

REPORT

# KEY PLAYERS AND SUPPLIERS FOR SMART COMMUNITIES



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## Foreword

On behalf of Innovation Norway, Menon Economics has charted suppliers and value chains that are of key importance in realizing smart communities. The objective of the project has been to put together a population of companies that act as suppliers to smart communities, and to provide information about the size and maturity level of these suppliers.

The study was led by Anne Espelien, with Eirik Handegård Dyrstad as a project member. Erland Skogli has provided expert knowledge on health and welfare services, while Erik W. Jakobsen acted as quality assurer.

Menon Economics is a research-based consultancy operating at the interface of economics, politics and the market. The company provides economic analyses and advice to enterprises, organizations, municipalities, counties, directorates and ministries. Our main focus is on empirical analyses of economic policy, and our employees have economic expertise on a high scientific level. Menon won the Norwegian Consultancy of the Year award in 2015.

We would like to thank Innovation Norway for an interesting assignment. We would also like to thank the project group from Innovation Norway, consisting of Karin Ammerud Sørensen, Gaute Hagerup, Olav Bardalen, Erlend Ystrøm Haartveit, and the many others who provided valuable input in the process of putting together this study. The authors are responsible for all content in this report.

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## Summary

In almost every area of society today, environmental considerations, efficiency improvements and cost savings are important issues. Goods and services needed by the community must be delivered as efficiently as possible. To be able to meet future requirements related to functionality and the environment, more and more traditional areas are making use of technology and online services.

Access to and increased capacity of network services in combination with technology has provided new opportunities for the creation of effective systems that combine data from different sources to deliver better services and goods. Sharing information and being able to view information in context is therefore a key factor in the development of smart communities. Being able to control the use of resources is another.

The requirements of smart communities open up entirely new business opportunities and provide a basis for change in traditional industry sectors and for the growth of new industries in Norway.

This report has charted suppliers to smart communities that deliver solutions developed *in interaction* between companies and the community and use *digitalization technologies* as a key component of their products and services.

The latter delimitation has posed an especially difficult challenge in the selection of companies. Many companies that enable smart communities deliver products that are technical, but do not contain a digital component. This leaves us with a grey area of companies which, based on the digital limitation, do not belong to the population due to the definition used in this survey.

This report identifies such suppliers within six areas of society and community development. We have identified 425 companies covered by the definition above. The table below presents some key figures for the companies surveyed in this study. In addition to this, we have found several one-man firms and entrepreneurial ventures. Due to the fact that there are no accounting data available for these enterprises, these companies are not included in our figures.

### Key figures supplier's smart communities

Smart industry (2015)	Number of companies	Number of employees	Sales (mill NOK)	Value added (mill NOK)
Transport	94	8 411	33 143	7 834
Energy	79	11 624	28 683	10 944
Welfare Services	74	1 788	5 413	2 196
Buildings	66	2 794	6 149	1 757
Community planning	57	4 776	9 803	5 248
Resources	55	1 414	3 924	1 253
<b>Total</b>	<b>425</b>	<b>30 807</b>	<b>87 116</b>	<b>29 231</b>

# 1. What are smart communities?

More than half of the global population lives in cities, and the share keeps rising. In Norway, more than 50 percent of the population live in a city.<sup>1</sup> 40 percent live in the surrounding areas to a city. An ongoing trend towards urbanization and centralization is reinforcing this development, both nationally and internationally. For a sustainable development of these urban communities and to ensure that they are attractive places to live and work in, also in the future, good solutions for transportation and communication, the use of energy and water, waste management, security, welfare services, planning and decision processes are required.

*Cities of the Future* has been a Norwegian initiative for the development of smart cities. The programme was a collaboration project between the Norwegian government and the 13 largest cities in Norway aiming to reduce greenhouse gas emissions and make the cities better places to live in. It ran in the period from 2008-2014.

Almost every area of society today is influenced by environmental considerations, efficiency improvements and cost savings. Delivery of goods and services required by the community today needs to be made in a way that is as efficient as possible. To be able to fulfill future requirements with regard to functionality and the environment, more and more traditional areas are using technology as an aid.

Smart communities are a concept that has developed as a result of the fact that traditional industries are combining the use of technology and social development to solve local, national and global challenges. This opens up entirely new business opportunities and provides a basis for change in traditional sectors and the growth of new industries in Norway.

The development of smart communities is interesting for both national and international authorities, because it provides the opportunity to realize a pent-up innovation potential in services, for example by increasing the quality of services for users and improving operational efficiency.<sup>2</sup> By establishing a population of companies whose business activities focus on products and services for the development of smart communities, we gain some insight into the size and maturity level of this new industry.

## 1.1. Four areas are drivers for the development of smart communities

In the course of this project, we have charted four areas that are especially important for the growth of suppliers to smart communities. These revolve around sharing existing resources, increasing the use of environmentally friendly transport options, using technology for more efficient community planning and for efficient production of welfare benefits.

**Scarce resources need to stretch further and more people need to share them.** Almost all areas of society today are concerned with consuming and utilizing existing resources in a smarter way, so they last longer and more people can benefit from them. The possibilities to manage consumption, to plan and monitor, are part of this development. A scarcity of resources means that these have to be distributed between many people that demand them, in such a way that everybody gets something. In a situation with rising demand for electricity, for example, we need systems that will ensure efficient utilization and distribution of the available output.

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<sup>1</sup> Skogstrøm et al: *Samspill mellom by og omland som kilde til økonomisk vekst*, Menon 2015

<sup>2</sup> *Smarte samfunn - Drømmeløftet, Innovasjon Norge* [part of Innovation Norway's Dream Commitment-initiative]

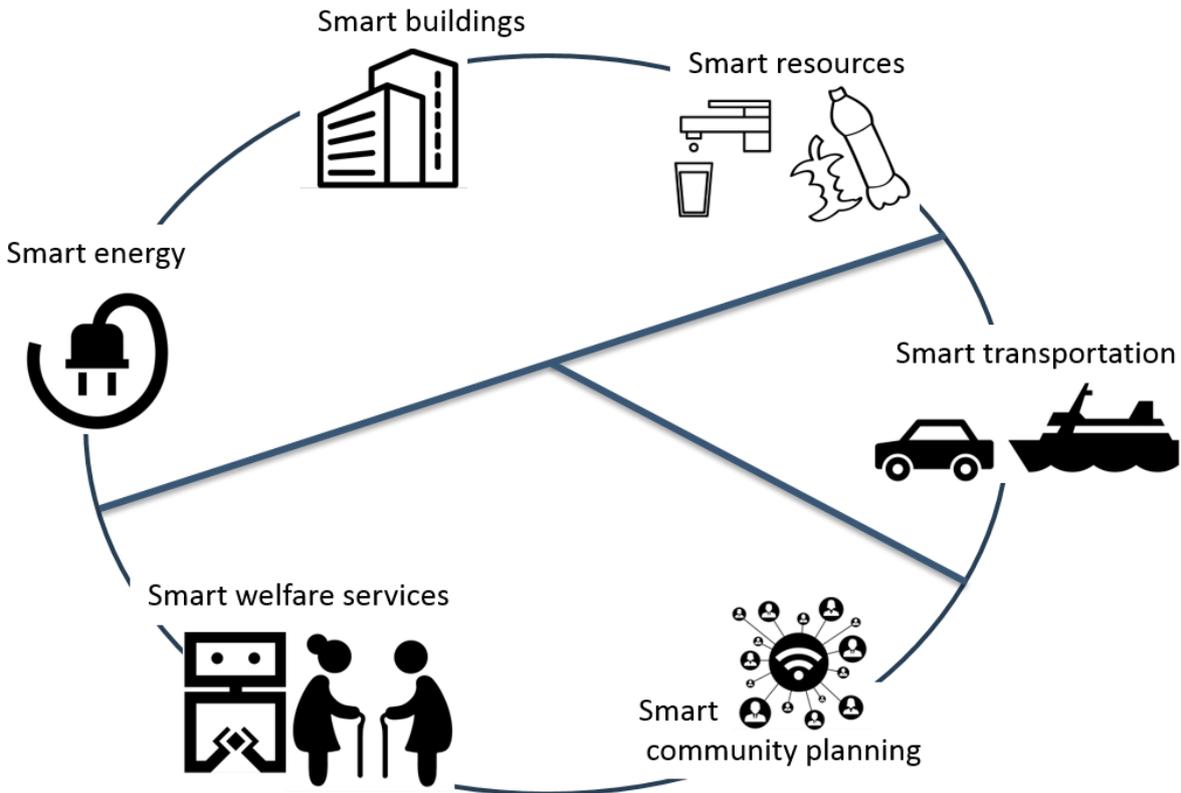
The possibilities for taking detailed measurements and collecting large data sets open up new opportunities within efficient community planning. Technological development has made it possible for us to collect large amounts of data that provide new insight into how different parts of society function and change. Each of these data sets is useful in itself, but their value is even higher when they can be put together and used to plan and develop communities in a smarter way and direction.

High wage costs and a shortage of labour require increased use of technological solutions for efficient production of welfare services. More and more people need help from the state, while fewer ‘warm hands’ are available to do the work. Technological solutions make it possible for more people to gain a sense of security and get the help they need.

Efficient transportation of passengers and goods with minimal environmental impact by substituting fossil fuels with environmentally friendly energy sources. Avoiding pollution is just as important from society’s point of view as ensuring traffic flow and reducing traffic jams. Society is losing millions of kroner in lost working time and because of goods that spend more time in transit than necessary.

In the figure below, we have illustrated the smart areas we identified in the course of this project.

Figure 1-1: We charted suppliers within four smart areas and six subgroups



## 2. What companies act as suppliers for smart communities?

Producing good statistics on smart communities is a challenging task. There are no existing official statistics on the subject, and there have not been any previous attempts to classify these companies as a separate industry. To start with, we have to assume that all enterprises that contribute to building communities are also potential suppliers to smart communities.

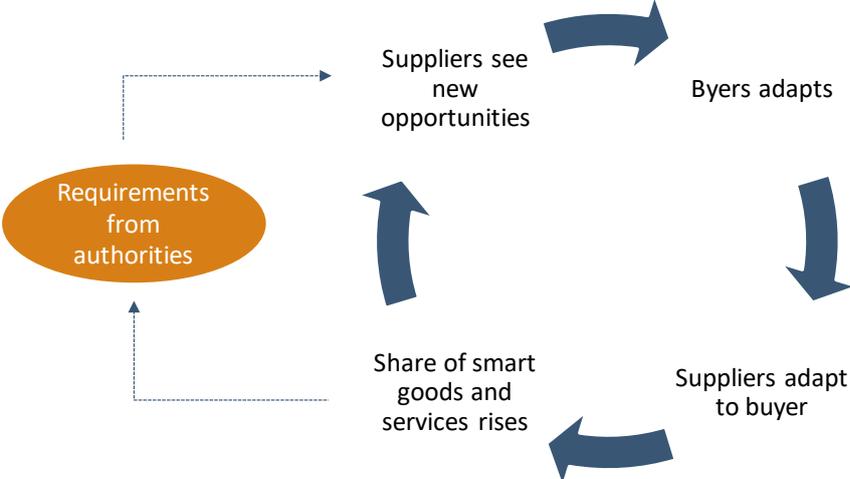
This is also pointed out in a recent report on smart communities published within the framework of Innovation Norway’s Dream Commitment-initiative,<sup>3</sup> which states that «there is no clear definition of smart cities or smart communities.» In addition, the study states that digital technologies and geographically limited development processes are two defining factors for smart communities.

One important realization in this context is that it is the *buyer* who determines the pace of social development. This also applies to the development of smart communities. The buyer adapts to the laws and regulations that are in force at any time. Regulations and requirements from authorities are therefore an important driver for the development of the supplier market for smart communities.

The companies that are suppliers to communities adjust to social development and existing demand. Many realize the technological possibilities and develop goods and services that help society and its actors behave in a smarter way. Some companies have progressed further than others and appear innovative and proactive, others deliver more traditional goods and services.

Suppliers to smart communities only have the chance to deliver goods and services that make society smarter when there is a buyer who demands these. In the long term, it is not possible to develop smart solutions if this does not also create profitable growth for the companies. This means that companies develop smart solutions when it is profitable for them to do so. The availability of new solutions provides incentives for the authorities to tighten their requirements. These dynamics are illustrated in the figure below.

Figure 2-1: Drivers for the development of smart goods and services for communities



<sup>3</sup> *Smarte samfunn – Drømmeløftet*

## 2.1. Smart companies have two characteristic features

A white paper to the Norwegian parliament, *Digital agenda for Norge* [Digital agenda for Norway], provides the following definition: «A smart city uses digital technology to make the city a better place to live, reside and work in. Smart city initiatives aim to improve public services and quality of life for their inhabitants, make optimal use of common resources, and improve the city’s productivity, while reducing climate-related and environmental problems.»

This means that suppliers to smart communities have two characteristic features:

1. The companies deliver solutions *in interaction* between companies and the community. This means that suppliers of input factors that are needed before this stage and enable deliveries to the community fall outside the scope of this study.
2. For all areas, our survey is limited to enterprises that use *digitalization technologies* as a key component of their products and services.

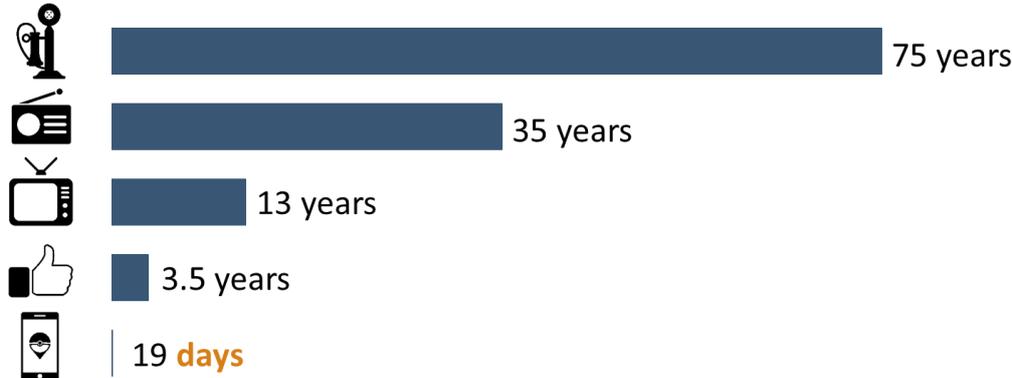
The latter delimitation has posed an especially difficult challenge in the selection of companies. Many companies that enable smart communities deliver products that are technical, but do not contain a digital component. This leaves us with a grey area of companies which, based on the digital limitation, do not belong to the population.

## 2.2. Technological development is proceeding at a fast pace

The number of companies that are suppliers to smart communities is increasing all the time, in line with communities’ demand for new solutions. The figure below illustrates this point. When telephones were invented, it took 75 years until more than 50 million users had access to the service. For radio and TV, it took somewhat less time to get to this point. When Facebook was introduced, it took 3.5 years until the service had 50 million users. When Pokémon Go was launched, it took only 19 days until 50 million users had downloaded the game.

The fact that technological progress is moving so fast also means that companies see new business opportunities in the development of goods and services for smart communities. There is reason to believe that many suppliers in the value chains for the different smart areas see new possibilities that have not yet been realized. In addition, new, specialized suppliers are developing. These dynamics mean that the population of supplier companies is changing and expanding all the time.

Figure 2-2: Time until the service reached 50 million users



### 2.3. It is the projects which are smart and demand smart solutions

The business idea of many of the companies that are suppliers to smart communities is based on the delivery of traditional goods and services. That there is no demand for smart solutions by the projects is not the same as the suppliers not being able to deliver such solutions.

This poses a challenge when we try to establish a population of suppliers to smart communities: How can we pick a selection of companies when it is not the actual companies, but the projects that are smart? What if a company delivers smart solutions to some projects, while its other deliveries are more conventional – should it be included the population?

This challenge has been a key part of this project. We have solved it by stating which *value chains* are of essential importance as either drivers or suppliers for the six smart areas. Within each of these, we find suppliers that have to a smaller or larger degree specialized on smart communities. As far as possible, we have charted those suppliers that show the most initiative in this area. It is likely that there are a number of other relevant suppliers in the grey zone here which we have not been able to identify in the short timespan available for this project.

The realization that suppliers to smart communities exist in all parts of the value chain for society, and that it is the actual *projects* that demand smart solutions results in a significant potential market for new companies that manage to carve out a place for themselves as suppliers to smart communities.

### 2.4. Suppliers for smart communities can be found in the value chains of the smart areas

The six smart areas have internal value chains. Within each value chain, there are some key suppliers to smart communities. The fact that companies in *several* parts of the value chain are of essential importance in helping to realize smart communities is important to understand. Therefore, identifying *which* parts of the value chain are crucial to realizing smart communities is just as important as finding companies that deliver especially smart goods and services.

In the following, we will look at the value chain for each SMART area in more detail and also find out which industries are important in providing terms and premises for development. Within those value chains, we have, as far as possible, identified companies that have progressed especially far in the development of smart solutions. The list is by no means complete, but work has begun. In addition, we find a number of companies that are important content suppliers by providing guidelines and taking an advisory role in social development.

### 3. Scarce resources have to stretch further

In line with population growth, available resources need to stretch further, they need to be recycled and their effect must be distributed between more people. In almost all areas of society today, there is a necessity to consume and utilize existing resources in a smarter way, so they will last longer and benefit more people. The new possibilities of managing consumption and planning and monitoring resource use are part of this development. When more and more people require electricity, for example, we need systems that ensure efficient utilization and distribution of the available output. One way of achieving this is the construction of smart buildings that ensure functionality, comfort and user friendliness with less energy consumption, and the establishment of smart energy systems that distribute the available output between more people while enabling prudent use and recycling of resources.

#### 3.1. Smart energy

Smart energy solutions for cities and communities include the delivery of renewable energy through a secure energy supply, efficient use of energy, and systems that enable users to manage and control their own energy consumption.<sup>4</sup> More than 90 percent of energy production delivered via the power grid in Norway is hydropower, which by definition is renewable. In addition, new production capacity for renewable energy is being installed, with wind, sun and small hydro as energy sources.<sup>5</sup>

The deliveries of renewable energy result in the output that can be utilized at the other end. Being able to manage energy use is of crucial importance, because energy becomes a scarce resource when it needs to be divided between an ever-increasing number of users. Smart Grid is the general term for a new generation power grid using new communication technology to use the energy infrastructure more efficiently. Smart grids are characterized by a number of different systems and components with a common feature – they have combined the power grid with the internet. In a Smart grid, output can go both ways, and buildings can produce electricity which is then fed back into the grid.

The introduction of smart meters, also called advanced or automatic metering systems (AMS), is part of the development of smart grids. They replace the old electricity meters in the fuse cabinet, and send automatic readings to the grid company.<sup>6</sup> Smart meters are an important component of a smarter power grid, since they deliver comprehensive information on the load on the grid and the effect that is being taken out at any time. All Norwegian households are expected to have smart meters installed within 2019.

In order to get maximum output, the grid needs to be built, and critical infrastructure must be operated as rationally and efficiently as possible. In this work, the energy companies play an important role. Ensuring a secure power supply is an important task they help to achieve. Implementation of systems for monitoring and remote control are also components that contribute to ensure a secure power supply.

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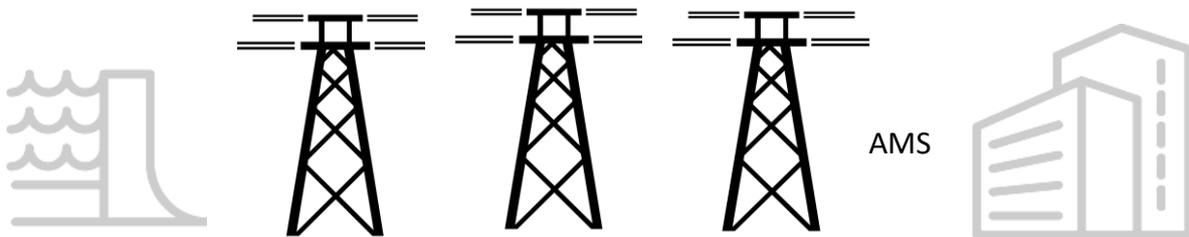
<sup>4</sup> Since energy consumption and management mainly happens in connection with the buildings that consume the energy, this part of the definition belongs under the area 'smart buildings'.

<sup>5</sup> We have excluded energy exchange with the rest of Europe here, as the energy mix contains fossil sources such as coal.

<sup>6</sup> Source: Smartgrids.no

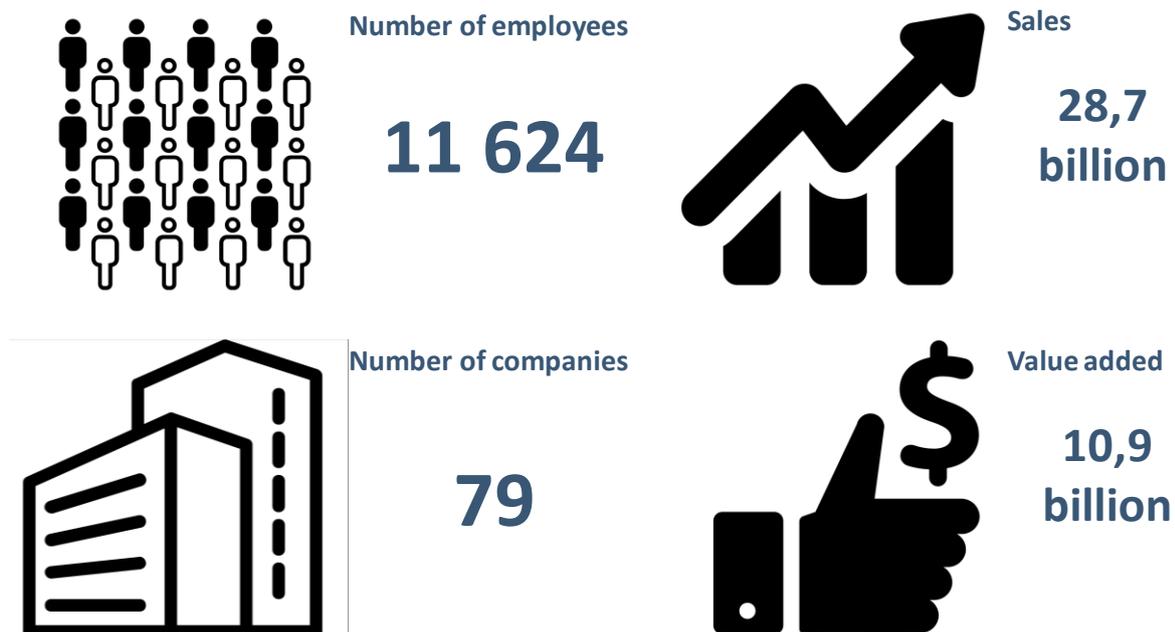
In the value chain for the realization of smart energy solution, we find both the traditional energy companies, companies that deliver solutions for power management, application developers and systems for monitoring and registration.

Figure 3-1: Smart energy value chain



We have identified 79 companies within smart energy. In addition, there are eight sole proprietorship or entrepreneurial enterprises, in the population. In 2015, total value added by these companies amounted to NOK 10,9 billion. The companies employed approximately 11 600 people, while overall sales were NOK 28,7 billion.

Figure 3-2: Key figures Smart energy

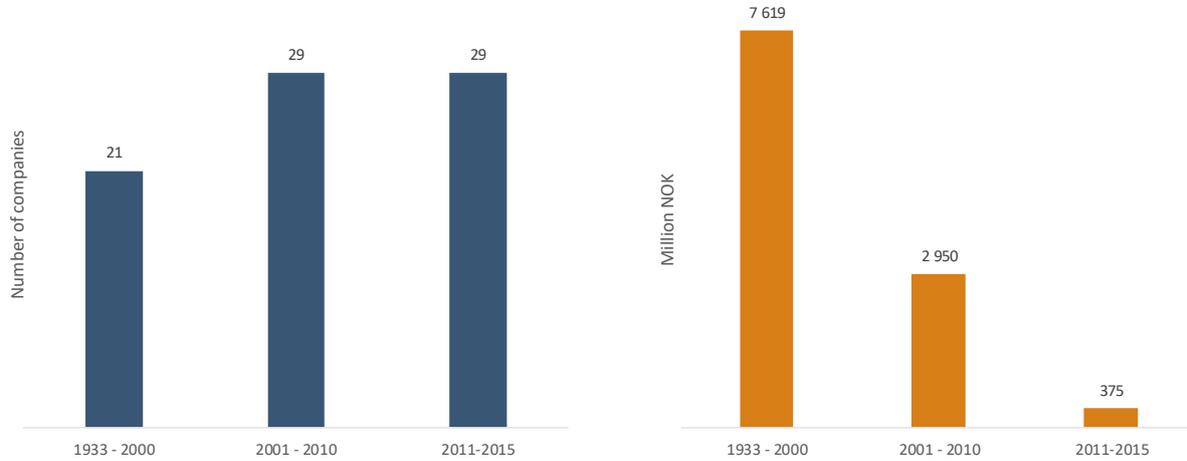


The suppliers of smart energy are mainly mature and established companies. Many of them have existed for a long time, which indicates a high level of maturity. New suppliers tend to be niche suppliers targeting a narrower part of the market.

This is illustrated in the figure below. Here we have divided the suppliers into three groups based on the year of establishment of the companies. The three periods indicate if the suppliers were established for a long time ago, are fairly new or established in recent years. The figure to the left shows number of companies in 2015, by year

of establishment, and the figure to the right, shows value added in 2015 in million NOK, by the year of establishment.

**Figure 3-3: Year of establishment and aggregated value added. Source: Menon**



In the following, we present some examples of companies within the area of smart energy that illustrate the variety of activities in this field.



eSmart systems provides software solutions to the energy industry, service providers and smart cities. More specifically, their software platform is developed to handle Internet of Things, big data and to perform analyses in real time. The software platform yields many smart solutions. For instance, it can give grid operators insight into the energy distribution network, and makes it possible to monitor the air quality in cities.

Smart grid Norway provides flexible solutions for operation and and energy optimization through integration of smart technology. Their software platform Discovery is modularized and based on open interfaces. It can be used for measuring, processing, analysis and is applicable in a variety of industries.



Zaptec's vision is to revolutionize numerous industries including electric mobility, power grid infrastructure, and renewable energy by applying a unique and patented technology for supercompact power electronics and transformers. One of their coming products, ZapCharger Pro, will make it possible to charge over 100 electric vehicles in a day, using only a single 63A circuit.

### 3.2. Smart buildings

The construction industry was an early adopter of technology to control and improve the efficiency of energy consumption in buildings. The authorities have been important drivers of this development by setting requirements for everything from energy consumption levels in new buildings to the use of specific materials and sorting of the rubble when buildings are pulled down. The possibilities for smart solutions in buildings are endless. One common denominator is the development of systems that communicate with each other and ensure that the user gets the right information at any time. In every aspect of this process, from the choice of materials to technical solutions, there is a large potential for improving building quality while reducing resource use.

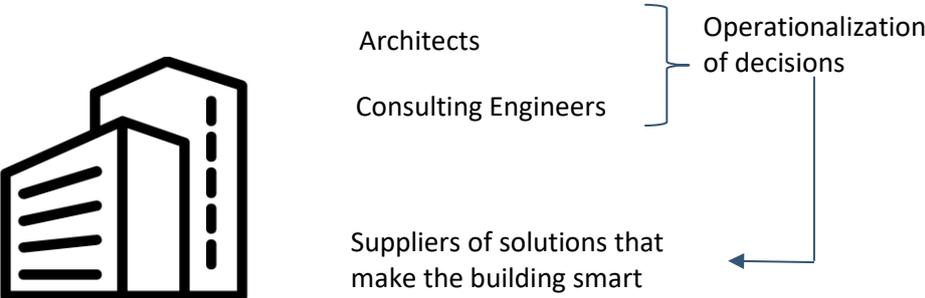
One goal, for example, is that the energy balance of new buildings being constructed today should be zero during their life-cycle. This means that they must produce the same amount of environmentally friendly energy that has been expended on their construction and operation in the same period. This would have been completely unthinkable only a few years ago. To achieve this, the buildings have to employ smart technology that manages energy consumption in an efficient way. The construction industry terms these buildings “smart buildings”.

It is the owner of the building who determines the specifications of the building during planning and construction. This has an impact on what technical details are implemented in the buildings, and thus how smart these buildings will be. The official requirements for the design of new buildings by the authorities can be seen as minimum requirements with regards to functionality and energy consumption. Our discussion partners in the industry state that these requirements mostly apply to new buildings, while regulations for rehabilitation projects are less strict.

The value chain for a building, regardless of whether it is a smart building or not, is long. Within this value chain, architects and consulting engineers play an especially important role in the process of realizing smart buildings, because they set the premises for planning the building in a smart way. The part of the construction industry that does the actual building then operationalizes the decisions made at the drawing board. This is done by procuring and implementing solutions that make the building into a smart building.

Identifying and defining suppliers that are specialized within smart buildings is a demanding task. The reason for this is that all parts of the value chain must contribute to realizing a smart building.

Figure 3-4: Multiple parts of the value chain contribute to realizing smart buildings



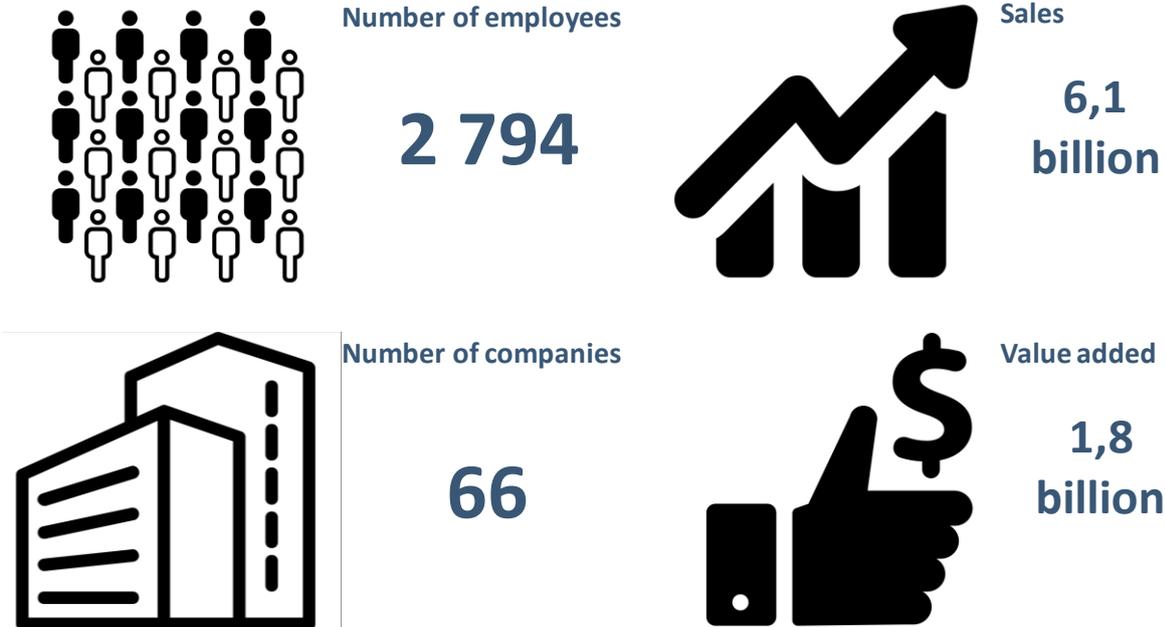
Since it is the actual *projects* which are smart, this means that suppliers deliver smart solutions to those projects where there is demand for such solutions, and more traditional solutions for other projects.

Systems to control energy consumption in buildings have been on the market for many years and are thus not a new thing. At the same time, better access to broadband and smartphones have opened up new possibilities, with more actors developing applications for management and monitoring of energy consumption.

The Norwegian Interest Group for Energy Efficiency (IEE) is a good example of how suppliers join together to strengthen traditional goods and services in connection with new solutions. IEE is a network of electro companies and suppliers that have, or wish to gain, knowledge and competence on energy efficiency in commercial and industrial buildings. IEE is meant to promote demand for future-oriented and innovative solutions within energy efficiency in the market. IEE helps companies to enter this market through competence building and market activities.

We have identified 66 companies within smart buildings. In addition, there are seven sole proprietorship or entrepreneurial enterprises, in the population. In 2015, total value added by these companies was NOK 1,8 billion. The companies employed approx. 2 800 persons, while total sales were NOK 6,1 billion.

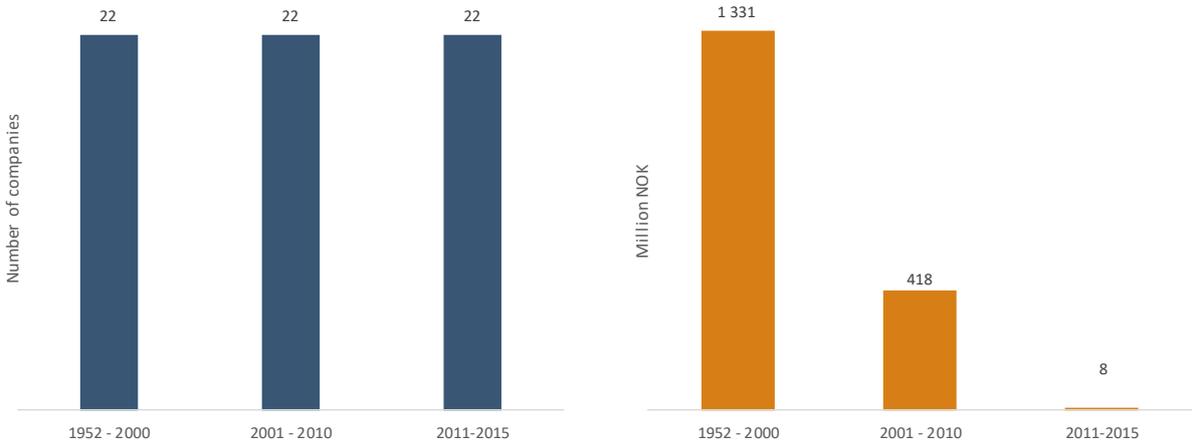
Figure 3-1: Key figures Smart buildings



The suppliers to smart building are a mix of mature and established companies and suppliers that are finding new business opportunities due to the emergence of smart cities. New suppliers tend to be niche suppliers targeting a narrower part of the market especially in monitoring of energy consumption.

This is illustrated in the figure below. Here we have divided the suppliers into three groups based on the year of establishment of the companies. The three periods indicate if the suppliers were established for a long time ago, are fairly new or established in recent years. The figure to the left shows number of companies in 2015, by year of establishment, and the figure to the right, shows value added in 2015 in million NOK, by the year of establishment.

Figure 3-2: Year of establishment and aggregated value added. Source: Menon



In the following, we present some example for companies within smart buildings that show the variety of activities in this field. Many of these suppliers are active internationally.



**Schneider Electric** is a global specialist in energy management and automation with operations in more than 100 countries. It offers integrated energy solutions across multiple segments such as smart cities, energy efficiency, smart homes and electrical utilities & renewables.

**Viva Labs** enables partners within the utility, telecommunications and other industries to quickly launch cutting-edge smart home products under their own brand, strengthening their existing product portfolio, driving revenue, and increasing customer loyalty. The first Viva-based solution was launched in Norway in November 2015 under the Vord brand.



### 3.3. Smart resources

Smart resources is an area that comprises efficient and sustainable solutions for water supply, refuse collection and waste management. The suppliers are companies that deliver systems that allow us to use available resources in a smarter way, thus minimizing waste. The biggest challenge in identifying this group of companies is that digitalization technology does play a role in the production of goods and services in this area, but not necessarily as a key component.

Municipalities are important drivers for the choice and implementation of solutions on behalf of inhabitants and the business and industry sector with regards to both water supply and waste management solutions. This means that innovative public procurement plays in central role in realizing and developing the improvement potential especially with regards to household waste.

Waste management, sorting and recycling of both wet and dry waste is a mature industry in Norway. Many players in the sector are offering very advanced, specialized digital solution, while others offer this in combination with other services. Tomra is an example for an international company within waste management where digital technology is an important system component.

Waste is viewed as a resource, both because there are now many different applications for waste and because unused waste is an environmental burden. Within the field of waste management, especially influences from the development of the circular economy have had an impact on the development of smarter solutions. Greenhouse gas emissions from waste can be reduced through measures such as reducing the overall amount of waste, more recycling and increasing the use of organic waste for energy production. This has led to broader way of thinking where the overall life cycle of products and services constitutes the basis for the development of new technology. Economic actors, such as companies, private individuals and municipal enterprises all act as drivers to make this succeed.

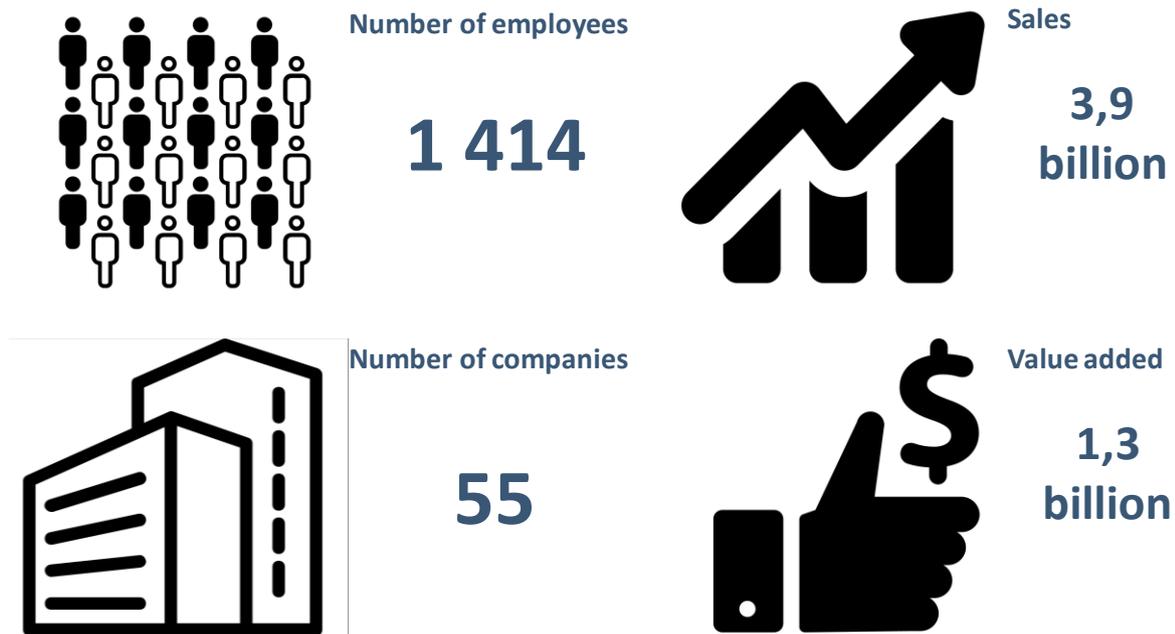
Laws and regulations also are a driver for the development of solutions within smart resources. On December 2, 2015, the European Commission presented its so-called Circular Economy Package. This contained an action plan with 54 measures to achieve a circular economy and concrete proposals for changes to the EU's waste regulations. The objective is to achieve increased efficiency in the use of resources with regards to production, consumption and waste management; this will trigger innovation in the waste industry.

Access to clean water may become a scarce resource on a global basis. Norway has strict quality requirements for Norwegian drinking water, with the consequence that Norwegian purification companies have developed knowledge and competence that make them internationally competitive. Despite the fact that water is not a scarce resource in Norway at the moment, the number of technical installations reducing water consumption is rising. A series of municipalities require the installation of water meters in order to increase residents' demand for technology that reduces water consumption. The use of digitalization technologies when renewing water pipes is also part of the water cycle in smart communities.

Within both the waste management industry and actors that ensure a supply of clean water, we find several major corporate groups that play an important role in the development and implementation of new solutions. Digitalization technology can be a component of these solutions, but does not necessarily have to be.

We have identified 55 companies within smart resources. In addition, there are seven sole proprietorship or entrepreneurial enterprises, in the population. In 2015, their total value added was NOK 1,3 billion. The companies employed just under 1 400 persons, while total sales were slightly less than NOK 4 billion.

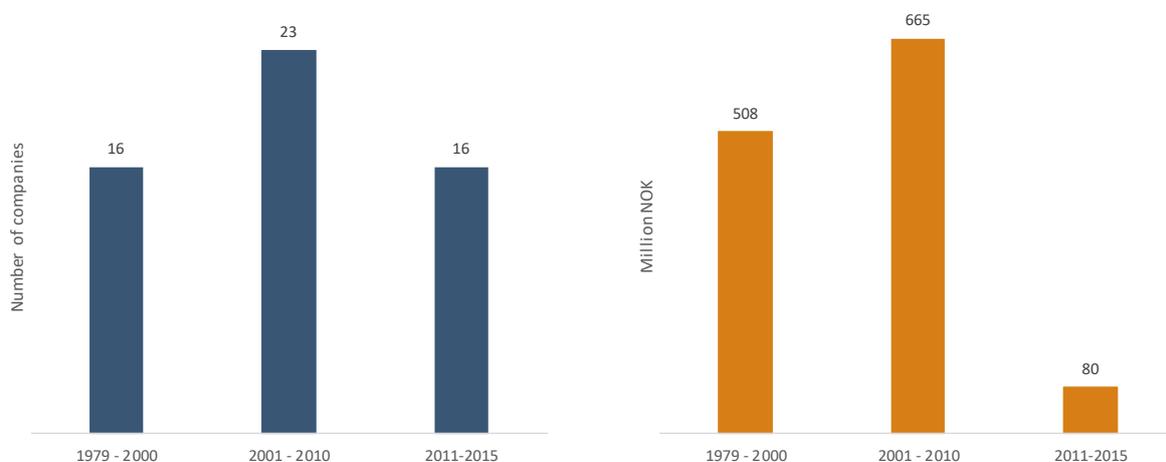
Figure 3-3: Key figures Smart resources



The suppliers to smart resources are a mix of mature and established companies and suppliers that are finding new business opportunities due to the emergence of smart cities. New suppliers tend to be niche suppliers targeting a narrower part of the market. Most companies are established after year 2001.

This is illustrated in the figure below. Here we have divided the suppliers into three groups based on the year of establishment of the companies. The three periods indicate if the suppliers were established for a long time ago, are fairly new or established in recent years. The figure to the left shows number of companies in 2015, by year of establishment, and the figure to the right, shows value added in 2015 in million NOK, by the year of establishment.

Figure 3-4: Year of establishment and aggregated value added. Source: Menon



In the following, we present some examples of companies within the area of smart resources that illustrate the variety of activities in this field. Several of these suppliers are active internationally.



**Olimb** offers pipe renewal without digging. The company has developed solutions for the rehabilitation of existing pipe networks without having to dig up the ground, open up floors or demolish walls. Pipe rehabilitation is offered both outside for the municipal network and for individual buildings.

Biowater Technology develops and builds innovative solutions for treatment of municipal and industrial wastewater. The company delivers innovative technologies and solutions for the future that provides an environmentally-friendly result.



## 4. Smart community planning

It is the inhabitants that make use of the community. Being able to influence social development so that society becomes more functional for more people is therefore an important part of the development of smart communities. Through the Dream Commitment-initiative, this mechanism is defined in the following way: Planning and decision-making includes services that can deliver efficient and user-oriented services to the population which can contribute to active participation in planning and decision processes and result in a well-coordinated offer of services.<sup>7</sup>

The companies that supply services for community planning are characterized by two features: Either they deliver an application that allows the user to give feedback, or they collect data on the status and flow of movement in the community that can be used to plan social development in a new way and to take action where needed. Big data is a natural part of smart community planning. Sensor technology makes it possible to collect this type of data. Satellites can be used to survey larger areas.

In principle, all actors that plan, build and use a community are integral parts of smart community planning. Three main components are put together to create a bigger pattern:

1. Artificial intelligence that charts how different actors use the community
2. A system that forwards this information
3. Finally, the data must be combined and analyzed

Some of these tools are difficult to trace back to the company that has developed them. *Traffikagenten* is an example.



Trafikkagenten, with its slogan «We need you to spy», is distributed as an application and mapping tool that lets pupils report positive and negative experiences from their way to and

from school. Trafikkagenten was developed by Oslo City's Agency for Urban Environment in cooperation with the Norwegian Institute of Transport Economics and the Agency for Education. The pupils give feedback on traffic safety and on how they experience their journey to and from school with the help of smartphones and tablet computers.

Linking data from multiple sources is a tool that can be used in a smart community planning. The example below shows some of the data sources that can provide a better understanding of how people of Oslo uses bikes to get around. In the example below are some of the sources to understand this visualized.

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<sup>7</sup> *Drømmeløftet – Innovation Norway*

Figure 4-1: Different elements in smart bike planning



40 stations that register passings by bicycles in Oslo

+



Bike application that registers your activity on the bike

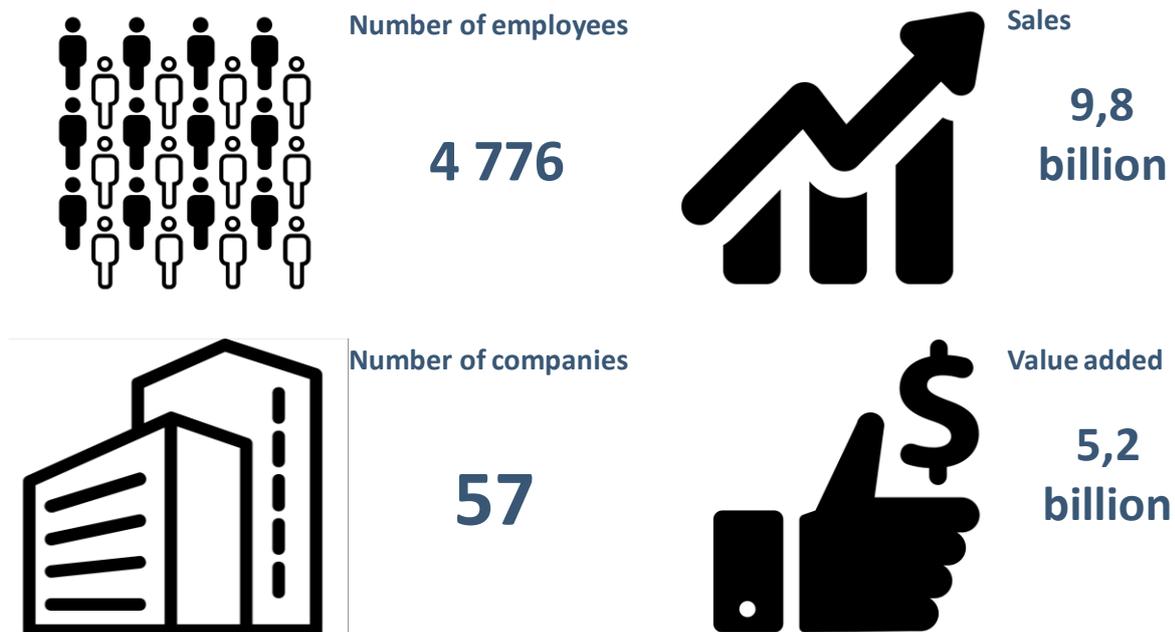
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Use of city bikes is registered and provides information on how users move around the city

We have identified 57 companies within the area of smart resources. In addition, there are eight sole proprietorship or entrepreneurial enterprises, in the population. In 2015, total value added for these companies was NOK 5,2 billion. The companies employed around 4 700 persons, while total sales were NOK 9,8 billion.

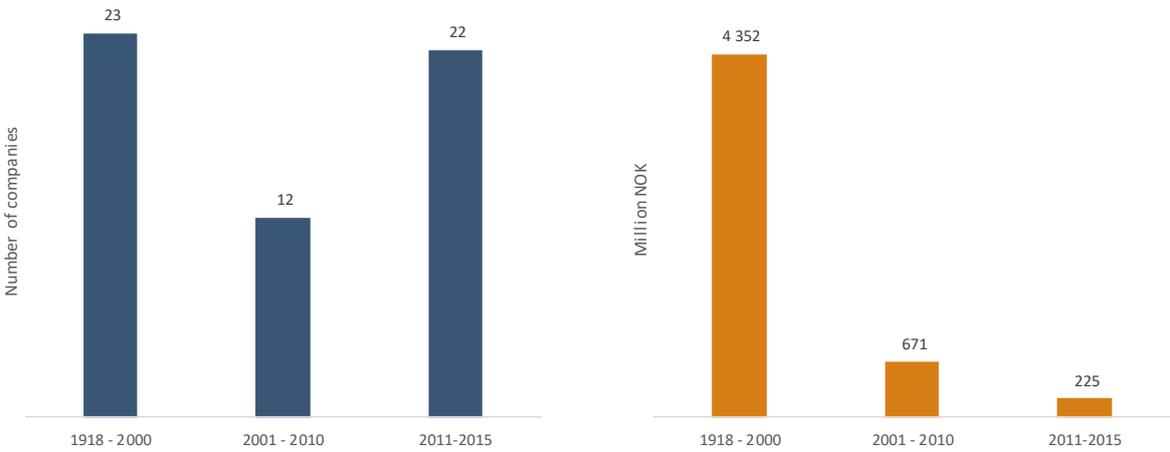
Figure 4-2: Key figures Smart community planning



The majority of suppliers to smart community planning are fairly new companies established after 2001. Internet of Things has especially created new business opportunities in this area.

This is illustrated in the figure below. Here we have divided the suppliers into three groups based on the year of establishment of the companies. The three periods indicate if the suppliers were established for a long time ago, are fairly new or established in recent years. The figure to the left shows number of companies in 2015, by year of establishment, and the figure to the right, shows value added in 2015 in million NOK, by the year of establishment.

Figure 4-3: Year of establishment and aggregated value added. Source: Menon



Social development is driven by a complex interaction between technology, environment and human choices. Good results require a holistic understanding, planning and implementation of projects. Cowi is an example of a firm that plans and develops within several smart areas.

## 5. Smart transportation

The defining feature of development within the transportation sector is the transition from fossil fuels to zero emission solutions. The development of battery technology and charging stations has led to a revolution in passenger traffic in the form of electric and hydrogen-powered vehicles. An increasing share of public transport makes use of biofuels, and more and more ferry routes are exploring the possibilities to switch to electric ferries.

The Dream Commitment-initiative defines smart transportation as follows: Transport and mobility comprise ICT-supported solutions for well-integrated transport and logistics services. This includes both public transport, commercial transport, private vehicles, cyclists and pedestrians. The objective is to establish the safest, most environmentally friendly and efficient transport solutions possible.

Companies in the transport sector have two defining characteristics: One is that traditional goods and services are delivered in a new way with the help of technology, such as car sharing, real-time systems, and applications for the purchase of travel cards or the use of city bikes. The second is the use of new energy solutions such as electric power. In this area, we also find companies that deliver smart solutions for optimal traffic management. Smart transport solutions encompass a large number of different areas and ways of moving around in society. Many of these solutions are technical, and digitalization technology does not constitute a key part of the product.

The suppliers of smart transport solutions deliver high-technology solutions that are of essential importance to the development and functionality of society. The companies supply solutions for transport and communication that result in large social benefits, and also create significant business opportunities.

### 5.1. A strong maritime cluster is developing environmentally friendly sea transport

Within the area of transportation, a number of companies supplying maritime equipment and services are focusing on developing environmentally friendly sea transport. A strong maritime cluster has taken the lead in the development of new solutions in cooperation with other environments. Siemens for example is running an extensive project, headquartered in Trondheim, to develop electric propulsion systems for ships. Systems from here were installed on *Ampere*, the world's first zero-emission car and passenger ferry. The electric ferry *Vision of the Fjords* was named "Ship of the Year" in 2016. When discussing the national budget in 2015, the Norwegian parliament stated that all future public tenders for ferries should include a requirement for zero-emission (and low emission) technology where such solutions are technically feasible. The ferry company Fjord1 has started testing of the gas-powered ferry *Fannafjord*, which employs a hybrid gas-and-battery solution.

Norwegian ports are now facing a situation where offering land-based electricity to ships may become mandatory when vessels stay in the harbour area for an extended period of time. New technology and smart solutions make this possible. The use of land-based electricity is intended to reduce noise and local pollution in ports. A transition to land-based electricity means that fuel consumption in port will be eliminated or significantly reduced. The Norwegian parliament has requested the government to draft an integrated plan for increased use of land-based power in Norwegian ports, including financing options and appropriate policy measures to achieve this objective.

## 5.2. Cycling, car-sharing and environmentally friendly fuels have an impact on private passenger traffic

Passenger traffic is changing. Companies that offer car-sharing schemes contribute to a development where fewer people see a need to own their own cars. Oslo, Trondheim and Drammen are offering city bike schemes, and Bergen is about to establish a similar programme. The Norwegian incentive scheme for electric cars has resulted in the number of electric vehicles increasing from just above 3000 in 2010 to more than 100 000 in 2016.<sup>8</sup> This has created new business opportunities for companies that supply charging equipment and charging stations. Supply of and demand for electric bicycles is growing. Electronic travel cards lead to increased cost-effectiveness in public transport, a development that benefits both the users and the providers of such services.

## 5.3. Sensor-based traffic management reduces travel time

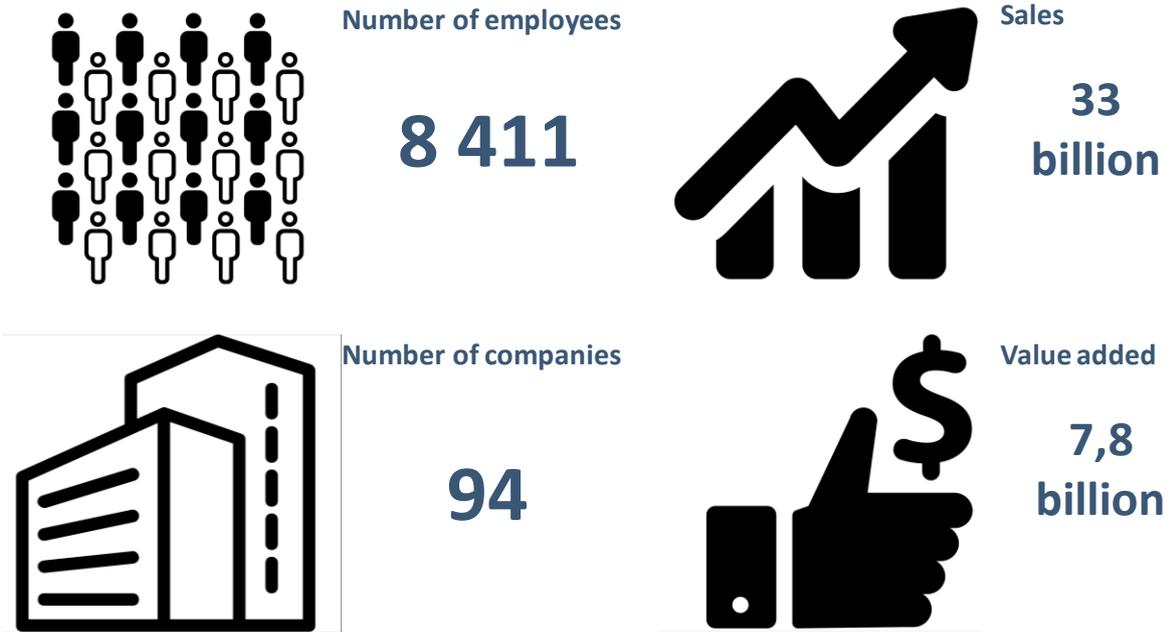
Sensor technology is well established, and increasingly being employed within traffic management. Smarter cities use new technology and insight to improve their infrastructure for traffic management. The technology to achieve this goal is well-known, so development in this area mainly depends on prioritizations and costs. Sensors in combination with big data provide unlimited possibilities to effectively manage pedestrians, cyclists and drivers of motorized vehicles in smart communities. This can be realized by equipping our surroundings with artificial intelligence, collecting information from these devices over the web, and then identifying larger patterns with the help of big data and analysis.

We have identified 94 companies within the area of smart transport. In addition, there are eight sole proprietorship or entrepreneurial enterprises, in the population. In 2015, total value added for these companies was just above NOK 7,8 billion. The companies employed around 8 400 persons, while total sales were NOK 33 billion.

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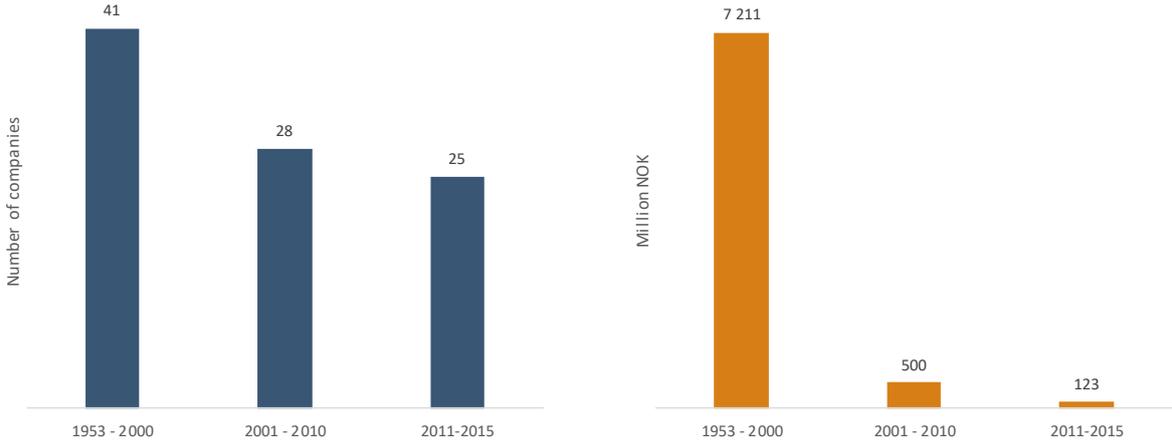
<sup>8</sup> *Norwegian Electric Vehicle Association*

Figure 5-1: Key figures Smart transportation



Suppliers to smart transportation are a mix of both mature and new companies. This is illustrated in the figure below. Here we have divided the suppliers into three groups based on the year of establishment of the companies. The three periods indicate if the suppliers were established for a long time ago, are fairly new or established in recent years. The figure to the left shows number of companies in 2015, by year of establishment, and the figure to the right, shows value added in 2015 in million NOK, by the year of establishment.

Figure 5-2: Year of establishment and aggregated value added. Source: Menon



In the following, we present some examples of companies within smart transportation that illustrate the breadth of variation within this field.

Uber was created in 2009 in order to solve a simple problem – how to get a lift by pushing a button. Seven years and more than 2 billion journeys later, the problems Uber works on are much more complex: Removing traffic jams and reducing pollution by ensuring that more persons travel in fewer cars. Innovative technology makes it possible to deliver this product.

**UBER**



BT Signaal is a supplier of Intelligent Transport System (ITS) technology, such as solutions for road user charging, parking, access, ticketing and traffic management.

## 6. Smart welfare services

The combination of an ever-increasing share of older people, high wage costs and a shortage of labour has resulted in a growing need for the development of welfare technology in order to be able to provide good-quality care to more people with fewer resources. Technological progress makes it possible to develop new, user-friendly and cost-effective solutions within health and welfare services, and increased use of technological solutions has contributed to the growth of new business areas and development of society as a whole. By combining different disciplines, a new market within welfare technology has opened up. The municipalities are important drivers of this development and employ the new solutions for their care and health services.

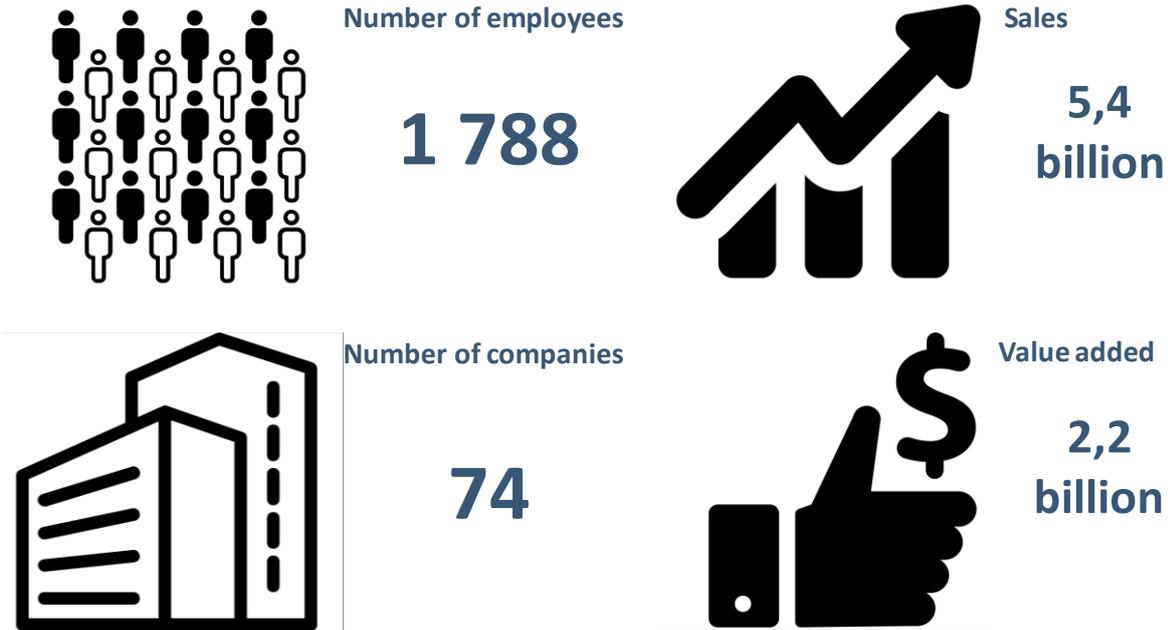
The smart companies within the health and welfare sector are characterized by the fact that they either develop IT-services aimed at the health industry, or employ technological solutions which have not been used in the industry before to any great degree. Products and services can vary from more general solutions for security and safety such as smart house technology to individual technical aids such as health-related smartphone applications and sensor-based warning systems.

Demand for smart health and welfare services comes from both private and public actors. The products and services aimed at private individuals are mainly intended to fulfill needs and requirements such as analyzing one's own state of health, warning systems that make it possible for ill and older persons to keep living independently in their own homes, and digital solutions that simplify personal communication between patients and health professionals.

Products targeted at public institutions often help reduce the workload of staff, make communication between employees more efficient, or improve the speed with which a diagnosis can be made. In other words, the smart companies within health and welfare services improve the user experience, help save money, and make the health industry more efficient, both already now and with a view to the future.

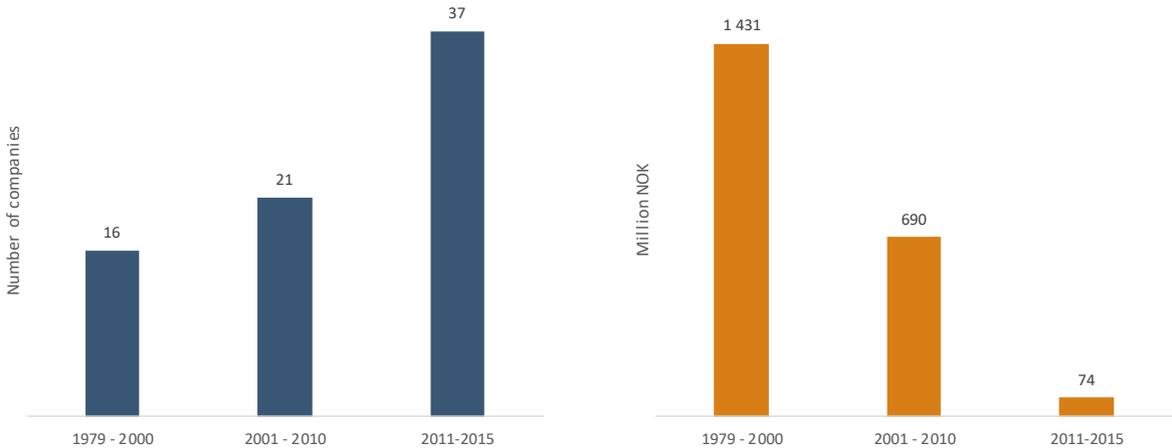
We have identified 74 companies supplying health and welfare services that fit our definition of smart companies. In addition, there are five sole proprietorship or entrepreneurial enterprises, in the population. In 2015, total value added for these companies was NOK 2,2 billion. The companies employed around 1 800 persons, while total sales were NOK 5,4 billion. Digitalization is at the core of the development and use of the health-related products that can be considered 'smart', and the smart companies will typically engage in IT-activities.

Figure 6-1: Key figures Smart welfare services

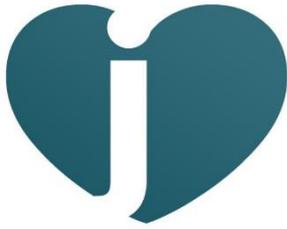


Most suppliers to welfare services are relatively new companies. This is illustrated in the figure below. Here we have divided the suppliers into three groups based on the year of establishment of the companies. The three periods indicate if the suppliers were established for a long time ago, are fairly new or established in recent years. The figure to the left shows number of companies in 2015, by year of establishment, and the figure to the right, shows value added in 2015 in million NOK, by the year of establishment.

Figure 6-2: Year of establishment and aggregated value added. Source: Menon



In the following, we present some examples of companies within smart welfare services that show the breadth of activities in this field.



Jodacare has developed a smartphone application targeted at dementia sufferers, their families and healthcare professionals. The application makes it easier to communicate and interact for all parties with the help of direct messages, picture-sharing, a joint calendar and a personal profile that provides care professionals with information on the person receiving services.



Enforme AS has developed an e-health tool that allows users to assess their own lifestyle and state of health. Once the assessment is completed, the users receive a report supposed to motivate them to make smaller and bigger changes to their lifestyle. The report also provides information on progress over time, and tailor-made solutions are available for

companies, municipalities and upper secondary schools.

Xcenter offers solutions and products for effective supervision of residents in nursing homes, assisted living facilities and private homes. The product RoomMate automatically triggers an alarm in critical situations, for example when the user has experienced a fall.



No Isolation helps people to break out of loneliness and social isolation. The concept aims to enable the user to participate actively in his own everyday life. The first product is the robot AV1, for children and young people with long-term illnesses. AV1 was made available in the autumn of 2016.

# 7. R&D environments and projects

The R&D community working on the development of smart products is both numerous and varied. Numerous because there are many different research institutions and environments that are researching and developing solutions within fields that provide a scientific foundation for the development of smart products, varied because the areas of research span a wide range of topics, both internally within the individual institutions and across different institutions.

Despite the fact that the individual institutions tend to specialize within specific niches, it can often be difficult to categorize research projects according to the operative definition of ‘smart companies’. A lot of the research being done at the moment will likely be able to provide a basis for the development of services and products within several of the smart industries. In this study, we have charted more than one hundred research projects from ten research institutions that are relevant for the development of smart products. We have categorized these projects as best we can – they have either been finalized within the last five years or are still ongoing. We would like to point out that several of them are cooperation projects, which means that in some cases, the assignation of projects to specific institutions can appear somewhat misleading.

Figure 7-1: Research projects at the University of Stavanger

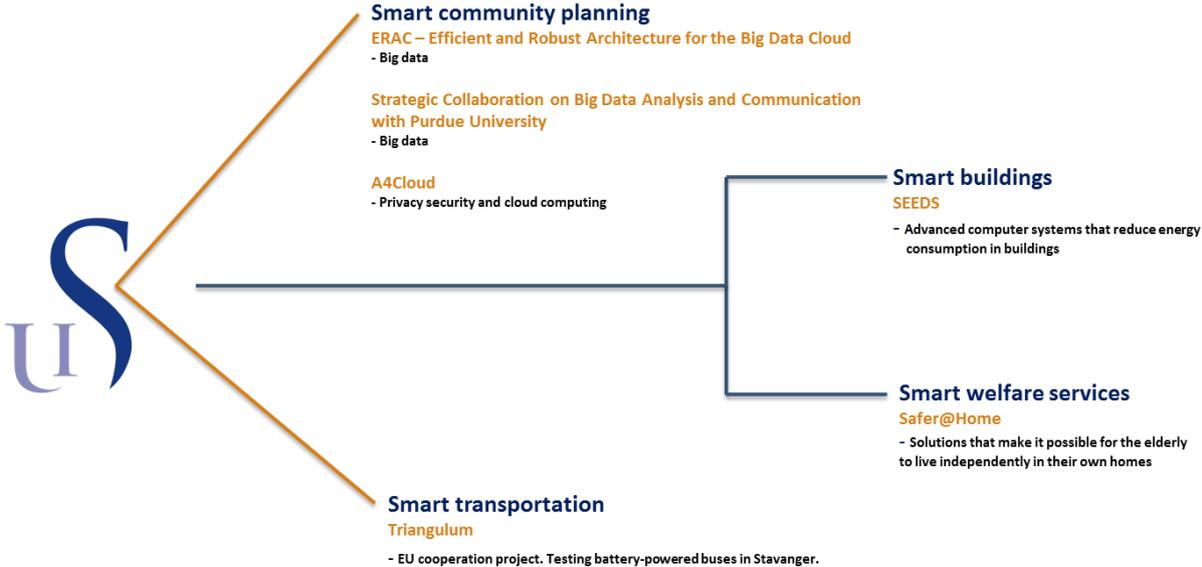


Figure 7-2: Research projects at the Norwegian University of Science and Technology (NTNU)

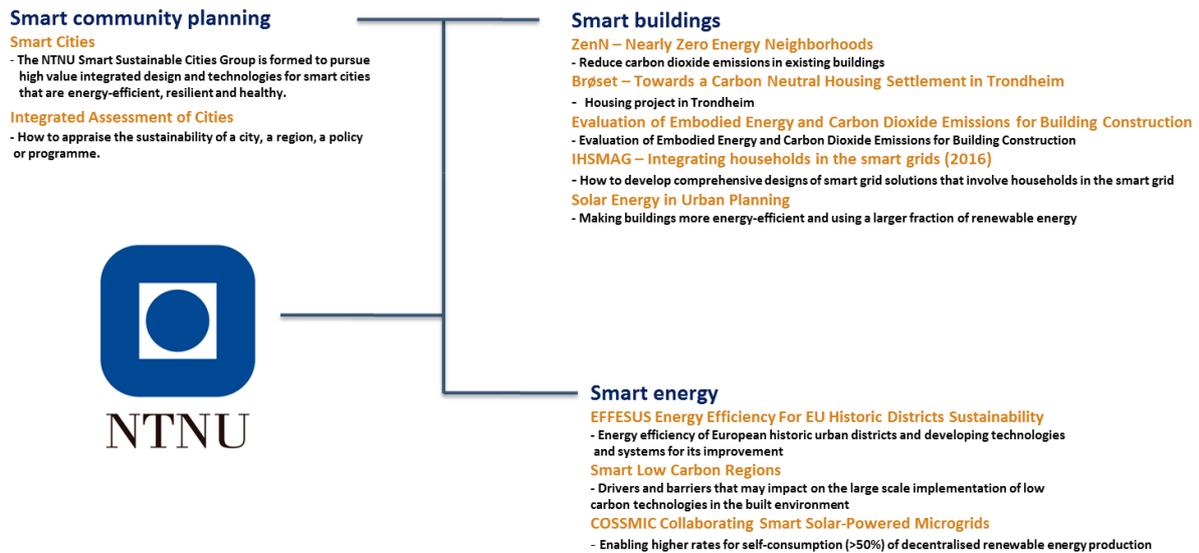


Figure 7-3: Research projects at University of Oslo

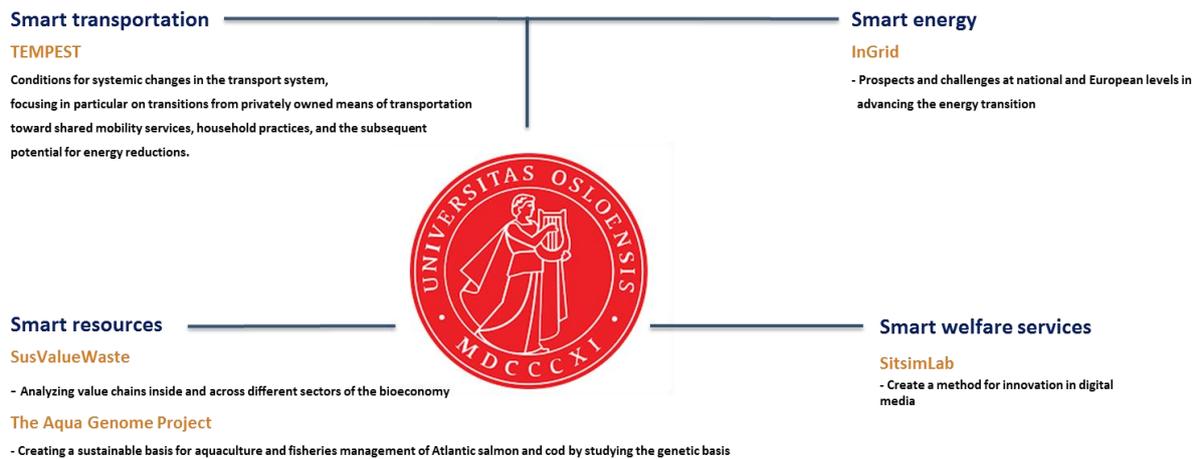


Figure 7-4: Research projects at the Institute for Energy Technology (IFE)

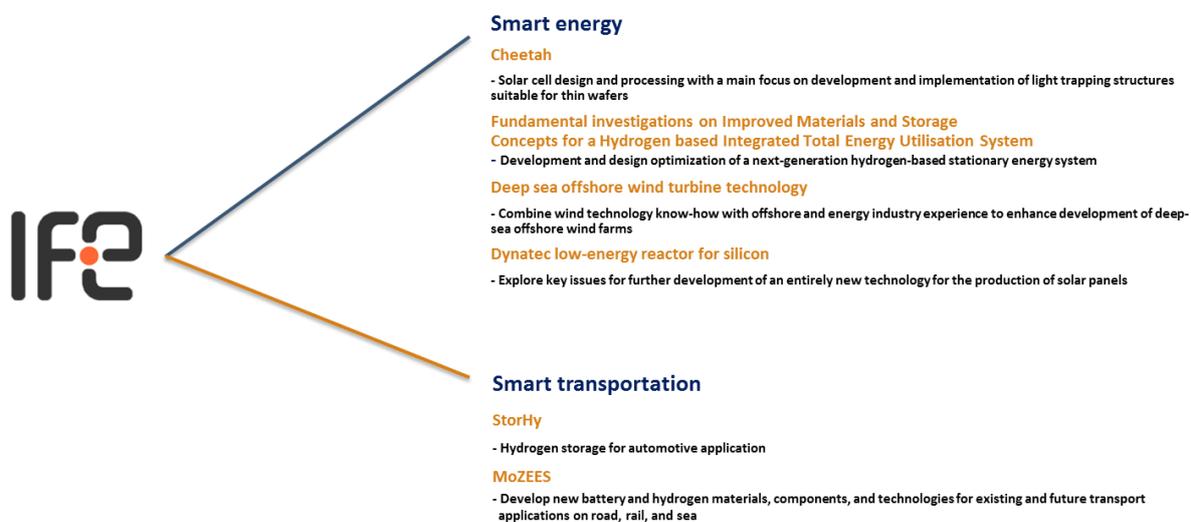


Figure 7-5: Research projects at SINTEF

**Smart welfare services**

- Ung IT**
- Identify commercially available technological welfare solutions for children with disabilities.
- App i Apotek**
- Develop a service model for the use of a drug application (mobile phone) in connection with administration of medications at home after discharge from hospital.
- SAMSPILL**
- Develop knowledge and experience about how the use of warning and localization technology can be integrated as part of the municipal operative care services.
- Erre mulig?**
- Digital solutions for children with ADHD
- Aktive Spor**
- Developing telephone application for dementia patients.

**Smart resources**

- PLATIRUS**
- Reduce the European deficit on Platinum Group Metals
- CABRISS**
- Develop a new recycling economy for solar panels.
- Compact**
- Develop a concept for the internationalization of agricultural technology to new applications in waste, energy and food.
- OptiCom**
- Increased sustainability in the value chain for energy recovery from waste

**Smart community planning**

- DYNAMO**
- Smart use of ICT to ensure a more dynamic transportation sector in Oslo.
- SMIO**
- Examine utilization of household waste and residual materials from fish processing, manufacturing products that will give added value.



**Smart energy**

- SuperSmart**
- Achieve significant environmental benefits through rapid implementation of efficient heating and cooling systems
- CINELDI**
- Designing tomorrow's flexible and robust electrical distribution network
- SET-Nav**
- Promote the development of good technology portfolios to achieve sustainable and efficient energy supply.
- BestPaths**
- Help solve the challenges of integrating large amounts of renewable energy in Europe's energy mix.

**Smart transportation**

- LORCENIS**
- Develop reinforced concrete with live-time extension.
- Leda**
- Transport oil and gas efficiently from offshore installations ashore through pipelines.
- RESGRAM**
- Development of recycled aggregate from excavated material for use in road construction and concrete production.

**Smart buildings**

- SkinTech**
- Develop knowledge and solutions for future exterior walls and windows with integrated technology.
- SEOPP**
- Help ensure that homeowners will rehabilitate their small houses to ambitious levels of energy efficiency.
- ZEB**
- Methods to eliminate greenhouse gas emissions caused by buildings.

Figure 7-6: Research projects at NIBIO, Bergen University College and UNI Research

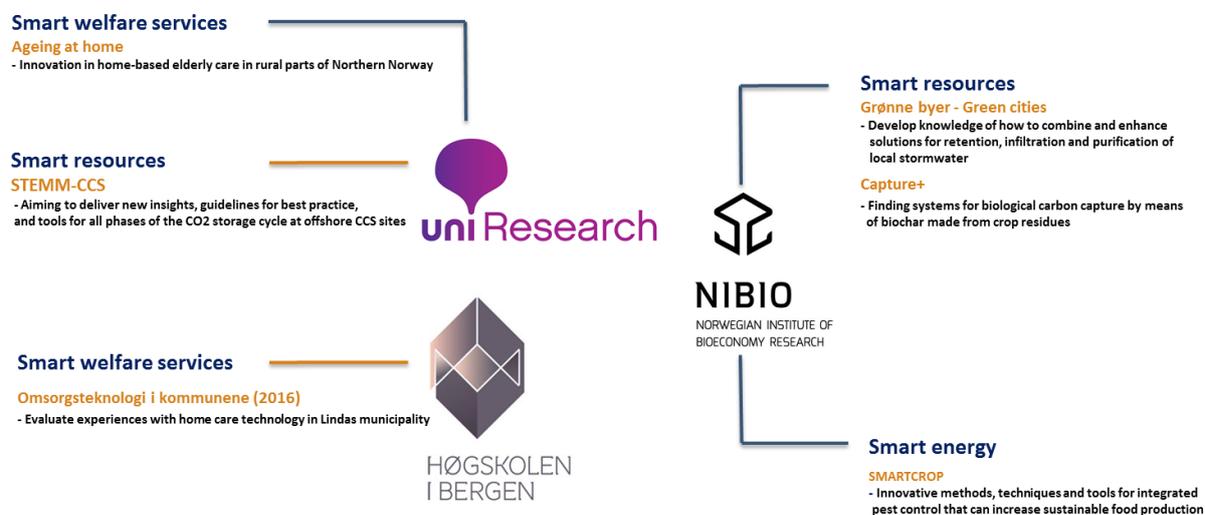


Figure 7-7: Research projects at Nofima

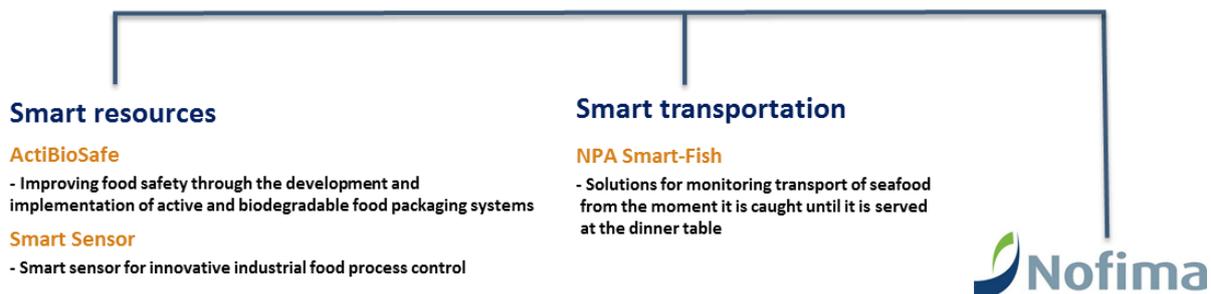


Figure 7-8: Research projects at the University College of Southeast Norway



## 8. Method and definitions

### 8.1. Method

There is no clear definition of the concept of «smart companies» in the literature on economics. In order to develop an unambiguous and joint understanding of the requirements the companies falling under this definition must fulfill, Menon has had a series of meetings and an ongoing dialogue with Innovation Norway. Once an operative definition had been agreed on, we have employed a number of different methods in the work of putting together a population of «smart companies».

Menon's accounting database, in combination with a detailed overview over Norwegian companies working with environmental technology, in the construction industry, the maritime sector, and the ICT and health industries, has provided the basis for our efforts to identify and select companies that belong to the six smart areas. Despite the fact that Menon's accounting database contains detailed information on Norwegian companies over the course of the last 25 years, the format of the data material is such that it had to be edited, supplemented and extended in order to satisfy the operative definition. Publicly available member and participant lists for major projects, conferences and relevant associations were used to complement the information from the database. Amongst others, Menon has reviewed the member lists of Abelia, Smarte Byer Norge, Vannklyngen and Oslo Medtech, and participant lists from conferences such as Smarte Veger, Zerokonferansen and Nordic Expo. While working on this study, we have also had discussions with key personnel and experts within several relevant industries and associations to help with quality assurance of the company population.

Due to the fact that resources for the project were limited, it has not been possible to investigate the topic in more detail for the time being.

### 8.2. Definitions

**Value added** is the industry's contribution to as a measure is directly comparable with Gross Domestic Product (GDP)NP. In accounting terms, it is expressed as operating profit (EBITDA) plus payroll costs. By value added, we mean the amount left to be distributed after the factors of production have been paid for – in other words, wages and salaries, dividends, taxes, and interest and instalments paid to lenders.