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Analysis of the Danish robotics industry

- A position of strength on
the rise

Executive summary

One of Denmark's fastest-growing industries

In only few years, Denmark has established one of the leading robotics and automation industries in the world – consisting of 292 companies across the country. Research, development and production for the global market have already created 8,500 direct jobs and annual exports of more than DKK 10 billion. Including sub-suppliers, the industry today employs more than 18,000 FTEs and generates revenue totalling DKK 27.8 billion. Our forecasts also show that the market will only keep growing in the years ahead.

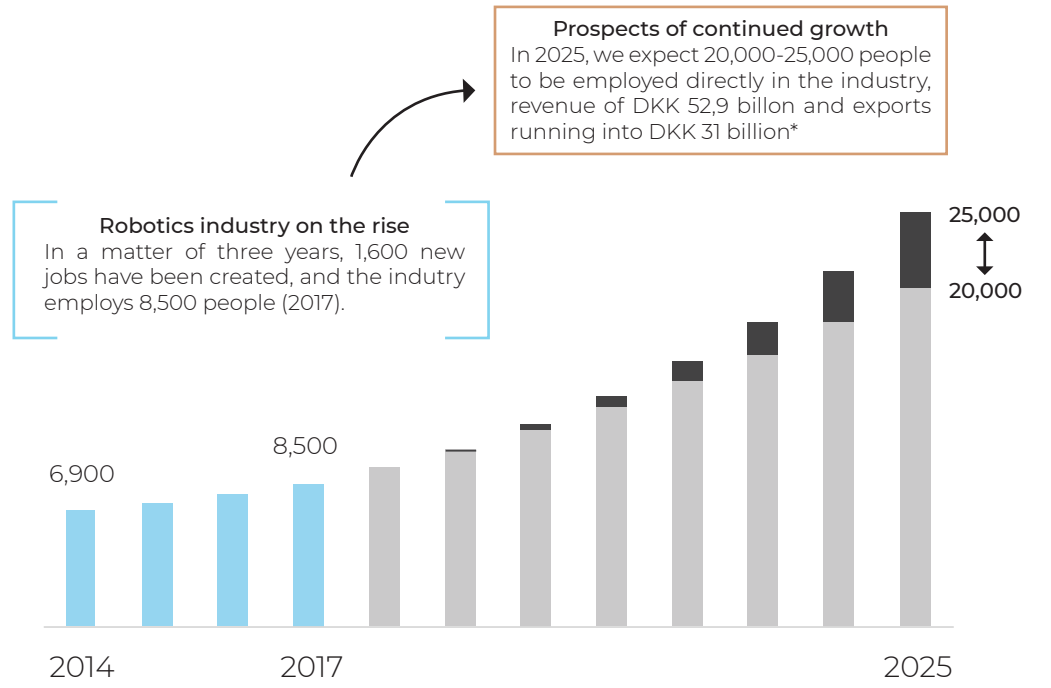
Denmark is one of the world leading

Particularly in the market for mobile robots and industrial robots that work alongside human beings, Danish businesses are leading in the global market. A market that is expected to grow by over 30% annually until 2025. The potential for Danish export and job creation is thus considerable.

20,000-25,000 jobs in 2025

According to our calculations, the Danish robotics industry may create up to 55,000 jobs already in 2025, provided that it follows the global market trends. Hereof, 25,000 people will work directly at producers, integrators, advisors and distributors. In addition, up to 30,000 people will be employed indirectly: individuals, who do not work in the above sectors itself, but whose jobs are dependent on activities in the robotics and automation industry. At the same time, revenue of DKK 42.6-52 billion is expected to be generated – a doubling/trebling in only six years.

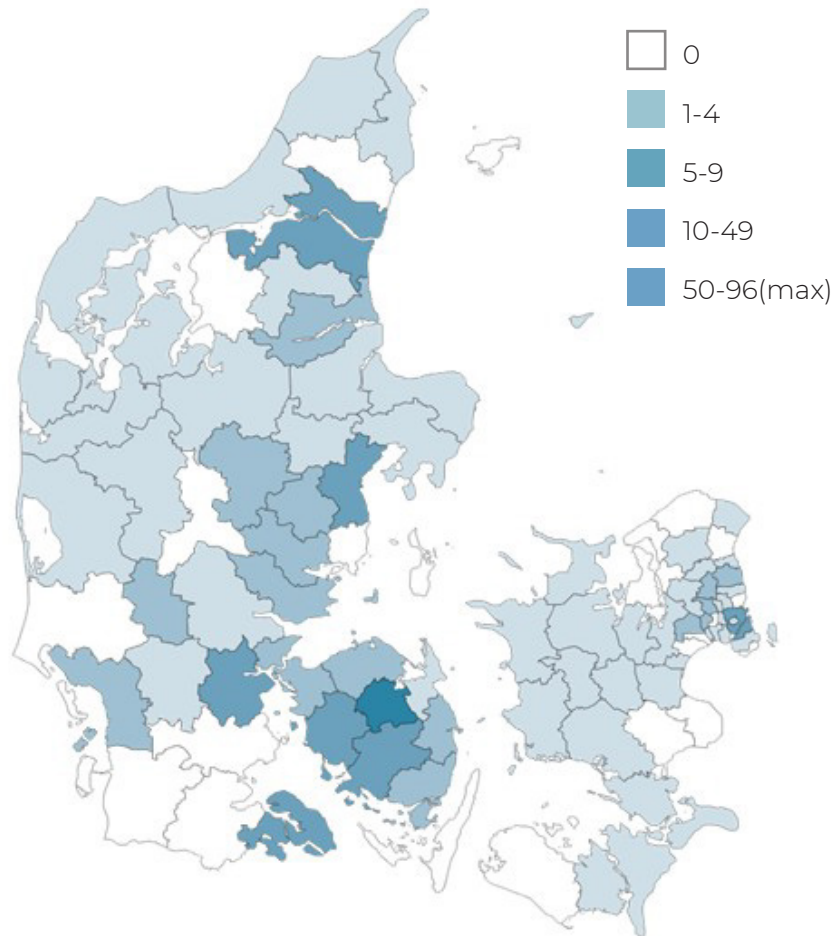
Prospects of fast-growing employment in the robotics and automation industry



*The scenarios are based on the leading International Federation of Robotics' (IFR) expectations as to growth in the world market for industrial robots and collaborative robots.

Executive summary

Businesses in the robotics and automation industry



The robots are arriving – from all parts of Denmark

Growth in the robotics and automation industry will benefit all of Denmark. The mapping of the companies shows that more than one third of all Danish municipalities have more than 50 jobs in the industry. Many of these jobs are close to educational institutions offering programmes related to the robotics industry. A great number of jobs are placed on Funen. In addition many jobs are placed in Aalborg, Aarhus, Sønderborg and Lyngby as well.

Provided that the growth rates in the industry keep increasing, it is very likely that the next Danish company with more than 1,000 employees will be a robotics company.

Improving the productivity of Danish industry

The robotics and automation industry is also of great value to Danish industry in general. A strong Danish robotics and automation industry has been one of the main reasons for the widespread use of robots in the Danish manufacturing sector, where Denmark ranks five on a worldwide scale – ahead of countries such as the USA, Austria, the Netherlands, Italy, among others. A position that is directly mirrored in the industry's productivity and as a result in Denmark's GDP. Studies show that the increased use of robots accounted for up to 10% of GDP growth from 1993-2007 period.

Qualified manpower in demand

Already today the robotics industry is calling out for qualified manpower – a challenge that is only going to increase as the industry grows. Universities, vocational and technical colleges as well as other educational establishments already offer robotics-focused programmes. However, whether that is sufficient to meet the demands of the industry is open to question. With prospects of up to 17,000 new jobs in the industry, more investments in robotics and automation training may be needed.

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The robotics industry today

Highlights

- The robotics industry stimulates growth and creates jobs all over Denmark
- Heading towards 10,000 jobs
- The next Danish business with 1,000+ employees is likely to be a robotics company



What is the robotics and automation industry?

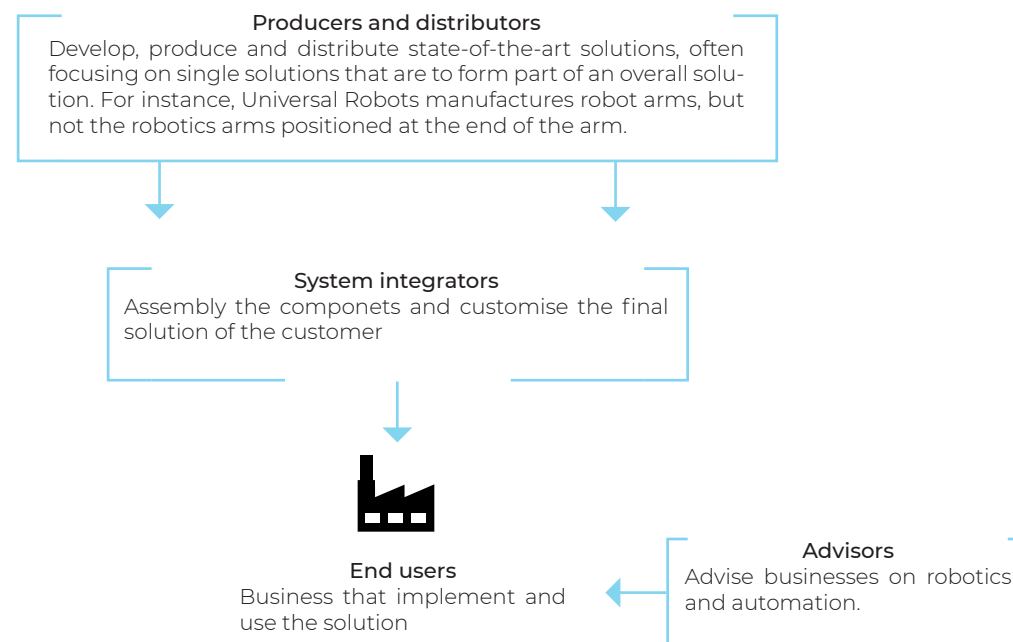
There is no one definition of the robotics and automation industry. If you google “robot”, you will get hits on everything from chat robots to industrial robots. No industry codes exist that can be used to identify this type of robotics and automation businesses unambiguously, one of the reasons being that this industry is relatively young, having matured in just the past few years. This is the reason why we have identified robotics and automation businesses individually in this analysis, see the description of method.

For this purpose, a clear idea of what we mean by the robotics and automation industry is needed: which types of business are included in the analysis – and which are not. In this analysis, we focus on businesses involved in automation of processes, e.g. using industrial robots, service robots and drones/logistics robots.

As a main rule, we include businesses that produce and work with *hardware*. We also include businesses that develop software if the product is predominantly used as input for the physical robots. Software robots such as chat robots are thus not included.

The mapping comprises four types of businesses: producers, systems integrators, distributors (typically subsidiaries of foreign producers) and advisors.

The robotics and automation industry consists of producers, distributors, integrators and advisers



Four types of businesses characterise the industry

For the purpose of this analysis, we identified four types of businesses in the robotics and automation industry. These four groups make up the core of the industry in relation to development, production and implementation of innovative solutions.

The first group consists of producers. These are the businesses that develop and produce robotics and automation technologies in Denmark.

The other group consists of distributors. These are businesses that develop and produce technologies outside Denmark, but sell them in Denmark – typically through a subsidiary.

The third group consists of systems integrators. These combine the technologies provided by the producers and the distributors into an overall solution to be used by the end customers for their production process.

The fourth group consists of advisors, who advise industrial companies on how to implement and use robotics and automation technologies.

As the above four types of businesses are ideal types, there will be quite a few businesses which are hybrids and perform several of the functions described.

The overall value chain of the robotics and automation industry includes two other groups of businesses: sub-suppliers and end users. We have not identified end users and sub-suppliers, but they form part of this analysis in selected calculations and future predictions.

Examples of producers, distributors, systems integrators and advisors

Producers



Distributors



Systems integrators



Advisors



An industry driven by development and production

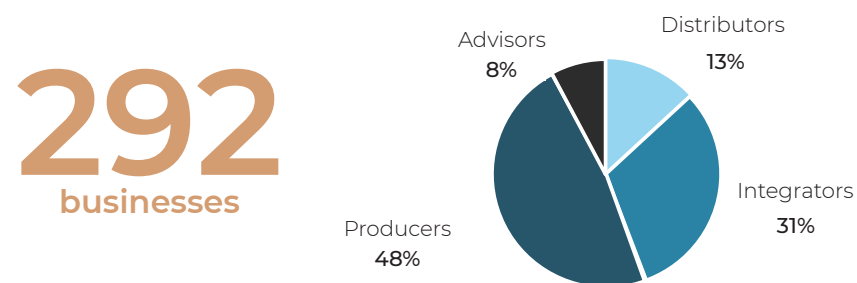
We have identified 292 businesses in the Danish robotics and automation industry. Some of these are fully dedicated to robotics and automation. Other businesses have departments which are targeted at robotics and automation, but which also carry on other activities, e.g. the consultancy firm Niras and the integrator NNE. When we calculate the economic activity, i.e. revenue, exports and employment, we only include the part of the activity that concerns robotics and automation.

Nearly half the businesses are producers developing and producing technologies in Denmark. The second largest group consists of integrators, which account for almost one third of the businesses. Distributors account for 13%, while advisors account for 8%.

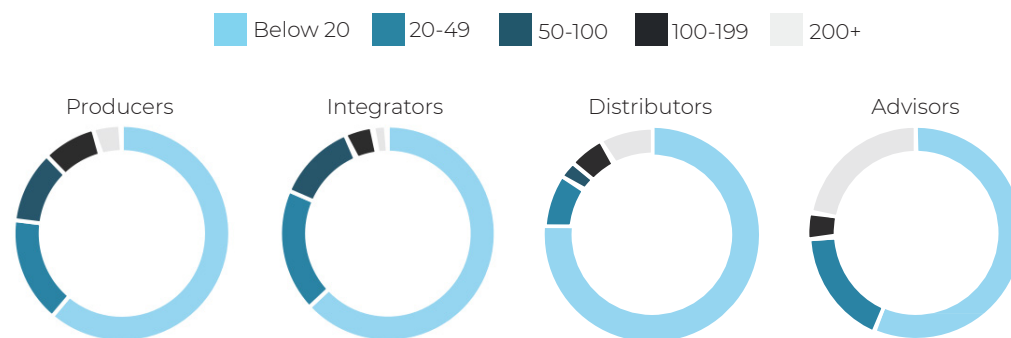
It goes for all four groups that most employ fewer than 50 employees. However, the consultancy firms differ slightly, as a relatively high number of them have more than 200 employees.*

*Please note that when we break down the businesses by size in this slide (the figure bottom right) and the next slide, we look at the total size of the businesses, not only the part we believe is related to the robotics and automation industry. When we count the number of employees, total revenue, etc. on the next slides, we only include the activity which is related to robotics and automation.

292 businesses - nearly half of which are producers



Breakdown of businesses by size (no. of employees)



Sources: DAMVAD Analytics and the Central Business Register (CBR).

The next Danish business with 1,000+ employees is likely to be robotic

Every third business in the robotics and automation industry was established after 2009. This implies that the industry is characterised by entrepreneurs entering the market with newly developed technologies. There are many young businesses with great growth potential. Universal Robots is an example of a young growth company with high ambitions. The company was founded in 2005 and employs around 500 people today (2018). There is a strong presumption that the company may be the next in the overall industry to employ more than 1,000 people.

Another example is Mobile Industrial Robots, which launched its first robot in 2015 and was worth DKK 1.7 billion in 2018 – a mere three years after.

At the other end of the age spectrum are the large and medium-size businesses. These businesses are rather different and consist of major consultancy firms that are partially engaged in robotics technology, e.g. Force Technology and Niras, and major foreign robot producers, e.g. ABB from Switzerland and Marel from Iceland.

Furthermore, there are businesses such as Aasted, which has historically supplied machinery for manual assembly line production, but which – in line with the technological development in the area of automation – is now producing robots and automated solutions.

The robot industry includes many young businesses - several of which are relatively large

FTEs	Date of incorporation		
	Before 2000	2000-09	2010
1-19	35	48	102
20-49	19	18	9
50-100	22	4	1
100-199	14	4	
200+	14	2	
Total number:	104	76	112
Share of the industry:	36%	26%	38%

Sources: DAMVAD Analytics and the Central Business Register (CBR).

An industry on the rise

- heading towards 10,000 FTEs

The businesses in the robotics and automation industry had approx. 8,500 FTEs in 2017, a number that is on the increase. In only three years, the number has risen by a total of 1,600, representing an annual growth rate of slightly under 7.5%.

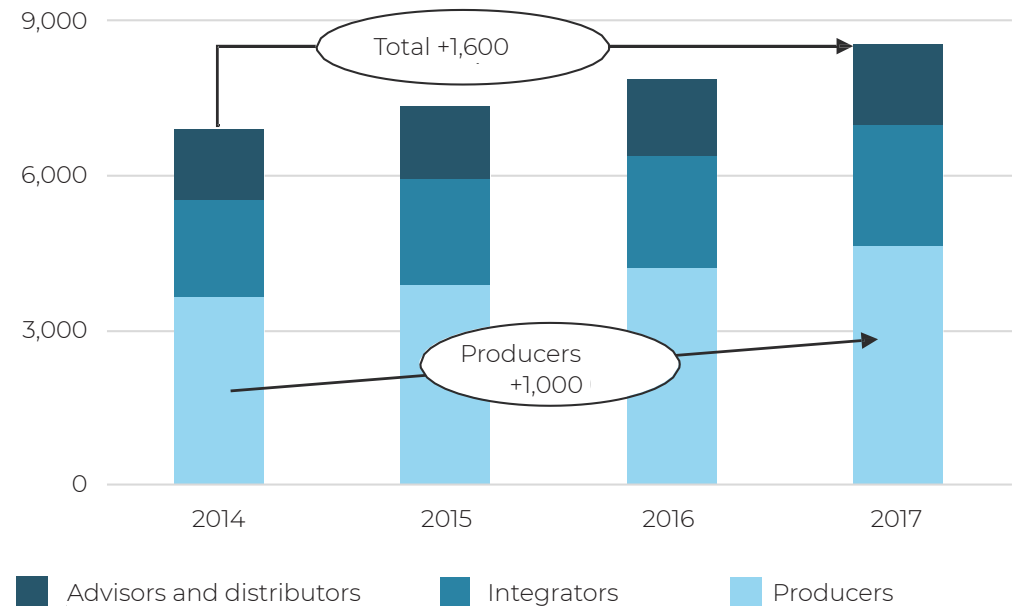
This corresponds with comments from several large businesses in the cluster, which also expect to take on more staff in the years ahead.

Although growth is broad-based in the cluster, producers in particular have created new jobs in recent years: the number of FTEs grew by 1,000 in the 2014-2017 period – to well over 4,600 in 2017.

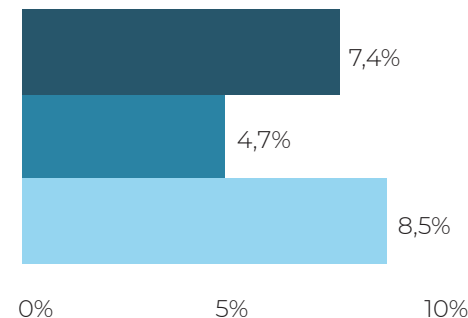
Measured by employment, producers account for a little more than half the cluster (55%). Integrators account for a little over one fourth (27%), whereas advisors and distributors* account for nearly one fifth (18%).

8,500 FTEs in 2017

1,600 new jobs created in three years.



The producers reported the highest annual growthrate in the 2014-2017 period



*For reasons of discretion, it is not possible to specify the number of jobs at advisors and distributors. Sources: DAMVAD Analytics & Statistics Denmark.

Businesses located all over Denmark

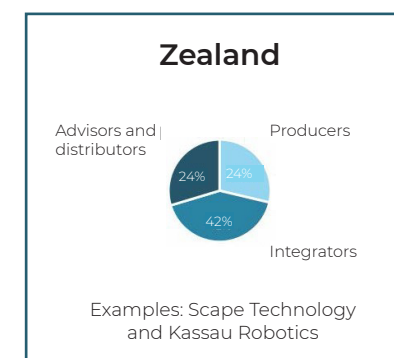
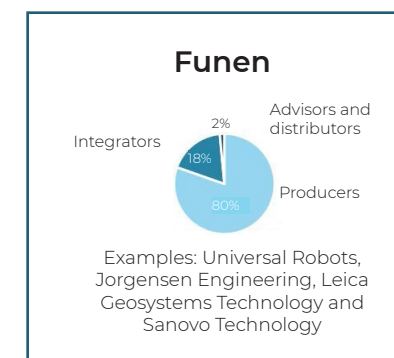
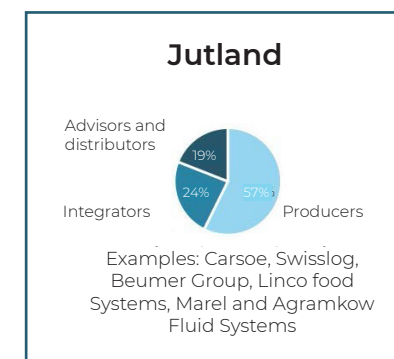
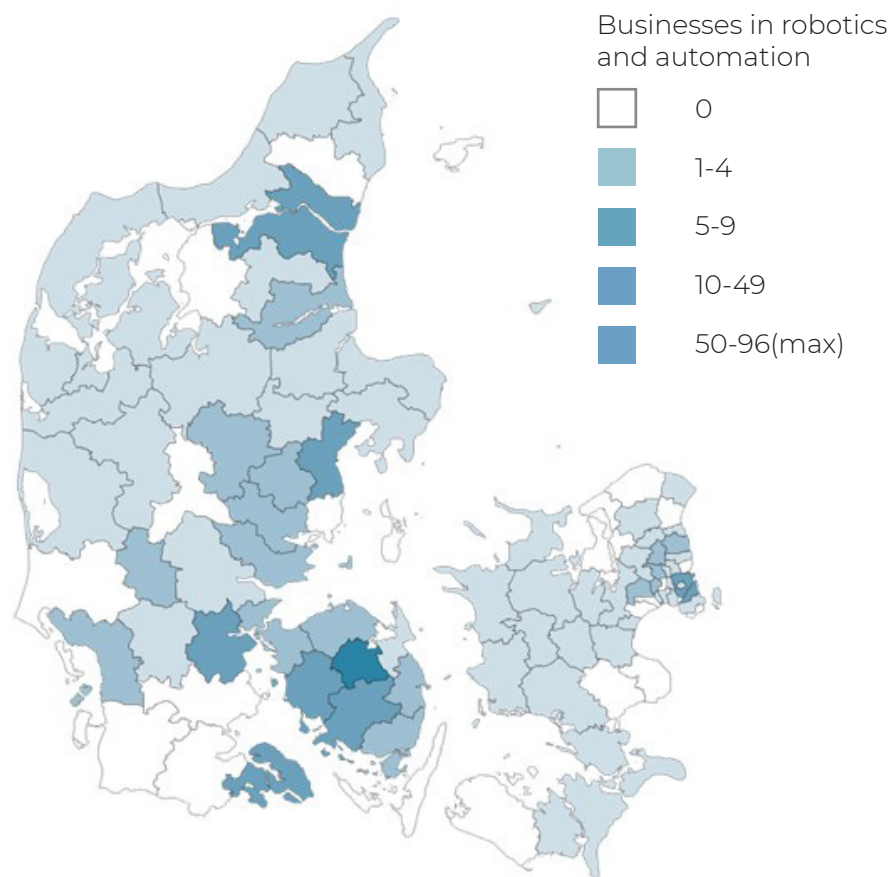
- with high concentration on Funen

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Although growth is broad-based in the cluster, producers in particular have created new jobs in recent years: the number of FTEs grew by 1,000 in the 2014-2017 period – to well over 4,600 in 2017.

Measured by employment, producers account for a little more than half the cluster (55%). Integrators account for a little over one fourth (27%), whereas advisors and distributors* account for nearly one fifth (18%).



Sources: DAMVAD Analytics and the Central Business Register (CBR).
 Note: The pie charts showing a breakdown of businesses by business type in the three provinces are based on employment, whereas the map shows the geographical breakdown of workplaces.

A billion kroner industry on the rise

Highlights

- The revenue from robotics technology has increased almost by 26% in four years
- New revenue and 10,000 new jobs have been created among sub-suppliers
- The productivity of the manufacturing industry benefits from a strong robotics and automation industry



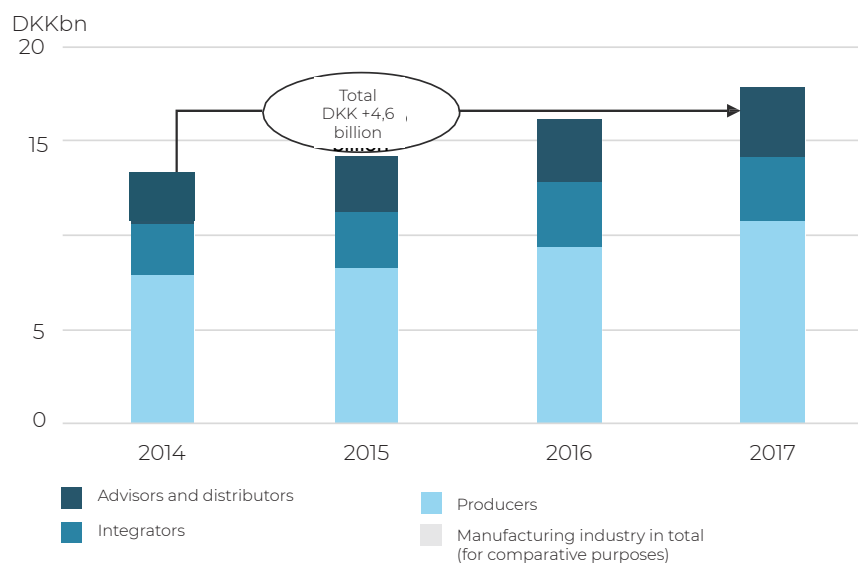
The Danish robotics and automation industry reports revenue of DKK 18 billion

In 2017, the robotics and automation industry reported revenue of DKK 18 billion, a figure that is increasing at a rapid pace. Since 2014, revenue growth in the industry has been DKK 4.6 billion, representing an annual growth rate of more than 10% and significantly outperforming total revenue growth in the manufacturing industry, which was slightly under 7% in the same period.

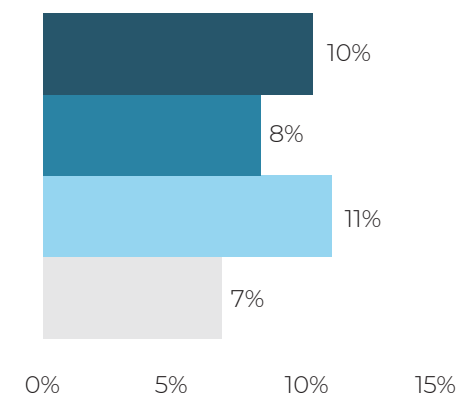
Producers' revenue came to approx. DKK 10.7 billion kroner.

At the same time, the producers saw the highest revenue growth – up 11% annually. However, the other parts of the industry also reported handsome revenue growth of 8-10%.

DKK 18 billion turnover in 2017



Revenue growth of some 10% annually



Big socio-economic impact

- sub-suppliers gain 10,000 extra jobs and DKK 10 billion revenue

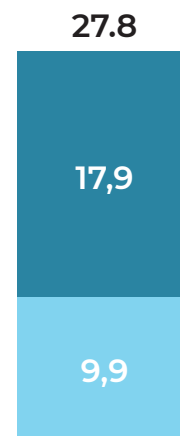
The robotics and automation industry has great socio-economic impact besides the revenue and new jobs that are created directly by the businesses in the industry.

For every robot sold by a company, that same company has received supplies such as gearboxes, metal goods and electronic components from other businesses. In addition, the robotics and automation industry makes use of various services provided by, e.g., external cleaning firms, lawyers and auditors. This supports revenue and employment in companies that are not a direct part of the robotics and automation industry.

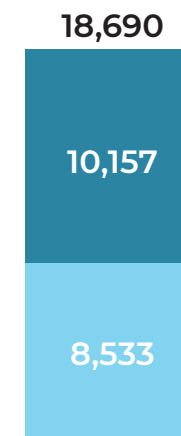
Sub-suppliers included, the industry supports revenue of DKK 27.8 billion, DKK 9.9 billion (36%) of which represents revenue from sub-suppliers.

The spill-off effect of the robotics and automation industry itself exceeds the direct employment in companies that are not part of the actual industry. 10,157 of the total employment of 18,690 is created by sub-suppliers outside the industry.

The industry generate total revenue of DKK 27.8 billion



The industry supports 18,690 FTEs in Denmark



■ The robotics and automation industry
■ Sub-suppliers

Sources: DAMVAD Analytics based on. Input/Output tables from Statistics Denmark.

Most impact in the industry's direct value chain

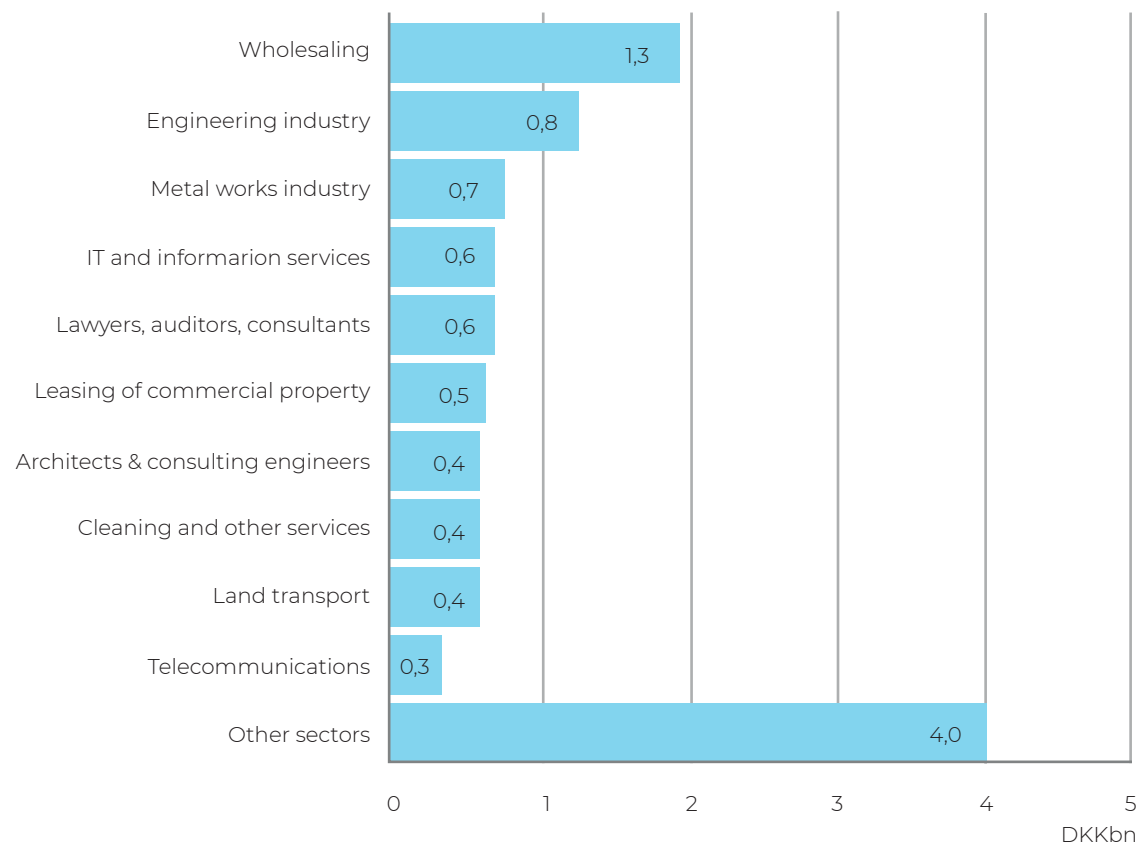
The robotics and automation industry generates derived revenue growth of DKK 9.9 billion in the rest of the economy. Revenue stems from many diverse industries that are part of the value chain of the robotics businesses or which service the businesses.

The lion's share of the derived revenue is generated by businesses that produce or sell parts or raw materials to the robotics industry without being themselves part of the industry itself.

In addition, the robotics businesses purchase many other services such as consultancy services, IT services and servicing of the robotics businesses' office premises and production plants.

Revenue supported by the robotics and automation industry in other sectors

The robotics and automation industry supports revenue in many sectors, including in particular wholesaling and the engineering and metal works industries



Source: DAMVAD Analytics based on Input/Output tables from Statistics Denmark.

Note: The figure shows the 10 sectors from which the robotics and automation industry purchases most. The 10 sectors account for 60% of derived revenue. The other sectors not shown here account for very little each.

A strong robotics industry has made Denmark rank five on a global scale as regards robot application

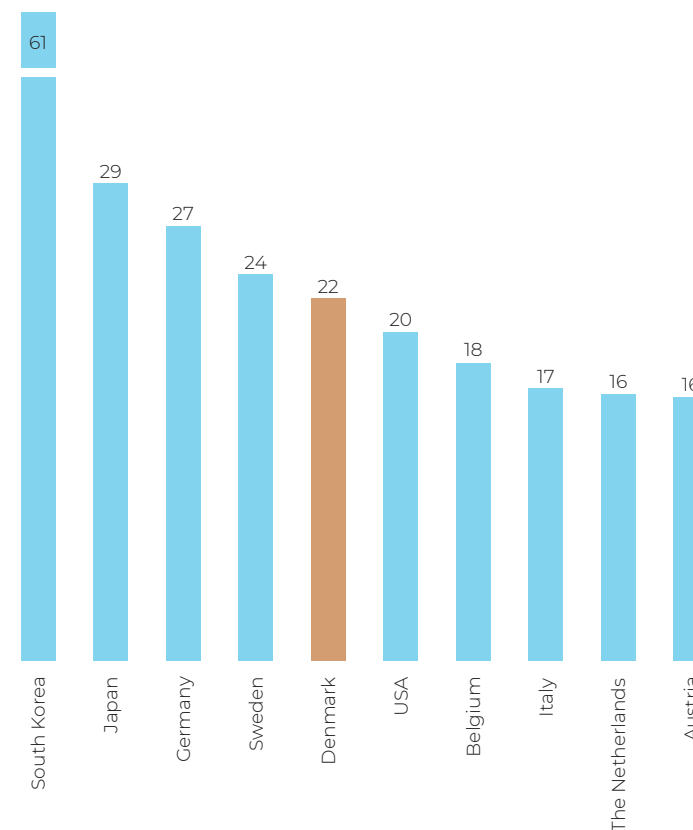
Denmark is one of the countries in the world with the use of robots in industry is most widespread. Reports from the International Federation of Robotics (IFR) show that only four countries have a larger robot density measured by the number of robots per 1,000 employees in the industry. Said four countries have heavy car and metal works industries – traditionally the most automated industries.

There are several reasons why Denmark is among the countries with the highest robot density. Analysis conducted by SDU & Pluss (2018) lists the strict requirements for working environment, the high degree of flexible production and high wages as some of the factors having influenced Danish businesses' early use of robots. As a result, there has long been demand for robotics technology, which has meant that Danish robot producers have been able to test and develop new solutions.

Many of the largest robot producers reside in the countries with the highest robot density: FANUC, Kawasaki Robotics and Mitsubishi Electric from Japan, KUKA from Germany, ABB from Switzerland/Sweden, Yaskawa Motoman from the USA and Universal Robots from Denmark.

The generally high educational and technological level in Denmark, coupled with a corporate sector that is ready for change in relation to new technology, probably also contributes to increasing the demand of the manufacturing industry for state-of-the-art robotics and automation solutions.

Robots per 1000 employee in the industry



Robots strengthen the entire manufacturing industry

- productivity increases

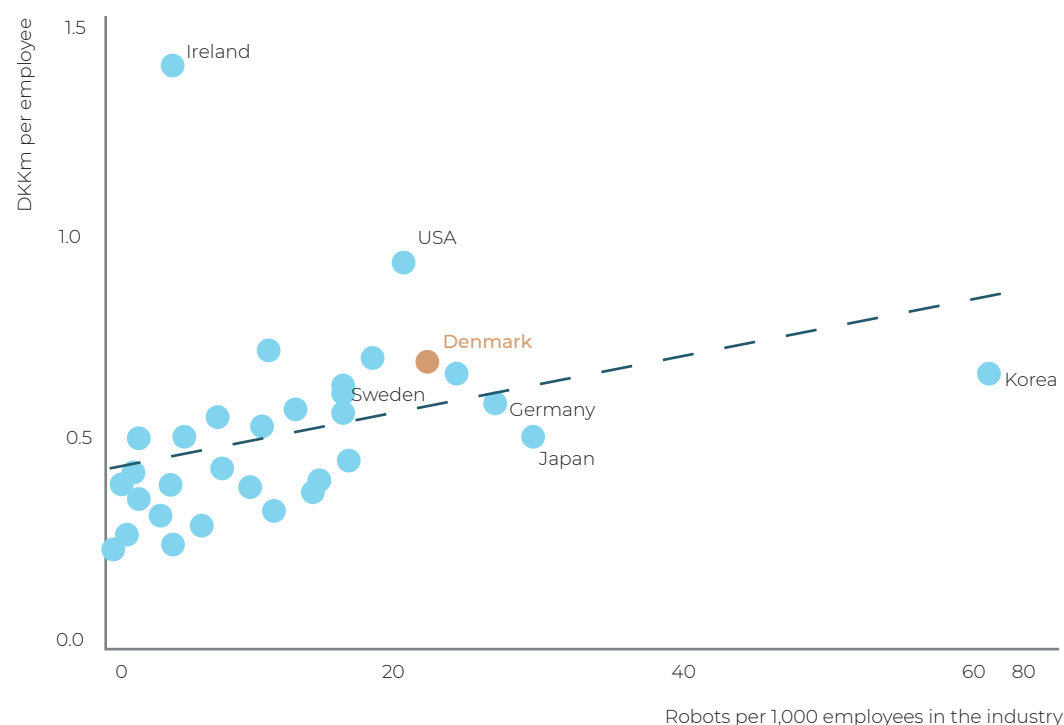
Businesses can generate more value per employee, when they use robots and automation. In other words: businesses can increase their productivity. This benefits society at large, as it increases welfare standards measured by GDP.

The use of robots increases annual productivity growth by 0.36%, according to a recent analysis by Graetz and Michaels (2018) analysing 224 industries across 17 countries from 1993 to 2007. This may not seem impressive, however, this productivity gain accounted for 10% of total GDP growth in the period analysed.

The figure to the right shows a positive correlation between robot density, measured as the number of robots per 1,000 employees, and productivity in the manufacturing industry. The countries with the highest robot density also have the most productive manufacturing industries.

It does not come as a surprise that robots as well as other machines and IT, etc. have a positive spill-off effect on productivity. However, allowance being made for the size of the capital stocks, Graetz and Michaels (2018) point to a separate effect from the use of robots.

Productivity of the manufacturing industry (increase in value per employee)



Sources: DAMVAD Analytics, IFR (2018) & the OECD.

World lead with great growth potential

Highlights

- Significant global market growth expected in coming years
- Especially in the area of collaborative robots – an area in which Denmark is a market leader



A global industry

- 60% exported

The Danish robotics and automation industry has a strong domestic market driven by a technologically sophisticated industry – but the global market is the most important one to many businesses in the robotics and automation industry. For instance, Universal Robots' financial statements show that 29% of revenue derives from the USA, 26% from Asia and the remaining 45% from Europe.

Overall, the robotics and automation industry exports for more than DKK 10 billion, meaning that exports account for close to 60% of total revenue. This highlights the industry's global outlook.

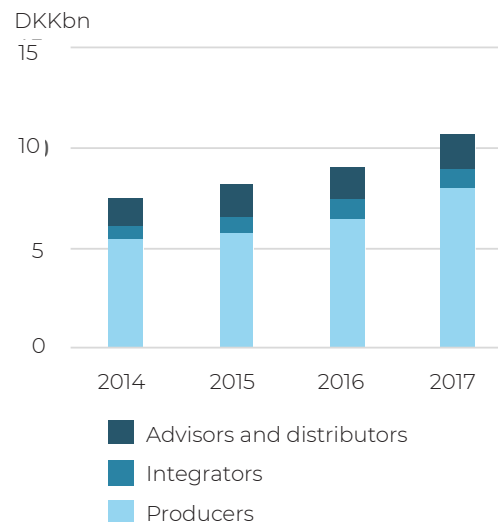
The high export share reflects the industry's international competitiveness. In other words: the Danish solutions successfully compete with solutions from markets abroad.

The fact that exports have grown faster than revenue implies that exports account for a rising share of cluster's revenue and stresses the importance of the international markets for the cluster's continued growth.

The producers are significantly more international than the integrators, advisors and distributors, accounting for 60% of revenue, and as much as three-fourths of exports. Their export share has also grown faster than that of the other types of businesses.

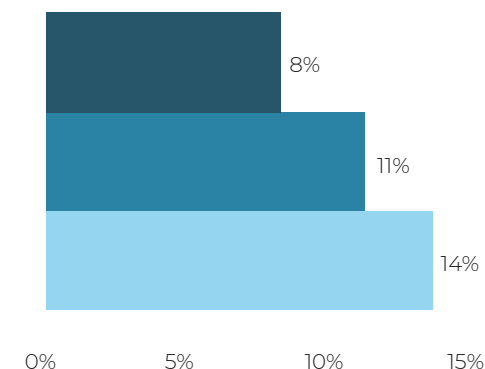
Exports account for 60% of revenue

Today, the entire industry exports good worth more than DKK 10 billion



Producers report the highest annual growth in exports in the 2014-2017 period

Producers' exports have grown by 14% annually since 2014



The global market for industrial robots is on the rise

Since the 1970s, robots have been used in the heavy industries in particular, including especially the automotive industry. But in recent years, the market is growing strongly, among other reasons, because robots and automation are being used in other areas to an increasing extent. Several analyses point to further growth in the years ahead.

The growth potential is also substantial for the domestic, export-oriented robotics and automation industry.

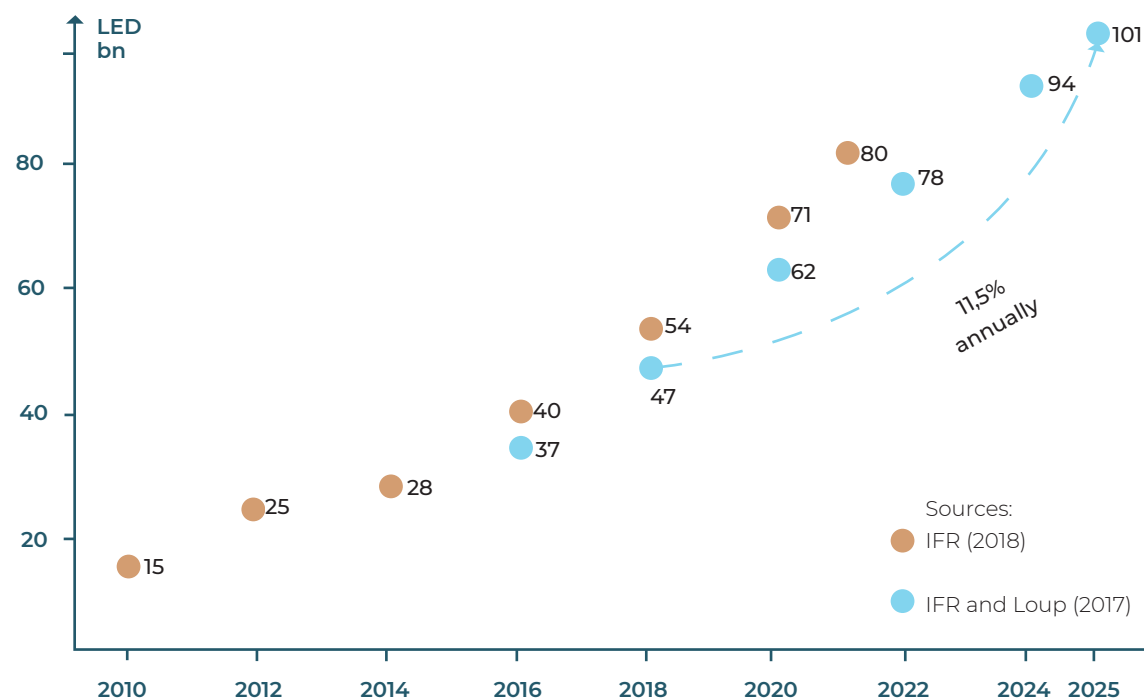
The size of the global market for industrial robots is associated with some uncertainty – and so is the pace at which the market is expected to increase. IFR is one of the bodies that have the best overview of the sector. According to IFR, the global market grew by more than 15% in the 2010-2018 period – to approx. USD 50 billion, see IFR (2018) and IRF and Loup (2017).

IFR and Loup (2017) expect the market to grow to USD 101 billion in 2025, provided that the price of robots remains relatively unchanged. This reflects an annual growth rate of 11.5%, i.e. slightly below the annual growth rate in the years up to 2018.

Relative to their 2017 projection, IFR increased in 2018 their estimate of the value of the market today and in the future. So, this indicates that the growth rate may be higher than 11.5% as expected from IFR and Loup (2017).

Value of the global market for collaborative robots, including service and software

The global market is expected to grow from USD 47 billion in 2018 to USD 101 billion in 2025, representing an annual growth rate of 11.5%.



Denmark is a world lead

- in high-growth markets

In particular, the market for collaborative robots is expected to surge in the coming years, because collaborative robots have opened up an entirely new market. Businesses that have not previously used robots now have access to technologies which they can apply and which do not call for large and heavy production lines.

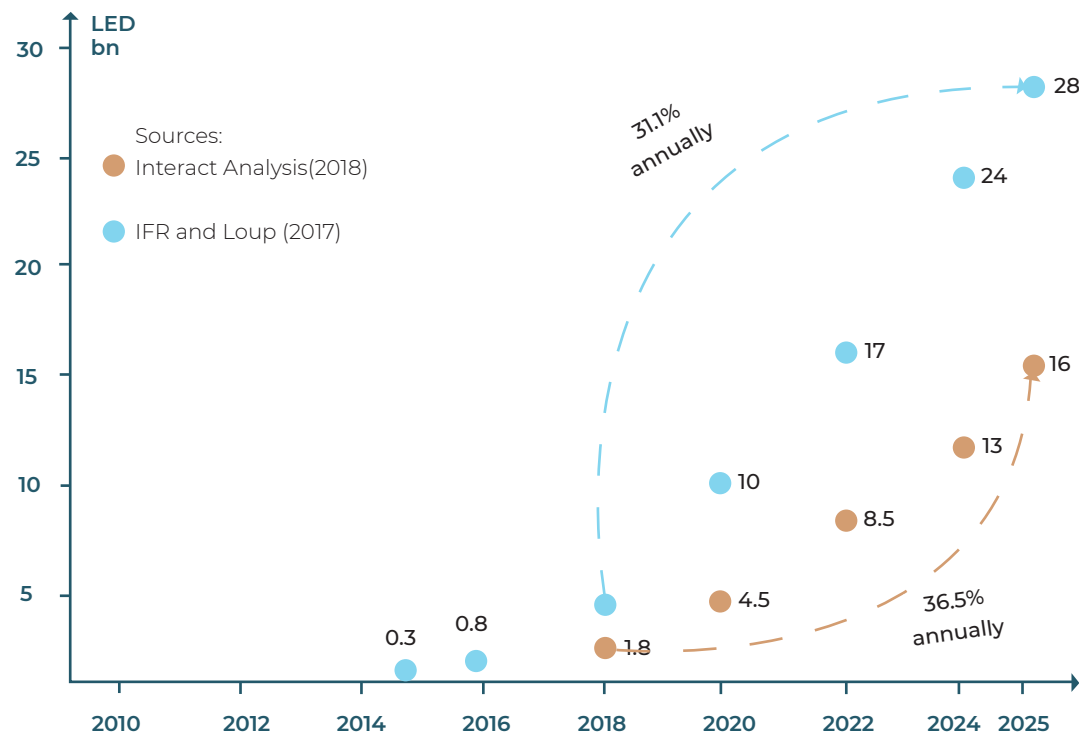
IFR and Loup (2017) and Interact Analysis (2018) have made a separate assessment of the size of the global market for collaborative robots, showing that Denmark, with Universal Robots, holds a market share of approx. 50% of the global market. They estimate that the value of the global market was USD 0.8 billion in 2016, or 2% of the entire global market for industrial robots.

Collaborative robots are expected to play an even bigger role going forward, and IFR and Loup believe that the market will grow by 31.1% on average each year from 2018 to 2025. They anticipate collaborative robots to account for 27% of the entire global market for industrial robots in 2025.

Interact Analysis (2018) also predicts rapid growth in the market: 36% annually from 2018 to 2025. However, their assessment of the market value in 2018 is less than half the assessment made by IFR and Loup (2017).

Value of the global market for collaborative robots, including servicing and software

The global market for collaborative robots is expected to grow by 31.1-36.5% annually from 2018



Robotics technology may generate revenue of DKK 52 billion in 2025

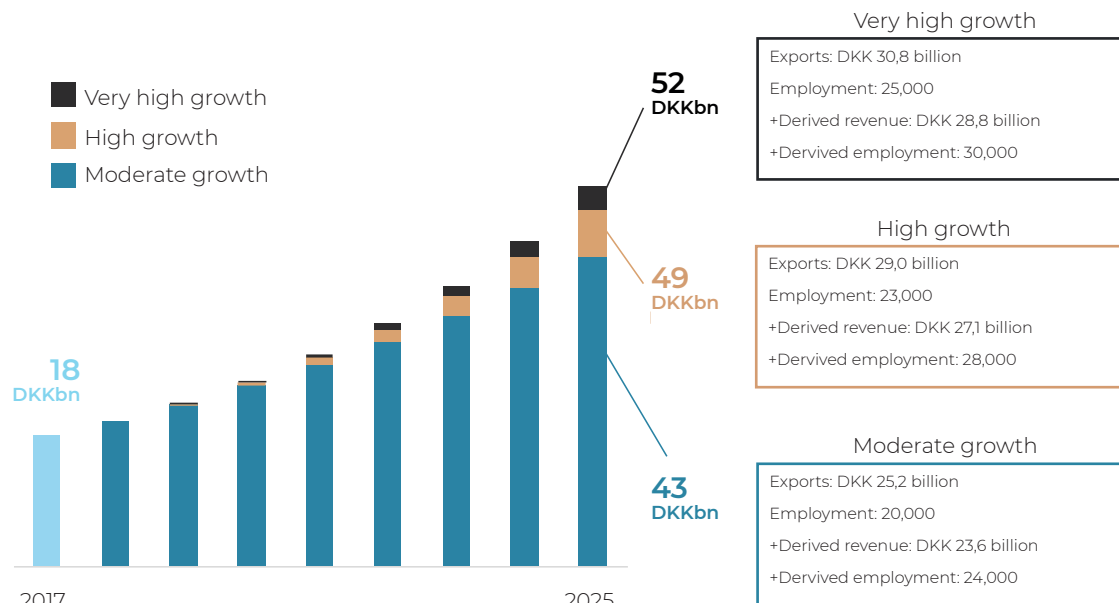
The growth prospects for the robotics and automation industry are generally strong, see the two preceding slides. This is particularly true for collaborative and mobile robots, areas in which Denmark is a world lead. We have presented three possible growth scenarios in the period leading up to 2025. In the most conservative scenario – which we call moderate growth – we expect revenue to rise from 18 billion kroner in 2017 to 43 billion in 2025. This presumes that the growth rates are equal to 2014.

If we take into account that the market for collaborative robots will develop at an even faster pace, the Danish robotics and automation industry will generate revenue growth in the order of DKK 49-52 billion in 2025.

Employment will increase accordingly. In 2025, the robotics and automation industry will employ 20,000-25,000 people, while sub-suppliers will employ an additional 24,000-30,000.

This means that the robotics and automation industry, as a whole, may increase employment by 44,000-55,000 people and give rise to revenue of DKK 66.6-80.8 billion.

Revenue growth in the Danish robotics and automation industry



Technical note

Projections are always associated with uncertainty. The calculation is based on the following growth expectations, which are based on the two preceding slides:

Growth scenario:	Moderate	High	Very high
Annual growth of the ratio of collaborative robots in the industry	11.5%	31.1%	36.5%
Annual growth in the rest of the industry	11.5%	11.5%	11.5%

Demand for qualified manpower

Highlights

- Future growth calls for employees with training and education specifically related to robotics and automation



All Danish universities offer relevant programmes

Robotics and automation technologies are developing rapidly these years. Employees with the right competencies are needed to support a high innovation level ensuring that Danish-developed technologies remain among the most cutting-edge, sought-after technologies in the world.

Many different programmes are of relevance to the robotics and automation cluster: e.g. technical programmes directed at the development of technologies and software and more commercially orientated programmes to ensure propagation and sale. In this analysis, our focus is on the more technical programmes. We have scanned the programme guide (www.ug.dk) to identify programmes where either robotics or automation is mentioned. In addition, we have added the bachelor's degree programmes mechanical engineering and production.

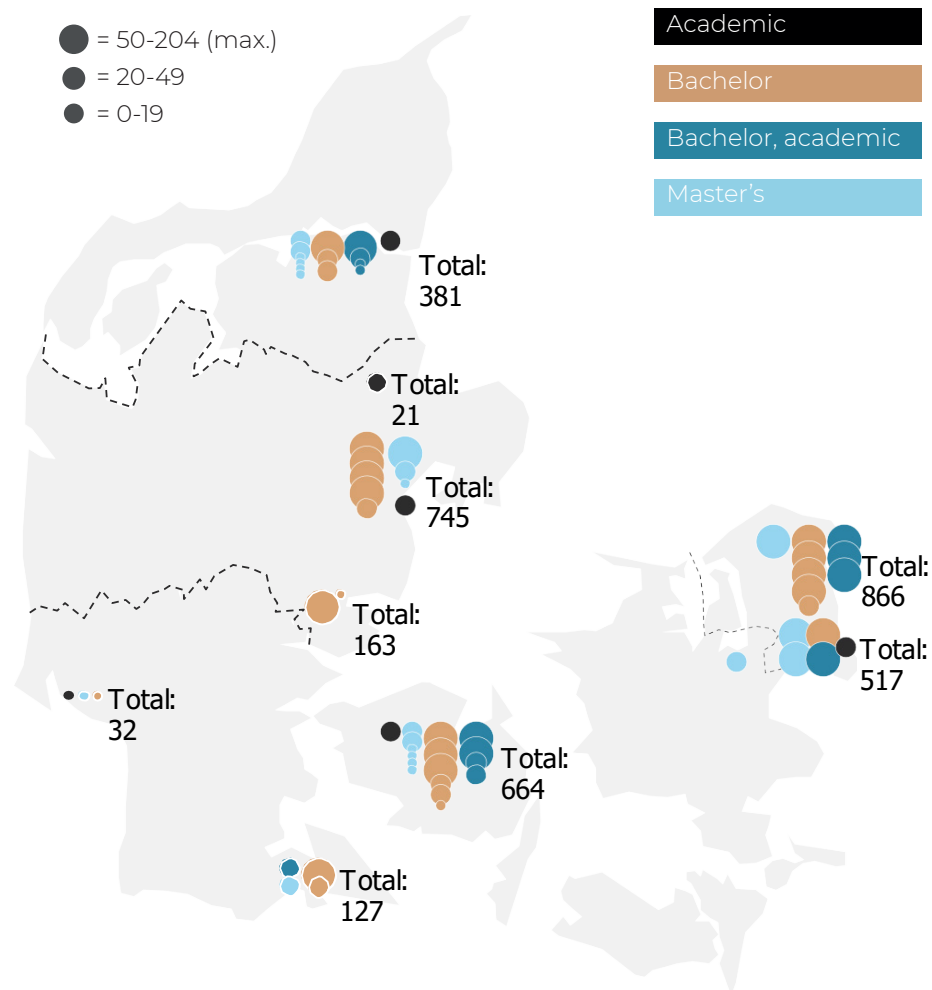
The map of Denmark to the right shows the number of students admitted to these programmes in 2017. The Technical University of Denmark (DTU) in Lyngby offers several engineering programmes of relevance to robotics and automation businesses, but the University of Aarhus, the University of Southern Denmark (located in Odense and Sønderborg) and the University of Copenhagen admit almost as many students to relevant programmes.

With the prospects of up to 17,000 new jobs in the industry over the next 5-10 years, more investments in further education programmes directed at robotics and automation technologies may be needed.

Many educational establishments offer programmes

directed at robots, drones & automation.

Students admitted to robotics-related programmes in 2017



Note: By the number of students admitted is meant individuals starting studies in the period from 1 October in the preceding year to 30 September in the current year.

The University of Southern Denmark offers most robotics-focused programmes

A number of educational establishments offer programmes directed at robotics and automation. At master and bachelor levels, this is particularly true for the University of Southern Denmark, which is reflective of the growing cluster on Funen. The University of Aalborg also offers university programmes targeting at the cluster.

We identified such programmes by assessing whether the descriptions of the programmes offered at the various universities reflect that they are targeted at robotics and/or automation.

Focusing on short-cycle programmes, we noted that several business academies across Denmark offer courses in the field of automation and operation. Cities offering such programmes include Odense, Aalborg, Copenhagen, Aarhus and Randers.

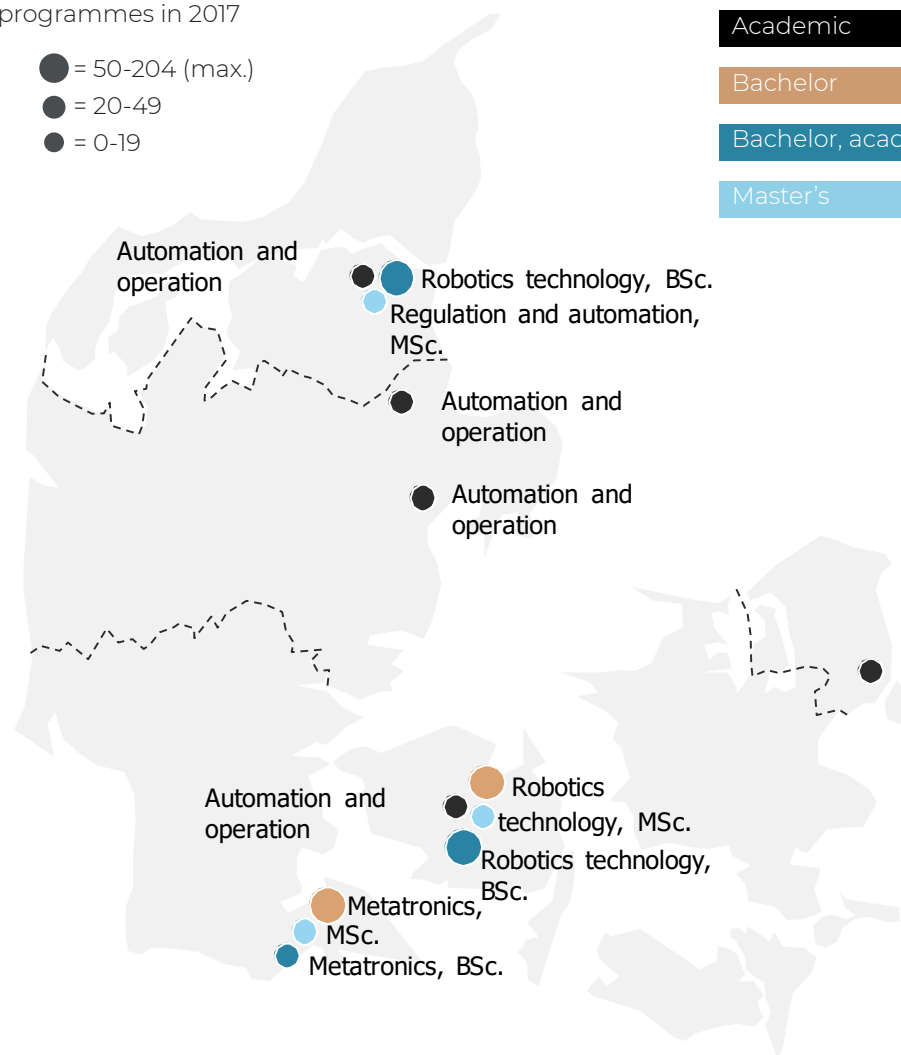
It goes for several of the programmes, that relatively few students have completed them. The number of students admitted has, however, increased considerably in recent years.

Southern Denmark offers the highest number of robotics-focused programmes

Students admitted to robotics-focused-programmes in 2017

- = 50-204 (max.)
- = 20-49
- = 0-19

Academic
Bachelor
Bachelor, academic
Master's



Note: By the number of students admitted is meant individuals starting studies in the period from 1 October in the preceding year to 30 September in the current year.

Method

A description of how we identified the businesses in the robotics and automation cluster as well as a list of references.



Identification and weighting of the businesses

The first step in mapping the cluster is identifying businesses involved in robotics and automation. To do this, we applied various methods. We reviewed lists showing former analysis conducted by the Region of Southern Denmark, lists of members of relevant industry and cluster organisations, input from technical staff possessing expertise in the area and searched through Jobindex (a job portal listing vacancies in Denmark), see the overview to the right.

Thus, we selected a broad palette of data sources to identify all relevant businesses in all parts of Denmark. It was a separate objective of ours not to have an over-representation of certain regions in the list of businesses.

The businesses we identified are involved in robotics and automation to varying degrees. Some businesses focus on, for example, the development and production of robots, such as Universal Robots. Other businesses have other activities. Such businesses could be long-established companies that have begun in recent years to use robotics technology to improve their existing products, or consultancy firms such as Niras that offers advice on automation of product processes among other areas. Finally, some of the businesses we identified are completely outside our definition of the robotics and automation industry.

As a result, we reviewed all businesses manually and gave them a weighting indicating how large a share of their activities relate to the robotics and automation cluster. We did this based on knowledge about the businesses and a review of their websites and annual reports.



Lists of members and businesses:

We consulted lists from Odense Robotics, UAS Denmark, RoboCluster, DIRA (Dansk Robot Netværk), Stålcetrum, Dansk Automationselskab (DaU), MADE, Scale-Up Denmark Robotics and the Region of Southern Denmark (2017).



Search through DAMVAD Analytics' job posting database:

Together with employees at Odense Robotics, we prepared a list of words (technologies, competencies, vacancies, etc.) related to robotics and automation. Then we searched through DAMVAD Analytics' job posting database, which includes all job postings at Jobindex since 2007. In doing so, we identified businesses which very probably work with robotics and automation.



Expert review of list of businesses:

In cooperation with technical staff at Odense Robotics, we reviewed the list of businesses, added some more and gave all of them a weighting (0-1) to indicate how large a share of their activities are relevant to our analysis, according to our definition of the robotics and automation cluster.



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