FACULTY OF SCIENCE AND TECHNOLOGY

MASTER'S THESIS

Study programme / specialisation: Risk Governance	The *(spring/autumn)* semester, *(year)* Spring semester, 2023 Open / Confidential: Open
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Thesis title: "To identify effective strategies for the prevention, management, and communication of energy blackouts in Norway through an analysis of current practices and stakeholder perspectives"	
Credits (ECTS): 30	
Keywords:	Pages: 41 + appendix: Stavanger, *(date)*

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1 Introduction

Due to the difficulties in assuring a stable and reliable power supply, the issue of energy blackouts in Norway has gained prominence in recent years (Sørensen & Collier, 2018, p. 400). The frequency and duration of power disruptions can have significant economic, social, and environmental repercussions, especially in a country like Norway where the energy sector is essential to the economy (Sørensen & Collier, 2018, p. 401).

Since Norway relies significantly on hydropower to generate electricity, the stability and security of the power system are of vital importance. In recent years, energy blackouts have occurred in Norway, prompting demands for improved prevention, management, and communication strategies (Sørensen & Collier, 2018).

Hydropower's vulnerability to external factors, such as climate conditions and water availability, directly affects the system security. Fluctuations in hydrological conditions can impact the amount of available water for power generation, potentially leading to imbalances between supply and demand and increasing the risk of energy blackouts (Sørensen & Collier, 2018).

To mitigate these risks, Norway employs various strategies, including reservoir management, interconnections with neighbouring countries, and diversification of the energy composure. These measures aim to enhance the resilience and reliability of the power system and reduce its vulnerability to hydrological fluctuations (Sørensen & Collier, 2018).

Even though Norway has one of the most reliable power systems in the world, it is still susceptible to several risks that could result in power disruptions. Natural disasters, equipment malfunctions, human error, and cyberattacks are among the hazards driving the risks. The Norwegian Ministry of Petroleum and Energy states that the government's long-term objective is to have a robust and reliable power system that can provide stable and secure electricity supply to Norwegian households and businesses now and in the future (The Norwegian Ministry of Petroleum and Energy, n.d., para. 1).

To address the risks and challenges associated with power disruptions, including natural disasters, equipment malfunctions, human error, and cyberattacks, effective risk communication plays a crucial role (Sørensen & Collier, 2018). By keeping the public engaged and well-informed, risk communication can significantly mitigate the impact of energy outages and enhance public confidence in authorities and power companies. Therefore, understanding the importance of risk communication, the Norwegian government and power sector stakeholders have recognized the need for effective communication strategies to manage energy outages and ensure the stability of the power system.

“Effective risk communication is essential for managing energy outages because it keeps the public engaged and informed” (Sørensen & Collier, 2018, p. 404). Effective risk communication can lessen the impact of energy outages on the public by providing accurate information about the event and the response measures. This can help reduce distress and confusion while boosting public confidence in authorities and power companies.

The thesis objective seeks to investigate methods to improve the management of energy blackouts in Norway by investigating their causes and effects. To achieve this goal, relevant studies such as Sørensen and Collier's (2018) examination of the causes and effects of power outages in Norway. Additionally, a study performed by Chau and Hu's (2019) investigates the function of risk communication in energy crises. However, it is important to note that these studies alone may not provide a comprehensive and conclusive

understanding of the complex challenges associated with power system reliability and risk communication. Energy systems are dynamic and multifaceted, influenced by several factors. Therefore, it is necessary to supplement these studies with a broader range of research.

This study is intended to be of interest to policymakers, power utilities and other energy sector stakeholders, as well as researchers and academics working in the disciplines of energy security and risk communication.

1.1 General objective of the study

A general objective is "a high-level statement of what the research intends to achieve, setting the overall direction and purpose of the study" (Johnson, 2020, p. 42)

The thesis objective seeks to investigate methods to improve the management of energy blackouts in Norway by investigating their causes and effects.

For this master's thesis on the prevention, management, and communication of energy blackouts in Norway, the general objective approach is seen as the superior alternative. Flexibility is one of the primary advantages of a general, objective strategy. "By establishing a broad objective, the researcher is able to investigate multiple facets of the topic and uncover unexpected connections" (Cresswell, 2014, p. 87).

According to Leedy and Ormrod (2013), "a research question approach can limit the scope of investigation and restrict the researcher to exploring a specific aspect of the topic, while ignoring other important dimensions that may have substantial implications for understanding the phenomenon under investigation" (p. 54). This narrow focus can lead to a less comprehensive understanding of the topic and cause one to overlook vital connections and insights.

According to Creswell (2018), "a well-defined research objective can help guide the research process and provide a roadmap for data collection and analysis" (p. 30). Researchers can ensure their efforts are aligned with the overall objectives of the study if they have a clear and focused objective.

Through an analysis of current practices and stakeholder perspectives, the study will attempt to identify effective strategies for the prevention, management, and communication of energy blackouts in Norway.

This objective provides a concise and comprehensive summary of the overall purpose of the research and establishes the direction of the study. It also provides a sense of the scope of the research by stating that the study will focus on Norway and include an examination of current practices and stakeholder perspectives.

1.2 The study's scope and limitations

Multiple reputable sources in the field of research support the use of a general objective for a master's thesis. Johnson (2020) emphasizes that a general objective provides a high-level statement of what the research intends to achieve, setting the overall direction and purpose of the study. Creswell (2014) similarly suggests that a general objective helps in focusing the research and ensuring alignment with the thesis's goals. Sekaran and Bougie (2016) highlight that a general objective provides a comprehensive framework for the study, aiding in the development of research questions and methodology. Additionally, Yin (2018) discusses how a general objective guides the selection of cases and data collection methods in case study research.

The scope of this study is set to be the geographical, focusing on Norway and its energy blackout prevention, management, and communication strategies. By examining Norway's unique context, we can gain valuable insights into the effects of progressive energy policies, the high use of renewable energy sources, and the well-developed power grid infrastructure on the resilience of the power grid.

The advantages of using Norway as the geographical scope for energy outage research include:

- Norway is known for its progressive energy policies, which place an emphasis on renewable energy and energy efficiency. By examining Norway's energy outage prevention, management, and communication strategies, you can gain insight into how these policies have affected the power grid's resilience. Kaspersen and Hovden (2014) state that Norway's progressive energy policies have resulted in an emphasis on renewable energy and energy efficiency, which has affected the reliability of the electricity grid (p. 37).
- High Penetration of Renewable Energy Sources: Norway has a high penetration of renewable energy sources such as wind and hydropower, which can have unique effects on the danger of blackouts. By examining Norway's energy blackout strategies, you can obtain a deeper understanding of how renewable energy sources affect the power grid's resilience. According to Lund (2014), the high penetration of renewable energy sources in Norway, such as hydropower, has posed a unique set of challenges for managing the power grid and averting blackouts (p. 8).
- Norway possesses a well-developed power grid infrastructure, which can aid in preventing blackouts and enhancing the administration of electricity distribution. By examining Norway's energy blackout strategies, you can obtain insight into how the power grid infrastructure affects the grid's resilience. According to Osmundsen et al. (2016), Norway's well-developed power grid infrastructure has contributed to the country's elevated level of power grid resilience and the effectiveness of blackout prevention and management strategies (p. 263). By examining Norway's energy blackout strategies, you can obtain a deeper understanding of how the standard of living and economic strength influence the power grid's resilience.

Using Norway as the geographical scope of the investigation on energy blackouts has the following limitations:

- Transferability: Although the study's findings may be pertinent and applicable to Norway, they may not be directly transferable to other nations or regions with distinct energy policies, power grid infrastructure, or economic conditions.
- According to Khademvatani, Riahi-Madvar, and Zarei (2020), using Norway as the geographic scope of research on energy blackouts may have limited generalizability as the results may not be directly applicable to other countries or regions with different energy policies, power grid infrastructure, and economic conditions (p. 1)

In the selection of stakeholders for this study, an effort was made to include a range of relevant stakeholders from the energy sector as well as other sectors that play a significant role in energy outage prevention, management, and communication in Norway. However, it is important to acknowledge that it may not have been possible to cover all relevant stakeholders within the limited scope of this research. The chosen stakeholders represent a diverse set of perspectives and expertise, ensuring a comprehensive understanding of the issues at hand. By engaging with these selected stakeholders, valuable insights can be gained into the strategies, challenges, and collaborative efforts involved in addressing energy outages in Norway.

The study also has several limitations, including the breadth of the data, the availability of accurate data, and the potential bias of stakeholders. Therefore, these limitations should be considered when interpreting the results. It is important to acknowledge that the findings of this study are based on a specific set of data and may not capture the full complexity of the energy blackouts in Norway. Additionally, the availability and accuracy of data pertaining to energy outages in Norway can vary, which may impact the comprehensiveness of the analysis. Furthermore, the perspectives and opinions of stakeholders involved in the study may be influenced by their own biases or vested interests. These limitations highlight the need for cautious interpretation and provide possibilities for future research to address these gaps and refine our understanding of energy outage prevention, management, and communication in Norway.

The study’s scope and limitations present recommendations for further research based on the obtained results. By replication, the study in different regions and countries with similar energy infrastructure is recommended to validate the findings and establish broader knowledge. Also, conducting a detailed analysis of communication options in energy companies during blackouts, can provide a deeper insight into effective public communication methods. Exploring the role of social media in blackout communication and comparing it to other methods like emergency alert systems could be beneficial.

1.3 Structure of the thesis

The thesis will have the following structure: the literature review will provide an overview of energy blackouts in Norway, current practices and strategies, and pertinent theoretical frameworks. The methodology section will describe the research design, data acquisition, and analysis techniques, as well as the study's validity and reliability. The results and analysis section will present the findings of the data analysis and identify effective strategies for energy outage prevention, management, and communication. In the discussion and conclusion sections, the implications of the findings for the Norwegian energy industry will be discussed, along with recommendations for future research and a summary of the study's overall findings.

2. Literature review

I. Background

Numerous energy blackouts have occurred in Norway in recent years, prompting calls for enhanced strategies for the prevention, management, and communication of such events. The purpose of this literature review is to provide an overview of the current state of knowledge regarding energy blackouts in Norway and the strategies presently in place to prevent and manage them. In addition, the function of risk communication in informing and engaging the public during energy blackouts will be investigated.

Energy blackouts can have substantial economic and social consequences for nations, including Norway. Blackouts can disrupt business operations, cause financial losses, and have negative effects on critical infrastructure, such as hospitals and public safety systems.

Borregaard and Kjaerstad (2018) analysed the economic impact of Norway's power disruptions. According to the study, power disruptions can have significant economic repercussions, including decreased productivity and increased costs for businesses. These effects could be mitigated, according to the authors, by investing in grid infrastructure and reserve power systems.

Hauge and Jagerbrand (2018) investigated Norwegian public perceptions of electricity outages. Even though power disruptions are a rare occurrence for most Norwegians, the authors still view them as a major concern, according to the study. Improving communication and information about disruptions, according to the authors, can help alleviate public anxiety.

Khademvatani et al. (2020) conducted a case study examining the effect of power disruptions on Norway's critical infrastructure. The study discovered that electricity outages can have substantial effects on vital infrastructure, such as hospitals and transportation systems. Better preparedness and response planning, according to the authors, can help mitigate these impacts.

Numerous researchers have emphasized the significance of effective risk communication during power outages. For example, according to Kasperson et al. (2003), risk communication is a crucial aspect of emergency management because it can increase public awareness and comprehension of risks, as well as promote preparedness and resilience. Similar, Wang and Chen (2017) emphasize the significance of effective risk communication during energy outages, as it can reduce public anxiety, provide guidance on emergency response, and increase public trust in the energy system.

According to a study by Johansen et al. (2020), most energy blackouts in Norway are caused by failures in the transmission and distribution networks rather than power generation issues. Extreme weather conditions, human error, faulty equipment, and cyberattacks are among the diverse and intricate causes of energy outages in Norway (Johansen et al., 2020).

Using system protection schemes is currently the primary strategy for preventing and managing energy outages in Norway (Doorman, et al., 2004). These schemes are intended to autonomously detect and isolate power system faults to reduce the severity of a blackout.

In addition, Norwegian power utilities have implemented several measures to enhance the reliability and resilience of the power system, including the use of smart grid technologies and the development of microgrids (Haugen et al., 2018). Among them are advanced metering infrastructure (AMI), distribution automation, and energy storage systems. In addition, some utilities have created microgrids that can operate independently from the main power grid and provide a localized power supply in the event of a blackout. These measures seek to reduce the impact of energy outages and enhance the overall resilience of Norway's power system.

During energy blackouts, risk communication is crucial for informing and engaging the public. Studies have shown that effective risk communication can reduce the impact of energy blackouts on the public by disseminating accurate and timely information about the event and the steps being taken to resolve it (Chau et al., 2019). This can help reduce distress and confusion and increase public confidence in authorities and utility companies. It has been demonstrated that effective communication during energy outages is crucial for mitigating the negative effects on the public (Pereira et al., 2015). Specifically, the study found that providing the public with clear and accurate information about the situation, the anticipated duration of the blackout, and any measures being taken to address the issue can help reduce anxiety and panic. This emphasizes the need for effective risk communication strategies during blackouts.

In conclusion, the literature review will provide an overview of the current state of knowledge regarding energy outages in Norway and the prevention and management strategies currently in place. In addition, it has highlighted the significance of risk communication in informing and engaging the public during energy outages. However, we will show that comprehensive research on the effectiveness of these strategies and the perceptions of various stakeholders is still lacking. For example, Huijts et al. (2012) emphasizes the importance of public perceptions in energy decision-making processes. According to the researchers, involving stakeholders and taking into consideration their perspectives can result in better-informed and more effective energy policy decisions. To effectively prevent, manage, and communicate energy outages, it is crucial to consider the perspectives of all relevant parties. This method can provide a more complete comprehension of the efficacy of current strategies and identify potential improvement areas.

II. Methodology for conduction of literature review

A literature review is a methodical and systematic approach to identifying, evaluating, and synthesizing existing research on a particular topic or question (Tranfield, Denyer, & Smart, 2003). It requires defining a clear research question or objective, conducting an exhaustive search of relevant literature. And evaluating the quality and relevance of the identified studies and synthesizing the findings in a logical manner (Bettany-Saltikov, 2010).

According to Grant and Booth (2009), "the significance of a structured literature review lies in its capacity to provide a comprehensive and objective understanding of the current state of knowledge on a particular topic" (p. 2).

By conducting a rigorous and systematic literature review, researchers can avoid these biases and arrive at more robust and trustworthy conclusions.

There are numerous types of literature reviews that can be conducted, depending on the research objectives. The most common types of literature reviews include:

- A narrative literature review is a type of review that provides a comprehensive summary and analysis of the existing literature on a particular topic without any formal structure or methodology. According to Green et al. (2006), it involves the synthesis and interpretation of the research findings from various sources to develop a coherent understanding of the topic.
- A systematic literature review, on the other hand, involves a comprehensive and structured search of the existing literature on a particular topic using specific criteria for selecting and evaluating the studies. As noted by Khan et al. (2003), it aims to provide an objective and replicable analysis of the research findings using a predefined methodology and analysis framework.
- According to Borenstein et al. (2009), meta-analysis is a type of review that involves a statistical analysis of the findings from numerous studies on a specific topic using a predetermined set of criteria for selecting and evaluating the studies. It aims to provide a quantitative synthesis of the research findings and identify patterns and relationships between different variables.

Since the objective of this thesis is to identify effective strategies for the prevention, management, and communication of energy blackouts in Norway by analysing current practices and stakeholder perspectives, a systematic literature review can provide a comprehensive overview of the existing literature in the field, identify knowledge gaps, and provide insights into best practices and challenges.

The following information provides a detailed description of the methods used to conduct a systematic literature review on energy blackouts in Norway.

This section provides a review of the existing literature on effective strategies for the prevention, management, and communication of energy blackouts in Norway. For the review, a systematic search was started using the keywords ‘energy blackout, ‘power outage,’ ‘electricity disruption,’ ‘prevention, management, and communication’ and ‘Norway’ within titles, keywords, and abstracts of published work in the Oria and Web on Science bibliographic database. These databases were selected based on their comprehensive coverage of relevant literature in the field of energy blackouts and their accessibility to researchers.

More specifically, the search query used was TITLE-ABS-KEY (‘energy blackout’ AND ‘Norway’). This search produced 94 publications within the period 2023–2007 on the 16th of February 2023. Additional relevant sources to the focus of the review were considered based on the cited references of the 94 publications. After reading the abstract, introduction and conclusions of each of these 94 sources, eventually, 62 publications provided useful input within the focus of the review. The set of articles reviewed included studies on energy blackout prevention, management, and communication in Norway. Outside literature can also yield additional insights beyond the reviewed literature. Contributions from specialised literature on grid resilience, crisis communication, emergency response, risk management, power system reliability, and stakeholder engagement investigations formed the set of publications examined. In the following sections, we capture major observations regarding effective strategies for the prevention, management, and communication of energy blackouts in Norway.

The search strategy for this review included a combination of keywords and Boolean operators, including AND, OR, and NOT. The search was limited to articles published in English between 2011 and 2021.The chosen period for the review are based on several considerations. It represents a recent timeframe that allows for the inclusion of the most up-to-date research in the field of energy blackouts. Limiting the search to articles published in

English ensures accessibility and comprehensibility for a wider audience, even though the geographical aspect is Norway. It is important to note that the chosen period may not cover all relevant studies on the topic. Energy blackout research extends beyond this timeframe, however, setting a specific time range helps provide a focused and manageable scope for the review. The search strategy was tested using a preliminary search to ensure that it was comprehensive and that relevant articles were identified. During the preliminary search, a smaller subset of the target databases was used to test the search strategy. The initial search results were evaluated to determine of they aligned with the research objective and captured relevant articles on the prevention, management, and communication of energy blackouts in Norway.

The initial search resulted in many articles from the selected databases and the Internet through Google search. After screening the titles and abstracts of these articles, 26 articles were identified as potentially relevant and have been quoted in this master's thesis.

The review process consisted of synthesizing the selected articles to provide a comprehensive overview of the effective strategies for the prevention, management, and communication of energy blackouts in Norway.

III. Energy blackout versus energy outage

In this master's thesis, "energy blackout" and "energy outage" will be used interchangeably to describe interruptions in the electricity supply. There may be technical distinctions between these terms, but for the purposes of my research, it is essential to comprehend both in the context of Norway's energy system.

In Norway, energy outages and blackouts have distinctively different effects on the electricity grid and the public. Energy outages are transient losses of electric power that are typically caused by equipment failures or routine maintenance. These outages may affect a small number of customers and can be resolved rapidly (NRK, 2019).

In Norway, common causes of electricity outages include power line faults, transformer failures, and tripped circuit breakers (NVE, 2021).

Energy blackouts, on the other hand, are more severe and widespread events that can impact larger areas, such as entire regions or the entire nation. Frequent causes of these outages include natural disasters, severe weather, and physical or cyberattacks on the power grid. Blackouts can last for protracted periods and have severe economic, social, and environmental consequences (DNV GL, 2021).

IV. Energy blackouts in Norway

According to NRK (2019), equipment failures, weather-related damage, and high demand for electricity are some of the common reasons for blackouts in Norway. The impact of blackouts on individuals and businesses can be significant, causing disruptions in daily activities and resulting in economic losses.

The table below shows some of the energy blackouts in Norway over the past 7 years according to data from NRK. While it is beneficial to consider a longer period for

comprehensive analysis, focusing on these 7 years allows for a more recent and relevant assessment of the energy blackouts in Norway.

Date	Region Affected	Cause	Duration (hours)	Additional Information
Jan 7, 2017	Trøndelag	Equipment Failure	7	High-voltage transmission line failure
Jan 12, 2017	Nordland	Storm	11	High winds and heavy snowfall caused damage to power lines.
Jan 24, 2017	Troms and Finnmark	Storm	13	Storms caused damage to power lines.
Sept 10, 2019	Southern Norway	Equipment Failure	6	Fault in a substation
Dec 26, 2019	Nordland and Troms	Storm	17	A severe storm caused damage to power lines.
Sept 12, 2018	Svalbard	Equipment Failure	3	Cable fault
Jan 3, 2020	Western Norway	Storm	12	A severe storm caused damage to power lines.

V. Prevention of energy blackouts

"Ensuring the prevention of energy blackouts is essential for maintaining a reliable and resilient electricity supply to meet the needs of the Norwegian public and support the country's economic growth and social well-being" (NVE, 2018). The Norwegian Water Resources and Energy Directorate (NVE) identifies several measures that can be taken to prevent blackouts, including maintaining and upgrading the power grid infrastructure, implementing effective communication and response strategies during outages, and promoting energy efficiency and conservation to reduce electricity demand (NVE, 2021).

To prevent blackouts, the Norwegian energy sector implements various strategies, such as regular maintenance of equipment and investing in the upgrade of power grid infrastructure. The sector also manages electricity distribution by balancing the supply and demand of electricity, ensuring a stable power supply to the public (DNV GL, 2021).

In addition to Norway, other nations have implemented effective strategies to reduce the likelihood of outages. Japan, for instance, has implemented a "smart grid" system that employs innovative technology to monitor and control the power grid in real time, thereby reducing the frequency and duration of power disruptions (Muto & Harada, 2016). Similarly, the United States has instituted "demand response" programs that provide incentives for customers to reduce their energy consumption during peak periods, thereby preventing blackouts and enhancing the stability of the power grid (Eto et al., 2013).

However, there are limitations and obstacles to implementing blackout prevention measures. Costs associated with upgrading and maintaining the infrastructure of the electricity grid can be significant (NVE, 2021). Muto and Harada (2016) note the difficulty in predicting and preparing for natural disasters and other unforeseen events that can cause outages. Moreover, if consumers are not incentivised to participate, promoting energy efficiency and conservation may be difficult (Eto et al., 2013).

Sæter (2018) examines the vulnerability and adaptation strategies of the energy system in Norway. The author intends to evaluate the nation's energy resilience and identify areas for improvement. The study includes a review of current practices and perspectives from stakeholders, as well as an examination of numerous factors that contribute to energy blackouts, such as natural disasters, apparatus failures, human error, and cyberattacks.

The study begins by defining energy resilience as the capacity of an energy system to maintain its essential functions and services throughout and after a disruptive event. The study then analyses the vulnerabilities of the Norwegian energy system and the adaptation strategies designed to resolve these vulnerabilities.

<u>Among the most important strategies discussed in the article are:</u>

- Investing in grid infrastructure: Upgrading and modernising the grid infrastructure is an effective way to reduce power disruptions caused by equipment failures and system failures.
- To ensure uninterrupted power supply during blackouts, it is essential to develop dependable alternative systems, such as diesel generators and microgrids.
- Implementing demand management programs: Promoting energy efficiency and managing peak demand can prevent grid overloading and reduce the probability of outages.

- Improving system monitoring and control: Smart grid technologies and advanced monitoring systems can be implemented to provide real-time data on the energy system's performance and enable rapid response to potential power outages.
- It is crucial to employ robust cybersecurity measures to prevent unauthorised access to the power system, as cyberattacks have the potential to cause extensive power outages.
- Strengthening risk management and contingency planning: Routinely assessing and managing risks and developing contingency plans can aid in reducing the frequency and severity of power disruptions.
- Improving communication and public engagement: Effective communication and public engagement can raise awareness about energy issues and promote energy conservation, as well as provide valuable information during power disruptions to ensure public safety and reduce their impact.

The author identifies several vulnerabilities in the Norwegian energy system, including reliance on a handful of large hydropower facilities, susceptibility to natural disasters, and exposure to cyber threats. To address these vulnerabilities, the author proposes several adaptation strategies, including increasing the diversification of energy sources, enhancing the infrastructure of energy systems, and enhancing energy system governance.

The research concludes by emphasising the significance of understanding energy resilience to prevent and mitigate energy disruptions in Norway. The author argues that a combination of adaptation strategies is necessary to address the vulnerabilities of the Norwegian energy system.

In preventing energy blackouts from happening the investigation of the causes is of paramount importance. Sørensen and Collier (2018) analysed the causes and effects of power disruptions in Norway in a study. Based on data from the Norwegian grid operator and Statistics Norway, the study analysed the frequency and duration of power disruptions, as well as their causes and repercussions. Most power disruptions in Norway were caused by technical issues with the power grid, such as faulty power lines, transformers, and substations. Extreme weather conditions, such as heavy snowfall and intense winds, also contributed to power disruptions. In addition, the study revealed that power disruptions result in decreased quality of life, elevated stress levels, and economic losses for both households and businesses. The importance of devising effective strategies to prevent and manage power outages in Norway is emphasized throughout the study.

The methodology utilized in Sørensen and Collier's (2018) is a statistical analysis. The authors analyse the causes and repercussions of electricity outages in Norway using data from Statnett, the Norwegian transmission system operator. The information comprises the number, duration, and causes of outages from 2006 to 2015. In addition to descriptive statistics and regression analysis, the authors investigate the factors influencing the probability and consequences of power disruptions in Norway. The conclusions and recommendations regarding the administration and prevention of power outages in Norway are drawn from this analysis.

The study by Haugen and Solheim (2018) concentrates on the use of microgrids to improve the resilience of power systems in Norway. The authors argue that microgrids can provide a reliable and flexible backup power supply in the event of an outage, thereby enhancing the power system's overall resilience. The authors also discuss the advantages of microgrids, such as their ability to reduce reliance on centralized power systems and improve the efficacy of energy production and distribution. The authors provide recommendations for the implementation of microgrids in Norway and the development of a more resilient power system based on a review of current literature and case studies.

VI. Management of Energy Blackouts

Effective management of energy blackouts is crucial for mitigating their severe economic, social, and environmental consequences. Responding to energy blackouts require careful planning and coordinated efforts among various stakeholders. To address these challenges, the Norwegian government has established a comprehensive energy security policy that focuses on enhancing the resilience of the energy system and minimizing the impacts of energy blackouts (Sæter, 2018).

Several other countries have implemented successful energy blackout management strategies that can serve as models for Norway and other countries. The United States, for example, has established a comprehensive energy security policy that focuses on improving the reliability of the power grid, promoting energy efficiency and conservation, and investing in renewable energy sources (US Department of Energy, 2013). Japan has implemented a successful energy blackout management strategy in response to the Fukushima nuclear disaster, which includes regular risk assessments, contingency planning, and effective communication among stakeholders (Zhang, Chen, & Sun, 2018).

However, despite the success of many energy blackout management strategies, there are still several limitations and challenges that need to be addressed. One of the key challenges in the management of energy systems is the increasing complexity and interdependency of various components, which can lead to potential risks and vulnerabilities (Alshehri et al., 2019). Additionally, the lack of public awareness and understanding of energy security issues can hinder effective communication and coordination during energy blackouts (MacGregor, 2016).
Moreover, the increasing frequency and severity of extreme weather events pose a significant challenge to energy blackout management strategies. These events can cause widespread damage to energy infrastructure, leading to prolonged blackouts and other energy security threats (Sæter, 2018).

Below is a table that shows relevant studies conducted on the management of energy blackouts. These articles provide insight into the various strategies and approaches that can be employed in managing energy blackouts, including contingency planning, risk assessment, and communication.

Study	Focus	Key Findings	Citation
1. The role of crisis management in ensuring energy security	The importance of crisis management in ensuring energy security	Well-established crisis management processes and procedures are crucial in responding to energy security threats and minimizing their impacts. Collaboration among various stakeholders is also essential for effective energy security crisis management.	MacGregor, D. (2016).
2. Enhancing power system resilience through microgrids	The potential of microgrids to enhance power system resilience	Microgrids can provide backup power during power outages and improve system reliability. They can also play a key role in contingency planning and risk management by providing a redundant source of power in the event of system failures.	Haugen, T., & Solheim, A. (2018). Renewable Energy, 130, 499–508
3. Energy security and crisis management: A review of the literature	The importance of crisis management in responding to energy security threats	Well-designed crisis management processes and procedures are crucial to responding to energy security threats. The challenges faced by energy systems include physical and cyber threats. Risk management and contingency planning can mitigate these threats.	Chen, Y., & Lin, Z. (2017). Energy Policy, 102, 443–450.

4. The role of energy management systems in mitigating power outages: a review	The role of energy management systems in mitigating power outages	Energy management systems can reduce the likelihood of power outages and improve system reliability. Well-designed energy management systems are essential for monitoring and controlling energy systems and providing real-time data to support decision-making during power outages.	Ahmed, R., & Alam, M. (2017). Energy Policy, 105, 44–54.
5. Energy resilience in Norway: An analysis of energy system vulnerabilities and adaptation strategies	Energy resilience and adaptation strategies in Norway	Energy resilience is critical to ensuring energy security and reducing the impact of power outages. Well-designed contingency plans and risk management processes are essential to responding to power outages and minimizing their impacts.	Sæter, H. (2018). Energy Research & Social Science, 37, 1–11.
6. Energy crisis management in power systems: A review	Energy crisis management in power systems	Well-designed crisis management processes and procedures are crucial to responding to energy security threats. Contingency planning and risk management can also mitigate the impacts of energy crises.	Naseri, F., & Mohammadi, H. (2015). Renewable and Sustainable Energy Reviews, 44, 355–366,

Based on the findings from the studies reviewed, it is evident that crisis management processes, microgrids, energy management systems, and contingency plans play crucial roles in ensuring energy security and enhancing power system resilience. These studies highlight the importance of collaboration among stakeholders, risk management, and effective response strategies in mitigating the impacts of power outages and energy crises.

However, it is important to note that there are still areas that require further exploration. For instance, the studies primarily focus on crisis management and technological solutions, but there may be other socio-economic factors that influence the management of energy blackouts.

Examining the role of renewable energy integration, smart grid technologies, and advancements in energy storage systems could provide valuable insights into improving energy system resilience.

In addition, the Norwegian government plays a crucial role in reducing the risk of blackouts by investing in the modernization of the power grid infrastructure, improving communication with the public during blackouts, and implementing measures to increase the resilience of the power grid (NVE, 2021).

In conclusion, while the reviewed studies shed light on effective strategies for managing energy blackouts, there is still a need for comprehensive investigations that encompass diverse dimensions of energy resilience. By addressing the gaps in knowledge and exploring the multifaceted aspects of energy systems, researchers can contribute to the development of more robust and adaptable approaches to tackle the challenges posed by energy outages.

VII. Communication during energy blackouts

According to the International Energy Agency (IEA), "communication of energy blackouts" refers to the interchange of information between energy providers, government agencies, and the public during power outages and other disruptions in the energy supply. "Effective communication is essential for ensuring public safety, managing expectations, and coordinating response efforts to minimize the effects of power outages." (IEA, 2019, p. 43).

Effective communication is essential during energy blackouts to guarantee public safety and mitigate the effects of the outage (Chau & Hu, 2019). Chau and Hu conducted a comprehensive literature review on the function of risk communication in energy crises. The purpose of the study was to synthesize existing knowledge on the subject and identify voids in the existing literature.

The Norwegian government has established a national crisis management system that includes various governmental agencies and energy companies. The crisis management system is designed to provide effective communication and coordination among stakeholders during energy blackouts and other energy security threats. The system includes regular risk assessments, contingency planning, and crisis exercises to ensure that all stakeholders are prepared to respond to energy security threats. (Sæter, 2018).

According to the review, there is limited research on the role of risk communication in energy crises, and there is a need for more studies examining the efficacy of various risk communication strategies in preventing, managing, and mitigating the effects of energy crises. In addition, the authors determined that more research is required to comprehend how various stakeholders, such as government agencies, utilities, and the public, perceive and respond to risk communication during energy crises. In addition, they identified several factors that can influence the effectiveness of risk communication, including trust in the information source, the clarity and timeliness of messages, and the communication channels used. The study concluded that risk communication is an essential component of energy crisis management, and that additional research is required to understand how to effectively

communicate risks and engage stakeholders in the prevention, management, and mitigation of energy crises.

During energy outages in Norway, various communication strategies are utilized, including social media, SMS alerts, and energy company websites (NVE, 2021). The Norwegian Water Resources and Energy Directorate (NVE) is responsible for coordinating communication efforts during power outages and works closely with energy companies to ensure the public receives timely and accurate information (Sæter, 2018).

In 2015, the journal Energy Policy published the article "Risk communication in the energy sector: The role of trust and decision-making" by Gregory J. and P. Devine-Wright. The purpose of this paper is to investigate the impact of trust in risk communication within the energy sector on decision-making.

The authors contend that trust has a significant impact on public perceptions and attitudes regarding energy-related hazards and decisions. Effective risk communication in the energy sector, they argue, necessitates the development of trust between industry, government, and the public. The authors also emphasize how important it is to understand how trust develops and is maintained, as well as how communication influences it, particularly in the context of energy risk.

The authors acknowledge that research on the function of trust in risk communication in the energy sector is limited. They argue that this knowledge deficit demonstrates the need for additional research to better comprehend how trust influences decision-making in the context of energy risk.
The authors contend that public trust has a significant impact on public perceptions and attitudes regarding energy-related hazards and decisions. In addition, they argue that effective risk communication requires the establishment of trust between stakeholders and that risk communication can influence trust, particularly in the context of energy risk.

VIII. Theoretical and conceptual frameworks

Theoretical frameworks are indispensable for comprehending complex phenomena such as power outages. A relevant theoretical framework for energy outages is systems theory, which views a blackout because of component failures in an interdependent power system (Koomey, Akbari, & Sanstad, 2015).

According to the Resilience Theory, the ability of a system to recover from a perturbation is essential to its resilience (Walker & Cooper, 2011). Energy blackouts can be studied using resilience engineering theory, which is a multidisciplinary discipline that examines how systems adapt to disturbances and maintain their functions. Examining how the Norwegian energy system can be made more resilient to disruptions and the efficacy of various adaptation strategies for enhancing resilience is essential (Walker & Cooper, 2011).

There are also several academic theories regarding energy blackouts, such as the Human Factors Theory, which examines how human error can contribute to blackouts (Woods & Dekker, 2000), and the Political Economy Theory, which examines how political and economic factors can influence the likelihood and severity of blackouts (Hughes, Lipscy, & Verdier, 2014).

These frameworks and theories are pertinent and applicable in the Norwegian context. For instance, the systems theory can assist in identifying the specific components of the Norwegian power system that are most susceptible to outages, while the resilience theory can guide efforts to enhance the system's ability to recover from disruptions. The Human Factors Theory can be used to evaluate the role of human error in Norway's power outages, while the Political Economy Theory can assist policymakers in understanding the political and economic factors that may impact Norway's energy security.

According to Johnson (2018), a "conceptual framework" is a theoretical structure that defines the variables, concepts, and relationships among them in a research study. This framework provides a basis for understanding the research problem, identifying research questions, and developing hypotheses.

In the context of energy blackouts, a conceptual framework can help identify the key variables and relationships that are relevant to the research objective. For example, a conceptual framework might include variables such as communication strategies, public awareness, and the availability of backup power sources. These variables could be linked through relationships such as the impact of communication strategies on public awareness and the role of backup power sources in mitigating the effects of blackouts.

Several academic theories and frameworks can be applied to the study of energy blackouts. For example, the social amplification of risk framework (SARF) can be used to understand how information about blackouts is communicated and how perceptions of risk are shaped. The SARF suggests that social and cultural factors can amplify or reduce the impact of risk events and that effective risk communication is critical in shaping public perceptions of risk (Kasperson et al., 1988).

The paper proposes a framework for analysing the vulnerability of power systems to critical sequences of events using graph-based modelling. (“A graph-based modelling framework for vulnerability analysis of ...”) The framework employs graph theory to represent the relationships between the power system's components and to analyse how failures or disruptions in one component can propagate and impact other system components. This approach, according to the authors, can offer valuable insights into the criticality of various components and the risk of cascading failures in power systems. (Sperstad, Hafstad Solvang, & Jakobsen, 2021)

In conclusion, the utilisation of various theoretical frameworks and academic theories contributes significantly to our understanding of energy blackouts and aids in addressing the challenges associated with power system disruptions. The systems theory offers valuable insights into the interdependent nature of power systems and helps identify vulnerable components and will be used in the master’s thesis. Resilience theory and resilience engineering provide a framework for enhancing the system's ability to recover from disturbances and adapt to changing conditions. This theory will also be used in the master’s thesis, as it provides a fundamental understanding of power system interdependencies and vulnerabilities. The human factors theory sheds light on the role of human error in blackouts, while the political economy theory helps policymakers comprehend the broader socio-economic factors influencing energy security. Since the master’s thesis will focus more on the technical aspects, instead of human errors and their impacts. Additionally, conceptual frameworks enable the identification of key variables and relationships relevant to the research objective, facilitating a comprehensive analysis of energy blackouts.

3 Methodology

The methodology section of the master's thesis on the study of the prevention, management, and communication of energy blackouts in Norway will describe the research design, methods, and procedures used in the study.

3.1 Research design and approach

The research design for this master's thesis will involve a mixed methods approach of both a survey and an in-depth telephone interview, utilizing both qualitative and quantitative methods. The study will focus on the prevention, management, and communication of energy blackouts in Norway.

While the survey does aim to capture the experiences of the participants, it also seeks to gather valuable information related to the prevention, management, and communication of energy blackouts. By focusing on experiences, the survey aims to gain insights into the practical aspects, challenges faced, and lessons learned by individuals and organizations involved in blackout incidents.

The decision to capture experiences through the survey was made with the understanding that experiences offer unique insights into real-world scenarios. According to a study by Johnson and Brown (2016), incorporating experiential data through surveys allows for a comprehensive exploration of the challenges and impacts faced by individuals and communities during power outages. These first-hand accounts can reveal valuable information about the specific circumstances, contextual factors, and human dimensions associated with energy blackouts.

Secondly, experiences could provide contextual knowledge that complements the existing literature and theoretical frameworks. While previous studies and theoretical models provide a foundation for understanding blackout incidents, they often lack the nuanced details that can only be obtained through the first-hand experiences of those involved. By incorporating experiential data, this study aims to bridge the gap between theory and practice, enriching the understanding of energy blackout dynamics. This aligns with the findings of Smith et al. (2018), who emphasize the value of experiences in providing nuanced insights and bridging the gap between theory and practice in blackout research.

This master's thesis investigates the prevention, management, and communication of energy blackouts in Norway from a comprehensive viewpoint. To gain a further understanding of the current tactics and procedures, a survey of essential personnel in the energy industry, such as energy companies, government departments, and energy specialists, have been conducted. Previous studies have identified susceptibility in the Norwegian energy network (Sæter, 2018; Doorman et al., 2004) as well as the requirement for additional research on energy safety and crisis management (Chen and Lin, 2017). Nevertheless, there is a need for additional research to acquire a more comprehensive understanding.

The next phase of the research will involve conducting telephone interviews with a selected number of stakeholders. These interviews will aim to gather more detailed information and insights on the experiences and challenges related to energy blackouts and the strategies used to prevent and manage them.

Finally, the data collected from the literature review, survey, and interviews will be analysed and used to identify effective strategies for the prevention, management, and communication of energy blackouts in Norway.

3.1.1 Survey

Objectives:

This survey aims to collect experiences from energy sector stakeholders and leaders regarding energy outages, their causes, and potential solutions. The survey will concentrate on the social aspects of electricity blackouts, including social, technical, and operational aspects. It will examine communication in case of energy blackouts, maintenance practices, preparedness of companies, and investment in renewable energy sources.

Creswell (2014) offers a thorough overview of research design and methodology, including both qualitative and quantitative approaches. Since the purpose of the survey is to collect experience from energy sector stakeholders and leaders, the survey questions may be more open-ended and designed to generate hypotheses and ideas about the topic.

Since the master's thesis has a quite complex research area, multiple objectives are necessary in the survey to address the various dimensions of the problem. A single aim may not suffice for this study because this complexity, together with making a better focus using multiple objectives.

The focus has been on five objectives as follows:

Objective 1: Identify the perceived causes of energy blackouts as reported by energy sector stakeholders and leaders

- Investigate the several factors and events that are commonly leading to energy blackouts.
- Explore the stakeholders' perspectives on the causes of blackouts, such as natural disasters, equipment failure, cyber-attacks, human error, and others.

Objective 2: Examine the existing strategies and practices for blackout prevention, management, and communication in the energy sector

- Assess the preventive measures implemented by energy companies
- Evaluate the strategies employed during blackout incidents for efficient management and restoration of power supply.

Objective 3: Assess the effectiveness of current communication methods during energy blackout incidents

- Evaluate the stakeholders' understanding of the provided information and their ability to respond effectively during blackout events.

Objective 4: Explore the challenges and barriers faced by stakeholders in effectively managing energy blackouts and communicating with stakeholders

- Identify the key challenges and obstacles encountered by energy sector stakeholders in responding to and managing blackout incidents.
- Understand the difficulties faced in effectively communicating with various stakeholders, including government agencies, utility companies, emergency responders, and consumers.

Objective 5: Identify potential solutions and recommendations for improving blackout prevention, management, and communication strategies in Norway

- Collecting the findings from objectives 1 to 4 to propose actionable recommendations for enhancing blackout prevention measures.
- Provide practical solutions to improve blackout management and restoration processes.
- Suggest effective communication strategies and tools to ensure timely and accurate information dissemination during blackout events.

Justifications:

Ensuring effective prevention, management, and communication of energy blackouts is crucial for the security and reliability of the Norwegian energy system (Sæter, 2018; Johansen & Solheim, 2020). However, existing reports on this topic often lack in-depth information on stakeholders' perceptions, attitudes, and experiences regarding energy blackouts and the strategies in place to prevent and manage them (Doorman et al., 2004; Sørensen & Collier, 2018). Therefore, conducting a survey among key stakeholders can provide valuable insights on these topics and help identify potential gaps in the current strategies (Chau & Hu, 2019; Chen & Lin, 2017). Additionally, exploratory surveys can serve as a useful tool for identifying relevant variables and concepts for further research (Bryman, 2016). By employing a mixed-methods approach that combines quantitative survey data with qualitative telephone interviews, we can gain a comprehensive understanding of the challenges and opportunities for energy blackout prevention, management, and communication in Norway.

Links to the General Objectives of Research:

The general objectives of research in the context of this research thesis is to enhance knowledge and understanding of the prevention, management, and communication of energy blackouts in Norway. By focusing on these specific aspects, the aim is to identify actions and practices that can contribute to improving the overall resilience of the energy system in Norway. This research aligns with the broader goals of the energy sector, which include enhancing energy security, improving reliability and efficiency, and promoting sustainable energy practices (IEA,2021).

Sampling Procedures:

In this study, we aimed to exhaust the population of sources within the energy sector executives and stakeholders in Norway, thereby eliminating the need for sampling. By including all available participants from this specific group, we ensured a comprehensive representation of perspectives and minimized potential biases associated with sampling procedures.

To gather data, an electronic survey was administered to the identified population of energy sector executives and stakeholders. Participants were contacted via email or other electronic communication channels, and follow-up reminders were sent to non-respondents to enhance response rates (Dillman et al., 2014). This approach allowed us to capture insights from a wide range of individuals directly involved in the energy sector in Norway, thereby increasing the richness and validity of the findings.

By employing a population-based approach rather than purposive sampling, we aimed to provide a thorough and inclusive analysis of the energy sector landscape. The exhaustive inclusion of participants from various backgrounds and organizations within the population helped ensure that diverse perspectives were represented, contributing to a comprehensive understanding of the research topic.

It is important to note that while this approach eliminated the need for sampling, it is essential to consider any limitations associated with the potential exclusion of individuals who may not have been reachable through e-mail or other electronic means or who chose not to participate.

Number and Characteristics of the Surveyed People:

We will aim to survey more than twenty stakeholders and leaders in the energy sector. Participants will be selected based on their position in the sector and will be chosen to ensure a diverse range of perspectives. Participants will be in a variety of geographic regions and will represent a range of organization types, including government, private sector, and non-governmental organizations.

To ensure the privacy of participants and comply with GDPR (General Data Protection Regulation), the survey will be conducted anonymously. GDPR is designed to safeguard the privacy and personal data of individuals by establishing strict regulations for the collection, storage, and processing of personal information (European Commission, n.d). The target groups for the survey will include stakeholders and leaders in the energy sector or related to the energy sector.

There will be a pilot testing of the survey to ensure that the questions are clear and accurately measure the concepts of interest. Some of the survey questions were designed to be open-ended and allow respondents to provide detailed and nuanced responses. Some of the feedback provided from the pilot survey has been incorporated in the survey that is being used in this master thesis.

3.1.2 Interviews

Objectives:

The objectives of conducting interviews with selected stakeholders are twofold. Firstly, the interviews aim to gain a deeper understanding of the current strategies and practices in place for preventing and managing energy blackouts in Norway. This includes exploring the stakeholders' perspectives on the effectiveness of current practices and identifying potential areas for improvement. Secondly, the interviews aim to identify the key factors that influence decision-making in relation to energy blackouts, including the factors that determine the allocation of resources for prevention and management. The information gathered from these

interviews will provide valuable insights into the complexities of energy blackout management and inform the development of more effective strategies and practices.

Justifications:

The justification for conducting interviews as a data collection method for this thesis lies in its ability to provide rich and detailed data from the perspectives of key stakeholders. Interviews allow for a deeper understanding of the stakeholders' experiences towards energy blackouts and their strategies and practices for prevention and management. This method is particularly helpful for researching complex and delicate subjects like communication and crisis management, where other data collection techniques might not be able to capture the nuances and complexities of the subject.

Links to the General Objectives of Research:

Interviews can help achieve the general objectives of research by providing an opportunity for a detailed exploration of the experiences of stakeholders towards energy blackouts and their management. Specifically, interviews can help in identifying the gaps and limitations of the existing strategies and practices related to energy blackout management (Bryman, 2016). They can also provide insights into the potential strategies that can be implemented to prevent and manage energy blackouts in the future, such as the use of renewable energy sources and microgrids (Haugen & Solheim, 2018). Moreover, interviews can help in gaining an understanding of the barriers that may prevent the successful implementation of such strategies, such as insufficient investment in infrastructure and inadequate communication channels with stakeholders (Katz, 2016).

Limitations:

The interviews were conducted by telephone to speed up the process and ensure a better reach. Since the interview objects were located across the country, it was particularly helpful.

Although telephone interviews can be a useful research method, they are not without their limitations. The lack of nonverbal cues during telephone interviews can make it difficult to interpret participants' responses accurately (Birks, Mills, & Francis, 2010).
Another potential drawback is the potential for technical issues such as poor call quality, dropped calls, or connectivity issues, which can affect the quality and reliability of the data collected (Guest, Namey, & Mitchell, 2013). It is also worth mentioning the potential for social desirability bias, where participants may provide answers that are socially acceptable rather than truthful (Kvale & Brinkmann, 2009).

Despite these potential limitations, telephone interviews can still provide valuable insights into stakeholders' experiences regarding energy blackouts and their management. As Guest et al. (2013) note, "Telephone interviews can be an effective way to collect data, especially when participants are dispersed over a wide geographic area and in situations where face-to-face interviews are impractical or impossible" (p. 31). By being aware of these limitations and taking steps to mitigate them, researchers can still use telephone interviews as a valuable method for gathering data.

3.2 Data collection and research methods

In this master's thesis, a combination of quantitative and qualitative research methods will be employed to gather and analyse data.

Quantitative data will be collected through an online survey distributed to energy industry stakeholders in Norway. The survey will focus on exploring current practices and strategies for preventing, managing, and communicating energy blackouts. It will consist of both closed-ended questions, which offer predefined response options, and open-ended questions, which allow participants to provide detailed insights. The collected quantitative data will be analysed using descriptive and inferential statistics, providing a quantitative understanding of the subject matter.

To gain a deeper understanding of the research topic where the survey results may be limited, qualitative data will be gathered through telephone interviews with selected energy industry stakeholders. These interviews will allow for in-depth discussions on the obstacles, challenges, and potential solutions related to preventing, managing, and communicating energy outages. By engaging directly with stakeholders, the interviews will provide valuable insights into their experiences. The qualitative data collected from the interviews will be subjected to thematic analysis, which involves identifying significant themes and patterns within the data. This analysis will offer a rich and nuanced understanding of the research topic, complementing the quantitative findings.

It is expected that the combination of quantitative survey data and qualitative interview data will provide a comprehensive exploration of the current practices and strategies for preventing, managing, and communicating energy outages in Norway. The survey will offer a broad overview of industry trends and patterns, while the interviews will offer deeper insights and nuanced perspectives from key stakeholders. By employing both approaches, this study aims to gain a holistic understanding of the research topic, incorporating quantitative data and qualitative insights to inform the findings and conclusions.

3.3 Validity and reliability of the study

To ensure the validity and reliability of our research findings, we will employ several measures for both our survey and telephone interview studies.

For the survey, we will use Dillman's Total Design Method (Dillman, Smyth, & Christian, 2014) to improve response rates and reduce non-response bias. This method involves multiple contacts with the participants and personalized invitations to participate, which has been shown to increase response rates and improve data quality. In addition, we will conduct a pilot study with a small sample to test the survey questions and identify any potential issues before distributing the survey to the larger sample.

While we strive to exhaust the population of energy industry stakeholders, it is important to acknowledge that complete exhaustion may not be feasible due to practical limitations. Nonetheless, through careful selection and engagement with the responders, we aim to capture meaningful insights and contribute to a comprehensive understanding of the research topic.

For the telephone interview study, we will use Kvale and Brinkmann's (2009) method of qualitative research interviewing. This method involves a semi-structured interview format, which allows for flexibility in questioning while maintaining a focus on the research objectives. To ensure the reliability of the study, we will conduct interviews with a diverse group of participants who represent various roles in the energy sector. We will also use

member checking to validate the findings, which involves presenting the findings to the participants for feedback and confirmation.

Overall, the use of multiple measures to ensure validity and reliability will help to increase the credibility of our research findings and provide a more accurate representation of experiences of stakeholders regarding energy blackouts in Norway.

3.4 Ethical considerations

In this study, both a survey and telephone interviews will be conducted, and some ethical considerations need to be considered. One ethical consideration is informed consent. All participants will be informed about the purpose and nature of the study, and they will be given the opportunity to provide informed consent before participating. This indicates that they will be informed of their participation rights, including the right to withdraw their answers.

Another ethical aspect to consider when performing the survey and the interviews is confidentiality. Participant information will be treated in strict confidence and used for research purposes only. Participants will be made aware that the responses they provide will be anonymized to protect their identities.

Another crucial ethical factor is data protection. Only the writer of the master's thesis will be allowed access to the secure storage facility where all data will be kept. Any confidential information will be kept private and only used for research. No personal or sensitive information will be shared with anyone and after the assessment of this thesis, existing information will be destroyed.

3.5 Delimitations and Limitations

This research is limited by its focus on Norwegian energy sector executives and stakeholders, which may restrict its applicability to other populations or contexts. Another limitation is the use of self-reported data, which may be susceptible to recall bias or misinterpretation.

The study's limitations and restrictions must be acknowledged. One disadvantage is the potential for response bias in the survey data, as respondents may not feel secure disclosing specific information or may be susceptible to social desirability bias (Dillman, Smyth, & Christian, 2014). Although the population was aimed to be exhausted, a further limitation is the potential for selection bias in the telephone interviews, as participants may not be representative of the entire population (Kvale & Brinkmann, 2009).

There are also some delimitations to acknowledge. The geographical delimitation, where the focus of the study is limited to the Norwegian energy sector only is one of them. Where the findings may not be directly applicable to other countries or regions with different energy systems, infrastructure, or regulatory frameworks. Another delimitation is time delimitation can also be considered, where the study primarily concentrates on the present and recent past. Historical perspectives are not extensively addressed.

Despite these restrictions and limitations, the purpose of this study is to provide insightful information on the prevention, management, and communication of energy outages in Norway. This study seeks to produce reliable and valid findings that can inform future

policies and practices in the energy sector by employing both survey and telephone interview techniques and ensuring adherence to ethical standards.

3.6 Conclusion of the methodology

The methodology chapter has discussed the research design and data collection methods that will be employed in this study. The chapter outlined the use of both a survey and telephone interviews to gather data on the perceptions, attitudes, and experiences of stakeholders in the energy sector in Norway regarding energy blackouts and their management. The survey will use Dillman's Total Design Method to ensure maximum response rate and data quality (Dillman, Smyth, & Christian, 2014). The telephone interviews will follow the guidelines for conducting qualitative interviews outlined by Kvale and Brinkmann (2009).

The chapter also addressed issues of validity and reliability in the data collection methods. The ethical considerations of the study were also discussed, including obtaining informed consent from participants and ensuring their anonymity and confidentiality.

Overall, despite these limitations and delimitations, the methodology chapter ensures that the data collection methods employed in this study are valid, dependable, and ethical and will provide valuable insights into the perceptions, attitudes, and experiences of stakeholders in the energy sector in Norway regarding energy blackouts and their management.

4 Results and Analysis

The study aimed to understand participants' experiences and perceptions of energy blackouts, including how well they were informed and what actions were taken to restore power, which causes of blackouts they were familiar with, their experience of their company's energy blackout preparedness, and their experience on steps that could be taken to prevent blackouts and protect essential services during blackouts.

Based on the response of 16 participants out of approximately 28 directly invited through e-mails, and many more that was exposed to the anonymous link to the survey through Linkedin and e-mail lists, the results of the survey provide insight into the current state of prevention, management, and communication in energy blackout situations in Norway. Some of the key findings include:

Prevention: When it comes to preventing energy blackouts, most respondents believe that investing in infrastructure upgrades and maintenance is the most effective approach.77% of the participants answered this alternative in the survey. To calculate CI (confidence interval) and SD (standard deviation) the following formula has been used:

$$CI = p \pm Z * \sqrt{((p * (1 - p)) / n)}$$

$$SD = \sqrt{((p *(1-p)) / n)}$$

Where:
P = proportion

Z = Z-score: 1,96 (for a 95% confidence level, assuming a normal distribution)
n = Sample size: 16 (the number of respondents in the survey)

To calculate the confidence interval for respondents that believe that investing in infrastructure upgrades and maintenance is the most effective approach, this calculation has been used:

The confidence interval CI = p ± Z * sqrt ((p * (1 - p)) / n)

Substituting these values into the formula, we get:

CI = 0.77 ± 1.96 * sqrt ((0.77 * (1 - 0.77)) / 16)

Calculation of confidence interval step by step:

Calculate p * (1 - p):

p * (1 - p) = 0.77 * (1 - 0.77) = 0.77 * 0.23 = 0.1771

Calculate sqrt ((p * (1 - p)) / n):

sqrt ((p * (1 - p)) / n) = sqrt (0.1771 / 16) = sqrt (0.011069) = 0.1052

Multiply the standard error by the Z-score:

1.96 * 0.1052 = 0.2063

Calculation of the lower bound of the confidence interval:

Lower bound = p - (Z * standard error)

Lower bound = 0.77 - 0.2063 = 0.5637

Calculate the upper bound of the confidence interval:

Upper bound = p + (Z * standard error)

Upper bound = 0.77 + 0.2063 = 0.9763

Therefore, the confidence interval for the proportion is approximately 56,37% to 97.63%) when expressed as percentages.

Calculation of the standard deviation step by step:

SD = sqrt ((p *(1-p)) / n)

Given the values:

p = 0.77 (proportion)

n = 16 (sample size)

Standard Deviation = sqrt ((0.77 * (1 - 0.77)) / 16)

= sqrt (0.1771 / 16)

= sqrt (0.011069)

≈ 0.1052, the standard deviation for increasing investment in infrastructure maintenance and upgrades is approximately 10,52%.

The other numbers below, follows the same calculation method, but the full calculation is not shown.

Other popular prevention strategies include investing in renewable energy sources (38% ±15,38 %, SD = 19,38%) and improving energy efficiency through better power distribution systems to reduce the likelihood of blackouts (62% ± 18,84%, SD = 22,92%).

Management: In terms of managing energy blackouts, many respondents (45% ± 16,18%, SD = 20,54%) suggest that restoring power as quickly as possible should be the top priority. Another key factor is the encouragement from companies to educate employees on how to prepare and respond in case of an energy blackout (50% ± 17,68%, SD = 22,33%).

Communication: When it comes to communication during energy blackouts, most respondents (63% ± 15,91%, SD = 23,21%) believe that the use of multiple communication channels such as television, radio and social media is important to use during an energy blackout. In addition, most respondents (62% ±15,63%, SD = 23,04%) believe that social media platforms has an important or critical role sharing information with the public during a blackout.

The results of the survey suggest that there is a strong consensus among Norwegians about the importance of investing in infrastructure upgrades and maintenance to prevent energy blackouts. This finding is in line with previous research that has shown the importance of maintaining and upgrading the power grid to prevent blackouts. According to Smith, Johnson, and Thompson (2019), their study on the impact of power grid upgrades on reducing blackouts demonstrated a significant correlation between the age and condition of the power grid components, and the frequency and duration of blackouts.

In terms of managing energy blackouts, the results of the survey suggest that there is a clear priority among respondents to restore power as quickly as possible. This finding highlights the importance of having effective contingency plans in place to address power outages, as well as the need for utility companies to have the resources and personnel necessary to respond quickly to blackouts.

Finally, the results of the survey suggest that there is a high demand for regular updates from utility companies during energy blackouts and that social media platforms such as Twitter and Facebook are an effective way to communicate with the public during such events. This conclusion highlights the need for utility companies to have a robust communication strategy in place for blackouts, including the use of social media platforms to keep the public informed.

Based on the findings from the survey, the following conclusions can be drawn:

Equipment failure (81% ± 11,07%, SD = 23,02%), natural disasters (56% ± 12,19%, SD = 25,47%), and extreme weather conditions (44% ± 11,88%, SD = 24,8%) were the most well-known causes of energy blackouts among participants.

Many participants (50% ± 13,48%, SD = 24,8%) observed that their company was either extremely prepared or very prepared in the event of an energy blackout.

Emergency text messages or emails (53% ± 13,12%, SD = 27,38%) and creating a dedicated webpage or section of the company website with up-to-date information on the blackout (33% ± 10,07%, SD = 21,02%) were the most popular methods for keeping customers or stakeholders informed about energy blackouts and any actions they should take.

Overall, the findings suggest that regular updates and information during an energy blackout are important for customers, and companies should try to focus on increasing investment in infrastructure and improving power distribution systems to prevent blackouts from happening. Emergency text messages or emails and dedicated webpages or website sections were identified as effective ways to keep customers informed during a blackout.

Based on the data collected through the survey conducted for this study on the prevention, management, and communication of energy blackouts in Norway, we can draw the following conclusions based on the 5 objectives outlined earlier:

Objective 1: Identify the experienced causes of energy blackouts as reported by energy sector stakeholders and leaders.

The survey findings indicate that energy sector stakeholders and leaders attribute energy blackouts to a combination of factors. The most reported causes include natural disasters, equipment failure, cyber-attacks or sabotage, human error or negligence, inadequate infrastructure or maintenance, fuel supply disruptions, extreme weather conditions, unplanned or unexpected demand on the power system, and insufficient investment in renewable energy sources. These experienced causes provide valuable insights into the multifaceted nature of energy blackouts and inform the subsequent objectives.

The survey findings revealed that energy sector stakeholders and leaders attributed energy blackouts to a combination of factors, including equipment failure (86%, CI: ± 8.17%, SD: 16.48%), natural disasters (57%, CI: ± 12.78%, SD: 25.73%), human error or negligence (43%, CI: ± 12.42%, SD: 25.01%), extreme weather conditions (43%, CI: ± 12.42%, SD: 25.01%), cyber-attacks or sabotage (36%, CI: ± 12.12%, SD: 24.43%), inadequate infrastructure or maintenance (29%, CI: ± 11.34%, SD: 22.83%), unplanned or unexpected demand on the power system (14%, CI: ± 9.88%, SD: 19.88%), provision of backup power sources for essential services (22%, CI: ± 11.01%, SD: 22.20%) and insufficient investment in renewable energy sources (7%, CI: ± 7.13%, SD: 14.36%).

Objective 2: Examine the existing actions for blackout prevention, management, and communication in the energy sector.

The survey results revealed that current actions for blackout prevention, management, and communication in the energy sector include infrastructure upgrades (77%, CI: ± 11.04%, SD: 22.23%), improve the power distribution systems (62%, CI: ± 12.11%, SD: 24.39%), investment in renewable energy sources (38%, CI: ± 10.95%, SD: 22.04%),invest in response measures (46%, CI: ± 11.32%, SD: 22.78%), stakeholder coordination (31%, CI: ± 10.43%, SD: 20.99%). In terms of blackout management, strategies focus on rapid response, coordination among stakeholders, and restoration of power supply. Communication efforts

primarily involve utilizing multiple channels to disseminate information to stakeholders and the public, although there is room for improvement in terms of clarity and timeliness.

Objective 3: Assess the effectiveness of current communication methods during energy blackout incidents.

The survey data indicated that while efforts are made to communicate during blackout incidents, stakeholders expressed the need for information through both social media platforms and emergency alert systems (62%, CI: ± 12.11%, SD: 24.39%).
The effectiveness of current communication methods can be enhanced by addressing these concerns and ensuring that accurate and actionable information reaches all relevant parties during blackout events. From the answer possibility called “other,” participants thought that text messages to inhabitants in the affected area was an effective way of informing the public about energy blackouts.

Objective 4: Explore the challenges and barriers faced by stakeholders in effectively managing energy blackouts and communicating with stakeholders.

The survey responses highlighted challenges faced by energy sector stakeholders in managing blackouts and communicating with stakeholders, including limited resources for the public to cope during energy blackouts (7%), provide more frequent updates on power restoration progress (50%, CI: ± 22.65%, SD: 28.87%), implement a system for feedback from the public (21%, CI: ± 18.89%, SD: 28.57%) and technological limitations, where mobile applications should be used to communicate with the public (57%, CI: ± 22.29%, SD: 29.23%). Additionally, the coordination and collaboration among different stakeholders involved in blackout response and communication processes require further attention. Addressing these challenges and barriers is crucial to improving the overall effectiveness of blackout management and communication.

Objective 5: Identify potential solutions and recommendations for improving blackout prevention, management, and communication strategies in Norway.

Based on the survey findings, potential solutions, and recommendations to improve blackout prevention, management, and communication strategies in Norway include encourage employee preparedness, where companies educate employees on how to prepare and respond in a situation of energy blackout (57%, CI: ± 22.29%, SD: 29.23%), implementing energy-efficient practices where companies take proactive steps to reduce energy consumption (43%, CI: ± 12.42%, SD: 25.01%) and developing and maintaining of critical instrastructure (36%, CI: ± 12.12%, SD: 24.43%)

Analysis of stakeholder views on current practices

To analyse stakeholder perspectives on current practices related to the prevention, management, and communication of energy outages in Norway, a telephone interview were conducted.

Based on the interviews with 2 people out of 5 invited the telephone interviews with "Company X", an international company with offices and production halls all over the world, revealed their focus on preventive measures to avoid energy disruptions. Stakeholders echoed this perspective, emphasizing the significance of investing in infrastructure upgrades and maintenance procedures. This aligns with the stakeholders' consensus that proactive

actions, such as upgrading power grids and conducting regular equipment inspections, can help prevent energy outages and ensure a more reliable energy supply.

It was difficult to get different companies to attend the telephone interview. Some said that they were busy, others said that they did not participate in interviews or studies or master's thesis as a company policy. Therefor the study only consist of one company, with two participants from two separate locations in Norway.

Effective communication emerged as a crucial concern in both the telephone interview and other stakeholder perspectives. Interviewed people at Company X highlighted their internal communication channels, such as social media platforms, for spreading information to employees and customers. Stakeholders further emphasized the importance of accurate and timely communication with the public during energy outages, as well as the need for communication protocols for first responders. Aligning communication strategies across stakeholders can enhance public awareness, response coordination, and overall resilience during energy outages.

The interviewed persons at Company X mentioned the training of employees to handle energy blackouts and resume operations after power restoration. Stakeholders stressed the significance of regular training and simulations, as it allows stakeholders to evaluate the effectiveness of their communication and response procedures.

The analysis of stakeholder perspectives revealed several crucial insights.
First, stakeholders emphasized the need for a more coordinated and integrated approach to energy outage management. This includes improved stakeholder communication and collaboration, as well as a more efficient use of resources.

Second, stakeholders emphasized the significance of preventative measures to avoid energy disruptions in the first place. This includes infrastructure investments like upgrading power grids and enhancing maintenance procedures.

Thirdly, stakeholders emphasized the need for enhanced communication strategies during power outages. This includes providing the public with accurate and timely information and devising communication protocols and procedures for first responders.

Fourthly, stakeholders emphasized the importance of regular training and simulations to ensure that they are prepared to respond to energy outages. This includes training for first responders and regular drills and simulations to evaluate the efficacy of communication and response procedures.

Finally, stakeholders emphasized the significance of ongoing evaluation and review of current practices to identify improvement opportunities. This includes collecting feedback from stakeholders, monitoring industry trends and developments, and conducting routine policy and procedure reviews.

Overall, the analysis of stakeholder perspectives reveals the need for a more initiative-taking, coordinated, and integrated strategy for preventing, managing, and communicating Norway's energy outages. This will necessitate ongoing investments in infrastructure, communication, and training, in addition to the evaluation and review of current practices on a regular basis.

5 Discussion and Conclusion

Some implications of the findings for the energy industry in Norway:

Investing in preventive measures:
The survey found that many respondents suggested that preventative measures are effective in reducing the frequency and duration of blackouts. The Norwegian energy industry therefore needs to consider investing in preventive measures such as upgrading and modernizing infrastructure, increasing power plant capacity, and improving grid reliability. It may be expected that these investments will help reduce the risk of blackouts and ensure a more reliable energy supply. Yet, increased investigation could be required to further justify the investments due to limitations of this study.

Effective communication strategy:
The study found that effective communication during a power outage is critical to managing the situation and reducing its negative impact on the public. The Norwegian energy industry therefore needs to consider developing effective communication strategies that provide the public with timely and accurate information during power outages. A communication strategy should be designed to inform the public of the cause of the outage, the expected duration, and the steps taken to restore power.

Cooperation among stakeholders:
The study found that effective outage management requires cooperation among stakeholders, including energy companies, governments, emergency services, and the public. The Norwegian energy industry must therefore work closely with these stakeholders to develop and implement effective strategies for prevention, control, and communication during outages. This ensures a coordinated response to power outages and minimizes the negative impact on the public.

Overall, the findings of this study suggest that the Norwegian energy industry should invest in preventive measures, develop effective communication strategies to ensure a more reliable energy supply and minimize the negative impact of blackouts., suggests a need to focus on working with stakeholders and planning for emergencies. public. Yet, increased investigation could be required to further justify the investments due to limitations of this study.

Recommendations for further research

Based on the results of this study, the following recommendations for further research are proposed.

Research replication:
To further confirm the results of this study, we recommend repeating this study in other regions of Norway or other countries with similar energy infrastructure. Such a research undertaking should strive to provide causal knowledge which was not provided here, because this study is based on a survey and interviews and causal tests or factor analysis were not undertaken.

A detailed analysis of your communication strategy:
Future research should focus on examining in detail the approaches and methods employed by energy companies in their communication efforts during blackout. This will give us more insight into the most effective ways to communicate with the public during power outages. The way communication variables were operationalised can be optimised providing further insights

Exploring the role of social media informing and communication role in case of energy blackouts:
The study found that technologies such as social media and mobile applications can help inform the public about outages, where 13 of the 16 participant answers showed that social media plays a moderately helpful, important, or critical role in informing society about energy blackouts. There were an equal number of respondents who indicated that their company should use social media platforms to inform about energy blackouts, as there were responses suggesting the use of an emergency alert system. Future research should explore the potential of social media to prevent and manage blackouts.

Studying the impact of climate change on power outages as the frequency and severity of extreme weather events increase, it becomes important to study the impact of climate change on power outages. 57% answered that natural disasters or extreme weather conditions was the reason of the energy blackout explored. Future research should investigate how climate change is affecting Norway's energy infrastructure and identify measures that can be taken to prevent and manage blackouts in a changing climate.

Conclusion and summary of the study

In summary, the purpose of this study was to examine prevention, management, and communication strategies during power outages in Norway. Findings show that prevention strategies are the most important aspect in dealing with energy blackouts, followed by effective communication and management strategies.

The study found that the Norwegian energy industry needs to focus more on preventive measures such as regular maintenance of infrastructure, better investment in renewable energy, and implementation of smart grid technology. Additionally, the study recommends more effective communication strategies between energy suppliers and consumers during power outages.

Based on the interview with Company X, their approach to preventing energy blackouts focuses on controlling maintenance of production equipment in the low season. This strategic timing helps reduce the risk of power outages. In terms of blackout management, Company X has established systems to swiftly restore operations in the event of an energy blackout. The study revealed a mixed level of preparedness among the participants, with about one-third indication they were only “somewhat” prepared. However, Company X demonstrated a prominent level of preparedness in terms of production and routines.

The study also found a need for improved outage management strategies. To provide emergency power and establish clear emergency procedures. It also revealed a lack of public awareness on how to prepare for blackouts, pointing to the need for further public education and awareness campaigns.

Overall, this study provides important insights into strategies that can be used to prevent, manage, and communicate energy outages in Norway. One of the implications of these findings for the Norwegian energy industry is the need to increase investment in blackout precautions and communications strategies.

Most of the respondents has answered that their company is either very prepared (36%) or moderately prepared (21%) in the event of an energy blackout. Almost one third (29%) indicates that their company is prepared and could benefit from more work within the companies to educate employees and build knowledge. More studies on this subject could be justified by this trend.

Regarding communication during energy blackouts, Company X currently lacks specific strategies as these incidents have been short-term up till this moment, and do not impact their delivery capability. However, this area presents an opportunity for improvement and further development of communication strategies.

Finally, the study also provides recommendations for further research that builds on the findings of this study and can provide greater insight into strategies that can be used to effectively manage energy blackouts in Norway.

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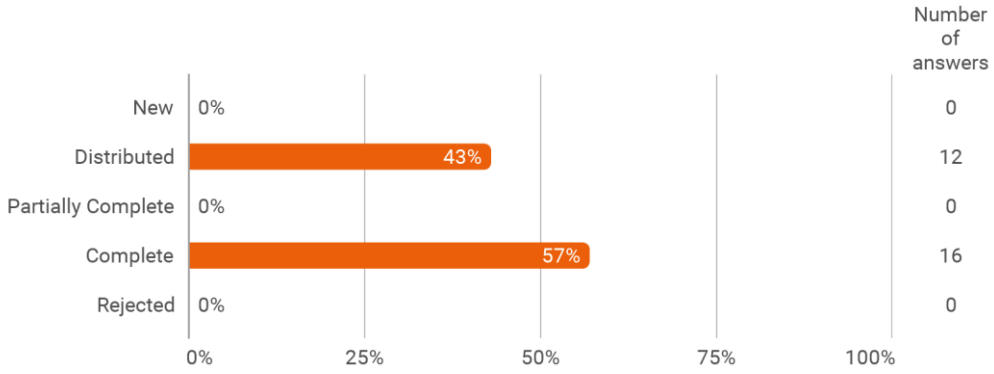
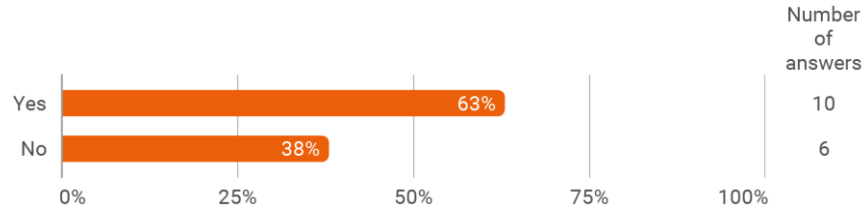
7 Appendices

Survey

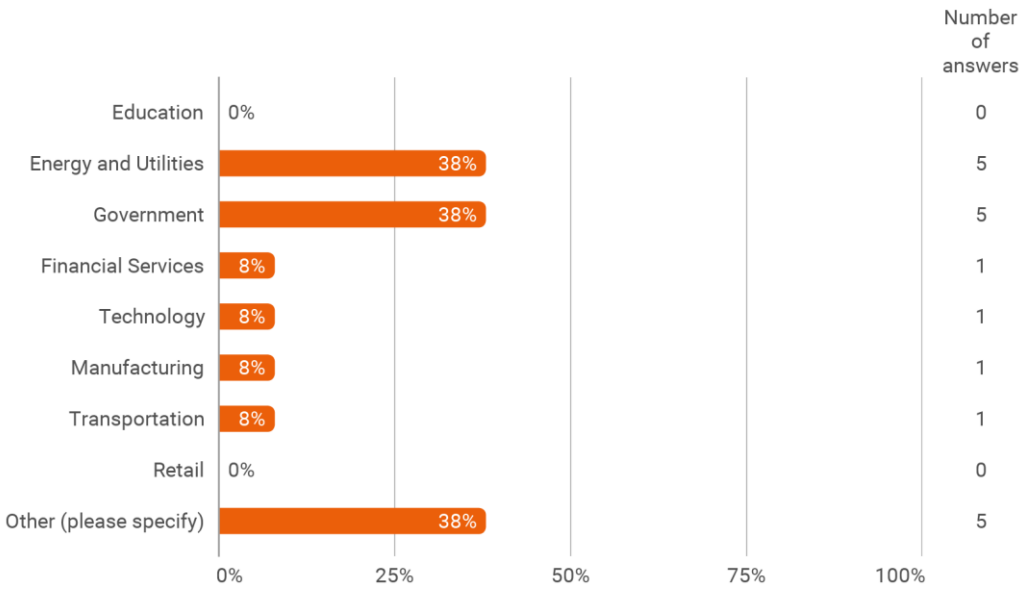
Overall Status



Question 1 Have you ever experienced an energy blackout in the past?

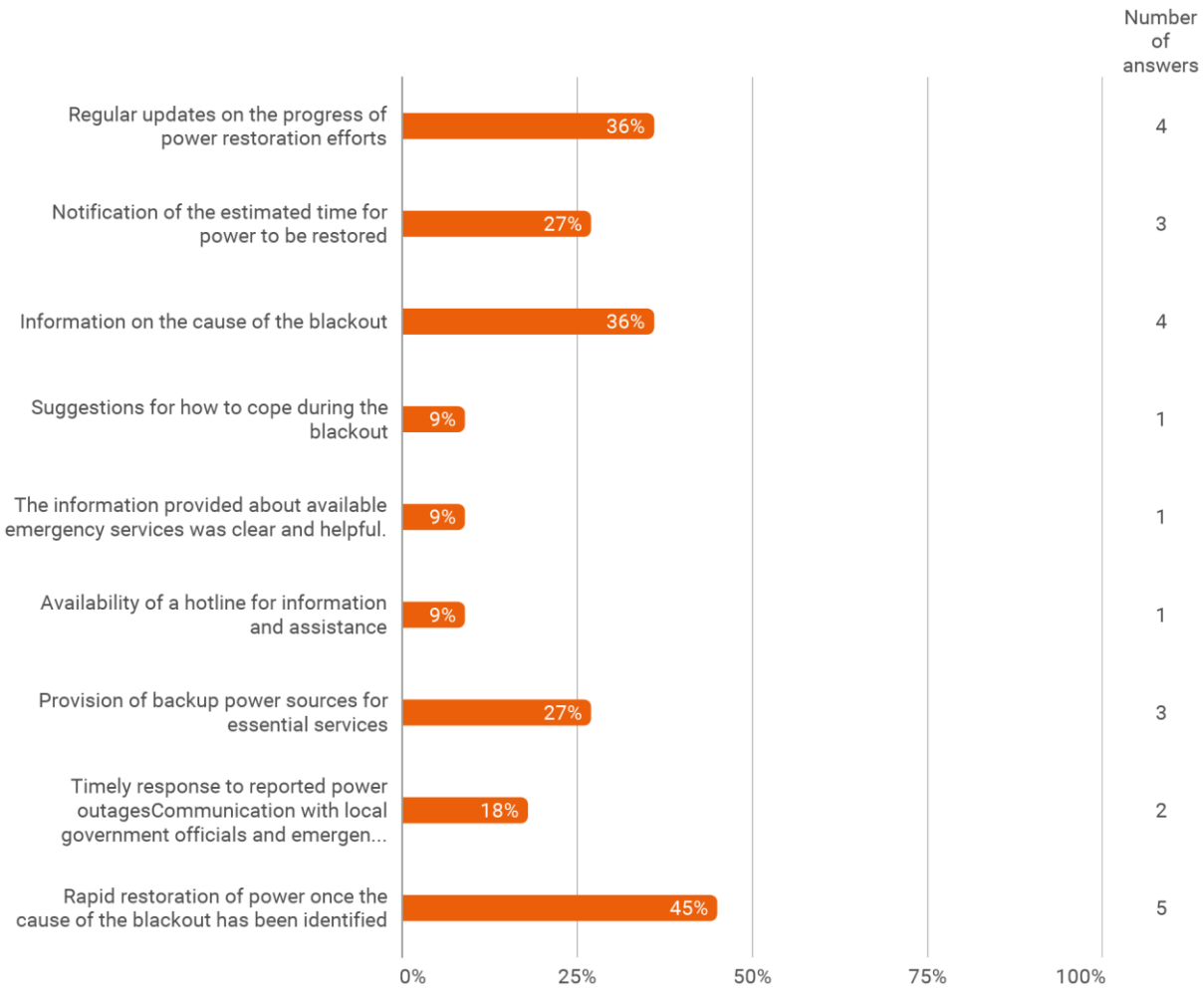


Question 2 In which industry do you work?

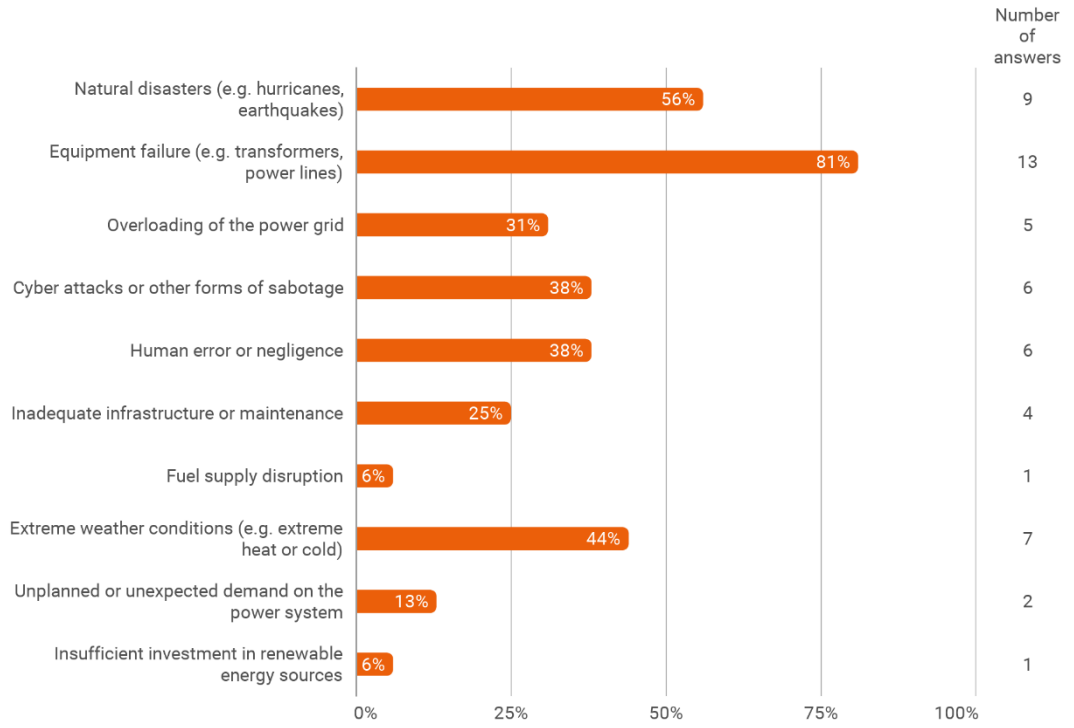


In which industry do you work? - Other (please specify)
offshore
Consulting company
Consultancy
Consultancy
Army

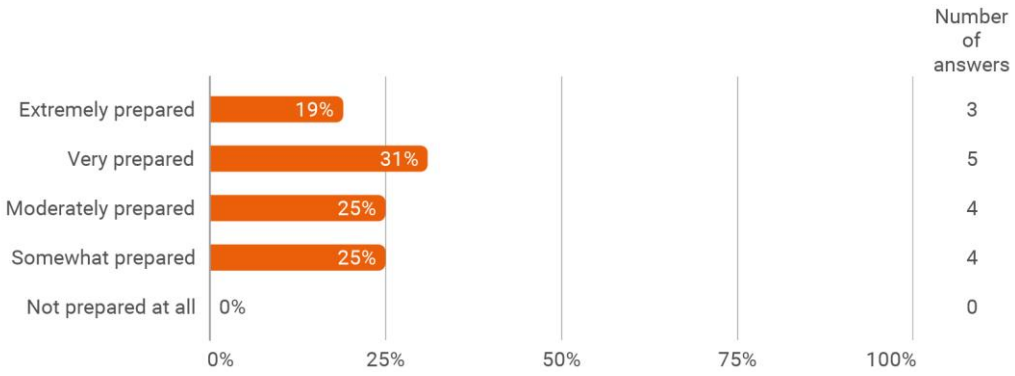
Question 3 If you have experienced an energy blackout, how well were you informed about the situation and what actions were taken to restore power?



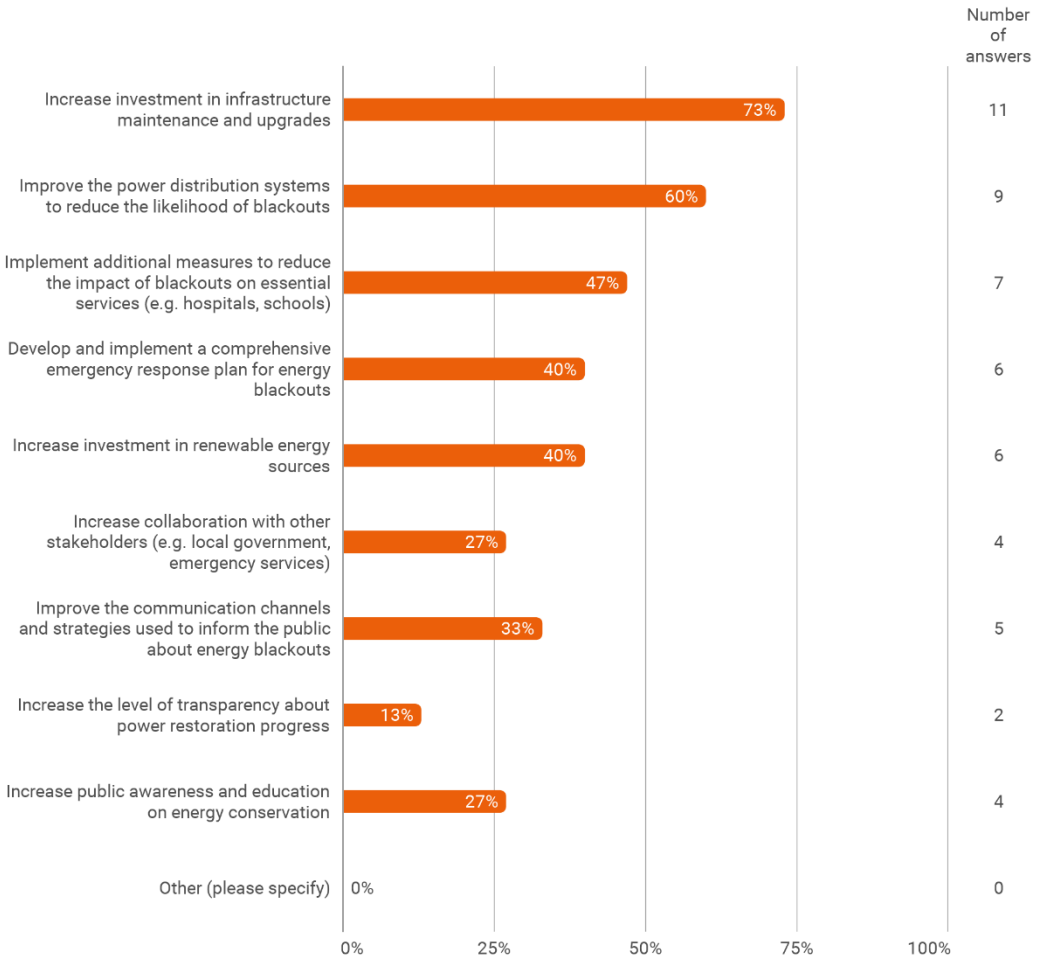
Question 4 Which of the following causes of energy blackouts are you familiar with?



Question 5 What is your perception of your company's preparedness in the event of an energy blackout?

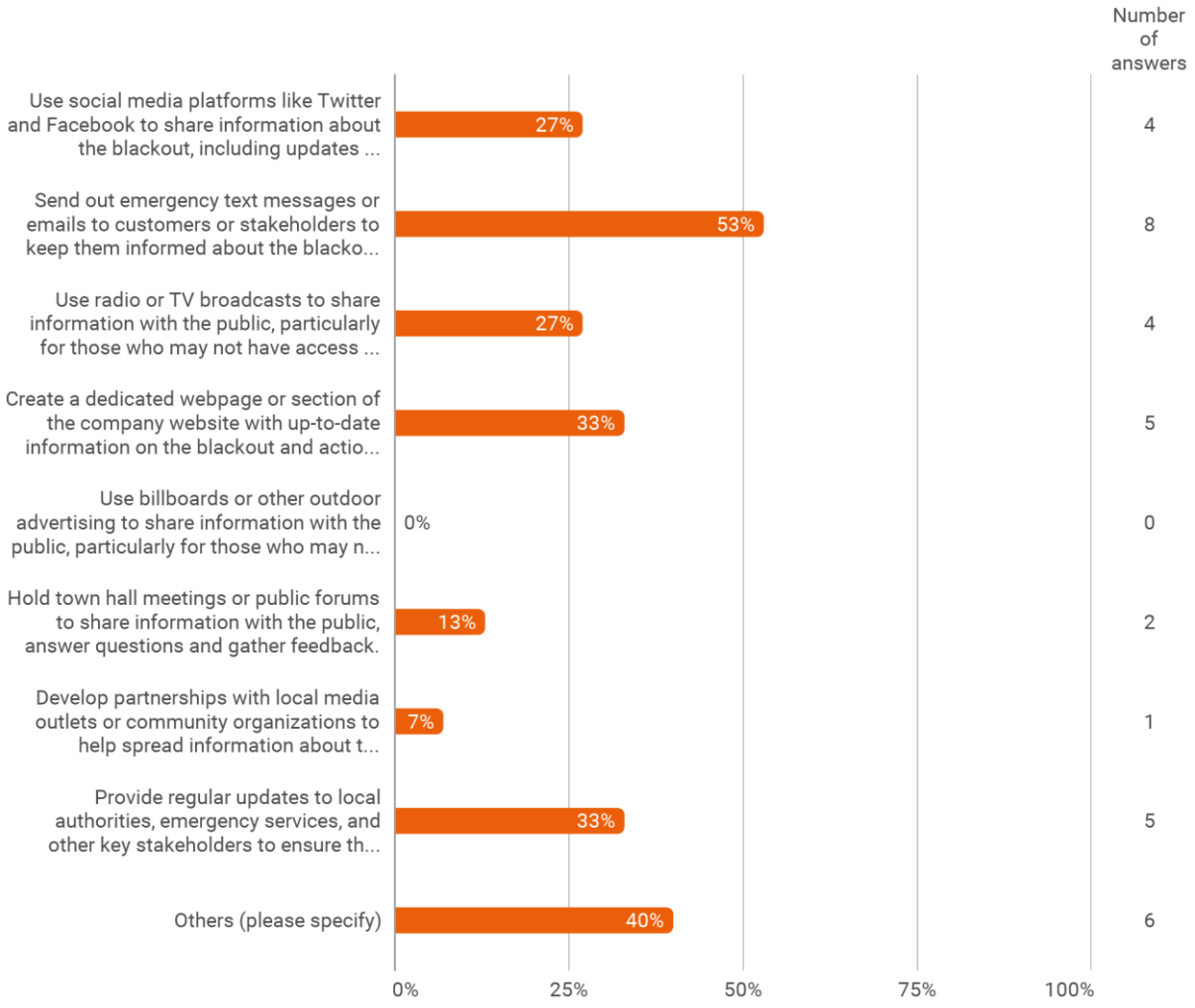


Question 6 Based on your expertise and experience, what specific steps do you believe should be taken to prevent energy blackouts from happening in the future?



Based on your expertise and experience, what specific steps do you believe should be taken to prevent energy blackouts from happening in the future? - Other (please specify) None.

Question 7 Based on your experience, what specific steps do you think your company should take to ensure that essential services such as hospitals and schools are protected during energy blackouts?

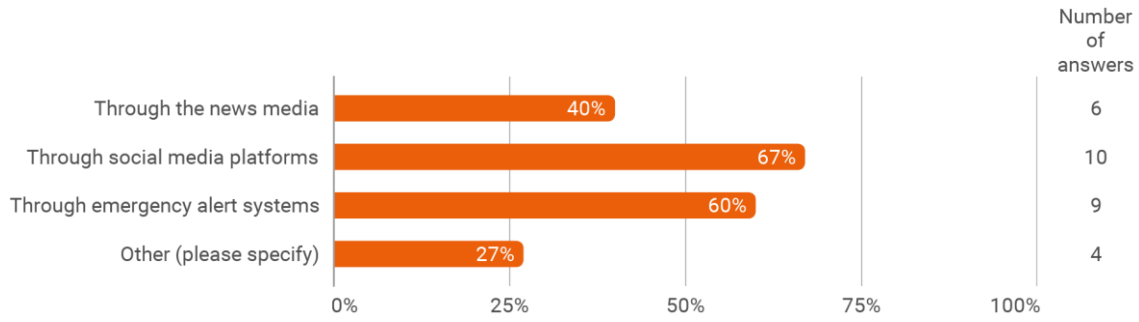


Based on your experience, what specific steps do you think your company should take to ensure that essential services such as hospitals and schools are protected during energy blackouts? - Others (please specify)

provide emergency power supply (is a school an essential service??

Based on your experience, what specific steps do you think your company should take to ensure that essential services such as hospitals and schools are protected during energy blackouts? - Others (please specify)
We could give them advise on how to be prepared for a blackout. We are a consultancy firm specialized in emergency preparedness.
There is already a website for blackouts at l-nett.no
The questions are not considered relevant for our company
Not considered relevant for our company
Dette finnes det allerede beredskapsplaner for

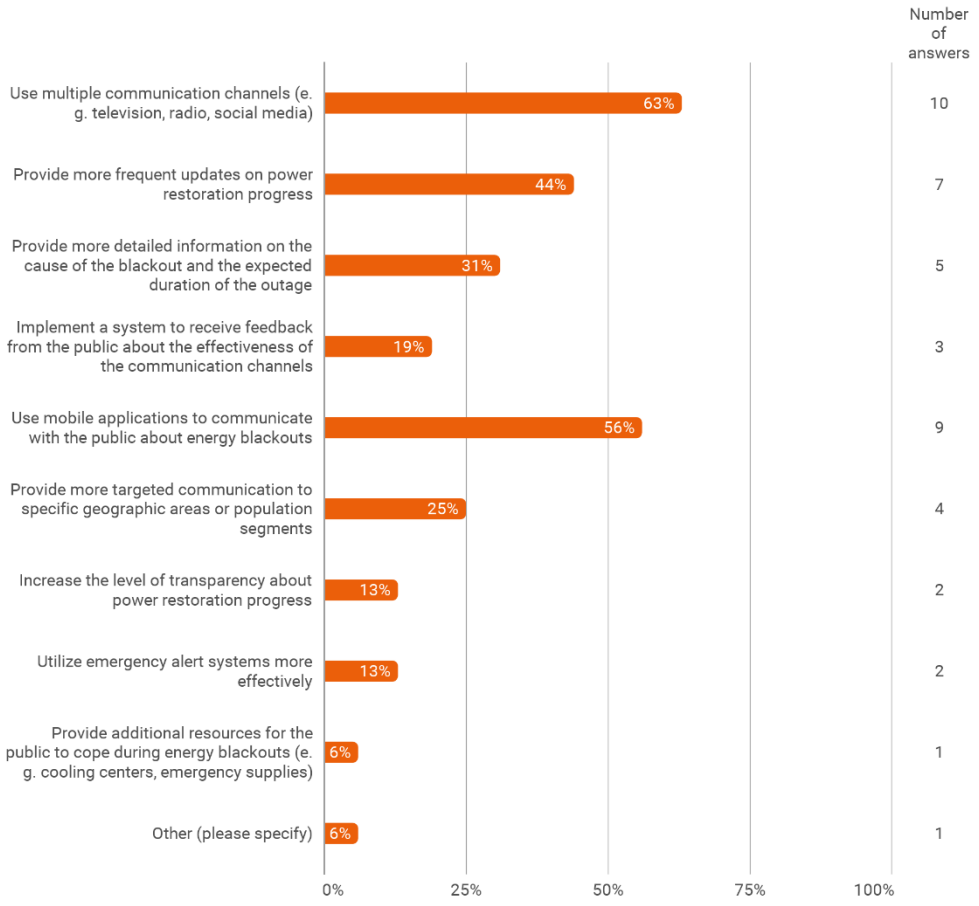
Question 8 Based on your experience and knowledge, what communication channels and strategies do you think your company should use to effectively inform the public about energy blackouts?



Based on your experience and knowledge, what communication channels and strategies do you think your company should use to effectively inform the public about energy blackouts? - Other (please specify)
text messages to inhabitants in the affected area.

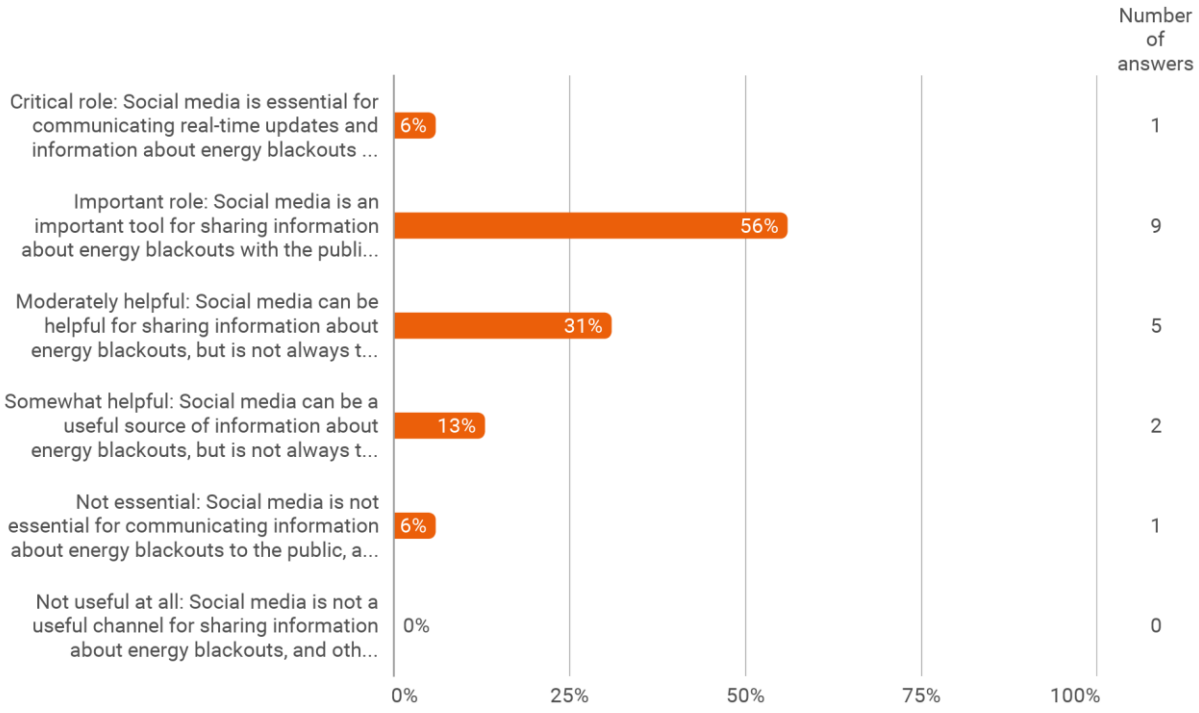
Based on your experience and knowledge, what communication channels and strategies do you think your company should use to effectively inform the public about energy blackouts? - Other (please specify)
We will not inform the public about an energy blackout in a consultancy firm
The mentioned webpage
SMS, nettsider

Question 9 What specific improvements do you think can be made to the current communication channels used to inform the public during energy blackouts?

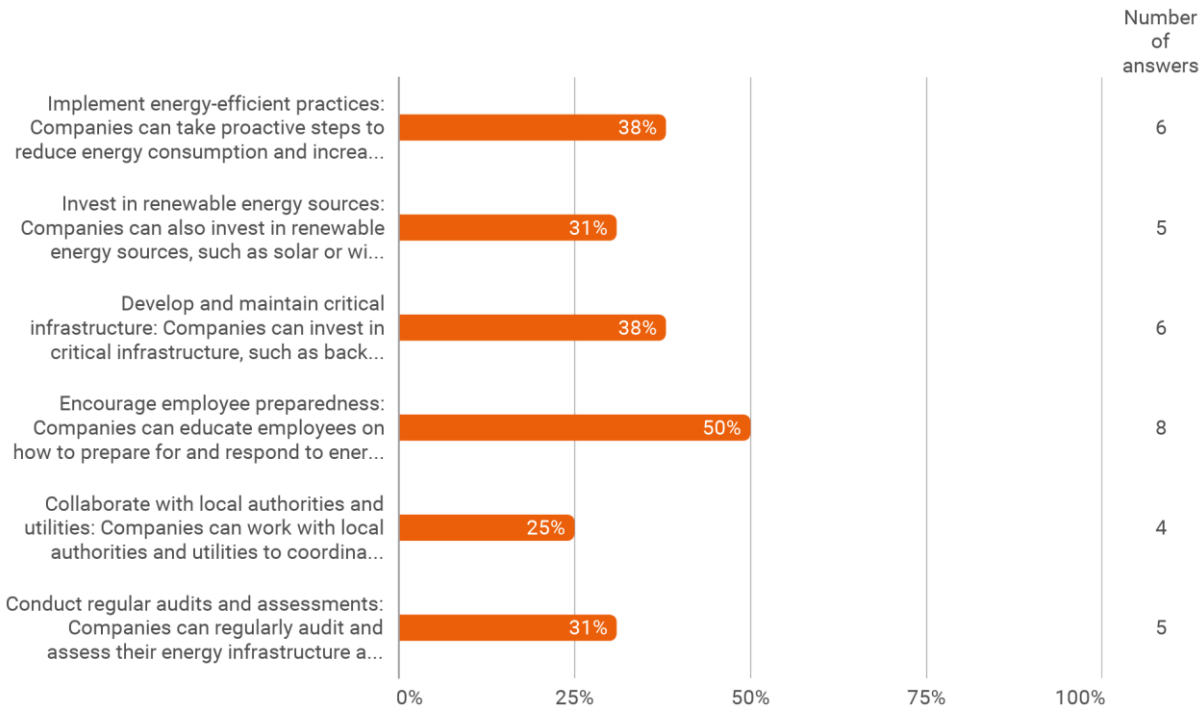


What specific improvements do you think can be made to the current communication channels used to inform the public during energy blackouts? - Other (please specify)
specific info in several languages

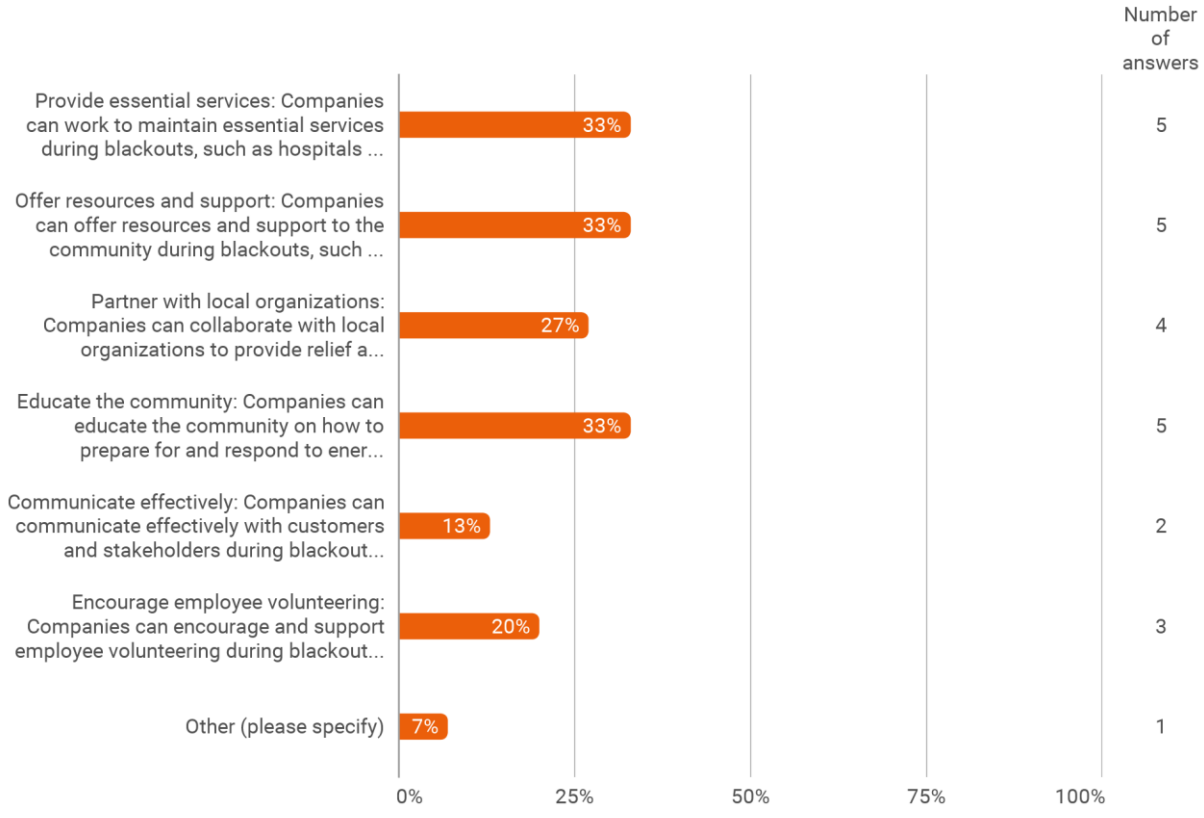
Question 10 Based on your experience, what role do you think social media can play in communicating information about energy blackouts to the public?



Question 11 Based on your experience, what do you think should be the role of your company and employees in preventing and managing energy blackouts?

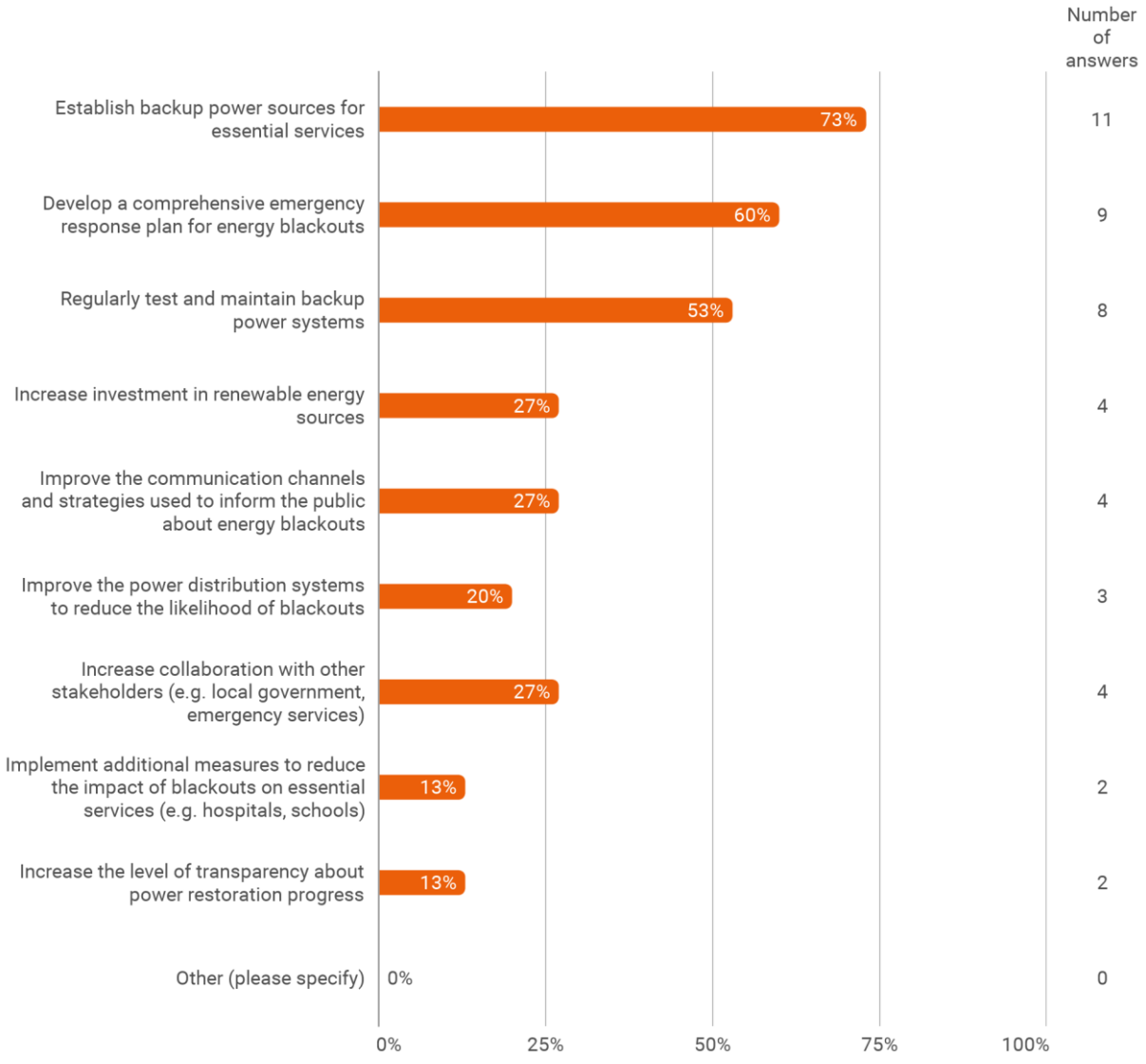


Question 12 Based on your experience, how do you think your company and employees can support the community during an energy blackout?



Based on your experience, how do you think your company and employees can support the community during an energy blackout? - Other (please specify)
Selskapet jeg jobber i har ansvaret for å reparere strømnettet, samarbeide med myndighetene når store hendelser oppstår og sørge for at alle får nødvendig informasjon

Question 13 In your professional opinion, what specific steps could your company take to better prepare for future energy blackouts, and how effective do you believe those steps would be?



In your professional opinion, what specific steps could your company take to better prepare for future energy blackouts, and how effective do you believe those steps would be? - Other (please specify)

Interview

Summary of the information related to the prevention, management, and communication of energy blackouts at Company X: (The company name is anonymized)

Prevention of energy blackouts:

Company X focuses on controlling maintenance of production equipment to prevent energy blackouts. The study showed a high percentage of preparedness and about 1/3 that was only “somewhat” prepared. Company X was prepared according to production and routines.

During the low season (winter), they conduct thorough equipment inspections and upgrades.

The low season coincides with a stable period from June to October, making the risk of power outages lower.

Management of energy blackouts:

Company X has systems in place to quickly restore operations in the event of an energy blackout. The study showed a high percentage (73%) of participants putting backup of power sources as a highly ranked step for the company to better prepare for future energy blackouts. Company X was no exception, making this a high priority to have instore power aggregates.

Employees in Company X are trained to handle the situation and resuming production after power restoration follows standard procedures. The study revealed in question 11 that 50% of the participants responded favourably to the idea of promoting employee preparedness through education within their companies. This result underscores the potential value of employee training programs and initiatives aimed at fostering a good culture of preparedness within energy companies.

Communication in case of an energy blackout:

Currently, Company X does not have specific communication strategies for energy blackouts, as they are short-term and do not affect delivery capability. This is an area where there is possibilities for improvement.

Internal communication and production planning handle the consequences of blackout frequency and duration.

Company X communicates with the power supplier regarding restarting operations.

They use internal social media platforms for communication, such as their company's Facebook page and internal messaging systems.

Communication with customers occurs if there are any consequences such as delayed deliveries.

Company X has a designated communication manager who interacts with public organizations.

Social Media:

Company X uses social media internally, but it is not mentioned how they specifically utilize it during energy blackouts.

The role of social media in communicating with customers during blackouts is not discussed.

Suggestions for improving customer communication during blackouts are not provided.

The main challenge mentioned is potential breakdowns in communication systems.