

Literature-Analysis RECIPE

Social impacts of power outages

An output from RECIPE WP3 'Impact of energy system disruptions on the society, economy and vital resources' (Milestone 3.3)

Gioia Hilpert MA, Prof. Dr. Corinne Moser, Prof. Dr. Mirjam Hauser,
Stephanie Huser MSc

Contact: gioia.hilpert@fhnw.ch

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Aims and research questions

Aims of the literature analysis (Milestone 3.3):



- Inform methods and data collections within Task 3.3
- Provide insights to all consortium members and a common ground for further collaboration within WP3 and beyond

Current status of this document:



- «Living document» intended to be refined as needed

Research questions (RQ):

According to the literature:



1. Which factors influence the **vulnerability** of populations to power outages?
2. What are the possible **impacts** of power outages on populations?
3. What is the expected behavioural **response** to power outages?
4. How can the social **resilience** to power outages be enhanced?

Method



Procedure

- An extensive list of **keywords** was constructed covering keywords related to 1) types of disturbance, 2) social dimension of impacts and 3) level of analysis (all keywords are listed in the appendix).
- A keyword search was conducted via Web of Science to identify **review articles**, published between **2015 and 06/2025**.
- After screening of records **16 reviews were retrieved and assessed for eligibility**.
- Based on this „review of reviews“ primary sources (scientific and other documents) were sought out additionally to gain deeper insights or fill in gaps.

Examples of keywords

Disturbance		Impacts		Level of analysis
blackout OR "power cut" OR "energy disturbance" OR "gas shortage" OR "energy pric*" OR "energy rationing" OR "load shedding" ...	AND	preparedness OR "adaptive capacity" OR response OR behavio* OR vulnerab* OR "risk factors" OR "impact disparity" OR "risk disparity" OR behavio* OR perception ...	AND	household* OR population OR soci* OR demographic OR psych* OR individual* OR people

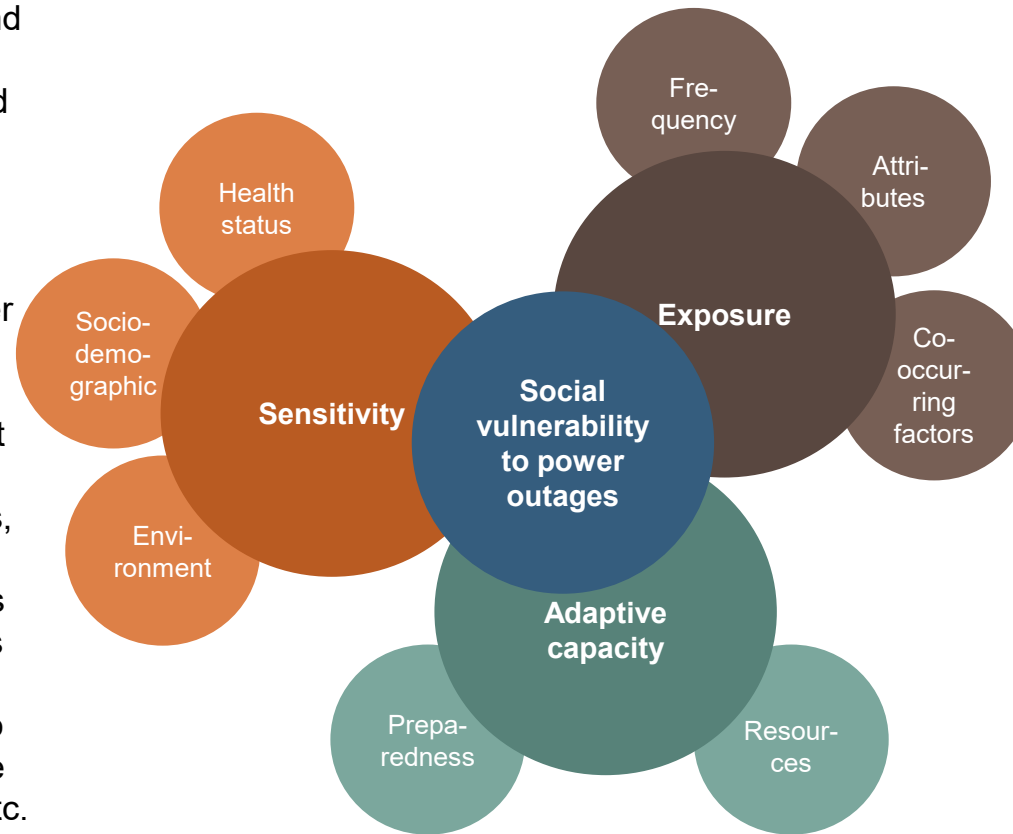
The list of keywords included high energy cost and energy shortage (rotating blackouts, energy rationing etc.), but this output focuses on power outages.

Executive summary

RQ1: Social vulnerability to power outages. Social vulnerability refers to the degree to which individuals or groups are susceptible to sustaining damage from power failures. It is a function of exposure, sensitivity and adaptive capacity.

Sensitivity: Demographic variables and social inequalities influence both how much individuals or groups are affected by power outages and how much they can adapt to their impacts.

- Disadvantaged social groups have a greater potential for harm from power outages. Considering the potential interaction of overlapping sensitivity factors (intersectionality) is important for assessing individuals' sensitivity.
- Apart from population characteristics, environmental and infrastructural characteristics may influence actions prior to an outage as well as impacts and ability to cope during an outage.
- “New” vulnerable groups are likely to result during the outage, for example people trapped in elevators, trains etc.



Exposure: Social vulnerability to power outages is influenced by event-specific factors causally related to or coinciding with the outage. This includes the spatial and temporal scale and frequency of power outages as well as cascading and compound drivers.

Adaptive capacity:

- Well-prepared individuals can support themselves and others and contribute to an efficient crisis management. Social inequalities and cognitive factors are relevant barriers. Prior experience positively influences preparedness.
- Access to resources – whether due to conscious preparation effort or not – and knowing how to use them helps in withstanding the impacts of power outages.

Figure based on Brooks, 2003

RQ2: Social impacts of power outages. People are not only impacted by the loss of power and its implications but also by additional factors causing or co-occurring with the outage. Impacts vary between different segments of society.

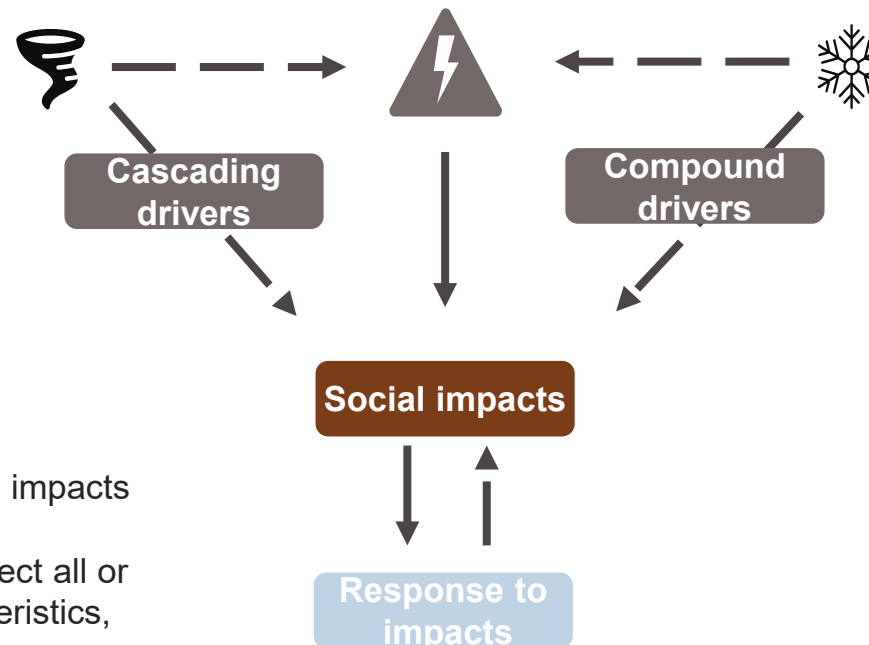
Cascading drivers

- Natural or human-induced hazards
- “Human threats” may be exogenous (e.g. foreign cyber or terrorist attack) or come from inside Switzerland (e.g. riot).

Social impacts may result from

1. The loss of power and related services/infrastructure
2. Cascading and compound drivers
3. Societal and behavioural responses to the impacts from 1 and 2 (secondary impacts)

While some impacts have the potential to affect all or most people, others relate to certain characteristics, such as location or health status and therefore disproportionately affect some populations.

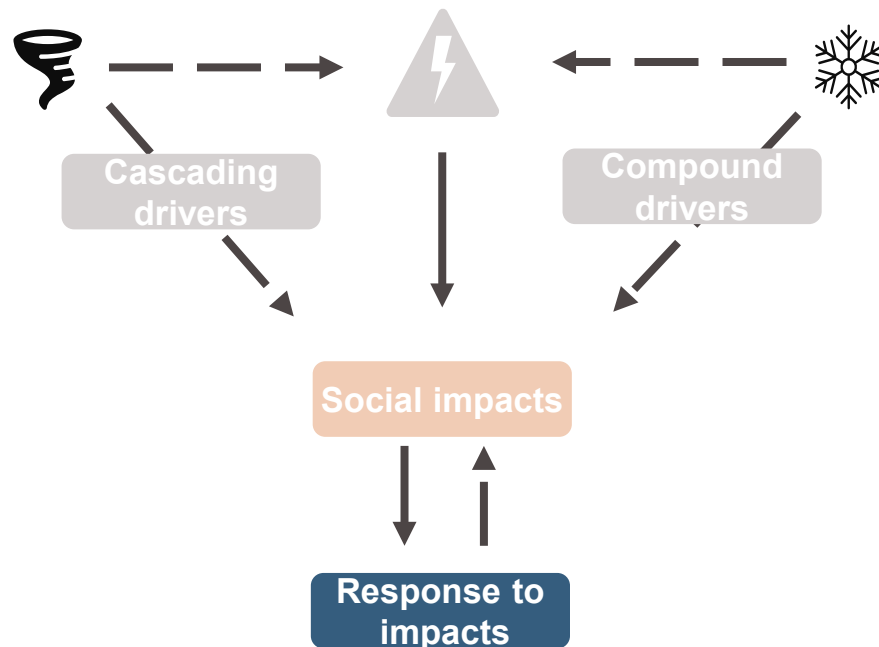


Compound drivers

- Natural hazards or climate extremes happening in co-occurrence with the power failure (e.g. heat wave or heavy snow).
- Societal conditions and challenges present at the time such as a low degree of social cohesion, high cost-of-living, a pandemic, a geo-political conflict etc.

Figure adapted from Pescaroli et al., 2017.

RQ3 – Behavioural response to power outages. People's responses to impacts may relieve or exacerbate impacts or create additional impacts. Behaviours can be categorized by whether and to whom they are beneficial.



Response to impacts

- Behaviours can be categorized by whether and to whom they are beneficial. Individual actions can be in synergy or in conflict with individual and collective interests.
- Adaptive behaviours reduce vulnerability and impacts and typically prioritize immediate health and well-being. People are generally expected to adjust routines, make use of existing resources, seek helpful information and support each other.
- Maladaptive behaviours may lead to health and safety impacts, burden public services and complicate restoration. Despite being less frequent, they should be considered and where possible prevented to limit vulnerability transfers, secondary impacts, relieve emergency services, and efficiently use resources during outages.
- A positive emotional response is possible in the short-term. Uncertainty, social responsibility and loss of communication contribute to negative emotional response.

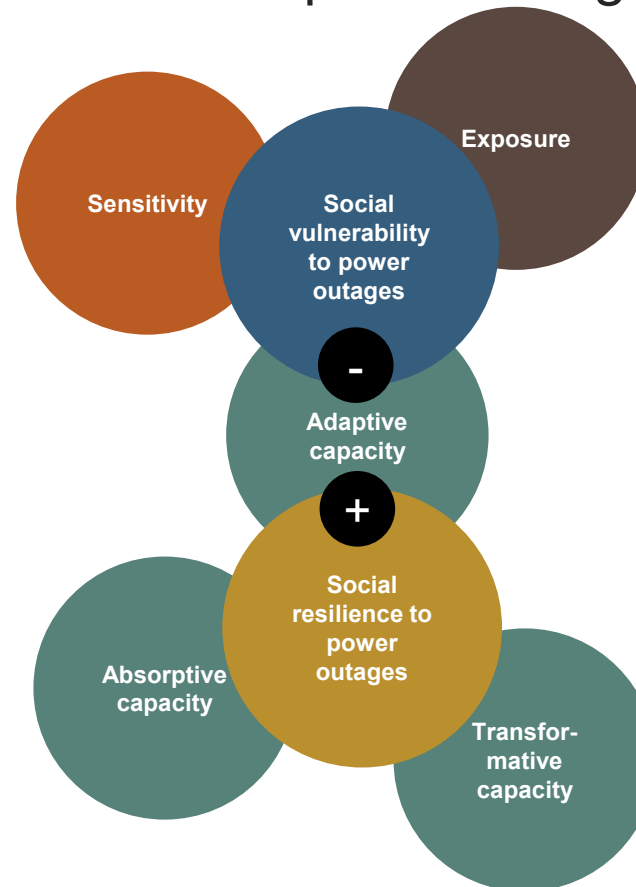
Figure adapted from Pescaroli et al., 2017.

RQ 4: Enhancing social resilience to power outages. Expanding engineering perspectives on energy system resilience to include end-users is important to understand and promote protective factors in power outage exposure.

Social resilience is the ability of societies, communities, households and other entities to cope in the presence of adversity.

One important element of resilience is adaptive capacity. Adaptive capacity is negatively related to vulnerability, and it is positively related to resilience.

Hence, resilience can be seen as the „flip side of vulnerability“ (IPCC, n.d.). Both concepts relate to the question of the circumstances under which disturbances have more or less destructive impacts (BBK, 2019).



Social resilience enhancement measures proposed in the literature typically revolve around

- Enabling people to **rely on themselves** by responding adequately prior to and during outages. For example, through communication interventions.
- Enabling people to **rely on each other** by fostering community resilience and collective strategies.
- **Supporting vulnerable groups** prior to and during outages.

RQ1: Which factors influence the social **vulnerability** of populations to power outages?

Conceptualising social vulnerability. “Vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger, 2006, p.268)

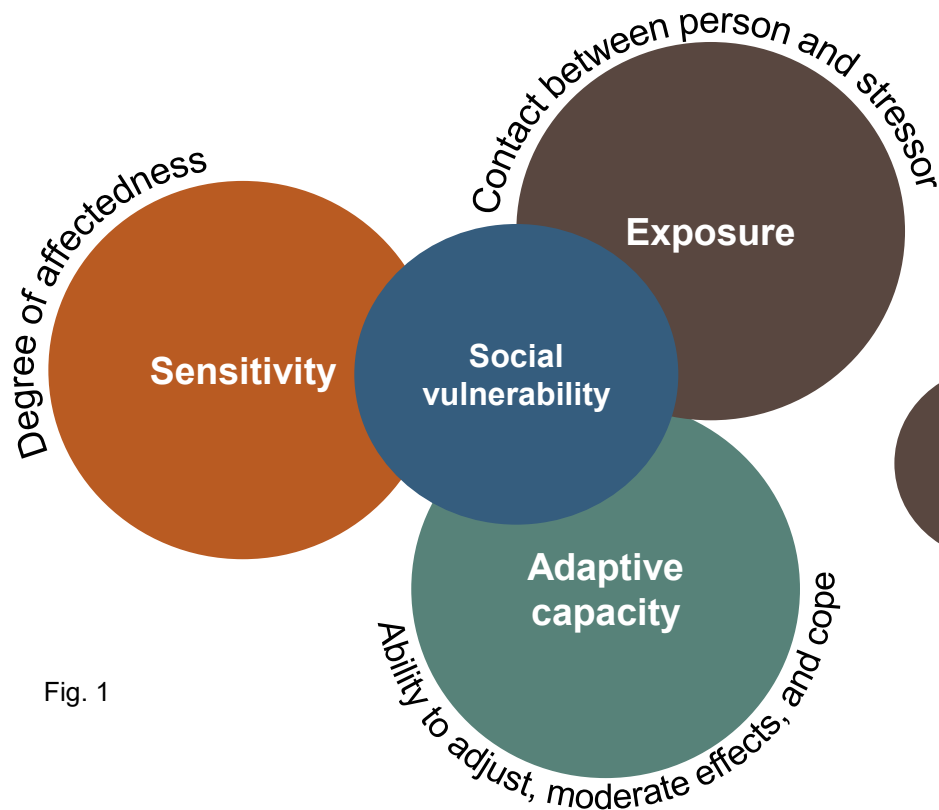


Fig. 1

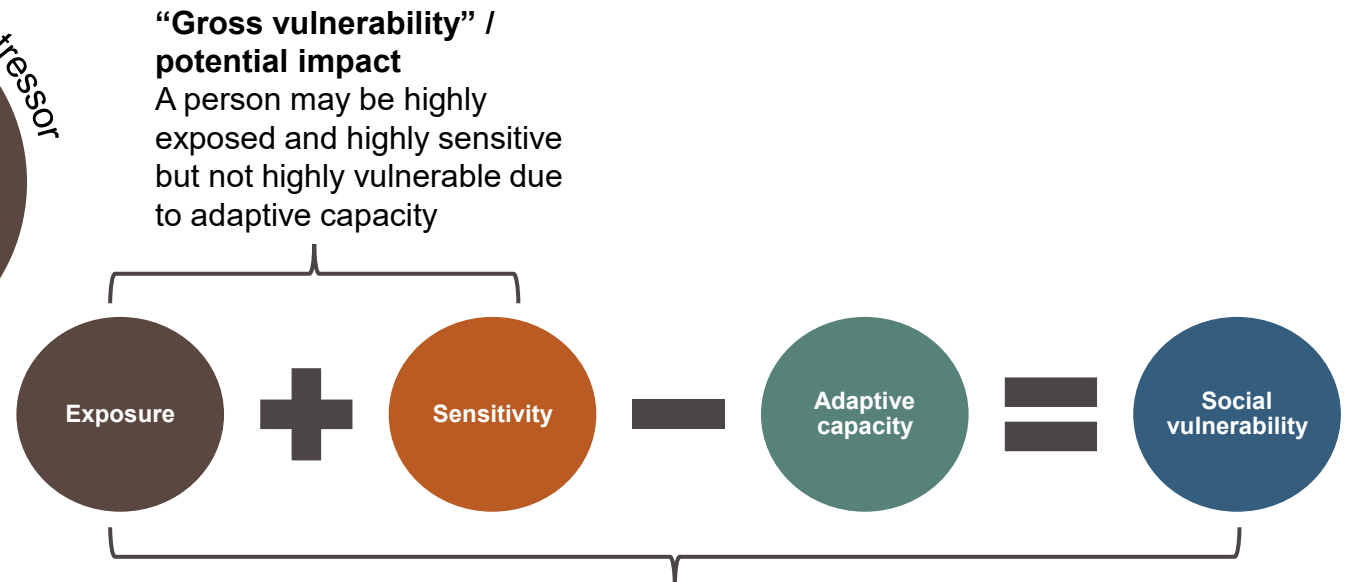
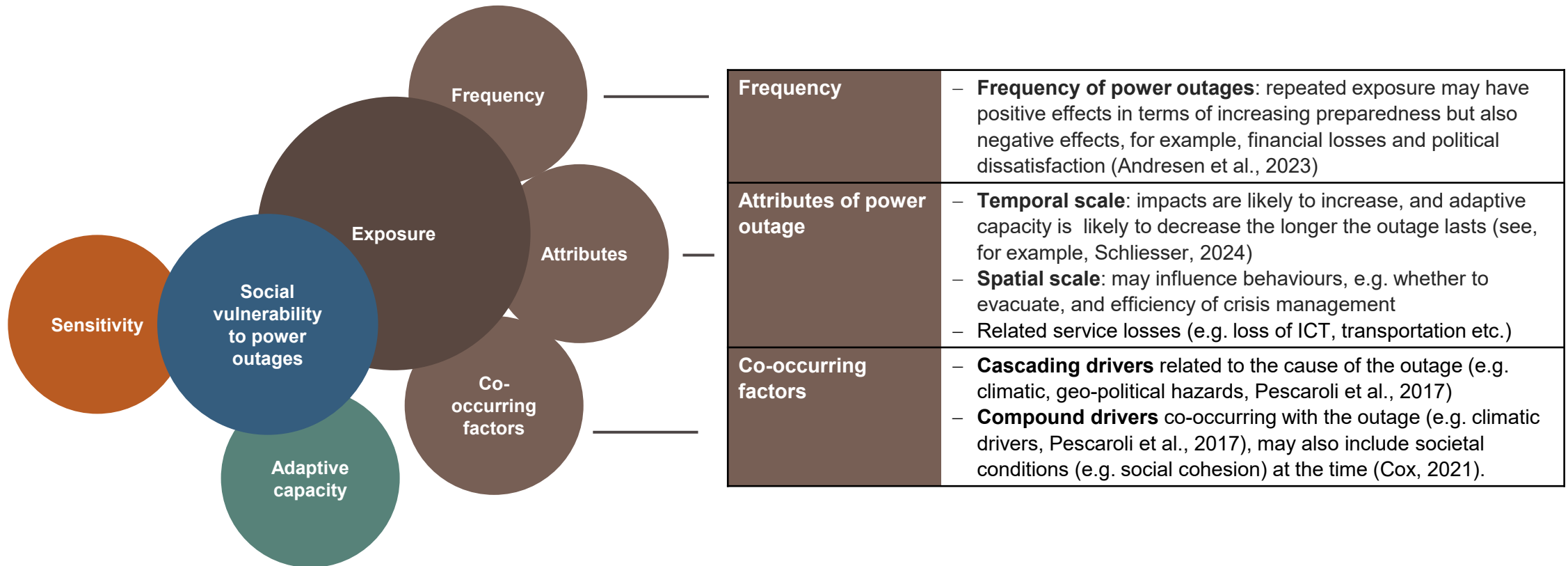


Fig. 2

“Net vulnerability”
Function of exposure, sensitivity and adaptive capacity → Degree to which people/communities are susceptible to injury, damage or harm

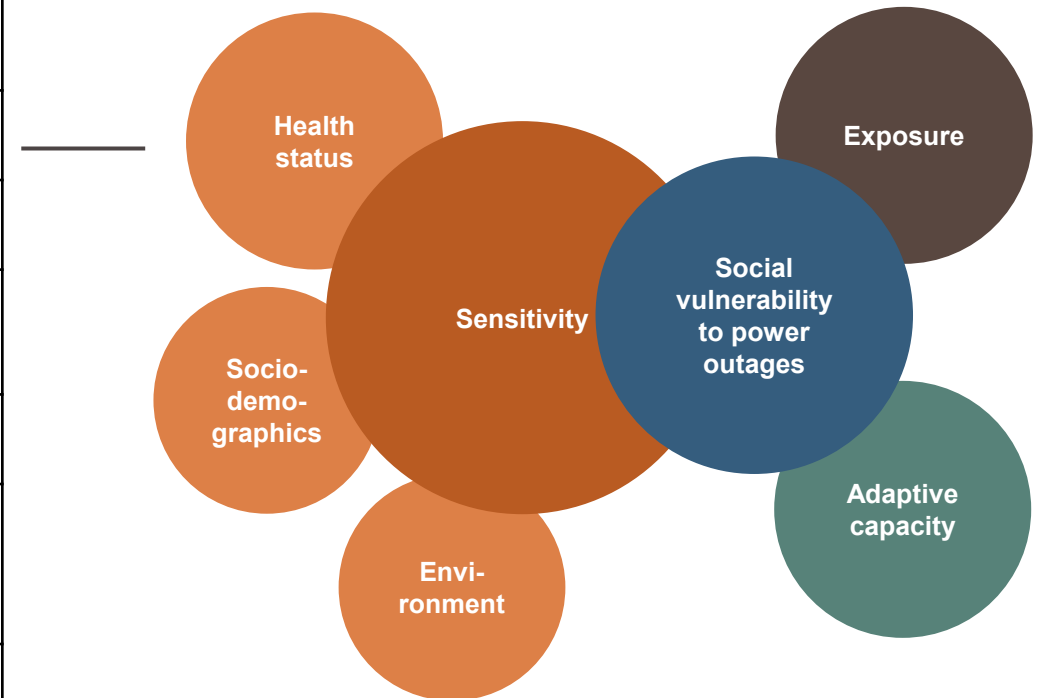
Fig. 1 based on Brooks (2003); Fig. 2 based on Yoshikawa et al. (2023)

Exposure. Social vulnerability to power outages is influenced by event-specific factors related to or coinciding with the outage.



Sensitivity and health status. People with health conditions are at greater risk of experiencing negative health impacts from power outages. They may also be less able to adapt during outages.

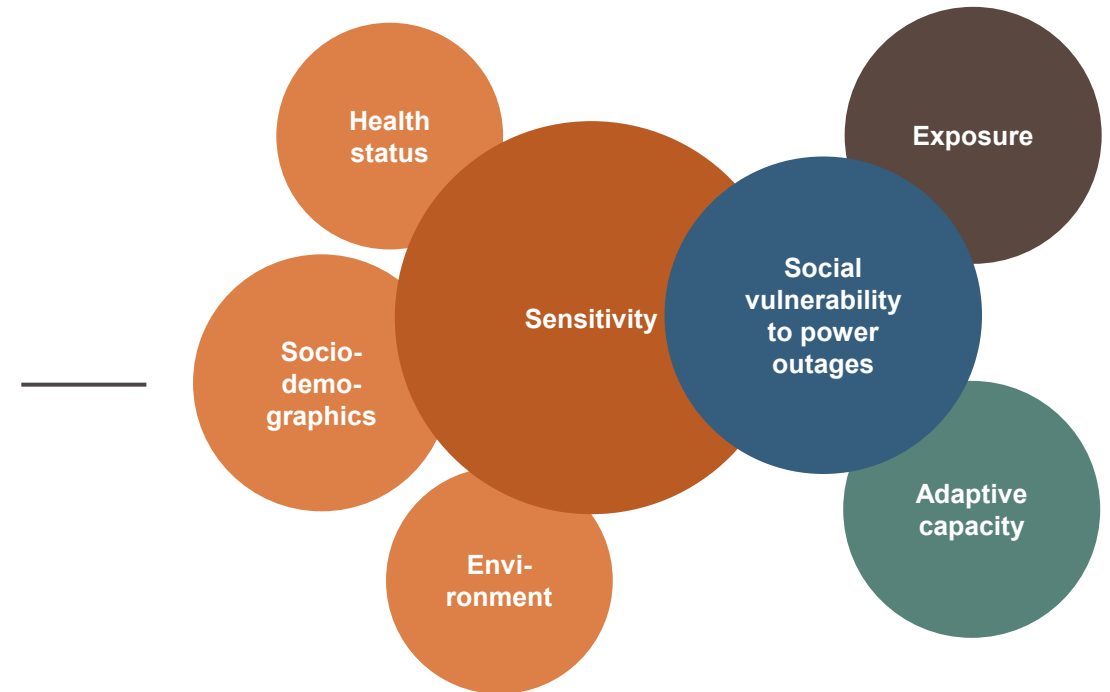
Underlying physical and psychiatric conditions	– Risk of disease exacerbation (Casey et al., 2020) – Risk of exacerbation of psychiatric disorder, e.g. previous trauma exposure may increase psychiatric symptoms (Rubin & Rogers., 2019)
Reliance on medical devices	– Risk of medical device failure (Casey et al., 2020) – More likely to call emergency services (Andresen et al., 2023)
Reliance on regular treatments	– Risk of missing treatments, e.g. dialysis-patients (Andresen et al., 2023)
Reliance on prescription (refills)	– Risk of limited access to refills (Casey et al., 2020) – Inability to store medication appropriately (e.g. cooled) (Rubin & Rogers, 2019)
Reliance on support	– Reduced support as care-givers struggle with transportation (Rubin & Rogers, 2019)
Maternal/neonatal health	– Reduced i) ability to travel to and ii) odds of delivering in a healthcare institution (Casey et al., 2020) – Increased risk of mental health problems when experiencing a power outage during pregnancy (Casey et al., 2020)
Limited mobility	– Inability to evacuate independently, e.g. residents of health institutions (Casey et al., 2020) – Use of mobility aids increases vulnerability (Dugan et al., 2023) – Increased mortality of people over 65 in nursing homes (Dugan et al., 2023)



For more on health impacts see RQ3.

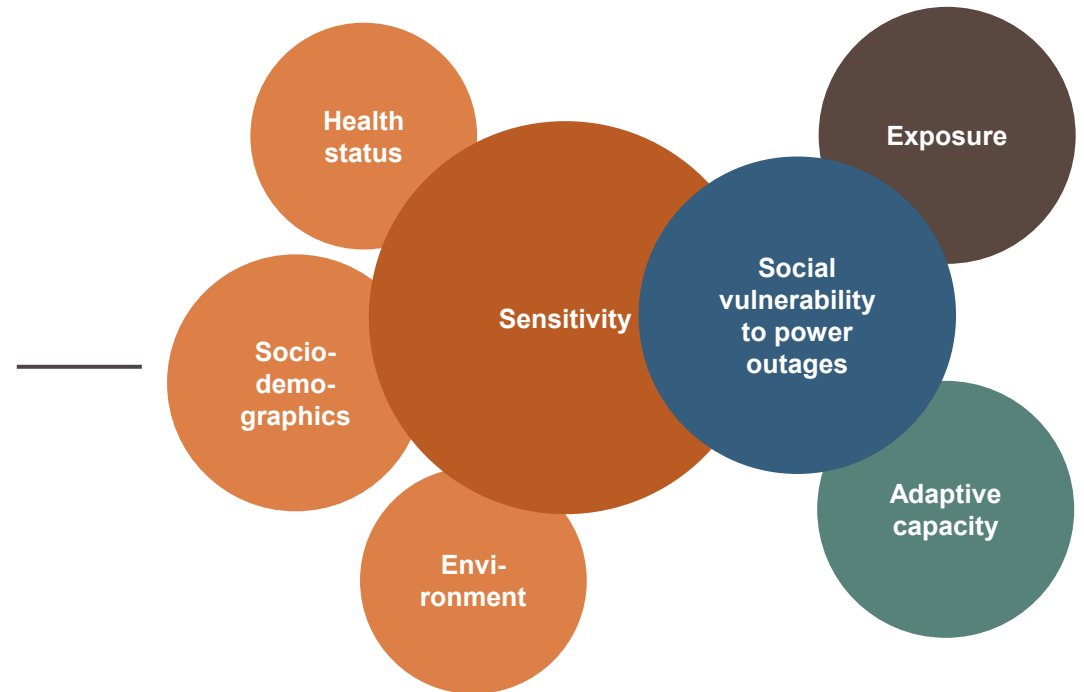
Sensitivity and socio-demographics I. Disadvantaged social groups have a greater potential for harm from power outages. It is important to consider intersectionality, i.e. the potential interaction of overlapping sensitivity factors, in assessing individuals' sensitivity.

Age	– Older adults (65+): more likely to be reliant on medical devices, overall need for greater support, vulnerable to negative mental health impacts (Andresen et al., 2023), risk of falls (Rubin & Rogers, 2019), more temperature-sensitive (Casey et al., 2020) but may also be more experienced (e.g. Heidenstrøm & Hansen, 2020) – Children: more temperature-sensitive (Loni et al., 2024), greater risk of CO poisoning (Andresen et al., 2023) – Young adults: some empirical findings suggest heightened vulnerability, especially to mental health impacts, due to social isolation, digital dependence and lower competence to cope (e.g. Cox, 2023; Dugan et al., 2023; Heidenstrøm & Hansen, 2020)
Minority status and language	– Non-native speakers are at risk of not understanding safety messaging (Andresen et al., 2023) – Ethnic minorities may be at greater risk to experience increased crime (Andresen et al., 2023) and carbon monoxide poisoning (Casey et al., 2020) – In the US ethnic disparities have been found in relation to outage duration with ethnic minorities being exposed for longer durations (e.g. Flores et al., 2023)



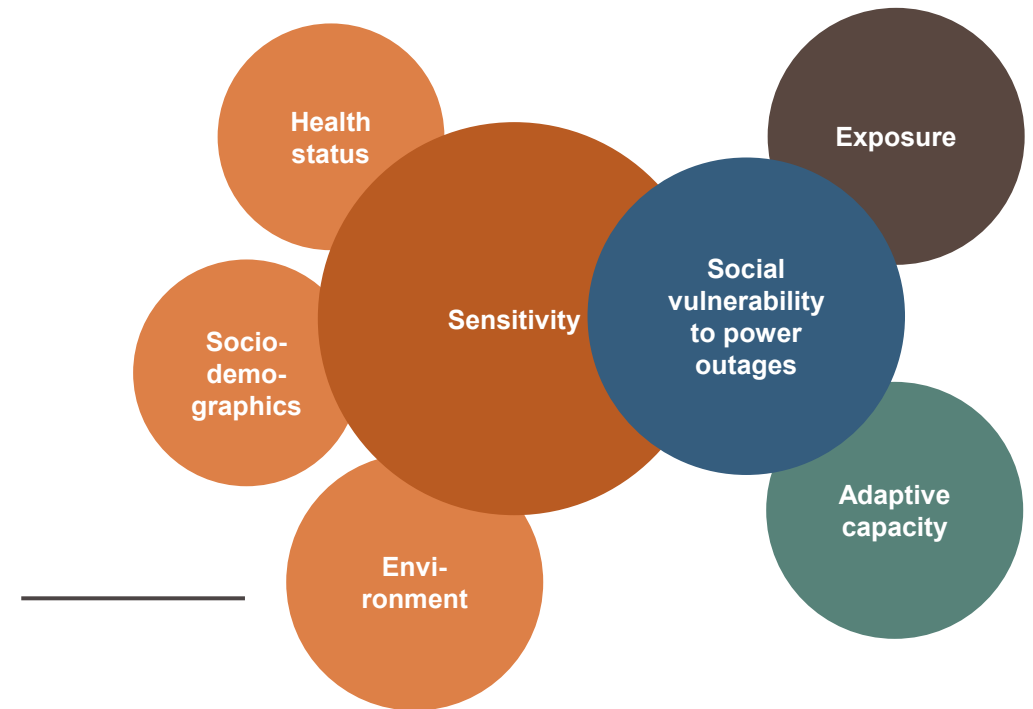
Sensitivity and socio-demographics II. Disadvantaged social groups have a greater potential for harm from power outages. It is important to consider intersectionality, i.e. the potential interaction of overlapping sensitivity factors, in assessing individuals' sensitivity.

Socio-economic status	– Low socio-economic status: greater risk of mental health problems and substance abuse (Andresen et al., 2023) and may be less likely to evacuate (Loni & Asadi, 2024) – High socio-economic status: more likely to experience heat-related symptoms (Andresen et al., 2023) – Socio-economic vulnerability has been positively associated with power outage duration in the US with longer outage durations for communities with lower SES (Ganz et al., 2023)
Education attainment	– Low education levels may lead to difficulties in understanding crisis warnings, safety messaging and associated health risks (Rudolph-Cleff et al., 2022)
Occupation	– Healthcare workers at risk of being overworked and overstressed (Andresen et al., 2023)
Caring responsibility	– Caring for vulnerable individuals within or outside the household or livestock increases risk of negative emotional impacts (Rubin & Rogers, 2019)

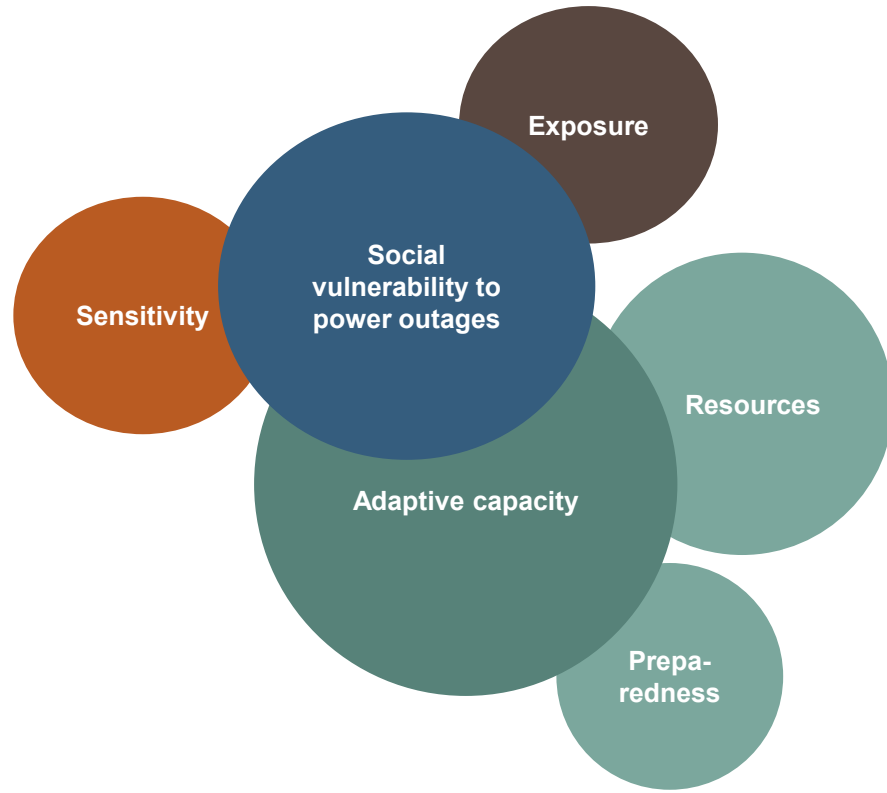


Sensitivity and environment. Environmental and infrastructural characteristics influence the probability of preparedness actions being taken prior to an outage as well impacts and ability to cope during an outage.

Location	– Rural populations: more likely to experience longer outages (Ptak et al., 2025), but they may also be more experienced and better prepared (Andresen et al., 2023) – Multiple studies find urban populations to be less prepared and experienced (e.g. BBK, 2013; Heidenstrøm & Hansen, 2020)
Housing attributes	– Living in high-rise buildings/living on higher levels and in multiple family housing has been negatively correlated with stocking emergency supplies (BBK, 2013) – Space: availability of storage capacity may influence preparedness (BBK, 2013) – Temperature-related health impacts may be more likely in older/poorly insulated buildings (Casey et al., 2020) – Houses may be more difficult to keep warm than flats
Crime rates in area	– Some areas may be more prone to increases in crime (Andresen et al., 2023)
Access to transportation	– Lacking reliable (individual) transportation may act as a barrier to evacuation (Loni & Asadi, 2024) and to accessing resources (Ezzati et al., 2025)
Accessibility to essential/ emergency services	– Individuals' access to facilities (e.g. health services and food/water supply) is often uneven and depends both on socio-economic status and proximity (Ezzati et al., 2025; for rural-urban disparity in access to services in CH see: BFS, 2018)

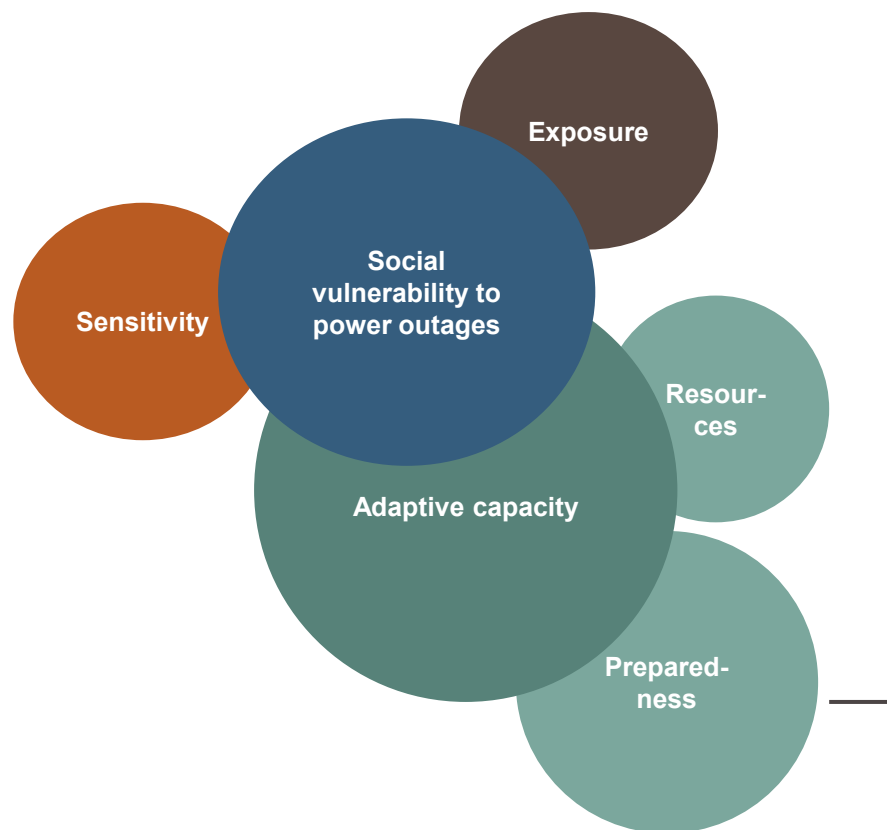


Adaptive capacity. Having resources at one's disposal and knowing how to use them helps in withstanding the impacts of power outages. Resources may or may not be available due to conscious preparation. Social inequalities influence access to resources.



Individual resources	– Financial capital: e.g. availability of cash, financial reserves to purchase non-perishable food, fuel, generators (Loni & Asadi, 2024) – Social capital: e.g. practical and/or emotional support from social network (Rubin & Rogers, 2019) – Material resources: including “dormant resources” not purchased specifically for outages, e.g. backup energy, emergency supplies, availability of individual transport to evacuate, wood burning stove, handpumps to extract water, etc. (Rubin & Rogers, 2019) – Knowledge and competences: about how to modify existing practices like preparing and preserving food, keeping warm, ensuring hygiene etc. Knowledge may be result of previous experience. (see for example: Ghanem et al., 2016; Heidenstrøm & Kvarnlöf 2018) – “Resilience reserve”: vulnerable populations’ resilience reserve, i.e. the “inventory of potential capacity to confront unanticipated challenges” (Hernández et al., 2018, p. 712) may already be depleted due to chronic challenges (e.g. dealing with limited budget, discrimination or chronic health conditions) making them more vulnerable to adverse effects and delay their recovery during additional acute events (see also: Jessel et al., 2019)
Collective resources	– Civil community resilience: e.g. social networks, community kitchens, individual acts of altruism (Rubin & Rogers, 2019) – Local and national authorities: e.g. shelter, health and safety information, financial/material aid, practical assistance etc.

Adaptive capacity. Well-prepared individuals can help themselves and others and crucially contribute to an efficient crisis management. Social inequalities and cognitive factors are relevant barriers. Prior experience positively influences preparedness.



Predictors of individual preparedness	– Prior experience improves preparedness (Rubin & Rogers (2019)) – Cognitive factors: Risk-perception that an outage is likely and belief in self-sufficiency improve preparedness (Rubin & Rogers (2019))
Barriers to individual preparedness	– Preparedness vulnerability, i.e. being likely to be unprepared, e.g. due to limited access to resources, lack of disaster experience or not receiving adequate warning, has been suggested to be higher among the following groups: • Age: elderly adults who live alone (Dugan et al., 2023), younger adults (Dugan et al., 2023) • Gender: female-headed households (Ezzati et al., 2025) • SES: groups with a low socio-economic status (Loni & Asadi, 2024) • Housing type: tenants compared to homeowners (Casey et al., 2020; BBK, 2013), multi-family housing residents compared to single-family home residents (Dugan et al., 2023) • Location: urban populations compared to rural populations (e.g. BBK, 2013) • Minorities: ethnic minorities (Casey et al., 2020), non-native speakers (Dugan et al., 2023) • Education attainment: people with lower education levels (Dugan et al., 2023) – Cognitive: thinking that an outage is unlikely/not worth worrying about, a sense of entitlement to constant power supply in the modern age and as a paying customer, lack of knowledge about how to prepare, low trust in worthwhileness of preparing, expecting authorities to step in (Rubin & Rogers, 2019) – Practical barriers: e.g. not having enough room to store items, property management may prohibit use of generators (Rubin & Rogers, 2019) – Financial barriers: concern about the costs of preparing (Rubin & Rogers, 2019)

SES: Socio-economic status

Adaptive capacity. Heidenstrøm & Hansen (2020) differentiate between formal and informal preparedness. They suggest that «households should be recognized as resourceful through their everyday practices» as well as more formal preparation (p. 1).

Formal preparedness	Informal preparedness
– Predefined readiness measures implemented on the individual household level with risks in mind and following official guidelines (usually emergency plan and supply stocks)	– Availability of resources including (socially shared) material supplies, experience, knowledge, competencies and social networks. For example: – Knowing who is likely to be under prepared or sharing generators in a socially closely connected rural place – Local geographical knowledge about climate and infrastructure, e.g. knowing how to interpret weather conditions – Experience from previous infrastructure disruptions – Knowing how to conserve food

- Via in-depth interviews and a representative survey of the population in Norway Heidenstrøm & Hansen found levels of *informal* preparedness to be generally higher compared to low levels of *formal* preparedness and that preparedness increased with distance to nearest city and age.
- More rural populations were found to better prepared than urban populations. They were more likely to benefit from previous experience and showed higher levels of local geographical knowledge, social networks and stronger sense of individual responsibility.
- Older respondents also showed higher levels of preparedness, which may be explained by their experience from previous crises, stronger reliance on formal information as well as know-how and materials of “off-grid” living. Young and urban single households indicated lowest competence to deal with extensive infrastructure breakdowns.

Similarly Maduz et al. (2019, p. 29) differentiate “between ‘hard’ preparations, which people must specifically consider, and ‘weak’ preparations that people tend to accomplish when going about their daily lives”

Insights about risk perception and individual disaster preparedness behaviour in Switzerland. A growing risk perception meets a wish for more information (Maduz et al. 2018) and demographics influence preparedness (Maduz et al., 2019).

Maduz et al., 2018 (representative sample of the population in CH)

Risk perception and knowledge

- The threat of a power outages was perceived as one of the most important technical threats by the respondents. About 50% of respondents feel „strongly“ or „rather“ threatened by them.
- A relatively high risk perception meets a feeling of being „badly“ or „not at all“ informed. This feeling is supported by comparatively low performance on knowledge tasks relating to power outages.
- The study finds an increased search activity (compared to 2011) and at the same time an increased wish for information – roughly 70% of respondents wished to know more about how to prepare for them and which measures to take in the case they happened – indicating potential deficits regarding the availability and actionability of information.

Emergency plan and emergency supply

- In the same study 12% of respondents had a personal emergency plan and
- 50% of the respondents stated to have an emergency supply of water for three and food for 7 days.

Maduz et al., 2019 (representative sample of the population in CH)

Emergency plan and emergency supply:

- In this study the likelihood of having a predefined emergency plan was found to be higher for men, people living in a big household, foreigners, people with hazard experience and people who consulted alertswiss.ch.
- The likelihood of having an emergency supply was found to be higher among men, in the German-speaking part of Switzerland, with rising age, among less educated people and in rural areas.

Zimmermann & Pescia, 2018 (representative survey among households in Switzerland about emergency food supplies)

- The study finds that motivation for having an emergency supply of food and water usually is not related to conscious emergency planning. It also finds deficits regarding outage-appropriate foods and water with only a third of people having the recommended supply of water.

Comment by the authors of this literature analysis: Identifying and analysing perceptions around power outage of different population groups in Switzerland – which may have changed following the energy crisis of 2022/2023 – is a key outcome of WP3.

RQ1 chapter summary. 4 take-aways about the social vulnerability to power outages.

- 1) **Social vulnerability refers to the degree to which individuals or groups are susceptible to sustaining damage from power outages.** It is a function of exposure, sensitivity and adaptive capacity.
- 2) **Demographic variables and social inequalities influence both how much individuals or groups are affected by power failures and how much they can adapt to their impacts.** The most vulnerable individuals/groups are characterised by high sensitivity and low adaptive capacity.
- 3) **Household blackout preparedness, in a broader sense, extends beyond family emergency plans and supplies to all resources – including non-material resources like knowledge, competencies and social networks - that contribute to adaptive capacity during an outage, whether they were consciously acquired or not.**
- 4) **Ambiguities remain regarding how certain demographic characteristics relate to vulnerability.**
 - For example, rural populations are both at higher risk of prolonged outages, but they may also be more experienced with and better prepared and their social networks may be better compared to urban populations.
 - Regarding age, there are indications for older individuals exhibiting both higher sensitivity and possibly higher adaptive capacity while the vulnerability of young adults may be underestimated.
- 5) **People can not only be vulnerable due to pre-existing characteristics, but new vulnerable groups will likely result during the outage.** For example, people trapped in elevators, trains etc.

RQ2: What are the possible **impacts** of power outages on populations?

Conceptualising social impacts. People are not only impacted by the loss of power and its implications but also by additional factors causing or co-occurring with the outage. Secondary impacts may occur from people's responses.

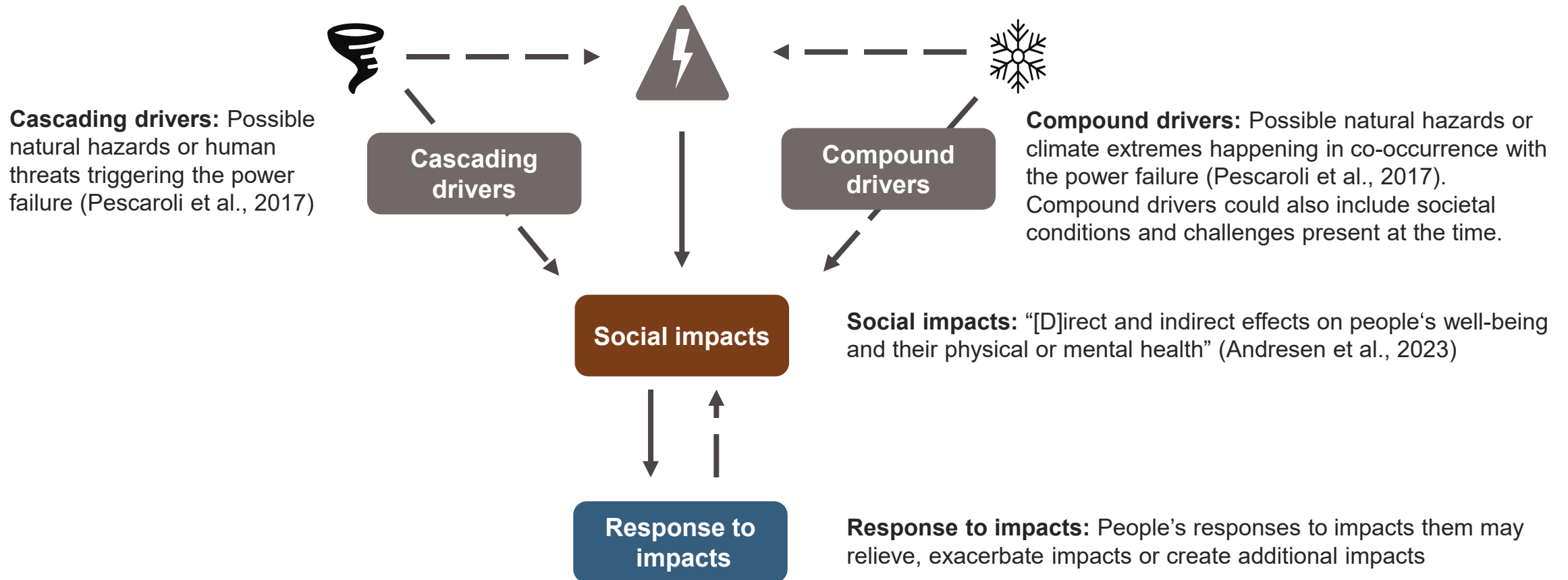
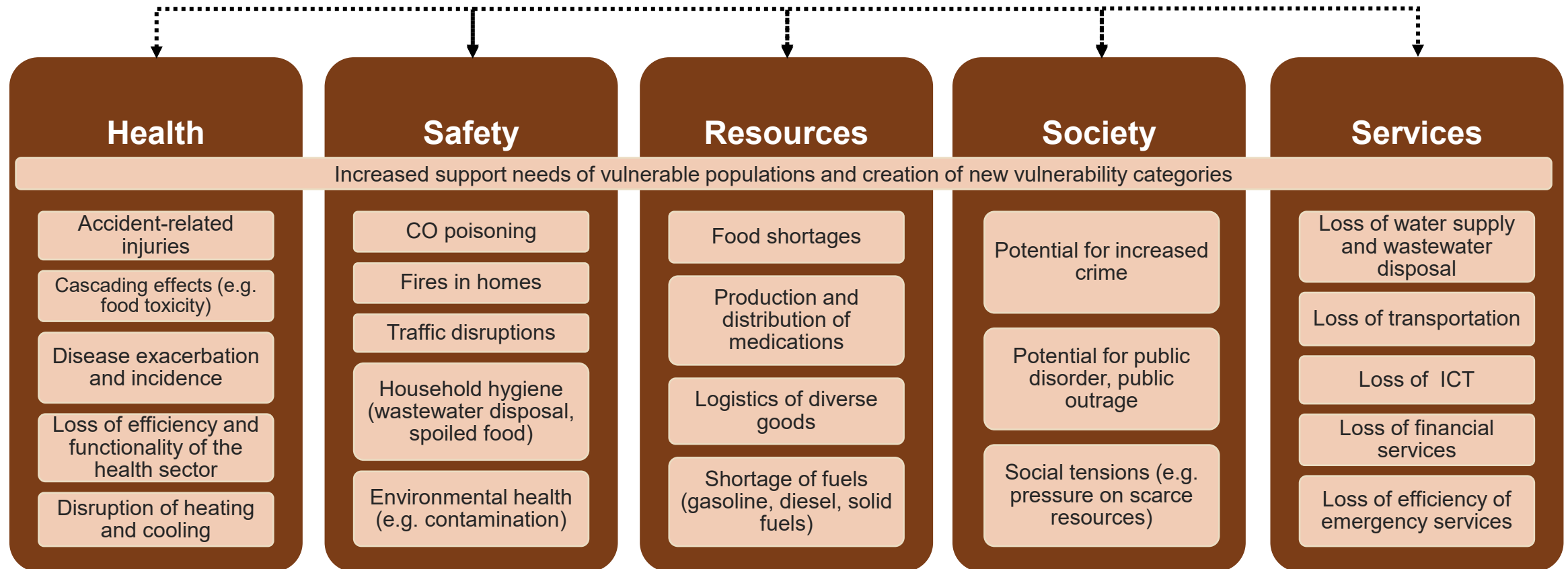


Figure adapted from Pescaroli et al. (2017)

Overview of impacts. Social impacts are diverse and range from health and safety issues and resource shortages to threats to social cohesion. They affect different social groups to varying degrees. Interactions between impacts are likely.



For overview of impacts see Pescaroli et al. (2017) and Federal Office for Civil Protection (BABS, 2020)

Health impact. Power outages are likely to trigger injury and disease and exacerbate existing disease. Mortality is expected to increase. Emergency department visits and casualties are commonly used in assessing social outcomes.

Vulnerability factors

Access to back-up power source

Age (young and old)

Baseline health status

Housing

Marginalized populations

Occupation

Socioeconomic status

Social support

Incident disease	– CO poisoning – Gastrointestinal illness – Heart attack – Injury – Mental health – Renal disease – Temperature-related illness
Disease exacerbation	– Respiratory conditions – Cardiovascular disease – Kidney failure – Mental health – Perinatal health – Prescription refills – Sleep problems
Mortality	– Higher rates of mortality are expected, especially when outages are due to weather events, but questions remain to which extent and coinciding factors.

Co-occurring factors

Air pollution

Disorder/disruption of everyday life

Displacement/evacuation

Loss of communication services

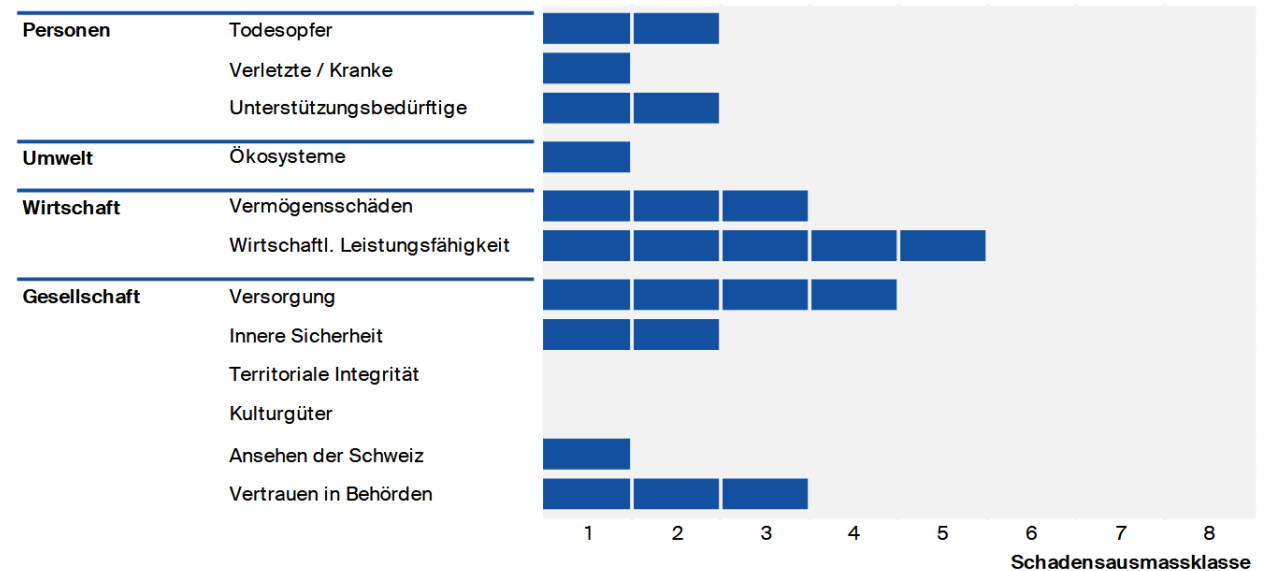
Motor vehicle collisions

Temperature extremes

Overview adapted from Casey et al., 2020. See also Jessel et al., 2019. In some cases, a methodological challenge lies in contributing health impacts, for example injuries, to power outages rather than co-occurring exposures.

Insights about social impacts of power outages in Switzerland.

- The impacts described in the scenario in the „Gefährdungsdossier Stromausfall“ by the Federal Office for Civil Protection (BABS, 2020) largely match the impacts included in this chapter.
- The described scenario “gross” (physical damage to grid infrastructure, multiple cantons, 2-4 days, summer) affects 10 out of 12 „damage indicators“.
- The societal dimension of indicators includes significant damage to the trust in authorities. Media reporting in particular is expected to be critical and focused on deficits, putting additional pressure on authorities and emergency services. This aspect (including social media) appears to be underappreciated within the scientific literature included in this analysis.



Comment by the authors of this literature analysis: The current literature analysis does not inform about social impacts of power outages in Switzerland specifically, since empirical research is limited (no study found, see chapter “limitations”). Identifying and analysing expected impacts of power outages on different population groups in Switzerland is a key outcome of WP3.

RQ2 chapter summary. 4 take-aways about the social impacts of power outages.

- 1) **Impacts of power outages on the population are broad and affect many if not most areas of normal everyday life.**
- 2) **Social impacts result from**
 - i. the loss of power and related services
 - ii. cascading and compound drivers
 - iii. societal and behavioural responses to the impacts from i. (power loss and related service disruption) and ii. (cascading and compound drivers).
- 3) **Power outages are likely to trigger injury and disease and exacerbate existing disease (mental and physical).**

Mortality is expected to increase. Emergency department visits and casualties are commonly used in assessing social outcomes.
- 4) **Not everyone is equally vulnerable to all impacts.** While some impacts have the potential to affect all or most people, others relate to certain characteristics like location, health status and preparedness and therefore disproportionately affect some.
- 5) **Impacts not only vary between population groups but also depend on event-specific circumstances of the outage.** For example, its duration, its cause, the availability of external resources, co-occurring factors, etc.

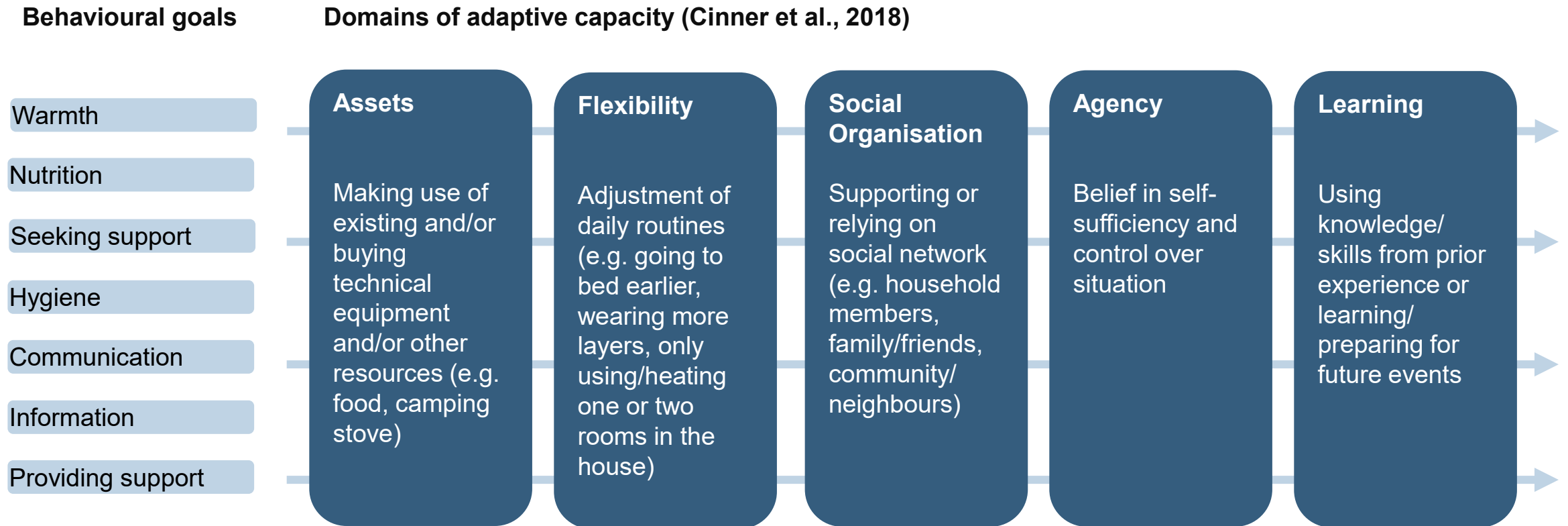
RQ3: What is the expected behavioural
response to power outages?

Conceptualising behavioural responses to power outages. Behaviours can be categorized by whether and to whom they are beneficial. Individual actions can be in synergy or in conflict with individual and collective interests.

- The behavioural response of the population during an outage influences its outcomes (Holenstein & Köng, 2014).
- Adaptive behaviours benefit the individual or society, maladaptive behaviours do not (Milsten et al., 2024).
- It is important to consider mechanisms of vulnerability transfer from i) one individual or group to another, ii) one risk to another, iii) short-term to long-term vulnerability (Sapounatzki, 2007).

	Benefits society	Does not benefit society
Benefits the individual	Many adaptive behaviours that serve the individual in turn benefit society/other people by relieving public services, e.g. <i>making use of existing resources</i>	Some behaviours, including anti-social behaviours, may benefit the individual at the expense of wider society, e.g. <i>excessive help-seeking behaviour, panic-buying, criminal behaviour such as looting</i>
Does not benefit the individual	Some behaviour, including pro-social behaviours, may come at a personal cost to the benefit of wider society, e.g. <i>care-giving, acts of altruism</i>	Some behaviours may neither benefit individuals nor society, e.g. <i>unsafe use of equipment, panic</i>

Adaptive behavioural response. Adaptive behaviours reduce vulnerability and typically prioritize immediate health and well-being. Behavioural goals are achieved by different means which are not necessarily the result of conscious preparation efforts.



The domains of adaptive capacity were originally applied to climate change (Cinner et al., 2018) but correspond well to findings about the behavioural response to power outages. For behavioural response to power outages see for example: Cox (2023); Ghanem et al. (2016); Heidenstrøm & Throne-Holst (2020); Rubin & Rogers (2019); Chakalian et al., (2019).

Communication: Communication plays an important role in determining social outcomes. During a power outage people make efforts to receive official information and maintain or re-establish contact with significant others.



Crisis communication

- Proactive and reactive communication play an important role in determining social outcomes (Ptak et al., 2025). People rely on information to understand what steps they should take. Most common information requested: “What has happened?” and “When is the supply likely to return?” (Rubin & Rogers, 2019).
- Additional information needs: health and safety issues (e.g. the safety of drinking water), where to evacuate to, how to care for the elderly, how to deal with refrigerated medicine, spoiled food or electrical equipment, whether job security is affected if transport to work is unavailable (Rubin & Rogers, 2019).
- *Barriers to accessing, understanding and reacting:* Functional impairments, single-language messaging, limited mental capacity, complex, confusing or contradicting information, distrust towards source of information are some factors that can lead to information not being accessed, understood or acted upon (Hansson et al., 2020).



Communication and mobile devices

- Communication with others is a key need and potential stressor. Several studies identify communication between members of the public as a priority. Loss of communication networks during disasters (e.g. terrorist attacks) has been documented to significantly add to stress (Rubin & Rogers, 2019).
- People prioritize charging phones, making repeated efforts to use phones despite connection difficulties (Ghanem et al., 2016).
- Losing phone contact has been described as “scary” (Rinkinen, 2013) and “isolating” (Cox, 2023).
- People may not expect to lose mobile coverage and therefore, they may be more severely impacted by it (Cox, 2023).
- Some people may depend on their smartphone for medical reasons, e.g. to measure blood sugar (Cox, 2023).

Providing and seeking support. Importantly „the ability of households to respond to power outages [...] depends not only on the household itself, but also on other actors and the social resilience of the wider community [...]“ (Ghanem et al., 2016, p.137).



Providing support

- Acts of altruism are likely to outweigh criminality and can be encouraged (Rubin & Rogers, 2019).
- Especially in the short term, positive aspects of humanity appear to be brought out, for example as "acts of spontaneous humanity" such as sharing water or information, assisting people over barriers and members of the public taking on roles such as directing the flow of traffic (Rubin & Rogers, 2019).
- In many cases, people proactively take on responsibility in caring for vulnerable people or follow official requests to do so (e.g. providing warmth, food or shelter; Rubin & Rogers, 2019).
- Collective strategies can be crucial for the care of vulnerable people, especially in long-duration outage scenarios, and relieve emergency services (Rubin & Rogers, 2019).



Seeking support

- Increased help-seeking behaviour is likely among vulnerable populations and can burden health, social and emergency services (Rubin & Rogers, 2019; Ptak et al., 2025).

For description of how people helped each other out during an outage in Great Britain see for example: Ghanem et al. (2016)

Maladaptive behavioural response. Pro-social behaviours are likely to outweigh anti-social behaviours. Problematic behaviours may lead to secondary impacts like health and safety threats, burden public services and complicate restoration.

- Panic and criminality during disasters tend to be exaggerated by the media which could lead to inappropriate public resource allocation (see for example Andresen et al., 2023; Milsten et al., 2024; Holenstein & Köng, 2014; Petermann et al., 2011; Rubin & Rogers, 2019).
- According to Cox (2021, p. 1) historical contexts influence whether societies respond with cohesion or conflict to outages; “In cases where the societal context at the time was one of poverty, inequality, cuts to public services, corruption or racial tension, then disruptions have been associated with disorder, violence and crime”.
- Uncertainties across variables like communication, access to nutrition, health or mobility were found to increase risk behaviours, especially when external assistance is not available (Ptak et al., 2025).

	Examples	Possible implications
Maladaptive practical response	• Consumption of spoiled food (Andresen et al., 2023) • Unsafe use of (technical) equipment (e.g. generator-related, candles etc.) (Andresen et al., 2023) • Remaining at home without heating (Rubin et al, 2019) • Consumption of false information (Rudolph-Cleff et al., 2022)	• Health impacts (e.g. injury, gastro-intestinal illness, CO poisoning) • Safety impacts (e.g. fire) • Burden on emergency services • Security issues • Public disorder/outrage • Limited adaptive capacity (e.g. ill-informed decisions)
Maladaptive emotional response	• Drug abuse (Andresen et al., 2023) • Panic (Rubin et al, 2019)	• Burden on emergency services • Security issues/public disorder
Crime	• Pro- and anti-social looting (Andresen et al., 2023)	• Burden on emergency services • Security issues/public disorder • Complication of restoration
Counter-productive response	• Excessive use of mobile network (e.g. help-seeking via emergency calls, contact with other) • Intense use of electricity after it has been restored	• Mobile network overloading • Complication of restoration

Emotional response. A positive emotional response is possible in the short-term. Uncertainty, responsibility and loss of communication contribute to negative emotional response.



A positive emotional response is more likely

- in the short-term
- if preparedness and competences help normalize the experience
- when everyday practices can be upheld in an adapted form
- when needs are met

Positive response may include

- a sense of „cosiness“
- more social interaction
- increased feeling of community
- “downtime”, e.g. related to enforced time off work, earlier bedtimes
- enforced „digital detox“



Positive effects are less likely

- under uncertainty (e.g. about likely duration of outage, safety of friends/family)
- with responsibility for vulnerable children, adults or livestock
- when the mobile communications network has failed (increased stress)

Positive short-term effects are likely to wane the longer the exposure lasts. Longer outages may induce anger. Levels of concern may be influenced by prior expectations, e.g. an outage lasting longer than previously announced.

Insights about the behavioural response of the population in Switzerland to power outages.

- Switzerland has not been affected by large scale power outages (or comparable disasters, excluding the Covid pandemic) in recent times.
- While there appears to be an increasing concern in the population about power outages, the population in Switzerland has little to no experience with them. This, and the fact that more than two thirds of a representative sample wished they knew more about how to prepare for and what to do in the case of a power outage, potentially indicate a need for fostering knowledge and competencies within the Swiss population (Maduz et al., 2018).
- The lack of practical experience is reflected in a lack of empirical research specifically about Switzerland.

Comment by the authors of this literature analysis: Identifying and analysing likely responses to the impacts of a power outage in the population of Switzerland is a key outcome of WP3. Insights of experiences from other countries reflected in the research help in informing data collection (e.g. generate hypotheses).

RQ3 chapter summary. 5 take-aways regarding the behavioural response to power outages.

- 1) **According to the literature, people generally behave adaptively and find ways to normalize the experience of a power outage** by making use of available resources, adjusting routines, gathering helpful information and seeking or providing support to fulfil basic needs.

Existing research highlights the importance of accurate information and communication among social networks in enabling adequate practical and emotional responses.

- 2) **Maladaptive behaviours often result from attempts to cope practically and emotionally and have potential negative implications** for the individual and/or others.

Despite being less frequent, maladaptive responses should be considered and where possible prevented to limit vulnerability transfers, secondary impacts, relieve emergency services, and efficiently use resources during outages.

- 3) **Disturbances to public order and anti-social behaviours may occur under certain circumstances** – for example, when existential needs are not met – but are generally expected to be less common than pro-social behaviours.

- 4) **As is the case with impacts, behavioural responses can be influenced by differences in vulnerability.** For example, carbon monoxide poisoning from unsafe generator use has been shown to be more prevalent among non-native English speakers in the U.S. who may have more difficulty in understanding safety warnings. Similarly, some people (like those with caring responsibilities) are more likely to respond emotionally negatively to power outages.

- 5) **Behavioural responses vary depending on the specific circumstances of the outage** (e.g. cause, duration, availability of external resources, co-occurring factors, etc.).

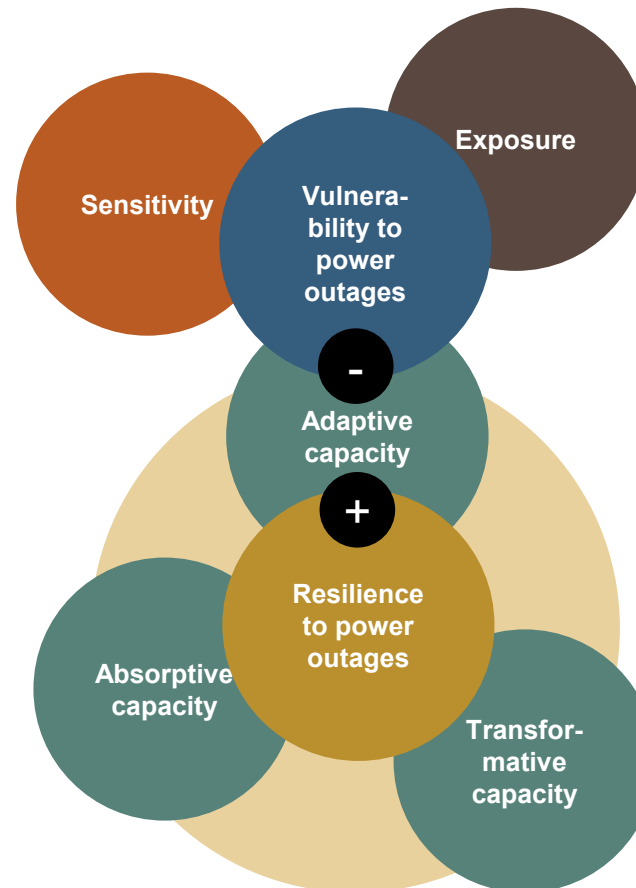
RQ4: How can the social **resilience** to power outages be enhanced?

Conceptualising social resilience I. Expanding engineering perspectives on energy system resilience to include end-users is important to understand and promote protective factors in power outage exposure.

Social resilience is not the absence of adversity but “the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change” (Adger, 2000, p. 347).

It enables “to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events. Enhanced resilience allows better anticipation of disasters and better planning to reduce disaster losses—rather than waiting for an event to occur and paying for it afterward” (National Research Council, 2012, p.1).

Levels of analysis: Communities, households, demographic groups, individuals etc.



Connecting vulnerability and resilience

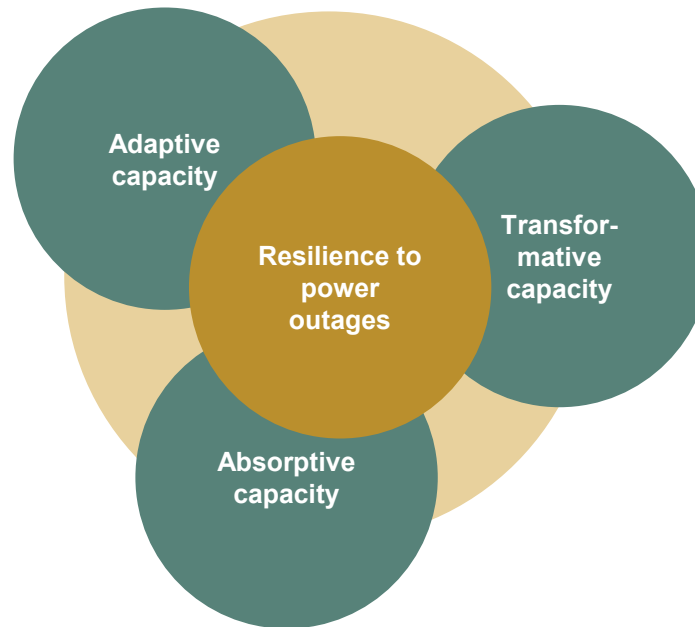
- Resilience can be seen as the „flip side of vulnerability“ (IPCC, n.d.). Both concepts relate to the question of the circumstances under which disturbances have more or less destructive impacts (BBK, 2019) and about responding to them (Adger, 2006).
- Adaptive capacity has been conceptualised as a common component between vulnerability and resilience. While adaptive capacity is negatively related to vulnerability, it is positively related to resilience. Therefore „increased resilience frequently results in decreased vulnerability“. (Lanlan et al., 2024, p. 19083)

Fig. adapted from Lanlan et al., 2024; for a comprehensive review of the theoretical resilience concept: Béné et al., 2012

Conceptualising social resilience II. Differentiating resilience capacities may be useful in understanding the social dimension of power outages. For example, different capacities may have to be mobilized depending on severity, vulnerability and level of agency.

Social resilience to stressors is commonly defined in terms of the capacities to

- **absorb**, i.e. the capacity to moderate or buffer impacts of shocks („bounce back“).
- **adapt**, i.e. the capacity to make adjustments in anticipation of or response to change in order to moderate or cope with damages.
- **transform**, i.e. the capacity to make fundamental changes if required (e.g. address the causes of risk).



In the case of power outages different capacities may have to be mobilised depending on the

- **Severity** of the disruption. For example, short-term outages may be absorbed without significant dysfunction, whereas long-term outages will require adaptations.
- **Individual household vulnerability**. For example, a household with backup energy supply may be able to absorb impacts without significant adjustments while another cannot.
- **Level of agency**. For example, which capacity is required by individuals, communities, households, in different regions etc.

Comment by the authors of this literature analysis: While the power outage literature included in this analysis typically does not differentiate between resilience capacities, it is a common differentiation used in risk and vulnerability reduction research that may be applied to power outages in a helpful way.

For one definition of the resilience capacities: Jeans et al., 2017; comprehensive review of the theoretical resilience concept: Béné et al., 2012.

Enhancing social resilience I. Communication before and during outages supports adaptive capacity and reduces maladaptive behaviours.



Crisis communication

Before outages

- Attempts to prepare the public may have greater impact if they emphasize the reality of the risk. (Rubin & Rogers, 2019) While necessary, the impact of preparedness communication may still be limited, according to Cox (2023) as long as outages are rare.
- Promotion of protective behaviours through social marketing campaigns to limit health impacts should ideally be developed and tested in advance (Ptak et al., 2025; Rubin & Rogers, 2019).

During outages

- Transparent communication about cause and estimated duration is likely to shape people's responses, encourage adaptive behaviours and reduce anxiety (Rubin & Rogers, 2019).



- Challenges in accessing, understanding and reacting to accurate information should be anticipated and reduced (e.g. providing safety information in multiple languages) (Ptak et al., 2025).
- Public interventions to promote helpful interactions between members of the public are likely to have a positive effect (Rubin & Rogers, 2019).



Enabling communication

- Re-establishing the communications network should be prioritized and is likely to help reduce levels of distress (Rubin & Rogers, 2019).

Enhancing social resilience II. Efforts to prepare the public should focus on community resilience and target vulnerable groups.



Vulnerable groups

- Anticipating reactive behaviours among vulnerable populations and preparing them could help reduce burden on public services (Ptak et al., 2025).
- Material support for economically vulnerable groups may increase adaptive capacity and reduce criminal activity during outages (Andresen et al., 2023).
- Supporting the health of vulnerable groups via measure like assisted preparation of people relying on medical devices, pre-disaster notifications to refill prescriptions, pre-care at healthcare facilities to allow individuals to go safely without power for longer, low-tech interventions to reduce likelihood of carbon monoxide poisoning, mobile clinics (Casey et al., 2020).



Community resilience

- Means to increase individual preparedness are less available among disadvantaged groups and individual preparedness may be lower in the case of unplanned events. Bolstering community resilience can help address this problem. Resilient communities deploy collective strategies such as community kitchens, checking on older adults, and providing each other with warmth, food, and shelter during outages (Casey et al., 2020).
- Heidenstrøm & Throne-Holst (2020, p. 9) propose local participatory approaches in developing community preparedness plans. Including “households’ expertise on their own everyday life” can be “empowering” and provide “vital input” while also increasing the potential for consensus and implementation by households.

“Switzerland’s focus on disaster risk reduction”. Selected insights from the Working Group on DRR about how to mitigate risks, reduce vulnerabilities and build resilience.

1) Enabling environment

- Hazards hit local communities; therefore, risk management should be well anchored at sub-national and local levels.
- Participation of communities is key in strengthening their resilience. Participation of all actors, including those most at risk must be ensured.

2) Know your risk

- Societies need to understand risks and their consequences in depth to effectively deal with them.
- The severity of hazardous events depends on vulnerabilities and insufficient capacities or measures to cope with their consequences. More systematic attention needs to be paid to the changes in vulnerability and exposure of people and assets.

3) Prevent and mitigate risks

- High vulnerability and low capacities due to inadequate access to resources and difficulties making a living, poverty, poor governance, discrimination, exclusion and inequality lower resilience against shocks and stresses and heighten the risk of falling into the poverty trap. Reducing the root causes of vulnerability is anchored in Switzerland’s development agenda.

4) Prepare for a better response and build resilience

- Strengthen individual as well as institutional preparedness efficiently through well-coordinated and combined measures.
- Response actions include saving lives, reducing negative health impacts, ensuring public safety and meeting basic subsistence needs of people affected.
- Training programs should include ordinary people and communities who are often first responders.
- Early actions include evacuating people at risk, reinforcing infrastructure etc.
- The aftermath of an event – when political will is often high, and communication is more effective – should be used to reduce future disaster risk.

Comment by the authors of this literature analysis: Identifying non-technical measures to enhance the resilience of the Swiss population to power outages is an outcome of RECIPE’s WP5.

Selected insights from the Working Group on DRR’s Input Paper to the 7th Session of the Global Platform for DRR 2022 (BAFU, 2022)

RQ4 chapter summary. 4 take-aways about enhancing resilience to power outages.

- 1) **Expanding engineering perspectives on energy system resilience to include end-users is important** to understand and promote protective factors in power outage exposure.
- 2) **Social resilience is the ability of societies (communities, households, individuals etc.) to cope in the presence of adversity.** One important element of resilience is the capacity to adapt, i.e. to make adjustments when exposed to a power outage.
- 3) **In the case of power outages different resilience capacities may have to be mobilised** depending on the
 - Severity of the outage event
 - Individual household vulnerability
 - Level of agency
- 4) **Resilience enhancement measures proposed in the literature include**
 - Enabling people to **rely on themselves** by responding adequately prior to and during outages. For example, through communication.
 - Enabling people to **rely on each other** by fostering community resilience and collective strategies.
 - **Supporting vulnerable groups** prior to and during outages.

Research gaps, scope and limitations

Research gaps identified in the literature.

Sensitivity

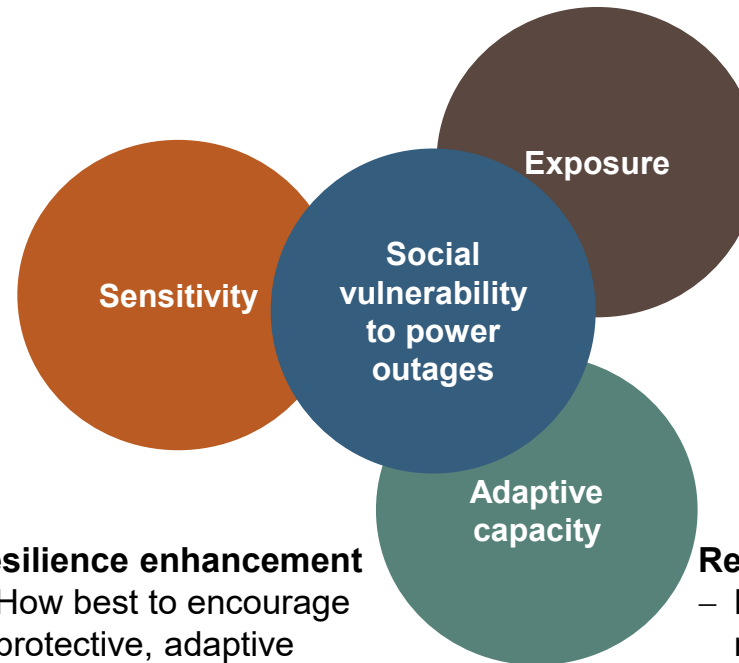
- Inequalities due to demographic variables (Andresen et al., 2023)
- Vulnerability of specific demographics
 - older and rural populations, children, people with cognitive impairment/functional limitations; Casey et al., 2020
 - (Young) urban households (Cox, 2021)

Types of impacts

- Financial impacts (e.g. from inability to work; Andresen et al., 2023)
- Timescale of impacts beyond short-term impacts (Casey et al., 2020)

Resilience enhancement

- How best to encourage protective, adaptive responses before and during outages (e.g. key features of effective messaging; Rubin & Rogers, 2019)



Spatial and temporal dimension of power outages

- Impacts of more frequent short duration outages compared to longer and less frequent outages (Andresen et al., 2023)
- Impacts of outages that are lengthy and widespread (Cox, 2021)
- Impacts of repeated outages (Casey et al., 2020)
- Seasonal variation of impacts (Andresen et al., 2023)
- Relationship between location of outage and impacts (Casey et al., 2020)

Response

- Limited evidence-base regarding people's reactions to major power outages, often relying on small opportunity-driven sampling (Rubin & Rogers, 2019)
- Lack of evidence regarding specific areas of response (e.g. behaviour around evacuation, work and purchasing behaviour; Rubin & Rogers, 2019)

Research gaps identified through the literature analysis and preliminary findings of expert interviews.

Sensitivity

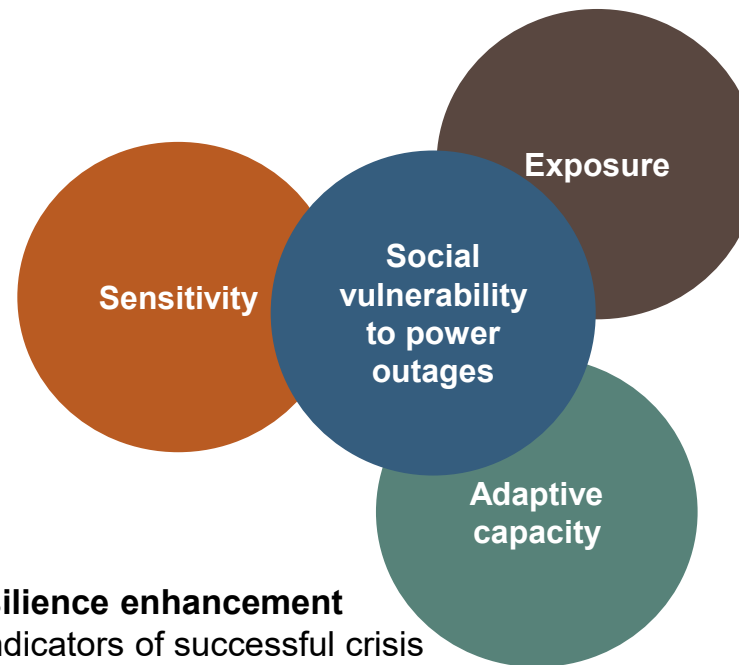
- Vulnerability of specific groups (refugees, prison inmates, tourists, (unattended) children)

Types of impacts

- Impacts outside the home vs. inside the home, i.e. if household members are not home at time of outage (e.g. being stuck and unable to collect children from school)
- Impacts during the “restoration phase”, when electricity has returned but supply is not yet sufficient/stable, potentially leading to more disruptions, necessitating rotating blackouts etc.

Resilience enhancement

- Indicators of successful crisis management regarding the social outcomes of power outages



Circumstances of power outages

- Expected vs. not expected outages
- Time of onset (e.g. night-time/early morning vs. midday)
- Cause of event (e.g. human-made vs. naturally caused)

Response

- Variations in response depending on context of outage
- In-depth consideration of current/recent societal trends, e.g. growing digital dependency, social media dynamics, electrification of transport and in the home, ...

Scope and limitations

Limitations in existing research.

Methodical limitations

- Large scale power outages do not frequently occur and their impacts on populations are complex to research empirically.
- Studies usually analyse retrospectively after real events, which does not allow for systematic variation of attributes and types of disturbances, and it is often difficult to attribute outcomes directly to power outages (e.g. in the case of natural disasters).

Data availability and quality

- Social impacts of power outages are a relatively young (but growing) field of research. Multiple research gaps were identified in the literature as well as through this analysis.
- Events are usually large-scale outages following extreme weather events.
- In many cases mixed, weak or lack of evidence does not allow for clear, directional hypotheses.
- While the research included in this analysis is relatively recent, certain societal developments may not yet be reflected sufficiently (e.g. increasing psychological digital dependency, electrification of mobility and homes etc.).

The research included in this analysis was primarily conducted in the global north (US, UK, Scandinavia, Netherlands etc.).

Limitations of this literature analysis

Scope

- The analysis is non-exhaustive and serves as a basis to conceptualise the social implications of power outages, facilitating further research and discussion among project partners as well as stakeholders.

Transferability of findings to the Swiss context

- As most scientific research evaluates the social impacts from real power outage events, research from/about Switzerland – which to the best of our knowledge does not (yet) exist – could not be included in this analysis. While a degree of transferability can be expected, it's important to consider that certain contextual differences may still come into play, including differences in social structure (e.g. age structure of population, proportion of urban vs. rural population, income distribution etc.), in prior experience of the population, in infrastructure, political structure (e.g. federalism) and more (Holenstein & Köng, 2014).
→ To address this limitation, sources about Switzerland ("grey" literature, relating to disasters more generally) have been and will continue to be included in this document.

References

References

Adger, W. N. (2000). Social and Ecological Resilience: Are They Related? *Progress in Human Geography*, 24(3), 347–364. <https://doi.org/10.1191/030913200701540465>

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281. <https://doi.org/10.1016/j.gloenvcha.2006.02.006>

Andresen, A., Kurtz, L., Hondula, D., Meerow, S., & Gall, M. (2023). Understanding the social impacts of power outages in North America: A systematic review. *ENVIRONMENTAL RESEARCH LETTERS*, 18(5). <https://doi.org/10.1088/1748-9326/acc7b9>

BABS. (2020). Gefährdungsdossier Stromausfall (Nationale Risikoanalyse «Katastrophen und Notlagen Schweiz») [Gefährdungsdossiers und Szenarien]. Bundesamt für Bevölkerungsschutz. <https://www.babs.admin.ch/de/gefaehrungsdossiers-und-szenarien>

BBK. (2013). Kapazitäten der Bevölkerung bei einem Stromausfall: Empirische Untersuchung für das Bezugsgebiet Deutschland (No. 12; Praxis im Bevölkerungsschutz). https://www.claytonhusker.de/archiv/Band_12_PraxisBS_Stromausfall.pdf

BBK. (2019). Stromausfall – Grundlagen und Methoden zur Reduzierung des Ausfallrisikos der Stromversorgung (Bd. 12). Bundesamt für Bevölkerungsschutz und Katastrophenhilef. https://www.bbk.bund.de/SharedDocs/Downloads/DE/Mediathek/Publikationen/WF/WF-12-stromausfall.pdf?__blob=publicationFile&v=

Béné, C., Godfrey Wood, R., Newsham, A., & Davies, M. (2012). Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes [Report]. The Institute of Development Studies and Partner Organisations. https://opendocs.ids.ac.uk/articles/report/Resilience_New_Utopia_or_New_Tyranny_Reflection_about_the_Potentials_and_Limits_of_the_Concept_of_Resilience_in_Relation_to_Vulnerability_Reduction_Programmes/26454337/1

References

- BFS. (2018). Dienstleistungen für die Bevölkerung und regionale Disparitäten—Distanzen zu den Alltagsdienstleistungen im Jahr 2015 (No. 21 Nachhaltige Entwicklung, regionale und internationale Disparitäten; BFS Aktuell). Bundesamt für Statistik. <https://www.bfs.admin.ch/asset/en/6468358>
- Brooks, N. (2003). *Vulnerability, Risk and Adaptation: A Conceptual Framework*. Tyndall Centre for Climate Change Research and Centre for Social and Economic Research on the Global Environment. https://www.researchgate.net/publication/200032746_Vulnerability_Risk_and_Adaptation_A_Conceptual_Framework
- Casey, J., Fukurai, M., Hernández, D., Balsari, S., & Kiang, M. (2020). Power Outages and Community Health: A Narrative Review. CURRENT ENVIRONMENTAL HEALTH REPORTS, 7(4), 371–383. <https://doi.org/10.1007/s40572-020-00295-0>
- Chakalian, P. M., Kurtz, L. C., & Hondula, D. M. (2019). After the Lights Go Out: Household Resilience to Electrical Grid Failure Following Hurricane Irma. In NATURAL HAZARDS REVIEW (Bd. 20, Nummer 4). ASCE-AMER SOC CIVIL ENGINEERS. [https://doi.org/10.1061/\(ASCE\)NH.1527-6996.0000335](https://doi.org/10.1061/(ASCE)NH.1527-6996.0000335)
- Cinner, J. E., Adger, W. N., Allison, E. H., Barnes, M. L., Brown, K., Cohen, P. J., Gelcich, S., Hicks, C. C., Hughes, T. P., Lau, J., Marshall, N. A., & Morrison, T. H. (2018). Building adaptive capacity to climate change in tropical coastal communities. Nature Climate Change, 8(2), 117–123. <https://doi.org/10.1038/s41558-017-0065-x>
- Cox, E. (2021). Resilience of the future energy system: The impacts of energy disruptions on society. The UK Energy Research Centre. <https://ukerc.ac.uk/publications/the-impacts-of-energy-disruptions-on-society/>
- Cox, E. (2023). "I hope they shouldn't happen": Social vulnerability and resilience to urban energy disruptions in a digital society in Scotland. Energy Research & Social Science, 95, 102901. <https://doi.org/10.1016/j.erss.2022.102901>

References

- Dugan, J., Byles, D., & Mohagheghi, S. (2023). Social vulnerability to long-duration power outages. *International Journal of Disaster Risk Reduction*, 85, 103501. <https://doi.org/10.1016/j.ijdr.2022.103501>
- Ezzati, F., Xiao, Q., Dong, Z. S., Jiao, J., Vargas, A., Yeh, V., Ptak, T., & Pan, K. (2025). Power outage-risk integrated social vulnerability analysis highlights disparities in small residential communities. *Communications Earth & Environment*, 6(1), 294. <https://doi.org/10.1038/s43247-025-02278-1>
- Flores, N. M., McBrien, H., Do, V., Kiang, M., V., Schlegelmilch, J., & Casey, J. A. (2023). The 2021 Texas Power Crisis: Distribution, duration, and disparities. In *JOURNAL OF EXPOSURE SCIENCE AND ENVIRONMENTAL EPIDEMIOLOGY* (Bd. 33, Nummer 1, S. 21–31). SPRINGER NATURE. <https://doi.org/10.1038/s41370-022-00462-5>
- BAFU. (2022). *Switzerland's Focus on disaster risk reduction* [Input Paper to the 7th Session of the Global Platform for DRR (GP 2022)]. Working Group on DRR. https://www.shareweb.ch/site/disasterriskreduction/themes-and-resources/DOC_themesresources/Themes-and-resources/CH%20Focus%20on%20DRR%20for%20GP2022%20_29042022.pdf
- Ganz, S. C., Duan, C., & Ji, C. (2023). Socioeconomic vulnerability and differential impact of severe weather-induced power outages. *PNAS Nexus*, 2(10), pgad295. <https://doi.org/10.1093/pnasnexus/pgad295>
- Ghanem, D. A., Mander, S., & Gough, C. (2016). "I think we need to get a better generator": Household resilience to disruption to power supply during storm events. *Energy Policy*, 92, 171–180. <https://doi.org/10.1016/j.enpol.2016.02.003>
- Hansson, S., Orru, K., Siibak, A., Bäck, A., Krüger, M., Gabel, F., & Morsut, C. (2020). Communication-related vulnerability to disasters: A heuristic framework. *International Journal of Disaster Risk Reduction*, 51, 101931. <https://doi.org/10.1016/j.ijdr.2020.101931>
- Heidenstrøm, N., & Kvarnlöf, L. (2018). Coping with blackouts: A practice theory approach to household preparedness. *Journal of Contingencies and Crisis Management*, 26(2), 272–282. <https://doi.org/10.1111/1468-5973.12191>
- Heidenstrøm, N., & Hansen, A. R. (2020). Embodied competences in preparedness for blackouts: Mixed methods insights from rural and urban Norwegian households. *Energy Research & Social Science*, 66, 101498. <https://doi.org/10.1016/j.erss.2020.101498>
- Heidenstrøm, N., & Throne-Holst, H. (2020). "Someone will take care of it". Households' understanding of their responsibility to prepare for and cope with electricity and ICT infrastructure breakdowns. *Energy Policy*, 144, 111676. <https://doi.org/10.1016/j.enpol.2020.111676>
- Hernández, D., Chang, D., Hutchinson, C., Hill, E., Almonte, A., Burns, R., Shepard, P., Gonzalez, I., Reissig, N., & Evans, D. (2018). Public Housing on the Periphery: Vulnerable Residents and Depleted Resilience Reserves post-Hurricane Sandy. *Journal of Urban Health*, 95(5), 703–715. <https://doi.org/10.1007/s11524-018-0280-4>

References

Holenstein, M., & Köng, A.-L. (2014). Das Verhalten der Bevölkerung in Katastrophen und Notlagen [Schlussbericht Literaturstudie]. Stiftung Risiko-Dialog im Auftrag des Bundesamt für Bevölkerungsschutz.

IPCC. (n.d.). Working Group II: Impacts, Adaptation and Vulnerability. Chapter 1: Overview of Impacts, Adaptation and Vulnerability. Abgerufen 14. Oktober 2025, von <https://archive.ipcc.ch/ipccreports/tar/wg2/index.php?idp=60>

Jeans, H., Castillo, G. E., & Thomas, S. (2017). Absorb, Adapt, Transform: Resilience capacities. Oxfam. <https://policy-practice.oxfam.org/resources/absorb-adapt-transform-resilience-capacities-620178/>

Jessel, S., Sawyer, S., & Hernández, D. (2019). Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature. FRONTIERS IN PUBLIC HEALTH, 7. <https://doi.org/10.3389/fpubh.2019.00357>

Lanlan, J., Sarker, M. N. I., Ali, I., Firdaus, R. B. R., & Hossin, M. A. (2024). Vulnerability and resilience in the context of natural hazards: A critical conceptual analysis. Environment, Development and Sustainability, 26(8), 19069–19092. <https://doi.org/10.1007/s10668-023-03440-5>

Loni, A., & Asadi, S. (2024). Power System Resilience: The Role of Electric Vehicles and Social Disparities in Mitigating the US Power Outages. SMART GRIDS AND SUSTAINABLE ENERGY, 9(1). <https://doi.org/10.1007/s40866-024-00204-6>

Maduz, L., Prior, T., Roth, F., & Wolf, A. (2018). Individuelle Katastrophenvorsorge: Gefährdungswahrnehmung, Kenntnisse und Informationsbedürfnisse der Schweizer Bevölkerung. CSS ETH Zürich. <https://www.research-collection.ethz.ch/entities/publication/b0107cd1-c0b1-42fa-8198-f1e631848a17>

Maduz, L., Prior, T., Roth, F., & Käser, M. (2019). Individual Disaster Preparedness: Explaining disaster-related information seeking and preparedness behavior in Switzerland (Risk and Resilience Report). Center for Security Studies ETH.

Milsten, A. M., Kang, C. S., & Nemeth, I. (2024). Maladaptive behaviors in disasters: Case study evaluation of Hurricane Hugo, Hurricane Katrina and the Haiti Earthquake. Frontiers in Public Health, 12. <https://doi.org/10.3389/fpubh.2024.1396517>

National Research Council. (2012). *Disaster Resilience: A National Imperative*. The National Academies Press. <https://doi.org/10.17226/13457>

Pescaroli, G., Turner, S., Gould, T., Alexander, D., & Wicks, R. (2017). Cascading Impacts and Escalations in Wide-Area Power Failures (UCL IRDR and London Resilience Special Report 2017-01). Institute for Risk and Disaster Reduction, University College London.

References

- Petermann, T., Bradke, H., Lüllmann, A., Poetzsch, M., & Riehm, U. (2011). Was bei einem Blackout geschieht: Folgen eines langandauernden und großräumigen Stromausfalls. <https://publikationen.bibliothek.kit.edu/140085927>
- Ptak, T., Brooks, J., & Stock, R. (2025). A systematic review and typology of power outage literature: Critical infrastructure, climate change and social impacts. *RENEWABLE & SUSTAINABLE ENERGY REVIEWS*, 218. <https://doi.org/10.1016/j.rser.2025.115778>
- Ramos, A., & Meeus, L. (2024). Finding public outrage on social media during the Texas energy crisis. *Energy Research & Social Science*, 109, 103409. <https://doi.org/10.1016/j.erss.2023.103409>
- Rinkinen, J. (2013). Electricity blackouts and hybrid systems of provision: Users and the 'reflective practice'. *Energy, Sustainability and Society*, 3(1), 25. <https://doi.org/10.1186/2192-0567-3-25>
- Rubin, G., & Rogers, M. (2019). Behavioural and psychological responses of the public during a major power outage: A literature review. *INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION*, 38. <https://doi.org/10.1016/j.ijdrr.2019.101226>
- Rudolph-Cleff, A., Knodt, M., Schulze, J., & Engel, A. (2022). Crisis communication in a blackout scenario—An assessment considering socio-spatial parameters and the vulnerabilities of the population. *International Journal of Disaster Risk Reduction*, 72, 102856. <https://doi.org/10.1016/j.ijdrr.2022.102856>
- Sapountzaki, K. (2007). Social resilience to environmental risks: A mechanism of vulnerability transfer? *Management of Environmental Quality: An International Journal*, 18(3), 274–297. <https://doi.org/10.1108/14777830710731743>
- Schliesser, L. (2024). Blackout: Herausforderungen und Vorsorge. *CSS Analysen zur Sicherheitspolitik*, Nr. 353, 4 p. <https://doi.org/10.3929/ETHZ-B-000711405>
- Yoshikawa, T., Koide, D., Yokomizo, H., Kim, J. Y., & Kadoya, T. (2023). Assessing ecosystem vulnerability under severe uncertainty of global climate change. *Scientific Reports*, 13(1), 5932. <https://doi.org/10.1038/s41598-023-31597-6>
- Zimmermann, A., & Pescia, G. (2018). Notvorrat: Aktuelle Situation und Einflusskriterien. Bundesamt für wirtschaftliche Landesversorgung. <https://ira.agroscope.ch/de-CH/publication/39170>

Appendix

Keywords used in data collection

Disturbance		Topic		Level of analysis
blackout OR "energy disturbance" OR "gas disturbance" OR "gas shortage" OR "power shortage" "power cut" OR "power outage" OR "power loss" OR brownout OR "energy insecurity" OR "electricity outage" OR "power supply" OR "infrastructure disruption " OR "service disruption" OR "energy pric*" OR "energy rationing" OR "load shedding" OR "energy supply security"	AND	preparedness OR "adaptive capacity" OR vulnerab* OR "risk factors" OR "impact disparity" OR "risk disparity" OR behavio* OR perception OR "social resilience" OR "energy resilience" OR resilien* OR "household impact" OR "household resilience" OR "household energy resilience" OR "social impact" OR "community energy resilience" OR "health impact" OR response OR wellbeing OR hardship OR cognitive OR affective	AND	household* OR population OR soci* OR demographic OR psych* OR individual* OR people