Danish Energy Agency

5G Action Plan for Denmark

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5G Action Plan for Denmark

Denmark ready for 5G

In Denmark, we should be at the very forefront in rolling out digital infrastructure, implementing new technologies and utilising the potential brought along by ongoing developments. We should create a proper framework for the transformation required by a new technology, and we should have an ambitious approach to its adoption.

Traditionally, we have been good at that. Around the start of the millennium, 3G brought mobile internet access to the Danish public for the first time. And with the availability of smartphones from the latter half of the 00's, we experienced a marked shift in the use of mobile broadband technologies because it became possible to obtain effective access to the internet when mobile. It became possible to use mobile phones for many of the tasks handled by ordinary computers, e.g. online banking, social media and web browsing.

With the advent of 4G networks, data speeds increased further, and response times improved markedly. Now we could also use our phones for streaming and online gaming.

One of the great technological changes in society in the years to come will be the introduction of 5th generation mobile networks - 5G.

5G will provide extremely reliable communication, make it possible to handle even more simultaneous users and units, and enable data speeds up to 100 times faster than the present 4G network. With 5G, precision and reliability will be so good that we will be able to use mobile technology for entirely new purposes, e.g. driverless cars, drones and autonomous control in industry. With 5G, we get the foundation for new solutions that we cannot imagine today.

While 3G and 4G have notably been driven by consumer-oriented solutions, it is expected that 5G will primarily offer a wide range of efficiency gains when adopted for business purposes in various sectors. This may be in terms of automatic processes within agriculture, industry, energy, health and transport, and in large parts of the public sector. It is precisely in these areas where gains will be found.

Although the digital transformation is already well under way in many sectors, 5G offers the possibility of taking several digital leaps. Thus, it is important that we see a smooth and cost-efficient roll-out of infrastructure in Denmark, and that we rank among the best at using 5G.

With the roll-out of 5G, the importance of the telecommunications infrastructure to society will increase. At the same time, a greater focus on information security in the telecommunications sector will be required. In May 2018, the Danish

Government published a strategy for national cyber and information security, in which the telecommunications sector was identified as one of six critical sectors for society. The national strategy for cyber and information security for the telecommunications sector was published in January 2019. Thus, this 5G Action Plan does not deal with information security as a separate topic, we refer to the results of the national strategy mentioned above.

In the spring of 2018, all parties of the Danish Parliament entered into a new telecommunications policy agreement. One of the main elements of the agreement is the ambition that Denmark must be at the forefront in rolling out 5G, and that Denmark must have the best policy framework for using the newest technology. It was therefore decided that a 5G Action Plan should be prepared in collaboration with relevant stakeholders.

The vision of this Action Plan is for Denmark to be at the forefront in rolling out and using the 5G network and that we must have the best conditions for citizens, enterprises and the public sector to use 5G.

The vision is to be realised by focusing on four main topics, which we believe to be the chief cornerstones for a successful roll-out and utilisation of 5G: Frequencies, roll-out, regulation and use cases.

5G networks will not come automatically. A prior condition for telecommunications companies to roll-out the networks is the existence of a demand for services that rely on 5G. Roll-out is thus expected to begin in major cities, along transport corridors and in locally delimited areas such as factories. However, it is expected that 5G will be deployed nationwide in the long term, as was the case with 4G. But the telecommunications companies will only initiate the nationwide roll-out when demand has matured.

As far as the public sector is concerned, the important thing is to create the right environment for rolling out 5G. At the same time, public authorities and institutions may contribute by demanding advanced digital solutions supported by 5G for carrying out their tasks. As for the business community, it is a question of realising and making use of the potential of the solutions offered by 5G. The Action Plan contains, therefore, a number of action points that will be carried out in collaboration between public authorities, telecommunication companies and a number of sectors. It is essential that the industries capable of creating new business opportunities with 5G contribute towards the implementation - including collaborative relationships for testing and development etc. This should be seen in light of the Government's Strategy for the Digital Growth of Denmark, which focuses on new business models and better opportunities for testing new technologies.

Definition of 5G
In this Action Plan, 5G is defined as a mobile broadband technology that meets

the requirements and specifications that appear in the IMT-2020 Specification[1], adopted by the International Telecommunication Union - ITU.

The public sector's role in a liberalised market

In Denmark, the principle of market-based roll-out is applied in the telecommunications sector. It is the mobile operators, and not the State, who builds and operates the mobile networks. Thus, it is the market that faces the investments to be made in infrastructure for the future 5G networks.

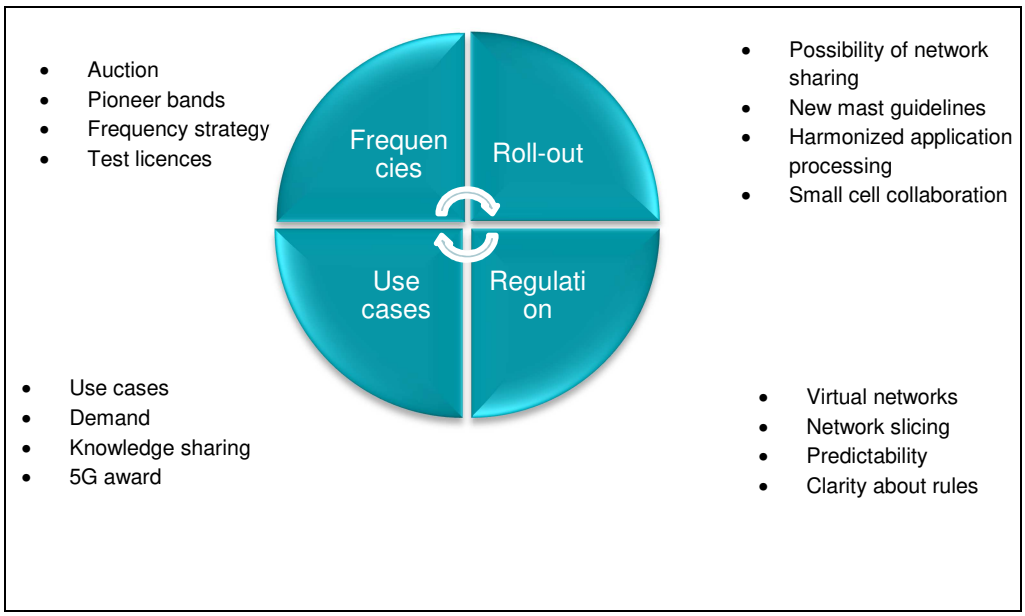
At the same time, there are a number of areas in which public authorities play a part. This applies in particular in relation to defining the information security and emergency-related requirements to be met by telecommunications providers; making frequency resources available; reducing administrative barriers to rolling out 5G networks; ensuring smooth and cost-effective access to set up new antennas; and ensuring the best regulatory framework.

Public authorities and institutions may also play a part if, in the course of carrying out their ordinary tasks, they demand digital services where 5G is part of the solution.

In light of this, the Action Plan contains four main topics. The figure below shows the four topics of the 5G Action Plan and the principal points under each topic.

Objective: Denmark must have a smooth and efficient roll-out of 5G networks, and we aim to be among the best in the world at using 5G

[1] Described in ITU-R Report M.2410-0 *"Minimum requirements related to technical performance for IMT-2020 radio interface(s)".*



Following up on the Action Plan
The 5G Action Plan has been prepared with contributions from a wide range of stakeholders, including the telecommunications industry, content providers, universities, municipalities, regions and sectors such as agriculture, transport and IT. These stakeholders have contributed through the Telecommunications Industry Forum appointed under the auspices of the Danish Energy Agency to facilitate the roll-out of 5G. The Danish Energy Agency has drawn up an implementation plan to follow up on the individual action points towards an evaluation of the 5G Action Plan by the end of 2020.

In the following, the points under the four main topics are described.

Topic: Frequencies

Frequencies for 5G
5G networks will enable much more reliable communication, with shorter response times (latency), higher data speeds, and a much larger number of simultaneous users.

This means that the mobile networks can be used for even more applications than nowadays, and that much of what requires a cable today will be able to work wirelessly.

At the same time, mobile data traffic is expected to continue its rapid growth for many years. This is already happening today with 4G, but the new 5G services will generate even greater data volumes.

In order to handle the increase in data traffic, it is necessary to extend the mobile networks capacity. This requires building the infrastructure and continuously making more frequency bands available for mobile technologies. More frequency bands are thus one of the decisive factors for enabling mobile operators to carry out a successful roll-out of 5G.

At the same time, it is important that mobile operators and other frequency users know the date by which the frequencies are expected to be made available and what frequency bands are being offered. This predictability and transparency may be decisive for the investments to be made by the users of the frequencies. It is particularly important to manage the frequency resources efficiently.

The Danish Energy Agency is the authority representing Denmark in international forums where it is decided which frequency bands should be used for which purposes. The Danish Energy Agency is also the authority managing the Danish frequency plan. Thus, the Agency plays a leading part in the work to ensure sufficient frequency resources for 5G purposes.

With this in mind, the Action Plan should contribute to ensuring:

- Frequencies in due time, also for tests
- Efficient frequency management
- Predictability and transparency

Frequencies in due time
The frequency bands used nowadays for 2G, 3G and 4G may also be used for 5G. Therefore, mobile companies may change over to 5G in the frequency bands already available to them when deemed necessary. This does not require the approval of the Danish Energy Agency. As the present frequency bands will continue to be used for 2G, 3G and 4G for a number of years, and are consequently not vacant for the mobile operators, it is expected that 5G will also be launched in new frequency bands. Moreover, the bandwidths available in present frequency bands are not sufficiently large.

Present frequency bands	**Primary use today**
800 MHz	4G
900 MHz	2G/3G
1800 MHz	4G
2100 MHz	3G
2600 MHz	4G

The 700 MHz, 3.5 GHz and 26 GHz frequency bands have been identified by the EU's Radio Spectrum Policy Group (RSPG) as pioneer bands for 5G in Europe. The date for access to the 3.5 GHz and 26 GHz frequency bands has been

appointed in the new telecommunications directive[2] establishing the European Electronic Communications Code.

New frequency bands	Expected future use
700 MHz	4G/5G
3.5 GHz	5G
26 GHz	5G

5G is expected to be introduced initially in the 3.5 GHz band, for which equipment and frequencies will be available from 2020, and later in the 26 GHz band. It has also been decided that an auction of the 700 MHz frequency band will be held in Denmark, and that the frequencies may be used from April 2020. The auction will be held at the end of February 2019.

5G trials (tests)
At this point it is possible for mobile operators, equipment providers, etc. to conduct tests and try out the capabilities of 5G. The Danish Energy Agency is currently issuing temporary frequency licences which may be used for such kinds of tests.

Efficient frequency management
It has been decided that activities for auctioning off the 3.5 GHz and 26 GHz frequency bands should be initiated, allowing these bands to be used for 5G by the end of 2020 at the latest. The technical conditions for the future use of the 3.5 GHz and 26 GHz frequency bands have already been set, as the technical work of CEPT[3], has been completed. The European Commission has made a decision on the 3.5 GHz frequency bands, but is expected during the first half of 2019 to adopt technical conditions for the 26 GHz bands in accordance with CEPT's conclusions. The goal is for the frequencies to be available for commercial use no later than the end of 2020.

Based on other countries' experiences, the Danish Energy Agency will consider if it would be appropriate in the future to make the frequencies available even before the European Commission has made a final decision on technical conditions. The specific technical requirements are often agreed upon at an early date in the decision-making process.

During the first half of 2019, the Danish Energy Agency will examine how the 3.5 GHz and 26 GHz frequency bands can be best utilised. The examinations will take into account that the frequencies in question range higher in the frequency spectrum than the frequencies used today for mobile broadband. Initially, the use of

[2] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code.
[3] European Conference of Postal and Telecommunications Administrations.

these frequencies is likely to be in local, geographically separated areas, depending on the specific demand.

The ability to provide extremely reliable communication and connect far more types of equipment to the network may make it attractive to establish dedicated local 5G networks to support services within the health sector, production industry, emergency management, agriculture, transport etc. Such dedicated local 5G networks may be either private or run by a mobile operator. For instance, there are plans in both Germany and Sweden to designate about one fourth of the 3.5 GHz frequency band for local 5G networks, which will enable further competition and make it possible to cater to the specific requirements that may exist in these sectors.

Predictable and transparent access to additional frequencies for 5G

The global World Radiocommunication Conference in November 2019 (WRC-19) will set the overall framework for using additional frequencies for 5G. Specifically, WRC-19 will identify a number of frequency bands above 20 GHz for 5G purposes. It is expected that frequencies around 26 GHz, 40 GHz and 66 GHz will be identified. It will also be decided whether any restrictions should be imposed on the use of the bands due to other applications, such as research, satellite communication, meteorology and earth exploration.

Normally, the decisions taken at WRC imply that the frequency bands may be used for a variety of purposes that are frequently not fully compatible. Therefore, the Danish Energy Agency will prepare a new frequency strategy, which will identify the frequency applications to be prioritised in Denmark after WRC-19, in 2020.

The Agency will collaborate with the industry on the content of the new frequency strategy, and in deciding when new frequency bands should be applied for 5G. This will ensure predictability and transparency in the access to additional frequencies.

Action points:

- The Danish Energy Agency will auction the 700 MHz, 900 MHz and 2300 MHz frequency bands during the first quarter of 2019
- The Minister for Energy, Utilities and Climate has decided that activities to auction off the 3.5 GHz and 26 GHz frequency bands should be started in order to ensure that the frequencies will be available by the end of 2020 at the latest.With this in mind, a specific decision will be made on the possibility of establishing local dedicated 5G networks
- On the basis of other countries' experience, the Danish Energy Agency will assess the possibilities of making frequencies available when there is agreement on the technical conditions for the use of frequencies at CEPT level, but before these have been finally adopted by the European Commission
- The Danish Energy Agency will revise the frequency strategy in 2020 as a consequence of WRC-19

- The Agency will issue temporary frequency licences for testing 5G

Theme: Roll-out of 5G networks

Easy access to roll-out of 5G networks
The transition to 5G requires the infrastructure to be extended with a significant number of new mast and antenna positions. This will be accomplished over a period of several years. It will be up to the mobile operators to develop and operate the publicly available networks. It is therefore of great importance to mobile operators to have good and predictable conditions for their work; that access to setting up antennas can proceed smoothly; and that costs remain in focus.

Public authorities play an especially significant part in relation to providing access to setting up antennas and rolling out 5G infrastructure. The 5G Action Plan should contribute to ensuring:

- Smooth case administration
- Reasonable mast rentals
- Cost-effective utilisation of infrastructure

Case administration in connection with the deployment of infrastructure
When the many new mast and antenna positions are to be established, it is essential that companies have quick access to setting up equipment, and that, to a large extent, the same practice be applied for issuing licences across the country. For example, an internal task force has been established in the municipality of Aabenraa with the object of ensuring effective, uniform, transparent and development-oriented case administration of applications for setting up masts. In 2019, the Danish Energy Agency will prepare guidelines for public authorities on how to deal with applications for permission to set up telecommunications infrastructure. The guidelines will include a "toolbox" with a collection of best-practice examples and good advice for case administration based on the experience of Danish municipalities. At the same time, it should be clarified if contact points can be appointed within the municipalities to manage the contact with telecommunications companies.

Nationwide knowledge sharing on municipal case administration
For the purpose of making the roll-out of 5G infrastructure smooth and simple, the Danish Energy Agency will look into the possibilities of a more uniform case administration for antenna and mast applications across the country's municipalities. The Agency will include municipalities, KL *(Local Government Denmark)* and the telecommunications industry in this study, which will also take account of the great efforts already made in many of the country's municipalities and regions in this area, including the existing joint municipal guidelines. The ambition is for municipalities and other stakeholders to collect their best experience in one place in the form of a "toolbox" consisting of a collection of best-

practice examples and good advice on how to deal with cases regarding mast and antenna applications.

In December 2018, the new EU Directive in the telecommunications field was adopted[4]. As an element in promoting the roll-out of 5G networks, the Directive states that any rules regarding the setup of small cells[5] should as far as possible be nationally consistent. In addition, prior individual town planning permits or similar permits on the part of the authorities cannot, except in a few cases, be required as a condition for operators to be allowed to set up small cells on suitable public physical infrastructure, including buildings, lampposts, bus shelters, etc. These rules will apply to small cells conforming to concrete technical specifications[6] to be adopted by the European Commission no later than 30 June 2020.

The Commission is expected to publish a draft for these specifications in 2019, after which it will be dealt with by a subcommittee. In this regard, the Danish Energy Agency will involve the telecommunications industry, which will be asked to provide input for the work.

Rental of sites for telecommunications infrastructure
New guidelines on market rentals will be prepared in 2019, to be used by municipalities, regions and government authorities when leasing sites for telecommunications infrastructure. It will be examined whether the guidelines should include a specific model solely for small cells, which will not typically be placed on a high mast but on lamp-posts, gables or in other installations relatively close to the ground. Finally, a series of meetings will be facilitated in order to examine if the so-called guest principle can be used in relation to the roll-out of mobile infrastructure.

Examining the possibilities of network sharing
As the economic costs of establishing and operating multiple parallel 5G networks may become a challenge, we will examine which opportunities and challenges may exist in relation to network sharing between mobile operators. This will be accomplished in collaboration with the telecommunications industry and the Danish Competition and Consumer Authority.

Working group to examine barriers
Under the Government's draft proposal *Danmarks hovedstad - Initiativer til styrkelse af hovedstadsområdet (Denmark's Capital - Initiatives to Promote the Greater Copenhagen Area)*, a working group will be appointed to identify whether

[4] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code.
[5] Small cells should be understood as small short-range antennas typically placed at street level.
[6] This includes various requirements for setup, design and transmitting power.

there are special competitive or legal challenges in the Greater Copenhagen area in relation to the roll-out of digital infrastructure, including 5G. The working group's tasks will include a review of the Planning Act.

Action points:

- In collaboration with the Danish Competition and Consumer Authority and the telecommunications industry, the Danish Energy Agency will examine the opportunities and challenges with respect to network sharing
- The Agency will involve the telecommunications industry for the purpose of establishing the definition of small cells within the EU
- In cooperation with the country's municipalities, KL *(Local Government Denmark)* and the telecommunications industry, the Danish Energy Agency will prepare guidelines on standardised case administration for public authorities
- The Danish Energy Agency will prepare new guidelines on mast rental

Topic: Regulation ready for 5G

Clarity about the regulatory framework in relation to 5G

A key condition for facilitating the roll-out and application of new infrastructure, including 5G, is a clear regulatory framework and predictable regulation. Predictability of the framework will reduce the uncertainty related to investments in infrastructure and the 5G tests that will form the economic basis for roll-out and application of 5G.

Network slicing
One of the key concerns of the regulation is the rules on network neutrality with respect to network slicing. Network slicing enables a mobile network to be split into several virtual networks that work independently of each other.

With network slicing, parts of the mobile network can be dedicated to specific purposes. For instance, there might be a "slice" for self-driving cars or emergency communications, where a very high degree of reliability is required. There might also be a "slice" for remote reading of water and electricity meters etc. The various virtual networks may thus have different technical characteristics and quality parameters in terms of speed, latency, security, reliability etc., depending on the service supported.

The use of network slicing in 5G offers the mobile operators a range of new possibilities in relation to the control, prioritisation and allocation of capacity in mobile networks. This applies in particular to the functionality that enables 5G networks to be made extremely reliable compared to present mobile networks.

Example: The self-driving car
Nowadays, the delay in 4G networks may be as much as 50 milliseconds. But with the 5G network the latency time - the delay from origination of the message until its reception - will be reduced considerably. Self-driving cars are equipped with many sensors intended to send and receive commands over the internet all the time. This means that when a self-driving car running at a speed of 100 km/h and connected to a 4G network gets a message to brake, it will drive 140 centimetres from the time when the brake command is given until it starts braking. However, if the car was connected to a 5G network, it would only drive 2.8 centimetres before starting to brake.

Network neutrality
With the possibility of using network slicing there is a need to clarify if there are challenges in relation to the EU rules on network neutrality. This is due particularly to the need of creating predictability in the regulation for the benefit of telecommunications companies and other users in relation to the use of new business models using network slicing.

Network neutrality
Network neutrality is the principle that the internet is neutral in relation to the traffic flowing through it. In other words, a neutral internet does not discriminate traffic either on the basis of origin or content. Within the EU, the rules are specified in a regulation on network neutrality intended to ensure that consumers have access to a free and open internet. This implies that the provider of an internet connection must treat all traffic equally, and that consumers have a right to access to content on the network freely and to use the services and the equipment they wish to.

Several stakeholders have expressed their wish that it should be ensured that the new technical opportunities with network slicing in 5G networks may be adopted and utilised in full - without conflicting with the rules on network neutrality.

Network neutrality is currently regulated under an EU regulation on access to the open internet. The Regulation sets the conditions for how internet providers may manage their networks and allocate resources in the network - for example for ordinary internet access and special services, as well as for prioritising traffic in the network.

The association of regulatory authorities within electronic communications in EU, known as BEREC[7], has contributed to the European Commission's forthcoming evaluation of the network neutrality regulation due in April 2019, and it has not found specific examples where network neutrality rules will prevent the use of 5G.

[7] Body of European Regulators for Electronic Communications.

Furthermore, BEREC has prepared a set of guidelines for using the EU regulation on network neutrality. The guidelines state that network slicing in 5G may be used for providing special services. The guidelines are expected to be revised in 2019.

Testing network slicing
The Danish Energy Agency will collaborate with DR and TDC in order to clarify if there are challenges in relation to the use of network slicing in the network neutrality rules. It is especially important to see whether the way network slicing is configured matters. The Danish Energy Agency will also enter into a dialogue with various stakeholders about any other specific scenarios where network neutrality principles in relation to 5G should be examined.

5G in the media world
DR, TDC and the Danish Energy Agency will enter into a joint project to test 5G technology in a professional TV production. The purpose of the test is to clarify if 5G can deliver the high technical quality necessary for the retrieval of media content, thus supplementing or replacing other technologies in the contribution link between the place of production and the DR City. Furthermore, the test should provide an insight into how to safeguard the network neutrality principles in a 5G network supporting network slicing.

Action points:

- Collecting experiences from the collaboration with DR and TDC
- Examining scenarios in relation to network neutrality principles in a 5G context

Theme: Use cases

Demand-driven roll-out of 5G

Many of the features that we already know and use today, e.g. in relation to the Internet of Things (IoT), can already function on 4G networks and other present wireless technologies[8]. We have not yet found a feature or application that will work solely on 5G. Although the development of 5G has been under way both nationally and internationally for many years, the various countries continue to be at a relatively early stage in terms of what will *drive* the roll-out and use of 5G. This is also the case in Denmark. At the same time it is widely agreed within the telecommunications industry that the roll-out of 5G should be driven by demand. Market maturity is necessary to see an effective roll-out of 5G. This applies to the

[8] Examples of already existing wireless technologies are Bluetooth and LPWANs (Low Power, Wide Area Network, e.g. Narrowband-IoT).

development of new business models and handling of barriers and challenges that may limit demand.

It is part of the objectives of the 5G Action Plan that Denmark should rank among the best in using 5G. The use of 5G will be brought into focus by, among other things, implementing various tests or user scenarios. That is to say, practical examples of using mobile broadband in sectors where 5G capabilities are decisive. An obvious sector is agriculture, where surveillance of crops etc. may employ a digital infrastructure using 5G, or the health sector, where hospitals may use robot technology to provide better health.

Thus, the purpose of a test or a use case is to gain a basic experience that may contribute to identifying and solving challenges as well as breaking down any barriers in connection with the roll-out and use of 5G. At the same time, it is possible to focus on the opportunities for entrepreneurs, and innovative, new solutions where Danish enterprises may take part in developing the technology of the future based on 5G.

The work on use cases will take place in collaboration with several stakeholders, including the telecommunications industry, user groups, entrepreneurs, universities, the Danish Business Authority, and other authorities. To a relevant extent, the Danish Energy Agency will act as a facilitator in such collaborative efforts.

Testing in Denmark
In Denmark, mobile operators are already in the process of testing 5G; in particular, to clarify technical issues in relation to the new technology. In addition, various sectors are beginning to look at possible future applications for 5G. For example, the Agency for Data Supply and Efficiency has launched a project on precision positioning in collaboration with DTU Space and the City of Aarhus. This can be used for purposes such as precision agriculture, driverless cars and drones. The municipality of Aabenraa has adopted a data centre strategy, which will make Padborg Transport Centre a recognised site for testing new technologies and systems by 2022.

Example: TAPAS
With the further introduction of new technologies and autonomous systems in society, the need for precise positioning will be greater and greater. The Testbed in Aarhus for Precision Positioning and Autonomous Systems (TAPAS) is a research and development platform which, together with the potential of 5G technology, can make very precise and fast positioning available in dense urban environments.

Example: Testbed in Padborg Transport Centre
GateDenmark and Aabenraa municipality are working to develop Padborg Transport Centre into a recognised testbed for new technologies and systems by

2022. The first test run will take place in 2019. The deployment of 5G infrastructure will begin in 2020 and the establishment of regular 5G application systems at company sites in the transport centre will take place from 2021.

5G in the public sector
In Denmark, we are at the forefront in our use of advanced digital services in the public sector. If development continues, we can thus expect that public authorities and institutions will demand digital services supported by 5G in the future.

The public sector (central government, regions and municipalities) may thus contribute to promoting solutions and services that can utilise the 5G technology, thus assisting in supporting a market-based roll-out.

Experience through use cases
The Danish Energy Agency will enter into or facilitate a number of collaboration agreements on use cases, intended to back the objective that Denmark should rank among the best in Europe in terms of rolling out and using 5G.

The use cases should contribute to:

- Identifying barriers to the use of 5G
- Demonstrating the public sector's role in creating demand
- Bringing new applications and solutions using 5G into focus
- Providing experience and knowledge sharing on the use of 5G

Testing Smart City solutions
5G also holds the potential to support new and better services for citizens and more efficient operation in cities. For instance, by using movement data which may be used for signal optimisation, area prioritisation as well as traffic and urban space projects.

Collaboration with Copenhagen Solutions Lab and TDC
The Danish Energy Agency, Copenhagen Solutions Lab, TDC and other interested parties in the telecommunications industry will enter into a collaborative project on the use of data on movement patterns. The purpose of the test is to focus on the demand for 5G and clarify what is needed for network roll-out to proceed easily and smoothly.

5G networks for using robot technology in hospitals
The important features of the 5G network are a very high degree of reliability, very short response times and a QoS (quality of service) that makes it possible for multiple technologies to share the network without interfering with each other. This makes 5G relevant for sectors that require a very high degree of precision for performing their tasks.

Cooperation with Welfare Tech, Systematic, Mobile Industrial Robots and Odense University Hospital
Welfare Tech, Systematic, Mobile Industrial Robots, Odense University Hospital and the Danish Energy Agency will initiate a collaborative project where the performance of the 5G network is tested by means of robot technology. The purpose of the project is to create a reliable and fast mobile network capable of supporting the interaction of humans and robots to deliver better health.

More knowledge about 5G
Although many sectors are aware of the fact that 5G will bring new opportunities, e.g. in the form of IoT solutions, there is of course a lack of knowledge as to what 5G technology can actually bring. Therefore, there is a need to create a better picture of the possibilities offered by 5G, and how 5G may support a continued digitalisation of Danish enterprises and society in general.

Cooperation with the Confederation of Danish Industry
The Danish Energy Agency and the Confederation of Danish Industry, together with a number of telecommunications companies, will put focus on the use of 5G, for instance, in workshops, conferences or roadshows. The purpose is to inspire and communicate concrete experience with 5G from industrial enterprises, and municipal and regional administrations.

Cooperation with the Danish Chamber of Commerce and the IT Industry Association
The Danish Chamber of Commerce and the IT Industry Association, in dialogue with the service sector, will identify and highlight relevant business models for 5G for this part of the business sector. For example, the transport sector may benefit from increased precision in navigation and positioning technology, in order to improve road safety, among other things.

Collaboration with the Danish Business Authority
In collaboration with the Danish Business Authority, the Danish Energy Agency will organise an inspiration workshop for enterprises and the telecommunications industry on the possibilities and benefits of 5G. The workshop will also help enterprises start up their projects; provide guidance on how to find cooperative partners; and inform participants about the financial support programmes available.

Collaboration with the telecommunications industry on cyber and information security
In January 2019, the telecommunications sector published a national cyber and information security strategy for the sector, with 12 initiatives for a more secure supply of telecommunications in Denmark. These initiatives are based on an overall risk and vulnerability assessment focusing on the consequences to society of incidents in the telecommunications sector.

5G in the agricultural sector

In agriculture, information and communication technology is already used in day-to-day activities, and the sector is expected to benefit greatly from the 5G technology. This applies for example to automatic analyses of satellite images for the purpose of determining how densely crops grow. In this way, it can be calculated how much and where fertiliser needs to be added to the soil to ensure an optimal use of resources and obtain the best possible yield from the soil.

Collaboration with SEGES

The Danish Energy Agency and SEGES *(knowledge and innovation centre for agriculture)* will collaborate to find specific and practicable scenarios for 5G in the agricultural sector.

5G and research

So far, the development and roll-out of mobile networks have chiefly been consumer-driven. The roll-out of 5G is expected, to a higher degree, to be driven by the need for professional applications in various industries. For example, this may be in connection with production lines in industrial enterprises, where cables can be replaced with 5G; for control of drones beyond the horizon; for the use of precision agriculture; or for augmented reality (AR) for repair technicians.

Collaboration with Aalborg University

The Danish Energy Agency and Aalborg University will collaborate to establish research projects focusing on the professional use of 5G. This includes looking for potential industrial interests who may participate in the projects.

5G in an international perspective

The Danish Energy Agency will continue the dialogue with various stakeholders with a view to facilitating further collaboration on the use of 5G. The Agency will also look towards other countries to draw on the experience gathered there.

Technical tests abroad

A number of tests with 5G are in progress in Europe, North America and Asia. In Europe, there are projects such as remote control of mining machinery in Sweden; broadband for rural districts in the United Kingdom; tests of HD streaming in France; and Industry 4.0 trials in countries such as Germany and Finland. In Asia, developments are focusing on smart farming, and in North America the main focus is on 5G for private homes. The Danish Energy Agency is following the development and experience in other countries and will take the initiative in 2019 to arrange a study tour to, for instance, Asia, in which relevant stakeholders will participate.

In addition, a number of action points are to be initiated, in order to gain experience on the use of 5G and contribute to knowledge sharing. For example, it should be

possible to see where financial support for 5G projects can be applied for. At the same time, the Danish Energy Agency will focus on projects that cater in particular to the objective that Denmark should be the best at using 5G. To support these efforts, the Agency will take the initiative to hand out a special 5G award.

Action points:

- The Danish Energy Agency, jointly with the Danish Business Authority and other authorities, will collect and disseminate experience from tests and collaborative projects on use cases for the purpose of solving challenges and breaking down any barriers to the roll-out and use of 5G
- The Danish Energy Agency will gather and communicate any opportunities of applying for financial support for 5G-projects
- In collaboration with the Danish Business Authority, the Danish Energy Agency will arrange a workshop for enterprises and the telecommunications industry on 5G
- The Danish Energy Agency will arrange a workshop for public stakeholders on the public sector as a party interested in solutions for which 5G may be the answer
- With the assistance of one of the Danish innovation centres, a study tour to e.g. Asia will be arranged in 2019 with possible participation of relevant stakeholders
- The Minister for Energy, Utilities and Climate will hand out a 5G award

Danish Energy Agency

5G Action Plan overview 2019-2020

Frequencies for 5G

- The Danish Energy Agency will auction the 700 MHz-, 900 MHz- og 2300 MHz frequency bands
- The Minister for Energy, Utilities and Climate has decided that activities to auction off the 3.5 GHz and 26 GHz frequency bands should be started in order to ensure that the frequencies will be available by the end of 2020 at the latest.With this in mind, a specific decision will be made on the possibility of establishing local dedicated 5G networks
- On the basis of other countries' experience, the Danish Energy Agency will assess the possibilities of making frequencies available when there is agreement on the technical conditions for the use of frequencies at CEPT level, but before these have been finally adopted by the European Commission
- The Danish Energy Agency will revise the frequency strategy in 2020 as a consequence of WRC-19
- The Agency will issue temporary frequency licences for testing 5G

Roll-out of 5G networks

- In collaboration with the Danish Competition and Consumer Authority and the telecommunications industry, the Danish Energy Agency will examine the opportunities and challenges with respect to network sharing
- The Agency will involve the telecommunications industry for the purpose of establishing the definition of small cells within the EU
- In cooperation with the country's municipalities, KL *(Local Government Denmark)* and the telecommunications industry, the Danish Energy Agency will prepare guidelines on standardised case administration for public authorities
- The Danish Energy Agency will prepare new guidelines on mast rental

Regulation ready for 5G

- Collecting experiences from the collaboration with DR and TDC
- Examining scenarios in relation to network neutrality principles in a 5G context

Use cases

- The Danish Energy Agency, jointly with the Danish Business Authority and other authorities, will collect and disseminate experience from tests and collaborative projects on use cases for the purpose of solving challenges and breaking down any barriers to the roll-out and use of 5G
- The Danish Energy Agency will gather and communicate any opportunities of applying for financial support for 5G-projects
- In collaboration with the Danish Business Authority, the Danish Energy Agency will arrange a workshop for enterprises and the telecommunications industry on 5G
- The Danish Energy Agency will arrange a workshop for public stakeholders on the public sector as a party interested in solutions for which 5G may be the answer
- With the assistance of one of the Danish innovation centres, a study tour to e.g. Asia will be arranged in 2019 with possible participation of relevant stakeholders
- The Minister for Energy, Utilities and Climate will hand out a 5G award