



5G COUNTRY PROFILE



NORWAY

© ITU October 2020

Version 1.1

Acknowledgements: This country profile was developed by the ITU Office for Europe within the framework of the ITU Regional Initiative for Europe on broadband infrastructure, broadcasting and spectrum management. It was elaborated by ITU Office for Europe team including Mr. Iago Bojczuk, Junior Policy Analyst, and Mr. Julian McNeill, Consultant, under the supervision and direction of Mr. Jaroslaw Ponder, Head of ITU Office for Europe. The country profile was prepared as the background contribution to the ITU Regional Forum for Europe on 5G strategies, policies and implementation. All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Note: Version 1.1 of this document is an advanced draft for possible additional inputs, comments, feedback. The final version of the document is planned to be released after the ITU Regional Forum for Europe.

1. ICT background and current status of broadband

Norway possess one of the most advanced telecommunication markets in Europe. The country has penetration rates for fixed and mobile services well above the regional average, in addition to having a mature digital media sector. As a member of the European Economic Area (EEA), Norway has adhered to EU electronic communication directives, which has paved the way for further economic expansion of ICT in the country by private stakeholders. Since the eNorway action plan in 2000, ICT has been an integral part of Government policies in the transition toward an information society, setting the basis for subsequent ICT-related government programs.¹ In the 2017 ITU ICT Index, Norway ranks 8th out of 176 countries.²

In 2016, the Norwegian Ministry of Local Government and Modernisation published the “Digital Agenda for Norway”³ in the format of a white paper, although initiatives on broadband have occurred in Norway since 2005.⁴ In the 2016 “Digital Agenda,” the government announced its intention to enable Norway to exploit the opportunities of ICTs.⁵ Additionally, the white paper is driven by two key objectives: to ensure a user-centric and efficient public administration, and to achieve value creation and inclusion. The five key priorities articulated in the agenda include the following: I) A user-centric focus; II) ICT should constitute a significant input factor for innovation and productivity; III) Strengthened digital competence and inclusion; IV) effective digitisation of the public sector; and V) A sound data protection and information security.⁶

In other words, “Digital Agenda for Norway” describes how better access to digital literacy in the public and private sectors, regulation better adapted to a digital society, and a public sector as a demanding customer will serve as policy instruments to achieve Norway’s goals for the information society.

Particularly regarding mobile and broadband for growth and inclusion, the Norwegian Government has set the following goals for future electronic communication policy:⁷

- 90 per cent of all households shall have access to at least 100 Mbit/s by 2020, based on a commercial rollout in the market;
- The long-term goal is that all households shall have access to high-speed broadband;
- Mobile coverage where people live, work and travel;
- Good electronic communication networks shall be a competitive advantage for business and industry nationwide;
- The electronic communication authority shall map demand for and access to infrastructure that can be used by data centres;
- It shall be easy to deploy broadband networks;

¹ See: <https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2018/MISR-2018-Vol-2-E.pdf>

² See: <https://www.itu.int/net4/ITU-D/idi/2017/index.html>

³ See: https://www.regjeringen.no/contentassets/07b212c03fee4d0a94234b101c5b8ef0/en-gb/pdfs/digital_agenda_for_norway_in_brief.pdf

⁴ See: https://en.wikipedia.org/wiki/National_broadband_plan

⁵ See: <https://www.regjeringen.no/en/aktuelt/digital-agenda-for-norway-digitisation-vital-for-welfare-and-jobs/id2484184/>

⁶ See: https://www.regjeringen.no/contentassets/07b212c03fee4d0a94234b101c5b8ef0/en-gb/pdfs/digital_agenda_for_norway_in_brief.pdf

⁷ See: <https://www.regjeringen.no/en/dokumenter/digital-agenda-for-norway-in-brief/id2499897/sec8>

- The regulations for laying broadband cables along municipal and county roads shall be as uniform as possible; and
- Electronic communication service providers shall have fast access to available frequency resources to meet their needs.

Norway's ICT policy also reinforces the importance of a robust broadband infrastructure and widespread digital literacy among the population. The three main priority areas of that policy are to:⁸

- Ensure an information society for all, including by facilitating the supply and distribution of high-speed broadband, increasing digital literacy in the population, and ensuring a universal design of ICTs.
- Contribute to innovation and value creation in business, by facilitating the development and use of services based on digital content, promoting a digital culture industry, make public data available for further use, and promoting smart, energy-efficient ICT solutions in transport, energy and construction. The digitisation of business processes and the development of innovative solutions for the healthcare sector add also significant value.
- Digitise public services, by coordinating ICT projects that have an impact across the public sector, promoting the development of self-service solutions, adapting regulations to promote digital solutions, and ensuring that common ICT solutions are established and made available to the rest of management.

While Norway has strong and affordable 4G coverage and its 3G networks are set to be phased out by 2025, significant investments and developments have occurred in the fibre sector as there are more emerging key players in the country. As of October 2020, at least nine new subsea fibre projects are under progress and are expected to be finalized by 2022,⁹ reaching more than 13,000 km of extension.¹⁰ This fits into the more than 316.7 million EUR expected to be invested in new submarine cable systems in the Nordic region by 2023. As a result, this will likely provide the country with a wider set of economic possibilities for different routes going in and out of the country,¹¹ and thus reduce Norway's reliance on existing networks coming out of other Nordic countries.¹²

In face of the COVID-19 pandemic, many Norwegian municipalities have successfully adapted to digital teaching, but as it is in the case of other countries in the region, not all municipalities have had equal access to infrastructure, equipment and resource. To mitigate the upcoming phases of the pandemic, the Norwegian government submitted its proposal for a revised national budget for 2020 on 12 May. This includes a proposal to increase the budget for digital teaching by 12.95 million EUR.¹³

⁸ See: https://joinup.ec.europa.eu/sites/default/files/inline-files/Digital_Government_Factsheets_Norway_2019.pdf

⁹ Projects in development include: England Cable NO-UK.com; Skagen Fiber East and West; North Sea Connect; Celtic Norse; N0r5ke Viking; Havor; and others.

¹⁰ See: <https://greenmountain.no/2020/05/06/fiber-projects-in-norway/>

¹¹ See: <https://greenmountain.no/2020/05/06/fiber-projects-in-norway/>

¹² See: <https://www.computerweekly.com/news/252474496/State-backs-Norways-fiber-cable-capacity-building>

¹³ See: <https://www.regjeringen.no/en/statsbudsjett/2020/rnb2020/id2715690/>

2. Broadband and mobile telecommunication sectors data

ITU data shows that 98% of individuals had access to the Internet in 2019,¹⁴ with practically all citizens connected to broadband.¹⁵ In 2010, the ITU data for the country was 93.39% and in 2000 52%.¹⁶ In 2018, the number of fixed-broadband subscriptions per 100 inhabitants was 41.34.¹⁷ In 2015, the country's Internet services relied on nation-wide DSL coverage and more than 100 local fibre providers. However, since 2016, digital subscriber line (DSL) technology has been steadily decreasing while fibre coverage is growing. The operator indicated that it aims to convert all customers on its copper network to fibre by 2023.¹⁸ Due to the demand and the Norwegian Communications Authority (Nkom)'s goal to expand broadband infrastructure in Norway, fibre has become a common technology for Internet access and is available in almost every city in Norway,¹⁹ offering a variety of services including the access to the delivery of pay-TV.²⁰

In 2018, Norwegian residential fibre connections exceeded 1 million for the first time.²¹ In October 2020, Nkom published its annual broadband survey, reporting that 74% of households had access to fibre broadband as of June 2020. Nkom highlighted the development of fibre-based technology in less populated areas in Norway, particularly noting that 55% of residential households in rural regions now have access to fibre-enabled broadband, up from 45% reported at mid-2019. Largely due to the revamped fibre-network coverage, the regulator also reported that 98% of Norway's households had access to at least 30 Mbps, and that the number of above 100Mbps connectivity is steadily growing.²² Moreover, the regulator recently selected Telia Carrier to build a secure diverse fibre route facilitating an increased geographic distribution of traffic between Norway and continental Europe and is set to be ready for service by the end of 2021.²³ From the regional perspective, Europe's average fixed-broadband basket cost was 1.5 per cent of the GNI per capita in 2019, while Norway's corresponded to 0.7 per cent for an unlimited data cap in 2019, ranking among the top ten countries in Europe.²⁴

According to ITU data, in 2018, the number of active mobile-cellular subscriptions per 100 inhabitants was of 107.17,²⁵ while mobile-broadband subscriptions per 100 inhabitants for the same year corresponded to 99.18.²⁶ There are three major mobile network operators (MNOs) that dominate the market in Norway: Telenor, Telia (formerly NetCom before being rebranded in 2016), and ice Norway. Over the past years, significant investment has been made in extending 4G infrastructure by private stakeholders.²⁷ In terms

¹⁴ See: ITU World Telecommunication/ICT Indicators Database online (2020): <http://handle.itu.int/11.1002/pub/81550f97-en> (indicator "i99H")

¹⁵ See: <https://www.ssb.no/en/statbank/table/11000/tableViewLayout1/>

¹⁶ See: https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Individuals_Internet_2000-2018_Dec2019.xls

¹⁷ See: https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Fixed_broadband_2000-2018_Dec2019.xls

¹⁸ See: <https://www.thefastmode.com/technology-solutions/14123-telenor-norway-aims-to-convert-all-copper-customers-to-fiber-by-2023>

¹⁹ See: <https://www.tutela.com/hubfs/Assets/Nordics%20State%20of%20Mobile%20Networks%20Report%20-%20January%202019.pdf>https://en.wikipedia.org/wiki/Internet_in_Norway#:~:text=Fiber%20is%20also%20almost%20in,place%20with%20super%20for%20it

²⁰ See: <https://www.broadbandtvnews.com/2019/05/14/fibre-takes-command-in-norway/>

²¹ See: <https://www.telecompaper.com/news/norwegian-residential-fibre-connections-exceed-1-mln-for-first-time-in-2018--1292512>

²² See: <https://www.commsupdate.com/articles/2020/10/07/nkom-says-74-of-households-now-have-access-to-fibre-as-it-publishes-annual-broadband-survey/>

²³ See: <https://www.capacitymedia.com/articles/3825948/telia-picks-bulk-for-new-fibre-route-from-norway>

²⁴ See: https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2019/ITU_ICTpriceTrends_2019.pdf

²⁵ See: https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Mobile_cellular_2000-2018_Dec2019.xls

²⁶ See: ITU World Telecommunication/ICT Indicators Database online: <http://handle.itu.int/11.1002/pub/81550f97-en> (indicator "i911mw")

²⁷ See: <https://www.lifeinnorway.net/the-worlds-fastest-mobile-internet/>

of 4G coverage, Telenor and Telia provide outstanding network coverage throughout the country, which makes Norway one of the countries with highest percentage of 3G and LTE/4G coverage, with both networks covering 99.90% of the population.²⁸ In 2018, the mobile-broadband Internet traffic within Norway corresponded to 0.298 exabytes.²⁹

Furthermore, Norwegian operators have been particularly efficient about encouraging adoption of VoLTE, enabling subsequent re-farming of the 3G spectrum to 4G. For example, Telenor announced that it has plans to entirely shut down the 3G network by the end of 2020³⁰ to provide better service on its 4G network.³¹ The country's mobile-data basket cost corresponded to 0.4 per cent of the GNI per capita in 2019 for a monthly allowance of 5.0 Gb, while the European region's average was 0.8 per cent during the same year.³²

3. Current progress on 5G: consultations and national strategies

Nkom began plans to clear the 700 MHz 5G frequencies in 2017 making Norway one of the first countries headed towards 5G development.³³ As listed in the state budget, this move had an approximate cost of approximately 13.9 million EUR to Norway,³⁴ which paved the way for the first 5G commercial activities in the country in March 2017.³⁵

Around the same time, the early stages of the Nordic 5G Action plan also occurred upon the Nordic-Baltic states discussing how their governments could better support and facilitate rapid development of 5G in the region. In such an early agreement, Norway and co-signers decided to:³⁶

- Make more spectrum available in a speedy manner, necessary for testing, research and the commercial roll-out of 5G networks;
- Cooperate with industry in pilots on 5G services through public-private partnerships, e.g. through Universities or public enterprises;
- Support innovation and development of products and services making use of 5G networks;
- Encourage participation from Universities and public research programs in the development of new use of 5G services; and
- Promote early deployment in major urban areas and along major transport paths.

²⁸ See: <https://www.tutela.com/hubfs/Assets/Nordics%20State%20of%20Mobile%20Networks%20Report%20-%20January%202019.pdf>

²⁹ See: ITU World Telecommunication/ICT Indicators Database online (2020): <http://handle.itu.int/11.1002/pub/81550f97-en> (indicator "i136mwi")

³⁰ See: <https://tefficient.com/who-has-the-best-network-in-the-nordics-winter-2018-update/>

³¹ See: <https://www.thefastmode.com/investments-and-expansions/13923-telenor-norway-to-start-shuting-down-3g-network-in-2019-to-maintain-2g-for-now#:~:text=Telenor%20Norway%20announced%20that%20it,will%20be%20completed%20in%202020.&text=Following%20the%20closure%20of%20the,connect%20to%20the%202G%20network.>

³² See: https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2019/ITU ICTpriceTrends_2019.pdf

³³ See: <https://www.commsupdate.com/articles/2019/11/04/norwegian-regulator-clears-use-of-700mhz-5g-frequencies-from-1-november/>

³⁴ See: <https://e24.no/teknologi/i/e8G129/regjeringen-vil-bruke-150-mill-for-aa-sikre-nye-mobilfrekvenser-og-tidligere-5g-start>

³⁵ See: <https://www.telenor.com/the-first-steps-towards-5g-in-norway/>

³⁶ See: <https://www.regjeringen.no/en/aktuelt/nordisk-baltisk-samarbeid-for-neste-generasjon-mobilnett-5g/id2540561/>

Although the country does not have a national strategy particularly targeting 5G, Norway articulates some of its objectives on 5G network development through the “National Strategy for Artificial Intelligence,” which was prepared by the Ministry of Local Government and Modernisation in February 2019 for both the private and public sector.³⁷

In the AI strategy, 5G is regarded as a vital enabling infrastructural technology for AI and a priority investment area by the Norwegian government.³⁸ The development of the Internet of Things (IoT) as well as 5G-enabled products in the Norwegian mobile market are considered as essential elements for the development of AI. In other words, the strategy highlights that 5G infrastructure is set to play a crucial role in implementing a full-scale realisation of IoT and other AI-enabled services across a variety of sectors such as transport, healthcare, and smart cities. While the 5G deployment is largely in the hands of private sector operators such as Telia—which plans to develop 5G network by the end of 2023³⁹—the Norwegian government indicates that it plans to facilitate the rapid rollout of 5G in the country.

Additionally, the Nordic Council cooperation in the field of 5G—comprised by Denmark, Finland, Iceland, Norway and Sweden as well as the Faroe Islands, Greenland and Aland⁴⁰—is another component of Norway’s 5G strategy. In 2018, the Nordic ministers signed a Letter of Intent (LoI) for the Nordic region to be first and most integrated 5G-region in the world.⁴¹ The LoI acknowledges the deployment of 5G will require substantial investments and an appropriate regulatory framework both in national contexts toward a common Nordic 5G space.⁴² This agreement is also aligned with other Nordic cooperation dealing with the adoption of IoT and other emerging technologies such as the Nordic Smart City Network,⁴³ which helps governments create best practices for smart city projects and urban development.⁴⁴

To achieve this goal, Norway agreed to cooperate closely with other Nordic countries to set up a common action plan for early adoption of 5G technology across the Nordic region. The action plan will:⁴⁵

- Encourage the development of new testing facilities, including testbeds;
- Ensure the technical coordination of 5G frequency bands within the region;
- Remove obstacles to the expansion of 5G network, in particular, the deployment of base stations and antennas; and
- Encourage and monitor the development of 5G, specifically for certain sectors such as transport, mission-critical communications, and advanced automation in the manufacturing industry, and the energy sector.

³⁷ See: https://www.regjeringen.no/contentassets/1febbb2c4fd4b7d92c67ddd353b6ae8/en-gb/pdfs/ki-strategi_en.pdf

³⁸ See: https://www.regjeringen.no/contentassets/1febbb2c4fd4b7d92c67ddd353b6ae8/en-gb/pdfs/ki-strategi_en.pdf

³⁹ See: <https://presse.telia.no/pressreleases/telia-norge-skjal-bygge-ut-et-nasjonalt-5g-nett-i-loepet-av-2023-2928999>

⁴⁰ See: <https://um.dk/en/foreign-policy/nordic-baltic-cooperation/#:~:text=The%20Nordic%20Council%20of%20Minister's,Nordic%20activities%20lead%20to%20synergies.>

⁴¹ See: <https://www.norden.org/en/declaration/letter-intent-development-5g-nordic-region>

⁴² See: <https://www.government.se/press-releases/2018/05/new-nordic-cooperation-on-5g/>

⁴³ See: <https://nscn.eu/>

⁴⁴ See: <https://aithority.com/news/nordic-enterprises-see-5g-networking-as-boost-for-internet-of-things/>

⁴⁵ See: <https://www.government.se/49b8be/globalassets/government/dokument/statsradsberedningen/letter-of-intent--development-of-5g-in-the-nordic-region-.pdf>

Norway is also instrumental in the EU project 5G VINNI, where Telenor, Ericsson Norway and Huawei Norway and others are pushing 5G technology development.⁴⁶

4. Spectrum assignment for 5G & market development

In April 2019, Nkom indicated the following frequency bands as relevant for allocation to mobile communications and 5G in the coming years: 738-758 MHz (700 MHz SDL); 1427-1518 MHz (1500 MHz SDL); 2300-2400 MHz (2.3 GHz); 2500-2690 MHz (2.6 GHz); 3400-3800 MHz (3.6 GHz); and 24250-27500 MHz (26 GHz).⁴⁷

Between June and August 2019, Nkom completed a consultation⁴⁸ on frequency resources for mobile communications and 5G. The first 5G auction in Norway took place on June 2019, with the allocation of 700 MHz Band. Telia, Telenor and Ice won spectrum in this auction. Then in May 2020, the 28 GHz (n257) and the 38 GHz (n260) were auctioned to these operators. Auction for the 2.6 – 3.6 GHz band is set to occur sometime in 2021.⁵⁰

The process ended with the following assignments:⁵¹

- Telenor was assigned 2×10 MHz of spectrum in the 700 MHz band subject to the coverage obligation on main highways, for a total auction price of 16.6 million EUR;
- Telia was assigned 2×10 MHz of spectrum in the 700 MHz band subject to the coverage obligation on designated railway sections, for a total auction price of 20.2 million EUR; and
- ice was assigned 2×10 MHz of spectrum in the 700 MHz band and 2×15 MHz in the 2.1 GHz band, for a total auction price of 31.2 million EUR.

In September 2019, Nkom has established a frequency compass, which is a roadmap for frequency bands for mobile communications and 5G. The regulator states that its plans for allocations and harmonization with international guidelines. Norway is part of the frequency harmonization within the EU, through the EEA agreement, for which the country engages as an observer in certain cooperation groups such as the Radio Spectrum Committee and Radio Spectrum Policy Group.

Nkom has suggested there are grounds for allocating 300MHz in the 3.6GHz band under national permits, with 100MHz to be issued under regional/local licences, although an alternative distribution method being examined is that all 3.6GHz spectrum would be offered on a nationwide basis, with 2.3GHz frequencies to

⁴⁶ See: <https://www.5g-vinni.eu/>

⁴⁷ See: <https://www.nkom.no/frekvenser-og-elektronisk-utstyr/frekvenser-til-mobilkommunikasjon-og-5g/tildeling-av-frekvenser-til-mobilkommunikasjon-og-5g>

⁴⁸ See: https://www.nkom.no/frekvenser-og-elektronisk-utstyr/frekvenser-til-mobilkommunikasjon-og-5g/tildeling-av-frekvenser-til-mobilkommunikasjon-og-5g/_/attachment/download/ed650cc2-d19e-4083-ba99-9fc968c4b4d2:1ade81420762f505c2728c61ced8c00f0d58bbf6/H%C3%B8ring%20om%20frekvenser%20til%20mobilkommunikasjon%20og%205G.pdf

⁴⁹ See: <https://www.nkom.no/hoeringer/h%C3%B8ring-av-overordnede-rammer-for-5g-tildelingen>

⁵⁰ See: <https://www.everythingrf.com/community/5g-frequency-spectrum-in-norway>

⁵¹ See: <https://www.dotecon.com/news/first-5g-auction-in-norway-completed/>

be issued on a regional/local basis.⁵² Based on this consultation inputs, the regulator started assessing the consultation and inputs and continue the preparations further ahead allocation.⁵³

With negotiations on standardization and technical prerequisites beginning 2020, observations on these frequency ranges have been conducted by the Nkom:⁵⁴

- 700 MHz: Available to mobile operators today and is considered. Frequencies with long-range, but lower data capacity. 700 MHz SDL is the former broadcast band that is now harmonized for mobile communications;
- 3.6 - 3.8 GHz: Most important pioneer band for 5G in Europe. In Norway, these frequencies will be auctioned off in 2021, but the mobile operators have test permits today, and test areas are being built where these will be used. The frequencies have a shorter range and high data capacity and are currently used for fixed-mobile broadband and 5G testing;
- 26 GHz: Used today for radio link and testing of 5G. The use will probably be to create smaller, delimited areas with good coverage in Norway. Short-range and very high data capacity.

Existing licenses in the 2.3 GHz, 2.6 GHz and 3.6 GHz bands expire on 31 December 2022. In the 700 MHz SDL, 1500 MHz SDL and 26 GHz bands, the current licenses and use are extended to a possible allocation has been decided.⁵⁵

Finally, the regulator is deliberating setting a spectrum cap for frequencies across all three bands, with consideration also being given to whether a 100MHz cap should apply in the 3.6GHz band specifically. In addition to this, the regulator also plans to set a starting price of approximately 2.2 million EUR per block and a frequency limit of 80MHz.⁵⁶

5. Electromagnetic fields levels and the implementation dynamics

Norway follows the EMF recommendation limits proposed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).⁵⁷ Since 2013, Nkom has performed outdoor measurements of EMF in Norway and today continues to monitor EMF-related subjects concerning the recent advances in telecommunications. In 2016, the government implemented the Norwegian Occupational Safety Regulation, which was enacted within the framework of the Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from EMF.⁵⁸

⁵² See: <https://www.commsupdate.com/articles/2019/06/19/nkom-consulting-on-plans-for-allocating-5g-suitable-spectrum/>

⁵³ See: <https://www.commsupdate.com/articles/2019/06/19/nkom-consulting-on-plans-for-allocating-5g-suitable-spectrum/>

⁵⁴ See: https://www.nkom.no/frekvenser-og-elektronisk-utstyr/frekvensstrategi-og-internasjonalt-arbeid/_/attachment/download/98446eaf-066d-46ed-a2b3-9e54ef30129d:780514ed387274913ced311f5a8fe2efd4e6137c/Frekvenskompass%20for%20mobilkommunikasjon%20-%20Utga%20september%202019.pdf

⁵⁵ See: <https://www.nkom.no/frekvenser-og-elektronisk-utstyr/frekvenser-til-mobilkommunikasjon-og-5g/tildeling-av-frekvenser-til-mobilkommunikasjon-og-5g>

⁵⁶ See: <https://www.telecomreview.com/index.php/articles/wholesale-and-capacity/3976-norway-prepares-for-2021-spectrum-allocation-auction>

⁵⁷ See: <https://www.nkom.no/fysiske-nett-og-infrastruktur/elektromagnetisk-straling>

⁵⁸ See: <https://www.who.int/peh-emf/project/mapnatreps/norway-2017.pdf?ua=1>

Nkom regularly monitors the EMF exposure in Norway and maps out the exposure from various transmitters to guarantee that they are not exceeding the limit values.⁵⁹ To facilitate the access to EMF information in the country, a radiation calculator is also available on the operator's website, which citizens can calculate the exposure level at a given geographic point within the country's territory.⁶⁰ More recently, Nkom also published a brochure from antenna systems for staff working on the installation of communication equipment who may be exposed to radiation.⁶¹

As of October 2020, Nkom and the Directorate for Radiation Protection and Nuclear Safety (Direktoratet for strålevern og atomsikkerhet – DSA)⁶² have produced several information brochures on radiation,⁶³ with the latest coming out in May 2020.⁶⁴ Moreover, Nkom dedicated an entire page on its website detailing information on EMF regulations within the 9 kHz–400 GHz frequency range to educate the general public on ongoing debates and the regulator's decisions to be abided by private operators.⁶⁵

Concerning the potential health hazards concerning the use of the highest 5G frequency (26 GHz), the DSA states that on its website that similar frequencies have for decades been used for radars and radio links as well as in countries such as the United States.⁶⁶

Nkom has also conducted surveys in private homes and several schools, kindergartens and other public buildings in the largest cities (Oslo, Kristiansand, Bergen and Trondheim) to gather more information on EMF in the country.⁶⁷ Other engagements on EMF-related issues have been headed by the Norwegian Institute of Public Health, commissioned by Ministry of Healthy as well as the Care Services and the Ministry of Transport and Communication, to educate the Norwegian public on the effects of wireless networks on health.⁶⁸

6. 5G Commercial launches: announcements, trail cities, and digital cross-border corridors

In May 2017, Telenor Group and Huawei jointly announced the first 5G-based E-band multi-user Multiple Input Multiple Output (MIMO) demonstration in Norway, reaching a maximum speed of 70Gbps.⁶⁹ In November 2018, Telenor founded the first Norwegian 5G testbed in Kongsberg,⁷⁰ which later received industrial support and now has grown to become a viable 5G innovation hub.⁷¹ Telenor has also been

⁵⁹ See: <https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2012/low-level-radiofrequency-electromagnetic-fields--an-assessment-of-health-risks-and-evaluation-of-regulatory-practice.-niph-report-20123.pdf>

⁶⁰ See: <https://finnsenderen.no/#/straaling>

⁶¹ See:

https://issuu.com/nasjonalkommunikasjonsmyndighet/docs/folder_for_installers_about_electromagnetic_radiat?fr=sY2U0NDE1Mjg1NjA

⁶² See: <https://dsa.no/mobil-og-tradlost/5g-og-radiosignaler>

⁶³ See: https://www.nkom.no/fysiske-nett-og-infrastruktur/elektromagnetisk-straling/_/attachment/download/a6098108-11ed-4cae-a309-28821f0de5e1:1903da3f9b389f5967066209f936c4db91e378d6/Brosjyre%20om%20str%C3%A5ling,%20mai%202020.pdf

⁶⁴ See: https://www.nkom.no/fysiske-nett-og-infrastruktur/elektromagnetisk-straling/_/attachment/download/a6098108-11ed-4cae-a309-28821f0de5e1:1903da3f9b389f5967066209f936c4db91e378d6/Brosjyre%20om%20str%C3%A5ling,%20mai%202020.pdf

⁶⁵ See: <https://www.nkom.no/fysiske-nett-og-infrastruktur/elektromagnetisk-straling>

⁶⁶ See: <https://dsa.no/mobil-og-tradlost/5g-og-radiosignaler>

⁶⁷ See: <https://www.nkom.no/fysiske-nett-og-infrastruktur/elektromagnetisk-straling>

⁶⁸ See: <http://www.emfexplained.info/?ID=25794>

⁶⁹ See: <https://www.huawei.com/en/news/2017/3/Huawei-Telenor-First-5G-Demo-Norway>

⁷⁰ See: <https://www.computerweekly.com/news/252480126/Telenor-opens-Norways-first-5G-service>

⁷¹ See: <https://norden.diva-portal.org/smash/get/diva2:1370095/FULLTEXT01.pdf>

coordinating the 2018 pan-European 5G-VINNI project, an EU-funded initiative within the Horizon 2020 which has a budget of 20 million EUR.⁷²

In February 2019, local press reported that the 5G tests using the non-standalone 5G variant began at the movie theatre Odeon Oslo, which is located within the Telia Norway's coverage area of the pilot networks. This cinema is the newest and biggest in the city of Oslo, with 14 halls all equipped with the newest sound and image technology. The location is testing 5G for delivery of digital movie files, as well as providing internet access to their guest Wi-Fi zones in the building. This makes Odeon Oslo the world's first 5G-based movie theatre.⁷³

In February 2019, ice Norway announced that it was building a 5G-ready network in urban areas across Norway based on Nokia AirScale Radio Access technology, with approximately 1000 5G-ready base stations already deployed. The deployment is part of a multi-year agreement between ice Norway and Nokia which includes network planning, site acquisition, civil works, deployment and care.⁷⁴

In March 2019, Telenor announced its plans of investing on Trondheim as the first major city in the country to receive 5G, which represents the operator's biggest 5G project. The existing partnerships between the municipality, the Norwegian University of Science and Technology and the business community on smart city, 5G presented as a promising network for the residents and a strategic investment focus for the operator.⁷⁵

In September 2019, Telenor launched Scandinavia's largest and 5G pilot in the municipality of Elverum in addition to other pilots in nine further locations in Norway.⁷⁶ Through this project Telenor became the first operator in Norway to integrate 5G into its mobile network, enabling more than 50 pilot customers in the municipality to be connected to the 5G network. Telenor also announced that Ericsson would be contributing to both 5G network equipment⁷⁷ and deployment.⁷⁸

In October 2019, Telenor Group and Cisco signed an agreement whereby Cisco declared it would upgrade Telenor Norway's existing mobile core network to deliver 5G in Norway. Since 2010, Cisco has provided core technology to Telenor Norway's 3G and 4G networks. In 2018, the companies upgraded Telenor Norway's core network to provide Scandinavia's first nationwide network for the Internet of Things (IoT).⁷⁹

Following the same strategy for the 4G deployment in the past, in October 2019 Telenor launched 5G pilots in Longyearbyen, the economic and administrative capital of the Archipelago of Svalbard, becoming

⁷² See: <https://www.telenor.com/how-about-a-slice-of-5g-to-boost-your-business/>

⁷³ See: <https://www.zdnet.com/article/norway-weve-just-opened-worlds-first-5g-movie-theater/>

⁷⁴ See: <https://www.ice.no/om-ice/pressemeldinger/ice-norway-ready-for-5g-with-nokia/>

⁷⁵ See: <https://www.telenor.asia/media/announcement/trondheim-to-become-norways-biggest-5g-city>

⁷⁶ See: <https://www.forbes.com/sites/forbes-personal-shopper/2020/10/05/marvel-pair-eyewear-superhero-themed-kids-glasses/#7ecbb2ec3c9b>

⁷⁷ See: <https://www.mynewsdesk.com/no/telenor/pressreleases/telenor-aapner-5g-nett-paa-fornebu-2919820>

⁷⁸ See: <https://www.telenor.com/media/press-release/telenor-launches-scandinavias-largest-5g-pilot-in-norway>

⁷⁹ See: <https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=2028213>

the world's northernmost 5G pilot. The operator chose the region because Svalbard is a testbed for new technologies. It also illustrates the potentialities and challenges presented by 5G-enabled smart city projects as an example for mainland Norway. The operator also reported on the development of 5G-powered drones on the Svalbard region for monitoring global warming effects⁸⁰ as well as the use of emergency networks and 360-degree cameras.⁸¹

In December 2019, after more than a decade of collaboration on 4G, Telenor ceased its collaboration with Huawei and chose Ericsson as the key technology provider for 5G. In the context of the new firm partnership, the operator announced that it carried out extensive security evaluation and consisted of factors such as technical quality, innovation, and modernization of the network. According to Telenor, the use of Huawei network components in Norway will be phased out over a 4-5-year modernization period.⁸² Despite that, the press also reported that Huawei would still maintain collaboration with Telenor both to maintain the 4G network and also upgrade to 5G coverage in selected areas of Norway.⁸³ The Norwegian Government has not yet decided whether the security legislation disqualifies Huawei from being a provider to the country's 5G-network.⁸⁴

Furthermore, in December 2019, the press reported that Ericsson, Telia and Norwegian University of Science and Technology (NTNU) partnered in the 5G testing of an autonomous ferry, named milliAmpère. Ericsson 5G technology enabled Telia to securely support the large amount of data needed to support the driverless transport ferry. milliAmpère was equipped with sensors that recorded its surroundings and controlled the steering system onboard via 5G.⁸⁵

In January 2020, Nokia Nuage Networks and Telia launched SD-WAN, the next-generation datacom services for the enterprise market. With SD-WAN, the control and operation of the network are simplified as it is separated from underlying infrastructure and hardware and depends solely on the cloud. The companies announced that the new datacom services will utilize their 5G network.⁸⁶

In March 2020, Telenor launched its commercial 5G network in nine different cities and villages across Norway, making it the first mobile operator in the country to offer 5G connection. According to the operator, it was intended that the official opening of Norway's first commercial 5G network would take place in the country's tech capital of Trondheim. However, due to the current situation with COVID-19, Telenor has decided to cancel the event and instead host the opening as a virtual video conference.⁸⁷ The

⁸⁰ See: <http://norden.diva-portal.org/smash/get/diva2:1370095/FULLTEXT01.pdf>

⁸¹ See: [https://www.telenor.com/media/announcement/telenor-to-pilot-5g-on-top-of-the-world#:~:text=\(Longyearbyen%2C%2014%20October%202019\),will%20launch%20on%2020%20October.](https://www.telenor.com/media/announcement/telenor-to-pilot-5g-on-top-of-the-world#:~:text=(Longyearbyen%2C%2014%20October%202019),will%20launch%20on%2020%20October.)

⁸² See: <https://www.reuters.com/article/us-telenor-ericsson-huawei-tech-idUSKBN1YH0RM>

⁸³ See: <https://www.reuters.com/article/us-telenor-ericsson-huawei-tech/telenor-says-huawei-will-still-play-role-in-5g-rollout-idUSKBN1YJ0BW>

⁸⁴ See: https://teknologiradet.no/wp-content/uploads/sites/105/2019/05/5G_english.pdf

⁸⁵ See: <https://www.smart-industry.net/driverless-transport-5g-takes-to-the-waves-with-automated-ferry-in-norway/>

⁸⁶ See: <https://www.nokia.com/telia-norway-launches-sd-wan-simplified-and-centralized-network-control-in-the-cloud/>

⁸⁷ See: <https://www.telenor.com/media/press-release/telenor-opens-first-commercial-5g-network-in-norway#:~:text=Telenor's%205G%20network%20was%20commercially,%20Bergen%20Stavanger%20and%20Sandnes>

enhanced mobile broadband services are being delivered on the 3.6 GHz band.⁸⁸ Telenor plans to launch 5G services in the capital town Oslo and Bergen, Stavanger, and Sandnes by the end of 2020.⁸⁹

In May 2020, Telia Norway launched its commercial 5G network while relying on Ericsson's NR radio access network (RAN).⁹⁰ Both companies started working on 5G-related development in 2019. The network launch celebrated the coverage of Lillestrøm and parts of Groruddalen in the greater Oslo region as the first areas to benefit from enhanced mobile broadband services.⁹¹ Per the agreement, the collaboration also involves the deployment of Ericsson's Spectrum Sharing (ESS) software,⁹² which enables Telia Norway to share its spectrum between 4G and 5G network.⁹³ The operator announced that it aims to provide coverage to at least half of the Norwegian population by 2021 and offer a nationwide 5G coverage in 2023.⁹⁴

In September 2020, ice Norway launched a main 5G pilot encompassing 7 main sites in the northern region of Tromsø. The operator received a 3.7-3.8 GHz band test license from the regulator, and it already has a large amount of 5G-ready Nokia base stations. In addition to lab tests reaching up to 1 Gbps. Press reports have indicated that the operator will invite just a few dozen customers to try out the network during the remainder of 2020.⁹⁵ The operator said it does not know exactly how long the trial will last but it is likely to run for several months. Customers wishing to participate must have 5G devices that support 3,600 MHz and ice Norway will probably offer the pilot for routers as well as smartphones.⁹⁶ The operator also said that initial public 5G offering in urban and rural areas expected during early 2021, using 700/2100MHz.⁹⁷

Telenor anticipated that during 2021 they will upgrade close to 2,000 5G base stations, while a total of 8,500 base stations are set to be upgraded within the next four to five years.⁹⁸

⁸⁸ See: <https://www.ericsson.com/en/news/2020/3/5g-switch-in-norway>

⁸⁹ See: <https://5gobservatory.eu/5g-launch-by-telenor-norway-in-march-2020/>

⁹⁰ See: <https://www.teliacompany.com/en/news/news-articles/2020/telia-launches-5g-in-norway/>

⁹¹ See: <https://www.ericsson.com/en/news/3/2020/telia-norway-launches-commercial-5g-powered-by-ericsson>

⁹² See: <https://www.rcrwireless.com/20200513/carriers/telia-launches-5g-network-norway-ericsson>

⁹³ See: <https://finance.yahoo.com/news/ericsson-boosts-5g-network-norway-155903535.html>

⁹⁴ See: <https://www.telecomtv.com/content/5g/telia-norway-launches-commercial-5g-powered-by-ericsson-38634/>

⁹⁵ See: <https://www.telecompaper.com/news/ice-norway-starts-5g-pilot-in-tromso--1354357#:~:text=Norwegian%20mobile%20operator%20Ice%20has,Lillestrom%20and%20parts%20of%20Oslo.>

⁹⁶ See: <http://www.gtigroup.org/news/ind/2020-09-27/15569.html>

⁹⁷ See: https://www.nkom.no/arrangementer/digitalt-frekvensforum/_/attachment/download/50561aa8-7b34-4616-91a0-00c51700baeb:194bf07a1c5b2ec000f4541b9ea3a84d9355b14b/Frekvensforum%2016.09.2020%20-%20Geir%20Andresen%20-%20ICE.pdf

⁹⁸ See: <https://www.telenor.com/media/press-release/telenor-opens-first-commercial-5g-network-in-norway#:~:text=Telenor's%205G%20network%20was%20commercially,%2C%20Bergen%2C%20Stavanger%20and%20Sandnes>