



CO₂

SUMMARY

THE NORWEGIAN PROCESS INDUSTRIES' ROADMAP

COMBINING GROWTH AND ZERO EMISSIONS BY 2050



OUR VISION: **COMBINING GROWTH AND ZERO EMISSIONS BY 2050**

Our vision is a pronounced growth for Norwegian process industries driven by higher production and development of new processes and products. At the same time, greenhouse gas emissions will be phased out altogether. This vision can be achieved if we succeed in developing and applying the technologies presented in this Roadmap.

The low carbon economy will increasingly demand products with small carbon footprints from both production and use. In addition, there will be more need for products used for both generation and storage of renewable energy. The Norwegian process industry sector is already well-positioned, and is highly capable of fortifying its position as a world-leader in areas relating to energy, climate and the environment.

The Federation of Norwegian Industries, May 2016

INTRODUCTION

The COP21 (Climate Convention in Paris) agreed on ambitious climate targets, where the overall aim is to restrict growth in global average temperature to well below 2°C compared to pre-industrial levels, and strive to keep the temperature growth to 1.5°C. The agreement also aims at "net zero emissions" between 2050 and 2100, with emissions not exceeding what can be absorbed by natural carbon sinks and by carbon capture and storage and utilization. This defines the future low carbon economy.

The Norwegian process industry's greatest advantage is that it is highly energy efficient and uses renewable hydropower as its source of electricity. It therefore has one of the smallest industrial carbon footprints in the world. Figure 1 compares emissions from primary aluminium production in a sample of European countries. Similar results are found for other industrial products. One implication of the low carbon economy is higher demand for products with small carbon footprints from both production and use. Norwegian process industries are, and will continue to be, capable of supplying this demand with new, increasingly clean and innovative products and processes. Achieving this requires predictable framework conditions and continued access to renewable energy at competitive terms.

The Norwegian process industry is part of EU's emissions trading system (EU ETS). Emissions covered by the EU ETS are targeted to decrease by 43 percent between 2005 and

2030. Norwegian process industries' emission abatement efforts will thus take place alongside those of EU-wide industries. There is no firm emission reduction target for 2050, although the EU Commission has signaled at least an 80 percent reduction compared to 1990.

This Roadmap presents and describes technological opportunities that will help achieve the vision of combining growth and zero emissions, and discusses barriers that may prevent this from happening. Higher production and lower emissions require stable, long-term and globally competitive framework conditions. The vision also requires a political determination to promote industrial growth, as well as powerful incentives to spur comprehensive and time-consuming technology developments at acceptable levels of risk.

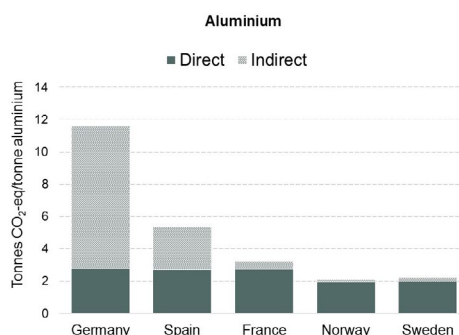


Figure 1: Emissions per tonne of primary aluminium.
Source: Eurostat, Prodcom, USGS, Hydro, Alcoa, Statista

THE NORWEGIAN PROCESS INDUSTRIES

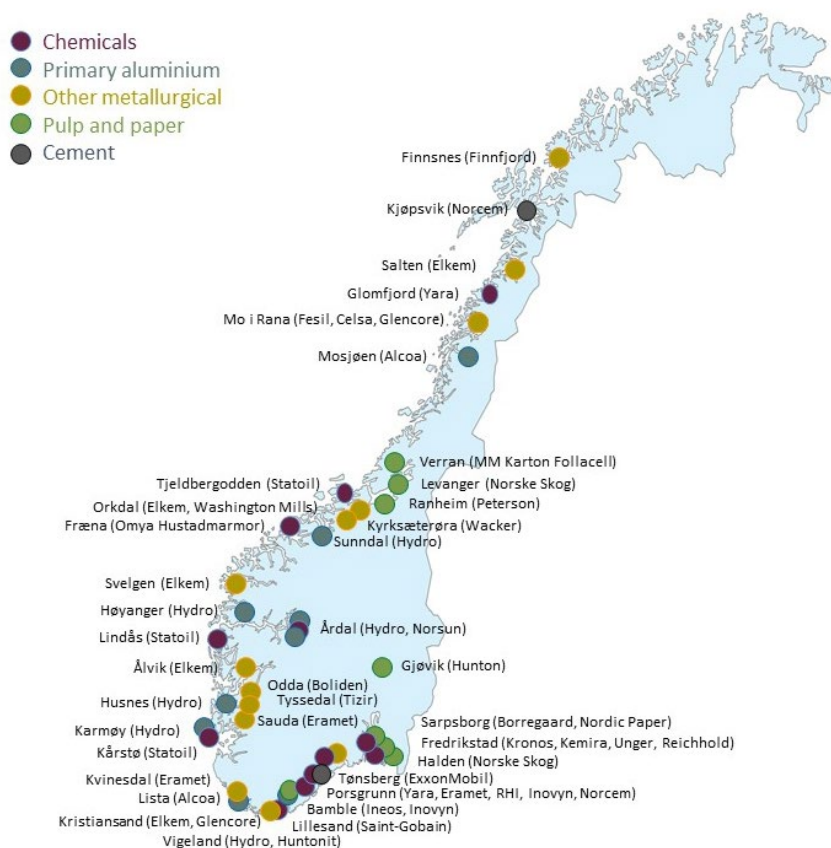


Figure 2: Geographical locations of industrial companies in Norway.

The process industry, which is made up of many export-oriented companies located across the entire country, makes up a significant share of overall value-added in Norway. Most companies are important cornerstones in their local societies. The process industry includes

the following sectors: aluminium, ferro-alloys, chemical industries, mineral industries, mineral fertilizers, refineries and pulp and paper. In 2013, industrial exports totaled 180 billion NOK, out of a total 911 billion NOK, or roughly 50 percent of total mainland exports.



THE INDUSTRY AND THE ENVIRONMENT

Greenhouse gas emissions from the process industries fell by 40 percent between 1990 and 2014. Over the same period, production increased by 37 percent.

In order to uphold its position in an increasingly competitive global environment, Norwegian process industries have made continuous productivity gains. At the same time, industrial companies have nurtured competence building through cooperation with academic and research institutions. Utilising this competence will be key going forward.

With formidable productivity and competence, Norwegian process industries are well-positioned to play a leading part in the global low carbon economy, in which further productivity gains and technological development are key building blocks. Boosting productivity and implementing new technology will phase out industrial emissions in Norway by 2050. The only alternative way to curb industrial emissions is through shut-downs. This would result in carbon leakage and higher global emissions, as lower industrial production in Norway is replaced with higher production in countries with less stringent climate regulations.

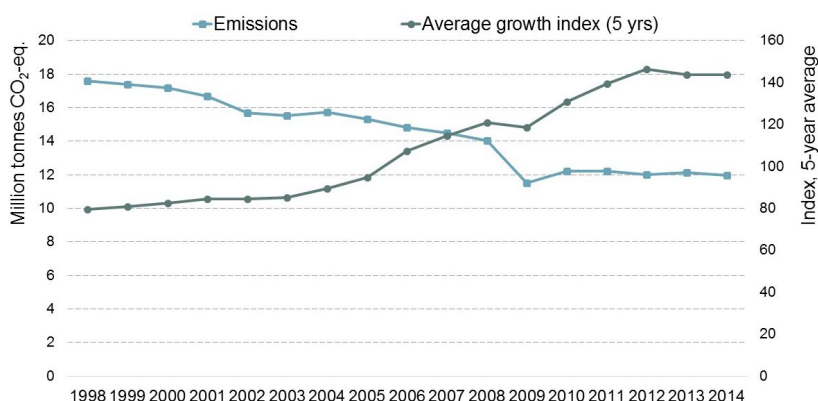


Figure 3: Industrial emissions and growth in activity 1998-2014. Source: Statistics Norway

NORWAY – HOST NATION FOR INDUSTRY

Norway needs to boost its position as an attractive location for process industries, providing predictable framework conditions as well as available and powerful incentives to support investment. Incentives should be in the form of State-managed support instruments, designed to cushion the risk industrial companies take by making large-scale, long-term investments in immature technology. The width and design of these instruments, and success in developing and making use of new climate technologies, are key to achieving the goal of zero greenhouse gas emissions by 2050.

What is required for Norway to be an attractive host nation:

- energy policy must ensure access to renewable energy at competitive terms, including network tariffs
- adequate access to sustainable biomass
- industrial and technological competence is maintained and developed
- GHG emission regulations in Norway align with those in the EU, to prevent carbon leakage
- support instruments cushion industrial risk, and adapt to changing national and international circumstances
- establish infrastructure for transport and storage of CO₂

The most important support instruments are:

- industrial profile in research efforts – Prosess21 and streamlining of industrial support instruments
- more efforts in industry-oriented research and separate programme for process industries in the Research Council, higher share in the form of grants, grant-period extended to 4-8 years, and prioritise climate technology in the BIA-scheme (user-driven arena for innovation)
- significant research efforts in CCS and CCU
- support energy- and environment-related pilot programmes
- support to pilots covering the width of industrial needs, alongside grants for pilot operations
- establishment of Norwegian Catapult (pilot arenas)
- sufficient support to trigger major pilots for industrial CCS and CCU
- increased efforts of the Climate Technology Fund and the Climate Technology Scheme
- grants to energy efficiency- and recovery
- support for developments of products with small carbon footprint from use
- adapt legislation and support instrument to circular economy, and establish a standardised system for LCA
- third-party access to LNG distribution facilities
- minimum requirements for environmental criteria in public procurements
- companies investing in carbon capture keep existing emission quota allocation
- establish loan-guarantee scheme, within the confines of the EEA agreement
- a Greenfund-scheme (Fornybar AS) with a sufficiently powerful mandate to invest in the process industry



Photo: Elkem Solar

TECHNOLOGY BREAKTHROUGH

CCS and CCU

Carbon Capture and Storage (CCS) or Carbon Capture and Utilisation (CCU) are collective terms for a number of processes involving capturing CO₂ from emission sources, transporting it, and then storing it in geological formations or using it for industrial purposes. Carbon capture technologies are widely researched, but no full-scale industrial CCS facility has been built so far. In industrial processes where emissions are difficult to avoid, carbon capture is one of very few technologies capable of curbing emissions.

Hydrogen

Hydrogen is a well-known energy carrier and input to industrial processes. Fuel cells convert its chemical energy to electricity and heat for buildings, vehicles, etc. Fuel cell efficiency is high, compared to other energy conversion technologies. The only residual is water.

Increased use of biomass

At present, the making of many materials and alloys requires the use of carbon for oxide reduction. Carbon is used for this purpose in silicone, ferrosilicon and aluminium production, or as a raw material in end-products such as silicon carbide. Most carbon-based input factors currently used in industry are fossil, such as petrol coke or coal. Theoretically, carbon from bio-based sources, such as charcoal or woodchips, is a viable alternative to fossil carbon sources. Major current barriers for using bio-based carbon are costs, lack of access to sustainable bio-carbon, and product quality issues.

Other technological breakthroughs

Gradual development of known, yet immature, technologies will not be sufficient to bring industrial emissions to zero. Other technological breakthroughs, that radically alter production processes and/or energy consumption, are required.

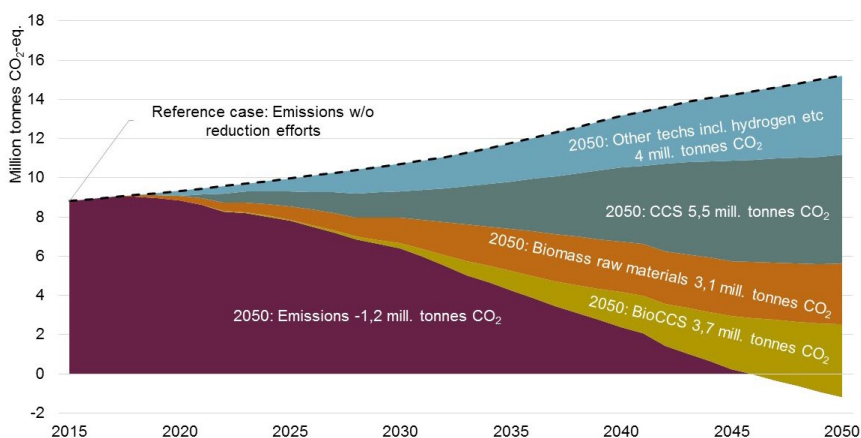


Figure 4: Emissions and emission reductions by technology, compared to reference case with robust industrial growth.

COMBINING GROWTH AND **ZERO EMISSIONS BY 2050**

www.norskindustri.no/veikartforprosessindustrien

NORSK INDUSTRI

Næringslivets Hus, Middelthuns gate 27
Postboks 7072 Majorstuen, 0306 Oslo

Phone: +47 23 08 88 00
post@norskindustri.no

norskindustri.no
twitter.com/NorskIndustri

The Federation of Norwegian Industries is the largest sectoral
federation in the Confederation of Norwegian Enterprise (NHO).