Oslo

MEREPUV | 2017/PREV/783153

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

MEREPUV

Summary of vulnerability assessment from Oslo

Deliverable no: 2.1 Oslo

Approved by head of Emergency Planning Agency:	Ann-Kristin Brunborg
Date:	08.05.2019

City of Oslo
Emergency Planning Agency

Funded by
European Union
Civil Protection

1 Introduction

Project MEREPUV is a project where the research is performed by professional actors to improve understanding on how long term disruptions in power supply will affect vital societal functions. MEREPUV has limited the scope of functions to investigate and the city of Oslo is researching the effect of power outage on rescue services.

The project is also researching what effect the strain on the rescue services will have on other vital societal functions and consequences to societal values.

There are 4 objectives set out to be fulfilled:

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.

2 Methodology and data collection

Method

The analysis has been done using a bow tie model designed for this project. A detailed description of the analytical model is annexed in annex 2.

Expert seminars

The municipality has conducted four expert seminars with rescue services. They have been organized as three seminars with one rescue service at a time where focus has been on gathering information: expert meeting 1 Fire service, expert meeting 2 Police and expert meeting 3 Oslo University hospital

The fourth seminar was a collective seminar with all rescue services (Police, Oslo University Hospital and the fire service), Civil defense, Hafslund and DSB. The focus was to show preliminary results, inspire conversation, presentations by the individual actors and gaining collective understanding.

Scenarios

The scenarios were chosen to increase the understanding of the impact of prolonged power outages, and how the rescue services were affected and if/when they were at risk of failing.
The municipality's assessments are based upon the expert meetings with the informers and the municipality's experience in addition to other sources. The scenarios researched have been 24 hour, 72 hour and 7 days power outage in mid-winter December/January.

Oslo municipality has chosen to examine scenario 1 most thoroughly. The other scenarios will only very briefly be referred to in the summary.

3 System description of the analytical object

The rescue service is organized as a collaboration between voluntary, private and public actors. The analysis is limited to the emergency services, the police, the fire service and the ambulance service, and thus does not treat other actors in the rescue service.

The emergency services are the core capacities and other actors act as supplementary capacity to the emergency services. The rescue services have an overall responsibility to provide lifesaving efforts. In some events, a service may have to contribute beyond its own area of responsibility to save lives where they are the first responder in an accident.

The services each have their own specializations and responsibilities, and coordination of efforts will often be necessary in incidents. In Norway, there is a handbook for the rescue service provided by the Police, which facilitate joint efforts and understanding of organization and rescue operations.

All the services have their own emergency centers that organize and alert units based on incoming information. The emergency centers are the link between the audience who call the emergency numbers, rescue management and the tactical personnel who carry out the effort.

All the rescue services' laws require effort in incidents, capacity to carry out the mission and the service they are to offer.

Common to all rescue services is the need for a stable and uninterrupted power supply. Regulation on electrical voltage (Fel) § 31 "Installations where interruptions in the power supply can cause danger to persons, domestic animals or property shall be planned and carried out so that maintenance, replacement, etc. can happen without danger.

If an unexpected power outage could cause danger to persons, domestic animals or the environment, the need for independent power supply should be considered."

Fel applies to all electrical installations below 1000V, regardless of whether these installations are situated in private residences or private or public enterprises.

Emergency power is clearly defined in Appendix I, 1 as a separate independent supply that is not from the normal grid the main power supply is from. $ 31 thus means that if unexpected power outages are associated with danger to persons, pets or the environment, emergency power solutions and / or other separate independent supplies should be considered.

Fire Service

The fire service is a specialized rescue service that has many capabilities in land and sea rescue, fire, chemical and accidents. The responsibility for the fire service is thus great. Fire services are organized as municipal enterprises. The first and foremost mission is to save lives, but the fire service must also protect property, environment and values. The fire service is performed as a municipal enterprise. Oslo fire and rescue services also possess national capabilities within urban rescue with the rescue group Urban Search And Rescue[1].

[1] Expert meeting 1 Fire and rescue

The fire service's tasks are anchored in Section 11 of the Fire and Explosion Protection Act. It is stated here that the fire service is to carry out information work on fire, fire protection, fire behavior and acute accidents. The fire service shall carry out fire prevention work, accident prevention work, response force for fire and acute accidents at land and sea, and arrange for sweeping and supervision of fireplaces. In addition, the municipality can define tasks based on risk and vulnerability analysis.

The fire service is required to organize 110 emergency centrals shall receive emergency calls from citizens, call out fire brigades and communicate with fire brigades during the operation and offer relevant support.

The fire service's emergency preparedness capacity is strongly rooted in the Regulations of the organization and dimensioning of the fire service. Due to Oslo's size, there is thus a requirement for keeping of teams in barracks and specific minimum requirements for the number of teams to be on duty.

Police

The police are responsible for enforcing law and order, which is a state enterprise. The police's responsibilities and goals are defined in Section 1 of the Police Act. The police shall prevent, enforce and assist the community through promoting and consolidating citizens' security under the law, safety and general welfare.

This shall be achieved through the execution of tasks in § 2 of the Police Act. It is described that the Police shall protect person, property and communal goods and protect all legitimate activities through 7 core tasks.

According to Section 27 of the Police Act, the police are responsible for implementing and organizing rescue efforts where life and health are threatened. Furthermore, the police are responsible for averting danger and limiting damage. The police are thus the overall responsible in crisis management. The Chief Rescue Officer at main rescue centers in Sola or Bodø is led by Chief of Police in their area, and the rescue management in the various local rescue centers is led by its district Chief of Police. This is stated in the Regulation Organizational Plan for the rescue service § 2-3 and § 3-4 and the regulation is anchored in the Police Act section 27. The police thus have a particular responsibility for rescue management from operational to organizational and local to national level.

The Police's 112 emergency centers are the leading center in triple alert incidents. These incidents can be alerted from any of the three emergency centers, but 112 will be the incident leader in these cases.

The police can be divided into four primary functions to cover their responsibilities: order, investigation, prosecution and rescue. To exercise and fulfill the responsibility, the police have developed a number of capacities.

Oslo is in a particularly strong position with a number of regional and national emergency resources located in Oslo and the surrounding area[2]. The police's emergency response unit, bomb squad and helicopter service are among them.

Health

The ambulance service and the 113 emergency center are part of the prehospital clinic at Oslo University Hospital. Hospitals are organized as state enterprises. Prehospital clinic specializes in emergency and rescue preparedness.

[2] Expert meeting 2 Police

Prehospital clinic works within the framework of a number of legislation and regulations that set provisions in a number of aspects of the service's organization and execution of the work.

The governing laws for organizing the service can mention: The Public Health Act, the Health and Care Act and the Specialist Health Services Act. The laws underline an obligation to provide necessary and vital health services to the population, promote public health, provide equal health services, confidentiality etc.

The personnel must also adhere to the Health Personnel Act, and the service is governed by a number of other laws such as the Health and Social Preparedness Act and the Mental Health Act. Furthermore, all information must be managed in accordance with the Health Register Act.

Underlying regulations will provide more detailed regulations of the services, and the hospital has established work instructions for employees based on the current framework.

Prehospital clinic has a large capacity with a large number of vehicles at its disposal for life-saving and acute efforts. The clinic also has regional and national emergency resources with the air ambulance. This involves both helicopter and fixed wing aircraft ambulances[3].

4 Results of the assessment of power outage

Scenario 1 – Power outage lasting 24 hours

INPUT FACTORS

Rescue services are dependent on many other external services or input factors in order to function in an optimal manner. Below are some of the most central input factors briefly described in terms of how they are expected to affect rescue services in the scenario. The external input factors are identified by using the DSB report "Vital functions in society"[4]

Water supply
Police and fire services will have little need for water supply in the scenario. All services do however need to supply personnel with water to maintain readiness.
The fire service has the opportunity to use emergency water from nearby fresh water lakes and rivers as a substitute for normal water supply for firefighting, without large strains on their efforts.
The ambulance service will have need for water supply for the cleaning of ambulances to prevent them from being taken out of service.

The water supply should not fail during a power outage as pumps, detection and rinse systems are powered by emergency generators. If it were to fail, it is not expected that the first 24 hours will have significant stress on the ambulance service if there was a lack of water supply.

Fuel supply
Fuel is critical for vehicles and emergency power generators and very high dependencies. The fuel supply and gas stations will seize to function, except a limited number of gas stations with emergency power. A fuel agreement has therefore been established by the police and ambulance services. Fire

[3] Expert meeting 3
[4] DSB 2017: Vital functions in society. What functional capabilities must society maintain at all times

services have no fuel agreement, but the fire services can manually pump from gas stations and fuel storages, as well as a limited storage tank at the port station.

ECom

There is very high dependency on telecom / data. Besides communication both internally and externally, ICT solutions are also used by tactical personnel. Telecom and data services will deteriorate and disappear altogether when the UPS to the mast is out of charge, leaving mobile phones not usable to communicate with. TETRA devices are essential for internal communication and will work in DMO[5] when the network fails. The fire service has also retained VHF.

Civil defense

The Norwegian Civil Defense is a national capability which can be requested to assist during crisis by other rescue services.

The Civil defense will be activated by the Police. The police will use the Civil defense to complement crews, utilize mobile emergency power, alternative communications and information center for citizens in cooperation with the municipality. The Civil defense is an actor that is supposed to mitigate hazards towards vital societal functions, and thus has some capacities to establish and maintain limited power supply and communications infrastructure.

Transport

Rescue services have very high dependency on functioning transport systems to reduce response time. Closed tunnels, and reduced accessibility due to queues, snow etc. will affect the initial effort to a high degree. Most tunnels should be able to operate conditional that there are no accidents or flooding, general traffic control like traffic lights and electric road signs will stop functioning and there are uncertainties connected to if road maintenance will maintain the ability to perform service if they are affected by the same fuel supply issues.

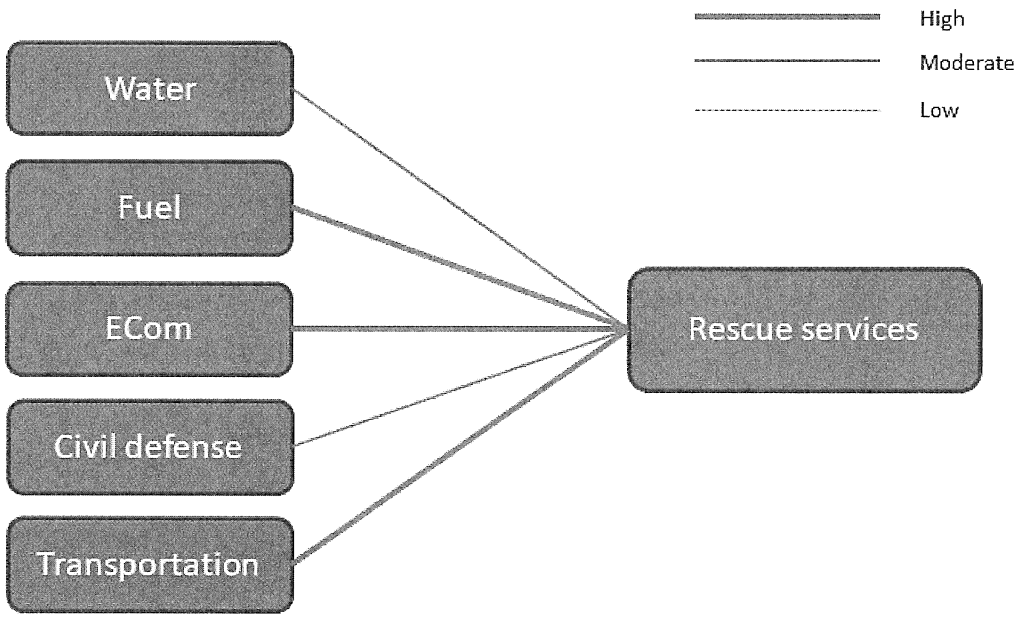

Figure 1 Input factors for rescue services showing degree of dependency

[5] DMO – Direct Mode Operation. The communication devices function directly between each other and do not rely on network to transmit and receive. DMO has limitations compared to the network capacity.

OVERALL IMPACT ON RESCUE SERVICES

The Police will depend on reassigning their resources to reinforce the operational personnel. Reassignments are also dependent on the operation center also being reinforced and that the communication lines are strengthened against their own personnel and against cooperating actors.

The fire service will depend on reassigning its resources to reinforce operational personnel and equipment. Reassignments are also dependent on the operation center also being reinforced and that the communication lines are strengthened against their own personnel and against cooperating actors.

Prehospital clinic will depend on reassigning its resources to enhance operational personnel and equipment. Reassignments are also dependent on the operation center also being reinforced and that the communication lines are strengthened against their own personnel and against cooperating actors.

The purpose of reassignments is to increase the detection capability and enhance communication and accessibility for citizens within their respective areas of responsibility. This will primarily take place within their own resources, but secondarily also through its cooperative actors, public and private.

In this section the aim is to outline the overall impact of the power outage on rescue services, both directly and indirectly due to disruptions in vital input factors.

Emergency power, backup power and UPS

The fire service has reserve power at their stations[8]. The reserve power should be able to maintain operation at the outage of normal power supply. Police and pre hospital clinics have emergency power function from their emergency units[9].

Emergency power and backup power generators rely on fuel supply to operate. This must be filled at regular intervals. All actors see that maintaining this over time can be challenging.

Reserve power covers the need for power beyond what the service is dependent on in order to function. Emergency power only covers what the service is dependent on in order to function. As this affects fuel consumption, strain and overhead on the generators, in addition to adding risk of failure from non-vital equipment and usage, rescue services should preferably use emergency power solutions.

Fuel

Prehospital clinic and the Police have fuel agreements[10]. Both actors have nevertheless expressed concerns about whether this can be regarded as real capacity. It is pointed out that there is really no governance and prioritization and one must at the ministry level before it rests a responsibility with someone. It is not known whether the Ministry has established a functioning routine for any practical management. Thus, the fuel agreements rest on; if the suppliers have the capacity to and actually deliver on all fuel agreements, does the suppliers prioritize agreements themselves, are there enough in storage that they can use in a shutdown and functional equipment to deliver on their contracts.

---

[8] Expert meeting 1
[9] Expert meeting 2 and 3
[10] Expert meeting 2 and 3

The fire service has no agreement, but has a limited tank at the port station and the ability to pump fuel itself[11].

No agreement has been entered into with fuel depot in Oslo which can be a good alternative to pick up from.

Communications
The rescue services have TETRA devices that will continue to operate as long as the batteries on the devices can be charged. After the emergency network has been dropped, the devices can function in the DMO - Direct mode operation - where the devices can then function directly against each other as long as they are in range of each other. The fire service still uses VHF and thus has an alternative to TETRA. There are separate DMO channels between the rescue services and other actors[12].

Emergency water
If the pressure in the water supply should decline or be lost during power outages, the fire service has the opportunity to collect water from freshwater lakes and rivers in Oslo[13]. This will cover the needs of the fire service. Other than their normal trucks, the fire service have two additional trucks with just water tanks. If there was a need to refill during an incident they would fill at the nearest source, also salt water if need be.

Aid
The rescue services are able to request assistance from other regions. This can add personnel and equipment that will provide a more resourceful and effective rescue service for crisis handling.

Civil Defense
All the emergency services can request the Civil defense if needed, but it is likely that this will mainly be governed by the police and local rescue center as the overall crisis leader[14] [15].

Police reserve
There is uncertainty attached to the police reserve and its real ability to respond to the incident[16]. The police reserve is not trained or used and has not been called in for major crises in recent times. There is potential that it can contribute, but it is uncertain whether this is a reliable capacity.

110, 112 and 113
The 110 center has reserve power. 112 and 113 have emergency power. The centers will function as long as the generators have diesel and are supplied with diesel. As long as cellular bases are functional, the public will have the opportunity to call emergency centers, but after a few hours this will be depleted of power.

112 and 113 have redundancy by automatically forwarding calls to other centers if they are unavailable. 110 have no forwarding. In the scenario this means citizens in peripheral areas within the municipality may have cell coverage from outside the municipality. No forwarding of systems with cooperative centers may impact the ability to help the caller. In scenarios where the outage is more localized to the 110 center location or other reasons for unavailability, is a more probable and may thus affect more callers.

---

[11] Expert meeting 1
[12] National Police Directorate (2018) *Common rules for network communications* – The Police' contingency system part II
[13] Expert meeting 1
[14] Expert meeting 2
[15] Communications with the fire service about requisition rights
[16] Expert meeting 2

The rescue services are now initiating cooperation between the various emergency centers where a representative from 110 and 113 will physically work from the 112 operations room[19]. This will provide direct communication between actors.[20]. In large incidents the communications channels will need to prioritize communications traffic and rescue efforts will take priority above other traffic types that does not relate to rescue of life and health.

Rescue services
Much of the rescue service's equipment can be maintained without power, but there are some critical dependencies:

- *The police:*

  Vehicle maintenance may be difficult without power tools and electronic diagnostics.
  They need to be able to charge electronic equipment to retain communication abilities and other important capacities.

- *Fire service:*

  Vehicle maintenance may be difficult without power tools and electronic diagnostics.
  Parking must be heated to avoid freezing of water on trucks. Air compression must deliver air to the brakes to their trucks to avoid several minutes delay on start up[21].
  They need to be able to charge electronic equipment to retain communication abilities and other important capacities.

- *Prehospital clinic:*

  Vehicle maintenance may be difficult without power tools and electronic diagnostics.
  Prehospital clinic must be able to wash and flush ambulances to avoid taking them out of traffic due to contamination considerations[22].
  They need to be able to charge electronic equipment to retain communication abilities and other important capacities.

Overall assessment
It has begun to become problematic for the rescue services to maintain their detection ability of fire and incidents. Automatic 110 fire alarm systems will start to waive and the public will begin to experience trouble contacting emergency centers[26].

The rescue services will experience some degree of internal communication problems and potentially some issues between the services and the crisis management, though unlikely it will render them inoperative.

The rescue service should be able to obtain the necessary fuel to the vehicles in the scenario[27]. It is likely that one will be able to supplement the generators with fuel either through fuel agreements or pumps from petrol stations / storage.

---

[19] Expert meeting 2
[20] National Police Directorate (2018) *Common rules for network communications* – The Police' contingency system part II
[21] Expert meeting 1
[22] Expert meeting 3
[26] Expert meeting 1
[27] Expert meeting 1, 2 and 3

The rescue services can request assistance from other regions that can provide with increased capacity to deal with the crisis.

The research showed that the rescue services had near identical perceptions of the dependency to and from each other, demonstrating that they expect and provide services in accordance with the others perceptions and needs of them.

- At this time, the degree of impact is considered moderate.

DISRUPTIONS IN RESCUE SERVICES – IMPACT ON SOCIETAL FUNCTIONS

It is assumed that moderate disruptions in rescue services will not affect many other vital societal functions. In example disruptions in rescue services will typically not affect ECOM-services, water supply etc. Instead it is expected that disruptions in rescue services primarily will have consequences directly on life and health and social stability.

The rescue services have a very critical societal role. The police have overall responsibility for the security and safety of the population and are the leading actor of efforts in rescue[28]. Fire services can handle major accidents and fires and prehospital clinic will handle immediate life-threatening incidents.

The rescue services will be able to reinforce their own services with the assistance of other districts in their own service or through efforts by other actors in the overall rescue service.

A reduction of the police effort will affect the rescue service's overall rescue effort. In the absence of the Police, the rescue work will thus suffer.

If there were reduction in prehospital clinics efforts it will have major consequences for the population. The absence of rapid response to life-saving efforts could lead to loss of life that could have been saved. In addition, many who may incur long-term injuries that could have been avoided with immediate treatment. Both the police and the fire service will notice that ambulances will not assist in operations anymore. Operations such as smoke diving require an ambulance present during the mission, and will now have to consider the risk and feasibility of the assignment in the absence of medical treatment on site[29].

If the fire service were to experience reduced service, it would be significant for fire protection and citizens' safety. There are automatic measures such as automatic extinguishing by sprinklers and inergen gas. Some actions will depend on power for detection to be triggered, the actual trigger and others are purely mechanical. These are also not measures that exist everywhere or give ample ability to extinguish fires with certainty.

There is also industrial safety in some selected places. They will be able to handle smaller incidents themselves, but will not necessarily be equipped for large incidents and therefore dependent on the fire service[30].

The societal values social stability and life and health will be under severe stress by failure of the rescue services. Reducing the communication and mobility capabilities of the rescue services will lead to high stress on the societal values.

---

[28] Police act § 27
[29] Expert meeting 1
[30] Expert meeting 1

A reduced ability in the organizations is likely to occur, with a focus on maintaining rescue services. The stresses are considered moderate and will come in the form of a lack of telephone contact with rescue centers and redeployed personnel from administrative tasks such as investigation and supervision.

DISRUPTIONS IN RESCUE SERVICES DUE TO POWER OUTAGE – CONSEQUENCSE FOR SOCIETAL VALUES

Life and health

Life and health are measured in presumed dead and injured / sick. The data are difficult to estimate based on past events as the basis of experience. Oslo has experienced several smaller power outages in geographical areas or functions as single events. Since Oslo has not experienced a prolonged power outage of the entire city in recent times, there is limited value from the newer experience. In the case of power outages, society has either had the ability to use alternative solutions or refrain from specific functions for a shorter period. Estimates are thus based on information from MRA[31]. MRA scenario of telecom outage bases estimates from NRA[32] scenario and reviews them for local consideration. The estimates is based on that citizens are not able to call for emergency services and expected to increase linearly on a daily basis. It uses the same brackets as MRA for very low to very high consequences.

- It is estimated that there will be a 10 deaths (low), 50 injured and sick (low) that could have been avoided if the rescue services were in normal operation.

Social stability

Social stability is measured in social and psychological reactions (social unrest) and stresses in daily life.

The time aspect is pointed out as a key factor. It is a short time for stresses and challenges to make them felt in a high degree, though the stress is not negligible. By meeting the crisis actively and early, contingency systems that will sustain functions a few hours into the crisis, winter time which will probably cause people to seek protection from the elements rather than gather in the streets are considered to be factors that will reduce risk of turmoil and rioting[34].

The rescue services have high confidence to that the crisis will bring about cohesion between local residents. Without direct comparison, the cohesion is specifically mentioned after July 22 and the traditional communal spirit which one often associates with national identity[35]. It is difficult to determine how much this can be weighted in the assessment, but cannot be ruled out as possible consequence.

- It is assessed there will be a low degree of social unrest and stress in daily life.

[31] Municipal Risk Analysis Oslo (2017)
[32] National Risk Analysis
[34] Expert meeting 1, 2 and 3
[35] Expert meeting 1, 2 and 3

Scenario 2 (72 Hours) and scenario 3 (7 days)

The general result from the considerations and assessment of the two other scenarios indicate a gradual worsening of the situation both for rescue services and life and health. The research indicates that some resource will become available just a few hours into the crisis, but most will be functional between 48 to 72 hours. There are uncertainties regarding at which stage the rescue services and also the population will start to get accustomed to the situation, but it is assessed that normalization process, in large, will start when the resources are available at 48 – 72 hour.

Uncertainty

Power outages are a known phenomenon. What is unknown is the extent of the consequences in perspective of time, number of inhabitants affected and the number of functions affected.

There are relevant data from Norway, but the degree of transferability is low. There are, for example, previous power outages in Oslo, but limited in scope. There are several places where there have been extensive power outages, but this is in districts that have little degree of comparability in handling, impact and number affected by the crisis.

The most relevant data is abroad. They can nevertheless be challenged as they have other prerequisites for the cause, handling and impact of the crisis. For example, in 2003 Italy experienced a very extensive outage in September[44], a Mediterranean country that will provide completely different conditions with temperatures, culture, crime, build-up of energy production, grid design and its capacities and more.

Two events that show direct contradictions but have a high degree of comparability with each other in many aspects are the power outages in New York (and other states) in 1977 and 2003. In 1977, there was extensive plundering shortly after the power outage started, while 2003 went by relatively peacefully. Some of the assumptions are cultural problems, current societal problems and unsuccessful social policies which in 1977 led to the widespread looting[45].

The events show that extensive power outages are very vulnerable to a number of factors other than the actual outage itself and are unpredictable. There is a lot of potential in dealing with the crisis early in order to prevent instability in society, which was learned in 1977 and used in 2003. In modern times we are much more dependent on electricity than we were in 1977, but at the same time the outage in 2003 shows that it potentially does not necessarily lead to greater consequences in itself.

The scenario is very sensitive to a number of factors, such as;

- An intentional act such as a coordinated attack will have great potential for influencing social and psychological reactions and affecting societal stability to a very high degree. This can change a number of conditions for the rescue services.
- A scenario placed in the summer will also mean that the citizens have less need to protect themselves from the weather.

---

[44] Union for the Coordination of the Transmission of Electricity (UCTE) (2004) *FINAL REPORT of the Investigation Committee on the 28 September 2003 Blackout in Italy*

[45] Greenberg, D. (2003) *Where have all the looters gone?*

- Changes in the winter with stronger and milder cold periods are a factor that can lead to major changes in consequences even in an exclusive winter scenario.
- If a new crisis were to occur during the crisis, this could be a catalyst for increased social unrest

The power outage can be predicted in a number of different directions based on past events and potential events. This means that the uncertainty is very high. It will be important to be able to take into account the different outcomes that may happen and meet the crisis with a perspective and dimensioning for the worst possible outcome in order to be able to control the crisis in the best possible manner until one has achieved control and predictability.

STEERING ABILITY

By steering ability we refer to whether there are efficient and well known measures of which can reduce the risk and vulnerability.

Rescue services can increase control over the scenario by ensuring access to fuel beyond an agreement that will not necessarily secure access in itself if a crisis arises. Such as an agreement to use fuel depots to directly retrieve fuel.

The police cooperate with several actors. To formalize a contingency plan for handling long-term power outages with a cooperative actor such as the municipality and Civil defense will improve the chances for dealing with the crisis successfully.

The analysis indicates that steering ability can be increased by securing the necessary resources for the rescue services. It can thus be beneficial for the rescue services to have clear requirements for maintaining the emergency preparedness in prolonged power outages. Something that can be defined as requirements for emergency power, scope of service to be maintained, over how long it must be maintained and requirements for fuel agreements and / or fuel storage.

Vulnerabilities and measures

The analysis points to the following vulnerabilities:

- There is no redundancy on the 110 emergency center for connecting calls to other 110 centers.
- Conditional normal water supply stops functioning, access to water and drain during longer power outages.

Based on the analysis, the following measures are proposed:

• A collaboration should be established with other 110 centers that can receive incoming calls when telecommunications make 110 Oslo and Asker and Bærum become inaccessible for the population.
    - The fire service will be responsible for the implementation.

• Establishment of emergency power function for the fire service. By being able to separate only its emergency power requirement, the fire service will have the potential to reduce its fuel

consumption, as well as increasing overhead and reducing potential overload if other equipment had been connected in the reserve power provided.

- The fire service will be responsible for the implementation.

• Health has very high water consumption and can consider alternative solutions to be able to supply water to be able to wash textiles and vehicles to prevent reduction or discontinuation of service.

- This must first and foremost be explored by professionals within hospital and water operations before any potential solutions can be provided and implemented.

• The City of Oslo is an actor with many employees and resources. It is likely that the municipality can contribute with coordination and facilitation that can increase the security of the citizens in cooperation with the rescue services.

- Rescue services and municipality will need to come to agreement. Other actors may be relevant which will need their own cooperative agreements.

• Instructions for long-term usage of DMO or establish more DMO channels for use in power outages / outage of network.

- The National Police Directorate is responsible for the communications instructions.

• Ensure access to food and water through contingency agreements. The City of Oslo may be a collaborative actor to use, which with its suppliers supplements a large number of canteens and employees daily.

- The rescue services and municipality must reach an agreement.

WAY FORWARD

Unexpected findings and measures

- *Reserve power*
  It was unexpected to find the fire service has organized their backup power as reserve power rather than emergency power. Recommended measure to reconfigure it to emergency power is based on the need to provide the critical function of rescue service with top priority in power usage. During a prolonged power outage when it will not be vital to power computers or other commodities that will have little functional use in the scenario other than siphoning power. This will decrease the available power for the rescue service and increase fuel consumption putting unnecessary strain on both the rescue service and fuel needs.

  During discussions with the fire service they agreed with the point of view the municipality had and would investigate into how this could be changed. It is recommended that the municipality continues to follow up on the issue and is oriented about the status and progress.

- *Water consumption health*
  Oslo University Hospital have a very high water usage which they are very dependent on. As a worst case scenario the hospital cannot receive any patients if they cannot provide a clean environment, which includes textiles. The ambulances also have to some degree a high usage of textiles. If the ambulances cannot be cleaned after potential contagious hazards like bleeding

inside the ambulance, it cannot be used. However, there are alternatives such as delivery of textiles, ambulances and equipment from other areas with power and water supply.

The very high dependency to water supply could be challenged by prolonged power outages. If in example freezing occurs in water pipes they may have reduced or lost access to the water supply.

There are many unknown factors to this which has not been investigated in this analysis. The issue should be investigated in depth and identified at what point the water supply may fail and if there are scenarios such as prolonged power outage that would lead to such a failure of the water supply.

- *Fuel storage*
  There is not much local storage of fuel, to sustain rescue services in prolonged power outages. Except for the fire service which have equipment to manually pump fuel as a consequence of their rescue service needs, there are no other ability to manually pump amongst the rescue services.

  Police and prehospital clinic rely on fuel agreements to deliver in a power outage scenario. There are unclear responsibilities and roles for where prioritization of fuel agreements would come from, also what capacity the supplier would have in the scenario to deliver. It is considered important to research this issue.

5 Experience with the method and process

The analysis has been a very positive experience. To approach the issue from a professional angle offers new ways to understand the mechanics in and in-between the rescue services, while the rescue services are given the opportunity to communicate with each other about the scenario and increase their mutual understanding.

The municipality has benefited from being the professional performing the research. As a municipality with extensive obligation and commitment to its citizens, the increased understanding of how the rescue services will function during a crisis has been very positive. The insights has provided the municipality with new understanding of how the rescue services will focus their efforts which has revealed several aspects as where municipal efforts must be focused to harmonize with the rescue services efforts to provide a better and more complete service to the citizens.

Such insights can be exemplified in: fire rescue will focus personnel into rescue efforts, reducing focus on fire preventive measures. The municipality can focus personnel and resources towards informing citizens about fire hazards and fire preventive measures to reduce the hazard towards life and health.

The municipality can focus efforts towards particularly vulnerable groups in the society to reduce risk towards life and health. These are issues the municipality, fire service and Oslo University Hospital deal with normally. During a power outage the fire service and Oslo University Hospital must focus efforts towards rescue services and it will be natural that the municipality redirects personnel from jobs that will be incapacitated during a power outage to supplement the rescue services normal efforts.

The municipality is given a better understanding about cascading consequences and the strains the rescue services are put under, and a better understanding is reached that the municipality does carry a lot of responsibility to help resolve a number of issues during such a crisis. These have been issues that have been unbeknownst before, such as previous mentioned deeper involvement in dealing with fire preventive issues. Or the reaffirmation of issues more known or obvious, such as actively reduce social unrest and risk of crime through social measures in cooperation with the Police.

The analysis underlines the need for the municipality to provide common locations for the municipality and the rescue services to provide information to the citizens, and where the citizens are able to reach the municipality and the rescue services. Establishing and maintaining such locations will be a municipal responsibility where the rescue services are able to only provide with the necessary resources to maintain their presence. The municipality will also for the same reasons be responsible for establishing evacuation centers.

The municipality views the scenario to further anchor the rescue principles. The co-operation between actors is vital to secure enough resources to handle the crisis and coordination of resources to use them where they matter. A crisis of the magnitude of a prolonged citywide power outage will put a strain on all of society and it is vital that resources finds each other and cooperates to solve it the best possible way.

The analysis has been a learning curve to how wide or narrow to approach a subject and it is clear that limitations must be set. Though the municipality has had new knowledge gained about issues, the municipality has through set limitations learned what they do not know about yet. This gives the municipality the opportunity to focus efforts to issues that it does not know about or issues it needs a deeper understanding of. This is important for a professional actor as issues must be weighted by the municipality's needs, which may supersede academic needs.

Involvement of stakeholders

The City of Oslo involved the fire service, Oslo University Hospital and police in 3 separate, individual seminars and a 4th collective seminar with all actors including the Civil defense, Hafslund and DSB.

The individual seminars were information gathering, while the collective seminar was presenting preliminary findings for a preliminary review and fact check. The collective seminar was also used to let actors present themselves and capacities to other actors and encourage discussions and thoughts between the actors. The process was advantageous for all parties and new thoughts and aspects were brought up. Quality checks have been done during the process with either checking with the informants, their organization or checking with sources.

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

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

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

7. Better understanding of the municipalities` role vis a vis other actors` responsibilities in preventing severe consequences of undesirable incidents hitting urban vital functions

8. 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 / EKOM services is the analytical object in the model.

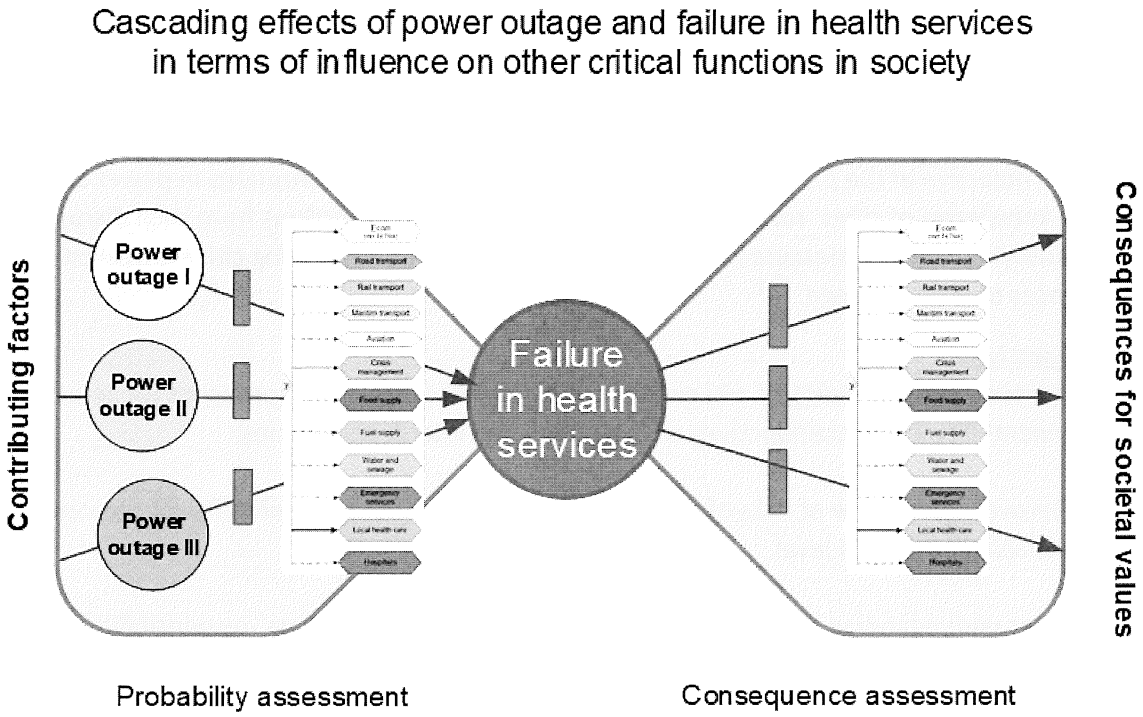

Figure 2. Risk and vulnerability assessment in four steps: 1) How do the scenarios affect other vital functions? 2) How does failure in such vital functions affect health services? 3) How does disruption in health services affect other vital societal functions (interdependencies) 4) What are the consequences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