

Future Perspectives

Hammerfest is not only known for its particularly northerly location, but also for its LNG production. The extracted gas is transported from the subsea LNG plant through a 143 km long pipeline to the small island of Melkøya, where it is further processed. From there it is shipped by tanker, in some cases even to the USA.

But what actually is LNG? Liquefied natural gas, or 'LNG' for short, is natural gas extracted from under the sea. Then it is cooled down to a liquid form, which shrinks its volume to about a 1/600th of the gas' original form. This also makes the transport a lot easier, since the liquid form allows non-pressurized storage during which. The final product then is exported by ship. After the normal temperature is reached again the LNG is regasified and can be used, like any other natural gas, for generating electricity for example.



Hammerfest LNG has been one of the world's most energy-efficient LNG plants for the last 15 years. It was responsible for the supply of liquefied natural gas to customers worldwide.

But the demanding voices of the energy transition became louder and the consequences of LNG production for the climate more drastic. There were more and more discussions about the electrification of the Melkøya gas plant. This step is expected to reduce CO₂ emissions by around 850,000 tonnes annually.¹ After the decision of whether Melkøya should be electrified or not was made in the favor of it in August 2023, authorities have already postponed the start of electrification by two years, from 2028 to 2030. Until and during this period the plant will continue to run on gas turbines.

This is said to be the most drastic emission reduction decision that has been made in the question of gas production in Norway so far. The government is willing to invest NOK 13.2 billion (2022) in the Snøhvit Future project, which is about 1.16 billion €. ²

Currently during average production, about 6.5 million European households are supplied by energy from Hammerfest, which makes up about 5% of all Norwegian gas exports. ³

In 2023, gas exports accounted for 35.1% of Norway's total exports, making it the most significant share of the country's total international trade. ⁴ That being said, it can be proposed that LNG production and export are going to play a major role in

¹ <https://www.highnorthnews.com/en/norwegian-government-approves-electrification-melkoya-lng-plant-northern-norway>

² <https://www.equinor.com/news/20230808-governmental-green-light-snohvit-future>

³ [The Snøhvit Future project - Equinor](#)

⁴ [Norwegen - Wichtigste Exportgüter 2023 | Statista](#)

Norway's economy even in the future. To which extent remains an open question for now, but it is important to look at the main uses of which in order to predict certain developments.

What are the main consumers of gas-generated energy?

Where does the gas go to?

And what is LNG even needed for?

Natural gas is one of the most cost-effective ways to ensure economic growth. With a share of 23% of the worldwide electricity production in 2022, gas is the third most important source after coal (36%) and oil (unlisted). The perceptual share and with that the importance of gas has shown an almost constant increase since 1985 as well.⁵ That is why natural gas will continue to be an essential component, especially with a look at the increasing demand for power due to globalization, digitalization and industrialization.

Digitalization:

While the digital advancement of many technologies used in transportation, agriculture or manufacturing promises to reduce global emissions by more than 15%, their energy consumption is still remarkable. In addition to the 8-10% of global energy consumption for which digital technologies are responsible, there is also the amount of energy required for the production and water cooling of the devices, which needs to be discussed.⁶ Not to mention the electronic waste generated, the disposal of which is also complex and energy-intensive.

Industrialization:

Fossil fuels such as gas also remain the dominant source of energy in the industrial sector, which itself accounted for 37% of the global energy consumption with 166EJ in 2022. In the same year 65% of the industry-used energy was based on fossil fuels. In 2010 it used to have a share of up to 74%. Additionally the productivity of industrial energy is expected to rise about 3% each year up to 2030.⁷ Nevertheless fossil fuels are still vital for countless industrial processes, including those in the generation of renewable energy.

Transport:

Even though the efficiency of many global processes has increased, the demand for worldwide transportation of goods in the shortest possible time, fast passenger transport and high-speed exchange of information has also risen rapidly. Overall the transport sector is accountable for 28% of the total energy consumption.

That is why transport is the largest source of energy related emissions for almost every second country and for the rest it is in second place. And since 95% of the world's transport energy is still based on fossil fuels, global shipping and traveling are playing a key role in the question of future gas demand.⁸

⁵ [World Electricity Production by Source since 1985. \[1\] | Download Scientific Diagram](#)
[Share of electricity production by source](#)

⁶ [Impact of technology on energy efficiency - Telefónica](#)

⁷ [Industry - Energy System - IEA](#)

⁸ https://www.un.org/sites/un2.un.org/files/media_gstc/FACT_SHEET_Climate_Change.pdf

Due to global warming another energy demanding trend has gained a lot of popularity: Air conditioning.

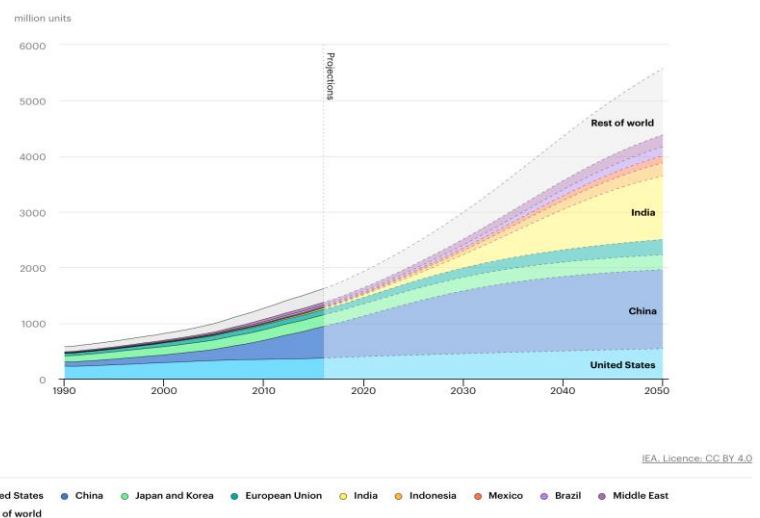
“Growing demand for air conditioners is one of the most critical blind spots in today’s energy debate. Setting higher efficiency standards for cooling is one of the easiest steps governments can take to reduce the need for new power plants, cut emissions and reduce costs at the same time.”

-Fatih Birol, IEA Executive Director (Turkish economist and energy expert)⁹

As one of the rapidly changing energy consumers, it is important to take a look at air conditioning in the context of LNG. The global climate change is highly discussed and that way nothing new, but one of the many consequences of which is an increase in the use of air conditioning.

The following graph depicts the predicted air conditioner stock until 2050 based on the numbers from 2018 worldwide¹⁰:

It presents a steady increase of air conditioners with the biggest share from India and China, not taking into account that both have a comparatively high population. Overall the stock of ACs is not expected to decrease or stagnate in any of the listed countries. Until 2050 the stock of air conditioners is expected to multiply by three at least.



This development can directly be connected to global warming, which is illustrated in the following diagram¹¹:



It shows the drastical and steady growth in temperature increase per year since 1880 worldwide, which has reached an all time high in 2020, as the last example listed here. Temperature increases up to +1.18°C per year are then resulting in a higher demand of air conditioning now and in the future.

⁹ [The Future of Cooling – Analysis - IEA](#)

¹⁰ [Global air conditioner stock, 1990-2050 – Charts – Data & Statistics - IEA](#)

¹¹ [Chart: 2023 Was the Warmest Year on Record - by a Record Margin | Statista](#)

Significance:

The role that air conditioning plays for us today is nothing compared to what we can expect from the future. So far general space cooling – including fans, dehumidifiers and air conditioners – accounted for more than 2,000 TWh of electricity per year and that way made up about 10% of the global electricity demand¹². Of all the electricity that is generally consumed in buildings, ACs alone account for almost 20%.¹³ Due to changes in the climate and globally increasing incomes the use of air conditioning is going to grow dramatically over the next years.

Experts predict that by the year 2050, about 2 out of 3 of the households world wide will be equipped with an air conditioner.¹⁴ China, India and Indonesia, as the three main players in the air conditioner sales market, will together make up about half of the total number by then. Today air conditioning is concentrated to only a small number of countries, but the so-called ‘cold crunch’ is expected to change that, making the use of air conditioners a worldwide phenomenon.

Efficiency:

The term “Air conditioning” was coined in 1906 by the mill owner Stuart W. Cramer from North Carolina. He used it to describe his invention for controlling changes in the humidity of air in textile factories. Since then there were many developments in the AC industry, aiming for faster, cheaper and, especially in recent years, more environmentally friendly ways of modifying the temperature of indoor spaces. This has led to more energy-efficient air conditioning systems becoming increasingly popular, which is particularly important when considering the overall energy consumption of these appliances.

“The more we cool, the more we heat the planet.”

-UN environment program¹⁵

But why is an increase in air conditioning such an issue?

First of all, the artificial cooling of the air is very energy-intensive. Due to their comparatively low efficiency and use of fossil fuel burning electricity, the standard air conditioner is classified as one of the main fossil fuel heating and cooling technologies.¹⁶

Additionally, most of the air conditioning equipment which is used in the cooling of houses nowadays works through hydrofluorocarbon, a group of synthetic gases, as refrigerants, which are also potent greenhouse gases.¹⁷ The negative effect for our climate is therefor doubled. In terms of energy requirements, and therefore for suppliers such as Melkøya, a drastic increase in the energy consumption by air conditioning systems is to be expected in the future.

¹² [In a Warming World, 10 Air Conditioners Are Sold Every Second](https://www.bloomberg.com/news/articles/2016-07-28/in-a-warming-world-10-air-conditioners-are-sold-every-second)[bloomberg.com](https://www.bloomberg.com/news/articles/2016-07-28/in-a-warming-world-10-air-conditioners-are-sold-every-second)<https://www.bloomberg.com/news/articles/2016-07-28/in-a-warming-world-10-air-conditioners-are-sold-every-second>

¹³ [The Future of Cooling – Analysis - IEA](https://www.iea.org/publications/freemove/?q=The%20Future%20of%20Cooling%20-%20Analysis%20-%20IEA)

¹⁴ [The Future of Cooling – Analysis - IEA](https://www.iea.org/publications/freemove/?q=The%20Future%20of%20Cooling%20-%20Analysis%20-%20IEA)

¹⁵ <https://www.unep.org/topics/energy/cooling>

¹⁶ <https://energy.ri.gov/heating-cooling/fossil-fuels/standard-air-conditioning#:~:text=Because%20standard%20air%20conditioners%20are,fossil%20fuel%20heating%20%26%20cooling%20technologies>

¹⁷ <https://www.ccacoalition.org/short-lived-climate-pollutants/hydrofluorocarbons-hfcs>

Conclusion:

What do developments in transport, industrialization or air conditioning mean for Melkøya and Hammerfest?

Firstly it can be concluded that natural gas is likely to remain one of the most important sources for energy used by consumers worldwide. The growth in natural gas demand shown in the past lets us propose a similar pattern in the future. Gas extraction in Hammerfest is considered important today and will continue to be so in the future, as demonstrated by major investments by the government. This also highlights the importance of Melkøya for Hammerfest and Norway as a whole. Especially as funds amounting to NOK 13.2 billion are to be invested particularly in the future viability and maintenance of the plant. So there seems to be just as much desire on the Norwegian side to maintain the Melkøya plant as there is on the consumer side. The consumption of gas for various purposes has shown increasing developments in the past and processes such as the increase in air conditioning, transport and digitalization promise a high demand for (gas generated) energy in the future as well.

With the prospect of Melkøya becoming electrified in 2030, the CO₂ footprint will also be reduced, so that natural gas extraction could continue to be possible even under stricter climate protection guidelines. Nevertheless, the competition from renewable energy sources must be taken into account. Although they still play a comparatively minor role, they could become increasingly important in the future due to new innovations and the expansion of wind, water and solar power plants. Additionally, the efficiency of many automated processes is also increasing, meaning that many devices require comparatively less electricity to provide the same performance. Despite all this, certain examples such as air conditioners show that the increasing prosperity of society and the increasing naturalness of owning and using many devices is nevertheless leading to a significant increase in the number of these devices.

In summary, it can be said that the continued use, expansion and conversion of Melkøya is out of the question. This is because a shortage of customers is not very likely due to the strong demand for gas. The exact extent to which electrification will have a direct impact on Hammerfest and the local people requires a closer look at the electrification process itself and possible criticism, which is what we will do in the following.

Electrifying Melkøya

The climatic effects of Melkøya's electrification

Does this project really help to reduce the emissions? Or is it harming the environment?

In the context of Melkøya's electrification their wind power plants are being changed from gas-driven turbines to electric power by the year of 2030. At this point the island makes up 5% of Norway's gas exports and the assumption of the responsible organisation Equinor is that this electrification will reduce the emissions by around 850,000 tonnes CO₂ a year. This would mean a 90% cut of Norway's emissions, making it the biggest step to prevent environmental pollution that has been taken in Norway's history.¹⁸

Furthermore, this would create a new industry and multiple new jobs in that area. In contrast to this, the Ministry of Oil and Energy estimated the project to emit 152.1 million tonnes of CO₂ due to the burning of the projected gas production.

The Snøhvit field, from which Melkøya is a part of, has been in production since 2007 producing and shipping out LNG. During this time, they have had emissions in the height of 163 million tonnes of CO₂, comparable to a bit more than three times the greenhouse gas emission of 2022 in Norway.⁶

Carbon Capture and Storage (CCS):

CCS is a method to store CO₂ underground at the seabed or at land to prevent it from getting into the atmosphere. Scientists estimate it to keep save 85% from the CO₂ in the long run. The problem with this though is that it increases the consumption of fossil fuels about 40% and the health risks in case of a CO₂ leak are quite dangerous as it can intoxicate the groundwater and nature. A lot of this field is still unexplored which makes it even more difficult to predict the future consequences of CCS.¹⁹

Electrification:

The goal of electrification is to replace technologies that are using fossil fuels like coal, oil or natural gas by technologies using electricity to produce energy.²⁰

Would CCS have been a better alternative for Melkøya than electrification?

Although CCS can reduce a large amount of CO₂ it has been assessed, based on the experiences from Snøvit (another gas field close to Hammerfest) that an electrification would have an even better impact on the reduction of emissions with a lower accident risk. But most importantly it is way less expensive than CCS which would cost about NOK 37 billion which is nearly three times of what the government agreed to pay. These expenses come from the work involved in integrating this system because new devices, a new CO₂ pipeline and a new Reservoir for storage would have been necessary. On top of that, a CCS integration would have required the energy production to close for 170 days, delaying the gas exports drastically. In

¹⁸ <https://thebarentsobserver.com/en/industry-and-energy/2023/08/norway-outlines-powerful-electrification-its-north>

¹⁹ <https://www.umweltbundesamt.de/themen/wasser/gewaesser/grundwasser/nutzung-belastungen/carbon-capture-storage#grundlegende-informationen>

²⁰ <https://www.rff.org/publications/explainers/electrification->

101/#:~:text=Electrification%20refers%20to%20the%20process,as%20a%20source%20of%20energy

consideration of these aspects the partnership decided that an electrification is much more advantageous.²¹

“The solution the government has chosen will lead to huge environmental damage and major conflicts with reindeer herding that could have been avoided” says Lars Haltbrekken an environmentalist from the Socialist Left Party about the government’s decision to electrify Melkøya. He also doubts if it will even reduce emissions due to the delayed start in 2030 instead of 2028. From all the parties, the Conservatives were the only ones to endorse the electrification of Melkøya.²²

What actually are the criticised problems of this project?

On the one side there is the destruction of the nature surrounding the wind turbines and the power lines. This has already become visible if you look at the development of the island itself. Years ago, it was fully natural and now it is completely mechanised and industrialised. Then there are also the conflicts with the indigenous people called the Sami as the electrification disturbs their reindeers and they have complained that the government did not respect their geographical borders and were excluded from the decisions and information concerning the electrification, which is likely to cause great protests from the Sami.⁴

The Sami:

After mentioning the Sami multiple times above, we are now going to have a closer look at them and their dispute with the government.

The Sami are the descendants of the indigenous people of northern Scandinavia where they have lived for over thousands of years. They are located in Norway, Sweden, Russia and Finland. A major part of their culture was the reindeer herding and today about 2,600 Sami are still living from it.²³

Nowadays they are having many conflicts due to this with the government, because they have placed their wind power plants in their territories and have put them into production against their will. Recently they have again violated their rights by planning to build a 52 km long 420 kV power line to Hammerfest in order to electrify Melkøya. This power line would cross three of their most important reindeer pasture territories, which is likely to result in negative effects on the animals, which is why the Sami did not want to give them permission to built it.²⁴

Interview:

During our time in Hammerfest, some of our students conducted an Interview with a couple of local students and teachers. Concerning the electrification of Melkøya one 17-year-old student criticised the government’s decision to invest 37 billion Norwegian krone into the project. In her opinion they should have spent it on more permanent things instead, that will benefit Norway longer in the future.

Another student of the same age had a similar opinion, as she assumed, that Melkøya will have negative consequences for the climate in the long run and will end up in higher costs for the locals.

²¹ <https://www.equinor.com/magazine/future-of-melkoya-lng-plant>

²² <https://www.newsenglish.no/2023/08/09/sparks-fly-over-electrification-plans/>

²³ <https://www.twinkl.de/teaching-wiki/sami-people#>

²⁴ <https://priceofoil.org/content/uploads/2023/09/Norway-Melkoya-Briefing.pdf>

When asked if she supports the governmental decisions, a teacher at the same school answered that she thinks their attention should be directed more at general institutional things of a larger scale like energy and fossil fuels instead of individual projects.

Overall, the interviewees are all of the opinion, that the government focuses are not always quite on the most important and urgent topics.

Another matter which was discussed in the interview was how conscious of the climate crisis they and their social environment are and what their own contribution to helping the planet looks like.

Among the students there was the impression that a lot of people talk about the dramatic consequences of climate change, which already has become visible to them in form of delayed winters and snow every year, but no one actually takes action to prevent it.

Small actions that they told us they already do to help are to not buy fast fashion clothes, do recycling at home and take public transports to get to school.

Wind power – Energy source of the future?

In Germany the majority of energy is won from wind power plants, and it is planned to make it even more in the next years. The German Federal Government has published the goal to double the production of renewable energy until 2030 with wind power being a large contributor. Of the 0,8% approved land for onshore wind energy plants in Germany, only 0,5% can be used at this point although they are planning to expand the approved space up to 2% to realise their goal. Here it is important to take care not to harm the surrounding nature, the animals and the environment in general. If this all works out as they plan, 80% of Germanys energy will come from renewable sources in order to achieve greenhouse gas neutrality by 2045.²⁵



In comparison to Germany, which is winning more than 30% of their energy with wind and is working with nearly 30,000 onshore wind turbines,²⁶ the energy produced by wind power in Norway is much lower. It is amounting to 11% of their energy production but has nevertheless still increased massively over the last years and is in planning to expand even more in order to have more renewable energy. As

²⁵ <https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/onshore-wind-energy-act-2060954#:~:text=To%20achieve%20the%20targets%20in,for%20wind%20energy%20by%202027.>

²⁶ <https://www.wind-energie.de/english/statistics/statistics-germany/#:~:text=Numbers%20and%20facts&text=At%20the%20end%20of%202023,onshore%20wind%20turbines%20in%20Germany.&text=745%20new%20onshore%20wind%20turbines,wind%20energy%20is%2061%2C010%20MW.>

of 2023 there are 65 wind farms in Norway operating with 1,392 active wind turbines.²⁷

Even though wind energy has a lot of benefits it has some negative sides as well.

Firstly, it is often difficult to find the right spots for the turbines which have to be rather far away from the cities making it harder to take care of them easily.

A lot of people also mind the noise and the looks of the wind plants and even though the negative impact on the wildlife in these areas are smaller than with many other energy resources it still has to be minimised to protect the ecosystem.²⁸

Lastly, with wind power there is always the uncertainty of energy income due to the unpredictably changing weather conditions, moreover it is quite difficult to store the won energy for the future.

Hydropower

88% of Norway's energy production come from Hydropower and due to its flexible production speed, which can be changed depending on the current energy need and its large storage capacity, which makes up to half of Europe's capacity, Hydropower has become very important to the country.

Although Norway has around 1769 hydropower plants the energy income always depends on the season and the year, so they have built many storage reservoirs helping them to produce energy for the population in times when the hydropower plants are not able to produce power naturally, even for longer periods of time.²⁹

In Germany the Energy coming from hydropower is much less than in Norway, as it is making up only around 3% of Germany's energy production (2021). The government's plan though is to make hydropower in Germany grow until the year of 2035.³⁰

The problems with Hydropower are besides the high costs of installing the plants that it often times disturbs the natural flows of the water in the rivers or can harm the surrounding wildlife.³¹



²⁷https://en.wikipedia.org/wiki/Renewable_energy_in_Norway#:~:text=The%20Norwegian%20Water%20Resources%20and,%25%20of%20Norway's%20electricity%20generation).

²⁸ <https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy>

²⁹ <https://energifaktanorge.no/en/norsk-energiforsyning/kraftproduksjon/>

³⁰ <https://www.power-technology.com/data-insights/hydropower-in-germany/#?cf-view>

³¹ <https://www.energysage.com/about-clean-energy/hydropower/pros-cons-hydropower/#disadvantages-of-hydropower>

