MEREPUV

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

MEREPUV

Summary of vulnerability assessment from Stavanger

Deliverable no: 2.3 Stavanger

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1 Introduction

This paper sums up the main findings from Stavangers` risk and vulnerability assessment of direct and indirect effects of power outage on critical electronic communications systems in Stavanger. The vulnerability assessment is conducted as part of the *MEREPUV*[1] project.

As described in the Grant Agreement part B, the general objective of the project is 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 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.

The focus in the MEREPUV project is risks related to power outage in cities, and vulnerability to such disruptions in health services, emergency services and critical communications systems. Each of the cities participating in the project have 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. Bergen, Dordrecht and Valmiera have studied direct and indirect consequences of the scenarios on health services. Oslo have examined consequences for emergency services, and Stavanger have focused on consequences for electronic communications services.

The aim of the project 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.

Overall goals of the project and the vulnerability assessment are further described in annex 1.

[1] **Me**thods and measures to enhance **re**silience against electric **p**ower outage in **u**rban **v**ital societal functions

2 Methodology and data collection

The assessment is performed in accordance with the bow-tie method. For a detailed description of the method reference is made to annex 2.

An important part of the analysis process has been involvement of different stakeholders. Several meetings, including four expertseminars with essential private, local and state stakeholders, has been arranged. The expert seminars are described in Table 1.

A brief description of the external key actors is given in Table 2.

Table 1 Expert seminars

	AGENDA	STAKEHOLDERS
EXPERT SEMINAR 1 OCTOBER 16TH 2018	The following themes was discussed: • Electronic communications in the City of Stavanger • How power outage may affect electronic communications • Critical input factors for electronic communications • Barriers to protect electronic communications services against power outage • Cooperation with Nkom	The following stakeholders were represented: • Nkom • The City of Stavanger (Section for emergency planning, Section for digital services)
EXPERTSEMINAR 2 NOVEMBER 6TH 2018	The following themes was discussed: • Long-term loss of power in major cities (NVE) • Regional and local power supply (Lyse Elnett) • Loss of power and consequences for electronic communications services (Nkom) • Cascading effects	The following stakeholders were represented: • Nkom • NVE • County Governor of Rogaland • Lyse Elnett • The City of Oslo • The City of Stavanger (Section for emergency planning, Section for digital services, Department of health and welfare)
EXPERTSEMINAR 3 DECEMBER 6TH 2018	The following themes was discussed: • How power outage may cause impact on electronic communications • Welfare technology in the City of Stavanger • How loss of electronic communications affects welfare technology	The following stakeholders were represented: • The City of Stavanger (Section for emergency planning, Section for digital services, IT department, Section for technical home-services, Section for welfare technology, Department of Communications, Section for Smart City)

	AGENDA	STAKEHOLDERS
EXPERTSEMINAR 4 JANUARY 7TH 2019	The following themes was discussed: • How power outage may cause impact on electronic communications • How loss of electronic communications affect the ability to communicate with the public	The following stakeholders were represented: • Lyse Elnett • The Police • DSB • Rennesøy municipality • Finnøy municipality • The City of Bergen • The City of Stavanger (Section for Public Service, Department of Communications, Section for Smart City, Department of health and welfare, Stavanger emergency medical centre (Legevakten), Section for emergency planning, Section for digital services)

Table 2 Description of external key actors

KEY ACTOR	DESCRIPTION
Nkom - Norwegian Communications Authority *Nasjonal kommunikasjonsmyndighet*	Nkom supervises providers of post and telecommunications services and makes decisions pursuant to the Electronic Communications Act and the Norwegian Postal Services Act.
NVE - The Norwegian Water Resources and Energy Directorate *Norges vassdrags- og energidirektorat*	NVE bears overall responsibility for maintaining national power supplies.
DSB - The Norwegian Directorate for Civil Protection *Direktoratet for samfunnssikkerhet og beredskap*	DSB's overall task is maintaining a complete overview of various risks and vulnerability in general. DSB's responsibilities cover local, regional and national preparedness and emergency planning.
County Governor of Rogaland *Fylkesmannen i Rogaland*	The County Governor is an important link between central government and the municipalities, and performs tasks on behalf of several different ministries and directorate / supervisory authorities.
Lyse Elnett	Lyse Elnett is the local grid operator to 11 municipalities in the southern Rogaland. Lyse Elnett is responsible for developing, operating and maintaining the electricity network in the region.

Scenarios

The vulnerability assessments conducted by the norwegian citizes are based on four scenarios developed by DSB and NVE. These scenarios are described in

Table 3.

Table 3 Brief description of scenarios

DESCRIPTION
Scenario 1 Electrical power outage 24 hours Sunday night 29 December 2019 the electrical power suddenly disappears in the City of 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 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 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.
Scenario 4 Electrical power outage for one month Night to New Years Eve December 2019 the electrical power suddenly disappears in the City of Stavanger. After two weeks electricity rationing is implemented. Access to electrical power is regained for all citizens in the municipality 28 January, after one month. It is cold outside during the whole period with temperatures between -5 and 0 degrees celsius.

An electrical power outage will immediately have consequences for electronic communications services. Hence, the City of Stavanger has defined additional scenarios (power outage for 2, 4, 6, 8 and 12 hours) which has been discussed in the expert seminars. The assessments are included as a part of *Scenario 1*.

DSB has, in collaboration with the Norwegian cities, decided not to include scenario 4 in this summary, as there are no significant changes from scenario 3 (power outage for 1 week) to scenario 4 (power outage for 1 month).

3 System description of the analytical object

Description of the societal function electronic communications services

The societal function electronical communications comprices electronical communications through commercial networks and Nation-wide TETRA – network (*Nødnett*), which is the states infrastructure for mobil communication for emergency services and other emergency actors.

In line with the project description, this assessment focuses essentially on electronic communications services through commersial networks, including:

- Landline telephones
- Mobile (voice, data and messages)
- Fixed broadband

Nation-wide TETRA – network (*Nødnett*) is included in the assessments when this is regarded as especially relevant. The Government has decided that the next generation of *Nødnett* will be realized in the commercial mobile networks.

Central terms used in this assessment are presented in the bullet points below (definition in accordance with the Electronic Communications Act section 1-5):

- **Electronic communications:** Transmission of sound, text, pictures or other data using electromagnetic signals in free space or by cable in a system for signal transmission
    - E.g. signals for the transmission of telephone calls or SMS
- **Electronic communications network:** Electronic communications system that includes radio equipment, switches, other connection and routing equipment, associated equipment or functions
    - E.g. networks for mobile or landline telephony
- **Electronic communications service:** Service that wholly or primarily comprises conveyance of electronic communications and that is normally provided for a fee.
    - E.g. broadband services, telephone services or SMS services

Description of the roles and responsibilities for the electronic communications services

The Norwegian Communications Authority (Nkom) is the sector authority for the electronic communication sector. Nkom is an autonomous agency of the Ministry of Local Government and Modernisation. Nkom supervises providers of post and telecommunications services, manages frequencies and numbering resources, investigates ex ante competition problems in the electronic communications markets and makes decisions pursuant to the Electronic Communications Act and the Norwegian Postal Services Act. Nkom also manages the duty of confidentiality in electronic communications and works on security and readiness.

The electronic communications infrastructure is owned and operated by private actors (e.g. Telenor). Today there are more than 200 providers in mobile telephony, broadband, fixed-line telephony, etc. in the Norwegian telecommunication market. These telecommunications providers are supervised by Nkom.

Electronic communications providers have a legal obligation to notify Nkom of significant outages or other events that may severely impact networks and services. Nkom will, depending on the severity of the event, prepare a situation report and notify relevant agencies such as DSB, NVE and the County Governors affected by the event.

Central legal framework

Central legal framework regulating the electronic communications services in terms of preparedness in case of power outage are listed in Table 4.

Table 4 Central legal framework

LEGAL INSTRUMENTS	DESCRIPTION
Electronic Communications Act *(EKOM loven)*	The standard of justifiability means (among other things) to provide proper emergency power (§ 2-10)
Electronic Communications Regulations *(EKOM forskriften)*	When recovering after shutdown, customers with responsibilities for citizens life and health should be given priority before commercial consideration (§ 8-4)
Classification Regulations *(Klassifiseringsforskriften)*	Emergency power for a minimum of 2-3 days (class A, B and C) (§§ 4 and 10)
Decision on backup power supply requirements in land-based mobile networks *(Reservestrømvedtaket)*	Emergency power for minimum 2 or 4 hours in mobile networks (depending on population in the area)
Programme for strengthened electronic communications *(Program for forsterket EKOM)*	Reinforcement of mobile networks in vulnerable areas with emergency power for a minimum of 3 days
The Regulations of priority in mobile networks *(Forskrift om prioritet i mobilnettene)*	Prioritize customers with important societal functions
National Security Act *(Lov om nasjonal sikkerhet)*	Object security and basic national functions

4 Results of the assessment of power outage

An electrical power outage will immediately have consequences for electronic communications services. Electronic communications services, as we use in our daily life, will to a large extent be unavailable after 2-4 hours. Hence, most of the assessments are documented under Scenario 1: *Electrical power outage 24 hours*. To avoid repetition, only changes from the previous scenario are documented for the other scenarios.

Scenario 1 (Electrical power outage 24 hours)

Does the electrical power outage affect input factors critical for electronical communications services?

The most critical input factor for electronical communications is power supply. Hence, a power outage will have major impact on electronic communications services.

Electronic communications are totally depended on power supply to function. Components in the transport networks (*transportnett*) and in the core network (*kjernenett*) are more robust and better secured against power outage then components in the access network (*tilgangsnett/aksessnett*). If the operator get access to fuel, a minimum of operations of the transport network / core network most likely will be maintained in affected areas. Access to fuel, especially diesel, is a critical factor in case of long-lasting power outage. Lack of, or rationing of fuel, will give significant societal repercussions.

The access network / access points will typically shut down within hours, when the battery back-up is empty. Back-up power for the electronic communications infrastructure is regulated in the *Classification Regulations* and the *Decision on backup power supply requirements in land-based mobile networks*. According to the *Decision on backup power supply requirements in land-based mobile networks,* base stations for mobile network shall as a minimum have emergency power for 2 or 4 hours, depending on the population in the area.

In case of a power outage it does not help if the components in the networks are secured with backup power generators or batteries, if the subscriber's equipment don't have power (e.g. telephone, router). Actors dependent on uninterruptedly power supply must ensure back-up power to critical equipment. For electronic communications to function, all parts of the infrastructure must be powered. Power outage in the City of Stavanger are unlikely to affect the core network or transport network (depending on cause). However, this has no matter of significance in this analysis, since the analysed scenarios will affect the access network and the power supply to the user equipment. As described above, well-functioning electronic communications requires all parts of the infrastructure to work.

An illustration of the electronic communications infrastructure is presented in Figure 1. On the right side we can see examples of user equipment (computer and telephone). The access network connects the user equipment to the transport network. Important parts of the providers service are produced in the core network.

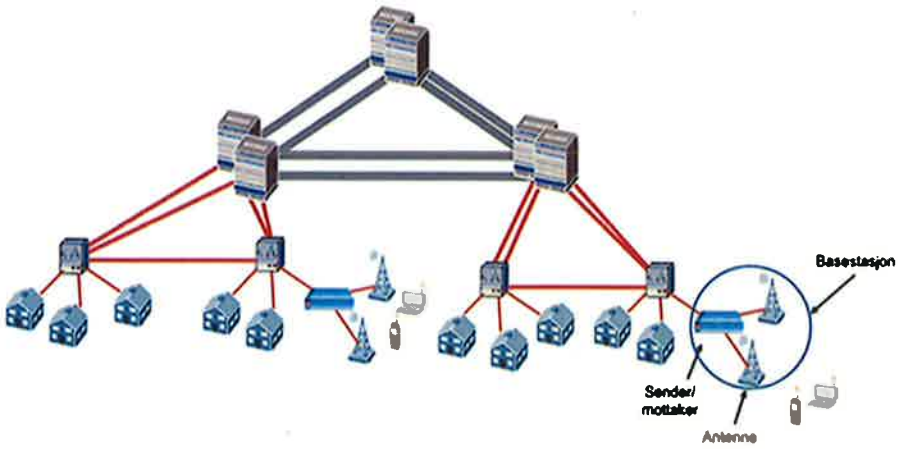

Figure 1 Electronical communications infrastructure (from Nkom presentation in Stavanger 6.11.2018)

Overall impact on electronical communications services

Electrical power outage for 24 hours will have major impact on electronic communications services.

In case of a power outage, most base stations for mobile networks will switch directly to back-up power. Hence, short power outage will most likely not affect consumers at all.

In accordance with the *Decision on backup power supply requirements in land-based mobile networks,* base stations for mobile networks shall as a minimum have emergency power for 2 or 4 hours (depending on the population in the area). When the base station(s) covering an area is out of power, the area will be without mobile coverage.

Several base stations in the City of Stavanger are directly connected to centrals in the transport network. These centrals have backup power generators with several days of fuel. Base stations connected to a central will function as long as the central have power.

Based on this, it is considered that most areas in the City of Stavanger will have mobile coverage the first 2-4 hours after a power outage. After 2-4 hours, most base stations will run out of power, and there will only be mobile coverage in areas covered by base stations directly connected to one of the centrals. The same premises apply for mobile voice, data and message services.

A SIM card from one operator will only provide access to that provider's network unless that operator also has domestic roaming agreements with other operators to provide additional coverage. Likewise, a subscription with a foreign operator provides access to those networks where the operator maintains international roaming agreements with operators abroad. However, calls to emergency number 112 will go through regardless of subscription, as long as there is network coverage from any operator in the area.

A situation where the majority of the base stations are out of order may cause overload for the remaining base stations. In such a situation a priority subscription may be a good investment.

Under certain conditions, analogue landline telephone systems based on copper wires (PSTN/POTS) will remain functional during a power outage, given that they are connected to a telephone central with electrical power. Digital technologies such as those provided over fibre require electrical power supply in the home. Broadband will not be functional since routers require electrical power supply in the home, regardless of technology. The number of PSTN/POTS landline telephone system

subscribers is decreasing, and the system is being phased out in favour of IP-based telephone systems and mobile networks.

The City of Stavanger, by illustrator Egil Bjørøen, has prepared a set of drawings to illustrate how a power outage will impair electronic communications services. During the analysis process, we became aware that several actors find it a little difficult to understand and analyse risk and vulnerability related to electronic communications outage. We hope the drawings can contribute to make this topic a little easier to understand.

The picture below illustrates an ordinary day in the City of Stavanger, where families are at home watching television and chatting with friends on *Snapchat* and *Messenger*.

EN VANLIG FREDAGSKVELD I STAVANGER

Sunday night 29 December 2019 the electrical power suddenly disappears in the City of Stavanger. User equipment without back-up power, such as computer screens and television screens, immidetely turns black. Mobile services (voice, data og messages) will function as long as the base station(s) covering the area has back-up power.

STRØMMEN GÅR

After four hours there will only be mobile coverage in areas covered by base stations directly connected to one of the centrals.

24 hours without power will to a large extent affect electronic communications services. As described above, most of the commercial electronic communications services will be unavailable 2-4 hours after loss of power.

Cascading effects

Norway is one of the leading countries in digitization of societal functions and has to a great extent made itself dependent on electronic communications services. Almost all other vital societal functions rely on electronical communications, and disruption can quickly lead to chains of negative impacts and severe consequences for citizens.

The City of Stavanger identified on an early stage in the process a need to delineate the analysis. We decided to perform an overall assessment of how electronic communications outage impacts the following societal functions:

- Supply of fuel and food
- Water and wastewater
- Financial services
- Transport

In addition, two subjects; welfare technology and resident communications are analysed in more detail.

Electronic communications outage will have a significant impact on most vital societal functions. Crisis management at all levels becomes demanding when most of the electronical communications stop working. It gets hard to reach out with important information to the residents when information channels like internet, radio and television breaks down. Emergency services becomes challenging when telephones stop function and alarm centrals and *Nødnett* have reduced capacity. Ill and injured may not get help fast enough. All welfare technology services included in this assessment are depended on an operative mobile network to function. The services will stop working as intended, when there is no longer mobile coverage.

Failure in the financial service will cause great challenges for businesses and the residents. Both ATMs and terminals in the stores will be affected.

The electronic communications outage will cause great challenges for the transport sector, as all railway departures and commercial flights will be cancelled. The outage will cause major delays in the road traffic, and some roads and tunnels will be closed. The maritime traffic will also be affected.

Consequences for societal values

Electronic communications outage is considered to have great consequences for life and health, as well as societal stability (which are the two assessed consequence classes).

Reduced possibility to alert the emergency services in case of acute incident, lack of opportunity to request ambulance in a regular way, inadequate communications and coordination between the emergency services and reduced efficiency and delayed patient care within the health- and care-sector, will have consequences for life and health.

Further, long-lasting electronic communications outage could lead to uncertainty and turmoil among the residents. The event could be perceived as surprising, frightening and strange, and lack of information will contribute significantly to the turmoil. The reactions can be amplified when people in emergencies don`t get in touch with the emergency numbers.

Electronic communications outage impacts critical societal functions like food supply, financial services and transport. This will lead to significant stress in the resident's daily life.

Electronic communications outage will have a reinforcing negative effect if the incident coincides with another incident, for example extreme weather or a major accident.

Scenario 2 (Electrical power outage 72 hours)

In case of an electrical power outage for 72 hours, there will only be mobile coverage in areas covered by base stations directly connected to one of the centrals. These base stations should be able to function as long as the central have power. Broadband will not be functional since routers require electrical power supply in the home.

The radio is the most important source of information in this phase. Based on relevant requirements, it is assumed that the radio will be operative for at least 6 days in case of a power outage. Note that the radio device must have its own back-up power to function.

Scenario 3 (Electrical power outage for one week)

It is uncertain whether the radio will function after 6 days (requirement regarding back-up power in network). Except that, there are no significant changes from previous scenario.

Uncertainty and steering ability

The quality and validity of the assessments depends heavily on input and contribution of relevant expert knowledge. The quality of existing knowledge used in the assessment is considered high. Power outage is a well-known and studied event. However, there are few examples of long-lasting power outage in cities, especially in the Western world.

In the scenarios it is assumed a situation with total black out in the hole municipality. This assumption has great impact on the results.

The analysis has identified efficient measures, of which can reduce the risk and vulnerability. Several of the measures are available at the local level for protecting citizens against severe consequences of power outage. Most of these measures are well known. Prevention and handling of this type of event requires many actors to collaborate. This requires arenas for collaboration, both on a vertical and horizontal level. Identified proposals of measures are presented in the next section.

Vulnerabilities and identified proposals of measures

A brief description of the most central vulnerabilities and proposals of measures identified in the analysis are summarized in Table 5. Each proposal is categorized as a preventive or preparedness measure.

A complete overview of vulnerabilities and identified measures can be submitted on request.

Table 5 Vulnerabilities and proposals of measures

VULNERABILITIES AND PROPOSALS OF MEASURES

Knowledge and awareness regarding power and electronic communications outage
There are few cases of prolonged power outage in cities. In 2002 the power in the Stavanger region were gone for 4 hours. This is the power outage with the longest duration since the war. Typically, the power is back within an hour. Hence, it is reason to believe that actors will await the situation and not initiate any special measures in an early phase of power outage (effective notification and mobilization of resources are possible the first 2-4 hours after a power outage).
 	
Preparedness measures:
 	
Short term:
• Establish procedures to ensure early notification of a power outage and information about the potential
  ○ *Responsible:* Grid company in cooperation with relevant stakeholders (e.g. municipalities)
 	
Long term:
• Increase the knowledge and awareness related to which consequences power and electronic communications outage can have for different actors and businesses
  ○ *Responsible:* Joint responsibility (no actor can archive this on his own)
• Relevant actors should discuss when to push the *big red button* in case of power outage (when should the society mobilize resources to handle this event as an emergency?)
  ○ *Responsible:* Relevant for collaborators, at several organizational levels

Alternative communications solutions
A power outage will affect commercial electronic communications services to a very large extent.
 	
Preparedness measures:
 	
Short term:
• Consider acquiring alternative communications solutions that can be used when ordinary commercial electronic communications services are out of function (e.g. satellite radio)
  • *Responsible*: Actors/companies with a need for communicating with people who are on different locations and tasks to be performed during a power outage
• Actors/companies should be familiar with each other alternative communications solutions, including relevant number. Numbers to alternative communications solutions should be included in notification lists
  • *Responsible*: Actors/companies with a need for communicating with people who are on different locations and tasks to be performed during a power outage
• Charging points must be provided for powered units (e.g. satellite radio)
  • *Responsible*: Actors/companies who has powered units
• Disruption of electronic communications services should be included in exercises (practice on using alternative communications solutions)
  • *Responsible*: Actors/companies with a need for communicating with people who are on different locations and tasks to be performed during a power outage

VULNERABILITIES AND PROPOSALS OF MEASURES

Information and expectations to the citizens

In the event of electronic communications outage, it will be challenging to provide information to the citizens.

The City of Stavanger must give priority to assisting the most vulnerable groups in society and the rest of the citizens must be able to take care of themselves. The DSB's preparedness campaign and Stavanger72 contributes to increase people's awareness of the vulnerabilities, and what they can do to take care of themselves during long-lasting events.

Preparedness measures:

Short term:

- Define assembly points that the citizens can visit during long-term loss of electronic communications, to get in tough with the emergency services and to get information. The citizens must be aware of these locations prior to an event
    - *Responsible:* The City of Stavanger has initiated a follow-up project and invited the emergency services to define assembly points and prepare guidelines

Preparedness measures:

Long term:

- Increase the citizens knowledge and awareness related to consequences due to electronic communications outage
    - *Responsible:* Joint responsibility (no actor can archive this on his own)

Cooperation

2-4 hours after loss of power, most of the commercial electronic communications services will be unavailable. This will make the handling of the situation challenging.

Preparedness measures:

Short term:

- Assess the need for co-location of actors who needs to collaborate
    - *Responsible:* The City of Stavanger will initiate a follow-up project and invite relevant stakeholders to participate, to assess the need for co-location in Stavanger

Long term:

- Consider whether today's organization is suitable for handling long-term events with potential to affect large parts of the society. Such events require an organization that can ensure adequate coordination and management of long-lasting events. This applies both in advance of an event and during the actual handling of the incident
    - *Responsible:* To be determined. The City of Stavanger will take the responsibility for further addressing this topic.

Planning

In case of a power outage, some buildings (areas) in the city will be given priority regarding power supply.

Preventive measures:

Long term:

- As part of the planning process, it should be considered whether buildings where vital societal functions shall be ensured, can be established in areas with high degree of redundancy (power, mobile coverage etc.)

VULNERABILITIES AND PROPOSALS OF MEASURES
Resources In case of a long-lasting power outage, many actors depend on fuel supply to maintain vital social functions. A power outage will affect several aspects related to diesel supply. Preparedness measures: Long term: • Consider assessing distribution, access and transportation of fuel in case of a long-lasting power outage   • *Responsible:* To be determined. The City of Stavanger will take the responsibility for further addressing this topic.

The story - How will a power outage impair electronic communications services?

On the next page, all drawings prepared by illustrator Egil Bjørøen are presented together as a story.

EN VANLIG FREDAGSKVELD I STAVANGER

STRØMMEN GÅR

4 TIMER UTEN STRØM

4 TIMER UTEN STRØM MED TILFØRSEL AV DIESEL

24 TIMER UTEN STRØM

72 TIMER UTEN STRØM

1 UKE UTEN STRØM

1 MÅNED UTEN STRØM

Way forward

The most critical input factor for electronical communications is power supply. Hence, a scenario with power outage will have major impact on electronic communications services.

Electronic communications are crucial in today`s society, since almost all other vital societal functions rely on electronic communications, and disruption can quickly lead to chains of negative impacts and severe consequences for citizens. Both DSB and NVE highlights the importance of increased awareness regarding consequences due to power and electronic communications outage. We hope this analysis can contribute to this.

There is a need for increased awareness both within companies responsible for critical tasks and among actors who must collaborate (*samvirkeaktører*) to handle long-lasting events with potential to affect the hole society.

Actors must have knowledge of how an electronic communications outage will affect their ability to perform tasks. Furthermore, it is crucial that necessary measures to reduce vulnerability are implemented and that actors 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 communications 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 electronic communications even stronger. The society's dependence on electronical services and vulnerabilities are well known. So why aren't we better prepared? Now it's time for action.

Stakeholders involved in the project have acquired knowledge from participating in the project. These actors are expected to be potential ambassadors for the project also after the assessment are finalised and will contribute to spread knowledge.

The work with this assessment has made the City of Stavanger more aware of what can happen in case of a power and electronic communications outage. Because of this, long-lasting loss of power and electronic communications will be highlighted in the revised risk and vulnerability analysis (*helhetlig risiko- og sårbarhetsanalyse*).

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, actors, companies and municipalities. The City of Stavanger has developed a plan for dissemination of the results to other cities and relevant stakeholders.

5 Experience with the method and process

Experiences with the method used

Power supply and electronical communications are the two vital societal functions with strongest mutual dependency. Hence, it has been challenging to evaluate electronic communications without simultaneous evaluate power supply. The scenario assessed in the analysis is power outage. Power supply is the most critical input factor for electronic communications, and back-up power is the most critical barrier for electronic communications. This dependency has made it challenging to document the analysis results in accordance with the report template without repeating the text.

The City of Stavanger's experience with the method, and adaptions that have been made, are described in section 1 to 4. The adaptions are summarized in the bullet points below:

- The City of Stavanger have defined additional scenarios (power outage for 2, 4, 6, 8 and 12 hours)
- Most of the assessments are documented under Scenario 1: *Electrical power outage 24 hours*. Only changes from the previous scenario are documented for the other scenarios
- The City of Stavanger has performed an overall assessment of how electronic communications outage may affect four societal functions. In addition, two subjects; welfare technology and resident communication are analysed in more detail.

Expert seminars

The City of Stavanger spent some time choosing the right people to attend the different seminars. All the partakers that has been invited to expert seminars have been positive and expressed willingness to participate. The experience is that partakers have contributed with relevant information, but also shared generously from their own experience.

The experience is also that it has been useful and informative to arrange expert seminars to discuss this type of theme. Loss of power and electronic communications are incidents which will affect the society at large which will require extensive cooperation to be handled. To gather to get an agreed understanding of how loss of power will affect electronic communications and how loss of electronic communications will affect other vital social functions are in our opinion invaluable.

Through the seminars we have gained knowledge on so many levels. Several of the identified measures are related to collaboration or require cooperation to be solved. All participants that have given feedback after the seminars have expressed that the seminars have been useful and informative.

Annexes

Annex 1 Joint objectives for project MEREPUV

The general objective of the project is 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.

Specific objectives:

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 actors` responsibilities in preventing severe consequences of undesirable incidents hitting 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

Annex 2 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 / electronic communications services is the analytical object in the model.

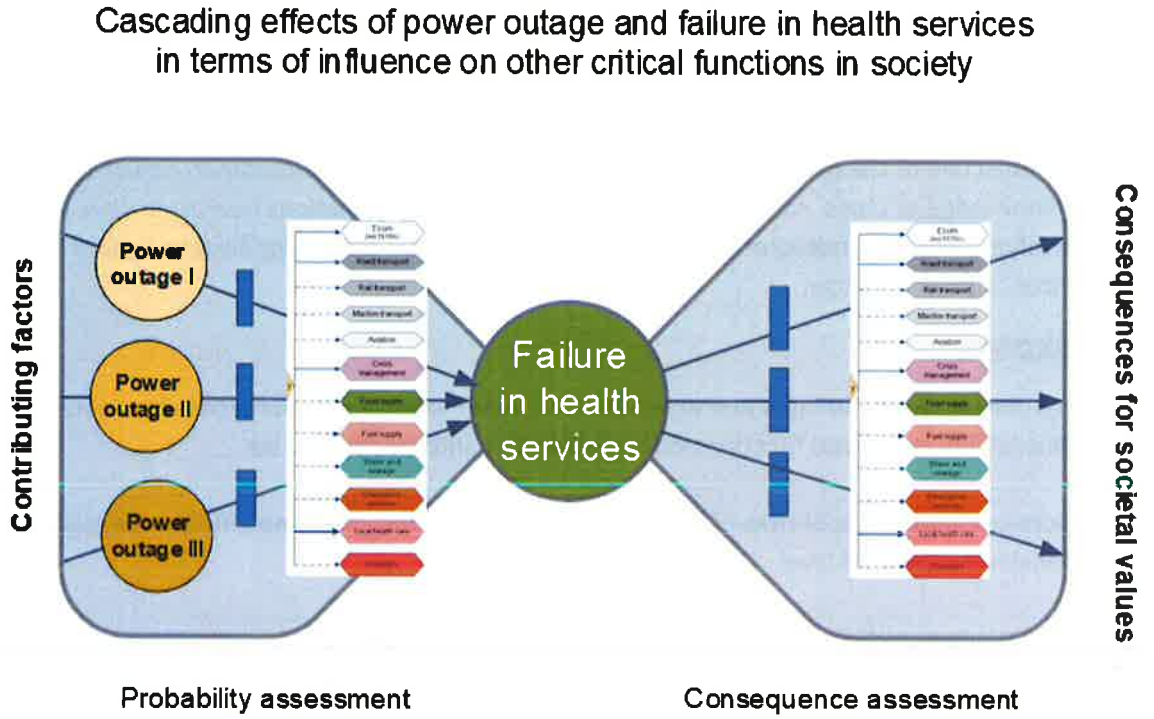

Figure 1. Risk and vulnerability assessment in four steps: 1) How do the scenarios affect other vital functions? 2) How does failure in such vital functions affect health services? 3) How does disruption in health services affect other vital societal functions (interdependencies) 4) What are the consequences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

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 probability: 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 severely 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 existing 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 addressed.