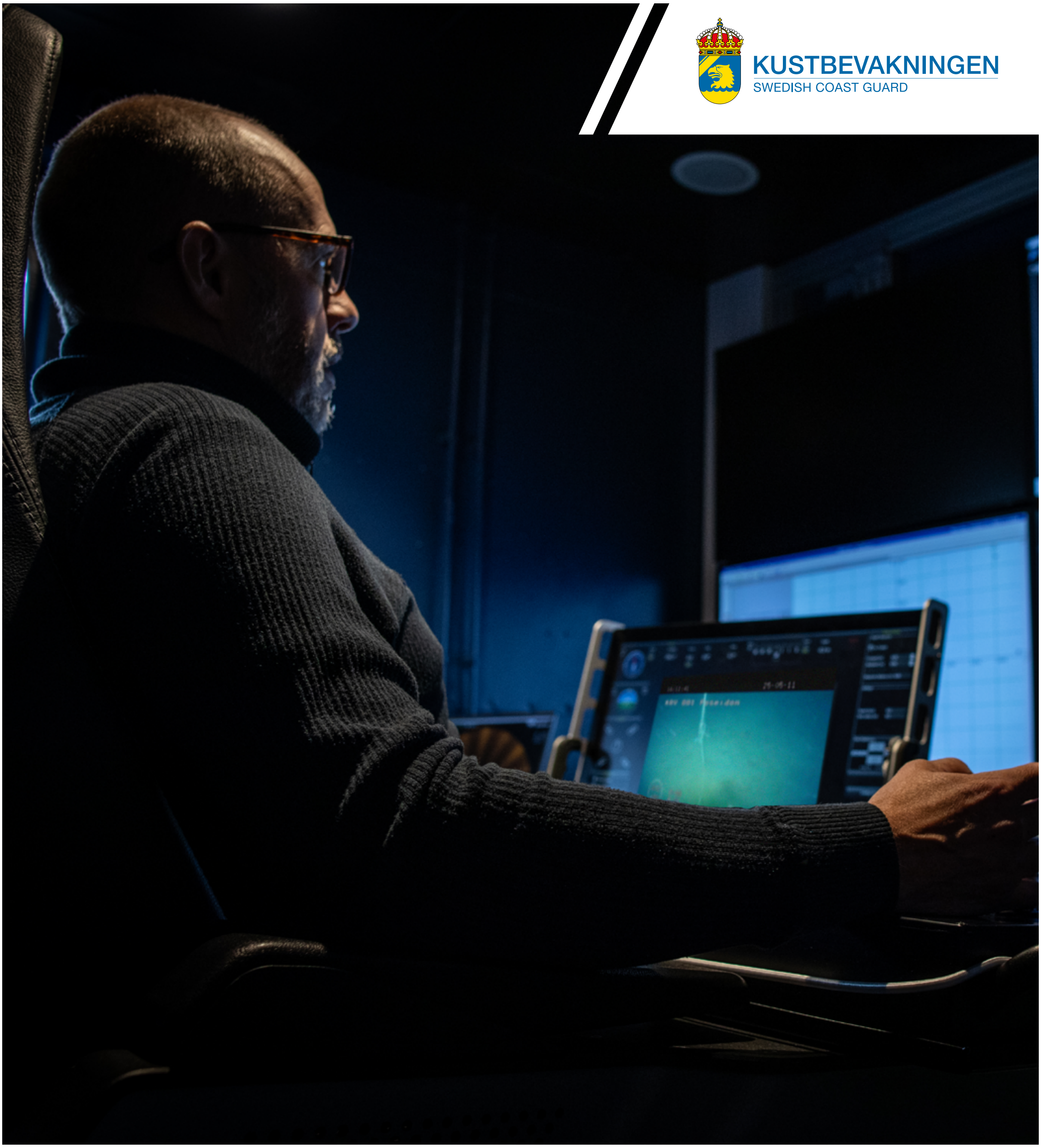

KUSTBEVAKNINGEN
SWEDISH COAST GUARD

Undersea Infrastructure in Sweden's Territorial Sea

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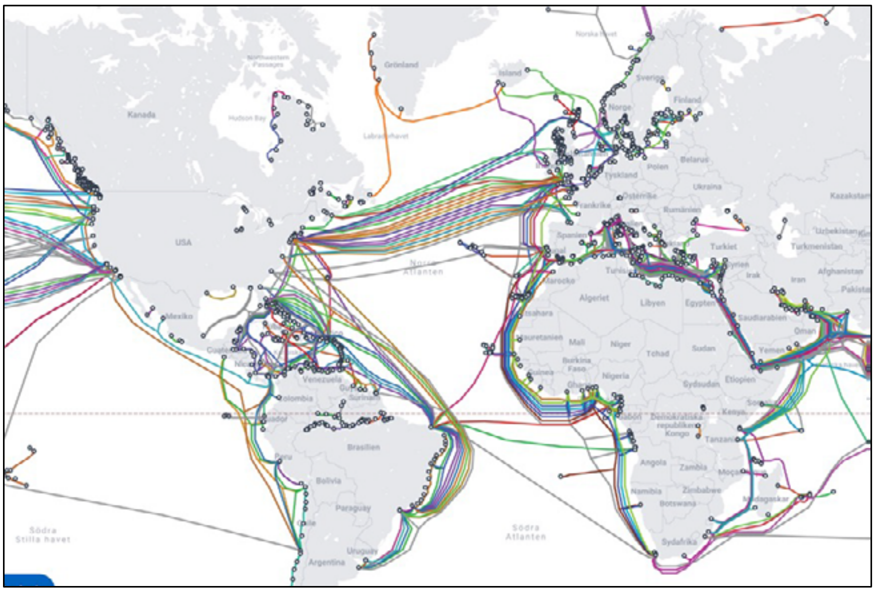
1. Introduction

Critical undersea infrastructure, a term that is sometimes used in a cursory manner, refers to civilian undersea infrastructure disruption to which will have serious consequences for vital societal functions. It is also critical in that disruption will negatively impact our capacity to defend civil society in the so-called *grey zone* between peace and war.

In December 2024, the Swedish Coast Guard's management decided that between 7 January and 6 June 2025 a survey would be conducted of threats to critical infrastructure in the maritime environment as it affects Swedish interests. This report is the result. The report is descriptive by design and is the culmination of a learning process. The main point of departure is the cable cutting incidents in the Baltic Sea during 2024/25, some of which have been investigated as suspected sabotage by law enforcement agencies. This report does not, however, shed any new light on these incidents. Nor does it address infrastructure of purely military interest.

2. Background

Undersea infrastructure such as energy cables, telecommunications cables and gas pipelines cross the seabed all over the world. A network of 1.5 million kilometres of cables run between continents and countries. Much of this infrastructure is critical to national energy supplies and communication, and it is vulnerable to external interference. Globally, there are between 150 and 200 incidents resulting in damage to undersea infrastructure each year. It has been estimated that ships dragging their anchors account for two-thirds of all cable breaks, but exceptional environmental factors such as earthquakes and hurricanes can also cause similar damage. Telecommunications cables are especially vulnerable to damage as they often lie unprotected on the ocean floor. These cable faults rarely receive international attention as most companies spread their network capacity across multiple cables. When functionality is impaired in one cable, data is transmitted over other cables while service is restored to the damaged cable. The sketch below shows the global communication network.



Historically, breaches to undersea infrastructure in Sweden's territorial sea have been uncommon, especially in the Baltic Sea. Swedish seas rarely or never experience the weather conditions or natural phenomena that cause breaches in undersea cables. However, merchant vessels destined for Russian ports on the Gulf of Finland have destroyed undersea infrastructure on four occasions over a period of 18 months. Other cables on the seabed have been worn or damaged during these incidents. Public authorities, cable owners and cable repairers are agreed that events in shipping lanes around Sweden during the period under review are highly unusual.

3. Purpose

The Swedish Coast Guard has prepared this report in order to increase awareness within the agency and disseminate this knowledge to other stakeholders, as well as to enhance capacity to predict and counter threats to critical undersea infrastructure. In practice, this involves:

- identifying the appropriate level of protective security for each installation;
- updating the infrastructure layer in the Swedish Coast Guard's *Sjöbasis* system with relevant information; and
- making recommendations concerning surveillance in specifically identified areas.

4. Method

Work commenced in autumn 2024 by collecting and categorising data that could be considered relevant for processing as a basis for an overall situational analysis of critical undersea infrastructure. Much of this was open data from national and international databases. A more detailed picture of each area required in-depth interviews with various stakeholders in Sweden. Many meetings have therefore been held with relevant government agencies and representatives of the private sector.

5. Structure of the report

The report is divided into three main subject areas based on the function of each cable as a transmission medium: electricity, natural gas, and data and telephony. The report also deals with repairs to damaged or cut cables and the replacement of installations damaged beyond repair. As previously noted, the report is descriptive in nature in order to provide a situation report on each subject area, along with an overall analysis of the potential consequences of lost functionality for civil society.

6. What is undersea infrastructure?

The term *undersea infrastructure* refers to technical systems on or beneath the seabed.

With the focus on Swedish conditions, the subject areas are:

- **high-voltage cables** for energy transmission
- **natural gas pipelines** (less extensive)
- **ibreoptic telecommunication/data cables**

While this infrastructure is often invisible, it is vital to society that it functions normally. It extends across the Swedish Economic Zone in the Baltic Sea, Gulf of Bothnia, Kattegat and the North Sea. Undersea infrastructure is vital but vulnerable. One problem highlighted by all interviewees involved with undersea infrastructure is the openly available information online, especially given the unstable global situation. Information on the geographic location of undersea infrastructure, landing points and telecommunication masts is available on nautical charts and maps as well as online, as is other potentially sensitive data.

7. The energy sector and its connection to undersea infrastructure

Sweden is part of the Nordic synchronous area along with Finland, Norway and parts of Denmark, meaning that our electricity grids are physically synchronised and operate in coordination. This means that:

- **the frequency of the electricity grids are kept at their nominal level;**
- **the countries share balancing reserves; and**
- **Svenska Kraftnät, Fingrid, Statnett and Energinet cooperate as Transmission System Operators** (TSOs).[1]

This has several advantages, particularly with regard to the stability and balance of the grid. A large joint grid is more resilient to disruption. For example, if a power station goes offline in one country, the others can quickly compensate.

Sweden’s electricity grid is an infrastructure network that transmits electricity from production sources to industry, households and other users. It consists of three levels as described in the figure below:

- **The national grid, which is owned and operated by the government agency Svenska Kraftnät** (TSO).
- **Regional grids,** which are owned by large electricity companies such as E:ON and Vattenfall.
- **Local networks,** which are owned by local operators.

1 The Transmission System Operator is the entity responsible for operating, maintaining and developing the transmission system in a given area, in this case the electricity grid.

7.1 Energy transmission via undersea cables

The Swedish energy sector is served by a number of high-voltage undersea transmission cables that connect the mainland with both large Swedish islands and neighbouring countries. These cables facilitate the transmission of electricity within Sweden, as well as the import and export of electricity. They are also connected to the European electricity grid. They play a key role in the Swedish energy market, especially during cold winters when imports of electricity can cover the demand for power, or for exporting surplus electricity.

7.2 Consequences of cable failure

When undersea cables are taken out of service, it becomes more difficult to balance electricity grids in different countries. This can create imbalances, increase prices and impose limits on production.

The consequences of high-voltage cable failure in the maritime domain:

- **Reduced import capacity could potentially increase the risk of energy shortages, particularly in winter.**
- **Increased electricity prices as supply decreases while demand remains constant.**
- **Power shortages in southern Sweden, where capacity is weaker and dependence on imports higher.**

8. The natural gas network and its connection to undersea infrastructure

The natural gas network in western Sweden crosses the Sound from Dragør in Denmark via an undersea pipeline to Skåne. It then continues from Trelleborg on the south coast to Stenungsund on the west coast. Sweden is a net importer of gas and the western Sweden natural gas network is a key component in Sweden's energy supply, especially for certain industries that rely heavily on gas.

Sweden is dependent on natural gas and has no large-scale production of its own. The Danish and western Sweden natural gas markets are integrated in a joint balancing zone.

8.1 The importance of the gas network to industry and energy supply

- **Process industries** (pharmaceuticals, chemicals, metals, plastics)
- **Food production**
- **Electricity and heating production**
- **Transport sector** (especially heavy vehicles running on biogas)

Natural gas is often used for applications in which it cannot be substituted with electricity due to temperature requirements or technical limitations.

In Sweden, natural gas is primarily used in industrial processes and as raw material by industry.

8.2 Consequences of pipeline failure

The consequences of undersea gas pipeline failure:

- **Production stops in the chemical, plastics and food processing industries.**
- **Interruption to supply may lead to heating and electricity production shut downs.**
- **Heavy vehicles that run on biogas may run out of fuel.**

9. Electronic communication and its connection to undersea infrastructure

Our digital infrastructure is heavily dependent on undersea fibreoptic cables that connect Sweden with other countries. These cables are the arteries of global communication and are crucial to Sweden. Meanwhile, their physical vulnerability potentially risks severe disruption to vital societal functions. Fibreoptic cables facilitate the rapid, reliable transfer of data over long distances. In Sweden, these cables are used for:

- **international internet traffic**. Most of Sweden's internet traffic passes through undersea cables connecting the country to other continents;
- **telecommunications**. Fibreoptic cables are used to maintain telephony and data services between Sweden and other countries; and
- **vital societal functions**. Public authorities, banks and healthcare are dependent on these cables to ensure continuous operation and communication.

The Swedish Post and Telecom Authority (PTS) is responsible for supervising electronic communication and postal services. The term *electronic communication* refers to telecommunication, IT and radio.

9.1 Consequences of cable failure

While the fibreoptic communication network has excellent redundancy, any loss of function can have serious consequences, especially if several cables are out of service at the same time. These include:

- **financial losses**. Businesses and industries that depend on rapid, secure communication may suffer from production stops;
- **disruption to societal services**. Healthcare providers, public authorities and banks may have difficulty maintaining their services;
- **national security**. Disruptions to communication may hinder communication between government agencies and the Swedish Armed Forces, with a negative impact on national security; and
- **mobile networks** may be affected as a great deal of data traffic uses undersea fibreoptic cables.

Various solutions for monitoring critical undersea infrastructure are currently under consideration.

10. Repairing and producing undersea infrastructure

Infrastructure in the maritime domain is a critical component of Swedish society's energy transmission, digital communication and security of supply. Meanwhile, undersea infrastructure is sensitive to interference and damage.

The situation is aggravated by the many challenges involved in both making emergency repairs and replacing damaged undersea installations. In Baltic Offshore, Sweden has a major supplier of maintenance for undersea infrastructure. The company has one cable-laying vessel sailing under the Swedish flag. Sweden is also home to one of Europe's largest and most advanced cable factories. Owned by NKT, the factory produces all types of undersea high-voltage cables. However, the process of manufacturing high-voltage cable for undersea use is a long one. Lead times for spare parts are also long.

10.1 The differences between high-voltage and fibreoptic cables in the marine domain

High-voltage cables:

- **Dimensions:** between 10 and 25 cm in diameter, the cables are very thick and heavy.
- **Materials:** copper/aluminium, insulation, lead, armoured.
- **Cable-laying vessel:** require large cable-laying vessels with powerful winch capacity.
- **Installation time:** long-term, complex planning.
- **Repairs:** technically highly complex, very expensive, take weeks to months.
- **Installation on seabed:** buried in sediment on seabed.

Repairing a high-voltage cable underwater is a technically advanced process. Both electrical and mechanical damage must be repaired, while water penetration often causes serious insulation issues in the cable. Repairs can take several months depending on the scope of the damage, the availability of specialist vessels and crews, and site and weather conditions.

High-voltage undersea cables are designed with waterproofing such as expanding waterstop, copper shielding tape, metal sheath or plastic coating. If the cable is damaged by, for example, a ship's anchor, water penetration may lead to:

- total loss of insulation;
- partial discharge;
- corrosion of shielding or conductor.

A specialist vessel is required to repair high-voltage cables, with cable winches, jointing box and high-voltage testing equipment. Skilled specialist technicians are also required to join the high-voltage cable, and the replacement cable must match the original cable structure. The process itself is advanced with many steps and requires bulky equipment.

Fibreoptic communication cable:

- **Dimensions:** 1 to 5 cm in diameter, the cables are thin and lightweight.
- **Materials:** fibreglass, plastic sheath, sometimes armoured.
- **Cable-laying vessel:** can be laid by a smaller vessel.
- **Installation time:** relatively quick and flexible, usually takes weeks.
- **Repairs:** technically demanding but cheaper and quicker than high-voltage cables.
- **Installation on seabed:** laid slack, can move on the seabed.

Repairing a fibreoptic cable underwater is a highly technical process that demands precision, speed and water resistance. It does not take as long to repair and undersea fibreoptic cable as a high-voltage cable, but it does require extreme precision. The process is sensitive to the weather, cable type and access to a specialist vessel and skilled technicians. This type of cable is also susceptible to water penetration if the cable sheath is damaged, which will further complicate the process.

Fibreoptic communication cables are designed with a core of optical fibres, a gel or water barrier, steel armouring and an outer sheath.

10.2 Responsibility and preparedness for undersea infrastructure

In Sweden, the owner has extensive responsibility for their undersea infrastructure. This includes responsibility for the security and emergency preparedness of their cables, meaning that they must have a plan for dealing with incidents. They are also responsible for ensuring that secure and reliable function of the cable, for inspecting the cable and for preventive maintenance. Owners of undersea infrastructure must report disruptions to operations and security incidents to the relevant public authorities.

11. Conclusion

Sweden's undersea infrastructure is crucial to energy security, industrial resilience and digital communication. Undersea infrastructure is strategically vital, critical infrastructure, but it is vulnerable.

- **Energy cables:** damage can lead to energy shortages, disrupt the electricity market and destabilise the electricity system.
- **Gas infrastructure:** disruption to the western Sweden natural gas network would have a negative impact on industrial production and energy resilience.
- **Fibreoptic cables:** damage may disrupt digital communication, with a negative impact on healthcare defence and the operations of public authorities.

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