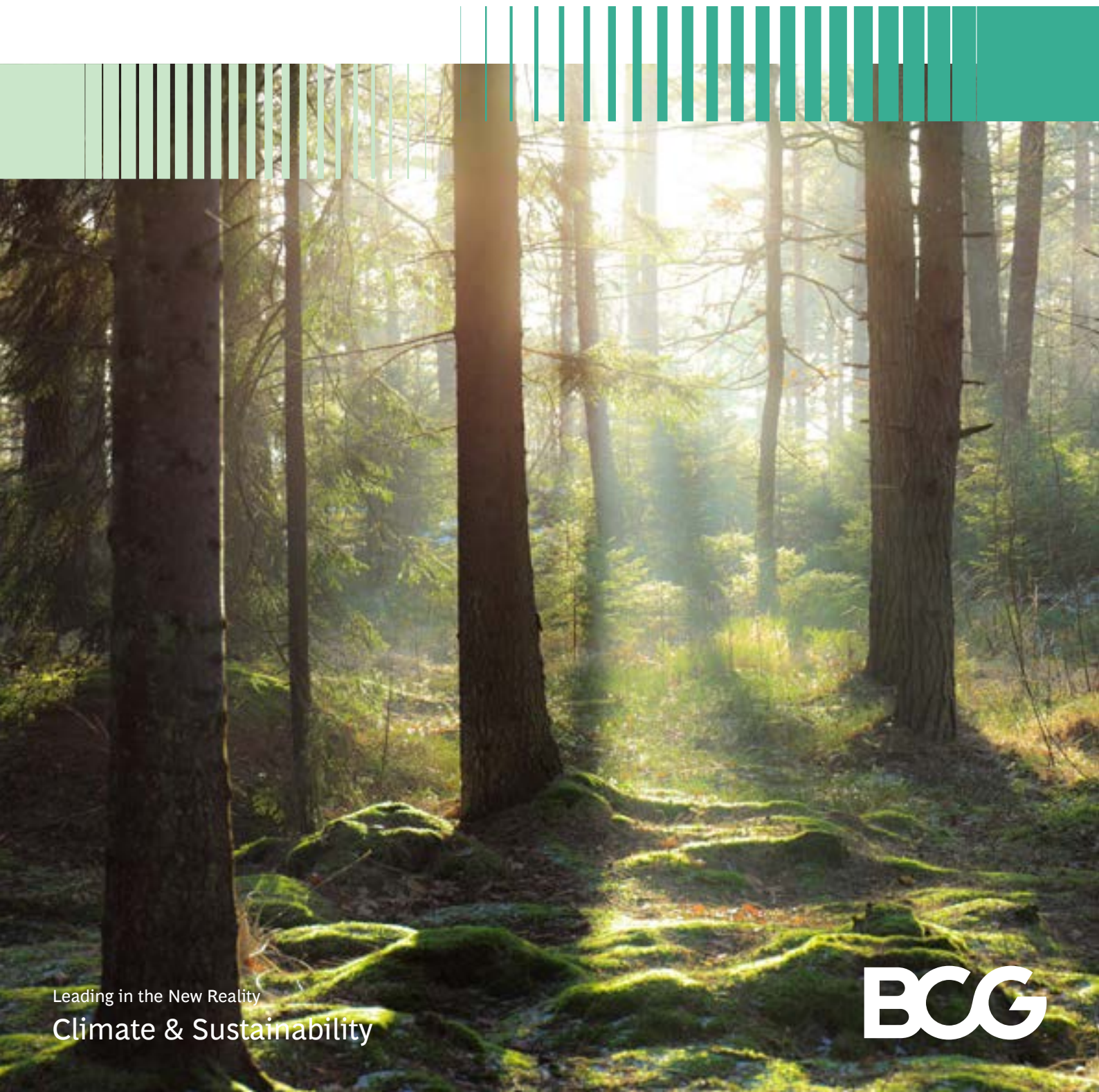


Nordic Net Zero

The Green Business Opportunity

Nordic Agenda: April 2022

By Robert Hjorth, Esben Hegnsholt, Peter Jameson, Lauri Saarela,
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An aerial photograph of a long, modern bridge spanning a body of water. The bridge starts from a rocky shoreline in the bottom right and extends towards the top left, crossing over several small, green islands. The water is a deep blue-green, and the sky is a pale, hazy blue. The bridge has multiple lanes and is supported by several large concrete pillars. The islands are covered in low-lying vegetation and some have small buildings or structures on them.

Executive Summary

Achieving net zero by 2050 is a massive undertaking. The Nordic countries have set worthy ambitions to reduce greenhouse gas emissions and are taking bold action, but on their current trajectory they will fall short of their net zero objectives. They are making progress, but not fast enough. It is essential to dramatically expand efforts focused around an achievable, affordable pathway to net zero.

BCG recently conducted an in-depth study of net zero levers, looking at the abatement potential and marginal abatement cost of individual solutions, their technology maturity, and the investments required to implement them. Based on that analysis, we determined a pathway to reach net zero in the region by 2050. The pathway is achievable and affordable, and it jointly optimizes for local abatement potential and the global export potential of technologies where Nordic companies have a competitive advantage. This is what we call smart decarbonization.

Specifically, the plan hinges on investing not via individual solutions and levers but in a coordinated approach across five ecosystems. This approach will achieve far greater carbon emission reductions worldwide—a significant increase compared to reductions within the Nordics. More importantly, it will unlock significant economic growth by positioning the Nordics as global leaders in sustainability.

Reducing greenhouse-gas emissions represents the biggest challenge of our generation. We believe it also presents the biggest opportunity for the Nordics.



Introduction

When it comes to environmental sustainability, the stakes for the planet could not be clearer. The recent report by the UN Intergovernmental Panel on Climate Change confirmed what most people already suspected: we have a brief and rapidly closing window to secure a livable future.

The unfolding tragedy in Ukraine has only underscored the urgent need for change, as energy markets that were already strained have been thrown into further turmoil. The geopolitical situation demonstrates just how intertwined climate, energy, and security domains are. In our view, the long-term commitment to net zero continues to be imperative and reinforces the need for all countries to rethink their energy mix.

Within the Nordics, countries have set worthy ambitions to reduce greenhouse gas emissions and are taking bold action, but on their current trajectory they will fall short of their net zero objectives. What’s missing? A realistic plan for success, grounded in a clear analysis of the options available. Both the scope and maturity of solutions to reduce greenhouse gas emissions are expanding all the time, challenging companies and governments to keep pace and make decisions about where they should focus and how best to invest. Many solutions don’t yet have a clear ROI. Compounding the challenge is the interconnectedness of net zero solutions.

To help solve these challenges, BCG recently conducted a technical analysis of hundreds of potential net zero levers, from renewable energy production, to changes in transportation and logistics, to advanced building materials. We looked at the abatement potential and marginal abatement cost of each lever, its technology maturity, and the investments required to implement it in order to determine a pathway to reach net zero in the Nordic region by 2050. This plan, which we call “smart decarbonization,” is affordable and achievable. It identifies specific solutions, the order in which to pursue them, and the investment required to succeed.

Moreover, this plan unlocks economic growth by positioning the Nordics as global leaders in sustainability, able to develop and implement technologies and solutions that can be applied worldwide to create new markets and opportunities. Specifically, we identified five ecosystems where the Nordics can capitalize on the economic and geographic advantages of the region:

- Low-carbon materials and manufacturing
- Connected, emissions-free energy systems
- Green buildings and infrastructure
- Sustainable agriculture and biosphere
- Fossil-free transport and logistics

Smart decarbonization makes net zero achievable. The green transition is here, and if Nordic companies and countries approach it correctly, that transition can help them achieve their net zero ambitions. It can also create new business opportunities and unlock economic growth. Most importantly, it can help build a sustainable, livable world for the future.



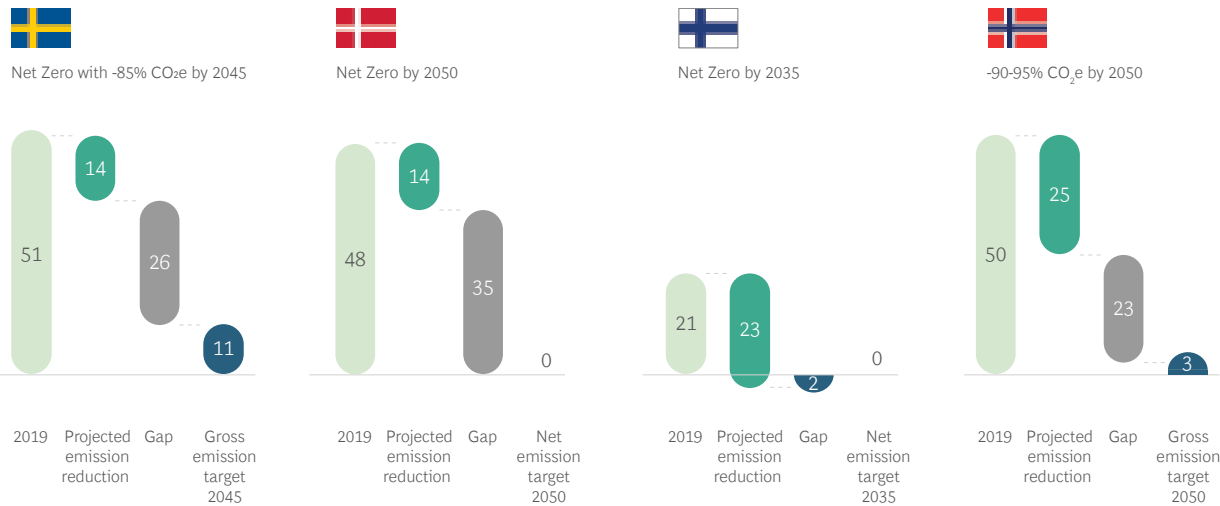
Nordic Countries Are Making Progress Toward Net Zero – But Not Fast Enough

Over the past two decades, the Nordic countries¹ have become global leaders in environmental sustainability. As part of the UN Paris Agreement goals to keep climate change to 1.5 degrees above pre-industrial levels, governments in the region have announced and implemented major initiatives to reduce their carbon footprint. (See the sidebar “Ambitious National Goals.”) These measures have generated noteworthy results. But in absolute terms, no Nordic country is on track to reach its emission targets. (See Exhibit 1.) At the current trajectory, the region will face a gap of approximately 80 megatons in emissions by 2050 to reach net zero.

At a company level, the same issue is apparent. Approximately 70% of the top 400 companies in the region have targets in place, addressing nearly three-fourths of the companies’ Scope 1 and 2 emissions. Moreover, Nordic companies are early adopters of science-based targeting, with a higher fraction of companies in the region having SBTi² net zero targets relative to other EU countries and the world as a whole. Yet as with the region overall, real progress has been limited. Only about 39% of companies have reduced emissions in the past year. Just about all companies want to reduce emissions, but many are waiting for the right incentives to do so. At the same time, many companies see themselves being able to create value in the green economy, but technology and/or the market is still immature for many products and services. These goals are still within reach, but they will require much more ambitious steps. Specifically, the Nordics must accelerate their reduction pathway by a factor of three -starting today. (See Exhibit 2.)

¹ In this report, we only discuss Denmark, Finland, Norway, and Sweden. The fifth Nordic country, Iceland, was deliberately left out due to its small size and unique geological factors.

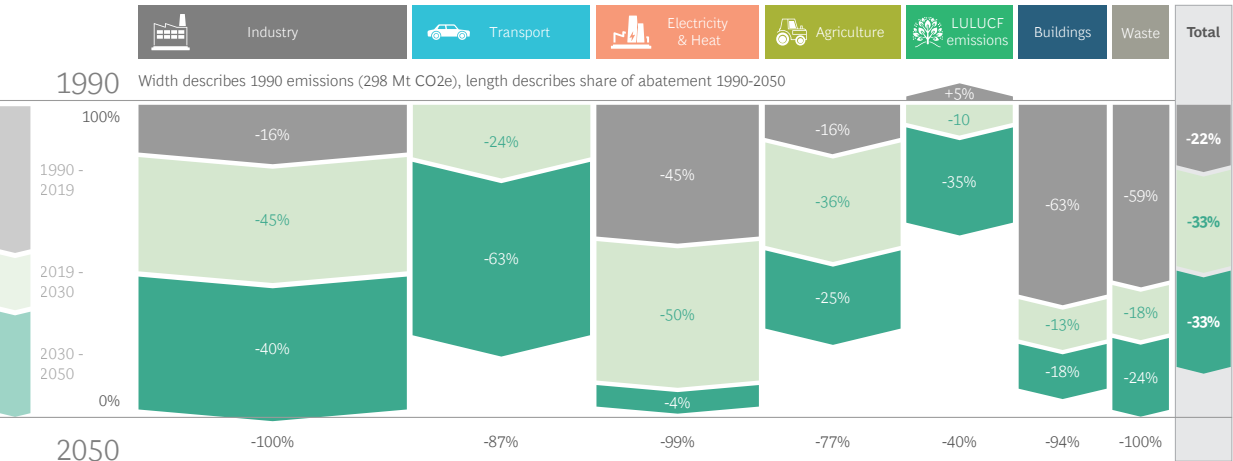
EXHIBIT 1 | Current policies leave ~80 Mt CO₂e gap to country targets



Source: Naturvårdsverket; Swedish Ministry of Environment; EEA; UNFCCC; The Norwegian Climate law; Norway's Climate strategy to 2050; Norwegian Gov't: "Norway's climate goals"; Denmark's Integrated National Energy and Climate Plan from the Danish Ministry of Climate Energy and Utilities; Danish Council on Climate Change (DCCC) Status Outlook 2021; Valtioneuvosto (Finnish Gov)/HIISI project; BCG analysis

EXHIBIT 2 | Net zero will require 3x the historical rate of CO₂e reductions

Relative development of emissions in Nordics by sector 1990-2050 (% of 1990 emissions)



Source: UNFCCC; BCG analysis



In Setting Goals, the Nordics Are Going Big on Net Zero

The four Nordic countries in our analysis have all passed ambitious goals to dramatically reduce carbon emissions in the medium term. As Exhibit 3 shows, all four countries have laws in place to mandate government reporting on progress (as opposed to other countries, which have policies but not formal legislation), and all four exceed the overall requirements of the EU.

Denmark:

Net zero by 2050, with an interim goal of reducing CO₂e emissions by 70% between 1990 and 2030.

Finland:

Climate neutral by 2035 (including a reduction of 55% between 2005 and 2030), and negative emissions after that. Finland has extensive carbon sinks from land use, land-use change, and forestry (LULUCF) activities.

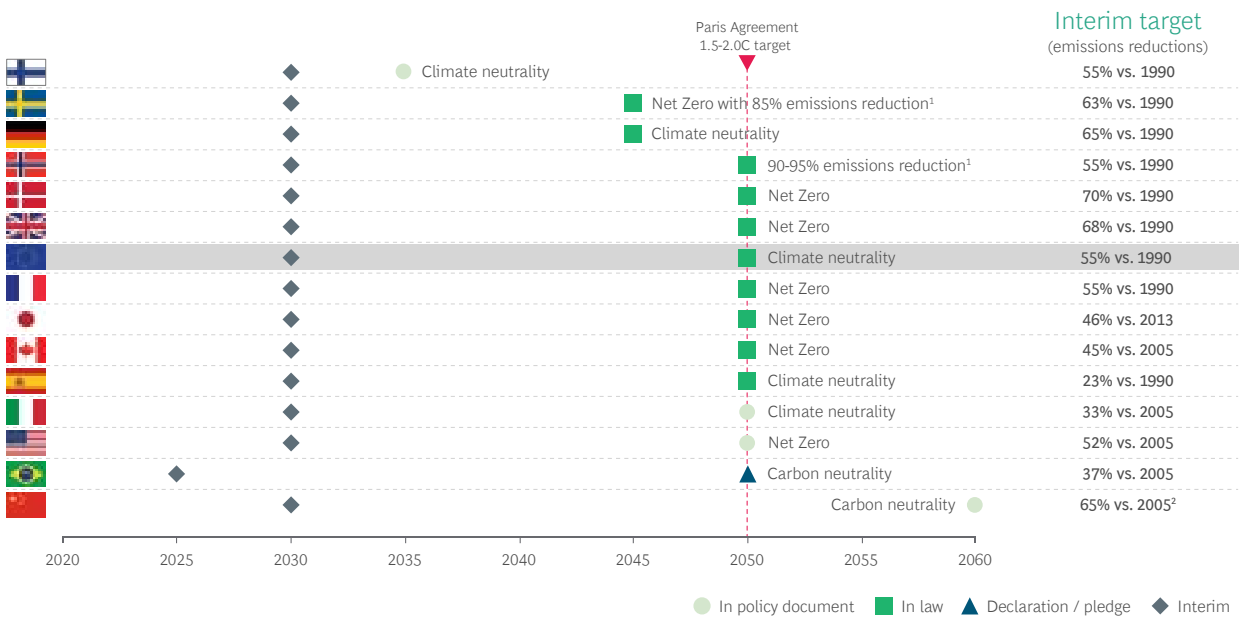
Norway:

90 to 95% reduction of gross CO₂e emissions by 2050, with an interim target of 55% reductions between 1990 and 2030. Due to benefits from LULUCF sinks, this target means that Norway could achieve net negative emissions by 2050

Sweden:

Net zero by 2045, requiring an 85% reduction in CO₂e compared to 1990 levels (including a 63% reduction by 2030). Sweden also benefits from large LULUCF sinks, meaning the country could achieve negative net emissions.

EXHIBIT 3 | Nordic countries have ambitious Net Zero targets with strong interim goals



1. NO and SE have gross emissions targets which will make them net negative in 2050 when including LULUCF
Source: Net Zero Tracker; BCG analysis

² The four Nordic countries in our analysis use different definitions of net zero, particularly regarding how they factor in carbon sinks based on land use, land use changes, and forestry (LULUCF). Certain natural resources such as forests naturally remove CO₂e from the environment even in the absence of deliberate measures to increase that effect (the so-called “baseline sink”). Finland and Denmark both use calculations based on gross emissions minus the carbon absorbed by LULUCF, including the baseline sink, while Sweden only factors in CO₂e abatement above and beyond the baseline sink. In addition, the terminology varies by country. For example, Denmark uses the term “climate neutral” for net zero.



The BCG Plan: Net Zero Can Be Cheaper than Netflix

BCG recently analyzed the Nordic countries and developed a pathway to reach net zero for Denmark, Finland, Norway, and Sweden. We analyzed the prevailing solutions and technologies to reduce carbon emissions (either directly or indirectly). We also spoke to the CEOs and sustainability leaders of nearly 100 top companies in the Nordics, to understand their current level of action and where they face challenges in taking bolder steps.

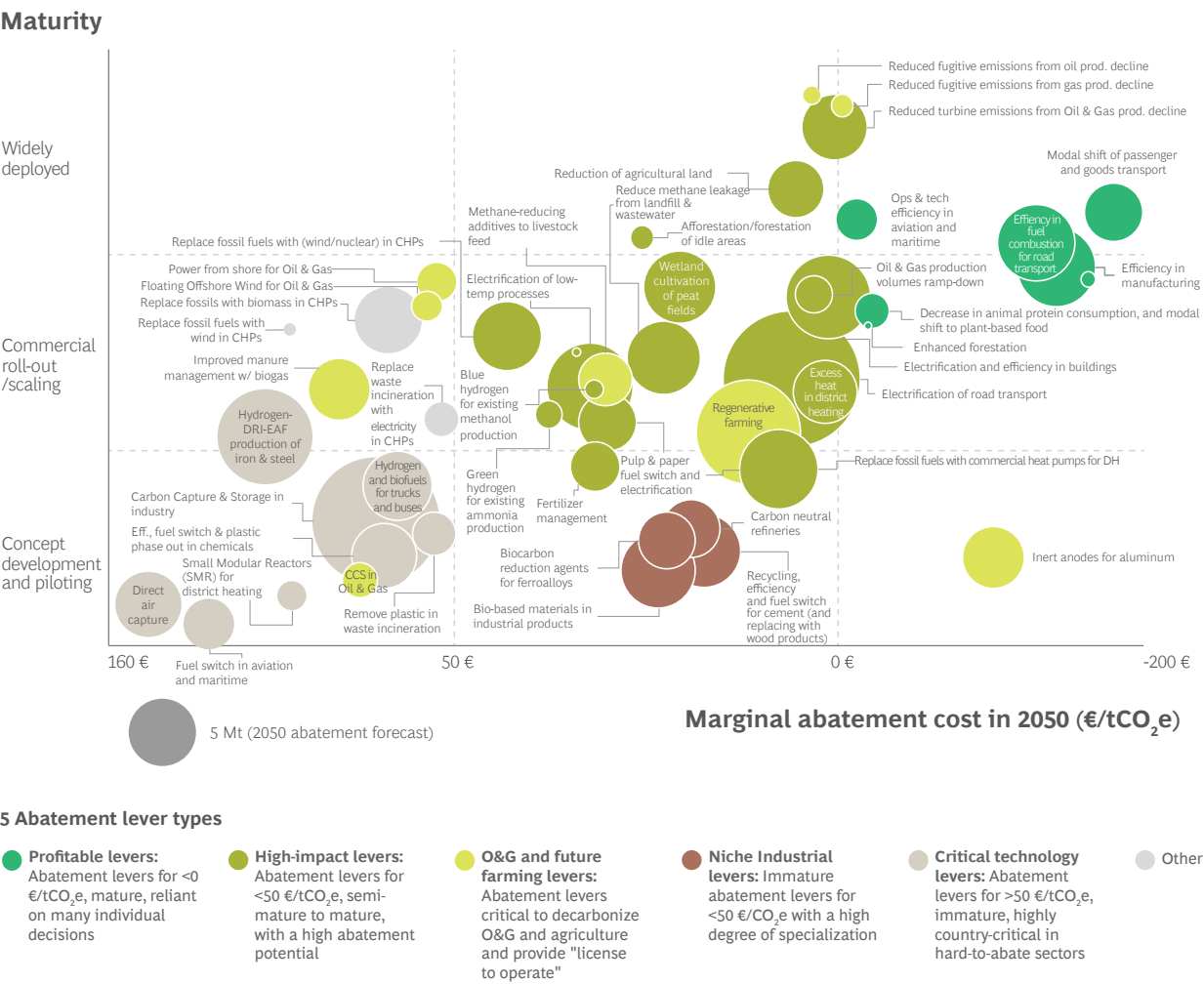
Our plan—smart decarbonization—optimizes for local abatement potential and the global export potential of technologies where the Nordic companies have a competitive advantage. It requires choosing the right levers and applying them logically.

THE PATHWAY TO NET ZERO:

We looked at a wide range of solutions and identified those with the biggest value opportunities for Nordic companies—those with the highest abatement potential and where the Nordics hold a differentiated right to win when exporting the solutions. We quantified the abatement potential and cost of each lever and assessed the maturity of the required technologies.

By considering a map similar to Exhibit 4, governments and companies can prioritize the abatement levers that are the most cost-effective and mature. For example, more efficient manufacturing, more efficient fuel combustion in existing truck powertrains, and shifting some cargo to other modes of transit are all essentially quick, easy wins. Companies that don't take these steps are leaving money on the table.

EXHIBIT 4 | Abatement levers vary in maturity and costs



Source: BCG analysis

At the same time, other technologies that are more expensive and/or still in development or testing should not be dismissed. These critical technology levers include direct air capture, carbon capture and storage for CO₂e generated from industry, and converting trucks and buses to battery-electric, hydrogen, and biofuels. Although such measures are not yet in wide use, they all have a larger potential impact and are essential solutions in any pathway to net zero, making early and continued investment a societal requirement.

Our pathways are essentially the identified solutions, sequenced in a way that optimizes for local abatement and global export potential. They are not the only pathways to reach net zero, but they demonstrate achievable and affordable ways to reach net zero.

QUANTIFYING THE INVESTMENT REQUIRED:

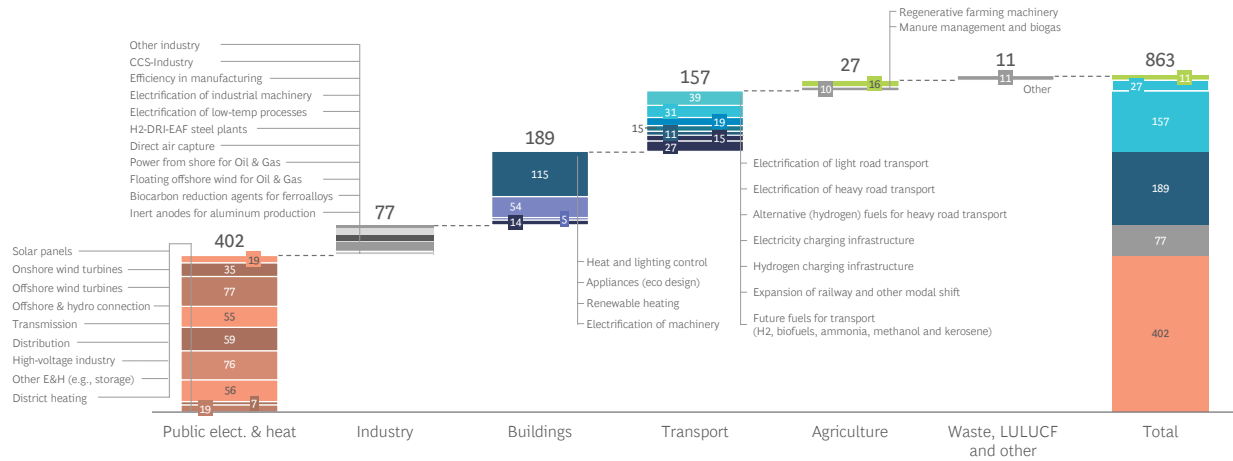
With the suggested pathways as a starting point, we analyzed the aggregate investment required and found that it is approximately €860 billion by 2050. (See Exhibit 5.) To put that number in context, on

an average yearly basis the current Nordic commercial investments in real estate are less than half of this total. But that amount is only one part of the equation. Those investments will also generate financial gains, unlock efficiencies, and reduce future costs. Additionally, much of the technology itself will become less expensive as it matures over time, due to experience and scale advantages.

Factoring in these elements, the marginal societal cost of achieving net zero is far lower—approximately €118 billion, or just 0.21% of total GDP for the Nordics. On a per-capita basis, the total cost works out to €140 per person, per year—cheaper than a subscription to Netflix Premium. The alternative of not investing will likely have a significantly higher cost. (See Exhibit 6.)

EXHIBIT 5 | Accumulated additional investment of ~€860 Bn needed towards 2050

Cumulative additional investments 2020-2050
(B€ cumulated, in real terms 2019)



Note: Significant proportion of Electricity & Heat investments are related to electrification and decarbonization of industry and industrial processes
Source: BCG analysis

EXHIBIT 6 | Reaching net zero cost-efficiently costs €140 per person per year until 2050

Annual marginal abatement cost to society in 2050
(€ Bn p.a.)



Marginal abatement cost to society is the aggregated additional cost incurred by all stakeholders in society from implementing abatement levers, compared to status quo. It is a net cost accounting for both additional costs and savings, and includes the discounted cost of any investments associated with a lever.

Source: BCG analysis

BUILDING ON THE PLAN TO UNLOCK FUTURE ECONOMIC GROWTH THROUGH EXPORTS:

Nordic countries have significant regional advantages in terms of climate action in areas such as renewable energy resources, technology and innovation, accessible capital, strong government policy and legislation on climate, and human capital. For those reasons, there is a massive opportunity for the Nordics to become global players in sustainability. By first taking the steps necessary to achieve net zero within their own borders—focusing on the technologies and solutions that yield the greatest returns in both financial and environmental terms and making the necessary investments—the Nordics can position themselves to then lead the world in reducing emissions.

Doing so will unlock a much greater CO₂e abatement. According to our analysis, leveraging net zero technologies and services from Nordic companies worldwide can eliminate almost ten times the level of domestic emissions in the Nordics i.e. ~2,000 megatons CO₂e in total. Examples of Nordic export opportunities with global abatement potential include wind turbines, heat pumps, and sustainable building materials (See Exhibit 7).

In addition, this approach enables the Nordics to boost their exports, providing a key economic opportunity.

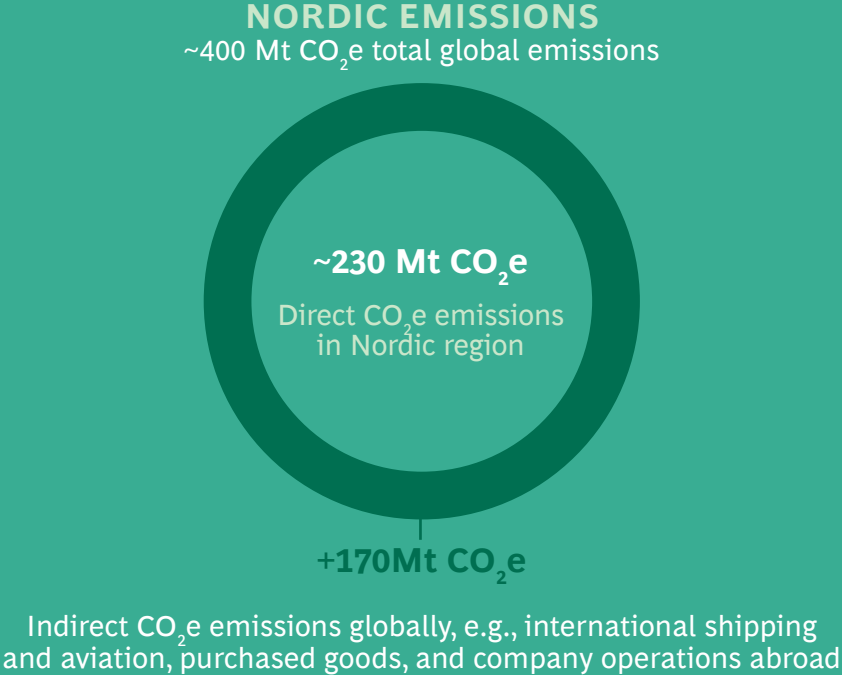
As countries worldwide focus their attention on environmental sustainability and energy security, they become willing and eager buyers of proven solutions. Carbon reduction and renewable power production are global growth markets for the foreseeable future—with regulations, consumer awareness, and other factors all creating a strong tailwind. The Nordics hold huge advantages in capturing that market. Specifically, we believe that companies can increase export revenue, with a total value of those goods and services at an estimated €14 trillion in global market value by 2050.

INVEST THROUGH ECOSYSTEMS:

Last, but not least, smart decarbonization requires an ecosystem approach. Although each of the net zero solutions we have identified holds significant merit on its own, we believe the true value of these solutions can only come from combining them into ecosystems—networks of organizations and stakeholders that can reduce emissions along the entire business value chain, including both demand and supply. Combining specific solutions into ecosystems enables them to reinforce each other, capitalize on complementary advances, and ultimately unlock greater benefits in terms of cost, carbon-abatement, or other metrics. This ecosystem approach is the only way to create comprehensive and coordinated action toward net zero.

The following section includes in-depth discussions of all five ecosystems.

EXHIBIT 7 | The global climate impact goes beyond Nordic countries' own direct emissions



Source: Global Carbon Project; CSR reports; Company interviews; Climate Partnership for ‘Blue Denmark’; Climate Partnership for Aviation; Carbon Disclosure Project; BCG analysis

The Fabulous Five: Ecosystems to Focus on

The five ecosystems we identified all offer the greatest abatement potential, both in domestic markets and around the world, and they are areas where Nordic countries have a clearly defined right to win. Exhibit 8 shows a breakdown of the main abatement levers for each and the subsequent pages describe each ecosystem—and related company stories—in greater detail.

EXHIBIT 8 | Collaborating in ecosystems is necessary to unlock full export potential



Low-Carbon Materials and Manufacturing

Low-carbon production, use, and recycling of materials & products, e.g., via

- Low-carbon materials
- Energy efficiency
- Electrification
- Green fuels & feedstock
- CCUS¹



Connected Emissions-free Energy System

Smart, efficient, and flexible renewable energy production through, e.g.,

- Expansion of renewable power & heat capacity
- Sector coupling
- Grid balancing & storage
- Green molecule from Power-to-X



Green Buildings and Infrastructure

Green design, construction, use, and recycling of buildings & infrastructure, e.g., via

- Low-carbon materials
- Emissions-free construction sites
- Energy efficiency
- Circular waste mgmt.



Sustainable Agriculture and Biosphere

Sustainable land-use mgmt., farming, forestry, and wood production through, e.g.,

- Regenerative farming
- Sustainable and value adding forestry
- Biofuel and biogas production
- Wood-fiber innovation



Fossil-free Transport and Logistics

Efficient & sustainable passenger & freight transport, e.g., via

- Low-carbon vehicle² manufacturing
- Modal shift
- Electrification
- Fossil-free fuels
- AI-optimization

Transition Finance

Enable the green transition across all ecosystems through, e.g., green bonds and loans, green investments, energy trading, GHG certificate trading

1. Carbon Capture, Utilization, and Storage 2. Incl. road, railed, watercraft, and aviation vehicles
Source: BCG analysis



Low-carbon materials & manufacturing.

Ecosystem 1:

The first ecosystem focuses on the green production, use, and recycling of raw materials (like steel, cement, and chemicals) and manufactured products (like machinery and furniture). It encompasses levers such as low-carbon extraction processes, increased energy efficiency, electrification, a changeover to green fuels and feedstock, and carbon capture and storage (CCUS). Low-carbon materials and manufacturing are feasible, but businesses need to prioritize their climate actions smartly to reach net zero cost-efficiently and capture green growth potential. Today, industry accounts for approximately 40% of all greenhouse gas emissions in the Nordics.

Energy use and processes are inefficient, and fossil fuel is still a major source of electricity, heat, transport, and feedstock. Factories and plants experience fugitive emissions, and many manufactured products (including plastic, steel, and aluminum) have carbon embedded into them. Complex process industries such as oil and gas exploration and production, mining, and manufacturing will require the largest emission reductions and potentially the biggest innovations, many of which are not yet on the market. For that reason, most reductions for industrial companies will be achieved between 2030 and 2050.

However, sustainability and circularity can be brought into all steps of the product life cycle. Lower-carbon (or no-carbon) alternatives can be used to power processes, and the processes themselves can be made far more efficient. Additionally, emerging technologies can present substantive gains. For example, carbon capture, utilization, and storage (CCUS) entails solutions to capture, transport, store, and use CO₂e from large point sources such as cement plants, paper processing, or biomass plants by using geological carbon storage reservoirs in the North Sea or as feedstock for other processes such as power-to-X (discussed below).

Green steel is another clear opportunity. In 2020, just 2% of steel in the Nordics was produced through sustainable processes. By 2030, that share should increase to 26%—and by 2050, green steel should comprise all production.

“The future will bring much higher product differentiation by footprint, and the Nordics can be a front runner in raw materials,” said Stefan Erdmann, CTO at Outokumpu, a global stainless steel manufacturer based in Finland.

In our analysis, low-carbon materials and manufacturing can reduce direct CO₂e Emissions in the Nordics by 85 megatons—and 170 times that amount worldwide. Moreover, we estimate the global market for these solutions to be €4.4 trillion by 2050.



Danish manufacturing company Danfoss is a good example of an early leader in this ecosystem. The company is aiming to be carbon-neutral (for scope 1 and 2 emissions) by 2030, and it is committed to setting science-based targets as part of the Science-Based Targets Initiative (SBTi). It has successfully reduced its energy intensity by about 51% since 2007 (in terms of megawatt-hours per million euros of net sales). Since January 2021, Danfoss has sourced carbon-neutral electricity for all its locations in Denmark and Germany, corresponding to 25% of the group's total electricity consumption, as an important step towards carbon neutrality by 2030. The PPA will reduce Danfoss' global CO₂e emissions by an estimated 25,000 tons.



Connected, emissions-free energy system.

Ecosystem 2:

Net zero is simply not possible without substantial changes to the power system. This includes extensive renewable power and heat generation, production of green molecules, substantial investments in the grid, and expanded smart-grid capacity, including sector coupling, grid balancing, and storage.

The Nordics are already front-runners in creating connected renewable energy systems. However, more decisive actions are required to meet the increasing future demand for green electricity.

“There is a real risk that we will not reach the renewable energy demand in the future. We need three times the current level by 2030,” said Jakob Askou Bøss, former senior vice president at Ørsted, a Danish power company.”

A critical issue is the intermittency in renewable power production, and the lack of sufficient scale for alternatives in hard-to-abate sectors such as industry and transport.

Wind power (particularly offshore wind) will be the most important contributor across the Nordics for increasing renewable power production—and this is an area where the Nordics hold significant advantages. As an example, the world-leading wind turbine manufacturer, Vestas, is Danish.

“We see a big push from stakeholders,” said Lisa Ekstrand, VP of Sustainability at Vestas. “Turbines need the lowest CO₂e footprint possible while being a green source of renewable energy.” In that way, she added, “The green transition brings a lot of growth opportunities.”

The Nordics—particularly Norway—have abundant and high-quality wind resources available off their coasts and can play an important role in supplying renewable energy to the rest of Europe. At the same time, hydropower, nuclear, solar, and biomass will also be important to increasing renewable power generation. But the Nordic governments must act

decisively and quickly in order to ensure that the wind value chain is being developed in the Nordics and not elsewhere.

Utilities such as electricity and heat are largely within reach of net zero emissions from their own operations. But they and other renewable energy developers play an essential role in the massive build-out of renewable power production, particularly in the critical period from now through 2030. (See Exhibit 9.) In Denmark, for example, meeting the increased demand for renewable energy requires increasing the current installed base by a factor of four (with a corresponding increase in the rate of construction). To support the expansion in intermittent renewable power production, a rapid build-out and strengthening of the entire power system is necessary. All Nordic countries are facing substantial investments in expanding the power grid. We need smart solutions which promote efficiency and balance, not least through demand response. Heat will largely be delivered by electric heating and biomass and will need to be coupled to the power sector more deliberately to provide balance in the energy system while also reaping efficiency gains by, for example, using excess heat in meaningful ways.

More advanced solutions require a steeper investment and carry greater uncertainties, but also hold the potential for larger benefits. For example, power-to-X (PtX) is a clear opportunity to generate carbon-free fuels, but it calls for significant investments in renewable energy to boost production. PtX entails using renewable energy (the “power”) to produce hydrogen through electrolysis. The hydrogen can then be used directly, to power fuel cells or as feedstock in high-temperature processes, or it can be combined with carbon or other elements to create ammonia, methanol, or synthetic hydrocarbon (the “X”).

The Nordics—particularly Denmark—have relatively more potential in PtX than other countries because of their large and increasing share of electricity



Norwegian energy producer Statkraft is a good example of a player in this ecosystem.

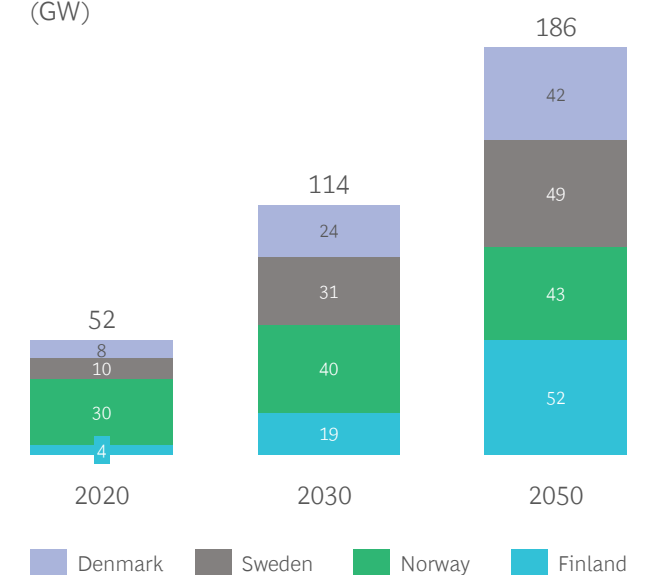
Statkraft is the largest producer of renewable energy in Europe, the largest producer of hydropower in Europe (and among the top 10 worldwide), and the largest owner and operator of onshore wind power assets in the Nordics. More than 90% of its power generation is focused on renewables, and the company invests all of its future growth in carbon-free energy. The company’s goal is to be carbon-neutral in scope 1 and scope 2 by 2040.

generation through wind power. Denmark has a strong PtX supply chain, which could be supplemented and redesigned to accommodate new technologies. According to our analysis, connecting large hydrogen production plants to PtX customers across Denmark would require an estimated €1.2 billion. In Denmark alone, PtX could abate 4% of domestic emissions, create 1,200 jobs, and generate €10 billion in annual revenue from fuel sales by 2050.

The total potential from the energy ecosystem is a reduction of 29 megatons CO₂e within the Nordics, and 365 times that globally. By 2050, the market for green energy will be €4.2 trillion worldwide.

EXHIBIT 9 | More renewable electricity needed

Renewable electricity capacity, Nordics (GW)



Source: BCG analysis



Green buildings and infrastructure.

Ecosystem 3:

The third ecosystem includes sustainable design, engineering, construction, use, and recycling of buildings and infrastructure via green materials, emissions-free construction sites, energy efficiency, and circular waste management. Currently, the construction process for new buildings emits unnecessarily high levels of CO₂e, as does the operation of those buildings after construction, primarily through heat and electricity consumption. The materials themselves (concrete, steel, glass, aluminum) include embodied carbon. At present, buildings and infrastructure account for up to 40 percent of all greenhouse gas emissions in the Nordics.

To improve, companies and governments must collaborate deeply across the entire value chain and rethink how buildings are designed, built, powered, and deconstructed. That impacts design, construction methods and materials, and recycling and waste management once the buildings are in use. Some of these improvements will come from new construction, but many others will occur through refurbishing existing buildings.

The Nordics have a unique advantage in buildings and infrastructure. During the design phase, the region can emphasize material reuse and circularity, as well as smart energy management solutions including insulation and on-site production of renewable energy, so that buildings can power themselves. Architects can also capitalize on the region's leading position in low-carbon and biogenic building materials (wood, hemp, straw, and low-carbon alternatives such as green steel and low-carbon cement), along with recycled and prefabricated elements.

During construction, a reliance on local materials and fossil-free vehicles and equipment can dramatically reduce emissions. During building operations, heat pumps, LED lighting, and energy management technologies play a role. Finally, designing for circularity can minimize waste when buildings are at their end of life.

In our analysis, the right investments and a switch towards greener alternatives in buildings and construction can reduce up to 54 megatons CO₂e (44 direct) in the Nordics, and up to 20.5 gigatons worldwide by 2050.



ROCKWOOL Group, a manufacturer of building materials in Denmark, demonstrates the potential in producing sustainable building materials. Over its lifetime, ROCKWOOL's stone wool insulation, sold in 2021, will save 100 times the CO₂e emitted and energy consumed in its production. The building insulation ROCKWOOL sold in the same year will continue to save the annual energy consumption of more than one million homes, for the lifetime of the insulation.

In addition, the company was a pioneer in taking systematic, measurable action to reduce the environmental impact of its own operations. In 2016, it set bold goals to improve several metrics, including CO₂e emissions intensity, water consumption, waste to the landfill, and use of reclaimed materials. ROCKWOOL has reached four of its six intermediate sustainability goals before the deadline of 2022 and is now looking to build on its progress.



Sustainable agriculture and biosphere.

Ecosystem 4:

The fourth ecosystem entails improving agriculture practices. Agriculture remains difficult to decarbonize due to methane emissions from animals and nitrous oxide emissions from soils and fertilizer. Across the Nordics, agriculture currently accounts for 20 percent of all greenhouse gas emissions, but under some projections it is on track to become the biggest source of such emissions in the next 10 years.

Farmers, forest owners, and companies will have to rethink most of the traditional land-use methods used today, switching to practices such as regenerative farming, sustainable forestry, and bioenergy production. In particular, three actions can dramatically help the Nordics reach net zero and unlock huge business opportunities. The first is to leverage livestock manure as feedstock for biogas installations.

Second, we should improve our natural environment and biodiversity through afforestation, sustainable forestry, and wetland cultivation of peat fields. The proper application of land use, land use changes, and forestry (LULUCF) applications will result in net negative emissions and contribute significantly to improving the agriculture sector's overall performance. Nordic countries can accelerate the benefits of LULUCF by increasing the volume of dedicated forest area and protecting wetlands from development or other threats. LULUCF levers are a clear area of advantage for the Nordics, due to these countries' abundant natural resources. However, there is an important policy debate to be had at the EU level around how to fund the carbon sink enhancements. Countries—and companies—choosing to go beyond net zero should be compensated accordingly.

Finally, ecological and regenerative farming practices will allow us to grow premium green produce, improve biodiversity, and store tons of carbon at the same time. These include crop rotation, the use of cover crops in the off-season to

improve soil quality, introducing grazing animals to restore nutrients, eliminating tillage and other soil disturbances, and reducing the use of chemical fertilizers, pesticides, and other inputs. All of these practices can achieve the dual effect of reducing CO₂e emissions associated with farming as well as storing atmospheric CO₂e as carbon in the soil, turning agricultural fields into carbon sinks.

Through these measures, the agriculture and biosphere ecosystem can eliminate about 58 megatons CO₂e in the Nordics by 2050, and more than 100 times that amount worldwide. At the same time, the global market for such solutions in 2050 is projected at €1.3 trillion.



Yara, headquartered in Norway, is a world-leading fertilizer company and provider of environmental solutions. The company aims to reduce emissions from its own operations (scope 1 and 2) by 30% by 2030 and become fully climate neutral by 2050. In addition, Yara collaborates with the value chain, supporting farmers to produce nutritious food at low environmental cost.

The company's most significant emissions reduction initiative has been the development and installation of N₂O catalyst technology in its nitric acid plants. The technology removes about 90% of the N₂O emissions in those plants—representing a 45% reduction of scope 1 emissions since 2005. Following the company mission to responsibly feed the world and protect the planet, the technology is now commercially available to third parties as well.



Fossil-free transport and logistics.

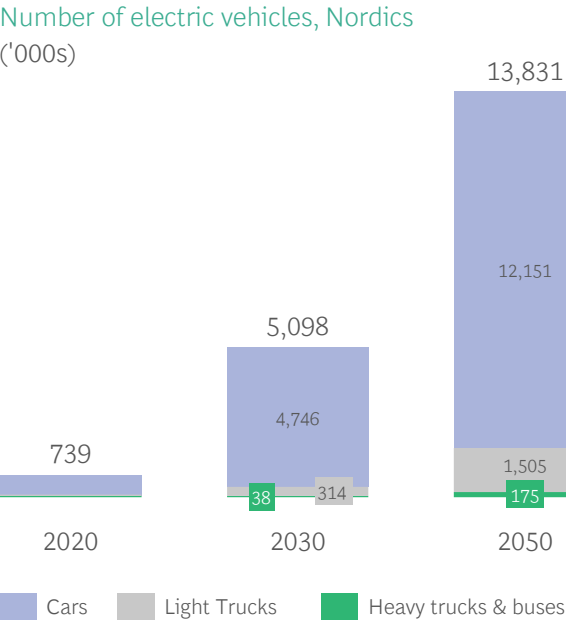
Ecosystem 5:

Last is transport, including efficient and sustainable production and operation of cars and trucks, seagoing vessels, rail, and aircraft, to decarbonize passenger and freight transport. This might include a shift to less-polluting modes, electrification, alternative fuels, or AI optimization. Today, the transport sector accounts for approximately 30% of all greenhouse gas emissions in the Nordics.

Aviation, navigation, and heavy transport will depend on emerging technology such as hydrogen, ammonia, and synthetic fuels, none of which are ready for widespread application. As a result, most emissions reductions for the sector will occur between 2030 and 2050 as these technologies come online and reach scale. The magnitude of the low-carbon fuels opportunity for the Nordics is enormous and cuts across traditional sectors including oil & gas, power generation, engine and equipment manufacturing, and the full scope of the transport value chain—it builds on existing Nordic strengths.

Passenger vehicles, in contrast, have already begun the transition away from carbon combustion due to commercially available electric vehicles. However, faster progress is necessary. In order to reach the desired goals, approximately 12 million passenger cars across the Nordics, or 95% of the fleet, will need to be electrified by 2050. (See Exhibit 11.) Some trucks, depending on their application and payload, can be electrified, but others with heavier cargo and/or longer routes likely need to rely on fuel-cell engines and drop-in biofuels. Notably, the transition will require a significant investment in infrastructure. In Sweden alone, decarbonizing the passenger fleet will require building about 3 million electric charging stations and 600 hydrogen stations.

EXHIBIT 10 | Increased transport electrification



Source: BCG analysis



Meyer Turku is revolutionizing the cruise industry by leading a consortium of organizations working to develop a climate-neutral cruise ship concept by 2025, and to make its operations at the shipyard carbon neutral by 2030.

The company already built a cruise ship powered by liquified natural gas—the first one in the world. Because ship-building is complex, partnerships are crucial. Meyer Turku is already collaborating with Swedish steel manufacturer SSAB—which is also taking proactive steps to transform its operations and product portfolio—to source green steel.



Transition Financing

The investment required to fund opportunities in all five ecosystems is vast. Banks and other capital owners are therefore critical to supporting the energy transition, and transition financing is a foundational element that supports all five of the ecosystems that we identified.

Nordic banks have a strong starting point and have naturally been exposed to green ecosystems. Most banks in the region have committed to net zero, and many are nudging decision makers through green financing products, thereby incentivizing behavioral changes across their client base. Green loans and bonds are increasingly available to fund companies that have a sustainable business model, adding another dimension to traditional credit markets (which traditionally looked only at financial metrics). Some local banks are going further by forging partnerships across banks to jointly incentivize emissions reductions. One good example is the ship financing partnership between DNB, Swedbank, Danske Bank, and KLP; another is Nordea's partnership with EIB to finance green small and medium enterprises.

Overall, however, the pace of development is too slow to fully support the Nordic net zero pathway. An approach based on "more of the same" will not be enough. To succeed, innovative products and scalable distribution tools are required. Retail and SME clients will require education and nudging as well as the financing capacity to invest in the required change. For large corporations, banks must finance the right opportunities and take the right risks to make the economics of green financing sustainable.

This requires significant capability uplifts. Across segments, partnerships between capital owners and corporations, as well as private-public partnerships, will be required to fully address the complexities of certain value chains and the pace of change required as well as the long payback of cumulative individual transitions.

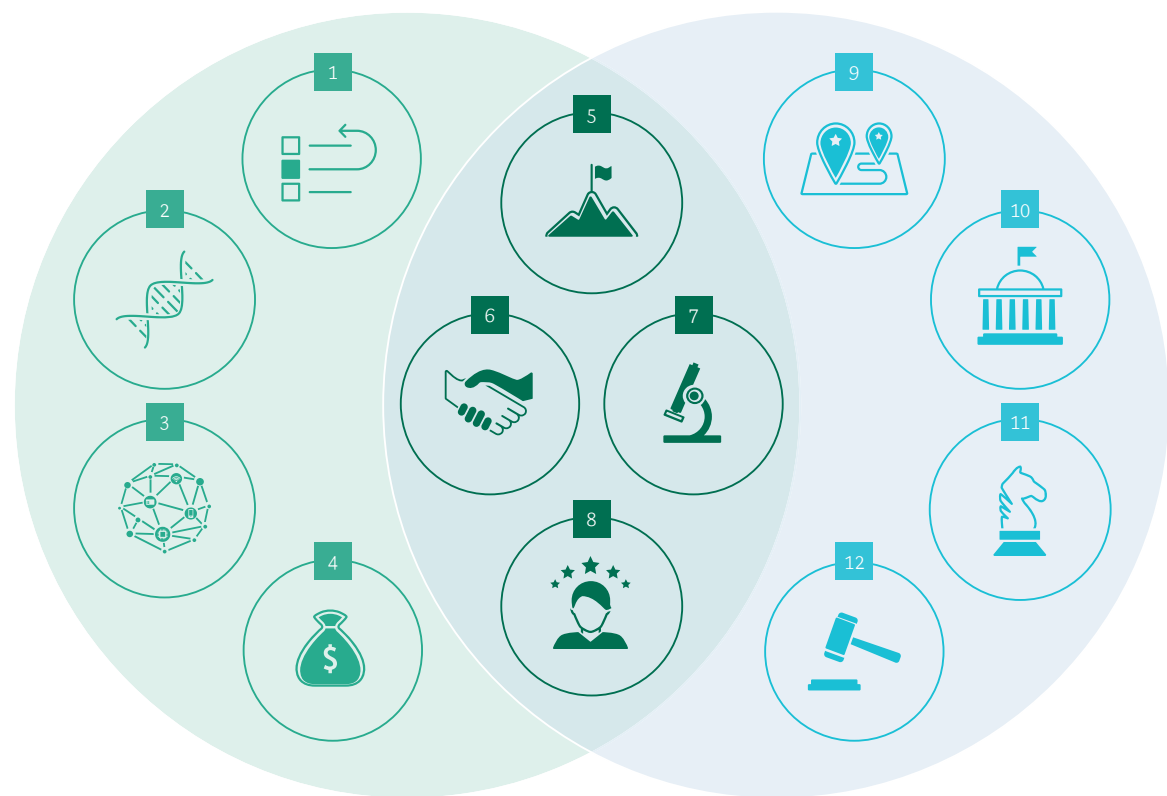
There are successful examples we can study to make the journey easier. For example, HSBC and Walmart—realizing that they can make faster progress together—have engaged in a joint supply chain decarbonization program that incentivizes companies both financially and commercially through improved terms. Other examples outside the sustainable finance sphere include export finance guarantees, which successfully incentivize foreign capital to invest in Nordic exports. We can envision similar setups to help accelerate required investments in the Nordics and fuel the green growth adventure in the coming years.

Banks cannot tackle these initiatives alone; success requires collaborations including public-private partnerships, bank-corporate ventures, and similar initiatives. In some cases, governments will need to structure the policies and governance of these partnerships. For example, we may require transition or green financing guarantees in the same way we have export guarantees, and capital requirements will need to reflect transition risk as well as traditional credit risk. Equity investors also have a critical role to play to fully support green ventures and early technology developments. If the Nordic net zero transition succeeds, the green financing opportunity will be enormous and the capabilities built in the Nordic green financing ecosystem will be a growth and export factor in their own right.



An Action Plan to Mine for Green Gold

Our analysis identifies steps that all stakeholders in the Nordics must take to get on the path to net zero and maximize the value-creation opportunities of the transition. Some measures apply to governments, others to businesses, & a third category requires joint action between the public and private sectors. (See Exhibit 11.)



Source: BCG analysis

EXHIBIT 11 | 12 actions to unlock green growth and Nordic Net Zero

Business

- 1 **Prioritize actions and set direction**
Focus on growth opportunities that play to Nordic strengths
- 2 **Embed climate action in company DNA**
Break down silos and bring all employees on the journey
- 3 **Collaborate with your ecosystem**
Work proactively with policy-makers and other companies
- 4 **Mobilize green finance**
Unlock green funding for firms and critical infrastructure projects

Collaboration Between Government and Business

- 5 **Take climate leadership and inspire others**
Lead by example and inspire others to make green decisions
- 6 **Create partnerships across sectors**
Connect strengths across public and private sectors
- 7 **Accelerate innovation and R&D**
Invest early in the technologies needed to realize Net Zero
- 8 **Upskill and reskill the workforce**
Prepare the labor force to meet the future needs of a green economy

Government

- 9 **Develop and commit to long-term roadmaps**
Create long-term national roadmaps for climate action and green growth
- 10 **Embed climate action in every government decision**
Include climate in policy-making, funding, and public procurement
- 11 **Create strategies for green growth opportunities**
Develop long-term roadmaps and provide support and funding
- 12 **Sharpen policies, incentives, and funding**
Fast-track updates to climate policies that enable action and green growth



Priorities for Business

Many net zero measures are industry-specific, but others are universally applicable.

Prioritize actions and set direction

Focus on “smart decarbonization” opportunities that can bring cost-efficient CO₂e abatements to the Nordic countries while creating long-term green export opportunities by building on Nordic countries’ pre-existing competitive advantages.

Embed climate action in company DNA

Break down silos to drive consistent sustainability initiatives and targets across organizations, and bring employees onboard early in order to embed climate action in company culture, learning, and incentive schemes.

Collaborate with your ecosystem

Work proactively with customers, policy makers, and other company players in the ecosystem to create a level playing field and promote incentives to adopt climate-friendly policies and practices.

Mobilize green finance

Provide green funds for growth opportunities, climate action, and key infrastructure investments through financial instruments that match the green investments’ risk profiles, for example green bonds, payments for performance, and carbon credits.

Priorities for Collaboration Between Government & Business

Governments and companies must take climate leadership and embed climate action into every decision.

Take climate leadership and inspire others

Make bold climate decisions and demonstrate climate leadership by inspiring others to take climate action, for example through ambitious green public procurement or by raising climate awareness among end consumers.

Create partnerships across sectors

Connect strengths with holistic long-term strategies across public and private sectors to enable coordination of interest and tackle major challenges, for example establishing a full Circular Economy and creating critical public-private partnerships.

Accelerate innovation and R&D

Invest early in the technologies needed to realize long-term roadmaps and drive collaboration across corporate and public research institutions by making data publicly available and openly sharing knowledge and expertise.

Upskill and reskill the workforce

Reskill and upskill the existing workforce to meet the future needs of a green economy, particularly for workers in emissions-intensive sectors who may face redundancy due to new production methods.

Priorities for Governments

Governmental action will vary between the Nordic countries, but some actions apply across all countries:

Develop and commit to long-term roadmaps

Develop long-term roadmaps, clarifying immediate actions and key green growth opportunities, and implement changes to policymaking, green funding, and public procurement accordingly.

Embed climate action in every government decision

Make climate impact and rate of green job creation key decision points in every government decision, for example, adopt green public procurement practices, factor climate implications into funding decisions, and anchor changes in law.

Create strategies for green growth opportunities

Create national strategies for prioritized green growth opportunities that build on Nordic countries’ strengths, and support them through investments in export infrastructure, funding, partnerships, and long-term guaranteed offtake agreements.

Sharpen policies, incentives, and funding

Fast track updates to climate policies and incentives that will drive climate action and enable green growth opportunities, for example enhancing green tax credits.

Conclusion

Achieving net zero by 2050 is a massive undertaking, and despite admirable efforts thus far, the Nordics are not on track to reach that goal.

They must dramatically expand their efforts, focused around an achievable, affordable plan for how best to move forward. Our plan—smart decarbonization—helps companies and countries identify and prioritize the right levers, determine the investment required to implement them, and capitalize on their export potential, across the five ecosystems we identified. Reducing greenhouse gas emissions represents the biggest challenge of our generation. We believe it also presents the biggest opportunity for the Nordics.



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