholders in such work, should also be studied closer.

The project suggest that the experience from MEREPUV is taken into account in revisions of existing guidance material for municipalities on such vulnerability assessments. Finally, the experience from the project shows that it is important to maintain focus on the municipalities' work with risk and vulnerability assessments as such, in terms of resources, methodology, stakeholder knowledge etc.

[52] See for instance DSB 2016a)
[53] Regulation on municipal preparedness duty, DSB 2019b): s 27, 30
[54] DSB 2019c): s 13,14

**Coordination role and principle of responsibility**

As mentioned in chapter 3, Norwegian municipalities face several regulations that apply for the municipalities' work with civil protection and safety and security. The coordination responsibility following from the regulation on municipal preparedness duty, does not in any way, replace or change obligations given to the municipalities in other sectors laws. [55]

The Norwegian partners from the cities have represented the municipality's coordination role. They have conducted the vulnerability assessments, involved stakeholders and led local expert seminars etc. The partners from the municipalities do not possess detailed expert knowledge from other municipal sectors' area of responsibility. Rather, they have knowledge about important civil protection stakeholders, risk factors in the municipality, vital societal functions and experience with holistic risk and vulnerability assessments. The vital functions chosen by the cities;- health, rescue and electronical communication services, consist of capabilities both internal and external to the municipal responsibility. Thus, the involvement of other municipal sectors, with duties related to prevention and preparedness within their respective areas, together with relevant national and private stakeholders, has been a crucial success factor. The intention of the locally arranged expert seminars has been to ensure such involvement.

The relation between coordinating and sectoral responsibilities will often be a question of balance and clear understanding and knowledge of roles. A key concern in the project has been whether involved stakeholders would consider that the municipal "coordination agents" went too far into areas of responsibility owned by others. The cities' impression however, has been the opposite, and they report that involved stakeholders have appreciated the initiative.

The reliance on knowledge from involved stakeholders represents both a potential and a challenge in producing assessments. The potential is related to many stakeholders gathering and contributing to illuminate a topic from different perspectives and different areas of expertise. Many of the stakeholders involved in the local expert seminars do not necessarily meet often. This can open up for effective learning for all participants in terms of dependencies, blind spots, unclear sectoral boundaries etc. These are issues typically associated with core activities in coordination initiatives. The cities' impression is that the local expert seminars have contributed to such an effect, with raised awareness, understanding and realization of vulnerabilities and dependencies among all stakeholders involved in the process.

There is also reason to believe that the quality of coordination initiatives are strengthened when municipal coordinators have a good understanding of roles and responsibilities of other (municipal) stakeholders. The Norwegian cities report that they have learned a lot about this during the process, and that it has been useful for them.

A challenge with the high degree of reliance on external stakeholders' knowledge is, amongst others, that it can be difficult for non-experts to get a sufficiently precise understanding of complex chains of consequences and important technical aspects. The identification of effective measures requires that the right experts are brought to the table, that they want to share, and that the recipient understands the information correctly. It can be assumed that the process becomes more

[55] DSB 2019a): s 12, 15

challenging when the involvement of external stakeholders, such as private and national stakeholders, is high. These are important aspects that municipal coordination agents must be aware of, and it can affect the degree of uncertainty in the assessments.

At the same time, it is important to underline that the purpose of the assessments in this project has not been to replace sector specific risk and vulnerability assessments. Rather, the objective has been to contribute to improved understanding among a broad set of stakeholders of cascading effects related to power outage and how various stakeholders are dependent on each other's prevention and preparedness efforts in such a case.

An interesting following up question from the project could be to examine whether vulnerability assessments are common within municipal sectors such as fire and rescue, water and sewage etc., and what methods such assessments builds on. This is also connected to the suggestions described in chapter 5.3.2 below.

The lesson learned from MEREPUV is that it appears that the project seems to have balanced well between coordination and sectoral responsibilities, and that learning in terms of roles and responsibilities has been an important effect of the project. Both DSB and the cities think that the project objectives related to improved knowledge and raised awareness have been achieved to a large extent

## 5.2 Findings and proposed measures based on the three city assessments

### *5.2.1 Identification of proposed measures by the cities*

As described in chapter two, there are many already existing barriers established to avoid severe power outages to occur, and to reduce consequences if it occurs.

At an overarching level, all three cities have also evaluated the need for risk reducing measures, and recommended implementation of new measures. Most of the proposals are of a character that enables implementation on basis of municipal decision-making, or in collaboration with other local civil protection stakeholders located in the municipality. The proposals vary in scope as exemplified below.

An example of a relatively modest measure proposal is Stavanger's suggestion to point out and communicate to citizens where they can go to get information in case of a long lasting disruption in electronical communication services. Another example is their proposal to initiate cooperation between relevant local stakeholders, in order to develop routines and procedures to ensure early warning to the relevant stakeholders in a situation with power outage. Such early warning mechanisms can ensure that important preparedness efforts are taken while electronical communication services and communication devices are still operational and not affected by the power outage.

One example of a proposed measure that is slightly more extensive, yet fully possible to implement by municipal decision-making, is Bergen's proposal to go through the municipality's IT infrastructure with the aim to identify and strengthen critical elements at various levels.

Finally, there are also examples of proposals which would require further assessment and decision-making at the central level. One example is Oslo, who addresses a question of whether more joint

guidelines for preparedness against power outage should be considered for the police, fire and rescue and ambulance services.

The cities identification of measure proposals illustrates that even if the topics addressed are complex and extensive, it is still possible to improve risk management by rather simple measures that are available locally, and not only by comprehensive and expensive measures managed at the central level.

### *5.2.2 Need for more knowledge about self-preparedness within vital societal functions?*

From the three Norwegian risk assessments we see that power outage affects almost all vital societal functions, for instance supply of water and fuel, road transport, rescue services, health services, electronical communication services, crisis management and crisis communication.

This confirms and supports previous studies.[56] Power supply is a crucial input factor for society. Thus, it also deserves high and continuous attention in the work with civil protection both in terms of high degree of redundancy in infrastructures, but also in terms of focus on self-preparedness amongst other services dependent on electrical power in order to operate. The latter might be especially important in cities where the probability of power outages is estimated to be very low due to robust infrastructure. One may ask if this can lead to less focus on self-preparedness for power outage in cities. Even if the probability is low, all the three Norwegian assessments conclude that the consequences of a long duration power outage would be severe for other vital societal functions and ultimately life and health in the cities.

A newly finalized project about electrical safety has pointed that there is a need to look closer at the requirements related to emergency power systems in DSB's regulations, as the requirements are seen to be vaguely formulated. The project has also proposed that DSB should initiate an examination of how back-up solutions for electrical power are regulated in other laws and regulations. In addition, the project recommends that DSB conducts an assessment of how other vital services and functions can be assisted in terms of information and guidance about emergency power[57]. The MEREPUV project supports these proposals from the electrical safety project.

However, the findings from the Norwegian cities also indicate that failure in electronical communication services may be just as severe as a power outage in itself, and that such a failure also would affect almost all other vital societal functions in addition to life and health. Furthermore, electronical communication services have a very high dependency on operational power supply. This is also a conclusion found in several previous assessments.[58] DSB, NVE and NKOM have many times underlined the importance of sufficient self-preparedness in vital services against disruptions in power supply and electronical communication services.[59]

The MEREPUV project therefore suggests to undertake a systemic review of regulations and requirements of self-preparedness in various enterprises and services. Such a review could start by focusing on municipal and private "owners" of vital societal functions and capabilities. Electrical power and electronical communication could be highlighted in such a project, as the electrical safety

[56] DSB 2012, NVE 2014:49: s 14,15, 23
[57] DSB 2017a): s 80-82
[58] DSB 2014, DSB 2013
[59] NVE 2012:03: s 14-16, 2012, Post- og teletilsynet 2012: s 9, Presentasjon NVE 28.aug 2018 MEREPUV seminar

project suggests, but the review should also include self-preparedness in general. An important objective could be to examine to what degree vital services have established a risk management system. Central questions in such a review could for instance be:

- Are there any requirements for assessing vulnerability to various strains / adverse events in terms of ensuring continuity of the service? Does this comprise assessing dependencies on external critical input factors?
- To what degree are vital services and enterprises aware of their criticality for other vital functions?
- Are there any requirements of self-preparedness?
- Are there requirements of preparedness efforts to avoid cascading effects in the case of disruptions?
- If such requirements exist, does guidance material explain how to comply with the requirements, or are standards on risk management used?
- Are there any control mechanisms for assessing degree of compliance?

The data gathered by the Norwegian MEREPUV project also supports the electrical safety project's conclusion that there are differences between sectors when it comes to if and how self-preparedness against power outage is regulated. Some services have specific requirements for back-up capacity in case of power outage, for instance demanding capacity for a defined amount of time.[60] Other areas have a more purpose-based regulation.

Purpose-based regulation is characterized by more general requirements and they are often directed towards goals and results, and not towards specific methods for how to achieve the goals or results. Purpose-based regulations are also often associated with terms like "sufficiently safe", "sufficient degree of safety" etc.[61] The regulations are not always accompanied by more detailed guidance of how the result or goal can be achieved when applied on a specific topic such as for instance self-preparedness against outage in power supply or electronical communication services.

There are advantages and disadvantages with both prescriptive regulation and purpose-based regulation. The preferred form is ideally balanced and defined on basis of several factors. Ability, resources and capacity for compliance are examples of such factors that are assumed to affect the effectiveness of various regulation forms. For instance, the effectiveness of general requirements as basis for defining an acceptable level of self-preparedness, is expected to be low, if ability in terms of knowledge, resources and capacity for compliance is low.[62]

The Norwegian MEREPUV project finds that the question of regulation form seems relevant both when discussing self-preparedness against specific hazards, such as outage of power supply or electronical communication services, and when looking at self-preparedness in general. Yet, the project cannot draw any clear conclusions based on our findings. Similar questions were also raised after the hurricane Dagmar, where the Norwegian Communication Authority pointed at a need for improved guidance material about preparedness related to electronical communication services for the municipalities.[63]

[60] Presentasjon Mattilsynet 28.august 2018
[61] (Red) Hempel, Kringen, Braut s 16-17, 37,38
[62] (Red) Hempel, Kringen, Braut s 50 - 66
[63] Post og teletilsynet nr 2 2012: s 16

It would be interesting for another project to examine more closely whether regulation appears to be an effective tool for ensuring sufficient self-preparedness in vital capabilities and functions, and if so, what regulation form that seems to be the most effective. Such a project could be carried out as a research project.

### *5.2.3 Information campaign about self-preparedness within vital functions?*

DSB has recently implemented an information campaign about self-preparedness among Norwegian citizens. In short, the campaign recommends all Norwegian households to have a storage with food, water, necessary medical supplies and other assets, which can enable them to be self-sufficient for 72 hours, in case of failures in vital functions or other adverse events.

The Norwegian MEREPUV project suggests a similar campaign is considered carried out towards services defined as vital in the Norwegian "Vital societal functions"-report. The main question could be related to how well prepared owners of vital societal functions and capabilities are when it comes to operating their services under various kinds of strains.

### *5.2.4 About the role of The Local Electrical Supervision Authority (DLE)*

Every year, the Norwegian DLE carries out a high number of inspections and audits towards owners of low voltage installations. DSB develops a checklist with mandatory check points for DLE to verify during audits and inspections. The project suggests to consider including electrical safety service systems / emergency power systems on the list of mandatory checkpoints for audits and inspections of objects where power outage could represent a risk for citizens directly or indirectly. Such an initiative would also provide a better overview than today of the status in preparedness efforts against power outage in vital services and functions.

The project also suggests that DSB considers whether the framework "Vital functions in society" could be useful for developing activities related to the DLE audits. Such thinking seems to correspond well with measures given by the earlier mentioned project for Electrical safety in DSB. They suggest to instruct the DLE to get a better overview of vital functions within their area of responsibility, and that DLE should work actively to improve preparedness against power outage in such services and functions.[64] With reference to chapter two in this report, such a direction for DLE, should probably be discussed closely with other authorities which audit capabilities / vital societal functions, to sort out who audits what.

### *5.2.5 Electronical communication - by many considered as a difficult topic*

From the Norwegian project, there are indications that many stakeholders consider electronical communication to be a complicated and technical topic that best can be dealt with by experts. This might suggest that many stakeholders who are primarily end-users with high dependency of ecom-services, experience thresholds when it comes to assessing their own vulnerability to ecom disruptions.

Digital safety and security is currently highlighted as one of the prioritized areas in DSB, and the findings in MEREPUV seem to support findings from a recent survey[65] with a similar focus done by DSB towards municipalities. The experience from the Norwegian cities' assessments should be taken

[64] DSB 2017a): s 86
[65] DSB 2018b)

into account in initiatives at this area towards regional and local level. It could also be useful to get an overview of whether scenarios of disruptions in electronical communication are common in municipal holistic risk and vulnerability assessments, and also in municipal sector-specific risk and vulnerability assessments.

### *5.2.6 Robust electronical communication infrastructure in cities*

In Norway, a program for strengthening electronical communication infrastructure in certain areas of the country is currently ongoing. The prioritization of municipalities and locations for such strengthening of electronical communication, is done in cooperation between NKOM and DSB[66]. Project MEREPUV would like to point out the importance of continuous focus also on ensuring redundancy in bigger cities, since disruption in electronical communication services in big cities quickly can lead to severe consequences for a lot of people and vital societal functions.

### *5.2.7 Fuel – a critical input factor for back-up power solutions*

All the Norwegian assessments point to fuel supply as a critical input factor to operate back-up power solutions in case of power outage of long duration. Findings from the project also indicate that there might be a need for more information to relevant local and regional stakeholders of existing plans for distribution of fuel, in a situation with shortage due to power outage. The project recommends that DSB assess how this best can be followed up.

### *5.2.8 Communication with citizens, other collaborators and internal communication.*

All the Norwegian assessments find that a serious consequence of power outage is related to disruptions and fall-out of emergency calls from citizens to the call centers of the rescue services. This could lead to loss of lives that under normal circumstances would have been saved. The Norwegian cities also mention that failures in other communicative devices, such as safety alarms used by elderly and vulnerable people to get in touch with health care, can lead to casualties.

Furthermore, challenges related to the spread of information to the public in general, is expected to be very difficult in the chosen scenarios. The same is the case for internal communication between different municipal stakeholders, but also between the municipality and other important stakeholders central for dealing with a situation with power outage.

The municipalities are required to develop plans for crisis communication towards their citizens and other stakeholders. The project concludes that it is crucial that such plans also include how to manage the need for information and communication in a situation where ordinary communication devices are unavailable due to disruptions. Such plans must be agreed upon by various stakeholders and trained regularly. An important lesson learned from the project is also the importance of having thought about communication channels such as radio, and about what advice to give citizens in a situation with power outage or outage in electronical communication services, including special plans for how to reach vulnerable groups.

### *5.2.9 The importance of a common framework defining vital functions in society.*

[66] NKOM 2017: s 12

In Norway, the Ministry of Justice and Public Security has the responsibility for coordination of civil protection work at the central level. This is similar to the responsibility for coordination that municipalities and county governors have at local and regional level. DSB supports the Ministry in their coordination role. Among the responsibilities following from the coordination role at central level, is to provide an overview of vital functions in society from a civil protection and cross-sectoral perspective. The purpose of the public report "Vital Societal Function" is to give such an overview. One of the objectives for the report is to contribute to a more systemized and targeted civil protection work across sectors as well as within the different sectors. The report is also meant to be used as basis for defining further civil protection activities, such as work with self-preparedness, management, prioritization of audit activities, stakeholder management etc.[67] The framework is adapted to a local context in guidance material for municipalities[68].

The Norwegian MEREPUV project considers the framework to be of great importance for creating a higher degree of mutual understanding of what is to be understood as vital societal functions in a civil protection perspective. The report also contributes to give civil protection work a more concrete content, and is an important tool for assessing interdependencies and cascading effects across vital functions. Furthermore, the report gives a clear indication of which stakeholders that should be involved in civil protection coordination efforts both at local, regional and central level.

[67] DSB 2016 b)
[68] DSB 2019 b)

## 5.3 Summary of main findings from the Norwegian MEREPUV project

| **Main findings** |
|---|
| Analytical model and work process<br>• The organizing of the work process seems to have contributed well to a rudimental overview about vulnerabilities, cross-sectorial dependencies and roles and responsibilities related to power outage. However, the uncertainty of the cities assessments is still evaluated to be high, partly due to the degree of complexity in the topics being addressed but also because of lack of available empirical data.<br><br>• Experience from the project indicates that there may be a need for more guidance about how the municipalities can assess vulnerability in vital societal functions at an overarching level, as part of their holistic risk and vulnerability assessments. |
| Other findings<br>• Even though the probability for long lasting power outages is low, all the three city assessments conclude that the consequences of such a scenario would be severe for other vital societal functions and life and health.<br><br>• The degree of self-preparedness among Norwegian households has been an important topic in DSB recently. The project suggests that a similar focus is considered towards owners of vital capabilities and / or functions. A following up project is also suggested for examining how self-preparedness is managed within municipal and private owners of vital capabilities and / or functions. Furthermore, the project suggest that more research is carried out, to examine whether regulation or other public tools seem to be the most effective tools for contributing to self-preparedness in vital services.<br><br>• The project supports the findings from the recent El-safety project and suggests that DLE considers to collaborate closely with other auditing authorities when evaluating if DLE to a larger degree should carry out audits with emergency power systems / electrical safety services in vital capabilities and functions.<br><br>• Findings from the project indicate that electronical communication is considered to be a technical and difficult topic by many stakeholders involved in the project.<br><br>• Stable access to fuel and challenges related to communication are described in all three city assessments as elements that stand out as very important in a scenario with power outage.<br><br>• A joint national framework defining what is to be meant with vital functions and critical infrastructure from a civil protection perspective, has been very important in the Norwegian project. This has been used to define the analytical objects, to assess critical input factors and cascading effects, and to identify which stakeholders to be involved in the process. |

# 6 Dissemination of results

The results of MEREPUV will be disseminated in various ways; it has been an ambition of the project to develop knowledge and methodology which can be utilized at local, national and regional level and in other European countries. The project may have an impact on planning and decision-making in multiple sectors. The output of the cities' assessments highlight not only the need for cross-sector coordination, but also the need to look at impacts of power outage at regional (county) or even national level. Although the probability of such events is extremely low, the results of MEREPUV can provide knowledge and learning points which can enhance prevention and preparedness measures at all levels and in various sectors. Dissemination of the results is thus critical in the years to come.

**Local level**
The cities' reports have already been utilized in all participating cities and constitute vital inputs for further planning, including holistic risk and vulnerability assessments, and disaster preparedness at municipal level. Due to the municipalities' mandate to coordinate civil protection and emergency planning according to the Norwegian Civil Protection Act, the municipalities will be in the frontline when it comes to define and implement preventive measures within their own areas of responsibility; to enhance prevention and preparedness for power outages in the private sector; and to further develop municipal contingency plans in case of undesired events.

Each city participating in MEREPUV will ensure that the results of their own report becomes well known by the municipal administration and its political leadership, and that the reports will be used as basis for further planning at local level. Dissemination at local level can be done in numerous ways; in local seminars and workshops, in municipal planning processes, through local media, etc.

Further, as coordinating institutions for civil protection and emergency planning, the cities will make use of already existing networks, such as municipal emergency councils, to ensure that relevant stakeholders will make use of the city reports.

**Regional (county) level**
All cities have benefitted from including regional stakeholders in their assessment process, such as the county governors, regional suppliers of electric power, regional health authorities, or other regional institutions. At regional level, the county governor is responsible for coordination of civil protection and emergency planning – similar to the municipalities' role at local level. The county governors have established regional emergency councils which may use the results of MEREPUV in their work. Both the cities and the Norwegian Directorate for Civil Protection (DSB) will be able to share results from MEREPUV to relevant county governors, and thus to the regional emergency councils throughout Norway. DSB will also ensure that other county governors will get information about results, findings and new methodologies developed in MEREPUV.

**National level**
The national working paper will be published online, including links to, or information about, the cities' reports. This will simplify the dissemination to all stakeholders in civil protection and emergency planning, including national authorities, regional authorities, municipalities, the private sector, universities/research institutions, and NGOs.

The final conference (November 2019) will be open for all relevant stakeholders from the participating countries as well as other European countries and institutions, and will constitute the

first major event to present the outcomes of the project. Further, information about MEREPUV may be presented in the annual national conference on societal safety, in February 2020, or at similar national events.

DSB has an overall coordinating role for civil protection and emergency planning at national level, on behalf of the Ministry of Justice and Public Security. DSB develops guidelines for ministries to enhance civil protection and emergency planning at national level within all relevant sectors. DSB carries out audits of the ministries and their underlying agencies to assess how they fulfil their tasks. The results of MEREPUV will make the basis for recommendations for further actions at various ministries and agencies. Thus, DSB can present the outcome of MEREPUV in their work targeted towards ministries and other agencies, and include recommendations from MEREPUV when following up relevant agencies.

**International level**

DSB, as well as the participating cities, participate in a wide range of international arenas, including conferences, workshops, programmes and international projects. All partners will seek to disseminate the outcomes of MEREPUV where relevant, making use of already existing arenas – especially after the project has been finalized and it is possible to present results from all three participating countries, and all five cities.

Further, there is a potential for follow-up by developing new projects, based on the same concept and methodology developed in MEREPUV. There is a potential for exploring interdependencies between other societal functions than those covered in this project, or for going more into details in some of the analysed sectors. The proposed Care4Power project, coordinated by Safety Region South, is a direct follow-up of MEREPUV.

# 7 List of literature and other sources used in the report


DNK 2014: *Robusthet i transmisjon – reservstrøm i transmisjonslinjer i Nødnett*. Rapport

DSB 2019a) Guide to the regulation on municipal preparedness duty

DSB 2019b) Guidance to holistic risk and vulnerability assessment in the municipality

DSB 2019c): *Kommuneundersøkelsen 2019*. Rapport

DSB 2019d): Instruks for det lokale elektrisitetstilsyn

DSB 2018a): *Kommuneundersøkelsen 2018*. Rapport

DSB 2018b): *IKT sikkerhet på lokalt og regionalt nivå.* Intern rapport

DSB 2018c): Instruks for det lokale elektrisitetstilsyn

DSB 2017a): *Elsikkerhetsprosjektet. Sluttrapport – helhetlig gjennomgang av DSBs arbeid med elsikkerhet*

DSB 2017b): *Vital functions in society. What functional capabilities must society maintain at all times?* Rapport

DSB 2016a): *Risikoanalyse av regnflom i by. Krisescenarioer 2016 –analyser av alvorlige hendelser som kan ramme Norge.* Rapport

DSB 2016b): *Samfunnets kritiske funksjoner. Hvilken funksjonsevne må samfunnet opprettholde til enhver tid. Versjon 1.0.*

DSB/NEK Elsikkerhetsprosjektet 1/2016: *Vår elektriske fremtid. Et veikart for elsikkerhet – utfordringsbildet.* Rapport

DSB 2014: *Risikoanalyse av "Cyberangrep mot ekom-infrastruktur".* Delrapport til Nasjonalt risikobilde 2014

DSB 2013a: *Evaluering av øvelse Orkan 2012.* Rapport

DSB 2013b: *Nasjonalt risikobilde*. Rapport

DSB 2012: *Nasjonalt risikobilde.* Rapport

DSB 2008: *Brann i kabelkulvert Oslo Sentralstasjon 27.11.2007*. Rapport

Meld. St. 25 (2015-2016) *Kraft til endring*

NEK 400

NKOM 2017: Årsrapport

Norconsult 2014-02-14: *Langvarig strømbrudd i Lofoten. Sårbarhets- og konsekvensvurdering.* Oppdragsnr.:5133772

NVE 60/2018: *Driften av kraftsystemet 2017*. Rapport

NVE Fakta nr 3/08/2018: *The Norwegian power system. Grid connection and licensing*

NVE 49/2014: *Øvelse Østlandet 2013.* Evalueringsrapport

NVE 03/2012: *Førsteinntrykk etter Dagmar julen 2011.* Rapport

NVE 45/2012: *Trær til besvær. Lærdommer om skogrydding i etterkant av ekstremværet Dagmar.* Rapport

Olje og energidepartementet 2015: Fakta Energi- og vannressurser i Norge

Ot.Prp. nr. 62 (2008-2009) *Om lov om endringer i energiloven*

Post og teletilsynet 6. juni 2014: *Minstekrav til reservestrømkapasitet i landmobile nett.* PT-ref. 1402794 (https://www.nkom.no/teknisk/sikkerhet-og-beredskap/ekomsikkerhet/tilbyders-sikkerhets-og-beredskapsplikter/_attachment/13634?_ts=152ca99b531)

Post og teletilsynet rapport nr 2 2012: Foreløpige erfaringer og forslag til tiltak etter ekstremværet Dagmar

Post- og teletilsynet 2012: Høringsbrev – forslag til justerte tiltak etter Dagmar

Statnett 2014: *Energiskolen* Lærerhefte

(Red) Hempel, Kringen, Braut 2018: Regulering og standardisering. Perspektiver og praksis. Universitetsforlaget

**Presentasjoner MEREPUV fagseminar 28. august 2018**

- Presentasjon fra NVE
- Presentasjon fra NKOM
- Presentasjon fra Mattilsynet
- Presentasjon fra Helsedirektoratet
- Presentasjon fra Statens Vegvesen
- Presentasjon fra Politiet
- Presentasjon fra DSB-ELS
- Presentasjon fra DSB-BRE
- Presentrasjon fra DSB-NBK
- Presentasjon fra DSB-PROD

**Nettsider:**

https://energifaktanorge.no

- https://energifaktanorge.no/norskenergiforsyning/forsyningssikkerhet
- https://energifaktanorge.no/norskenergiforsyning/kraftforsyningen

https://www.tu.no/artikler/politiet-2006-strombrudd-lite-sannsynlig/323707

http://www.hioa.no/extension/hioa/design/hioa/images/sifo/files/file79978_presentation_dagmar_homerisk_kick-off.pdf

# Annexes

## Annex 1 Joint methodology in MEREPUV

**Analytical model**

The assessment conducted is done within the framework of the so-called bow tie model. The model is adapted and specified on basis of purpose, analytical object and main questions to be examined in the assessments. The following risk elements are assessed:

- Probability
- Vulnerability
- Consequences
- Uncertainty

In addition, one other element is assessed:

- Steering ability: How manageable are the risk and vulnerability attached to the scenario? To what degree are there available measures which are likely to reduce risk and vulnerability?

Vulnerability in health services / rescue services / EKOM services is the analytical object in the model.

**Choice of scenarios**

Describe the choice of scenarios of power outage

**Assessment of probability – how likely is it that the scenario will occur?**
The probability assessment builds on results and insights from earlier risk and vulnerability assessments and other available existing knowledge and data material.

The probability intervals used are:

- Very low probability: 0-10 per cent likely in 50 years
- Low probability: 10-40 per cent likely in 50 years
- Moderate probablity: 40-60 per cent likely in 50 years
- High probability: 60-90 per cent likely in 50 years
- Very high probability: 90-100 per cent likely in 50 years

**How do the scenarios affect other vital functions?**
In the assessments we are examining whether and how the scenarios affect other critical input factors of which health services are dependent on in order to function.

**How are health services affected?**

In the assessment we are describing how the different scenarios affect health services, either directly or indirectly, due to failure or disruption in one or several other critical input factors for health services.

Furthermore, an overall assessment is made of how health services are affected in total. The assessment is based on a five-part scale from very low to very high degree.

**Cascading effects and consequences for other vital societal functions**
By examining other vital societal functions' dependency on health services, we get an impression of vulnerability in society related to failure in health services.

**Societal impact**
In this assessment we have chosen to assess consequences for society and citizens by focusing on the following societal values / types of impact:

- Human impact / life and health
- Societal stability / social impacts

The impact type "life and health" is further divided into two consequence categories: 1) number of deaths expected deaths and 2) number of severly injured or ill people

The impact type "societal stability" is further divided into two consequence categories: 1) Social and psychological reactions and 2) Challenges in daily life

**Uncertainty and steering ability**
Assessment of degree of *uncertainty* is related to an evaluation of the quality of excisting knowledge used in the vulnerability assessment as well as an evaluation of to what degree the results are sensitive to changes in the conditions.

Degree of *steering ability* is evaluated by an assessment of whether efficient measures, of which can reduce the risk and vulnerability, exist and are well known. This is an important evaluation after the results of the risk and vulnerability assessment are ready and alternatives of measures are being adressed.

## Annex 2 Vital societal functions and capabilities in Norway

Screenshot the 14 vital societal functions and belonging capabilities in the Norwegian report "Vital functions in society"

## Annex 3 list of involved directorates and agencies:

| Aktør | Hva |
|---|---|
| NVE | Continous dialogue during the project period and main source / provider of expert assessment chap 2<br>Contribution in seminar 28. august 18<br>Contribution in local expert seminars<br>Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |
| Helsedirektoratet | Contribution in seminar 28. august 18<br>Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |
| Statens Vegvesen | Contribution in seminar 28. august 18<br>Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |
| Politidirektoratet | Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |
| Nasjonal kommunikasjonsmyndighet | Contribution in seminar 28. august 18<br>Contribution in local expert seminars<br>Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |
| Mattilsynet | Contribution in seminar 28. august 18<br>Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |

| Contribution from other departments in DSB | |
|---|---|
| Department for prevention and safety<br>- section for for electrical safety<br>- section for fire and rescue<br>- section for product safety<br>DSB-depatment for public safety communications | Continous dialogue during the project period<br>Contribution in seminar 28. august 18<br>Consulted before finalizing English city summaries<br>Consulted before finalizing Norwegian working paper |

# ANNEX 4:
# EXPERIENCES FROM THE DUTCH PART OF THE PROJECT

MEREPUV

2017/PREV/783153

"Methods and measures to enhance resilience against electric power outage in urban vital societal functions"

# MEREPUV

# Working Paper from

# Safety Region South Holland South

D3.2 SRSHS

| | |
|---|---|
| Approved by | R.P. Bron Hoofd VRC VRZHZ |
| Date | |

Funded by
European Union
Civil Protection

# Content

# 1 Introduction

## Project MEREPUV

The Safety Region South-Holland South together with the city of Dordrecht has participated in the MEREPUV project, focusing on the effects of city-wide power outages on healthcare services. A wide range of professionals in both municipal and specialist healthcare services have been consulted, as well as professionals from several essential infrastructure providers for the healthcare services

## Overall goals of the project

The overall goals of the project were to increase the resilience of society during power outage by creating insights in the possibilities and recommendations to facilitate the community to increase the resilience of society and strengthen the capacities of the professionals in the vital infrastructure and crisismanagement.

## Scenarios

The selection of scenarios was made together with all projectpartners during the workshop in Bergen in May 2018 and after several consultations of the local coreteam, specialists and partners involved.

## Overall description of methods, process, data collection

The assessment conducted is done within the framework of the so-called bow tie model. The model is adapted and specified on basis of purpose, analytical object and main questions to be examined in the assessments. The following risk elements are assessed:

- Probability
- Vulnerability
- Consequences
- Uncertainty
- Steering ability:
  - How manageable are the risks and vulnerabilities attached to the scenario.
  - To what degree are there available measures which are likely to reduce risk and vulnerability.
  - Vulnerability in health services is the analytical object in the model.

The probability assessment builds on results and insights from earlier risk and vulnerability assessments and other available existing knowledge and data material.

The probability intervals used are:

- Very low probability: 0-10 per cent likely in 50 years
- Low probability: 10-40 per cent likely in 50 years
- Moderate probablity: 40-60 per cent likely in 50 years
- High probability: 60-90 per cent likely in 50 years
- Very high probability: 90-100 per cent likely in 50 years

Cascading effects of power outage and failure in health services in terms of influence on other critical functions in society


## The scenarios affecting other vital functions

In the assessments we examined whether and how the scenarios affect other critical input factors of which health services are dependent on in order to function.

## The scenarios affecting health services

In the assessment we described how the different scenarios affect health services, either directly or indirectly, due to failure or disruption in one or several other critical input factors for health services.

Furthermore, an overall assessment is made of how health services are affected in total. The assessment was based on a five-part scale from very low to very high degree.

## Insight in cascading effects and consequences for other vital societal functions

By examining other vital societal functions' dependency on health services, we perceived an impression of vulnerability in society related to failure in health services.

# 2 About power outages in the Netherlands

## Facts about reliability in deliverance of power in the Netherlands

The reliability of the deliverance of power is measured on EU-level. This is CAIDI,SAIFI and SAIDI. Customer Average Interruption Duration Index (CAIDI) is a reliability index commonly used by electric power utilities.
SAIDI is the System Average Interruption Duration Index and SAIFI is the System Average Interruption Frequency Index. The latter is commonly used as a reliability indicator by the electric power utilities. SAIFI is the average number of interruptions that a customer would experience.

| Power distributor Stedin | CAIDI | SAIFI | SAIDI |
|---|---|---|---|
| **2017** | 88 | 0.188 | 16 |
| **2018** | 76 | 0.223 | 17 |

The Saidi and Saifi numbers are within the accepted range of the EU, however the CAIDI (average interruprion duration) is above the accepted range of the EU which is 65 minutes.

The Regional Risk Profile and the National Safety Profile consider the possibility of Power Outage very likely and with an high impact on society. The National Safety Profile also considers the chain effects in vital infrastructure very high. In the light of Energy transistion the expectations are that the grid will be heavily strained due to higher impact and powerfluctuations which increases the chance of power outages. The investments made on the grid will take place and the grid will be have to be adjusted and when necessary renewed. However this will take time and also increases the number of power outages due to work on the grid.

## Facts about incidents of previous power outages

The Safety Region South Holland South and particularly the city of Dordrecht hasn't had experience yet with extensive and longterm power outage.

In other parts of the Netherlands we have had multiple incidents however these are all resolved within 24 hours, except in November 2005 due to extreme weatherconditions and in December 2007 when an Apache helicopter flew to the high voltage lines, which caused an power outage in a greater rural area with several municipalities. In the beginning, society didn't have severe problems, however after 24 hours the people got angry and they expirienced more (financial) damage and nuisances. The institutions in the area took their responsibility and adjusted the health care services as much as possible, no fatalities were known which accured due to the power outage.

In the years following there were several severe and large power outages which lasted from 4 up to 12 hours. The latest large power outage which also occured in an urban area was on the 17th of January 2017 in large parts of Amsterdam. The number of grid connections affected were 360.000 in the early morning at 4:19 hours. At 6:14 hours the majority of households and institutions regained power again, and the latest area reconnected was at 8:40 hours.
Although the power outage had a duration of  4 hours, unfortunately 2 persons deceased due to the effect the power outage had on the emergency call centre. There was a high increase in people who called the emergency call center. The lines were overloaded and the queues were full.

In 2015 there was a failure in a high voltage station, which caused a power outage in a large aera of the northern part of Holland. In the end 6 Safety Regions were affected and there was a large upscaling of the crisismanagement organisations. This power outage had a duration of 5 hours, but had an enormous effect on society, businesscontinuity and health care services. Although no fatalities were reported, operations in hospitals had to be cancelled or postponed and traffic, metro, trains and flights experienced great disruptions. The airports couldn't handle the planned flights and bridges couldn't be operated. Failure of 75% of Telecom occured within 1 hour. The distortions in society in fact took longer than the actual power outage.

## Expected societal development

Research by the National Institute for Public Health and the Environmenton shows the following[69]:

### Healthcare related expectations:

- Strong increase of people with elderly based illnes. It will cause extreme pressure on the whole of the Healthcare system
- By increasing numbers of elderly people in the future more people with multiple disease will have to be treated. A considerable part of these people wille also have social problems like loneliness and isolation. The number of people with complex transcending problems and demand for health care will increase.
- Patients will act more on themselves, it requires new skills as well as for the aid workers as for the patients. A number of people will not be able to do so and has to be taken care of.
- Mental pressure on younger groups is exceeding and brings new threats.
- Health care is shifting form institutions to home and requires adjustment in the health care system, the aid workers, adjustment in the skills of the professional care takes and patients.
- Explicit individual treatments or diagnoses will occur more often

### Society related expectations:

- More polution and more stress on public health due to expanding of the larger cities
- Differences between neighbourhoods and areas caused by segregation, will cause a numberous accumulation of health related risk in areas and neighbourhoods
- New types of forms of living which will expected to have a positive influence of well being
- New technologies will help in building resilience of civilians
- Air, water and soil quality increasement is expected, however new risk may occur
- Intensive lifestock farmingcauses risks for healthcare and pandemics
- Noise pollution will extend and are a serious threat for health care and well being
- Digitalisation will require different skills from the working force. This will ask for lifetime learning. This will not be a possiblity of lower educated people, elderly, people with health issues, thus could result in less job opportunities and poverty.

[69] Most relevant findings of the Research have been added to this summary. The complete research can be downloaded from the site of the National Institute for Public Health and the Environment website: www.rivm.nl

### Considerations of probability of the chosen scenarios in MEREPUV

The chosen scenarios were discussed with the power distributor Stedin and within the local coreteam. In addition the National Safety Profile and the Regional Risk Profile also used a similar scenario, based upon duration. On top of this,  the previous incidents show that the probability of the chosen scenarios certainly is feasable.

## 3 Reponsibility of the municipality in case of power outages

### Overall responsibility for societal safety for municipalities vs. state / region / other stakeholders

Legal responsibility for crisis response in the Netherlands is mostly delegated to the local level and the safety region, with the mayor of the largest municipality within the region as the "commander". The mayor is considered to be the one who is ultimately responsible for the choices made.

There are multiple laws in place that indicate the legal responsibilities the different health organisations have. The general principle is that the healthcare organisations and individual professionals (like general practitioners), are responsible for ensuring quality healthcare to their patients, also during a power outage or other crisis. So they have to prepare for crisis situations, and make sure they can continue to function in a certain manner.

The health organisation has to report their preparation to the Safety Region. The GHOR as part of the crisis management network will advise, support and make agreements with the health organisations and will have a coordinating role in this. The Safety Region will always pay special attention to the health care section in their risk analyses and crisis management planning. As they have a coordinating role, the health sector is always an important factor and partner in their preparations and crisis response plans.

## 4 Cities assessments - main findings, possible measures and following up

### Summary cities assessments

#### Scenario 1 - 4 hour power outage

*Impact on critical input factors for health services*

The impact of a power outage of 4 hours on the critical infrastructure is relatively low. Organisations that manage what is considered critical infrastructure (Power supply, ICT, water supply, gas-network, Sewage system) are required by law to take precautionary measures to deal with the effect of power outage.

Those measures for the most part ensure that the effects of a 4 hour power outage are minimal. The electrical company will have to fix the problem and repair the network within 4 hours, or else they

will have to pay for some of the damages. They are both technically and legally unable to restore the power to certain key locations first in case of a power outage (i.e. hospitals).
Both the gas network and water supply will continue to function, as the companies will be able to keep "pressure" on the infrastructure, ensuring the supply of gas and water. The city heating network and sewage system will stop to function, however impact is expected to be relatively low. If there is a heavy rainfall event at the same time, the impact could be much bigger. Sewage could dump in open water if the system reaches capacity, and water will rise in the lower parts of Dordrecht. This could lead to blocking tunnels and causing damages due to waterlogging in houses, and sewage water coming up through the toilets in homes.

Transportation and the road network are expected to experience larger delays, and public transport will mostly stop functioning, with the exception of busses. Tunnels will be closed off and bridges will no longer be operable by a central system. This will cause large delays, and could be very harmful in case of delayed emergency vehicles.

The ICT and Telecom infrastructure will experience heavy impact in case of a 4 hours power outage. As all Wi-Fi connections will fail instantly, all phones, laptops and other internet devices will try to connect to the mobile network, overloading it and causing it to crash. Although some have a power back up for a couple of hours, they are still expected to fail. Emergency numbers will be able to function for a while, and people can call these using landline phones; however experiences show that these will be overloaded with callers.

### *Cascading effects and impact on other vital functions*

During a power outage of 4 hours most health organisation will be able to (partly) continue to function. All organisations will face difficulties, especially the ones who do not have an emergency power system. It is however not expected to cause immediate loss of live.

The hospital will be able to continue to function, however they will only supply the necessary care, and will stop all non-critical appointments and treatments. Other health organisation indicates that they will improvise or fall back on regional organisations that will still have power. Because the impact will be manageable, the cascading effects are deemed to be minimal.

Although it is expected that the increased demand for communication will be very difficult, due to the problems expected in the ICT / telecom sector.

### *Consequences for societal values*

The capacity of the healthcare organisation will diminish, however critical care will be able to continue to function. The only exception is the very vulnerable home care patients, who require machines to continue to live. This can be taken over by individual care, however if this is not supplied immediately by health care professionals or family members, there is a substantial risk for fatalities.

The ICT / Telecom as well as the public transport are expected to be not functioning, while there is an increased demand for these services. This is not expected to cause any societal unrest.

### *Identified vulnerabilities, existing barriers and proposals of measures*

The dependence of the health organisation and society overall on ICT and telecom are a large vulnerability, especially considering these systems are expected to largely seize to function the moment there is a power outage.

Next to this the homecare health organisations are expected to not have the capacity to deal with the consequences of the power outage. Experiences show that they have a large degree of flexibility and motivation to help in such situations; however the small scale of these organisations creates extra vulnerability. There is no overview and likely no possibility to contact the local people of those organisations, who have crucial information and skills. This is also a barrier, the problem of getting the information of home care patients, there location and healthcare needs, and the capabilities of the home care organisations.

Furthermore it is often unclear who in case of power outage will communicate about the consequences and the expected moment the power will be restored. There is no clear division of responsibilities to communicate between the home care organisation, power supply company and crisis organisations.

Possible measures are start communicating to raise the awareness about possible consequences due to a power outage, and to stimulate health organisations (especially homecare) and patients themselves to take more precautionary measures.

Preparations can be taken to ensure a quick transfer of critical information from homecare organisation to crisis organisation, in order to quickly dispense emergency healthcare to targeted location. Concerns due to privacy laws will have to be solved. This is considered as a measure that could solve one of the biggest possible impacts and problems that will occur.

## Scenario 2 - 12 hour power outage

### *Impact on critical input factors for health services*

The expected impact during a 4 hour power outage scenario is also expected to occur during a 12 hours power outage.

Furthermore it is expected that transportation and public transport will further diminish in capacity, although people by this time will have adapted to the new situation, so there is also a smaller demand. It could however still cause large problem for emergency services.

The possibility to communicate via ICT and TELECOM will further decrease, batteries of transceivers (walkie-talkie) will run-out, decreasing the already limited possibility for health organisations to communicate internally and externally even further. The water supply, sewage department, and gas network are not expected to experience any further impact.

### *Cascading effects and impact on other vital functions*

During a power outage of 12 hours the impact on the health care sector will continue, however the strategy will remain the same. The organisation will still be able to ensure any critically needed healthcare. The impact on the other vital functions will therefore be relatively similar with the 4 hours scenario.

There will be an increased demand for assistance by crisis organisation, and patients who receive health care at home will also require more assistance. When this concerns patients who stay at special care institutions this could become problematic, as they could possible cause harm to themselves or their environments. If these problems occur it will cause an increased demand for assistance from other health organisation to deal with these problems. How this will be organized and communicated is unclear.

*Consequences for societal values*

The capacity of the health care system on the Island of Dordrecht will continue to decline, especially within the hospital.

The general practitioner also expects an increased volume of questions from patients, although they could possibly not be received due to the communication issues. No extra victims are expected, with again the exception of home care patients receiving critical care. As these patients are in need of constant care, and very vulnerable to any changes, the risk for fatalities will increase.

Furthermore some patients, who are housed in (semi-) closed housing, could cause unrest if they are no longer in the closed housing institutions. The expected chaos in traffic and public transport is expected to decrease, as people adapt to the new situation, as long as there is no extreme weather (cold / rainfall) the overall societal impact is considered to be low.

*Identified vulnerabilities, existing barriers and proposals of measures*

Any home care systems that run on batteries will have run out during the 12 hours, in case of no spare batteries constant care will be needed. There is a demand for fuel to power emergency generators supplying health care locations.

Finally the increased use of electrical cars within health care organisations will decrease the mobility of health care professionals. Existing barriers are the increased demand for assistance that several health care organisations will have, however they will not be able to communicate this via any systems.

Furthermore the emergency hospital located in Utrecht will possible be activated, however as they have only 100 beds, it could be that there is a further demand for capacity. The transport of the patients will also be a limiting factor, as there are only a limited number of emergency vehicles available.

Possible measures that can be taken are the organisation of extra assistance of material and people from outlying regions, as the distance is very short, extra capacity can be brought in very quickly. By supplying information to organisations and home care patients about the possibility and consequences of a longer power outage, further preventive measures could be stimulated, like the supply of back up batteries of vital medical apparatus people use at home.

### Scenario 3 - 24 hours power outage

*Impact on critical input factors for health services*

Again all the impact that is expected during a 4 and 12 power outage is also expected during a 24 power outage. A power outage of 24 hours is considered to be extremely harmful by most organisations, between the 12 and 24 hours changes occur in the critical infrastructure system, which will require a longer repair period. The strategy of most health organisations will change when they consider a 24 power outage situation.

Almost all organisations will start evacuating around this time; already there are deals in place with regional organisations to help each other during such an event. If there is a power outage of 24 hours the communication systems of the crisis organisations will be less reliable, and could partly stop to function.

Even without rainfall tunnels will fill up with water at this time, as the water is no longer pumped out. Localized flooding could occur from open water bodies, as the larger pump of the polder area will no longer function. Fuel shortages are expected to increase within Dordrecht. The city wide

central heating system will have cooled down to a point, where heating the water used for heating homes will take a long time, giving an exact time estimate is not possible.

#### *Cascading effects and impact on other vital functions*

In case of a power outage of 24 hours, most healthcare organisations indicate they will start evacuating their patients to outlying regions. Evacuating the hospital will require a large number of emergency vehicles, this is most likely the limiting factor of the time needed to evacuate. The evacuation will be hindered by the closing of tunnels, but will still be possible.

Most organisations indicate that if there is a power outage of 24 hours, all patients will be evacuated, and the regional health care providers and organisations will help. Crisis organisation have a central role in coordinating this response, and although there will be many difficulties; they are expected to be able to cope with the situation.

#### *Consequences for societal values*

Between 12 and 24 hours general practitioners expect a large increase of questions from people and elderly in their neighbourhoods, that need medical attention or are worried given the sitation.

This could cause unrest, as the capacity of the health care organisations will further decrease during this period. They also expect problems with staff and resources, which will be no longer sufficient to deal with the demand for healthcare.

That is why most organisations will have chosen to evacuate around this time. The evacuation will be risky for some patients, but staying within Dordrecht in such a situation is considered to be more harmful. The national government will have taken steps to assist with the crisis management, during such a situation.

#### *Identified vulnerabilities, existing barriers and proposals of measures*

There are various vulnerabilities that have been identified given a 24 power outage scenario. There will be an increased demand for healthcare, predominantly from people who receive healthcare at home, and elderly, at the same time the capacity for healthcare will drastically derease.

Furthermore cooled medicines and food will no longer be usable / edible, and the capacity of the staff is expected to decrease. Existing barriers during this scenario are the capacity of emergency vehicles, which can be used in an evacuation. With previous large scale evacuation of patients, this proved to be the limiting factor.

Furthermore there is no central database with information about people who receive homecare that can be accessed by crisis organisations. Possible measures that could be implemented, is the realisation of local support points in the neighbourhoods, which can give information and supply to the people living there.

Also the evacuation of the island could be coordinated, to make sure several organisations don't decide to evacuate at the same time, resulting in long delays before evacuations are actually completed.

### Scenario 4 - 72 hours/1 week power outage

#### *Impact on critical input factors for health services*

All previously mentioned impacts expected in the other scenarios are also expected to occur during the scenario of a power outage of 72 hours to 1 week. It has proven to be more difficult to assess what the expected impact is for this scenario, compared with the previous scenarios.

A real life example with similar circumstances as are in Dordrecht has not occurred, and most organisations don't see a week long power outage as a realistic scenario. The only situation which has been researched before in which there would be a power outage of a week, would be a large scale flooding of Dordrecht. However this would create a crisis on a different scale, and would include a complete evacuation of the island, and complete destruction of most critical infrastructure.

The only expected extra impacts on the critical infrastructure during a weeklong power outage, is that fuel available will further decrease, decreasing the mobility of people and healthcare organisations. If the water sanitation plant is not functioning for a week, it will need 3 weeks to start up again, as the biotope has to be recreated.

### *Cascading effects and impact on other vital functions*

As all health care organisation indicated that they would evacuated fully within three days, no further impact is expected on the critical infrastructure or other vital functions.

### *Consequences for societal values*

Patients on intensive care will have to be moved to other hospitals in the region, and possible the national emergency hospital in Utrecht. Moving patients on the intensive care will involve serious risk; however the hospital can no longer give the care needed to these patients.

Overall unrest will increase, not only within the health sector. No further consequences for the societal values were identified, as most organisations expect to be fully evacuated within 3 days.

### *Identified vulnerabilities, existing barriers and proposals of measures*

It was difficult for organisations to imagine this scenario, reports also did not give a complete overview of the expected impacts. The chance of such a period of power outage in Dordrecht is extremely low, which may explain the very limited preparation for such an occurrence. This is vulnerability in the (extreme small) chance that it does occur.

Possible measures could be the support for the evacuation plans of the local health organisations, to complete this as fast as possible.

## Cities experience with the work process

### Involving of stakeholders

The approach of bringing all the stakeholders together in a single workshop, was a possibility for most organisations to compare with other similar organisations and gain immediate insight into their own possibilities. This made the larger workshops very beneficial, both for the overall project, as well as for the participating organisations.

However due to capacity issues it proved difficult to involve all the different organisations. In general it can be said that how smaller the organisation, and the more it was involved in decentralized home care, the more difficult they were to involve in the assessment. With the ultimate example of the home care organisations, which appeared to be not possible to directly involved them in this assessment, this was a big challenge in the assessment.

### Chosen analytical approach

The involvement of the vital infrastructure partners was fruitful and due to the use of the VITAP method of TNO it was possible to distinguish the critical issues by power outage. The Power distributor Stedin was involved in the local coreteam and attended both Vital infrastructure meetings as well as the local core team meetings. This provided actual and vital information for the expertmeetings and a good starting point for the discussions.

By using a matrix per scenario, divided by categories and interdepencies of other institutions and authorities was an excelerator. By reviewing this per participant knowledge and different perceptions were exchanged and discussed.

### Ensuring validity in results

After each session the results of the session were shared with the participants. In the final stages of this assessment all stakeholder will be invited for the last general workshop. All results and conclusions will be discussed, and possibly adopted giving the commentaries en feedback that are expected to be received. A written "summary brief" will be distributed to all the partners so that they can comment on the most salient points, without the need to go through the complete project report. All the time the coreteam meeting consisting of the municipality, the safety region, the GHOR and the electricity infrastructural organisation STEDIN was involved throughout the workshops and the writing process. And the concept conclusion have been discussed with them, and adopted according to their input and feedback

# 5 Following up on city reports from SRSHS

## Considerations of uncertainty and transferability in the results of the city assessment

### Validity in results

For the first three scenarios there was both literature available, as the possibility to discuss possible impacts with the different health organisation, professionals and critical infrastructure organisations. The results from the work sessions reflected the same conclusions in the already available literature. Also the reports of power outages that actually occurred present the same overall picture.

Decisions that local organisations said that they would take at a certain moment, were mostly also executed by similar organisations that experienced a power outage. However small differences can have a large effect on the expected impact. If there is a large rainfall event during a power outage, the impact and consequences for critical infrastructure and healthcare organisations in Dordrecht would increase greatly.

Furthermore the final scenario of 72 hours to 1 week has proven to be difficult to analyse. Most organisation could not imagine such a situation, and there was only limited literature and previous experiences available. The degree of uncertainty increases with the duration of the power outage.

Finally although most organisation were included in the workshops, the home care organisation have proven to be a very difficult group to reach out to. Various methods were tried, and only very limited response was ever received. This does indicate the problems that will only grow during a power outage, the small organisation will have large difficulties to cope with changing situation, and especially crisis situation like power outages. Because there is currently not a properly functioning working relationship between these organisation and the crisis organisations, during an actual crisis the organisations will be slow to respond and organize help if they need it.

### Are the findings seen as transferable also to other cities?

The situation in Dordrecht has comparable elements with other cities and countries, however it does have some unique characteristics. The increased use and reliance on ICT and telecom within the health sector is a shared characteristics between EU countries, although on different levels.

It is becoming more common for people to stay longer at home, or more quickly be discharged from hospital, and receive the care they need at home. The amount of people who are not able to be self-reliant without the home care is increasing, these people often rely on certain powered systems for their health.

Another shared characteristic is the change in the energy network used by cities. It used to be that power was created at several large power stations, and diverted via a network from large national infrastructure to a fine grid within cities.

Because of the energy transition most countries are going through at the moment, it is shifting to a much more complex and dynamic network. This comes with more vulnerability, and therefore a higher risk for power outages.

An unique characteristic for the Netherlands is the actual make-up of the large part of the country. Where most countries experience rapid growth of only the biggest cities, the western part of the Netherlands grows quickly, but in many different cities at the same time. Because of this the health care are not all located in a relatively small area, but dispersed over a larger region, within various mid-level cities. This creates a flexibility in the network, as organisations can support each other, when certain regions experience difficulties. This dispersed urbanized structure creates a level of resilience.

## Following up of findings by SRSHS

### Unexpected findings

There have been numerous unexpected findings. The expectations that the ICT and Telecom sector would fail quickly was expected, just as the fact that other critical infrastructure partners would most likely (partly) continue to function.

What was a surprise was that most of those organisation did not foresee that their own communications system that they use daily would also be unavailable, and did not prepare fully for this in their crisis plans.

Another unexpected finding was that originally there was an idea that a possible preventive measure was the selective repairing of the network, in order to restore the power to certain vital functions first (hospitals, elderly homes). This however turned out to be impossible, both legally as well as technically.

It was unexpected that most organisations would already start a large scale evacuation after 24 hours. Around this time it was deemed to be better for the patients to evacuate to surrounding regions, in comparison with staying with the area with no electricity. Because of this most organisations could not indicate possible impacts within the 72 hours to 1 week scenario, as they would have already left at that point.

The last unexpected finding was that it proved impossible to involve the homecare organisations within the project and the specific workshops. Even individual appointments were not possible, while we tried to contact multiple organisations, professionals and on several levels of the organisation. This will need further assessments, as there are indications of the impact, but not as clear as compared with the other organisations.

Furthermore large benefits in crisis response could be made if these organisations take or stimulate preventive measures, or are involved with the crisis response of the safety region. There is a need for further progress in the possibility of sharing information during a crisis situation, by the municipality or home care organisations. This currently has both legal as well as practical limitations, while the information is vital for a proper disaster response during a long power outage.

### Steering ability , availability of efficient and achievable risk reducing measures / clear responsibilities for who can make decisions regarding implementation?

There are several risk reducing measures available in different sectors. The recommendation on measures were validated by the participating institutions. The measures and recommendations as

stated are divided on the several sectors: Critical infrastructure, Crisismanagement organisation and Municipality and Health Care organisations.

Critical infrastructure

1. Increasing understanding of interdependencies between different critical infrastructure partners, and increase the business continuity of the critical infrastructure organisations
2. Create a clear plan and structure of communication message internally for the critical infrastructure organisation, and between the different organisations. Clarity is needed on who communicates what.
3. Work together with a national program on critical infrastructure and decreasing vulnerabilities.*

Crisis management organisation and Municipality

1. Increased cooperation between crisis organisation and the Electricity power grid company (STEDIN) given the energy transition.
2. Create an interagency communication plan given several power outage scenarios, to clearly distinguish the responsibilities and actions between the crisis organisations, health organisations and other organisations.
3. Create prevention focussed action plan to create more awareness with home care organisation and patients, in order to increase self-reliance.
4. Crisis organisations have to organize a process in which data can be made available during crisis situations, on patients' needs and locations, in order to actively and directly offer the needed assistance. *

Healthcare organisations

1. The GHOR (organisations that coordinates healthcare during crisis situations) organises a closer working relationship with the homecare organisations.
2. By increasing the awareness and showcasing of possible measures people can take themselves their resilience can be increased, to decrease the possible impact of a power outage.
3. Make the general tasks and responsibilities of the crisis organisations known to the large group of small homecare organisations, to make sure they know where to ask for help during a crisis situation. *
4. Because the home care organisations have proven to be a difficult group to reach and to include within this research and the overall network. New methods have to be used to incorporate them within the standard crisis organisations network. The possible impact due to a power outage should be presented to them in an easy and attractive format, in order to create sufficient awareness and feeling of necessity within the organisations.

5. The health care organisation needs to be able to quickly supply needed information during a crisis situation. In order for this to be done data services need to be accessible during a crisis situation and people need to be trained to do this quickly.

- The recommended measures with the * are the measures that should preferably be followed up by central level

## The rol of the SRSHS role in following up

A workshop was organized in which all organisations that have participated in expert meetings during the assessment were invited, to discuss the current results and proposed measures. During this workshop the conclusions were sharpened and broadly shared and accepted between the different organisations. The proposed measures were discussed and prioritized.

The findings were shared with the local Coreteam and will be integrated in the project of the SRSHS with the municipalities within the Safety Region. This project is about enhancing resilience especially in vulnerable parts of society like the elderly, and people who depend on home care services.

The report and recommendations are shared with the resilience project initiated this April by the coordinating secretary of the municipalities and the Safety Region South Holland South. As this research contains vital information for this project the coreteammembers are included in this project as experts in this field.

The SRSHS also invited the housing corporations in Dordrecht to an especially for them designed introduction meeting. These introductions will also be presented to the housing corporations throughout the Safety Region in municipalities as Gorinchem, Hoeksche Waard and more. The municipalities will organize these meetings together with the Safety Region and focus will be on enhancing their knowledge on the network and the crisismanagement organisation as well as measures they can take in case of power outage. The necessity of preparation on emergencies and especially on communication and information efforts will be explained and best practises are shared.

## Measures that will not be followed up

All measures which is in the influence of the Safety Region will be followed up. The measures which depend on action from third parties will be highly supported by the Safety Region.

## Plan for following up by SR SHS

Based on the findings the Safety Region together with the cities Bergen, Stavanger and Valmiera the need for development of an inter-sectoral response plan was shared. Therefore a proposal is made for the DG Echo call of Prevention and Preparedness Projects for Civil Protection and Marine Pollution (UCPM-2019-PP-AG).

The response plan will be a direct result of this project and will include the proposed measures and recommendations gained by the MEREPUV project.
By including the national level in Latvia and the Netherlands, and in Norway the County level in the supervisory board, there will be national knowledge obtained and dissemination to other regions and cities.

## Following up on methodologies / work process

### Identified needs in terms of methodology? Need for new approaches? guidance material, more research and development?

The strength of the method is the structured approach towards the assessment. As a power outage would have large consequences, and many follow up impacts, it needs to be approached with a broad perspective.
The sequence of assessing the impacts first on the critical infrastructure network, secondly of the health organisation and thirdly back on the critical infrastructure was a logical sequence, and allowed for a complete mapping of the likely impacts.
It allowed us to properly assessing the impacts for the health organisation, by adding the most recent knowledge from the critical infrastructure partners on what the organisations can expect. However the assessment of impact from the health organisation back on the critical infrastructure was fairly minor, or at least did not result to many identified impacts. This could be due to the structure of the Netherlands, with a decentralized network of critical infrastructure and health organisations, creating over capacity and flexibility in the system, in case a certain area experiences problems.

### Identified topics regarding working with relevant stakeholders at local level – possibilities and limitations / challenges?

Plan for dissemination of the results to other cities/relevant stakeholders. A workshop was organized in which all organisations that have participated in the assessment were invited, to discuss the current results and proposed measures. Through this discussion the conclusions were sharpened and hopefully broadly shared and accepted between the different organisations.

The proposed measures were discussed and expanded or changed according to the expertise of the different organisations. This will also create partial ownership of the current results, in order to increase the likelihood of adoption of the possible measures.

# 6 Plan for dissemination to other cities / relevant stake holders

The report is direct input for the department of preparation on Disasters and Crises (Voorbereiding op rampen en crises VRC), particularly on the section Coordination on healthcare and the section Civil protection. The report will be used for the annual planning and policy planning and prioritization of actions and measures. Therefor the report will also be offered to the management board of the Safety Region.

- The following measures and recommendations will be integrated in the annual planning of the VRC:
    - Increasing understanding of interdependencies between different critical infrastructure partners, and increase the business continuity of the critical infrastructure organisations
    - A plan will created in which structuring the communication message internally for the critical infrastructure organisation, and between the different organisation. This will bring clarity on who communicates what.
    - VRC will work together with a national program on critical infrastructure and decreasing vulnerabilities
- The department of Risk management at the Safety Region South Holland South has recently (april 2019) started the project Self-reliance together with the municipalities in the Safety Region. Again this report and it's recommendations is direct input for this project.
- Furthermore the DG Echo proposal Care4Power is supported by the department of preparation on Disaster and Crises, and will be executed by this department which covers two of the main recommedations, a inter-sectoral response plan based on network building, communication and information procedures. As one of the outcomes an interagency communication plan given several power outage scenario will be created, to clearly distinguish the responsibilities and actions between the crisis organisations, health organisations and other organisations.
  If granted the execution will take place in 2020-2021, together with Erasmus University and Medical Center and can be implemented in the three coordinating organisations for Healthcare during crises and disasters in the south west part of the Netherlands.
- The introduction meeting is executed througout the Safety Region South-Holland South and will strengthen the network and encourages the preparations on power outage by the Housing Corporations.

# 7 Assessment of degree of achievement of project objectives

The following project objectives and results  were achieved:

- Better ability among the partners to conduct vulnerability assessments addressing cascade effects due to interdependencies between vital societal functions and structures.
  *By working together and using the VITAP tool of TNO the Safety Region and city of Dordrecht gained more insight in the interdependecies and how to conduct these assessments. In addition to this the involved Stakeholder also gained more insight or realised that there was a need for doing some more internal research or different approach to their own business continuity.*
- Better understanding of the municipalities' role in preventing severe consequences of undesirable incidents hitting urban vital societal functions.
  *The measures recommendend are of importance for the preventing role of the municipality, especially the recommendation to create an interagency communication plan and to create a prevention focussed action plan.. By using the research in the Self-reliance project in which this action plan should be formed, managed by the Safety Region and the municipalities of the Safety region the municipalities acknowledge their role.*
- Better knowledge of proper and efficient measures available at the local level for protecting citizens against severe consequences from power outage, with special emphasis on direct and indirect effects of disruptions on health services in Dordrecht.
  *Although the GHOR already put a lot of effort in the health services to prepare themselves for the direct and indirect effects of disruptions this research raised even more awareness by the local level and health services. The interaction between the stakeholders was of even more value and turned out to be a good initiative to emphasize the need of preparation. The need for a inter-sectoral plan is supported by the stakeholders and will provide the necessary preparations and measures on information, communication and so more when power outage occurs.*

# ANNEX 5:
# EXPERIENCES FROM THE LATVIAN PART OF THE PROJECT

MEREPUV

2017/PREV/783153

"Methods and measures to enhance resilience against electric power outage in urban vital societal functions"

# MEREPUV

# Working Paper from SFRS

## /State Fire and Rescue Service/

Deliverable no: D4.2 SFRS

| | |
|---|---|
| Approved by Chief of State Fire and Rescue Service Civil Protection Department | |
| Date | |

Funded by
European Union
Civil Protection

# Content

# 1. Introduction

This Working Paper from SFRS in cooperation with Valmiera city was prepared for the project "Methods and measures to enhance resilience against electric power outage in urban vital societal functions"; MEREPUV; 783153 — MEREPUV — UCPM-2017-PP-AG and co-funded by European Union Civil Protection finance instrument.

The main goals of the project are:

- To evaluate the main risks regarding the possible effects of power outage in the city as well as the direct and indirect consequences to the healthcare services;
- To prepare city risk and vulnerability assessment.

Four scenarios were chosen in the project based on the duration of the power outage:

- Scenario 1: Electrical power outage 24 hours;
- Scenario 2: Electrical power outage 74 hours;
- Scenario 3: Electrical power outage 1 week;
- Scenario 4: Electrical power outage 1 month.

Al of four scenarios are based on the one event when 14 years ago, in City of Valmiera power was not available for four hours. The probability of the scenario is evaluated by the calculation and expressed in per cent value.

- Scenario 1: low probability: 10-40 per cent likely in 50 years;
- Scenario 2: very low probability: 0-10 per cent likely in 50 years;
- Scenario 3: very low probability: 0-10 per cent likely in 50 years;
- Scenario 4: very low probability: 0-10 per cent likely in 50 years.

The assessment is done within the framework of the so-called bow tie model. The model is adapted and specified on basis of purpose, analytical object and main questions to be examined in the assessments. The following risk elements are assessed:

- Probability
- Vulnerability
- Consequences
- Uncertainty

The necessary information of the power outages impact on the health system in Valmiera city was gathered in qualitative terms at expert meetings when discussing the scenarios. During meeting experts discussed several topics, such as:

- Stakeholder mapping;
- Existing situation regarding power supply;
- Health healthcare services at LTD "Vidzemes slimnīca";
- Other supply services vulnerabilities.

# 2. About power outages in Latvia

## 2.1. Facts about reliability in deliverance of power in Latvia

In terms of reliability in deliverance of power in Latvia, Ministry of Economy states that regular survey and defect detection procedures of power lines are carried out with internal and external regulatory enactments. In order to reduce the risk of the damage occurrence to the distribution grid, both the gradual rebuilding of the electricity grid and the regular maintenance measures for electrical installations shall be carried out. Since year 2011, the share of naked power lines in the overall length of the distribution grid has been reduced by 16% (from 64% in year 2011 to 48% in year 2018), using such technical solutions as the construction of cable lines, insulated lines, overhead cables, which significantly reduce the electricity grid's vulnerability on weather effects. Improvements are implemented by strong emphasis on the possibility of unbundling the electricity networks of cities and rural areas in order to reduce the risk of disruption in cities and major villages where the majority of the population is concentrated. Special automatization programme, by using remotely controlled power switches, allows to identify damaged power lines and localize damaged sections.

The maintenance of the electrical line routes follows the 4-6 year route cleaning cycle (freeing the routes from trees and shrubs). Every year routes are cleaned for an average of 4500 km, using different technologies.

The amendments to the Protection Zone Law adopted by 18.04.2013 have extended power line protection zones to forest areas for power lines with a voltage of 10-20 kV to 30 metres from the axis of the line. Amendments to the Protection Zone Law and to Cabinet of Ministers Regulation No 982 on “Procedures for the Determination of Protection Zone for Energy Infrastructure Objects” introduce a framework for the felling of potentially threatening trees in the protection zone. The implementation of the felling of dangerous trees significantly reduces risks to power lines.

## 2.2. Facts about incidents of previous power outages in terms of duration and most common causes

In the end of year 2010 during the night from 25$^{th}$ to 26$^{th}$ of December an active cyclone was storming the territory of Latvia, bringing heavy rainfall in the form of rain, hail and wet snow. In the western part of the country, rain fall increased water levels in rivers basins and leading to flooding in the lower areas. The flooding and increased water levels in rivers posed a local threat to electrical installations, thereby the shutdown of individual electrical installations was arranged. As air temperatures fell, the freezing rain in the eastern part of the country caused considerable icing, a strong snowfall continued for several days. As a result of snow and icing, falling trees cause extensive breakdown of the distribution grid in the several municipalities. Electricity supply disruptions affected several tens of thousands of households. JSC “Sadales tīkls” has been doing repairs of damage since the morning of December 26th, but due to adverse weather conditions, the peak of damage to the grid was reached on 1th January 2011.

When without electricity was 4 188 distribution transformer substations causing 66 646 households left without power. On 1th of January, the JSC "Sadales tīkls" shall announce an emergency situation in the distribution grid. On 6th of January Cabinet of ministers declares Emergency Situation due to the long-term electricity supply disruptions. Repair works of damages under intense working conditions continues until 25th of January In general, disruption in the distribution grid lasts 1 month. Basically affected areas outside the cities. On 17th of January in one of the municipality the power outages disrupted the operation of Thermogenic plant, which caused a rupture in the heat track.

Damage to this magnitude has been identified as a result of snowfall and icing. A similar extent of electricity supply has been experienced following the damage caused by the hurricane on 9 January 2005. The night-time storm on 29 October 2013 caused damage to the distribution grid, which caused electricity supply to be disrupted by around 100 thousand households, causing further damage in neighbouring Estonia.

## 2.3. Expected societal development

Massive damage to the power distribution grid leaves a significant impact on one of the basic needs – electricity supply. Interruptions in electricity supply may lead to a cascade effect to other basic needs: water supply, heating, communication provision, housing maintenance and safety, health care. Risks can be reduced by the use of autonomous power generators to ensure the operation of critical infrastructure facilities. Disruption of electricity supply may result in a disruption or a total disruption of the heating of households and public buildings outside urban areas, which should result in the use of other heating sources.

## 3. About municipalities' responsibilities in case of power outages

According to Civil Protection and Disaster Management Law[70], disasters related to energy generation or transport infrastructure of energy and energy resources are coordinated by the Ministry of Economics. Coordination of disaster is carried out by involving the authorities that are subordinate to the Ministry or local government (hereinafter - the disaster management subject) in co-operation with other ministries, State and local government authorities shall perform the following disaster management coordination tasks:

1) to assess the risk;

2) based on risk assessment, to determine the preventive, preparedness, response and elimination of consequences measures, draw up planning documents for the development of the respective field, laws and regulations and other documents;

3) based on risk assessment, to identify and plan resources for disaster management.

Since power outage can drive and have previously caused disasters in municipalities heat and water supply system, therefore responsibilities in case of power outage emergencies have to be seen in multiple dimensions.

Ministry of Economics have delegated JSC “Sadales tīkls” to coordinate and to be Institution which is official also leader of rescue works in case of disaster related with damage to distribution grid.

Municipalities have no direct tasks to deal with the power outages in their administrative territory, but according to the Law On Local Governments[71], to organise supply of water and heat for residents is autonomous functions of municipalities. This requirement also applies in the event of a disaster and the force of this requirement is strengthened in Civil Protection and Disaster Management Law. Civil Protection and Disaster Management Law states disasters within the administrative territory of a municipality related to accidents in heating supply, water supply system are coordinated by the municipality.

One of the tool for municipalities to fulfil coordination of disaster is the civil protection commission of the co-operation territories. The aim of the Commission's work is to coordinate actions in the event of disaster and disaster threats and to promote civil protection, disaster management or disaster management coordination. The Commission consists of representatives of several sectors, including expert from JSC "Sadales tīkls".

In case of a major energy emergency municipalities will receive support from the State Energy Centre for the elimination of the disaster and the liquidation of the consequences caused by it. For more information about the State Energy Centre see By-laws of the State Energy Crisis Centre[72].

[70] Civil Protection and Disaster Management Law in English https://likumi.lv/ta/en/en/id/282333-civil-protection-and-disaster-management-law

[71] Law On Local Governments in English https://likumi.lv/ta/en/en/id/57255-on-local-governments

[72] By-laws of the State Energy Crisis Centre in English https://likumi.lv/ta/en/en/id/58439-by-laws-of-the-state-energy-crisis-centre

# 4. Cities assessments

## 4.1. Scenario: Electrical power outage 24 hours

### *Probability*

Taking into account that the last power outage in Valmiera happened 14 years ago, when power was not available for four hours, the probability of this scenario is evaluated as low: 10-40 per cent likely in 50 years.

### *Impact on critical input factors for health services*

The availability of services such as water supply and heat supply is important for the provision of health care services without electricity supply. In addition, catering and food supplies, which depend on the functioning of the transport system, are essential for the operation of the hospital. Each of these services is necessary for providing quality healthcare services to the population.

**Water supply**

Water supply system pipes are equipped with generators that are able to provide fully functioning water supply system for 24 hours. Water purification system has additional diesel generators that can provide its functioning. Water abstraction pumps are not supplied with additional power sources which results in the fact that drinkable water will only be available from the water container which could provide the city with drinkable water for 24 hours.

**Heat production**

In the case of power outage to the city, heat production would be interrupted because of the block of the pipe operation including boiler houses and circulating heat networks. In result of inertia, heat supplement would be available in the heat networks for two hours. In case the temperature would be less than -10 degrees Celsius, heat networks would freeze in 24 hours.

**Provision of public transport. Fuel availability.**

It is possible to provide the public transportation system with the available fuel. There are no additional emergency situation fuel reserves available for the city. Fuel tanks are equipped with generators to provide the functioning of the pumps. In addition, it is possible to connect the generator from the technical help truck.

**Provision of public order.**

Valmiera Municipal police is responsible for the functioning of Operative Information centre, public order and, if necessary, informative function for the local inhabitants. In the case of power outage, the functioning of Valmiera Municipal police will be interrupted by the outage of fuel for the operative transportation, the limited communication opportunities (phones and walkie-talkies will be available only till the end of current charge) and disruption of the video surveillance system.

## *Impact on health services*

"Vidzeme Hospital" is equipped with two power input lines (total power supplement 2400 kW) that can replace each other. In the case of one local power disruption, all the necessary power can be supplied from the other power input line. In case of more immense power supplement emergency – electro energy is not provided to the hospital.

The existing uninterruptible power supply blocks (UPS systems) would be able to provide the functioning of the most necessary medical equipment with the necessary power only up till two hours.

"Vidzeme Hospital" is equipped with diesel generator (300 kW) with 12 hours working time taking into account the available fuel reserves. This generator would provide the functioning of intensive care department, resuscitation department and children care department. The fact that these departments have experienced several important reconstructions must be taken into account because the diesel generators have not been tested since their installation so it is not that reliable source. The testing process of these diesel generators is almost impossible because of the fact that the hospital is treating patients 24/7.

The generator could provide the necessary light equipment in selected departments of the hospital as well as the functioning of some of the medical appliances. It must be taken into account that full light equipment will not be provided in all the hospital as well as the functioning of elevators and operating of inner water and heat supplement system.

In the case of power outage there are some additional diesel generators available at Valmiera city for example at Power Distribution network or SFRS. It would be necessary to provide "Vidzeme Hospital" with additional generator connection points as well as to install a separate power wiring.

Power outage would have a significant impact not only to the medical appliances but also to other critically important fields:

- Catering. Food reserves are strategically made for a week (Food is supplied to hospital once in a week). It is stored in freezers which would stop working after the case of

power outage. The cooking processes wouldn't be possible because the main source of energy for most of the technological appliances in the kitchen is electricity. Critically important will be necessity for the hot water.

- Communication. Inner communication at "Vidzeme Hospital" would be provided using the fixed inner phone networks. Mobile and other communication would depend on the national mobile network activities.
- Heat. The outside heat supplement system in case of lower temperature then -10 Celsius will freeze in 24 hours. The inner circulation will not be provided. In winter, if the power supply is not restored within 24 hours, the hospital will need to be evacuated.
- Autonomous heating system is not installed.
- Transportation. The provision of transport services is related to the inner fuel reserves. Of course, the availability of communications to coordinate transport will also be important. It is possible to involve the recourses of army and National Guard in order of evacuation. Evacuation of the critical patients would be done organised in cooperation and would depend on other hospital availability as well as the availability of the transport.

In case of power outage up to 24 hours "Vidzeme Hospital" can provide:

- Emergency medical care for critical patients
- Availability of the doctors

Ambulatory and unurgent specialist availability and consultations will be limited. The standard of patients recovering in the stationary care won't be available, because it will not be able to provide the necessary conditions including catering, heat and water supply.

### *Cascading effects and impact on other vital societal functions*

Evaluating the results and impacts of power outage on health care services and other vital societal functions, no significant impact was found. Limited first aid services or other health care services will encourage the population (especially people with children or relatives that need regular medical assistance) to move to regions were these services are provided which could escalate to the possible deficit of specialists and valuable resources (transportation, fuel) that would be essential to prevent the power outage. In the scenario of 24-hour power outage this possibility is evaluated as very low.

### *Consequences for societal values*

Results of power outage in health care system would have serious consequences on societal values like:

- Life and health of local inhabitants. After evaluating the impacts of power outage for 24 hours it is assessed that it will not lead to additional deaths that are related with the health care and emergency services because all the important medical services including medical appliances will be provided. In the case of a 24-hour power outage, communication and transport facilities will be able to ensure public access to health services. The provision of health care services will not be provided in full amount, but by focusing on providing assistance in the most critical cases.
- Public stability. The public's psychological response to the power outage in the given scenario would be closely related to providing security for themselves and for their relatives. The challenges of everyday life will be related to the provision of everyday necessities - home security, food, warmth and availability of information. No significant increase in the demand for health services is expected.

### *Identified vulnerabilities, existing efficient barriers and proposals of measures*

The following vulnerabilities were identified in the assessment:

- Water circulation in the hospital's internal networks will be interrupted, no warm water will be available.
- Without electric power, it will not be possible to cook warmly, but the food reserves will quickly deteriorate due to a break in the operation of the refrigerators.
- In winter, due to the interruption of heat supply, it will not be possible to provide the all necessary rooms heating during the winter.

The following measures have been identified that could effectively reduce vulnerability to power outages:

- Fuel reserves for diesel generators
- Testing of the available alternative power systems
- Development of an alternative power supply system for the provision of inner heat supply

Based on the risk and vulnerability assessment, following measures are proposed:

- Creating or increasing fuel reserves;
- Evaluation of electrical wiring systems to ensure proper backup power supply;
- Creation of new connection points for additional generators;

## 4.2. Scenario: Electrical power outage 72 hours

### *Probability*

Taking into account that the last power outage in Valmiera happened 14 years ago, when power was not available for four hours, the probability of this scenario is evaluated as very low: 0-10 per cent likely in 50 years.

### *Impact on critical input factors for health services*

The availability of services such as water supply and heat supply is important for the provision of health care services without electricity supply. In addition, catering and food supplies, which depend on the functioning of the transport system, are essential for the operation of the hospital. Each of these services is necessary for providing quality healthcare services to the population. Detailed information available in chapter 4.1.

**Water supply**

Drinkable water supplies will run out in the city within the first 24 hours. Due to the limited fuel reserves, no additional drinking water will be available.

**Heat production**

Within 24 hours the heat supply networks will be frozen and will not be usable.

**Provision of public transport. Fuel availability.**

It will be possible to provide the public transportation system with the available fuel reserves. There are enough reserves for one week.

**Provision of public order.**

Critical level of operations in communication and notification systems. There is a serious risk that the available communication systems will not be usable. This will make it impossible to communicate with the public (cannot call, get information, etc.)

### *Impact on health services*

Detailed information available in chapter 4.1.

The fuel reserves for running the diesel generator will end in the first 12 hours. If no solution is found for the supply of additional fuel reserves, the hospital will be closed. Evacuation of patients will be required.

If additional fuel reserves would be provided, the generator could provide the functioning of intensive care department, resuscitation department and children care department.

Provision of warm food won't be available for the patients as well as there will be no water and heat supply. As a result, the hospital will have to stop and start evacuation.

Full health care delivery will not be possible. Transfer of the critical phase patients to other health care facilities in other nearby regions should be started. The flow of incoming patients should be directed to other nearby hospitals.

### *Cascading effects and impact on other vital societal functions*

Limited first aid services or other health care services for 72 hours will encourage the population (especially people with children or relatives that need regular medical assistance) to move to regions were these services are provided which could escalate to the possible deficit of specialists and valuable resources (transportation, fuel) that would be essential to prevent the power outage.

### *Consequences for societal values*

Results of power outage for 72 hours in health care system would have serious consequences on societal values like:

- Life and health of local inhabitants. After evaluating the impacts of power outage for 72 hours it is assessed that some problem situations might arise that are related with the health care and emergency services because the provision of the important medical services including medical appliances will not be possible. The city of Valmiera will not be able to provide a full range of health care services without external assistance
- Public stability. The public's psychological response to the power outage in the given scenario would be closely related to providing security for themselves and for their relatives. The challenges of everyday life will be related to the provision of everyday necessities - home security, food, warmth and availability of motion. 72-hour power outage would bring much higher demand for a variety of health care services based on the lack of water, food and possible frostbites.

## *Identified vulnerabilities, existing efficient barriers and proposals of measures*

The following vulnerabilities were identified in the assessment:

- Water circulation in the hospital's internal networks will be interrupted, no warm water will be available. Water supply interruptions can cause an outbreak of diseases.
- Without electric power, it will not be possible to cook warmly, but the food reserves will quickly deteriorate due to a break in the operation of the refrigerators.

In winter, due to the interruption of heat supply, it will not be possible to provide the all necessary rooms heating during the winter.

- Communication will become problematic. The possibilities of using the means of communication will be limited. Exchange of information will be difficult.
- The availability of transport services due to lack of fuel reserves may be impaired.

The following measures have been identified that could effectively reduce vulnerability to power outages

- Fuel reserves for diesel generators
- Testing of the available alternative power systems
- Development of an alternative power supply system for the provision of inner heat supply

Based on the risk and vulnerability assessment, following measures are proposed:

- Creating or increasing fuel reserves;
- Evaluation of electrical wiring systems to ensure proper backup power supply;
- Creation of new connection points for additional generators;
- Creating an alternative communication (notification) system;
- Developing alternatives for water supply.

## 4.3. Scenario: Electrical power outage 1 week

### *Probability*

Taking into account that the last power outage in Valmiera happened 14 years ago, when power was not available for four hours, the probability of this scenario is evaluated as very low: 0-10 per cent likely in 50 years.

### *Impact on critical input factors for health services*

The availability of services such as water supply and heat supply is important for the provision of health care services without electricity supply. In addition, catering and food supplies, which depend on the functioning of the transport system, are essential for the operation of the hospital. Each of these services is necessary for providing quality healthcare services to the population. Detailed information available in chapter 4.1.

**Water supply**

Drinkable water supplies will run out in the city within the first 24 hours. Due to the limited fuel reserves, no additional drinking water will be available.

**Heat production**

Within 24 hours the heat supply networks will be frozen and will not be usable.

**Provision of public transport. Fuel availability.**

It will be possible to provide the public transportation system with the available fuel reserves. There are enough reserves only for one week.

**Provision of public order.**

Critical level of operations in communication and notification systems. There is a serious risk that the available communication systems will not be usable. This will make it impossible to communicate with the public (cannot call, get information, etc.)

### *Impact on critical input factors for health services*

Detailed information available in chapter 4.1.

The fuel reserves for running the diesel generator will end in the first 12 hours. If no solution is found for the supply of additional fuel reserves, the hospital will be closed. Evacuation of patients will be required.

If additional fuel reserves would be provided, the generator could provide the functioning of intensive care department, resuscitation department and children care department.

Provision of warm food won't be available for the patients as well as there will be no water and heat supply.

Full health care delivery will not be possible. Transfer of the critical phase patients to other health care facilities in other nearby regions should be started. The flow of incoming patients should be directed to other nearby hospitals.

### *Cascading effects and impact on other vital societal functions*

Limited first aid services or other health care services for 1 week will encourage the population (especially people with children or relatives that need regular medical assistance) to move to regions were these services are provided which could escalate to the possible deficit of specialists and valuable resources (transportation, fuel) that would be essential to prevent the power outage.

### *Consequences for societal values*

Results of power outage for 1 week in health care system would have major consequences on societal values like:

- Life and health of local inhabitants. The interruption of the weekly electricity supply will make it more difficult to provide emergency care or to provide daily care, and the

public will feel the need for water and food. The possibility of freezing should also be considered.

- Public stability. The public's psychological response to the power outage in the given scenario would be closely related to providing security for themselves and for their relatives. The challenges of everyday life will be related to the provision of everyday necessities - home security, food, warmth and availability of information. 1-week power outage would bring much higher demand for a variety of health care services based on the lack of water, food and possible frostbites.

### *Identified vulnerabilities, existing efficient barriers and proposals of measures*

The following vulnerabilities were identified in the assessment:

- Water circulation in the hospital's internal networks will be interrupted, no warm water will be available. Water supply interruptions can cause an outbreak of diseases.
- Without electric power, it will not be possible to cook warmly, but the food reserves will quickly deteriorate due to a break in the operation of the refrigerators.
- In winter, due to the interruption of heat supply, it will not be possible to provide the all necessary rooms heating during the winter.
- Communication will become problematic. The possibilities of using the means of communication will be limited. Exchange of information will be difficult.
- The availability of transport services due to lack of fuel reserves may be impaired.
-

The following measures have been identified that could effectively reduce vulnerability to power outages;

- Fuel reserves for diesel generators;
- Testing of the available alternative power systems;
- Development of an alternative power supply system for the provision of inner heat supply.

Based on the risk and vulnerability assessment, following measures are proposed:

- Creating or increasing fuel reserves;
- Evaluation of electrical wiring systems to ensure proper backup power supply;
- Creation of new connection points for additional generators;
- Creating an alternative communication (notification) system;
- Developing alternatives for water supply.

## 4.4. Scenario: Electrical power outage 1 month

### *Probability*

Taking into account that the last power outage in Valmiera happened 14 years ago, when power was not available for four hours, the probability of this scenario is evaluated as very low: 0-10 per cent likely in 50 years.

### *Impact on critical input factors for health services*

The availability of services such as water supply and heat supply is important for the provision of health care services without electricity supply. In addition, catering and food supplies, which depend on the functioning of the transport system, are essential for the operation of the hospital. Each of these services is necessary for providing quality healthcare services to the population. Detailed information available in chapter 4.1.

**Water supply**

Drinkable water supplies will run out in the city within the first 24 hours. Due to the limited fuel reserves, no additional drinking water will be available.

**Heat production**

Within 24 hours the heat supply networks will be frozen and will not be usable.

**Provision of public transport. Fuel availability.**

It will be possible to provide the public transportation system with the available fuel reserves. There are enough reserves for one week.

**Provision of public order.**

Critical level of operations in communication and notification systems. There is a serious risk that the available communication systems will not be usable.

### *Impact on health services*

The availability of services such as water supply and heat supply is important for the provision of health care services without electricity supply. In addition, catering and food supplies, which depend on the functioning of the transport system, are essential for the operation of the hospital. Each of these services is necessary for providing quality healthcare services to the population.

Power outage or one month will reduce the demand for health care services, as some part of the population will choose other cities where healthcare is available. The city will need

emergency care and care for patients who are not transportable. Detailed information available in chapter 4.1.

The fuel reserves for running the diesel generator will end in the first 12 hours. If no solution is found for the supply of additional fuel reserves, the hospital will be closed.

If additional fuel reserves would be provided, the generator could provide the functioning of intensive care department, resuscitation department and children care department.

Provision of warm food won't be available for the patients as well as there will be no water and heat supply. Full health care delivery will not be possible. Transfer of the critical phase patients to other health care facilities in other nearby regions should be started. The flow of incoming patients should be directed to other nearby hospitals provided that functioning communication channels are available.

### *Cascading effects and impact on other vital societal functions*

Power outage for one month will encourage all the population to evacuate to other nearby regions and leave the city.

### *Consequences for societal values*

Results of power outage for 1 month in health care system would have serious consequences on societal values like:

- Life and health of local inhabitants. After evaluating the impacts of power outage for 1 month it is assessed that it will make impossible to provide emergency care or to provide daily care, and the public will feel the need for water and food. The possibility of freezing should also be considered.
- bring many lethal cases that are related with the health care and emergency services because as well as with lack of food, water and risk of frostbite.
- Public stability. The public's psychological response to the power outage in the given scenario would be closely related to providing security for themselves and for their relatives. The challenges of everyday life will be related to the provision of everyday necessities - home security, food, warmth and availability of information. 1-month power outage would bring much higher demand for a variety of health care services based on the lack of water, food and possible frostbites.
- Due to the water and heat supply interruption deterioration of sanitary and hygienic conditions are expected, it may result in the outbreak of infection cases and diseases e.g. diarrhea. The outbreak of such cases may overload already existing health services.

### *Identified vulnerabilities, existing efficient barriers and proposals of measures*

The following vulnerabilities were identified in the assessment:

- Water circulation in the hospital's internal networks will be interrupted, no warm water will be available. Water supply interruptions can cause an outbreak of diseases.
- Without electric power, it will not be possible to cook warmly, but the food reserves will quickly deteriorate due to a break in the operation of the refrigerators.
- In winter, due to the interruption of heat supply, it will not be possible to provide the all necessary rooms heating during the winter.
- Communication will become problematic. The possibilities of using the means of communication will be limited. Exchange of information will be difficult.
- The availability of transport services due to lack of fuel reserves may be impaired.

The following measures have been identified that could effectively reduce vulnerability to power outages

- Fuel reserves for diesel generators
- Testing of the available alternative power systems
- Development of an alternative power supply system for the provision of inner heat supply

Based on the risk and vulnerability assessment, following measures are proposed:

- Creating or increasing fuel reserves;
- Evaluation of electrical wiring systems to ensure proper backup power supply;
- Creation of new connection points for additional generators;
- Creating a detailed plan for full evacuation of hospital patients
- Creating an alternative communication (notification) system;
- Developing alternatives for water supply.

# 5. Way forward

In parallel, while city of Valmiera was conducting this assessment, State civil protection system was developed. SFRS created two tools (Potential Hazard Catalogue and Methodology for Risk Assessment) with purpose to educate the disaster management subjects and develop a common approach for the submitted risk assessments. Risks assessment methodology structure used in MEREPUV project is strongly similar to SFRS developed methodology for risk assessment, therefore finding this project can be modified and implemented in national risks assessment.

Since findings of this assessment are closely relevant to main tasks for municipalities in field of civil protection this material and analytical approach can be used by SFRS as a for other municipalities during training for other civil protection commissions of the co-operation territories.

Evaluation, facts and the findings of city of Valmiera assessment as well as possible proposals for measures to improve the prevention of harmful effects in case of power outage, are transferable and usable in other cities, by adjusting parameters of certain areas of impacts. For example, in other cities, water extraction pumps may already be equipped with additional generators to provide full water supply, so there is no need to look for additional ones.

Basically, results of city of Valmiera assessment only once more emphasizes the importance and dependence of nation electricity grid for municipalities when ensuring the basic social needs for citizens.

# 6. Assessment of degree of achievement of projcet objectives

SFRS responds positively to city of Valmiera's contribution to the project. During the project it was observed that the staff of the city of Valmiera competence develops with every organized expert meeting, high sense of responsibility from Valmiera city side, was an integral part of cooperation. City of Valmiera already at the beginning of the project directly highlighted effects of electrical power outage for urban vital societal functions (accesability to health services, water and heat provision).

In the course of the project, vulnerabilities for societal functions was accurately described, hence consequences and uncertieties identifies and possible improvements to reduce the probable consequences were identified.

In the work with the citie of Valmiera vulnerability assessments, contributing participant were intredused with the national civil protection mechanism. The tasks and responsibilities of municipalitie for the citizens regarding civilprotection were explained. As it was stated in intreduction of workingpaper, an cross-sectoral meetings were organized, therefore, it can be argued that overall understanding between different stakeholders with different responsibilities was improved. Almost could claim that these assessment served as a prelude for multiharad risk assasment, and it certainly strengthened quality of further developed risk assessments.

ISBN 978-82-7768-492-5 (trykket utgave)
31.10.2019