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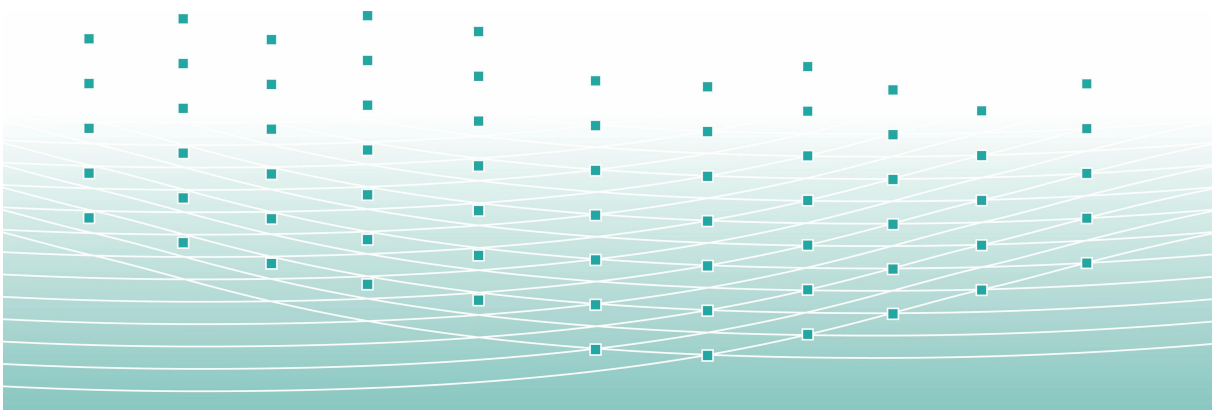
Power shortages

Improving the resilience of mobile networks

Public edition



Summary

In its decision of 7 December 2018, the Federal Council instructed DETEC (OFCOM), in cooperation with the EAER (FONES) and the DDPS (FOCP) and with the involvement of the telecommunications services sector, to examine improving the resilience of the mobile networks by means of emergency power supplies for telecommunications systems.

The content of the report to be presented[1] is an examination of how the population and the economy can continue to use key telecommunication services (emergency calls, data services, telephony, radio and TV programme services) in the event of a power shortage.

More than 20 supply scenarios, each with services to be provided and different population or geographical coverage levels – were used as the basis for cost-benefit analyses. For their part, mobile operators evaluated what operation of their networks remains possible in a power supply crisis and in particular estimated the essential number of transmitter sites which would have to be supplied with emergency power in the crisis. In the different supply scenarios, the costs of retrofitting the networks to protect them from power outages were determined and these were compared with the possible economic costs in the corresponding event of a crisis.

The analysis indicates that the resilience of mobile networks can be improved, with a comparatively favourable cost-benefit ratio, to protect against failure in the event of a power shortage or prolonged blackout. While the annual costs of the various supply scenarios to cover investment, maintenance and operation during the crisis add up to an amount in the double-digit millions (between CHF 40 and 90 million per year), the estimated benefit resulting from maintaining mobile radio network operation in the crisis is an amount in the three-digit millions (up to CHF 550 million).

Corresponding investments must be made by the mobile operators and a lot of effort is required to equip the networks with emergency power supplies. The issue of antenna sites in mobile communications is already strained. Requirements relating to an emergency power supply may further exacerbate the problem.

The majority of mobile operators have sold many antenna locations to third-party companies (so-called "tower companies") and leased them back for use. These ownership relationships can make it more difficult to implement security measures. The installation of a diesel generator unit for emergency power supply will not be possible at every transmitter site. In the case of existing sites, planning applications may be necessary for the installation of a diesel generator set. The acquisition of new locations may become more difficult. Future greener technologies, such as fuel cells, will alleviate these difficulties over time. The operation of emergency generators in a crisis, which is a rare occurrence, represents a logistical challenge which is not part of the daily routine of mobile operators. They will not be able to keep the necessary resources in reserve. Rather, tackling crises is a key task of public authorities. They could assist with the necessary logistics in the crisis. In addition, it will be necessary to examine how possible synergies can be exploited in implementing the improvement in the resilience of mobile networks by means of other public and private measures relating to emergency power supply. In particular, the project for the mobile broadband security communication system (MSC) within the civil protection framework is to be considered.

Article 48a para. 2 of the Telecommunications Act, which entered into force on 1 January 2021, provides a legal basis for the introduction of measures to improve the resilience of mobile networks.

However, the TCA does not provide a basis for the Confederation to participate in the necessary investments. Nor do the Civil Protection and Civil Defence Act (CPDA) or the National Economic Supply Act (NESA) provide for the possibility of funding improvements to the resilience of mobile networks. In the event of a crisis, however, the users of telecommunications services will benefit from increased security of network operation, which justifies passing on the costs via the subscription charges. According to the cost estimates, the additional monthly costs of the various supply variants

[1] This version of the report has been edited to remove sensitive personal data and commercial secrets.

are between CHF 0.30 to 0.70 per subscription per month. Since all the mobile network operators have to meet the same requirements, no market distortion is to be expected from the assumption of costs by the mobile operators.

As a first step towards ensuring operation in a power supply crisis, focusing on providing emergency services is recommended. This measure represents a sensible initial step in increasing the resilience of mobile networks because of its relatively low costs. A five-year implementation period is realistic.

The adoption of the necessary implementing provisions for realising the first stage must be provided for in the Telecommunications Services Ordinance (TSO). Together with other provisions relating to the implementation of Article 48a of the Telecommunications Act ("Security"), a public consultation must take place towards the end of 2021.

In the medium to long term, the objective is to secure the provision of mobile data services. According to the analysis, this scenario has the best cost-benefit ratio. The implementation period for this longer-term objective, the provision of mobile data services as well as possible intermediate steps must be determined in consultation with the mobile operators and within the framework of the necessary political processes.

Regulations relating to improving the resilience of the mobile networks will require considerable effort by mobile operators. Networks will be raised to a new level of security according to their importance to society and the economy. Even if direct funding by network operators is justifiable, the federal administration should contribute to this within the framework of its core competences and opportunities. The abovementioned logistics for the operation of emergency generators is one possibility.

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1 Starting point and objectives

1.1 Background

The economy and society are becoming increasingly dependent on the uninterrupted functioning of critical infrastructures. Critical infrastructures ensure the availability of key goods and services such as energy, communications or transport. In June 2012, the Federal Council adopted the National Strategy for Critical Infrastructure Protection (CIP) and updated it in December 2017.

According to the CIP, telecommunications are among the most critical infrastructures. Serious disruption of telecommunications services would impact the entire Swiss economy to an almost unimaginable extent, would have a massive adverse effect on the lives of the population and would greatly impede the work of the authorities. In the first months of 2020 there were, for example, a number of disruptions to Swisscom's network. These disruptions affected all customers and thus the whole country, with some vital services, such as emergency calls, affected. The population, politicians and the media reacted strongly to this. This response underlines the importance of telecommunications services for life today and for society's expectations in this regard. The importance of telecommunications is constantly growing in many areas of life and work.

With the national CIP strategy for 2018-2022, the Federal Council entrusted the competent specialist, supervisory and regulatory authorities in the telecommunications sector, as well as in all other sectors with evaluating serious risks. If necessary, the required measures to reduce the detected risks must be drawn up for the sectors.

The prerequisite for the functioning of the telecommunications infrastructure and for the provision of appropriate telecommunications services is to ensure a reliable power supply. In November 2009 the Federal Council and the administration first addressed the possible consequences of a power shortage as part of a two-day strategic leadership exercise (SLE 09). As part of the evaluation of the exercise, on 18 June 2010 the Federal Council instructed the EAER, together with the Departments and the Federal Chancellery, to analyse the effects of a power shortage in their own policy sector, to report to the Federal Council by mid-2011 and, if necessary, to submit proposals. This task was concluded with the "*Follow-up Report on the 2009 Strategic Leadership Exercise (SLE 09): Preparations for crisis-related supply shortages in the electricity sector"* of 27 June 2012. In particular, the report includes measures by the electricity sector to combat power shortages. It also highlighted the need for further clarification in a number of other sectors. In particular, proposals should be developed for appropriate measures to ensure the availability of essential telecommunications services during a power shortage.

As part of the 2014 Swiss Security Network Exercise (SNE 14), the availability of information and communication technologies in the event of a power shortage was examined in depth. The conclusions of SNE 14[2] feature a close correlation with those of SLE 09. In particular, there was a proposal to identify crisis-relevant systems which can be made more resilient for a proportionate cost and to examine possibilities to increase their availability in the event of power shortages.

Based on the findings of these two exercises, OFCOM and the FONES jointly drew up an overview of possible measures and summarised their results in an internal administration "*Report on ensuring telecommunications in the event of a power shortage* (*Bericht über die Sicherstellung der Telekommunikation bei Strommangellagen*)" of 6 July 2016. In order to supplement and define the possible measures and to estimate their costs and benefits, an external study[3] was subsequently carried out with the participation of major telecommunications service providers.

[2] https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-57427.html

[3] https://www.bakom.admin.ch/bakom/de/home/telekommunikation/zahlen-und-fakten/studien/sicherstellung-der-telekommunikation-bei-Power shortagen.html

On the basis of the findings from the preceding work, which were presented to the Federal Council in a DETEC discussion paper dated 7 May 2018 (EXE No. 2018.2354), the Federal Council decided on the further steps outlined below to ensure telecommunications in the event of a power shortage.

1.2 Federal Council decision of 7 December 2018

On the basis of the abovementioned discussion paper, the Federal Council decided in particular:

DETEC (OFCOM), in cooperation with the EAER (FONES) and the DDPS (FOCP) and with the involvement of the telecommunications services sector, shall examine improving the resilience of mobile networks by means of emergency power supplies to telecommunications installations. The cost-benefit ratio in relation to a crisis as well as the legal basis must also be examined. In addition, a contribution of the emergency power supply to the stabilisation of the power grids during quota fixing should be examined. A report must be presented to the Federal Council by the end of 2020 and appropriate proposals must be submitted to it.

1.2.1 Implementation

In order to implement the Federal Council's decision, OFCOM carried out a corresponding project, in which the FOCP, the FONES, the SFOE and the mobile network operators participated.

2 Other relevant projects related to improving the resilience of mobile networks

2.1 Temporary measures in the area of the OPNIR

By means of a temporary lifting of the equipment limit values for mobile radio systems in the Ordinance on Protection from Non-Ionising Radiation (OPNIR) based on the National Economic Supply Act (NESA), the failure of radio transmission systems can be partially offset in the event of a crisis by using increased transmitter power to bridge gaps in the network. To this end, the telecommunications service providers (TSPs) will be permitted to increase the transmitter power of mobile radio transmission systems which are still operational up to the immission limit value according to the OPNIR. This increases the range of the corresponding mobile radio transmission equipment, although not the capacity of the network. Thanks to the increased range, crisis-related gaps in coverage can be at least partially eliminated.

The measure can be applied in different scenarios. For example, it is conceivable to apply it in the event of physical damage to mobile radio transmission equipment, such as that which may occur, for example, during natural events (e.g. damage to transmitter masts due to storm damage). During a power shortage, the measure can be applied because only some mobile radio facilities have emergency power support. By increasing the transmitter power of the emergency powered mobile radio facilities, a desired geographical coverage can be maintained despite a reduced number of base stations.

2.1.1 Federal Council decision

The temporary lifting of the equipment limit value in the OPNIR was included in the Federal Council's December 2018 discussion paper on ensuring telecommunications in the event of a power shortage. It took the following decision in this regard.

The EAER (FONES), in cooperation with DETEC (FOEN, OFCOM), shall examine the possibilities and effects of a temporary non-application of provisions of the Ordinance on Protection from Non-Ionising Radiation of 23 December 1991 (OPNIR) with a view to increasing the permissible transmitter power of the most important mobile radio base stations. A report must be presented to the Federal Council by the end of 2020 and corresponding proposals must be submitted to it.

In accordance with the Federal Council's decision, the EAER (FONES) established a process in cooperation with the abovementioned federal agencies, which defines the temporary non-application of the equipment limit values in the OPNIR.

2.2 Mobile broadband security communication system (MSC)

The authorities and organisations responsible for rescue and security (AORS) communicate using the Polycom security radio system. This should work even during a power shortage or a blackout. With Polycom, however, only voice communication is possible. AORS, as well as the operators of critical infrastructures and other civil protection organisations need to exchange large amounts of data by mobile communications (access to search or other operational systems, etc.) in the event of a failure of public communication networks. This has not been possible to date. The Federal Office for Civil Protection FOCP, the cantons, operators of critical infrastructures and the army have therefore started work on a mobile broadband security communication system (MSC). This is intended for use in certain parts of existing and planned infrastructures of the public mobile operators and the civil protection partner organisations and to complement them with crisis-resistant and secure elements in such a way that mobile data communication is ensured in all locations for the federal government, cantons and third parties. By the end of 2023, various cantons will be carrying out a pilot project for this purpose in cooperation with the FOCP. A proposal for further action will then be submitted to the Federal Council.

There are some potential synergies between MSC and the present project which could be exploited. It must be taken into consideration that no final decision has yet been taken on the implementation of MSC and that MSC (and the associated funding from the Confederation and the cantons) is limited to the sphere of security communication. Accordingly, it will not be possible to ensure public mobile communications by means of mobile security communications facilities.

3 Power shortage

3.1 What is a power shortage?

In the context of this work, a power shortage is a serious shortage according to Article 102 of the Federal Constitution which industry cannot overcome on its own. Electricity supply and demand are no longer in balance for several days, weeks or months due to limited production, transmission and/or import capacities. Power shortages can occur, for example, when water levels in reservoirs are low, domestic electricity production is reduced as a result, and the deficit cannot be covered by additional imports.

3.2 Management measures

A power shortage necessitates coordinated management in accordance with the National Economic Supply Act (NESA). Various management measures can be taken to rebalance supply and demand.

- Appeals for savings
- Restrictions on consumption
- Electricity quotas
- Rolling blackouts (rotational load shedding)

Of these measures, rolling blackouts have the greatest impact on electricity consumers in general and the telecommunications companies in particular. This measure is therefore the main focus of this report. Electricity quotas are also of great importance for telecommunications because the TSPs' ability to save power without disrupting network operation is very limited.

3.3 Scenario

The present work is largely based on the *Electrical Power Shortage* scenario which is used in the Federal Office for Civil Protection FOCP national risk analysis of disasters and emergencies in Switzerland. It was developed by the Federal Office of National Economic Supply FONES, the Swiss Federal Office of Energy SFOE and the Federal Electricity Commission ElCom and has the following key values:

- Power under-supply 30%
- An appeal for savings to the population and businesses
- Consumption restrictions for certain applications for 12 weeks
- Quotas for large consumers for 12 weeks

- Restrictions on cross-border energy exchange, coordinated with neighbouring countries, for 12 weeks
- Temporary rolling blackouts for two weeks
- Uncontrolled power outages (total blackout) cannot be ruled out

It should be noted in this context that other versions of the scenario are also possible. The power shortage may be of shorter duration and without rolling blackouts or of longer duration with rolling blackouts for 16 weeks combined with several uncontrolled power outages. These variants must be taken into account when determining possible measures.

4 Other relevant risks

Measures to ensure nationwide security of telecommunications are in principle financially burdensome. It is also desirable to strive for them to be effective even in the event of other hazards. In many of the scenarios in the national risk analysis, the power supply may be affected, for example in the event of earthquakes, NPP accidents, storms or accidents at dams. Two particularly relevant risks are described in the following sections.

4.1 Blackout

A blackout is defined as a failure of the supply of electrical power, for example due to interrupted or damaged power lines, transformers or distribution nodes. The relevant FOCP risk dossier describes different scenario variants; the ‘large’ variant is designated as the basis for the detailed analysis. The key features of this scenario are:

- physical damage to network infrastructure
- affected area: several cantons with large conurbations (0.8 - 1.5 million people)
- time: summer
- complete outage in the affected area: 2- 4 days

As with the electrical power shortage, there are other scenario variants of both shorter duration in a smaller area and of longer duration (5 -7 days) throughout Switzerland.

4.2 Failure of information and communication technologies (ICT)

“ICT failure” has a broader scope than just telecommunications, but includes them. The FOCP's ICT failure risk dossier cites a failure of internet access as an example and lists a power failure as a possible triggering event. Depending on the characteristics of the threat, measures in the area of emergency power supply for telecommunications networks would be effective.

5 Measures to ensure telecommunications

5.1 Great importance of mobile networks

In today's fixed telecommunications networks, the terminals are no longer supplied with electrical energy by the telecommunications network. The operation of the fixed networks now depends, among other things, on the power supply at the users’ premises. In the case of rolling blackouts or a total blackout, the fixed-network connections therefore fail to much the same extent as those households which no longer have electricity.

Mobile phone terminals, on the other hand, are battery-powered and are inherently equipped for a certain period of time against local power outages. The development of mobile networks means they are becoming increasingly important, especially for the economy. The mobile networks are therefore becoming increasingly important for the country's provision of essential telecommunications services. It is therefore important that mobile networks are hardened accordingly. This applies to both the central locations of the service and network infrastructures and to antenna locations.

5.2 Supply scenarios

In order to evaluate an appropriate upgrade of mobile networks and in consideration of the cost-benefit ratio, supply scenarios were defined, each of which defines and prioritises telecommunications services which are of particular importance for the population with a view to possible different stages of upgrade.

The scenarios describe different general conditions which have to be considered for upgrading the networks. They are shown below in ascending order according to their scope and cost. In each case the subsequent expansion scenario includes the preceding requirements on a cumulative basis.

The five scenarios which build on each other are structured as follows. These are the so-called essential telecommunications services which are provided in the context of this work via mobile communications.

1. Emergency call services via mobile telephony for the entire population with reception outside buildings
2. Broadband data transmission for major routes and critical infrastructure locations
3. General voice telephony for the entire population with reception outside buildings
4. Broadband data transmission for the entire population with reception outside buildings
5. Reception of must-carry radio and TV programme services with existing subscriptions, such as blue TV from Swisscom or TV neo from Sunrise.

The scenarios also take into account different levels of population and geographical coverage (e.g. 50%, 80%, 100%).

For the different supply scenarios, an analysis of the respective benefits and the associated costs was subsequently undertaken.

5.3 Benefits of the supply scenarios

The calculation of the benefits of the supply scenarios is based on the FOCP's *Electrical Power Shortage* and *Blackout* risk analyses. In the case of the individual damage elements of the analyses, e.g. fatalities, reduction in economic performance, restrictions on order and internal security, it was estimated what available mobile phone coverage would contribute to improving the situation. This calculation was carried out for each of the two risks mentioned above[4] and for the mobile services considered. The financial value of the improvement in the respective situation due to functioning mobile networks represents the benefit of the corresponding mobile phone supply scenarios for the respective risk.

5.4 Cost of the supply scenarios

The calculation of the costs associated with the measures relating to a power shortage is based on information provided by the industry. The mobile network operators contributed with information about the network infrastructure and existing and additionally necessary emergency power supplies and the costs thereof. Further figures were provided by suppliers of emergency power supplies.

5.4.1 Necessary infrastructure

Based on the different supply scenarios, the participating mobile network operators calculated how many installations would need to be supplied with emergency power in order to ensure the appropriate coverage of telecommunications services.

In particular, the following two findings are important in this context:

- In order to ensure the supply of telecommunications services during the electrical power shortage, it is necessary to switch the mobile networks to a special radio network plan for the crisis. This switchover is a complex process which takes a lot of time. Emergency operation of

[4] "Electrical Power Shortage" and "Blackout "

the networks must therefore be applied continuously for the duration of the rolling blackouts. It cannot be switched back to normal operation during the periods when power is available.
- An increase in the transmitter power of base stations by temporarily lifting the precautionary OPNIR limits is an appropriate measure. Its effect is limited by the fact that terminals, e.g. mobile phones, cannot increase their transmitter power to the same extent as the base stations. The present report is therefore based on the existing OPNIR precautionary limits being complied with even in a crisis, in the sense of a "worst case scenario".

In all of the supply scenarios examined, it is necessary to maintain the fixed network infrastructure up to and including the local points-of-presence (PoPs). The supply scenarios differ mainly with regard to the necessary mobile base stations. For example, a network can provide a significant proportion of the population with the emergency call service with a few hundred base stations. On the other hand, a wide range of services, including radio and TV services, require several thousand base stations.

5.4.2 Investment

Investment in emergency power supply equipment and its installation represents the largest cost item. As a rule, the base stations have to be upgraded. The central locations of the highest network level are already equipped with autonomous diesel generators. However, these need to be adapted to meet the requirements of the power shortage, and this entails costs. Swisscom also has a number of mobile diesel generator units which can be used to maintain points-of-presence as required in the event of local incidents. However, additional diesel generators will be necessary in case of need to support the entire necessary infrastructure.

The default solution for dealing with a power shortage or a blackout are currently diesel generators, see also Section 8 *Future prospects*. The costing applied is based on this. Also included is a limited battery capacity to bridge a power failure until the diesel generator sets start up. The market already offers alternative solutions for power shortages which offer potential for a significantly lower carbon footprint on the one hand and on the other hand an energy supply which is independent of oil.

5.4.3 Maintenance

Emergency power supplies must also be maintained regularly when they are not being used. These maintenance costs are included in the calculation. Not included under maintenance are the costs associated with the use of the emergency power supplies in the event of necessity.

5.4.4 Operating costs

Using emergency power supplies in the crisis incurs operating costs. The key cost elements are:

- personnel costs for
  - refuelling
  - servicing,
  - monitoring / protection,
- fuel.

5.4.5 Total costs

In order to be able to represent and evaluate the total costs in a cost-benefit calculation in a meaningful way, they are converted into annual costs with the aid of corresponding depreciation periods and event frequencies.

5.5 Cost-benefit calculation

The result of the cost-benefit analysis is clear: while the annual costs of the various supply scenarios amount in each case to an amount in the double-digit millions (between CHF 38 and 92 million per year), the benefits of maintaining mobile operation during a crisis are of the order of an amount in the three-digit million range (up to CHF 550 million per year) on a per year basis.

All supply scenarios have a favourable cost-benefit ratio. Emergency call provision alone brings the least benefit but also involves the lowest costs. The supply scenarios with data service (including voice and emergency calls) feature the best cost-benefit ratio.

From the results it is apparent that, in order to deal with crises, the long term goal must be to provide mobile coverage which includes the data service. However, managing these two crisis supply scenarios leads to high financial and personnel investments which in the normal situation do not generate additional revenue for the network operators and which are not manageable in the short term. However, the also favourable cost-benefit calculation of the less extensive supply scenarios opens the way for an appropriate entry-level solution such as the provision of emergency services, which is less onerous in terms of investment and implementation. However, even this entry-level solution is an extremely demanding undertaking which should not be underestimated.

6 Quotas

In accordance with the Federal Council's mandate, a possible contribution of mobile operators' emergency power supply was also examined in relation to the stabilisation of the electricity grids during the imposition of power quotas. This means that by operating diesel generators and possibly other electricity-generating emergency power supplies such as fuel cells, network operators could reduce their electricity demand from the electricity grid.

The total electricity consumption of the three Swiss mobile network operators amounts to 1.13% of Switzerland's total electricity consumption. If one considers only the electricity consumption for the operation of the networks, this accounts for 1.06% of total electricity consumption in Switzerland. The possible savings in a quota allocation situation through the use of emergency power supplies by mobile operators are negligible in relation to Switzerland's total electricity consumption. On the expenditure side, the operation of emergency power supplies during several months of quotas would impose an enormous operational and logistical burden on mobile operators.

The unfavourable relationship between cost and effect tends to be an argument against a contribution from the emergency power supply of mobile network operators during electricity rationing. However, the present report cannot definitively assess whether telecommunications should be exempted from the quota system in a possible ordinance on power supply management within the framework of the National Economic Supply Act.

7 Challenges

The possible hardening of mobile networks against power grid failures represents an extremely demanding undertaking for the network operators. Emergency radio network planning must be developed, taking into account the possibilities of the individual sites and the effect of a temporary lifting of the OPNIR precautionary limits. Implementation involves upgrading hundreds or thousands of sites at all network levels. The necessary personnel and financial costs are likely to add to costs and make the development of telecommunications networks and services more difficult. Therefore, an appropriate implementation period of the order of 5 to 10 years is essential.

Acquiring antenna sites is a challenge. If, in addition to the network equipment, an emergency power supply has to be accommodated at transmitter sites, this will further complicate acquisition. In the case of existing leased sites, the leases would have to be renegotiated to take into account the requirements for an emergency power supply. The installation of an emergency power supply will in most cases require a planning application, which could lead to further difficulties.

The protection of emergency power supplies from theft and acts of vandalism is also a known problem. The protection and operation of the equipment involves high logistical costs which could exceed network operators' existing capacities.

Even if, depending on the legal basis applied, the funding of the resilience measures is primarily carried out by the mobile network operators (see section: "Legal basis"), the extent to which the public sector crisis organisations can provide operational support to mobile operators in this task should be examined.

8 Future prospects

With technical development, emergency power supply of telecommunications systems, and in particular antenna sites, is expected to become simpler and more environmentally friendly over time. On the one hand, the energy demand of modern mobile technologies or equipment is decreasing compared to previous mobile generations. On the other hand, great progress is being made in energy technologies. Energy technologies for sustainable power generation and storage are becoming ever cheaper. In particular, batteries are becoming better and cheaper, driven by the demands of mobility. Local renewable energy generation will increasingly be able to take over part of the emergency power supply. In the future, for example, fuel cells are expected to be an environmentally friendly alternative to diesel generator sets for emergency power supply.[5]

9 Legal basis and funding

From the perspective of the mobile network operators, a power shortage or a blackout is a case of force majeure which affects all network operators equally. The market does not provide a mechanism which leads to measures against these risks. It is therefore necessary for the federal administration to intervene in order to improve security. The intervention might take the form, for example, of financial support and/or legal provisions. In order to act, the Confederation must in any case have an appropriate legal basis. The Civil Protection and Civil Defence Act, the Telecommunications Act and the National Economic Supply Act were examined with regard to their suitability for such measures. The following sections outline the possibilities of these three laws.

9.1 Civil Protection and Civil Defence Act (CPDA)

The completely revised Civil Protection and Civil Defence Act (CPDA) of 20 December 2019 (which entered into force at the beginning of 2021) contains in Article 8, among other things, provisions on the protection of critical infrastructures (CIP). It sets out the tasks and responsibilities of the Confederation in the area of CIP. Explicitly listed are foundational work, the management of an inventory of critical infrastructures and the coordination of protective measures by operators. However, the article does not provide a basis for issuing additional stipulations for critical infrastructure operators. Furthermore, it does not create the possibility for the federal administration to participate in measures to improve resilience. In other articles of the CPDA, the Confederation is authorised to operate, together with the cantons, a secure data communications system (Art. 19) and a mobile broadband security communication system (Art. 20). Article 25 of the CPDA regulates its funding. The federal administration is responsible for the key components of the mobile broadband security communication system, for the decentralised components within its area of responsibility and for the security of their power supply. The cantons are responsible for the decentralised components of the system for which the Confederation is not responsible, as well as for the security of their electricity supply.

9.2 Telecommunications Act (TCA)

Under Article 48a of the current Telecommunications Act of 30 April 1997 (TCA; SR 784.10), the Federal Council may issue technical and administrative regulations for the security and availability of telecommunications infrastructures and services which are considered to be "directives of secondary importance" (see the Federal Council's Dispatch on the revision of the Telecommunications Act of 6 September 2017, p. 6651). As part of a legislative revision of 22 March 2019 (entry into force: 1 January 2021), it has now been granted the power to issue legislative directives. Article 48a of the TCA has also been clarified considerably. The new standard entered into force on 1 January 2021. It includes the following wording:

[1] Telecommunications service providers shall take action against the unauthorised manipulation of telecommunications installations by telecommunications transmissions. They are entitled to reroute or block connections and to suppress information in order to protect the installations.

[5] https://www.aramis.admin.ch/Texte/?ProjectID=37030
https://www.aramis.admin.ch/Texte/?ProjectID=26249

[2] To protect against hazards, avoid damage and minimise risks, the Federal Council may issue provisions on the security of information and of telecommunications infrastructures and services, in particular in relation to:

a. availability;
b. operation;
c. securing redundant infrastructures;
d. reporting interference;
e. tracing processes;
f. rerouting or blocking connections and suppressing information in accordance with paragraph 1

In particular, in accordance with Articles 48*a* para. 2 letter a (Availability), letter b (Operation) and letter c (Securing redundant infrastructures), the Federal Council's competence to define measures for emergency power supply is therefore given. The costs of such measures would have to be borne by the providers who are subject to the obligations, since the Act does not include any basis for making compensation to telecommunications service providers. This is also apparent from the Federal Council's explanations, according to which direct regulatory costs arise for companies operating in the telecommunications sector, among other things, from the obligations to combat cyber attacks. These would vary for the individual providers depending on the size of the company and the scope of the measures already taken without regulation (Federal Council dispatch on the revision of the Telecommunications Act of 6 September 2017, p. 6589f.).

9.3 National Economic Supply Act (NESA)

The National Economic Supply Act (NESA; SR 531) of 17 June 2016 regulates measures to ensure the supply of vital goods and services to the nation in severe shortage situations which the economy cannot cope with on its own. Article 5 paragraph 1 NESA instructs the specialist sectors of national economic supply (NES) to take preparatory measures. Preparatory measures can be designed differently in terms of type, scope and intensity. By Article 5 para. 4, the legislature established the prerequisite for the competence to oblige essential companies to take appropriate precautions.

Article 27 of the NESA requires the Federal Council to take the necessary measures to ensure that sufficient means of transport, information and communication are available in the event of a serious shortage (Art. 27 NESA).

The equipping of the mobile radiocommunications infrastructure with an emergency power supply solution could constitute such a preparatory measure within the meaning of the NESA.

However, in the case of mandatory directives, the principle of subsidiarity applies in many respects. In the first place, voluntary measures by businesses to strengthen continuity and crisis management are taken into account. In addition, activities of other federal regulatory and supervisory authorities take priority in ensuring the supply of vital goods and services (Art. 5 para. 5 NESA). This means that the NESA will only be applied if a corresponding legal basis of a specialist authority does not already exist.

9.4 Interim conclusion: legal basis

Under revised Article 48a of the TCA, the Telecommunications Act provides an appropriate framework for the introduction of measures to improve the resilience of mobile networks. On the other hand, the application of Article 5 para. 1 of the NESA is excluded on the basis of Article 5 para. 5 of the NESA in conjunction with Article 48a of the TCA. According to the explanations referred to in Section 9.2 the Federal Council is competent to issue implementing provisions on the security of telecommunications infrastructures and services. Its ordinance on telecommunications services is the appropriate vessel for the necessary provisions.

9.5 Funding

The beneficiaries of the measures are the customers of the mobile network operators. During a power outage they can make an emergency call in the event of a medical problem or, as a business customer, maintain the company's operations. Accordingly, it is logical that the network operators should bear the costs of upgrading the networks and pass these costs on via the subscription charges. According to the cost estimates, the monthly additional costs of the different supply variants are between CHF 0.30 and 0.70 per user. Providing security from network failure in the event of a power supply crisis will thus become a natural part of everyday telecommunications in the medium to long term. Since all mobile network operators will have to meet the same requirements, no market distortion is to be expected.

None of the abovementioned laws provides a basis for a direct contribution by the federal government to measures for upgrading the telecommunications networks. It is not currently intended to establish any legal means for covering the costs.

9.5.1 Burden on the public sector

Outside of times of crisis, the measures taken to improve the resilience of mobile networks will not involve any costs for the public authorities. If necessary, the public authorities will contribute to the costs of logistics in times of crisis. The operation of the emergency generator sets in a crisis will be very costly. Network operators will not be able to manage this task with their existing resources. Nor would it be economically viable to maintain the necessary resources in normal times for a crisis which occurs only rarely. Instead, commercial services should primarily be used to ensure logistics.

However, managing crises is also a key task for the public authorities. It will therefore also have to be examined, in the implementation of improving mobile network resilience, how, in a crisis, the Confederation, the cantons and communes will be able to support the network operators with their own services and what the costs of supporting the affected organisations would be. The costs of the logistics in times of crisis are as follows: in the event of a power shortage, they amount to a maximum of CHF 30.5 million for the provision of emergency calls and a maximum of CHF 44.5 million for the provision of the data service and, in the event of a blackout, a maximum of CHF 7.4 million for the provision of emergency calls and CHF 7.9 million for the provision of the data service. The power shortage lasts for a total of 3 months and the power grid shutdowns would take place for two weeks; the blackout would last for 3 days.

The cost of logistics in times of crisis converted to an annual basis is CHF 1.3 million for the provision of the emergency call service and CHF 1.8 million for the supply of the data service. These amounts constitute the medium-term or long-term cost ceiling for the public-sector if it were to assume the entire logistics.

10 Recommendations

With reference to improving the resilience of the mobile networks, a two-phase strategy is recommended. In a first phase, mobile coverage for emergency call services which can function during power outages must be ensured. In further longer-term steps, the provision of nationwide mobile voice and data services shall be worked towards.

When applying the power management measure of quota allocation on the basis of the National Economic Supply Act, it is recommended that telecommunications be given special consideration.

abbreviations

AORS	Authorities and Organisations for Rescue and Security
CPDA	Civil Protection and Civil Defence Act
CIP	Critical Infrastructure Protection
DDPS	Federal Department of Defence, Civil Protection and Sport
DETEC	Federal Department of the Environment, Transport, Energy and Communications
EAER	Federal Department of Economic Affairs, Education and Research
FDV	Telecommunications Services Ordinance
FOCP	Federal Office for Civil Protection
FONES	Federal Office for National Economic Supply
ICT	Information and communication technologies
MSC	Mobile security communication
NES	National Economic Supply
NESA	National Economic Supply Act
NPP	Nuclear power plant
OFCOM	Federal Office of Communications
OPNIR	Ordinance on Protection against Non-Ionising Radiation
PoP	Point of Presence
RTV	Radio and television
SFOE	Swiss Federal Office of Energy
SFU	Strategic Leadership Exercise
SNE	Swiss Security Network Exercise
TCA	Telecommunications Act
TSP	Telecommunications service provider
TV	Television

Legal basis and standards

[1]	SR 520.1 Federal Act on Civil Protection and Civil Defence (CPDA)
[2]	SR 784.10 Telecommunications Act of 30 April 1997 (TCA)
[3]	SR 531 National Economic Supply Act (NESA)
[4]	SR 784.101.1 Telecommunications Services Ordinance (TSO)