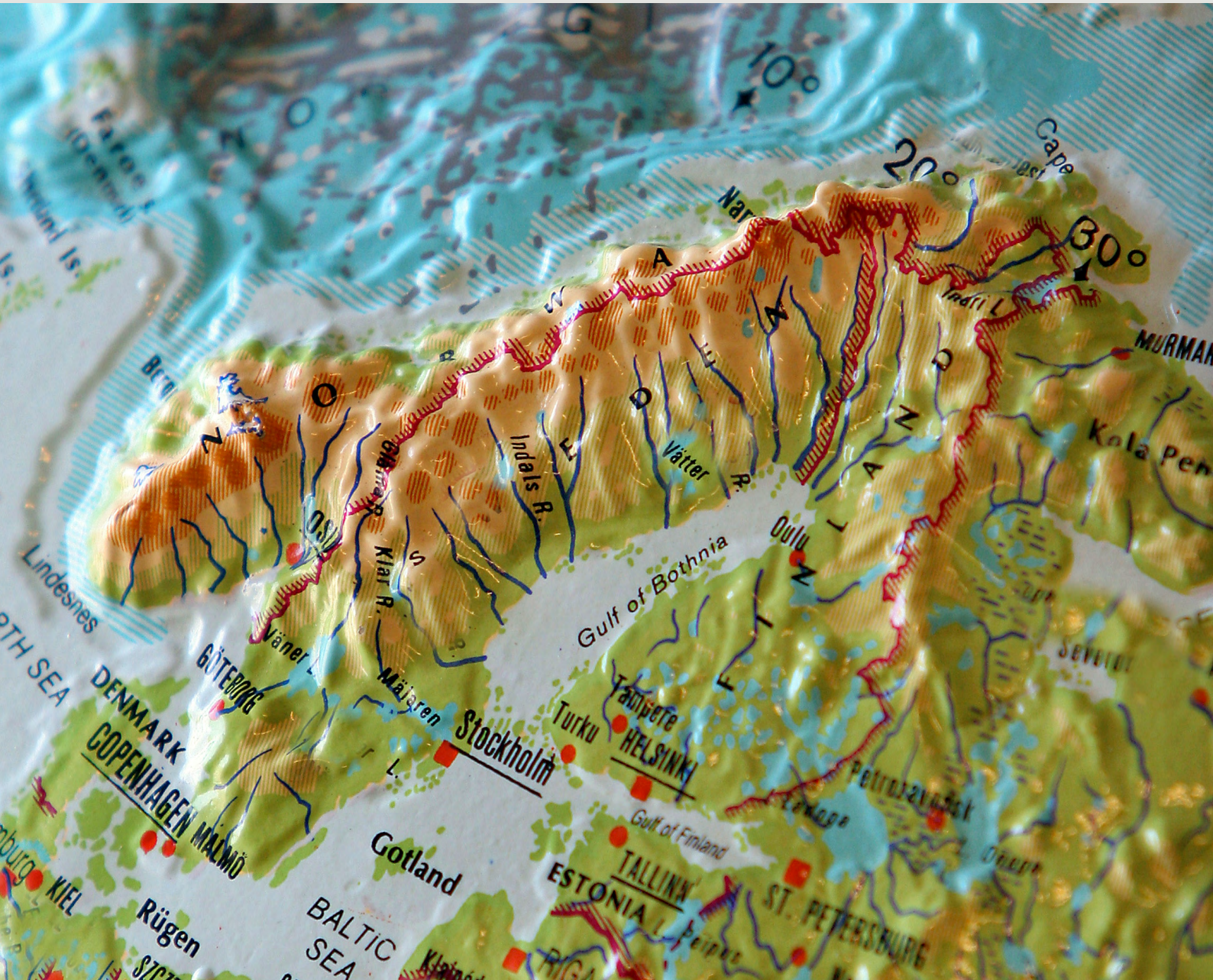
Swedish Civil Contingencies Agency

Learnings for Critical Nordic Flows

Fuel and Food Packaging



Learnings for Critical Nordic Flows: Fuel and Food Packaging

Section: Security of Supply Department

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Summary

This report is based on the analysis of two studies; “Fuel redundancy in the Nordics” and “Food packaging flows in the Nordics”. Firstly, it seeks to extract broader learnings from these two studies that may also be applicable in other sectors. Secondly, inspired by the aforementioned studies it recommends potential areas of further study. Thirdly, it summarizes the food packaging and fuel redundancy studies.

Broader learnings from fuel and food packaging

Businesses largely plan for limited supply chain disruptions, they do not take height for more extreme scenarios, and are thus not prepared for war.

Preparedness goals may be at odds with other objectives such as maximising market efficiency and certain environmental policy ambitions.

During crises it can be very difficult to predict outcomes, limiting the value of detailed plans. Hence it is more valuable to developed capacities to handle disruptions, rather than overly detailed plans.

Networks where members know and trust each other empower a more effective crisis response, hence develop such networks before a crisis.

Potential areas of further study

How could the EU develops its preparedness work in a way that is beneficial to the common interest of the Nordics?

What are the key goal conflicts between preparedness and environmental objectives?

Could mandating restrictions on single use plastics serve to reduce dependence on certain plastics?

How could firms’ cash flows and financing needs be supported during crisis?

How can costly preparedness measures be financed beyond regular budget measures?

Could best-practises be developed for public-private network building?

What changes are necessary to enable key logistical flows to use multiple modes of transport?

Which different national standards beyond winter fuels could be harmonised to adopt broader standards?

How can existing economic research be leveraged to determine when it is optimal to incentivise or legislate in order to get the best preparedness effect amongst firms?

How can Nordic cooperation contribute to Finland, Norway and Sweden contributing more effectively to NATO:s Seven Baseline Requirements?

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Introduction

Introduction

This report is an output of the Critical Nordic Flows cooperation between Finland, Norway, and Sweden. The Finnish National Emergency Supply Agency (FI), the Norwegian Ministry of Trade, Industry and Fisheries (NO), and the Swedish Civil Contingencies Agency (SE) have agreed upon a non-binding framework for cooperation to strengthen the three countries' cooperation regarding security of supply, continuity, and critical infrastructure protection.

The Critical Nordic Flows cooperation aims to explore and recommend ways in which the three partner countries could deepen their cooperation to prepare for potential disruptions in cross-border flows of critical goods and services. This is achieved by studying the dependencies and interdependencies on international value and supply chains in Finland, Norway, and Sweden. It is intended to provide a basis for collectively strengthening security of supply, continuity, and critical infrastructure protection. This cooperation is intended to be open-ended and not limited to any specific sectors.

This report assesses two recent studies undertaken in the field of critical infrastructure protection and provides suggestions for further research conducive to furthering Nordic preparedness cooperation. The two studies analysed here are "Fuel redundancy in the Nordics" produced by the Institute of Transport Economics at the Norwegian Centre for Transport Research (TØI) and "Food packaging flows in the Nordics" produced by the Finnish National Emergency Supply Agency (NESA), respectively. The research for the food packaging study was executed between December 2021 and March 2023 and the fuel redundancy study was finalised at the end of 2023. The two underlying studies are summarised at the end of the report. Following the first Nordic Flows report published in 2020 a working group identified fuel redundancy and food packaging as two areas where more information was needed, and could serve to inform on future cooperation between the three countries.

Purpose and structure of this report

The purpose of this report is to extrapolate broader lessons from these specific studies and based on that, gain inspiration to further develop collaboration between the Nordic countries as well as suggesting future areas of study for Critical Nordic Flows. Focus is on the role of the private sector and interaction between the public and private sectors. The purpose of this report is not to provide a comprehensive overview of the food packaging and fuel redundancy sectors in these three Nordic countries – for this purpose the underlying studies themselves should be the primary objects of study.

The report is divided into three main parts. The first part is an analysis of the two studies' content and particularly their cross-sectoral concerns, i.e., including other sectors than those focused on in the studies. The second part presents suggestions for possible areas of future research. The third part contains summaries of the two underlying reports' contents.

Qualified readers representing government authorities are recommended to access the original reports on these topics through NESA or the Norwegian Ministry of Trade, Industry and Fisheries to gain specific and deeper details regarding fuel redundancy or food packaging, the methodologies of the studies, and their case studies.

Methodology

The reports on food packaging and fuel redundancy that has been analysed and sought inspiration from for potential areas of further study, are extensive interview studies seeking to identify how theur respective logistical ecosystems are structured, as well as their vulnerabilities and the opportunities for addressing them in a Nordic context. The interviews covered private sector actors, civil servants, and researchers. The Norwegian fuel study compiled and mapped publicly available data as well as data from interviewed actors. Both reports illustrate how complex production supply chains from inputs to consumers are, and the difficulties of making fast and cost-efficient changes to enhance preparedness in an environment shaped by market forces.

The authors of this report have neither participated in the work of the two food-packaging and fuel redundancy studies nor influenced their subjects. However, the authors of those two studies have reviewed this report to minimise the risk for misinterpretations. This text is limited by the fact that there are only two underlying case studies, since any study gains in scope and relevance by covering a larger set of cases. We have sought to extrapolate broader lessons from these specific studies and sought inspiration from them for future areas of study for Critical Nordic Flows.

All societies are extremely complex. Consequently, establishing total defence, comprehensive security, or other preparedness structures are highly complex endeavours. Food packaging and fuel redundancy are important areas in themselves, but only constitute small parts of the broader body of total defence and societal preparedness. Yet insights from these two areas can also shed light on how to approach issues elsewhere.

Broader learnings

Broader learnings

The text below identifies subjects identified in both or one of the reports on food packaging and fuel redundancy, which might have wider significance beyond those two subject areas when thinking of preparedness. The two studies focused on different sectorial supply chains and were conducted by different researchers, consequently they picked up on different factors. Therefore, factors only identified in one study may still have broader relevance beyond that sector. Part 1 concludes with a focus on a synthesis of recommendations that may have broader applicability beyond these two sectors.

Both the packaging and fuel sectors share a number of traits, such as the value chain can contain key choke points, reliance on continued functioning energy supplies and logistics, storage (or increasing storage) of key inputs is expensive, geographical concentration of key capacity, dependence upon international supplies from outside the Nordics, the role of regulation, the impact of circular economy requirements, etc. These factors are applicable to other sectors beyond food packaging and fuels too. Even if every sector is unique there are also commonalities.

The food packaging study identified several factors relating to production processes that one could assume are relevant to fuel and other areas, but which were not covered in the fuel study. The maximum shelf life of fossil fuels may differ significantly from food products. However, certain biofuels do seem to have different storage requirements and shelf lives compared to the fossil originals, suggesting that the time perspective on storage is potentially relevant for fuels too. High levels of automation, spare part availability, know-how availability, regulations and standards, and end customer demand are examples of other factors identified as potentially impacting vulnerability, which appear as relevant for fuel as for food packaging – as well as for other sectors. This illustrates no only the benefit of conducting cross sectoral comparisons, but also conducting them using different authors focusing on different sectors. Not only are different sectors unique, and thus require individual assessments, but by having different authors conducting the studies can result in different approaches that may also provide potential insights useful for other sectors too.

Key insights

Plan for war, not limited supply chain disruptions

Several recurring themes figure in both reports. The first of these concerns the role that the COVID-19 pandemic and the Russian invasion of Ukraine have played in shifting the preparedness mind-set both amongst private and public sector actors. It is clearly positive that risk awareness has increased, and that this is resulting in some real-world changes. However, it should be borne in mind that the pandemic and a conflict further afield between two globally relatively small economic actors would have a very different (and more limited) effect compared to being exposed to a war affecting one's own territory. The significant, and not implausible, threat that the Nordics must prepare for at present is being drawn into a large-scale war. In other words, preparing for limited supply chain disruption scenarios, although useful, is insufficient.

The more detailed vulnerability assessment in the food packaging study potentially identifies factors that become more relevant during war or extreme crisis. For example, spare part availability and know-how availability become more serious factors of concern with significant physical destruction or deaths of employees. The danger of focusing on previous crises, which since the Second World War have been relatively benign for the West, is that the scenarios are unlikely to be extreme enough.

With an antagonist consciously trying to render key assets inoperative, and without restraint or concern for collateral damage, it is even hard to imagine all the potential actions to prepare for. Technological developments relating to data gathering through digitalisation in combination with a revolution in precision munitions, as well as the development of low-cost delivery options, means that we cannot simply extrapolate from history. Furthermore, it could be argued that Ukraine is a poor reference example in the sense the international support has been on such a massive scale that the logistical disruptions, product shortages and training requirements that manifest in war could be much more problematic in a broader war that is not limited to one European state supported by the entire West. The authors of this report assume that if the Nordic countries were drawn into a broader conflict the region could not count on targeted economic and humanitarian support on the enormous scale that Ukraine has received, furthermore several countries' economies and international economic flows would be negatively impacted. Consequently, a conflict scenario for the Nordics could entail large scale and crippling attacks on civilian infrastructure, whilst access to international (as well as regionally and nationally sourced) supplies would be limited.

Acknowledge that key factors may be at odds with preparedness

Markets may be at odds with preparedness. At the same time both the food packaging and fuel redundancy studies point out that in the face of industry consolidation economically rational solutions can be suboptimal from a preparedness perspective. Thus, commercial profit maximisation sometimes conflicts with national security requirements. Addressing this challenge is possible, but it is presented as costly in both time and money and requiring political will to address. A further complicating factor is the international nature of markets, implying challenges for individual, and particularly for small, states in attempting to address production redundancy issues alone.

Environmental objectives may be at odds with preparedness. If the commercial need to adjust to market conditions is one challenge to preparedness, adjusting to regulatory environmental objectives appears to be another challenge. In the packaging world effective large-scale chemical recycling appears some way off, and the use of virginal materials is still required even in packaging using mechanically recycled material. In the fuel universe bio-fuel requirements add further challenges to an already difficult task, requiring more products, mixing, and specific storage challenges. The political importance of "green policies" perhaps makes is difficult to address some of the potential goal conflicts posed by simultaneously pursuing both environmental and preparedness goals. An example of such a goal conflict outside of the areas of the two studies concerns the electrification of vehicles, which at least in the medium term could risk making certain forms of transport more dependent upon the continued functionality of the electrical grid, as well as reducing the size of the diesel market, which presently is the predominant fuel for back-up power generators.

Build general resilience

Certain risks are hard to address with detailed planning. The food packaging study highlights certain risks that can be easier to identify than to address with detailed planning. The example of the COVID-19 pandemic was highlighted, where a combination of container disruptions and manufacturing challenges made effect prediction difficult, making the identification of mitigation strategies hard. The chaos of war may make such planning even more difficult. Thus, generalised resilience – e.g., higher levels of redundancy – is an important part of crisis preparedness. That is not to say that planning and exercising are not important, but as Helmuth von Moltke said, "No plan survives contact with the enemy."[1] Dwight D. Eisenhower stated "Peace-time plans are of no particular value, but peace-time planning is indispensable." Developing practical capabilities to handle certain types of disruptions may prove more useful for handling a broad range of scenarios than preparing for specific scenarios.

1. More precisely "No plan of operations extends with any certainty beyond first contact with the main hostile force."

Build trust and understanding

Cooperation requires mutual trust and understanding. If actors are to cooperate effectively during crisis or war it is logical to assume that it will save time if they know and understand each other already before the cooperation is required. Investing in establishing networks already before they are needed would appear wise. It would appear reasonable to expect the state, with its broad responsibility for security, to take a lead on this.

Synthesized recommendations

Both studies present several reflections – many of which are applicable to both sectors, and even more broadly to other sectors. Here focus will be on the recommendations that could be applicable beyond food and fuel, having broader applicability.

Invest in resilience

- Investments in enhancing the protection of physical infrastructure, as well as fuel-back up solutions as well and measures enhancing redundancy.
- Both the food packaging and fuel reports point to key investments to improve redundancy (including stockpiling) that would be both costly and take significant time. It is pointed out that such measurements should be addressed in an actor-neutral way. This raises the spectre of the role of the EU. The three Nordics covered in the study are all relatively forward leaning in the preparedness field, at least compared to the broader EU/EEA. If the EU were to develop resilience requirements that would be to the advantage of the Nordics, not only because it would strengthen key allies of the Nordic states, but additionally if resilience requirements could become increasingly standardised via the EU it would imply that Nordic companies would not be disadvantaged by unique national requirements in the European common market. Furthermore, European solutions could address issues that would be too large-scale for individual member states to attempt to address.
- Cash flow and financing are key economic survival factors for companies, and states (and potentially the EU) need to develop mechanisms to help companies survive under extraordinary circumstances. Ideally emergency measures should be developed before they are needed so that they can be implemented at very short notice should a crisis manifest.

Enhance the potential for cooperation

- Enhancing cooperation between the public and private sectors, establishing networks that will be useful during crisis, as well as expert networks that can share best practises (in this context public sector mapping efforts will be useful).
- Enhancing the business sectors' understanding of how supplies will be prioritised during crises as they are the actors doing the actual distribution (A likely prerequisite for this is that the state helps identify overall orders of priority).

- As state structures tend to be nationally focused it is useful to identify obstacles to effective transnational cooperation in the Nordics, and how the three countries could become better at sharing situational awareness.

Develop transport alternatives

- Logistics will be severely impacted during a severe crisis or war, potentially requiring shipping, rail or road transports to be replaced by other forms of transport. Investigating potential transportation modes of different key goods that that would work on substitute forms of transport would be useful and developing working solutions in practise that could potentially be scaled up in a real-world situation.

Prepare regulatory exemptions

- Regulatory exemptions during extraordinary circumstances are useful tools, studying how the needs for exemptions have been identified in the past and how they have been implemented could be useful – and potentially serve as a tool to help prepare exemptions in other areas, ready to use in future potential crises.
- As stated above, exemptions to regular operating procedures during crisis make sense to prepare beforehand so that they can be implemented at shorter notice. This also has a bearing on the European level. Considering that Europe constitutes a common market dependent upon EU-level requirements it is not sufficient that individual member states prepare their own exemptions from regulation during crisis, the EU needs to develop such readiness too. Here the Nordics, being a bit more forward leaning in the preparedness space, could perhaps play a role in helping the EU understand areas in which it needs to get organised? Although Norway is not a member of the EU it is a member of the EEA, and thus shares an interest with Finland and Sweden in promoting common Nordic research that could also be relevant from a broader European perspective.

Make sustainability robust

- Adding preparedness components to sustainability initiatives. The high level of political prioritisation of environmental concerns suggest that sustainability initiatives are here to stay and ensuring that these initiatives integrate preparedness thinking is essential to minimize the potential conflict of interests between “environmental” and “security” objectives.

Broaden firms’ understanding of risk to include war

- Encourage firms to broaden their risk scope, so they focus on the extended supply chains, as well as including exceptional circumstances (such as war and catastrophic crises), not just what is deemed likely in their risk management processes.

Potential areas of further study

Potential areas of further study

The reflections below serve to inspire future studies that could contribute to the next steps in developing a Nordic strategy for preparedness preparation. The proposals are all areas of research that could potentially provide value for a broader range of sectors rather than focusing specifically on food packaging and fuel redundancy.

This report is written as part of the Critical Nordic Flows cooperation between Finland, Norway and Sweden, and the underlying studies focused on flows between these states. However, the fact that all of these three states are part of the European Economic Area makes it logical for this report to also be mindful of the broader European market within which the three states all operate. Consequently the recommendations below also relate to the European level.

More effective preparedness measures within the EU

Current and potential future EU-legislation has significant bearing upon resilience efforts that impacts member states (as well as members of the European Economic Area). Therefore, it would make sense for the Nordic countries to identify current shortcomings in European policy frameworks and together advocate improvements. This makes sense from several perspectives. The Nordics are relatively advanced when it comes to preparedness in the European context, and thus serve as credible advocates. Improvements to EU rules will not only benefit the Nordics themselves but will also help our allies and neighbours in the union become more resilient. From a competitiveness perspective it is also desirable that resilience or readiness requirements impacting Nordic companies do not disadvantage them versus other firms if other firms in the common market are subjected to similar requirements that will not disadvantage them to the same extent as uniquely national requirements. An EU-perspective on resilience also makes sense considering that a common market entails common risks, which therefore need to be addressed at the common European level rather than nationally or regionally. Several of the proposals below contain a potential European dimension.

Nordic cooperation on NATO's Seven Baseline Requirements

Since the two underlying studies for this report were commissioned, both Finland and Sweden have joined NATO – meaning that all three partners of Critical Nordic Flows cooperation are now members of the defence alliance. Consequently, assessing how Nordic cooperation could contribute towards NATO's seven Baseline Requirements has become an especially topical area of research. Specifically, this implies that cooperation on ensuring continuity of government, resilient energy supplies, dealing with uncontrolled movements of people, food and water resources, mass casualties, resilient communication systems and transportation systems are all key areas of focus. What does this mean for our cooperation and planning, and what is best addressed nationally, regionally, or with cooperation beyond the Nordics?

Incentivising better preparedness

Industry consolidation, driven by economies of scale, can lead to reduced redundancy and higher dependency on a limited number of economic actors. Pressures to increase profits and reduce costs can lead to suboptimal solutions from a preparedness perspective. Economic research on market interventions through subsidies, tax breaks, and other forms of incentives to enhance resilience in sectors key for all-of-society resilience could add value. Furthermore, assessing where mandated preparedness requirements may be more appropriate than mere "incentives" to promote societal robustness, even if a complex area makes sense.

Crisis cash flow support to firms

Exploring what policies and structures could support firms with cash flow and financing difficulties during crises would appear to be a critical area to investigate. Studying previous crises (such as the pandemic and financial crises) could provide some value in this context but planning for economically much more disruptive effects during wartime scenarios needs to be included too. A degree of harmonisation of national efforts between the Nordics might be desirable. Beyond national efforts European-level economic responses to enhance crisis preparedness would be important too.

New funding mechanisms for costly preparedness measures

Both the food-packaging and fuel redundancy studies identified that improving certain aspects of preparedness (such as increasing storage/stockpiling capability) were difficult to address as they were both costly and would take a long time to address. Likely there are investments in enhancing preparedness in other sectors too that would be both costly and time consuming. Investigating potential funding mechanisms that would enable states to make costly long-term commitments to enhancing the readiness and resilience of industrial infrastructure could be useful in a range of areas. The role of European

funding in such a context could be investigated – which makes sense if the investments would lead to the readiness of several member states improving.

The integration of preparedness into sustainability efforts

Sustainability has continued to grow in significance, and as indicated by both the food packaging and fuel sector studies, has potential consequences for preparedness. Therefore, it would be advisable to assess more in detail, and for more sectors, how preparedness could be integrated into sustainability efforts. Other than fuel and food packaging the energy and transport sectors would be key areas to focus on due to their strategic significance for other sectors, and due to their centrality to sustainability.

Potential goal conflicts between sustainability and preparedness objectives need to be identified and addressed as early as possible to prevent negative preparedness consequences.

Harmonisation of standards

Another area that could have broader relevance than fuel is the potential for harmonisation of different national standards. If winter fuel requirements differ between the Nordics, there are potentially other national requirements in other areas that potentially impact the interchangeability and thus resilience in other sectors too. Perhaps a mapping of potential areas of where European (or even international) standardisation could enhance societal resilience could constitute a productive research area.

European level mandating of recycling

The implementation of recycling appears challenging in complex economic ecosystems with many actors in different countries, thus it would appear that EU-level initiatives could be necessary to accelerate developments. Could new mandating of recycling and further restrictions on single use plastics, serve to reduce certain plastic dependence? It could at least be worthwhile investigating.

Public-private network best practises

Building networks and public-private contacts that are of value when a crisis occurs, or to share best practises during peacetime would appear to have value in most sectors. Developing best practises for network development that could be applied in different sectors, coupled with a structure to follow up and assessment on actual implementation of the networking in different sectors. By making sectoral authorities accountable for building networks they are more likely to be implemented or implemented well. Thus, an appropriate accountability mechanism for network development could be a potential area for study. Studying how networks can be developed and maintained across Nordic borders would be useful but could also serve to help enhance international networks beyond the three Nordics.

Ensuring that logistical flows can use multiple modes of transport

The fuel redundancy study suggested studying how key logistical flows could be interchangeably used on other modes of transport. This make sense for other areas than fuel, and furthermore considering that several logistical flows vital to several different sectors pass through several countries it also makes sense to study if there are potential EU standards that could be useful to promote such flexibility.

Other areas of potential study

Conceptually interesting areas of further research in several sectors/industries include vulnerability implications of; geographic concentration of key resources, automation (and commonalities across sectors due to digitalisation), raw material availability, spare part availability, and know how/labour availability.

Summaries of the food packaging and fuel redundancy reports

Summaries of the food packaging and fuel redundancy reports

Food packaging production

The following text follows the structure of the underlying report itself.
The Finnish National Emergency Supply Agency's (NESA) study was based on 63 interviews with actors in Norway, Sweden, and Finland. About two thirds of the interview objects were private sector actors. The aim of the research project was to provide an overview of the Norwegian, Swedish, and Finnish food packaging landscapes, their critical supply chains and dependencies, disruptions, and risks. From this the project aimed to identify and provide recommendations about circumstances under which Norway, Sweden and Finland could feasibly support each other to manage and secure national food packaging capabilities.

Food packaging supply chain

The packaging market

The global packaging market was valued at around one trillion dollars in 2021. Roughly half of that market is packaging for food packaging. Of the food packaging, roughly half is packaged for consumer products and the other half for the food service and hospitality industries (secondary or tertiary packaging). Although there are some similarities between the consumer and food service markets one important difference is the different packaging sizes and capabilities to distribute content.

Although a sizable market, packaging is frequently seen in the context of other areas (e.g. food production, logistics and retail) and is thus largely focused on the context of "surrounding" industries. The supply chain is dominated by large food producers, which are in turn relying on smaller and localised packaging converters, before the product ends up at large retail chains. The supply chains for packaging and packaging materials can be seen as intertwined with the products to be packaged – the packages do not come ready made to be filled but are rather created out of the material (cut, folded, sharpened or fastened) as part of the packaging process, which is either designed for the food or vice versa.

Both plastics and fibres are important for food packaging, and the Nordics often use more fibre-based packaging than many reference countries. The large forestry sectors in the Nordics ensure significant wood pulp production is present in the region. Plastic packaging on the other hand is much more dependent upon global markets for plastic granules and polymers, and ultimately crude oil fractions. Plastic raw materials, both recycled and virginal, largely hail from Central Europe. Production enablers, such as industrial chemicals and process equipment are being manufactured in both the Nordics and Central Europe.

Regulation

Two types of regulation dominate: food safety and waste management regulations. Due to the European common market most of this regulation stems from the EU level and affects Norway as well through its membership of the European Trade Area. Significant export to specific markets can also shape production standards due to those markets' national norms and guidelines.

Plastics and fibre-based raw materials

Many of the industrial chemicals required for both plastics and fibre production are derived from crude oil. Some are manufactured in the Nordics, but they are largely imported from Germany and the United States, as well as from China and South-East Asia.

Fibre based raw materials are plentiful in the region, especially due to the well-developed Finnish and Swedish forestry sectors, forest products are also imported from the Baltic Sea area to compensate for the loss of Russian imports since the invasion of Ukraine.

Medical-grade and high-end industrial plastics frequently fulfil the quality requirements for foods applications too, and food grade plastics could for example also be used in insulation. However, despite some potential for interchangeability, shifting from one application to another is not straight-forward due to both production techniques and food safety requirements that require extensive testing.

Packaging design and production

A typical packaging plant is specialised in a production technique, producing packaging material for a specific type and quality range. It can play all the roles of material producer, converter, and printing house. This requires staff that can operate, maintain, and repair the machinery. Shifting to other types of packaging becomes difficult due to specialisation.

Air gases used as protective gas in certain packaging are produced in all three countries, by a small number of large actors. Methane gas was imported from Russia to Sweden and Finland but has since been replaced by imports from elsewhere. The gas manufacturers are often closely involved in the design and packaging of food, as the gas mix needs to fit the barrier layer of the packaging and vice versa. Gases are distributed from the factory to user with temperature-controlled trucks.

Recycling, circularity, and biomaterials

Sustainability and recycling constitute significant trends in the packaging domain, driven both by consumers and company values (which align with interests for investing in sustainability). However, in practise shifting to a more circular economy is complicated by the multitude of actors involved as well as the complexity of the changes required. It is difficult to transition into a circular economy piecemeal, and actors from every level are required to participate. Furthermore, energy-efficient recycling technology is still only in the making and will require long-term investments.

Chemical recycling – dissolving plastics into their component monomers – is a potential future solution, but there remain many obstacles to its adoption at scale. Respondents saw mechanical recycling as easier and more energy efficient than chemical recycling. There is also little support for biodegradable materials as a systemic solution for making packaging more sustainable. The versatility of plastic suggests that it will not be replaced anytime soon.

Regional landscape

The food industry was the Norway's largest mainland industry in 2022, in Sweden it had a turnover of 200 billion SEK in 2021, and in Finland it also constitutes a significant industry. There exists packaging market overlap, for example the Norwegian fish industry buys significant Finnish and Swedish packaging raw materials, and part of the production is packaged in Finland that has large scale fish processing industry despite the small scale of domestic fishing. Denmark plays a regional role due to its shipping, plastics and meats industries, and plays a role as logistical hub due to its land border with continental Europe.

If the three Scandinavian countries can be considered a common land logistical area, Finland is separated by sea and is more dependent on sea transport, much of it via South-Western Sweden. Due to Finland's historic legacy, it also has a different rail-gauge than Sweden and Norway. Despite this the three countries membership of the European Economic Area, means that the three countries are all part of the European Union's single market, despite Norway not being a member of the European Union.

Disruptions and vulnerabilities

The COVID-19 pandemic and Russia's war on Ukraine were mentioned by most actors as having caused disruptions, for example, global container misallocation, shortages of seasonal workers, natural gas shortage, high energy prices, and logistic challenges due to a lack of East European truck drivers. Other specific cases of disruptions were also mentioned; the 2021 Suez Canal obstruction, the 2021 winter failure of the electricity grid in Texas, causing a temporary trans-Atlantic polyethylene shortage, the 2022 labour action at the large paper mill UPM's facilities in Finland causing a European shortage of packaging labels for foods and medicines, and the 2022 labour actions in UK ports. These events were less serious in magnitude than the pandemic or war in Ukraine, but nonetheless triggered sudden price changes and/or delays.

The private sector tended to view disruptions and crises through the lens of normal business operations (e.g. supply shortages, demand spikes and more intense competition). Business had a limited focus on systematic drivers behind the different events and had limited access to forums for public and private co-operation, or even just discussions, to gain a broader perspective were limited.

The variety in the food packing supply chain makes generalisations about identification of risks challenging. In some packaging supply chains, many functions are concentrated in the same facility, in others they are split into different locations and between different actors – such fragmentation can increase the risk for surprising disruptive effects. However, some factors that do tend to show up repeatedly are outlined below:

Production processes

The *maximum shelf life* of the packaged product is dependent upon the packaging quality. For example, a change in gas mix or gas barrier can shorten the shelf life of a product – impacting both logistics and retail.

Tolerance to lag generally increases after a food has been processed and packaged – products that gain more tolerance to lag after packaging are more useful in a crisis, canned food for example becomes highly tolerant. The highest vulnerability of these foods consequently lies before packaging.

Geographic concentration is a function of tight coupling, meaning that steps in the packaging process must take place in controlled succession which occurs in large scale food production. The geographic concentration results in vulnerability to localised events, and conversely loosely coupled and highly distributed processes may be less vulnerable to localised disruptions.

High levels of automation imply increased dependencies upon a stable electricity supply, software updates, spare parts, know how, etc. Automation increases flow speeds and volumes, both in manufacturing and retail, and can thus enhance competitiveness and/or profitability. How vulnerable automation makes a process depends upon how unique the capability is, and how easily it can be substituted.

Material factors

High supplier dependency translates into supplier problems automatically becoming buyer problems. Vulnerabilities increase in supply chains with small margins of tolerance for materiel variability and distant suppliers. Partnerships built on trust and long-term contracts have advantages in crisis situations, allowing joint information sharing and problem solving.

Raw material availability as a factor implies that supply chains using simpler and more common materials are less vulnerable due to more supplier options. However, the flexibility of raw materials can also constitute a vulnerability, as demand can be affected by other types of production too.

Product complexity affects vulnerability, with supply chains depending on specialty materials or uncommon material techniques having limited flexibility in changing materials and designs.

Spare part availability for machinery affect vulnerability, and the degree of automation, product complexity and know-how self-sufficiency – as well as logistics – can all have impact.

Know-how availability can be affected by access to specialised knowledge. For example, during the COVID-19 pandemic the limited mobility of skilled labour, including across Nordic borders, prevented laboratory technicians from conducting maintenance visits. In the longer-term recruitment can also be a factor, with certain sectors such as plastics manufacturing having difficulties attracting younger people to the workforce.

Markets and regulation

Large flow volumes generally mean that the throughput must be very large to maintain profitability. In process-industries starting and stopping can take significant time and resources, and production can require constant and stable inputs of raw material and power – implying vulnerabilities, including those relating to logistical capacity.

Lack of buffers means that without constant input of new materials the supply chain will only function briefly. Manufacturers saving money on warehouse costs or simply very large flow volumes that make significant warehousing difficult (such as for certain commodity plastics). This vulnerability is generally larger where there are high import dependencies.

Regulations and standards regarding food materials are strictly and uniformly enforced, largely from the EU-level with few exceptions. This implies limited freedom of manoeuvre at the national level.

End customer demand can constitute an indirect supply chain vulnerability, for example through panic buying during a perceived crisis.

Conclusions

The report concludes that packaging is a sizable and globally dispersed industry, and about half of packaging is for food. Serious disruptions to food packaging are likely to have direct effects on the vital functions of society.

Trade dependence

Production is extensive in the Nordics, and in Europe, dependent upon developed logistic and energy grid networks. Recycled packaging production is established in the region but is not yet able to operate at scale. Well-functioning recycling systems for e.g. PET bottles and glass exist. Investments into chemical recycling facilities are being made in all three countries. *However*, most food packaging is still dependent upon virginial materials, especially virginial plastics based on fossil imports. In extreme crisis Norway, Sweden and Finland have enough production capacity to cover domestic consumption and more, but how long it can be sustained depends on continued access to raw materials. If only one country was disrupted the other two would likely be able to provide sufficient plastic or fibre raw materials to cover acute needs.

Risk awareness

COVID-19, the Russian invasion of Ukraine, and other real-world events have shaped how companies approach risk management. Global disruptions to the availability of plastics would have quite different consequences for the Nordics than the global availability of wood pulp – for the simple reason that the Nordics are a key producer of wood pulp, but not of plastics.

It is easier to see risks than to address them.

For example, during the pandemic there was a mix of demand driven increase, whilst at the same time there were disruptions to container traffic and manufacturing challenges – identifying the exact effects was difficult, challenging mitigation strategies. Furthermore, most companies in the food packaging business are small or medium size business, and thus usually lack the resources to conduct large scale risk analysis and riskmanagement. In other words – it is not always easy to predict and handle upcoming challenges.

Cooperation is key

Effective cooperation is key for crisis management. Connections established during normal circumstances enable trust and effective information channelling when crisis strikes. The groundwork thus needs to be laid beforehand, and as companies tend to focus on cooperation when the need arises, there is a given role for the public sector in helping prepare the ground for effective cooperation already before crisis or war occurs.

Recommendations

For the public sector

- Find ways to enhance dialogue and cooperation with the private sector through existing forums, or creating new forums.
- Add preparedness components to existing sustainability initiatives.
- Map *and connect* actors collecting data on security of supply, creating a loose multinational expert network (and consider specific follow up studies specifically on 1) generic best practises for risk management of production techniques for nationally important products, 2) map know-how needs for running, maintenance, repair and software for packaging machines and compare this to the existing educational programmes for this know-how, 3) for narrow parts of the production chain identify half-finished products with maximal usability in different types of facilities and applications across the three countries, 4) case studies on how easy it is to change packaging, including cost estimates and how long it takes for the whole value chain to adapt, 5) scenario studies on the biggest risks and how to avoid them.
- Assess regulatory exceptions from different sectors during previous crises and disruptions. Analyse how the need for these exceptions were identified, how and when they were implemented by authorities, how they were motivated and their consequences.
- Identify legal and administrative obstacles to cross-border cooperation, and obstacles to exchanging situational awareness and potential warning signs between the three countries.
- Test whether the findings of the food packaging study hold true for different respondents and after some more time has passed since the COVID-19 pandemic and invasion of Ukraine.

For large national and multinational enterprises

- Focus on risks to the extended supply chain, including those faced by suppliers and customers, and the driving forces behind them. (A checklist of reference questions exists, see Annex A).
- Include exceptional circumstances into risk management processes, rather than focusing on what has happened or is deemed likely.
- Focus on partnerships, contingency plan and exercise with the supply chain including suppliers and customers and develop relationships with the public sector beyond narrow regulatory oversight remits.

For small and medium size enterprises

- Identify vulnerabilities in the extended supply chain from raw materials to the end user. (Check lists questions, see Annex A & B).
- Consider what the business' capacity could be used for during an extreme crisis or war.

Companies that have customers larger than themselves could seek potential synergies regarding continuity management with their customers.

Fuel redundancy

The Nordic Fuel Redundancy report includes a mapping of fuel infrastructure, logistics and supply chains in and to the Nordics and provides recommendations on measures to reduce vulnerabilities and managing crises in the fuel sector. The report authors note that the need to study fuel redundancy in the Nordics has increased for two key reasons: the war in Ukraine (the COVID-19 pandemic has also helped), and the long-term trend towards lower refinery capacity. Profitability concerns as well as decreased demand for fossil fuel-based products have led to consolidation of and reductions in European and Nordic refinery production. Consequently, dependence on the international markets has increased, especially after the closures of the Slagentangen refinery in Norway and Naantali in Finland 2021.[2]

Supply of fuel products

The three Swedish fuel refineries are all based on the West coast, two in Gothenburg and one in Lysekil. The one remaining Norwegian refinery is Mongstad (approximately 50 km from Bergen), and the one remaining Finnish refinery is in Porvoo (approximately 50 km from Helsinki). The closure of one Finnish and one Norwegian refinery in 2021 has had a noticeable impact on Nordic production. Although petrol production has remained relatively stable diesel production declined by 45 percent from 2019 to 2022, reducing exports and increasing imports by over a million tonnes. Plant diesel, jet fuel and marine gas oils all saw significant production declines, resulting in increased imports.

Norway: Sweden is the biggest single supplier of diesel products to Norway and has grown increasingly significant over the years. Sweden is by far the most significant supplier of petrol. For jet fuel and biodiesel, however, sources outside of the Nordics supply the majority.

Sweden: Other Nordic states (Denmark, Norway and Finland) are significant suppliers of diesel to Sweden, with the Netherlands also playing an increasing role since 2020, growing to the largest single supplier since 2021. Swedish petrol imports are largely concentrated from Finland, and Denmark, which has played a decreasing role over time. Swedish jet fuel and biodiesel imports predominately originate from outside the Nordics.

Finland: Sweden is by far the largest single source of diesel imports, and completely dominates Finnish petrol imports. Jet fuel imports, like in the other two Nordics, is dominated by imports from outside the region.

2. The study itself is based on interviews with several of the mail fuel actors in the three Nordic countries. Data was also used to map fuel supply volumes and origins, as well as distribution patterns. Vulnerability analyses were conducted based on both the analyses as well as interviews with concerned actors. Four vulnerability scenario analyses were also conducted, and finally measures to increase security of supply were assessed.

Half (50%) of diesel imports into the three Nordics are Intra Nordic. For petrol three fourths (74%) of imports are Intra Nordic. For jet fuel the intra Nordic share of imports were only 10%, and for biodiesel it is 15%.

Distribution patterns, fuel depots

The number of fuel depots has decreased over the years, and the majority are near the sea to enable supply with coastal tankers. Sea transport is key for supplying both diesel and petrol, with inland transport from the sea terminals. Sweden is the only country where diesel is transported by rail (from Gothenburg to Karlstad and Jönköping).

Preparedness and vulnerability

Refinery and production structure

Prior to the Russian war against Ukraine Europe had seen a 10–15 years period of closures and consolidation of oil refineries driven by demand developments, overcapacity and profitability.

Even after closure European petrol production remained above consumption, European dependence upon Russia for diesel and other middle distillates and crude oil had also grown. The Nordic market had also become dependent on Russia, especially Finland that imported a large part of its diesel and jet fuel from its Eastern neighbour, as well as Russian crude for its Porvoo refinery. This changed after the war, but Sweden had already started reducing dependence upon Russian imports years earlier.

Dynamics following the Ukraine war, the geopolitical tensions, sanctions, and later the incidents with the Nord Stream pipelines all contributed to uncertainty and volatility on the energy and fuel markets.

Large quantities of Russian fuel products, particularly diesel, continued to be imported to Europe during 2022 and early 2023. Partly such imports also served to fill up stocks. The shift away from Russian dependence since has increased dependence on imports from greater distances and increased the share that arrives with large tank vessels.

Nordic fuel quality requirements – particularly winter diesel, which also has different requirements between the three countries – imply a particular challenge for the region. Diesel volume availability became very tight following the start of the war. This resulted not only in higher prices, but also some actors refusing new customers and meeting only minimum contractual obligations even when there was greater demand. Maritime fuels saw some challenges too, but overall access was less problematic as temperature-performance requirements are less stringent and less specific for the Nordics. Jet fuel, although becoming more expensive, saw less of a supply problem, helped by the fact that standards are international.

Mitigating factors that helped reduce severity of the impact were: the relatively mild winter kept demand for heating oil relatively low. Unplanned periods with maintenance and production stops at refineries occurred at relatively favourable times. The Nordic countries relatively strong ability to pay high prices also made the situation more manageable.

Exacerbating factors that increased fuel demand were high gas prices, that led to Finnish district heating facilities switching to light fuel oil instead, and business customers buying to ensure sufficient volumes due to the uncertainty caused by the War. Households purchased light fuel oil due to concern over high electricity prices – due to similarity light fuel oil competes with diesel, putting upward pressure on both prices and road logistics capacity. The shut-down of the refineries in Norway and Finland 2021 has reduced regional flexibility and made sourcing replacement volumes more challenging, but the Baltic Sea area still seems to have oversupply and logistics in the Baltic Sea area are flexible and have relatively short lead times.

Logistical challenges

The replacement of Russian fuel shipped in smaller vessels with shipments in larger tankers from further afield (the Middle East, USA and India) resulted in periods of tight vessel and freight markets, causing a surge in freight rates. In the Nordics the shift towards larger tankers was also particularly challenging as there are few places with the infrastructure to handle very large ships.

The combination of the increased role of bio-based fuels, reduced local refining capacity and the fact that Russian products were more suited to the Nordic markets than winter diesel from the Middle East or India implied some specific challenges for the Nordics in particular – and vulnerabilities ahead.

Organisation of preparedness

Private fuel actors are primarily driven by commercial profit maximisation objectives. Therefore, their optimal levels of preparedness and redundancy may not coincide with broader societal interests – thus impacting investments, stocks and geographic locations.

Storage requirements differ between the three countries. In Norway, which constitutes a significant oil producer, the 20-day requirements (lowered to 17 days during the COVID-19 pandemic) are guided by the minimum requirements of the International Energy Agency (IEA). These requirements were set in a time when most retailers on the Norwegian market were integrated, having both oil supply and a refinery – which is no longer the case. Today there remains only one refinery and dependency on imports from abroad (especially diesel) has increased.

Swedish and Finnish storage requirements are considerably higher. Swedish requirements are based both on EU and IEA agreements and entail that storage must be kept equivalent to at least 90 days of average daily imports, or 61 days of average domestic consumption, depending upon which is higher.

Two thirds can be stored as crude oil/condensate/semi-finished products, and actors without refineries can by "tickets" ensuring that refineries keep crude oil on their behalf. Up to 30 percent of an actors' storage can be held abroad, although not all Swedish actors do. In Norway up to 20% can be stored in another country, however no such storage agreements are currently in place.

Finland goes over and beyond the IAE/EU requirements and stockpiles five months' worth of demand, with NESA storing three months of requirements and private actors a further two months. Storage requirements are only applicable to fossil fuels, but bio-requirements may be required in future. Finland may possess unused storage capacity, however falling demand over time may reduce actors' interests in maintenance and new investments.

Vulnerabilities

Following the sanctions on Russia, the Nordics have become even more dependent on access to North Sea oil – making this production critical. Transport capacity to refineries too is critical. It is noted that shut-downs of both oil platforms and refinery production take time.

Dependence on sea access concerns not only imports of crude oil and final products, but also domestic distribution and access to storage and other facilities. The sheer volumes by sea are hard to replace by road or rail transport, with the truck utilization already quite high, with limited potential to increase capacity in the short term.

Concentration of important functions in certain geographic areas – either production or serving a large hinterland. In Norway, examples are the Mongstad and Oslofjord regions, with key refinery, terminal and storage functions. In Sweden, the area around Gothenburg is critical both for taking in crude oil, but also for housing refining capacity. Baltic Sea trade routes are important both for Sweden and Finland. Without sea access Finland would become highly dependent upon the border with Sweden and Norway, reducing capacity significantly.

Weak links in the value chains include various examples: restrictions in ship size that can be handled, the geographic locations of logistic facilities may not be optimal from a crisis scenario perspective (e.g. ships and tank trucks might have to be loaded/unloaded in places where it is not usually conducted at such scale, fuel deliveries require facilities for mixing, etc) and access to electricity or back-up power (for e.g. pumps as storage facilities and terminals or at fuels stations). As an example, if the refinery, or logistics facilities that can mix fuels in Norway, became unavailable the effects would be felt not only in Norway but also in Sweden and Iceland.

The difference in fuel dependency depending on season and weather, with higher demand in autumn/winter both due to colder weather and demand of winter grade quality fuels, implies larger volumes that need to be handled in alternative ways.

Hoarding behaviour can manifest during crises – and result in stock shortages. The existence of contracts with "options" for fuel deliveries the winter 2022/23 added a degree of uncertainty and put high pressure on capacity.

Vulnerability Scenarios

Maritime blockade of Oslo Fjord

A closure of the Oslo Fjord entails that important terminals serving most of South-Eastern Norway will become inaccessible, resulting in changing distribution patterns. Other terminals will need to be served directly from refineries instead of via Slagentangen, and major import volumes to that would normally have gone to the Port of Oslo and Slagentangen, and some from the Swedish West Coast, leads to an increased need of land-based transport.

Challenges in distribution patterns in this scenario can lead to challenges regarding port calls as the large ships that can call at Slagentangen are not suitable for all locations.

Rail transport from Gothenburg, and imports from other places, is a possibility in this scenario.

Unplanned production stop at Preem's Gothenburg refinery

A long-term unplanned production stop at Preem's Gothenburg refinery would require increased imports from non-Nordic countries to satisfy the needs of Sweden, Norway and Finland. Imports must be sources elsewhere, exports from Preem's refinery no longer have to be considered.

Maritime cut-off of the Baltic Sea between Öresund and Åland

If maritime transport over the Baltic is rendered impossible imports to Sweden and Finland are only possible via Norway and the Sweden's West coast. The scenario leads to significant distribution changes across Sweden, as terminals across the Swedish Baltic Sea coast cannot be served from outside, distribution takes place via rail (where possible) and rail from the West coast. Ship transport can take place to Karlstad, reducing the need for available truck capacity. Northern Sweden and Finland will be served via the North of Norway via road and large volumes will also be transported via rail. Sea transport is still available in the Gulf of Bothnia between Sweden and Finland.

Joint Fuel distribution between Northern parts of Sweden, Norway and Finland

This scenario illustrates that the Port of Kemi can serve Northern parts of Norway and Sweden with fuel from the refinery in Porvoo, rather than terminals in Sweden and Norway. The Port of Narvik is supplied via rail.

All four scenarios display changes in Nordic flows between the three countries.

Discussion

In scenarios where sea transports are severely restricted, large fuel flows have to be replaced by land-based modes – tank trucks or by rail (where rail is feasible). Extended driving distances for trucks may pose a challenge for availability of drivers with valid licences and vehicles with ADR authorisation. Rail transport is a potential solution, but excess capacity is limited. Smaller volumes of fuel could potentially be transported via bulk containers or tank trailers that can be lifted with standard terminal equipment like reach-stackers or forklifts. A key advantage of rail transport availability is that it reduces the need for drivers – although it still requires access to equipment and rail capacity. Therefore, it makes sense to investigate whether tank trailers for fuel could be transported by rail in the same way that semi-trailers and swap bodies are transported by rail today – both to reduce the need for tank wagons and to improve flexibility for last-mile distribution by truck.

Disruptions at the scale of those in some of the scenarios will likely entail tough decisions on which flows to prioritise, which to limit (or cease completely).

Assessment of joint measures

Increased focus on preparedness

The joint effects of the COVID-19 pandemic and the war in Ukraine has significantly affected the focus on emergency preparedness in recent years. The pandemic made it clear that the level of detail in existing emergency plans was too limited – something that helped mobilise new Nordic preparedness initiatives, which was in turn further emphasised by the war in Ukraine.

Interviewed actors also report a change in mentality among customers. For example, actors higher up the value chain are relying less on spot markets and looking at long-term contracts, and diversifying suppliers. But retailers and final customers also show an interest in being more prepared. In Finland, for example, the interest in testing emergency plans has increased. Prior to the pandemic and the War in Ukraine access to electricity and fuel was taken much more for granted. The authorities too have displayed stronger interest and engagement than before.

Areas of improvement

Protection of physical infrastructure such as oil production, refineries, extraction terminals, depots and emergency stockpiles; critical routes, mostly by sea, for imports of crude oil and final products, as well as protection of distribution routes, were identified as potential areas of improvement.

Market actors highlight need to improve knowledge of where fuel might be needed in the time of crisis, for what functions, and in what volumes.

Furthermore, it is important for concerned actors to have a better understanding of the knowledge of how fuel will be prioritized in times of scarcity, – otherwise firms would have to decide by themselves which customers should be prioritised during a crisis, making strategic allocation of resources in time of crisis difficult. Norway is currently in the process of establishing a prioritisation order for crisis.

Measures and investments

Investing in back-up solutions and redundancy is a way to minimise vulnerabilities by. Such investments are costly and may not make sense from a purely commercial perspective.

Investigating whether it is practicable to transport tank trailers for fuel by rail in the same way semi-trailers and swap bodies are transported by rail today. This would limit the need for tank wagons and improve distribution flexibility eliminating the need for tank terminal access.

The significant investments and time required to improve redundancy imply that they need to be seen as long-term improvements. Firms are reluctant to absorb such costs – raising the question of the role of the state.

Dialogue and cooperation between concerned actors and authorities is seen as good according to the interviewees. However, communication and cooperation during normal times is different from emergency situations, and severe crisis often entail a risk of losing essential communication channels.

Emergency stockpiles

Extending storage requirements is not straightforward – both investing in storage facilities and keeping them is expensive. During the Ukraine war for example fuel prices were so high that companies wanted to minimise their stocks.

Mapping of storage facilities could be relevant for Norway, according to the report. When choosing the location of emergency stockpiles, it would make sense to choose locations with access to both sea and rail.

Bilateral stockpiling agreements, for example with Norway relying on Swedish storage is an alternative to be considered, reducing costs and needs for investments, whilst still increasing stockpiles.

Increasing Norwegian stockpiling requirements should not be introduced overnight and should be done in an “actor-neutral” way.

For Finland jet fuel storage might be given some attention as operations are currently highly dependent upon the Porvoo area. Furthermore, the NATO membership may have implications for the military’s storage needs.

Cash flow and financing

Cash flow and financing are also important factors affecting companies. Therefore, some actors interviewed for the report argue that authorities need to be better at handling high costs, low income and difficulties in obtaining financing for firms during crisis.

Storage of non-fossil fuels or fuels with special properties

There exists a trade-off between preparedness and costs. For example, winter grade diesels are more expensive, but can be used throughout the year. Biofuel blend-in requirements have implications for preparedness. Biofuels and fossil fuels are increasingly procured as separate products, that are blended at a later point. The petrol that is procured is of lower octane value, which is then increased by the blending. Consequently, the petrol cannot be used without access to the correct bio component. Diesel does not have the same problem and can be used without the biodiesel mix. However, biodiesel is more challenging to store over time than regular diesel. Furthermore, some biofuels have lesser cold properties than regular fuels. To fulfil (annual) biodiesel blend-in requirements actors blend in the majority of biodiesel during the summer, and much less during the winter.

International cooperation, agreements and joint distribution

One potential area for improvement presented was coordination of product qualities across the Nordic area. The different national requirements make trade and emergency preparedness more challenging.

International agreements to safeguard supplies into countries during crisis or war are desirable, but according to the Norwegian Total Preparedness Commission it may make more sense to pursue such agreements through broader international cooperation than bilaterally.

Improvements for potential follow ups

A number of potential improvements were brought up in the study improving better protection of physical assets and routes, more detailed mapping of fuel needs, a prioritization system for actors during crisis, strengthening “weakest links”, and reviewing legacy-based storage requirements. All of these measures will entail both significant costs (both for commercial actors and society) and take time to address. Difficult trade-offs will need to be made, that at the end of the day are political decisions.

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