

Roadmap for fossil free competitiveness

A SUMMARY OF ROADMAPS
FROM SWEDISH BUSINESS SECTORS



»The roadmaps demonstrate a change of attitude that has taken place in many parts of the business world in recent years, where reducing greenhouse gas emissions is no longer considered a burden; instead, it is a natural step towards strengthening competitiveness.«

Svante Axelsson

National coordinator, Fossil Free Sweden

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Introduction

Sweden will be one of the world's first fossil free welfare nations. This is not just a vision; it will soon become a reality, now that different industries are presenting their roadmaps for a fossil free future with increased competitiveness. This work is extremely important, since the pace of reductions of global greenhouse gas emissions is far too slow to keep the average increase in the planet's temperature well below two degrees.

The Fossil Free Sweden initiative was launched by the Swedish Government ahead of the COP 21 climate change conference in Paris in 2015. It gathers stakeholders from all sectors of society who share the vision of Sweden being one of the world's first fossil free welfare nations and are themselves prepared to contribute to the transition. Today, more than 400 companies, municipalities, regions, and organisations are taking part in the initiative. As national coordinator, it is my role to support these stakeholders in their transition to a fossil free society by identifying obstacles and opportunities, and encouraging politicians to create the right conditions to enable the stakeholders to reduce their emissions more quickly.

In 2017, Sweden's Parliament adopted a climate policy framework that included the goal of making Sweden climate neutral by 2045. Based on this decision, Fossil Free Sweden has encouraged different business sectors to draw up their own roadmaps as to how they will be fossil free while also increasing competitiveness. In the roadmaps, these business sectors describe when and how they will be fossil free, what technological solutions need to be developed, what investments need to be made and what obstacles need to be removed. The roadmaps also contain the sectors' own proposals for commitments by business stakeholders, and put forward political solutions.

According to the construction and civil engineering roadmap, the sector can halve its emissions as early as 2030 using existing technologies, and reach zero emissions by 2045 using technology currently being developed. For example, carbon capture and storage

(CCS) technology is needed, which the cement industry also describes in its roadmap to make climate-neutral cement possible. The concrete industry also sees several other ways to significantly reduce its climate impact and has set the goal of reach half the climate impact in 5 years. CCS will also be used to enable the heating sector to be fossil free by 2030, and by 2045 to become a carbon sink that will decrease the total amount of greenhouse gas emissions.

»The steel industry describes a unique initiative focusing on the development of a technology to reduce iron ore to iron using hydrogen.«

The steel industry alone accounts for 11 percent of Swedish carbon dioxide emissions. In its roadmap, the steel industry describes a unique initiative focusing on the development of a technology to reduce iron ore to iron using hydrogen. This technology can have a major impact on global emissions when taken up by other markets. The mining and minerals industry is now carrying out an electrification and automation program that, together with a transition to biofuels, will make mining operations fossil free by 2035. Electrification and increased circulation of material flows are important components also for the aggregates industry to halve their emissions by 2030 (compared to 2015) and become fossil free by 2045.

The food retail sector's goal is for all plastic packaging to be based on recyclable or renewable raw materials

by 2030, and all plastic packages in the shops to be recyclable by 2023. By transitioning to biofuel, the aviation industry aims to achieve the goal of fossil free domestic aviation by 2030, and to make all flights departing from Swedish airports fossil free by 2045. Between 2010 and 2016, the road haulage industry reduced its emissions by 25 percent, due in part to an increased use of biodiesel. In addition to switching fuel, it now sees further potential in route optimisation and digitalisation. In the shipping industry there are interesting developments in gas (LNG/LBG), battery, biodiesel (HVO) and methanol powered vessels.

The forestry industry not only describes its own way towards a fossil free future, but also explains how biomass can help other industries achieve their goals. In a similar way, the digitalisation consultancy industry shows how they can contribute to transformative solutions that speed up the development towards a fossil free future and resource efficiency within several areas in society and business.

Together, the roadmaps form a sort of 'jigsaw puzzle' of Sweden that tangibly shows how different parts of greenhouse gas emissions can be reduced while strengthening competitiveness. This 'jigsaw puzzle' shows common challenges, and also conflicting goals among the industries. Many industries where fossil fuels will be replaced by renewable fuels are dependent on the amount of biofuel it is possible to produce from Swedish forests. The challenge is that demand for biomass will probably be greater than what can be supplied. We therefore see the need for a national bioeconomy strategy. A long-term agreement on how forests and agriculture can be used while achieving other environmental goals would reduce the political risk and accelerate investments in, for example, biorefineries.

A national strategy for CCS technology should also be drawn up. The technology exists, but the costs are still too high for a single company to take on in a competitive market. In general, financing the technological leap is a key issue that must be addressed. Even if the fossil free transition strengthens competitiveness in the long term, companies must also survive in the short term, and cannot manage all the necessary investments themselves. Here the State must find a way to reduce financial risk. Besides the European Investment Bank and other

institutions which can cover the primary risk in financing major technological leaps, public procurement is a key factor if fossil free products are to out-compete fossil-based products.

The work on the roadmaps has been broad-based and transparent, and included large sections of participating industrial sectors. They demonstrate a change of attitude that has taken place in many parts of the business world in recent years, where reducing greenhouse gas emissions is no longer considered a burden; instead it is a natural step towards strengthening competitiveness. In this way, climate policy is becoming increasingly intertwined with industry and export policy. The roadmaps for fossil free competitiveness show the Swedish business sector that there is no contradiction between growth and reduced emissions; they are instead prerequisites for a modern welfare state.

The Swedish national team for a fossil free society has come together to show that a different world is possible. And once we have demonstrated that a fossil free country is also the path towards a better life, there will be a global race away from the fossil fuel-based society.

This is our hope!



Svante Axelsson
National coordinator, Fossil Free Sweden

Greenhouse gas emissions covered in roadmaps for fossil free competitiveness

The Swedish greenhouse gas emissions in 2016 was 53,000 thousand tonnes of CO₂ equivalents, whereof one third stem from the industry and one third from domestic transport.

The diagram to the right shows that the nine roadmaps for fossil free competitiveness presented in this report covers more than 32 % of the Swedish territorial greenhouse gas emissions. There are some overlaps between sectors, for example the construction and civil engineering sector cover parts from the steel and concrete industry as well as road haulage sector. Also, a part of the electricity and district heating share is covered, since one third of the Swedish electricity is consumed by the industry.

In addition to this diagram, there is a carbon dioxide uptake from woodland and wood products from the forest sector of 50 000 thousand tonnes of CO₂ equivalents.

EXAMPLES OF TARGETS PRESENTED IN THE ROADMAPS

The business sectors own their own roadmaps and are responsible for the visions, goals, obstacles and solutions described in the plans. The roadmap processes have been managed by sector associations or companies. Here are some examples of targets and intentions presented in the roadmaps.

The aviation industry

All domestic flights will be fossil free 2030 and all flights originating from Sweden are fossil free 2045.

The concrete industry

Reach half the climate impact in 5 years. Climate-neutral concrete available on the market 2030 and all concrete climate neutral 2045.

The construction industry

50 percent reduction in greenhouse gas emissions (cf. 2015) 2030, 75 percent reduction in greenhouse gas emissions (cf. 2015) 2040 and net zero greenhouse gas emissions 2045.

The food retail sector

All plastic packaging to be recyclable by 2022. Renewable or recycled raw material in all plastic packages 2030.

The forest sector

Fossilfree industry operations 2030. Fossil free vehicles in forest industries and in forestry 2030. Increased production of biofuels based on forest rawmaterial from 1 TWh to 10 TWh per year.

The mining and mineral industry

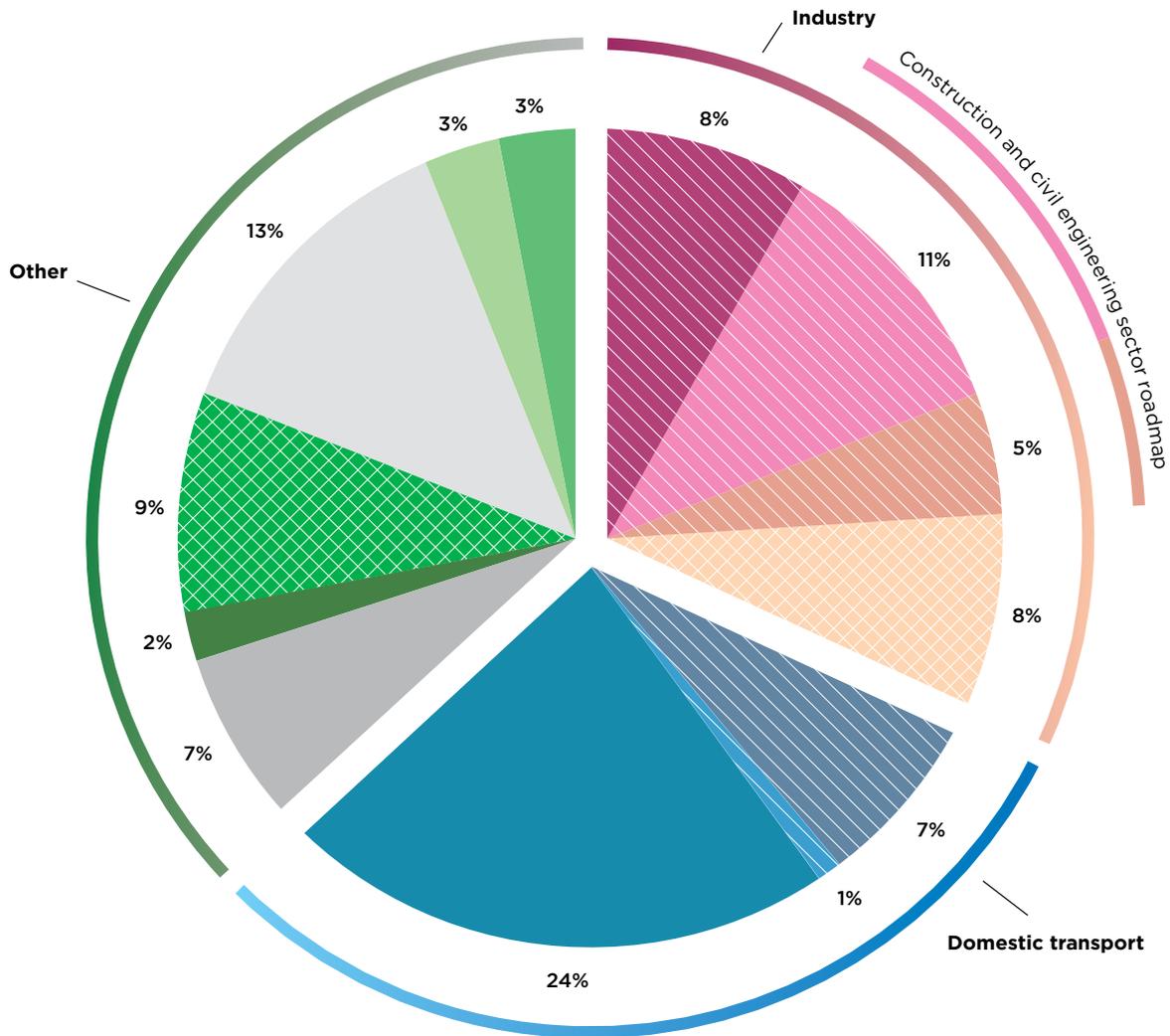
Swedish mining industry is aiming at having the first fossil free mine before 2035.

SWEDISH TERRITORIAL GHG-EMISSIONS COVERED IN ROADMAPS FOR FOSSIL FREE COMPETITIVENESS

▨ Business sectors covered by roadmaps for fossil free competitiveness in this report

◊ Partly covered emissions by different roadmaps

- Mining and mineral industry roadmap 8%
- Steel industry roadmap 11%
- Cement industry roadmap* & Concrete industry roadmap* 5%
- Other industries 8% (e.g. Forest sector roadmap 1,7%, Food retail sector roadmap)
- Road Haulage industry roadmap* 7%
- Aviation (domestic) industry roadmap 1%
- Other domestic transport 24%
- Non-road mobile machinery and equipment 7%
- Heating of homes and premises 2%
- Electricity and district heating 9%
- Agriculture 13%
- Waste 3%
- Solvents and other product use 3%



Source: Swedish Environmental Protection Agency, 2017 (*the sector's own calculation)

1. The aggregates industry

Summary of roadmap for fossil free aggregates industry

CURRENT STATE

Aggregates (sand, gravel and crushed rock) is an indispensable local Swedish raw material. Aggregates is necessary for a well-functioning infrastructure, housing construction, roads, railways, ports and airports and thus for business development and employment.

In 2017, about 100 million tonnes of aggregates was produced and delivered, making it the country's largest industrial product by weight. The value of the raw material is about 10 billion SEK and the aggregates industry employs about 5,000 people directly and amounts to approximately 30,000 people indirectly.

The fossil emissions from the aggregates industry amount to about 0.25–0.45 million tonnes of CO₂-eq. for the production chain, and an additional approximately 0.2 million tonnes of CO₂-eq. Emissions from the transport will be greater if the distance to the customer increases.

OBJECTIVE: EMISSION-FREE AGGREGATES INDUSTRY 2045

In 2045, the aggregate industry will be completely fossil-free and largely automated or remote-controlled. During the transition work, information and demonstration efforts will be required to implement and support this transition. By 2030, the greenhouse gas emissions of greenhouse gases from production processes will be reduced by 50 % compared to the 2015 level. The industry's measures for the fossil-free aggregate industry

The climate change in the aggregates industry is used mainly through development in four different areas:

1. *Electrification of the production process*

The electrification process will be carried out partly through connecting of crushers and machines in the production process to electricity network, and partly through increased battery operation of construction machines. Today, a large part of the work in the quarries is done with diesel-powered

equipment, especially with mobile crushers and to move the heavy material in the area. By operating machines with renewable electricity instead, the production processes in the aggregate industry can be virtually emission-free.

2. *Increased use of fossil-free fuels in the production process*

An important part of the reduction of emissions will be carried out using biofuels in cases where electrification is not suitable/possible. The availability of biofuels at competitive prices is an important prerequisite for the industry's transition. Most of today's machines can run on biofuels without measures.

3. *Smarter transports and more efficient location of quarries*

Reduced emissions from transports to customer through optimized localization of quarries and material terminals, and increased proportion of climate-efficient transports. Material transport accounts for a large part of the industry's emissions. Big savings can be made by buyers and producers together planning the logistics to minimize transport. Even more important is to locate the quarries smart, that is, close to the place where the material will be used. To enable more urban-based investments of quarries, the aggregates producers are continuously working on developing production equipment with noise less and dust less.

4. *Circular material flows*

Increased circular material flows mean that the need for processing of the material is reduced and that the logistics process becomes more efficient, which reduces fossil emissions. Today, several EU countries have come further with recycling materials, and here are several good »best practices« to be inspired by.

WHAT IS NEEDED TO MEET THE GOALS

Ensure legal and effective licensing processes

Legal, effective and predictable permit processes are required to create a rational supply of raw materials. By planning smart and placing quarries closer to the building site, the climate impact can significantly decrease. Then the processes for obtaining permits must be made considerably more predictable, legally safe and uniform.

Give long permits with flexible terms for investment

In order to promote electrification, a long-term approach is required. Even if the profitability meets the company's demand for repayment time, climate investments are not carried out if the remaining license period is too short and it is uncertain whether the cover will be granted extended operating license with reasonable terms. Too short counting permits with too rigid conditions do not give the operator the opportunities that are needed for long-term climate investments.

Produce End-of-Waste (EoW) criteria for ballast

It must become clear when waste ceases to be waste and the regulatory framework must promote recycling when it is environmentally justified. SBMI (Sveriges Bergmaterialindustri) considers that the Ministry of the Environment should give the Swedish Environmental Protection Agency the task of developing EoW criteria for ballast material.

Produce industry guides for what is NOT waste

In today's legal system there are big uncertainties about the recycling of aggregates. In many cases, a rational material handling and sound circular material flows are counteracted by an uncertainty regarding the outcome of government assessments. Clearer guidance is needed on what does not fall within the scope of the waste definition to ensure uniform assessments in the country.

Prioritize circular material flows during assessments

Today, too often restrictive authority assessments are made about where recycled materials may be used. This means great costs for society, long unnecessary transports, and counteracts circular material flows. The circular society needs site-specific government assessments that promote circular material flows, and where reasonable considerations regarding environmental protection are made.

Let public procurement be driving

A large proportion of the industry's production is sold to public procurers. These should be able to set higher climate requirements than private clients. It can, for example, reward recycled material. This could mean that the industry gets an opportunity to get more paid for products that meet higher requirements to promote climate investments.

Establish »Policylabs« for industry regulations

Many regulations have been developed in a society that was different from today. The regulations or instruments were relevant at the time of the introduction, but perhaps not today. Policylab is a form of cooperation where many different relevant stakeholder groups work closely together on the design of the regulations. This technique has proven to be effective and successful in many different ways.

Secure well-functioning market for biofuels

Electrification is not suitable everywhere. It is important that the industry can reduce fossil emissions through other measures. Demand for HVO will increase. There is a need for new policy instruments that enable the industry, together with authorities, to develop technology that encourages technology development and increased production of, for example, biofuels.

Speed up technology shifts with »The Climate Leap«

In larger plants, electrification is often more profitable, but in medium-sized revenues, for example, the governmental financial support is needed to create enough profitability for the conversion. A major change will require the support of society. With the support of, for example, the governmental investment program »The Climate Leap«, the return of investment period reduces to an acceptable level.

Consider the supply of aggregates early in the construction process

By considering the supply of aggregates early in the overview planning process, the conditions will be better for increased material recycling, efficient logistics and efficient material supply. Effective mass logistics require a holistic approach, collaboration between many actors and good planning.



2. The aviation industry

Summary of roadmap for fossil free competitiveness – Aviation

CURRENT SITUATION AND EMISSIONS TODAY

One of the prerequisites for national and regional competitiveness is that distances can be covered within an acceptable period of time. Air transport is, and will continue to be, the mode of transport that provides long-range accessibility with reasonable travel times.

Globally, aviation emissions of carbon dioxide account for around two percent of the world's carbon dioxide emissions. In Sweden, aviation emissions of carbon dioxide, domestic and international, account for around five percent of Sweden's total carbon dioxide output. In common with all other industries, emissions need to be reduced.

One of the solutions is that the aviation industry contributes to a fossil free future by switching to an alternative fuel. When fossil free fuel is produced, distributed and demanded in sufficient volumes, aviation can make a major contribution to the attainment of national and global climate goals. At the same time, a comprehensive improvement of energy efficiency and increased electrification are required, which contribute to limiting the demand for fuel regardless of its source. Domestic flights require approx. 200 000 m³ biofuel and international flights approx. 1 million m³, in other words approx. 2 and 10 TWh respectively.

The technology is available for producing fossil free fuel that can be used straight away in today's aircraft engines without the need for any technical modifications. But the limitations are largely due to the fact that there is currently no functioning market.

A transition to fossil free fuel within the aviation industry would have the effect of reducing aviation's climate impact, while also providing the opportunity to create more jobs in existing and new green industries. If Sweden leads the way in this development, many others

will follow and the solutions would have the potential to drive a global transition.

THE NEED FOR A MARKET

The Government notes that the additional costs of fossil free fuel for aviation are high and that the incentives for airlines to demand biofuels are therefore low. In order for the aviation industry to contribute to the Government's goal of a fossil free future, an increase in fossil free fuel production is crucial. This requires a functioning market.

The market for fossil free fuel could be created by the aviation industry committing itself to buying a specific volume, although this is impossible at the moment as the cost is unknown. The producers are faced with a similar challenge, not knowing if they can get a return on their investments and therefore not daring to invest. Solving this dilemma is key. We must therefore find a model that creates a market where various parties are initially involved, sharing the risk as well as the difference in price between fossil and fossil free fuels.

These initiatives will mainly be at industrial and political levels. This means that lead times can be reasonably short and that the aviation industry can contribute considerably to a fossil free future with a relatively fast transition.

The strategic objective for 2030 is that all domestic flights are fossil free. For 2045 the strategic objective is that all flights originating from Sweden are fossil free. This is in line with the Government's goals.

OBSTACLES/CHALLENGES ON THE WAY

The roadmap identifies three main obstacles which need to be overcome in order to facilitate the transition. These relate to economic incentives and terms, commodity availability, prioritisation and competition, and political will, coherence and regulation. Common to all these areas is



the necessity for all stakeholders to play an active role in the creation and development of a fossil free aviation market, thus enabling Sweden to realise its objectives.

Economic incentives and conditions will need to be implemented if the volumes of fossil free fuel required to achieve the two strategic objectives are to be produced. Production of these volumes in a commercially viable setting requires a number of actions. The price gap between fossil and fossil free fuels is a strong deterrent to any would-be purchaser of the latter. Furthermore, insufficient evidence of its commercial viability has a negative effect on the availability of risk capital. Policy instruments are therefore necessary if a transition is to be made possible.

Commodity supply and prioritisation are needed to facilitate adequate access to biomass, especially if production is to be carried out locally. Political clarity is required to ensure long-term access to the relevant biomass. The necessary investments in more production facilities

will not be made as long as the uncertainty surrounding the commercial viability and future remains.

Political will, coherence and regulation are necessary to enable a clear, long-term political plan detailing the way in which different industries, including aviation, should move from fossil to fossil free fuels. In order for investments to be made in Sweden, the market needs to know that a long-term demand exists. This requires clear political will, stable rules and clear objectives.

THREE SELECTED PROPOSALS FOR THE REMOVAL OF OBSTACLES

The roadmap identifies that the state has the ability to contribute to the creation of a market through a series of actions. Three of these are:

- The state should promptly decide on the direction of state aid for investment. Production capacity to provide the aviation industry with fuel required to attain the 2030 objective requires an investment of around SEK 5 billion.
- The state should formulate and communicate a public strategic objective for the transition to fossil free aviation, with the milestones 2030 and 2045, including a long-term goal of electric aviation.
- The state should conduct a public tender for the provision of the amount of fossil free fuel required for public sector air travel in Sweden.

Moreover, the roadmap identifies what opportunities the manufacturing and aviation industries have in terms of contributing to the creation of a functioning market for fossil free aviation.

Making a whole industry fossil free involves many players and value chains. The roadmap has been drawn up in a limited time and in a limited format. There are therefore aspects that need to be investigated more closely. However, the roadmap has taken as its starting point what can be done in a relatively short period of time to bring about a change. A primary conclusion is that if the market can be created, many of the conditions are already in place for a transition to fossil free aviation – a process in which Sweden can and should play a leading role.

3. The cement industry

Summary of roadmap for fossil free cement

POPULATION GROWTH AND DEMAND FOR CONSTRUCTION MATERIALS

The world is facing a decisive challenge: to limit global warming to a maximum of two degrees Celsius while at the same time mankind should have an effective, secure welfare system.

By the year 2050, the global population is expected to have increased from the current level of 7.6 billion to almost 10 billion. Twice as many people are expected to be living in metropolitan regions. This means that we need sustainable, robust and functional construction materials with a long service life. We must build in a resource-efficient, long-term way, recycle construction materials and convert to sustainable manufacturing processes for construction materials.

Agenda 2030 and the UN's Sustainable Development Goals state that we must be able to manage all of the sustainability challenges that we face. Society having access to sustainable concrete products plays a decisive role in our ability to achieve these goals.

ZERO NET EMISSIONS FOR SWEDEN IN 2045

Sweden has an ambition of zero net emissions by 2045. At the same time, the current population of ten million is expected to grow to just over twelve million by that date. Metropolitan regions become more densely populated and there will be a major need for housing and infrastructure. The way we deal with the climate challenge in Sweden has good prospects of having a global impact.

CEMENT FOR CLIMATE-NEUTRAL CONCRETE

Concrete is and will be decisive in the building of a climate-safe, sustainable Sweden of the future. Limebased cement will continue to be the main binding agent for the foreseeable future. If the built environment is to be

sustainable, we must find a way to produce cement for climate-neutral concrete.

This roadmap links in with the roadmaps of concrete industry, the construction sector and the mining industry.

OUR CALL TO ACTION

If we are to work together to achieve climate neutrality by 2045 – and at the same time secure a high level of welfare in Sweden through strong industrial production – a conversion is required. We have identified a number of measures that are crucial for climate-neutral cement and concrete production and a climate-neutral built environment.

- **A sustainable built environment requires a life cycle analysis**

Investments in housing and infrastructure must take place with a long time horizon. Design and material selection need to be informed by scientific life cycle analyses. Avoid special municipal demands on construction and adopt instead a national approach for climate requirements in order to support the right choice of materials, the resource-efficient use of materials and continued efficiency improvement in the construction sector.

- **Sustainability requirements in public procurement**

Make greater use of sustainability requirements in public procurement in order to drive demand and the availability of sustainable solutions in the whole built environment sector. This is key. Around one third of the cement produced and used in Sweden is currently procured indirectly using the requirements specified by the Swedish Transport Administration. Public actors need stronger ordering competence when it comes to climate impact and life cycle analysis.

- **Support the transition to biofuels**

Develop instruments to support a faster transition to biofuels in industrial production. In this respect we in Sweden can make better use of residual products from forestry. At the same time we must guarantee sustainable forestry and protect wetlands and biodiversity. Biomass from the forest should be used primarily for highly processed products and in areas where there are no alternatives.

- **Emission rights trading**

Trading in emission rights should continue to be the main instrument to reduce carbon emissions in cement production. This system results in gradual improvements. Major technology shifts require supplementary and supporting instruments.

- **Carbon capture – public initiatives for research and development**

Targeted, long-term public initiatives are required in order to support the highly competitive process industry as it strives to achieve greater technological advances in the field of low-carbon technology. For the cement industry, this primarily means the development of efficient, commercially available carbon capture technology. Significant initiatives will be required in research, development and demonstration.

- **Create commercial solutions to utilise and store carbon dioxide**

To prevent process emissions from industry from being released into the atmosphere, there is a need to develop commercial and large-scale solutions to utilise carbon dioxide in industrial processes (CCU) and to store carbon dioxide geologically (CCS).

- **National strategy for storing carbon dioxide**

The Swedish Energy Agency should be mandated to draw up a national CCS strategy. It needs to include the need for instruments, an identification of system solutions including storage site(s), technological development in full-scale installations, market models, issues of risk and responsibility, legal considerations, international collaboration and issues of acceptance. The strategy should be developed in close dialogue with the process indu-

stry. Knowledge and collaboration in this respect may be obtained from places such as Norway, where, there are good storage conditions.

- **More clearly defined mandate for authorities**

The transition process for more climate-friendly production is being slowed down partly by uncertainty about how environmental permits are issued and how environmental inspections are performed. Authorities responsible should be given a more clearly defined mandate to support a transition process.

- **Material-neutral allocation of public funds**

Allocation of public funds for development and innovation in the construction sector should be distributed in a broad, material-neutral way. This avoids incorrect priorities, sub-optimisation and uneven competition. It also stimulates the opportunity to develop technical construction solutions with combinations of materials.

- **Commercial conditions for a circular economy**

Concrete is a fully recyclable material, but handling and transport create financial thresholds for recycling in concrete production. Incentives are needed for a higher degree of recycling, including of whole concrete structures.

- **Access to electricity**

An increase in the electrification of transport solutions and industrial processes requires access to electricity with a minimal climate footprint at competitive prices. The conditions for indirect compensation in Sweden for increased electricity costs should be reviewed, and when electricity production changes, political vigilance is required in order to guarantee satisfactory supplies and an effective market.

4. The concrete industry

Summary of roadmap for climate-neutral concrete

Sweden faces two major challenges – building historically large volumes of both infrastructure and housing, and turning our society into a climate-neutral one by 2045. Combining these two challenges while maintaining competitiveness is nothing that one individual actor or the policy itself can achieve. We need to find common solutions where politics, academia, society and business interact.

Almost everywhere in our societies, concrete has made the building of society possible. The durability, life span and other characteristics of concrete make it difficult

for all parts of the community to replace concrete to any great extent. However, concrete contributes to major carbon dioxide emissions, mainly from cement production. Those of us who work in different ways with concrete have decided to change this and therefore we have started the Swedish Concrete Initiative. Together with the Fossil Free Sweden initiative, the Swedish Concrete Initiative is now taking a holistic approach with this roadmap for climate-neutral concrete.

CLIMATE-NEUTRAL CONCRETE 2045 – AVAILABLE IN 2030

Our vision and goal is that all concrete in Sweden should be climate-neutral by 2045 and that there will be climate-neutral concrete on the market in 2030. Our work is based on a life-cycle perspective.

Climate-improved concrete is already available for concrete for building construction. Development work is also under way for the cement and concrete used for infrastructure construction. The work so far has resulted in concrete with 20 to 30 percent lower climate impact than conventional concrete. This has been achieved through the development of new cement types, concrete composition with a lower proportion of cement, the use of alternative binders and climate optimisation of design.

HALF THE CLIMATE IMPACT WITHIN FIVE YEARS

The concrete industry has set the target that the concrete for building construction shall reach half the climate impact within five years. This will primarily be due to the continued development of concrete composition, the use of alternative binders, optimisation of design and lower climate impact from transport. But to achieve this, it is also necessary that the market, both public and private, demands concrete that has a lower climate impact.



EDUCATION LEAP - USING CLIMATE-IMPROVED CONCRETE TODAY

In addition to the concrete industry, politicians, builders and other actors have a responsibility for major changes in the short term. Efforts are needed for education and development, and from a political point of view, efforts must be material-neutral in order to enable the sustainable development of all materials.

»The concrete industry has set the target that the concrete for building construction shall reach half the climate impact within five years.«

FUNCTIONAL REQUIREMENTS AND LIFE-CYCLE PERSPECTIVES

Procurement regulations should be based on functional requirements from a life-cycle perspective. The starting point for assessment of climate impact for a building or infrastructure construction should be based on a life span of 100 years or more. Building materials with a long life span that allow flexible use of the structure over time should be prioritised to prevent waste. Recycling and re-use need to increase based on a circular economy perspective.

FOSSIL FREE TRANSPORT IS NEEDED

The concrete industry is dependent on the transport industry's climate work, with increased access to fossil free fuels and technological development of vehicles. For transportation, digitalisation also offers opportunities for management and optimisation of logistics. Control mechanisms also play an important role in several areas where they should be developed to stimulate step-by-step improvements and control the transition to biofuels.

FINANCING OF A TECHNOLOGY LEAP CCS/CCU

Cement accounts for about 90 percent of the climate impact of concrete. An extensive technology leap for cement manufacturing is therefore needed to achieve climate-neutral concrete by 2045, including geological storage of carbon dioxide (CCS) and utilisation of carbon dioxide in industrial processes (CCU). There are a number of obstacles here that need to be removed politically. Today, it is technically possible to start using CCS/CCU, but this requires extensive investments where the state contributes funding and takes on part of the financial risk.

NATIONAL STRATEGY FOR CCS/CCU

Politicians need to show leadership and develop a national strategy for the development of CCS and CCU. Regulatory changes also need to be made to build a functioning infrastructure for CCS/CCU.



5. The construction and civil engineering sector

Summary of roadmap for the construction and civil engineering sector

The construction and civil engineering sector, including the property sector, currently accounts for one fifth of Sweden's climate impact. As Sweden reorganises to reach the agreed climate goals, we want to take responsibility for our part and provide solutions. Within the framework of the government initiative Fossil Free Sweden, and under Skanska's project management, our sector has united around a common roadmap for a carbon-neutral and competitive sector. Working on the roadmap has united many key players throughout the entire value chain, and together with roadmaps from other industries, a unique and powerful force has come together for carbon transition.

Carbon emissions arise primarily from the manufacture of construction materials and buildings energy usage. There are, however, several positive trends:

- Digitalisation allows for new ways of working, services and markets, as well as more efficient, sustainable construction, operation and maintenance.
- The construction and civil engineering sector has potential to minimise waste and move towards circular resource usage.
- Access to financial capital can promote investments in new technology.
- Common goals can drive progress towards carbon neutrality.

The roadmap establishes goals to achieve a carbon-neutral value chain in the construction and civil engineering sector. Goals for the following years are:

- 2020–2022: Key players within the construction

and civil engineering sector have mapped their emissions and established carbon goals.

- 2025: Greenhouse gas emissions clearly demonstrate a declining trend.
- 2030: 50 percent reduction in greenhouse gas emissions (cf. 2015).
- 2040: 75 percent reduction in greenhouse gas emissions (cf. 2015)
- 2045: Net zero greenhouse gas emissions

Through current technology, the sector can potentially cut its carbon emissions in half by 2030, but technological shifts and innovation are necessary to reach net zero emissions. To achieve this, new incentives and tools and new ways of doing business are needed, as well as collaboration across the entire value chain.

We see five key factors for achieving a carbon-neutral value chain in the construction and civil engineering sector:

- Collaboration, leadership and knowledge.
- Long-term regulations that allow for investment in and conversion to carbon-neutral materials and processes.
- Development from linear to circular processes.
- Access to and efficient use of bio-based raw materials.
- Public procurement as an engine for transition.



To accomplish the goals of the roadmap, a life-cycle perspective is required in terms of planning, design, construction and utilisation of the built environment. Success will require clear leadership, new ways of thinking and everyone involved taking responsibility for their part in the value chain. We need to change current legislation, regulations, planning procedures, design methods and material choices. We need to collaborate in new ways to succeed with innovations, solutions, methods and materials, as well as new business models. To manage carbon emissions while maintaining or even strengthening competitiveness, it must be profitable for key players to reduce their carbon emissions.

The construction and civil engineering sector has agreed on 26 points of action plan for politicians, authorities and key players in the value chain to accelerate the carbon transition. We agree that key players in the sector should set carbon goals, be transparent regarding their carbon emissions and set their own requirements, streamline materials utilisation, plan carbon-smart from the beginning, and digitalise the entire planning and construction process. We challenge politicians to do the following:

Recommendations of actions to the Parliament and the Government

- Introduce ambitious, long-term and predictable legal requirements for the construction and civil engineering sector based on Sweden's goals to be carbon-neutral to enable necessary investments for transition that maintain or strengthen competitiveness.
- Create conditions for transformation of the base industry to ensure carbon-neutral cement and steel through financing, risk-sharing, support for innovation and control instruments.
- Develop a strategy and action plan in consultation with key players on the market for access to and distribution of sustainable, fossil free fuels for the construction and civil engineering sector.
- Introduce requirements for carbon impact declarations from a life-cycle perspective for buildings, infrastructure and construction products available on the market.

- Utilise public procurement as an engine for carbon transition. Strengthen knowledge of the Swedish Public Procurement Act for those active in public procurement and ensure that follow-up is as strict as procurement requirements.
- Change regulations for the classification of waste to remove obstacles to – and instead drive – circular business models and increased re-use and recycling of excavation materials and building and demolition materials.
- Work for the possibility of lower capital adequacy requirements and other incentives for green financing solutions aimed at stimulating investments with lower carbon emissions.
- Introduce incentives that promote efficient use of energy and resources in the refurbishment of existing property holdings, requiring a life-cycle perspective and carbon-reducing motivation for renovation and investment decisions.
- Appoint appropriate organisation to provide and manage an open database of generic carbon data that is life-cycle-based, quality-assured and representative of the construction and civil engineering sector in Sweden.
- Appoint appropriate organisation to investigate a method for visualisation of carbon emissions in value chain transactions, from suppliers of raw materials to consumers.
- Appoint appropriate organisation to develop procurement criteria and definitions of carbon-neutral and carbon-positive buildings and infrastructure through dialogue with the market.

With this roadmap, we have taken a unified first step towards building our society competitively and without carbon emissions. We, the undersigned, agree that construction and utilisation phases must be carbon-neutral by 2045. It is now time for us to move from words to action on carbon transition, and with the shared intentions inherent in this roadmap and the recommendations of actions we direct at politicians and key players within the sector, we unite to create conditions for a market that values carbon-smart solutions.

6. The digitalisation consultancy industry

Summary of digitalisation consultancy industry's roadmap to a fossil free future

By promoting new business models, behaviours, regulations and organisational approaches, strategic digitalisation has the potential to radically reduce greenhouse gas emissions, increase competitiveness and generate high growth in exports of transformative solutions.

Firms in the digitalisation consultancy industry that have joined forces behind this roadmap are united in their ambition to help society become aware of and tap the potential of digitalisation. We believe it is critical that one of the most powerful set of tools humankind has ever created are provided with a framework for promoting a smart and sustainable future.

The solutions enabled and implemented by digitalisation consultants have an enormous potential to reduce global greenhouse gas emissions. Studies that focus only on optimising current systems still show that digital solutions can contribute to an estimated 20 percent reduction of global emissions. But the opportunities to cut emissions is considerably larger if we also include the transformative potential of digitalisation, which can help meet the needs of society in entirely new ways.

Digitalisation should be considered a catalyst that can speed development in either a fossil free and resource efficient direction or a fossil intensive and resource intensive direction. This is why, in addition to adopting new technology, we also need to work with how it is used and for what, and ensure that business models, behaviours, regulations and organisational approaches are shaped in a way so they will contribute to sustainable and digitalised world.

VISION AND TARGETS

The vision of the digitalisation consultancy industry is: By 2045, we will have helped Sweden and the rest of

the world reduce its energy consumption to the point where we have a chance of keeping the rise in temperature below 1.5°C. In so doing, we will also support increased international collaboration. As a result, global sustainable solutions will enable sharper international competitiveness that leads to high growth in exports of transformative solutions (both products and services): solutions that deliver answers to societal needs through, resource-efficient and circular innovations.

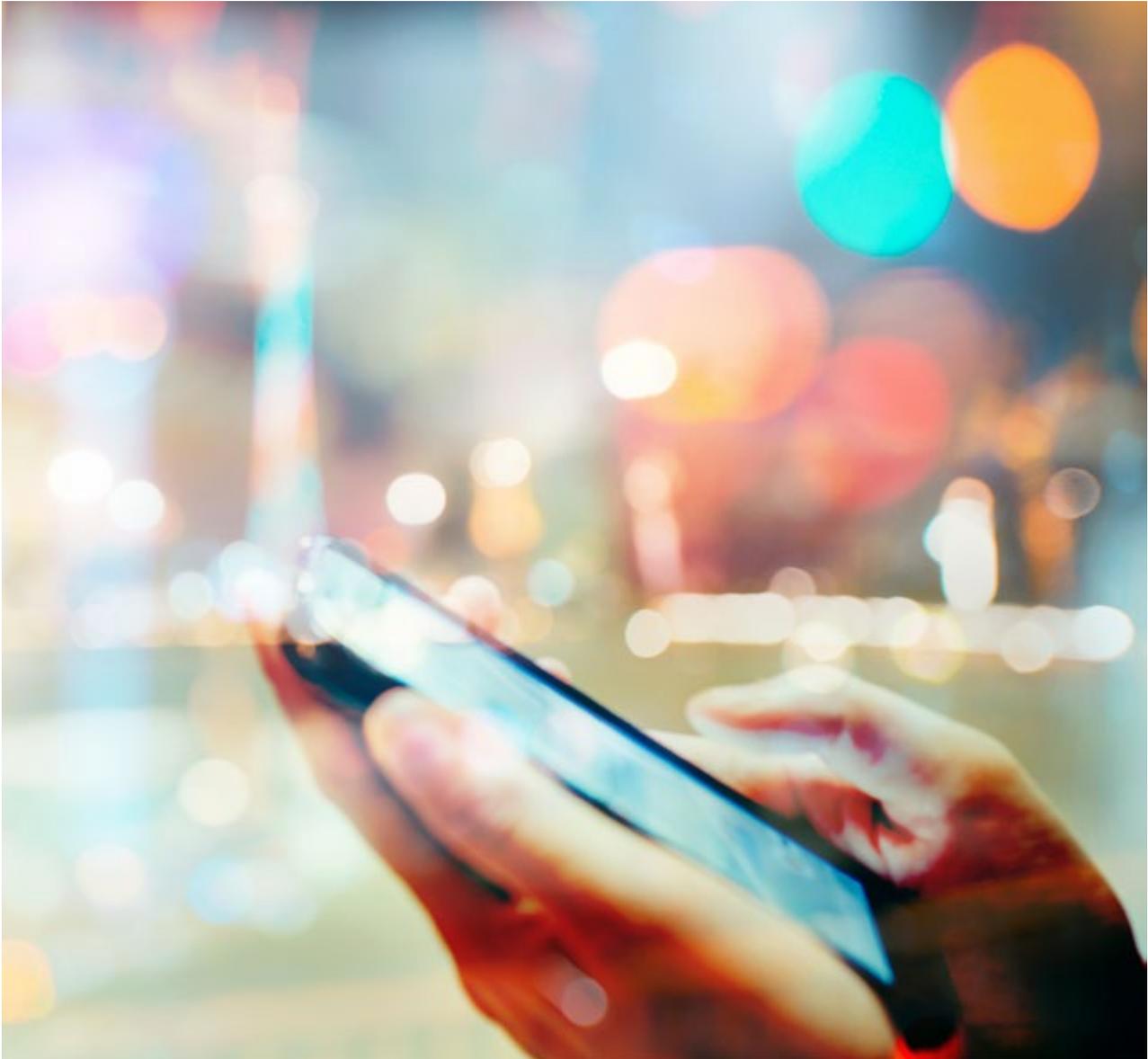
Firms in the digitalisation consultancy industry have set a target for their own operations to be fossil free by 2045.

Accelerating the journey towards a fossil free digital infrastructure is an obvious focus of the industry. By taking a proactive role and guiding our clients towards the right infrastructure investments, we can promote the continued reduction of emissions from the underlying infrastructure that digitalisation requires. The target is zero emissions from that infrastructure by 2045, with the ambition of getting there earlier, by 2030. This will take place alongside the accelerating digitalisation of all sectors in society.

SCIENCE POINTS TO THE KEY ROLE OF DIGITALISATION

Digital solutions can help reduce emissions in three different ways. First, existing systems can be optimised. Second, the adoption of existing best practice sustainable solutions can be accelerated. Third, transformative changes with totally new system solutions can be achieved.

Transformative changes that lead to radical and rapid reductions of greenhouse gas emissions occur when the impacts of digitalisation at various levels work to-



gether. That is, when new technical solutions, business models, economic incentives, new legislation, social planning, new financing models and methods for assessment and creating transparency, etc., are brought together.

A significant challenge is that the minor contributions of digitalisation (optimisation of individual products) are relatively easy to explain, measure and support politically, while the greater, transformative, systemic changes are often more difficult to measure and explain. They demand numerous interacting measures that are often ba-

sed on multiple government ministries, public agencies and business sectors collaborating in a way that seldom occurs today. Consequently, focus is apt to end up on the minor contributions of digitalisation, with risk that the major contributions will be overlooked.

COMMITMENTS OF THE DIGITALISATION CONSULTANCY INDUSTRY

Firms in the digitalisation consultancy industry must assume greater responsibility for more actively contributing to global development and implementation of sustainable, fossil free solutions.

We have prioritised the following strategic commitments.

By 2030:

1. Cut the industry's energy use by at least half by 2030, with the ambition of reaching zero emissions by 2045 (in accordance with the IPCC's low-energy scenario).

By 2020:

1. Agree a minimum level of knowledge among our employees regarding the impacts of digitalisation from a climate and sustainability perspective.
2. Carry out training initiatives to ensure that our employees meet the minimum level (above) within one year after they join the firm.
3. Agree a framework to report positive and negative contributions (Scope 1-4, including avoided emissions).
4. Find resources for building and launching a web platform where industry firms' capacity and contributions to a national knowledge boost are made available to each other, clients, academia and government. We recommend that the platform should include:
 - Presentation of cases including climate impact
 - Training materials, methods and reports
 - Information about joint initiatives
 - Contact details for individuals with particular expertise
5. Adopt new commitments up to 2022 based on conditions in 2020.

CHALLENGES TO THE SWEDISH PARLIAMENT AND GOVERNMENT

We have identified seven strategic measures within the framework of the roadmap process that can promote the central role of digitalisation in achieving a fossil free future:

1. Appoint a digital transformation committee with international ambitions

Appoint a committee tasked with identifying knowledge

gaps, legal barriers, organisational lock-ins and incentives blocking Sweden's opportunities to accelerate the adoption of digital solutions for a fossil free future.

2. Update appropriation directions with requirements for digital low-energy strategies

Task all government agencies, via their appropriation directions, with developing strategies by which digitalisation can optimally create the prerequisites for a global, sustainable fossil free future by means of energy-smart scenarios.

3. Encourage reporting of Scope 4/avoided emissions that unpack the potential of digitalisation

Augment current incentives that encourage businesses to report their own emissions (Scope 1-3 emissions), including incentives to also report contributions to reduced emissions from the goods and services they provide (Scope 4/avoided emissions).

4. Appoint a fast-track inquiry into data that supports global sustainability

Appoint a fast-track inquiry to determine what data is currently available or can be made available to equip citizens, government agencies and businesses to develop new and innovative solutions from a global sustainability perspective.

5. Clarify the responsibility for digitalisation and sustainability within all government ministries

In order to facilitate coordination within the Government Offices of Sweden, we recommend that the responsibility for the impacts of digitalisation from a sustainability perspective is clarified within each ministry.

6. Allocate resources for a national knowledge boost

Implement a national knowledge boost by augmenting current knowledge-building initiatives in digitalisation and sustainability with focus on how digitalisation contributes to a sustainable fossil free future.

7. Establish testbed zones for sustainable digital transformation

Establish a national initiative in which zones and entire cities interested in acting as testbeds for transforming society in a fossil fuel-free, ecologically sustainable and socially equitable manner can be brought together.

7. The food retail sector

Summary of roadmap for fossil free competitiveness – Food Retailers

The Swedish Food Retailers' Federation (Svensk Dagligvaruhandel, SvDH) has drawn up this roadmap within the framework of the government's Fossil Free Sweden initiative. The SvDH Roadmap was submitted to the government in April 2018.

BACKGROUND

The theme we have chosen for our roadmap is plastic consumer packaging. Because it extends the shelf-life of many foods and helps to reduce food waste, plastic is one of the most commonly used packaging materials for consumer food products. But using plastic in packaging materials also presents big challenges, since the raw materials used to make most plastics are fossil-based and the resulting packaging material has one

»Our goal is for all plastic packaging to be recyclable by 2022, and all plastic packages to be produced from renewable or recycled raw materials by 2030.«

of the lowest material recycling rates in Sweden. Rough estimates suggest that only 25 percent of the plastic packaging collected for recycling actually makes its way into new plastic products. One of the reasons for this is that the primary consideration has been protecting the food product and making it appealing from a consumer viewpoint rather than focus on the recyclability of the materials used in packaging. There has, in addition, not

been a demand for the recycled plastic, and it has been difficult to find ways to dispose of it.

We want to change this, and the purpose of this roadmap is to help to pave the way for increased recycling and a transition to plastic packaging made from renewable or recycled raw materials. The roadmap is thus part of our contribution to a circular economy and fossil free society.

THE GOAL

Our goal is for all plastic packaging to be recyclable by 2022, and all plastic packages to be produced from renewable or recycled raw materials by 2030.

We are aware that, based on today's requirements and conditions, this is a very challenging goal. The food retail industry is up for the challenge and will do everything it can to attain its goal and vision.

To succeed, however, we require a clear commitment from our politicians and long-term decisions that help to increase recycling and stimulate a demand for recycled materials, and clear incentives to develop domestic production of renewable plastic raw materials.

The measures that we will take in the food retail industry to reach this goal include:

- Investment in a new plastic sorting plant. The food retail and plastics industries are together investing a total of 260 million SEK in a new sorting plant that will be the most modern plant of its kind in Europe, with the capacity to cover all of Sweden's plastic package recycling needs.
- Introduction of cost-based fees for packaging based on the packaging's recyclability. There is at present no economic incentive for producers to use recyclable packaging. We therefore plan, on



our own initiative, to introduce a tiered system for packaging fees starting in 2019. Non-recyclable packaging costs more to handle and will therefore also be charged a higher fee.

- Analysis of the current situation and investigation of the amount of packaging that is currently recyclable. We will then work to successively increase this amount. This work will occur in close cooperation with the plastics industry and packaging producers. We will also work to increase the demand for recycled plastic materials.

Three important measures we would like to see from our politicians:

- A clear expression of political will in the form of

support for innovative research projects and strategic investments aimed at increasing recycling and stimulating a demand for recycled plastic materials.

- Economic incentives to promote a successive increase in the use of renewable and recycled plastics. It has to be economically viable to use renewable and recycled raw materials rather than virgin, fossil-based raw materials. This could be achieved, for example, through state aid for the production of renewable raw materials.
- Broad agreements across political party lines on policy are needed to increase predictability for all actors, such as a long-term approach to producer responsibility.

»It has to be economically viable to use renewable and recycled raw materials rather than virgin, fossil-based raw materials«

8. The forest sector

Summary of the forest sector's roadmap for fossil free competitiveness – How the forest sector increases climate benefits in society

How can the forest sector create increased profitability, competitiveness and jobs across the country, while at the same time phasing out the use of fossil energy sources up to 2045? The forest sector's roadmap for fossil free competitiveness, shows how the sector can create even more climate benefits than it already does today. The roadmap is developed by the trade association The Swedish Forest Industries Federation.

THE VISION OF THE ROADMAP IS:

»The forest sector drives growth in the global bioeconomy«.

The vision goes beyond its own sector by including a transformation of society to a bio-based economy. In a growing bioeconomy, the forest sector today already contributes to climate change mitigation in three overall ways: by *substitution*, whereby biobased products replace other products that are produced from fossil raw materials or which cause major fossil emissions during production, by *carbon capture* in the forests and in biobased products as well as by *reducing the use of fossil energy sources*.

The goal of the roadmap is that the overall climate benefits of the forest sector and its contributions to a fossil free society will have increased by 2045 by contributing with more bio-based products and by phasing out fossil energy sources in its own operations.

GOALS FOR 2030

To increase the overall climate benefits of the forest sector and its contributions to a fossil free society, The Swedish Forest Industries has defined goals to be reached by 2030. The goals are divided between the two focus areas: *climate benefits and competitiveness through growth in bioeconomy* on the one hand, and *climate benefits through phasing out of fossil energy sources in the operations*, on the other.

CLIMATE BENEFITS AND COMPETITIVENESS THROUGH GROWTH IN BIOECONOMY

- The forest sector's share of the Swedish GDP has doubled, from 3 percent in 2013 to 6 percent in 2030.
- The market for wood products has expanded and the value of deliveries has increased – at least 50 percent of all new homes are built with wooden frameworks and an increasing proportion of other buildings are built with wooden frames.
- Investments in research, innovation and demonstration facilities linked to forestry and forest industry have doubled to SEK 8 billion per year.
- The forest sector's deliveries of bioenergy have increased.
- The production of biofuels based on forest raw material has increased – an estimate is an increase from 1 TWh to 10 TWh.

CLIMATE BENEFITS FROM THE PHASING OUT OF FOSSIL ENERGY SOURCES

- The use of fossil energy sources in processes within forest industries has decreased further. Today, processes in sawmills are almost entirely free of fossil energy sources and the processes in the paper and pulp industry are 96 percent free of fossil energy sources.
- No fossil fuels are used in vehicles in forest industries or in forestry.



PHOTOGRAPHER: LENNART DUREHED

- Fossil emissions from domestic transportation in the forest sector have been reduced.

WHAT IS NEEDED FOR THE IMPLEMENTATION OF THE ROADMAP?

Measures are needed in many areas if the forest sector is to fulfil the roadmap's vision and goals. Here is a list of those we consider to be the most important and where politics need to contribute.

- **A clear political ambition to create a biobased society**

A growing bioeconomy requires an increase in the production of forest industry products, bioenergy and biofuels. Politics must create conditions for this by, for example, removing the uncertainty with respect to views about forestry, taxes and fees linked to biobased products, transportation etc. There is also a need for increased state funding for R&I, at least in line with the industry's own initiatives.

- **Competitive conditions for the forest sector**

The forest industries operate in global markets. This places high demands on competitive conditions when it comes to, for instance, electricity costs, permit processes, the investment climate and the burden of fees and taxes, which should be in line with the conditions that international competitors face.

- **Assured access to biomass from sustainable forestry**

For the forest sector to contribute to a fossil free Sweden, there must be an assured access to biomass from the forests. The ability to pursue efficient and sustainable forestry is crucial. The industry will demand more raw materials to enable an increase in current production of wood products, cardboard, paper and pulp. This is essential for increasing side-flows to energy, fuels and new bio-based products. Political instruments and subsidies that distort competition or control the use of raw materials must not be introduced.

- **Increased focus on goods transportation**

Goods and the transportation of goods must be given higher priority when investing in infrastructure. Infrastructure initiatives based on the

»The forest sector has a key role in the transition into a fossil free society«

needs of the sector are a key factor, for example initiatives for transfer of goods. Many of the member companies of The Swedish Forest Industries are able and willing to transfer more goods to rail and maritime shipping if the Swedish Transport Administration sorts out transportation bottlenecks and other obstacles. The measures presented in the Industry Council's (Industrirådet) Introduction to Goods Strategy need to be implemented.

- **Improving efficiency of transportation**

Improving efficiency can, for example, be achieved by permitting trains and lorries that are both heavier and longer. A first measure in the near future would be to ensure that the entire road network is adapted for lorries with a maximum weight of 74 tons. The potential for improving efficiency through the possibilities of digitalisation, e.g. horizontal cooperation, increases if authorities push for digitization in transport and infrastructure.

- **Electrification**

Electrification of road traffic can be increased, for example, through the use of battery operated small lorries and passenger vehicles. The electrification of major roads, such as the E-road network with lots of heavy traffic, or shorter distances with shuttle services should also be carried out.

- **Continued investments in research and innovation**

Investments in research and innovation from the state and the private sector must be intensified further. This is crucial to enable development towards a growing bio-based economy. Research needs to be targeted at the areas presented in the research agenda from the forest industries (Skogsnäringens Forskningsagenda 4.0).

9. The heating sector

Summary of roadmap for a fossil free heating sector

The heating sector will be fossil fuel free by 2030. In 2045, it will be a carbon sink that helps reducing the total Swedish greenhouse gas emissions. Collaboration is an important tool to achieve this vision.

The roadmap for fossil free heating has been developed in collaboration between about fifty actors in the heating market (district heating companies, heat pump companies, biofuel companies, property owners and builders, municipalities, county councils and regions) with the consulting and research company Profu as the editor. In order to realize the vision, they have agreed on 42 commitments for the actors in the heating sector and 21 calls for actors outside the heating sector, primarily parliament and government.

The goal is for the heating sector to be completely fossil fuel free in 2030 and, in addition, to be climate-positive in 2045

The heating sector is a large part of the Swedish energy market. It has an annual turnover of almost 100 TWh of energy and 100 billion SEK (Värmemarknad Sverige, 2014). The heating sector in this context concerns heating and domestic hot water preparation in housing and premises. The roadmap also includes comfort cooling in buildings. Cooling is a smaller product than heating, about 5 percent of the heating's energy use, but can become of greater importance in the long run.

From a large oil dependency, the heating has been re-

versed and is today dominated by district heating, heat pumps, electric heating and biofuel. The direct use of fossil fuels in individual boilers in buildings amounted to 2 TWh in 2016, compared to 27 TWh in 1995. The use of fossil fuels has also decreased in the production of district heating and electricity, in district heating to 5 TWh in 2016 compared to 14 TWh in 1995. The heating sector has thus made a powerful contribution to the conversion of the Swedish energy system.

This roadmap is a first step in the continued work towards a fossil free heating sector. The signatories' ambition is to continue the cooperation on the roadmap and to use it as the basis for collaboration between different parties in the heating sector, which all participants see as valuable and want to strengthen. All actors in the heating sector who want to contribute to the development towards a fossil free heating are encouraged to join the vision and commitments by signing the road map.

The goal is for the heating sector to be completely fossil fuel free (no use of coal, fossil oil or natural gas) in 2030 and, in addition, to be climate-positive in 2045. To achieve this goal, the actors in the heating sector have, among other things, undertaken to:

- Completely phase out the use of remaining fossil fuels and base also this district heating production on recycled energy, such as residual heat from industries, businesses and buildings, energy recovery of waste and fossil free renewable fuels.
- Promote the development towards being fossil fuel free by setting ambitious energy and climate targets in municipalities, regions and county councils and implementing these, both in their own business and in collaboration with other actors.
- Integrate reduced climate impact into goals and strategies for different public functions, such as building of housing and premises, energy supply,

transport, waste, resources, water and sewage, and work strategically with procurement for reduced climate impact.

- Sort and/or facilitate sorting of waste, especially plastics, in order to minimize fossil content in residual waste that goes to energy recovery, in the construction process and in the management phase.
- Recover the energy from waste in an environmentally safe manner for as long as there will be waste that is not allowed to or not possible to recycle, and reduce the amount of plastics to energy recovery.
- Through technology development, make heat pumps and system solutions more efficient and, by means of increased control and new models for business and collaboration, reduce electricity consumption and peak power requirements.
- Follow and aim to surpass the regulations stating which refrigerants that are allowed and the handling of these. Refrigerants with low climate impact should be used.
- With the help of new, more efficient biofuel boilers and smart system solutions, reduce emissions of harmful substances and, through increased efficiency, achieve a better use of biofuel from our green forestry.
- Intensify work on energy efficiency that reduces the heating and power requirement in newly produced and renovated buildings. The actors in the housing and construction sector behind this roadmap will push technology development in terms of reduced power peaks, energy storage, solar energy and solar heat. It is also important to make better use of excess heat.

The latest IPCC report shows that elimination of greenhouse gas emissions in the world by 2050 will not be enough, the international community must also bind emissions and reduce the concentration of greenhouse gases in the atmosphere in order to limit the global temperature rise to 1.5 degrees.

The heating sector is ready to take on this challenge. This means that the industry needs to bind carbon di-

oxide emissions, for example by using CCS (Carbon Capture and Storage) technology. This could potentially neutralize the emissions from the remaining fossil-based content of the waste being energy recovered. For the bio-based fuel, the impact could be climate-positive since carbon atoms that are already included in the natural cycle are removed. In addition, it can contribute to climate-negative emissions in Sweden as a whole.

The signatories behind the roadmap have also agreed on a common approach to implement the plan, we:

- Are positive to local energy partnerships and cross-sectoral collaboration and to develop business models that support such development
- Will work to phase out remaining oil boilers and electric boilers
- Will act as an example within each business to encourage fossil free energy, energy efficiency, resource management and reduced greenhouse gas emissions
- Premiere fossil free within procurements
- Strive to avoid the use of fossil fuels in their own operations, e.g. during transport
- Strive to engage in other challenges within “Fossil Free Sweden”
- Encourage the different parties within the heating sector to develop their own roadmaps on how to become fossil free, with explicit goals and sub-goals
- Strive to create a common method for greenhouse gas calculation for different energy carriers
- Strive to understand the overall consequences of our actions through a holistic view of the energy system and by assessments from a life cycle perspective, and act on these insights

There are however obstacles that need to be eliminated for the roadmap to be realized. Therefore, the recommendation to the government, parliament and government agencies is to address the following proposals:

- After the energy agreement between five political parties, focus on the power/capacity issue in the entire energy system, including the heating sector and cogeneration, is needed.
 - Redesign the building codes to stop them from controlling the choice of heating source.
 - Create incentives for increased cogeneration of heat and power by valuing power and not just energy.
 - Introduce policy instruments that provide incentives «early in the chain», for example, already in product design and procurement, in order to steer away plastic from residual waste.
 - Support research, development and demonstra-
- tion of new technology such as bio- and waste-CCS, bio-coal, solar heat, seasonal heat storage, combined heat and power production with higher electricity exchange, small-scale combined heat and power technology, fourth generation district heating and recycling refinery for plastic waste
- Ensure conversion from electric heating to district heating, heat pump or biofuel.
- To implement the heating sector's roadmap for fossil fuel free heating successfully, the actors behind it clearly see the need for increased collaboration throughout the value chain to continue the sustainable development and manage the complex challenges that it may entail. Together we have the power to change!



10. The heavy road haulage industry

Summary of roadmap for fossil free competitiveness - heavy road haulage industry

TODAY

Road haulage is integral to trade, construction and industry throughout Sweden. Important measures to reduce emissions include the scaling up of renewable fuels, optimising routes and increasing the load per driven distance. In recent years, reductions in greenhouse gas emissions from heavy duty vehicles have been entirely due to renewable fuels.

»Haulers reduce emissions through optimizing routes and increasing loads, practising eco-driving and investing in new and more efficient vehicles«

A survey conducted in March 2018 shows that the primary driving forces behind companies working to reduce emissions include customer demand, cost reduction and an ambition to contribute to fighting global warming.

Heavy duty vehicles transport as much as two thirds of total freight in Sweden. Road transport routes are typically short: almost 80 percent of total tonne kilometres is for distances shorter than 500 kilometres. The road haulage industry is heterogenic, and can broadly be

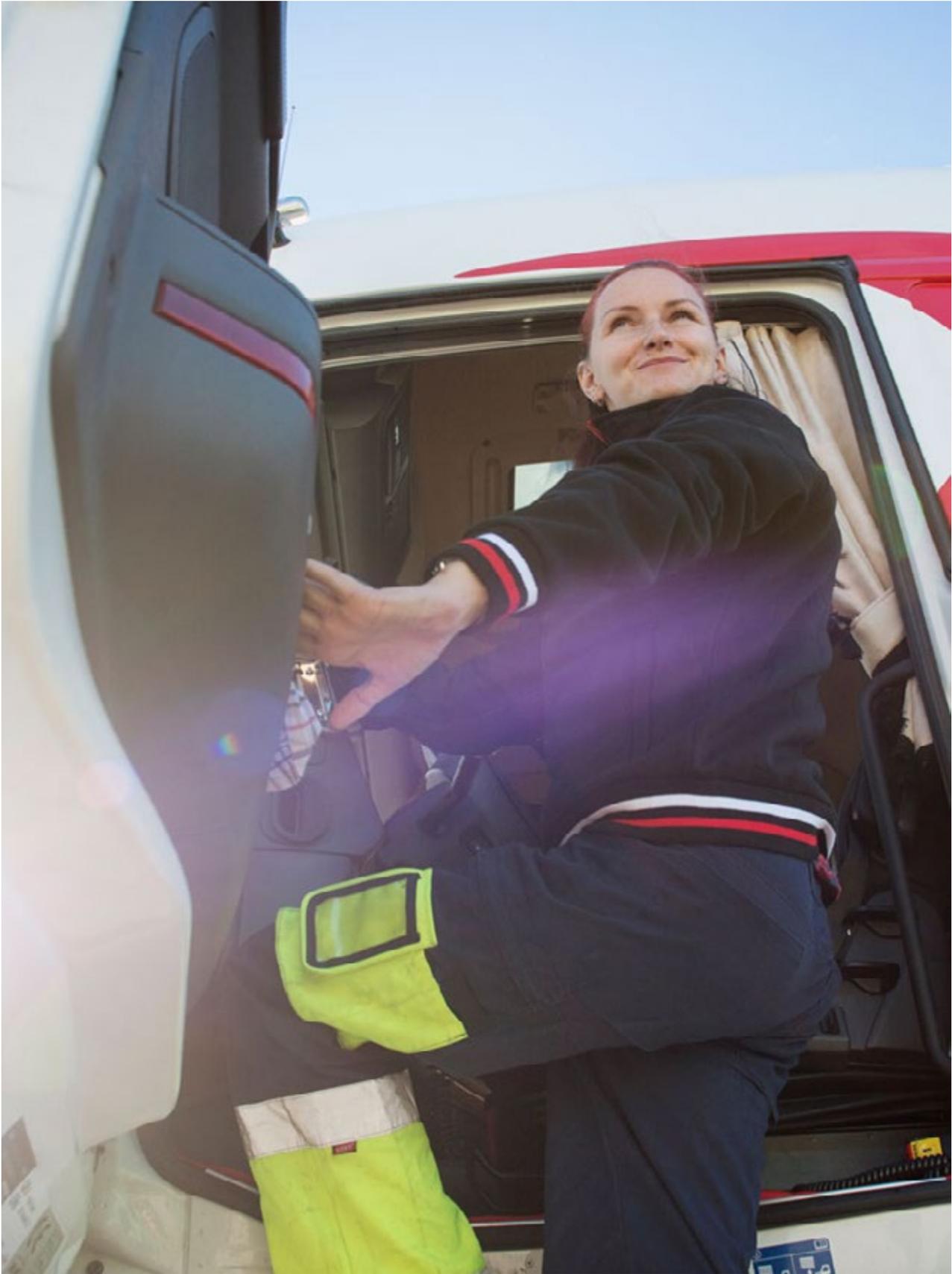
divided into long-distance transport, construction, distribution and waste transport. In 2016, the most common freight categories were ore and other extraction products, parcels and waste products.

In reducing emissions, the challenge and the solution lie in the heavy dependency on diesel. Some 97.5 percent of heavy lorries are driven on diesel. HVO (hydrated vegetable oil), a synthetic renewable diesel, requires no change in engines or infrastructure. Its surge accounts for emission reductions of 25 percent between 2010 and 2016, despite an increase in tonne kilometres.

In addition to emission reductions achieved by renewable diesel, road haulage companies reduce emissions by increasing loads per driven kilometre, practising eco-driving and investing in new and more efficient vehicles. The potential for reductions by such measures is not quantified in this road map.

IN THE FUTURE

The conditions for working to decarbonise road transport in Sweden are in place. The political will has ensured the long-term goals and policy. Research and innovations in vehicle technology are available, and higher weights and dimensions enable more efficient transport. The potential for scaling up production of biodiesel and other renewable fuels is evident. The challenge lies in the fact that demand for decarbonised road transport is not aligned with the willingness on the part of transport buyers to invest in this. Cost structures across the European Union vary greatly and Swedish haulage companies are in direct competition with companies with up to 60 percent lower costs. Thus, establishing quality competition and increasing incentives for emission re-



ductions is an important change that must take place to facilitate the greening of road transport. New business models and possibilities lead to climate-focused public procurements and transport commissions.

Below are some of the different pathways that will transform the road haulage sector.

EFFECTIVE LOGISTICS

- ITS, intelligent transport systems
- High capacity vehicles
- Flexible time schedules rather than just in time

ENERGY

- Biodiesel
- Biogas
- Ethanol
- Electrified roads
- Electric vehicles

COMPETITION

- Quality competition
- Public sector act as role model
- Emission reductions as a requirement

TECHNOLOGY

- Fuel-efficient vehicles
- Emission reduction schemes like VECTO etc.

OBSTACLES

The two most prominent challenges regarding the transformation of the road haulage sector are: rapidly increasing the production of sustainable renewable fuels, and Swedish policy having little or no bearing on international hauliers, which are increasingly transporting at lower prices than Swedish hauliers.

The road haulage industry competes in the European market. Swedish climate policy has a limited bearing on foreign companies as they mostly pay taxes abroad. The price of transport is far more important than climate efforts and Swedish hauliers cannot compete on the international market due to higher costs of labour and diesel. Fuel is one

of the highest single costs for Swedish road haulage companies, which pay 13 percent more than the EU average.

Road haulage companies are prepared, adept and motivated to contribute to the climate goals. Investing in new technology and more expensive fuels is an option, but one that affects the price of the transport assignment. The Swedish Society for Road Transport Companies is striving for the road haulage industry to be characterised by quality competition and companies living up to their responsibilities.

The biofuels development is crucial to reducing emissions. The share of biofuels, as well as the demand for it, will in 2030 depend on changes in demand for transport, vehicle efficiency, and the extent to which heavy transport is electrified. Freight transport by road is expected to increase by 1.8 percent per year between 2012 and 2040 – an increase of 39 percent between 2018 and 2040.

POLICY

The roadmap identifies several policy proposals to advance the greening of road transport. This summary presents three important ones.

1. The adaption of the Paris Agreement into EU policy

Sweden needs to push for higher climate standards in EU policy, and thus ensure EU Member States' policies are aligned with the Paris Agreement so as to ensure a level playing field.

2. Biofuels

Public investment contributes to the upscaling of bio-refineries for biofuels based on lignin and lignocellulose.

Biofuels should be reserved for the essential heavy road transport sector, also indispensable from a security and defence perspective

3. Eco-tax – a distance-based charging system

Fuel tax, only paid by those buying fuel in Sweden, is a suboptimal charging scheme. Fuel tax can be lowered to the EU-minimum level, allowing for a tax charged per distance and thus levelling out competition.

Eco-tax can be differentiated so that it incentivises the use of specific roads, vehicles and fuels.

Eco-tax should be administered automatically and safely, using GPS positioning technology.

Eco-tax should only be levied on trailers so as to ensure higher-capacity vehicles are not charged more than less efficient lighter and shorter vehicle combinations.

11. The Maritime Industry

Summary of roadmap for fossil free maritime industry

In the summer of 2017 the Swedish Government adopted a framework climate policy that included a climate law with the demand that emissions from national transport systems will be reduced by at least 70% by 2030 compared to 2010 levels. In order to achieve this goal Sweden needs to be a transport effective society through social planning, the use of fossil fuel free and energy effective road transport, and water born transportation that runs off renewable energy sources.

In April 2018 the International Maritime Organization, the UN body focused on shipping, adopted the goal of reducing greenhouse gases from international shipping by at least 50% by 2050, compared to 2008 emission levels, and to strive to phase out emissions totally by the end of the century in accordance with the goals of the Paris Agreement. Additionally, the IMO adopted a goal regarding further energy efficiency improvements and emissions per unit of transport work that shall be reduced by 40% by 2030. These goals were adopted with broad support from both IMO member states as well as within the shipping industry.

The Swedish shipping industry is a multi-faceted branch with actors operating locally, regionally, nationally and globally, with vessels that vary in size from small taxiboats to ocean-going vessels that are hundreds of meter in length. Common to all of these vessels is their ability to efficiently transport passengers and goods between the world's oceans, countries, regions, islands and within our own archipelagos which is of crucial importance for increased prosperity throughout Sweden.

Shipping can support the Swedish goal partly through absolute emissions onboard vessels, but maybe primarily through taking advantage of the efficiency of shipping by increasing the proportion of cargo carried by shipping compared to other modes, thus relieving other transport sectors through lower emissions of carbon dioxide per transported unit.

Today the major obstacles are not primarily technical, although there are some of these problems to be resolved still. Rather, it is the availability of fossil-free fuels, the availability of well-functioning financial instruments which offer the possibilities for environmental and climate-investments, and the suitable use of economic instruments, in the form of taxes and fees, which would help push industry in the right direction. In order to accelerate this transition there needs to be an increase in profitability, costs need to be kept low, and economic models need to be customised or adapted.

Technologies already exist to convert vessels to use alternative fuels or energy sources such as gas (liquid natural gas, liquid bio gas), battery power, biodiesel, methanol, bio-methanol and other fuels, but with limitations. These limitations include the insufficient supply, or current lack of availability, of biofuels to meet shippings' overall needs, whether domestic or international. Similarly, batteries do not have the required power capacity for larger vessels which sail longer distances. Given the scarcity of biofuels, the shipping industry notes, just as the Swedish government points out in its April 2018 climate strategy document, that biofuel availability, in both the long and short term, is dependent on the development of both global and regional biofuel markets.

Research has however shown that from a societal perspective investment in new environmental technologies can have environmental and health benefits, as well as create new employment opportunities in companies developing and marketing new solutions.

When socio-economic gains are calculated, then pay-off times of a few years are not uncommon. It is important therefore that society supports, in various ways, the introduction of new technologies. Different factors have differing levels of influence on the possibilities of reducing greenhouse as emissions from shipping, both internationally and nationally.

There are important changes needed to achieve a fossil-fuel free shipping industry that the industry itself has no influence or control over, such as the availability of sustainable fuels, shaping of regulations, government instruments and incentives, or the transport buyers (passenger or charterer) willingness to pay for sustainable transport.

Essential changes which the shipping industry does have the resources to influence include giving passengers the possibility to climate compensate, improved capacity utilization, increasing transport buyers' knowledge or awareness of the benefits of cleaner shipping, as well as testing, developing and investing in new fuels and energy efficiency.

To achieve the changes that are needed to be free of fossil fuels, it is essential that there is cooperation between all main actors within transport buyers, harbours, academic institutions, marine technology firms, shipyards, energy suppliers, authorities, politicians, and shipowners and operators.

Through an analysis of the obstacles of achieving the goals of creating a fossil-fuel free shipping industry, the following main challenges have been identified.

- Shortage of fossil fuel free energy solutions and renewable energy sources
- Limited technology solutions

- Disadvantageous economic factors
- Insufficient investment into research
- Obstructive regulation

Today the Swedish shipping industry leads the development within various fields and sits at the cusp of climate and environmental work, a position already identified by the International Transport Forum of OECD.

Sweden has the qualified industry actors willing to invest in and contribute to innovation and show the road to change, an absolute necessity in meeting both international and national climate goals.

One challenge is to achieve a suitably high level of profitability during this period of transition. This requires a conscious strategic investment from both industry and the state, this means investment in the development of new technologies and new solutions. There is no alternative, climate change is not a negotiation.

Finally The roadmap presents a checklist of suggested actions, in part for the shipping sector, but also for politicians, authorities, local councils and others.

Since no single action on its own can help us achieve the end goals, it is impossible to create mutually acceptable priorities of actions. An over-riding interests of all those involved is however that the actions listed are addressed and that they are acted upon as soon as possible.



12. The mining and minerals industry

Summary of roadmap for a competitive fossil free mining and minerals industry in Sweden

MINING AND MINERALS – AN IMPORTANT PART OF THE SOLUTION

The Swedish mining and minerals sector will play an important part in a fossil free future. The simultaneous transitions towards fossil free energy and transport systems, a climate-smart built environment and increased recycling are all dependent on sustainably produced, high-quality metals and minerals, not least due to the demand for the metals and minerals required by modern batteries and infrastructure. The Swedish mining sector already generates benefits for the global fight against climate change via the export of climate- and environmentally effective products and equipment.

THE VIEW FROM 2018 – TAKING STOCK OF THE SITUATION TODAY

Today the mining and minerals sector generates about 8 percent of Sweden's total CO₂ emissions. Fossil fuels are used in multiple parts of the industry's value chain, and greenhouse gas emissions arise from transport and mining operations and in part from the processing of iron ore, metal ores, limestone and cement. Most of the industry's emissions come from production of iron ore pellets, smelting of ore into metals, and limestone and cement production, though emissions from the Swedish sector are low relative to global competitors. At the same time, many of the industry's processes and technologies are already fossil free, especially in mining operations, and the transition towards fossil free alternatives is already underway. The sector has made significant progress in switching from diesel- to electricity-powered technologies, and digitalization continues to drive optimization and efficiency, reducing overall energy and fuel requirements.

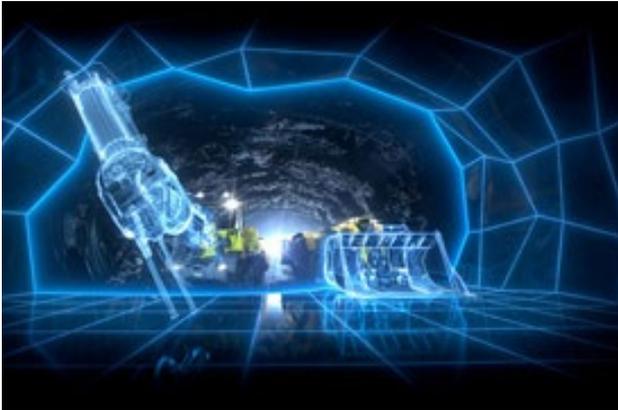
Processing of ore will require more to become fossil free, and especially to deal with the process emissions that

arise regardless of which fuel is used, for example when limestone is processed to lime and cement. Here development of existing technologies as well as a shift to new, currently undeployed technologies will be required. Biomass can replace some of the fossil fuels used today, but both fuel properties and supplies need development. Electric heating options can be a long-term solution but are immature technologically today. The iron- and steel industry is investing in hydrogen as a reducing agent in its HYBRIT project; research and development is likewise needed to identify process routes and system configurations for fossil free production of other metals and minerals. Cements has launched the initiative Cem-Zero to investigate the conditions for electrifying cement production and CO₂-emissions. Process emissions, however, will require a strategy for and development of technologies for CO₂-separation and sequestration, geological storage of CO₂ (CCS) and industrial re-use of CO₂ (CCU).

ROADMAP 2045 – THIS IS WHAT THE JOURNEY LOOKS LIKE

In 2045 modern mining of ores and minerals is a sustainable complement to recycling in meeting global demand. Improved product designs and value chains for reuse and recycling have made it possible to recycle much of the metals and minerals in use. Yet recycling is not sufficient to meet demand from a growing global population and increased living standards. Primary production of metals and minerals is needed even beyond 2045, and global competitiveness remains essential for the Swedish industry, since only profitable firms are able to make the necessary investments.

One of the most important paths to fossil free production is electrification. With help from biofuels in cases



One of the most important paths to fossil free production is electrification.

where electricity cannot be used operation of machines and internal transport in the mining sector become fossil free as early as 2035. The transition to electricity has been driven primarily by technological progress and has mostly taken place via phasing out of old equipment and normal investment cycles. Competitive biofuels and/or hydrogen-based solutions have played a complementary role where mine geography or shorter lifetimes and smaller-scale operations hinder deployment of electricity-based solutions. Automation and digitalization have decreased energy requirements by optimizing production and making vehicles more efficient. Infrastructure for charging and hydrogen fueling is in place and necessary investments in the electricity grid have been completed.

Sweden has established a unique, world-class CO₂-free system for processing iron ore. In part ore is processed by direct reduction using hydrogen. Iron ore pellets-production continues as well, with process heat from CO₂-free energy, either biomass or indirect heating via electricity. Hydrogen gas production, direct reduction and pellets production have been co-located for optimal energy use. Processing of other metals is also CO₂-free. Lime and cement production likewise uses indirect heat from electricity and/or biomass, and process emissions are handled via CO₂-separation and geological storage (CCS) or reuse (CCU), for example in methanol production or algae production. These investments have been expensive and have not been borne by individual companies – public and provide investments in technological

progress have been essential. New pricing models have been introduced.

CRITICAL CONDITIONS AND BARRIERS

The mining and minerals sector is optimistic that the transition will be successful. Yet the necessary development will require time and capital. Farsighted political decisions that promote the industry's global competitiveness will be central to achieving success, as will effective and reliable approval processes for new investments.

The industry is prepared to invest but barriers along the way need to be cleared. Here politics has a clear responsibility to maintain a long-term and holistic view.

THE MOST IMPORTANT CONDITIONS WHERE POLITICS CAN MAKE A DIFFERENCE ARE:

1. Effective and reliable permitting so that new, necessary and climate-smart investments are possible
2. A holistic view in political decisions that avoids (for example) policies that sub-optimize and harm the industry's competitiveness and ability to invest in fossil free production
3. Investment in research and development within fossil free production processes and CCS, including test sites and upscaling
4. Conditions for access to fossil free electricity with a low total system cost and high reliability
5. Strategic allocation of biomass and access to biofuels at competitive prices

The industry, the public sector and other actors need to work together to bear the cost of the transition, drive technological development and support the achievement of global and national climate goals.

Svemin is a national branch organization for mining, mineral, and metal producers in Sweden with more than 40 member companies active throughout Sweden. Members include mining companies, prospecting and exploration companies, limestone and cement companies and various equipment and service providers.

13. The steel industry

Summary of climate roadmap – For a fossil free and competitive steel industry in Sweden

SUMMARY

The Swedish steel industry intends to make a difference for the global climate. Already, Swedish steel products have an internationally low climate footprint and create climate benefits during use. To achieve Sweden's aim to become one of the world's first fossil free welfare nations will require commitment from all stakeholders, and greater cooperation between the political arena and industry.

SWEDISH STEEL CREATES CLIMATE BENEFITS

The Swedish production of 4.5 million tonnes of crude steel places Sweden among the smaller players on the global market. Sweden's steel companies have strate-

»The global climate would benefit if the share of steel produced in Sweden could increase, because global emissions would be reduced«

gically developed higher levels of specialisation within selected market niches, aiming to grow faster than surrounding markets. Efficient and climate-smart steel products from Sweden contribute to reduced materials consumption, longer lifespan, less wear and increased energy efficiency. Through maximal use of recycled raw materials, such as scrap, large resources can be saved.

Daily, the Swedish steel industry generates climate benefits, meeting the demands of modern society. Climate actions provide an opportunity to increase the value of these market offerings. The global climate would benefit if the share of steel produced in Sweden could increase, because global emissions would be reduced, even though emissions in Sweden might increase on a short- or medium-term basis. The best climate policy is to maintain full value chains in Sweden.

The Swedish steel industry will:

Continue to help its customers to create climate-smart and resource-effective solutions with Swedish steel so that their production, use and recycling become as efficient as possible.

The political agenda must ensure:

A solid base for global competitiveness through efficient transportation and infrastructure, secure power supply, top class competence supply and appropriate operating conditions such as harmonised taxes and duties.

LEADER IN TECHNICAL DEVELOPMENT

The emissions of fossil carbon dioxide from the steel industry are mainly direct emissions from production processes (5.8 Mtonnes CO₂, 2016) and internal transport. The direct emissions emanate from the use of coal when iron ore is reduced to iron (85%), the use of fuel to heat and process the steel (12%) and from the coal content in raw materials and additives (3%). To handle the direct emissions, the most important potential solutions today are:

- The development of a brand-new process technique which uses hydrogen to reduce iron ore to iron. With this technique, the carbon dioxide emissions are eliminated from the reduction process

and instead the by-product would be water. This technological leap involves numerous challenges but a successful outcome would allow blast furnaces to be phased out. Potentially, the new technique could also be spread globally. At the current level of production, the technique means an increased need of about 15 TWh electricity.

- The development of bio coke for reduction of iron ore for powder production and for scrap melting processes. This requires a suitable source of carbon, processes for coke production and access to biomass for bio coke at a cost equal to that of fossil coke. At the current level of production, at least 1-1.5 TWh is required.
- The use of bio-based gas as a substitute for the fossil fuels used in heating and heat-treatment processes where electrification is not an alternative. This requires access to a gas of the same quality as natural gas and liquefied petroleum gas. The cost of the gas has to be competitive related to international energy costs. The estimated need is at least 2-3 TWh at the current level of production.

These measures demand extensive, long-term research efforts including testing at pilot- and demonstration levels.

RESPONSIBILITY FOR THE ENTIRE CHAIN

The steel industry also causes indirect emissions in other sectors, for example in the manufacturing of raw materials, such as alloys, generation of electricity and external transports. For a majority of the Swedish steel companies the indirect emissions represent a significant part of the total emissions. By choosing products, services and suppliers with low climate impact, the steel industry can influence the value chain, deliver more climate smart products and reduce the total emissions. The Swedish steel industry is already in the front line in this area.

Maximum use of recycled raw materials, for example scrap, is a key factor for a more efficient use of resources and a low level of emissions. Access to steel scrap globally is today the limiting factor for scrap based steel production. With an increased demand for high quality scrap and in a more circular future economy, products designed for recycling, more efficient collection of scrap and improved sorting of scrap are required to a higher extent. This means that valuable metals can be conserved and contamination minimised.

Transport can be developed primarily by streamlining the handling of goods, by optimising the entire transport system and the choice of transport methods. The development of new fuels or other fossil free means of transport is dealt with in other sectors.

The Swedish steel industry will:

Continue to actively focus on research within prioritised areas which result in reduced direct emissions of fossil carbon dioxide.

The political agenda must ensure:

Financing for long-term research and knowledge development, also ensuring that the government campaign Industriklivet (Industrial stride) is maintained over parliamentary terms.

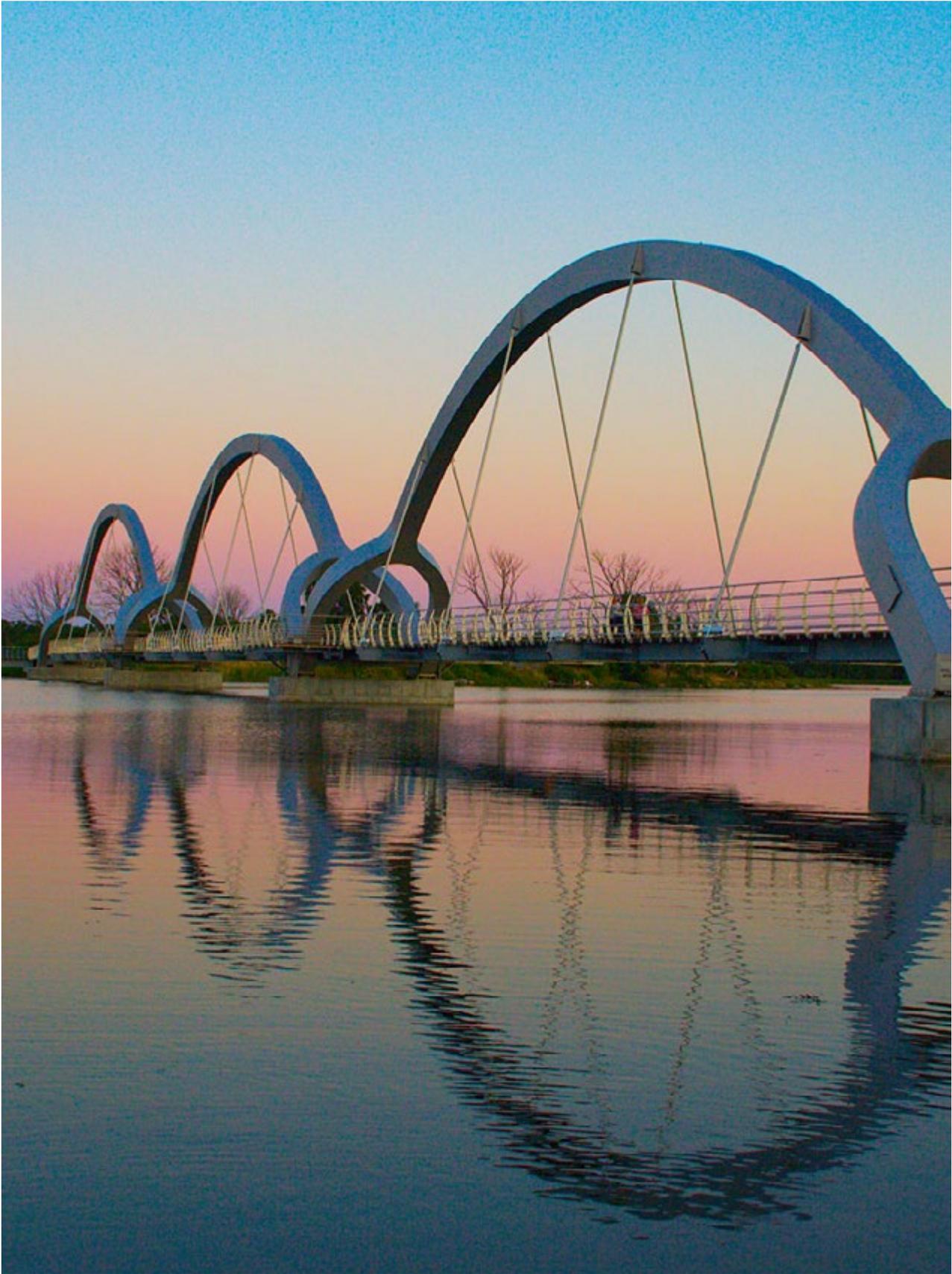
Secured access to electricity and bio-based energy at internationally competitive costs.

The Swedish steel industry will:

Continue to evaluate its value chains to reduce the total emissions through active choices of transport, raw material and more efficient recycling.

The political agenda must:

Facilitate increased collection of steel scrap and support the development of refined sorting of scrap. Invest more and faster in climate-smart means of transport such as railways. The steel industry also recommends development of more electric highways and 74 tonne trucks.



CONDITIONS FOR INVESTMENTS

The intention of the Swedish steel industry is to continue to develop its activities in Sweden. From a climate viewpoint, Sweden has advantages of electricity production which is close to emission free, iron ore which allows refining with low emissions and good availability of biomass compared to other countries.

In order to move towards fossil free steel production with retained competitiveness the companies must be able to invest at a pace adjusted to their production. Many steel companies have plants in other parts of the world and foreign owners, which means that competition for investments is also tough within the companies. It is essential that the conditions in Sweden are competitive compared to the conditions in other countries and that the time from development to market can be as short as possible.

The Swedish steel industry will:

Continue to implement new techniques for reduced emissions when commercially competitive.

The political agenda must ensure:

Efficient and predictable permit processes, including required time plans and adaption of legal frameworks to European legislation.

The Swedish steel industry will:

Further develop analysis and reporting models and declare relevant data so that the customers can evaluate the environmental performance of their suppliers' products.

The political agenda must contribute to a larger visibility through:

Supporting further development of qualified life cycle based models for declaration of climate impact.

The Swedish steel industry has a vision for the year 2050, *Steel shapes a better future*, in which only products of value to the society will leave the companies. The vision is based on the prerequisite that the Swedish steel industry remains competitive all the way to 2050 and thereafter. With this Climate Roadmap, the Swedish steel industry points out difficulties and possible solutions to achieve a fossil free and competitive sector, also underlining the importance of co-operation between the industry and the political agenda to achieve success.

DECLARE CLIMATE FOOTPRINT

Competition is tough on the global steel market with significant price pressure even on the specialised products from the Swedish steel industry. Currently, the steel industry cannot pass on the cost of lower emissions to the customer, this lies far into the future, since the market is global. Greater transparency in carbon dioxide footprint for the end product may activate this process since important steel users will want to stand out by reducing their climate impact. In time, declarations of environmental impact will be requested more often and it is crucial that models and methods for relevant declaration of climate impact are further developed.

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