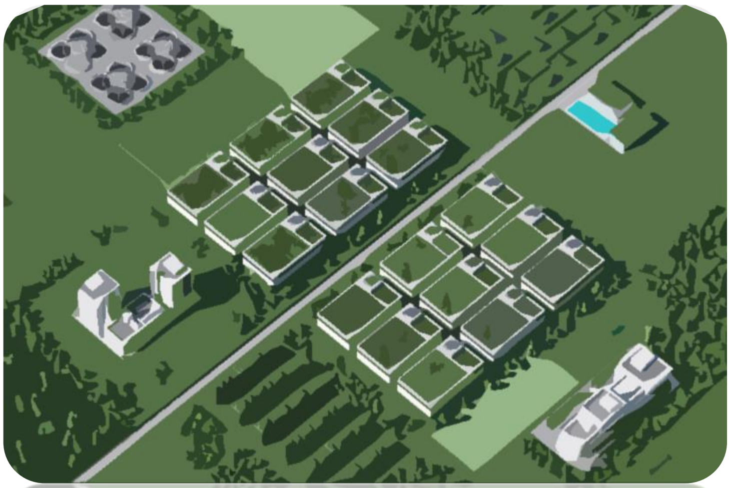
Kalberg Valley

Scenarios and Employment study



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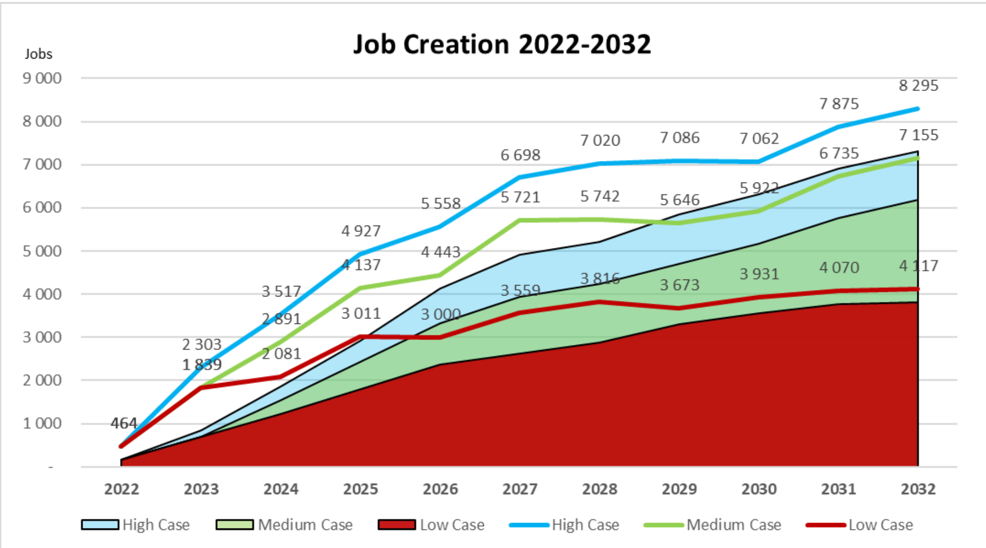
1 Introduction

In 2018 the Norwegian Government developed a datacentre strategy for Norway (Norge som datasenternasjon)[1]. The strategy is describing why Norway will be a good host for potential datacentres, and how Norway, businesses and employees can benefit from such industry. SINTEF developed a report (Nye muligheter for verdiskapning i Norge)[2] in 2019 describing what opportunities we as a nation have to create new jobs realizing that the petroleum sector will be decreasing in the years to come. Short summary from this report are if we are looking at the 100 billion opportunities there are 3 main takeaways: 1) decarbonizing the petroleum industry, 2) develop new energy consuming industry as i.e. datacentres and 3) services that supports 1 and 2.

With this background, knowing that the European datacentre market is looking to Norway for sustainability, and realizing the capabilities and the know-how in the Rogaland region, Kalberg is within a time frame of 3 years one of the best sites for developing this kind of industry.

2 Executive Summary

The study shows that there is a significant potential to develop a new industry in the Rogaland region related to enabling of new datacentres. The number of jobs will vary from the construction phase to the operation- and maintenance phase. Based on three different scenarios, between 4000 to 8500 new jobs will be created, during a time period of ten years. In addition, but not estimated, we expect the creations of a number of jobs within agriculture and industries utilizing energy and heat production from the datacentres as main components.



Our simulation shows that with proper planning the need will vary depending the three scenarios from 1.000.000 to 1. 500.000 square meters land. This is based on the construction of 20 datacentres in different shape and form. The figure shows three different scenarios and have also taken into consideration necessary area (approx. 500.000 square meters) for other relevant industry

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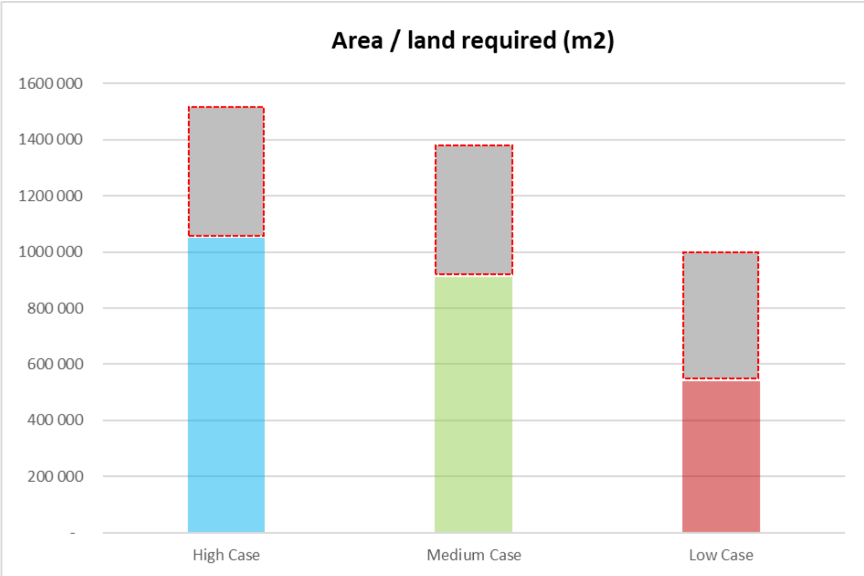
[1] Regjeringen, Nærings- og fiskeridepartementet, 2018, Norge som datasenternasjon, https://www.regjeringen.no/contentassets/6f1eda83c8f941418a5482b138466ea3/strategi-nfd-nett.pdf

[2] Sintef, 2019, Nye muligheter for verdiskapning I Norge, https://www.nho.no/contentassets/6ffd5dbbe6e54616b9565b737c7e94ca/sintef_verdiskaping2019.pdf

within the green and blue sector. i.e. biogas plants, vertical agriculture greenhouses and fish farms could easily be users of the waste heat from the datacentres.



3 Kalberg Valley – the next Generation Datacentre Site in Norway

The datacentre industry experiences very strong growth and the industry is in need of new power rich sites and power expansion of existing installations. These capacities exist in several countries and some close to the big cities in Europe. Ireland, Sweden, Denmark, UK and Holland have established clusters that already hosts several large datacentre facilities.

The challenges of most of these existing installations are that they mainly consume non-renewable energy and that the power grid supporting the datacentres are in a capacity constrained situation. Furthermore, 85% of the energy consumption is returned as waste heat.

Several datacentre players now look to Norway that has about 100% renewable energy production, mainly hydro power and adding new wind turbine power. The Norwegian relatively cold climate is also ideal for datacentre cooling. Norway has realistic opportunities to welcome the energy intensive datacentres and support these centers in a sustainable way using the country's inherent competitive advantages. Norway also has the lowest energy prices in Europe and is expected to have available renewable energy surplus in foreseeable future.

Throughout Norway there are only a few sites where a Hyper Scale datacentre could be located. This is restricted by power availability and proximity to the national power grid. On the west coast (close to UK and Ireland) Rogaland county supports two such areas, Kalberg Valley and Gismarvik. Provided that everything will pan out as planned, Kalberg will be ready for service with necessary power availability from 2023, and Gismarvik from 2026-2027. This document describes the capabilities of Kalberg, but the approach is also applicable for Gismarvik.

3.1 Scenarios for Kalberg Valley

To establish an area plan for Kalberg Valley it is important to limit the use of existing farming land for industrial purpose. It is important to strategically locate the datacentres and related common/shared functions as power, grid, fibre and district heating plant etc. allowing new industry to have maximum access, scalability, redundancy and flexibility.

We have described 3 scenarios based on our current market knowledge and realistic assumptions for possible datacentre over a period of ten years. These assumptions have been made by use of simplifications.

For all scenarios we expect the first datacentre construction to start in 2022. The scenarios are based on 3 different types of datacentres, Colocation, Enterprise and Hyperscale. See chapter 6 for further details about the datacentre types. The following assumptions have been made.

3.1.1 Key numbers energy and area usage

- 1 MW power = 1 da datacentre = 2 da datacentre, including free area, support and service functions
- 1 MWh energy usage gives 85 % heat dissipation

3.1.2 Service functions and infrastructure – area usage

- Transformer station – 10 da (general)
- Heat central – 10 da (estimate)
- Biogas plant – 10 da (estimate)
- Vertical greenhouses – 10 da each (estimate)
- Fish farms – 25 da each (estimate)

3.1.3 Power usages

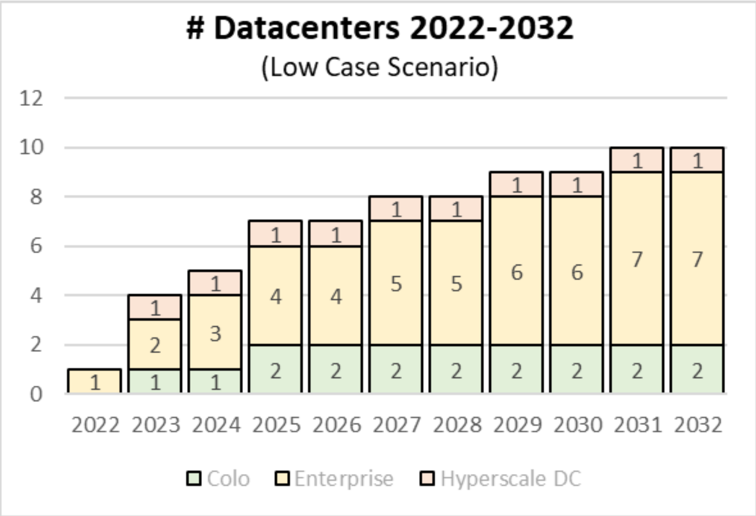
We have categorised datacentre into 3 types which with different erection time and power consumption at the time it is ready for service (RFS) as follows:

- Enterprise datacentre = 20 MW (Construction time 2 years)
- Colocation datacentre = 20 MW (Construction time 1 year + 5 years and full power utilisation after 8 years)
- Hyper Scale datacentre = 120 MW (4 stages of construction (30 MW each), each lasting 1,5 years)

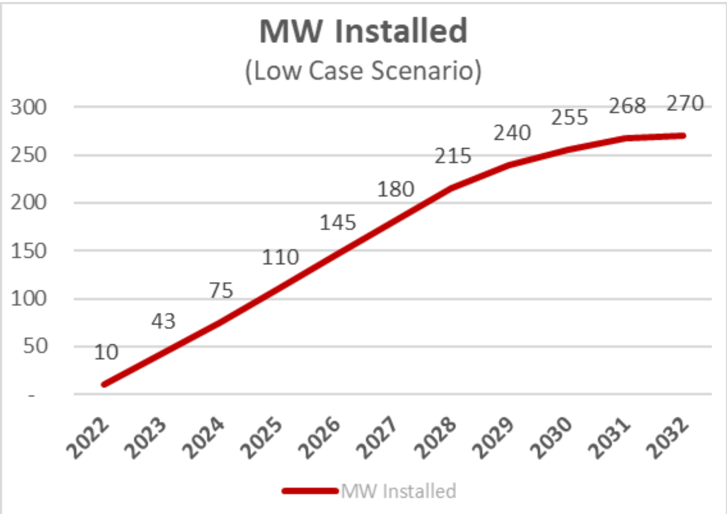
4 Scenarios

4.1.1 Low Case Scenario

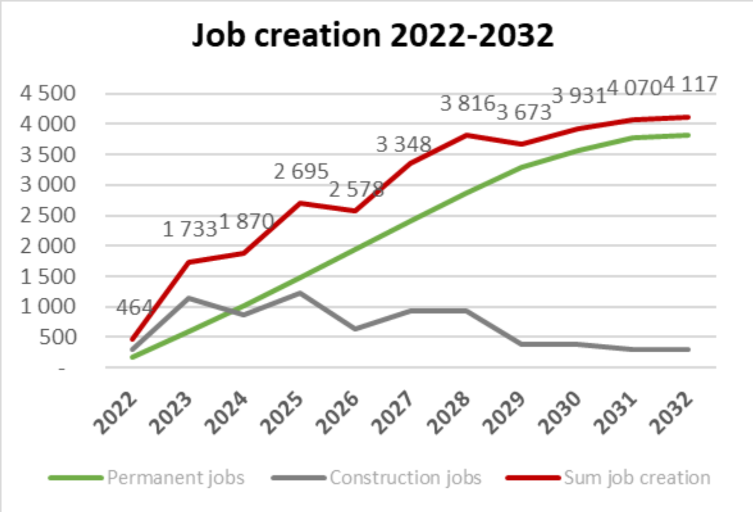
This scenario is based on a total of 10 datacentres being built, 2 hyperscale, 7 enterprise and 2 Colocation, from 2022 to 2032.



The scenario show that the power consumption from the installations will be of about 270 MW at the end of the period.

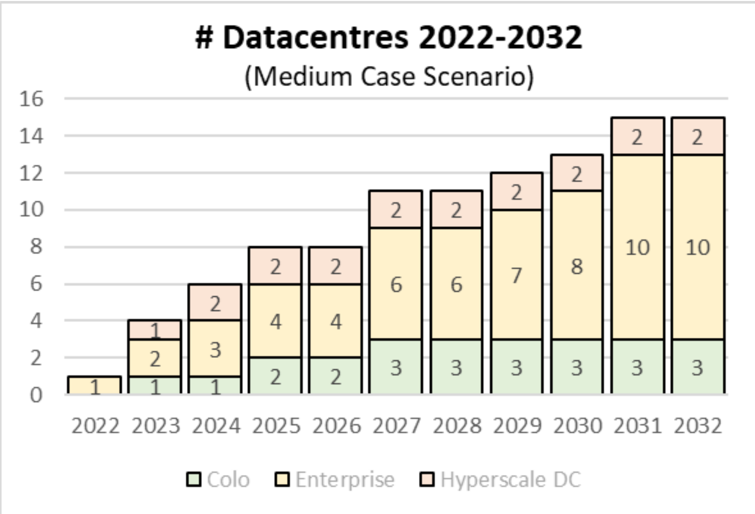


Furthermore, the scenario shows that the activity will, at the end of the period create a total of 4100 jobs, whereof about 3800 will be permanent jobs. At peak in the building phase the installations will contribute to about 1220 construction work jobs.

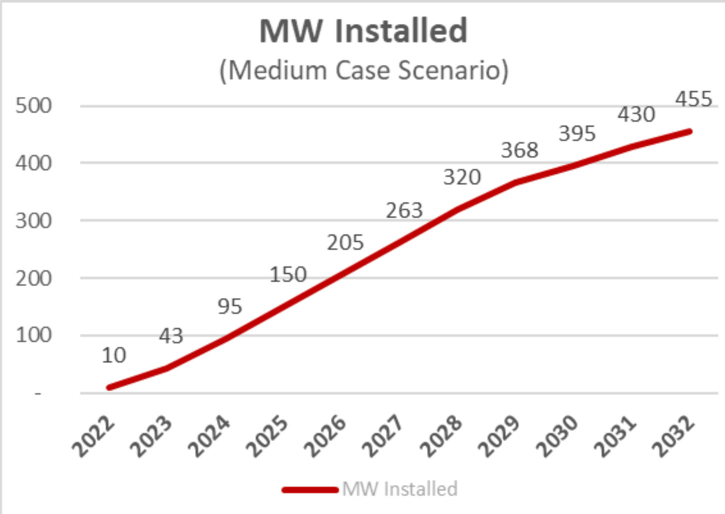


4.1.2 Medium Case Scenario

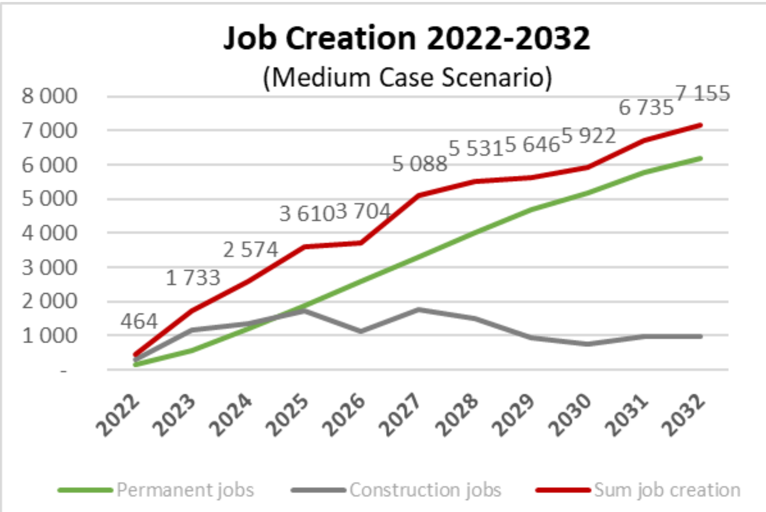
This scenario is based on a total of 15 datacentres being built, 2 hyperscale, 10 enterprise and 3 Colocation, from 2022 to 2031.



The scenario show that the power consumption from the installations will be of about 455 MW at the end of the period.

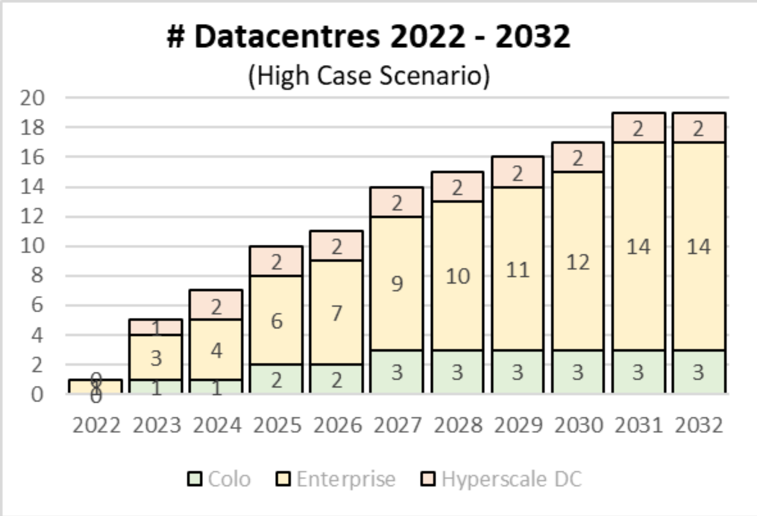


Furthermore, the scenario shows that the activity will, at the end of the period create a total of 7150 jobs, whereof about 6200 will be permanent jobs from the datacentre businesses. At peak in the building phase the installations will contribute to almost 1800 construction work jobs.

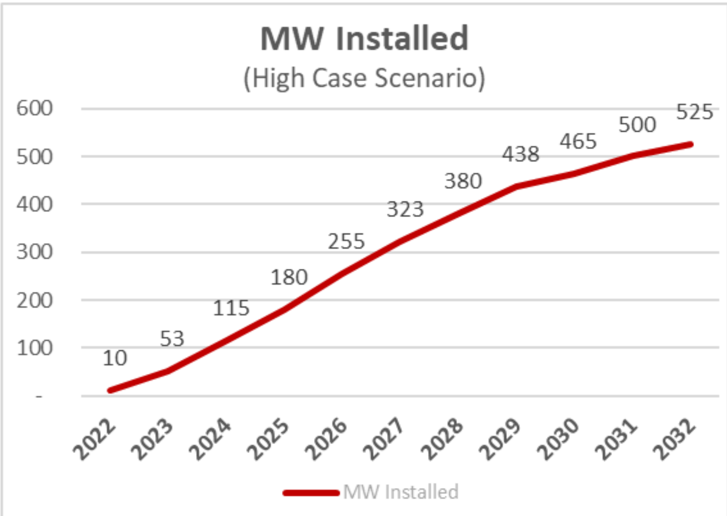


4.1.3 High Case Scenario

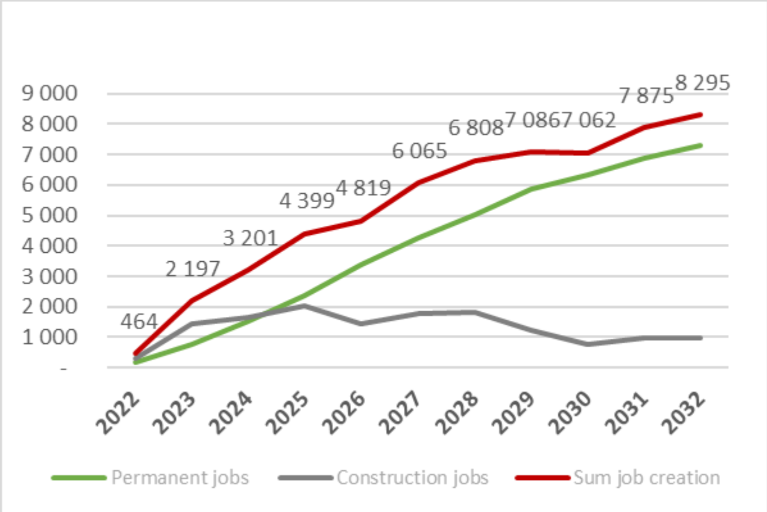
This scenario is based on a total of 19 datacentres being built, 2 hyperscale, 14 enterprise and 3 Colocation, from 2022 to 2032.



The scenario show that the power consumption from the installations will be of about 525 MW at the end of the period.



The scenario shows that the activity will, at the end of the period create a total of 8300 jobs, whereof about 7300 will be permanent jobs from the datacentre businesses. At peak in the building phase the installations will contribute to about 2000 construction work jobs.



4.2 Scenario Summary

The job creation described is significant in all three scenarios and varies from about 4.100 in the Low Case scenario, about 7.150 in the Medium Case scenario to about 8.300 for the High Case scenario. The jobs created are to a large degree local and regionally but will also to some extent nationally. With such a strong cluster established this will lead large international datacentre technology vendors to establish local offices to support the datacentre hub, similar to what the region has experienced from the oil and gas industry.

The number of datacentres will be dependent on the respective market scenarios. It should be noted that the datacentre industry in Luleå today consists of 19 datacentres, same amount that is described in the high case of this study. With the green profile and sustainability level that Kalberg Valley offers and the market development, the high case scenario in this study should be realistic.

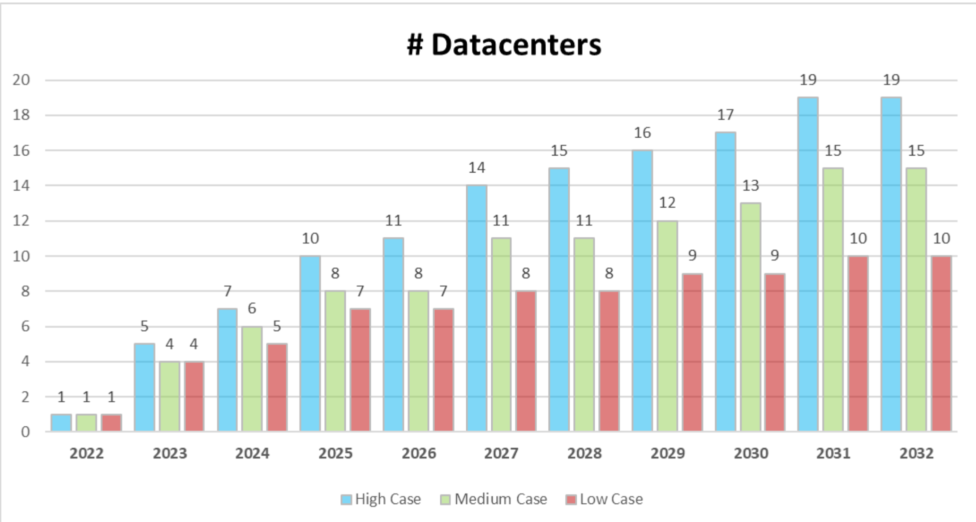


Figure 1: Summary of the number of datacentres for the scenarios

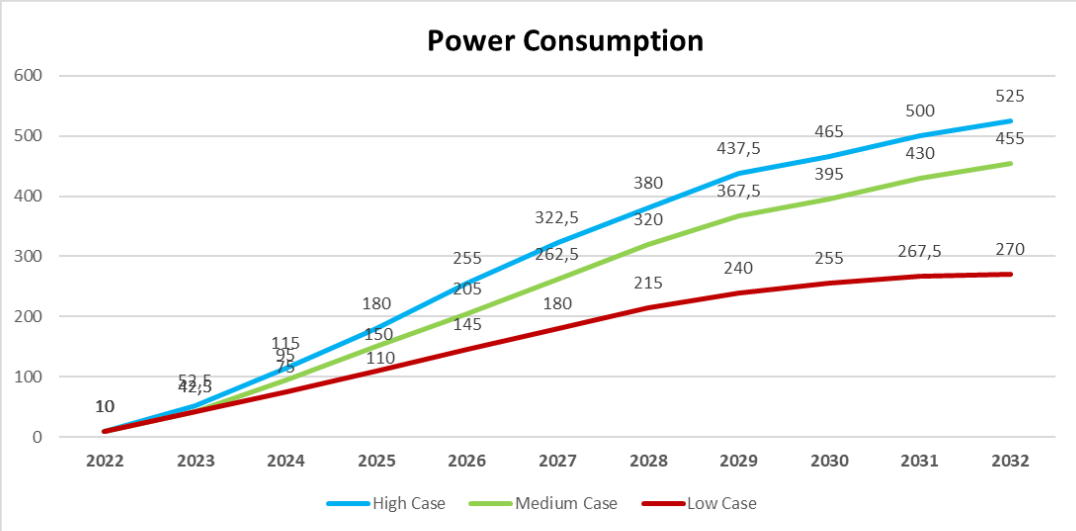


Figure 2: overview of the anticipated power consumption from the datacentres in each scenario

As described in chapter 5 and 6 below there are several types of datacentres, also within the 3 main types. Colocation datacentres creates more jobs than Enterprise datacentres which creates more jobs than Hyperscale datacentres. Some Hyperscalers create more jobs than others and successful ability to attract one or more will be one of the main enablers for the datacentre hub. Consequently, the actual outcome of jobs has a potential on the upside, if the most generating type of datacentres are established.

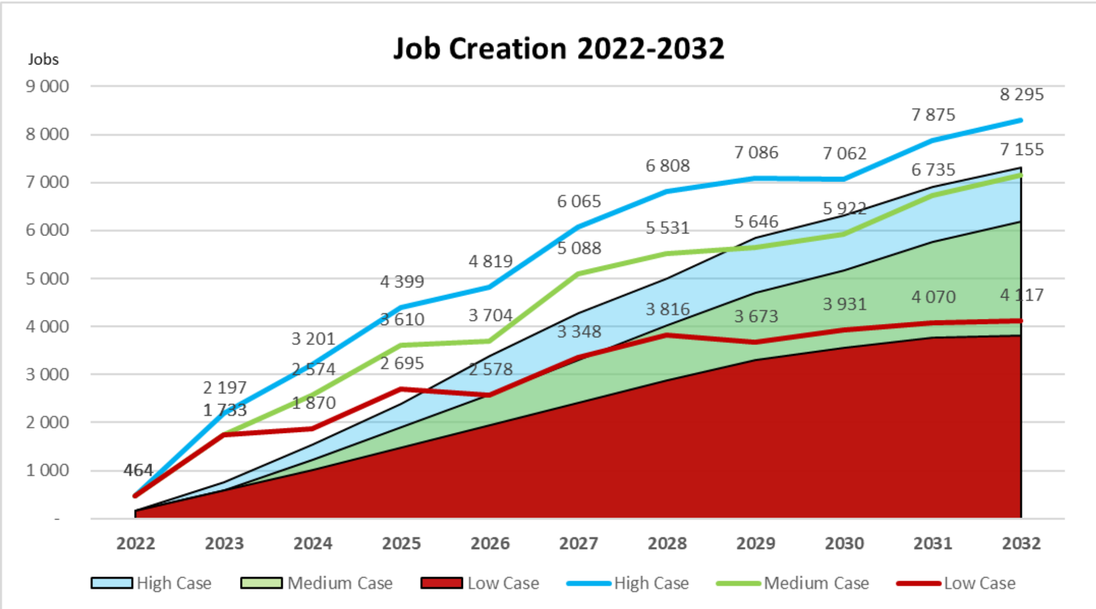


Figure 3: Total Job Creation in the three scenarios

Job Creation - Hich Case		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Hyperscale	Permanent	-	317	950	1 584	2 217	2 534	2 534	2 534	2 534	2 534	2 534
	Construction	-	493	985	985	985	985	985	493	-	-	0
Enterprise	Permanent	163	488	814	1 140	1 628	1 954	2 117	2 605	2 931	3 419	3 745
	Construction	301	602	602	602	602	602	602	602	602	903	903
Colocation	Permanent	-	47	95	190	284	426	569	711	853	948	1 042
	Construction	-	356	71	427	142	498	213	142	142	71	71
Jobs sum High Case		**464**	**2 303**	**3 517**	**4 927**	**5 859**	**6 999**	**7 020**	**7 086**	**7 062**	**7 875**	**8 295**

Job Creation - Medium Ca		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Hyperscale	Permanent	-	317	950	1 584	2 217	2 534	2 534	2 534	2 534	2 534	2 534
	Construction	-	493	985	985	985	985	985	493	-	-	0
Enterprise	Permanent	163	326	488	651	814	977	1 140	1 465	1 791	2 279	2 605
	Construction	301	301	301	301	-	301	301	301	602	903	903
Colocation	Permanent	-	47	95	190	284	426	569	711	853	948	1 042
	Construction	-	356	71	427	142	498	213	142	142	71	71
Jobs sum High Case		**464**	**1 839**	**2 891**	**4 137**	**4 443**	**5 721**	**5 742**	**5 646**	**5 922**	**6 735**	**7 155**

Job Creation - Low Case		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Hyperscale	Permanent	-	317	633	950	1 267	1 267	1 267	1 267	1 267	1 267	1 267
	Construction	-	493	493	493	493	493	493	-	-	-	-
Enterprise	Permanent	163	326	488	651	814	977	1 140	1 465	1 628	1 791	1 791
	Construction	301	301	301	301	-	301	301	301	301	301	301
Colocation	Permanent	-	47	95	190	284	379	474	569	663	711	758
	Construction	-	356	71	427	142	142	142	71	71	-	-
Jobs sum High Case		**464**	**1 839**	**2 081**	**3 011**	**3 000**	**3 559**	**3 816**	**3 673**	**3 931**	**4 070**	**4 117**

Figure 4: Table describing where the jobs are created in the Scenarios

Based on the key parameters described in chapter 3.1 we have estimated the required land to enable the described development. In addition, it will be essential for the type of clients that is sought attracted to the region, that supporting industries are developed in conjunction with the project. Several of the international clients have strategies to substantially reduce their carbon footprint. These companies will require that the heat generated is not just wasted. As described in chapter 3.1.2 these functions will require additional space, we have consequently added an-block 500 da additional space for all scenarios.

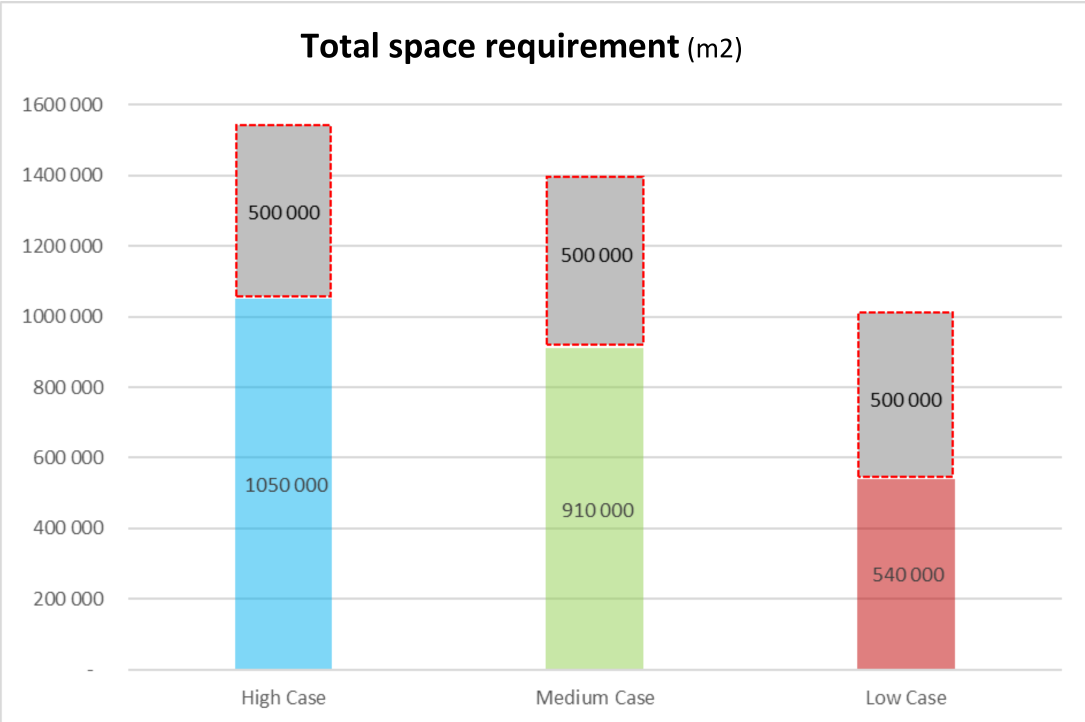


Figure 5: Summary of needed space for each scenario

5 Job generation assessment:

As described in this document, a datacentre is a very complex installation, the mere fact that most datacentres are designed to operate 24/7 – 365 days year after year creates this complexity. The consequence of the 24/7 requirement is that it must be possible to maintain all components with the datacentre in full operation. The datacentre is a very complex industrial process factory.

A large Colocation datacentre creates a substantial amount of jobs dependent upon the type of datacentre; Colocation, Enterprise or Hyperscale.

In a study done by Green Mountain[3] it was estimated that a 25 MW datacentre would create 750 jobs (årsverk). Less than 100 of these would be employed by the datacentre company itself, the main jobs are created by local and regional vendors and other service organization executing services for the datacentre industry.

Also, the building process of the complex datacentre infrastructure creates many jobs. The buildings may look simple from the outside, but the infrastructure built in and around the centre is complex and require highly skilled personnel.

Furthermore, the installation of all the computer equipment in the datacentre requires a lot of cabling of both copper cables, fibre cables etc.

Datacentres creates a large amount of future based jobs locally, regionally and nationally.

5.1 Type of jobs created

The main categories of jobs that are created locally, regionally and nationally are described below. In addition to the job creation described in this document, there are also more jobs created by the end users.

A datacentre built in Norway will generally provide services to customers in Norway and the rest of Europe.

- All IT-equipment must be installed and connected to power, cooling, copper cables and fibre. Then all equipment must be functionally tested.
- All IT-equipment has a relatively short expected lifetime and is replaced every 3 to 5 years. All of this equipment must be procured, ordered, transported, delivered, received, unpacked, installed and tested. At end of life all the equipment must be uninstalled, removed, taken care of, data deleted, critical component are crushed to avoid miss-use of data on-board, equipment is then recycled and disposed of according to certified procedures.
- As described above a large datacentre operates 24/7. This requires that there are engineers, technicians and security personnel available at any time. Technically this is so-called IMACD-services (Install, Move, Add, Change and Dispose), these services are often also called «hands and eyes» or «break-and-fix-resources».
- To maintain critical IT-equipment it is common to calculate about 2,5 hour per data rack per month, or about 30 hours per year. In a 20 MW datacentre this will amount to about 35 jobs.

[3] Green Mountain, https://greenmountain.no/2015/08/26/bare-haller-uten-folk/

- 24/7 Security services. Access control, perimeter security, delivery checking.
- In addition cleaning services, catering, administration, maintenance etc. is needed.

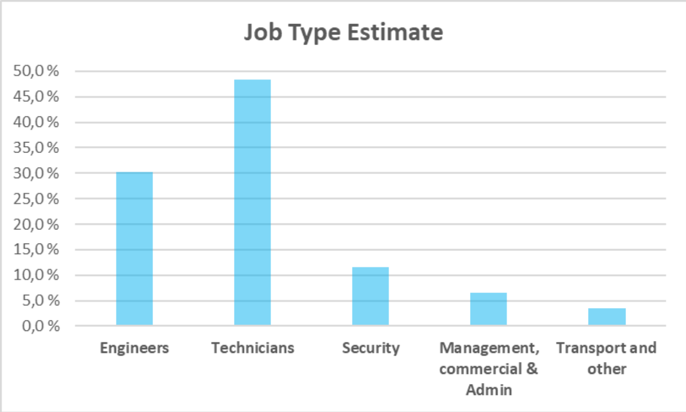


Figure 6: Estimate of type of jobs created.

5.2 Who employs the people?

It is normally only about 10% of the total jobs created that are employed by the datacentre company directly.

Most of the jobs are created by service providers and subcontractors.

- Service providers are companies such as security companies, cleaning, catering and transportation.
- Subcontractors are typically: Electricians, Ventilation companies, DC systems providers and other suppliers
- Other providers will be various types of consultancies (engineering, security, etc.)

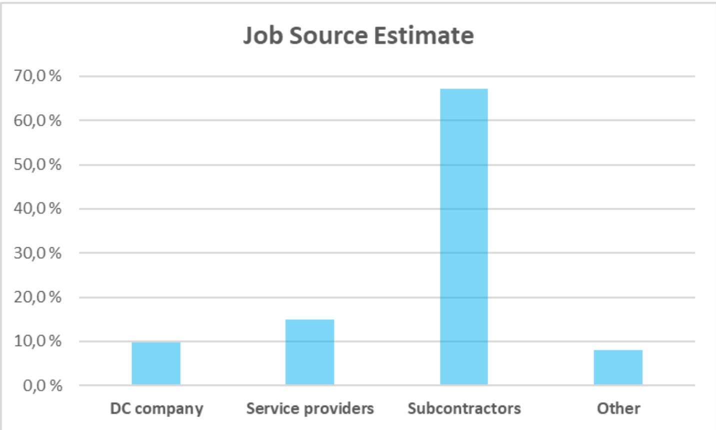


Figure 7: Estimate of who employs the people at a datacentre

The numbers of employees outlined in this document is based on historical data and an internal study by Green Mountain[4], Facebooks Luleå project[5] 2017, Facebook economic contribution report[6] from HIS Markit 2019 and a scenario evaluation made by Menon Economics[7] 2017. The anticipations of employment rate are based on realization of the datacentres and services related to this.

The considerations related to potential new agriculture industry has NOT been taken into consideration, neither other relevant IT-industry that could be realized along with the datacentre establishment in the region.

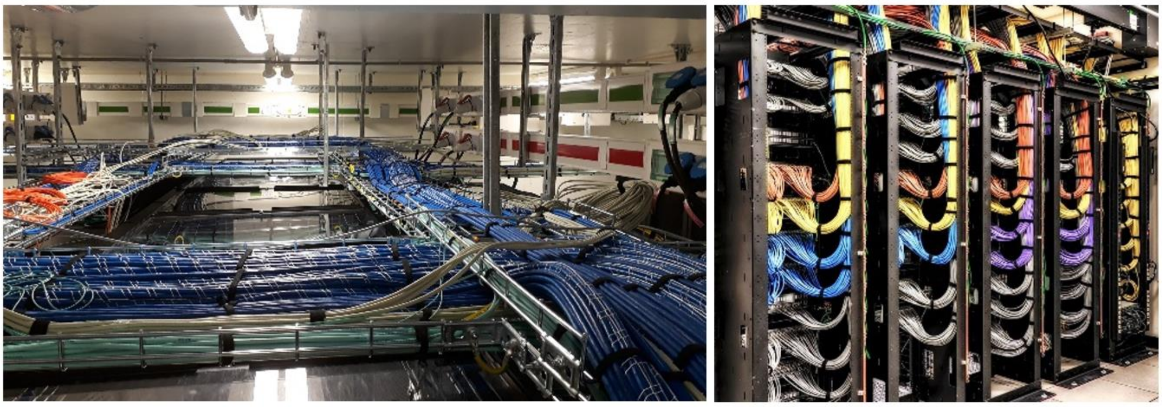


Figure 8: Photo from datacentres illustrating the amount of cabling necessary

6 Datacentre types and clients

Generally, the datacentre industry is divided into 3 types of datacentres; Hyperscale-, Enterprise- and Colocation datacentre. The different types are briefly described below.

There are some common features of all datacentres;

- They all need access to large amounts of power (normally also 2 separate grid supplies)
- The computing equipment requires cooling (normally the ambient air is used)
- Multiple connection to fibre cables (minimum 3 routes) and low latency to main European cities.

The importance of the location should not be underestimated. Power availability, power stability, power cost and connectivity are the most critical factors. The so called "cloud computing" which is the standard today involves a high degree of interconnectivity between multiple datacentres. Computing tasks are often shared between datacentres and the result is presented to the end user.

[4] Green Mountain, https://greenmountain.no/2015/08/26/bare-haller-uten-folk/
[5] Sweco AB, November 2017, "Effekter av Facebooks etablering i Luleå», https://www.investindalarna.se/app/uploads/2017/11/facebook-datahall-sweco.pdf
[6] IHS Markit, september 2019, «The economic contribution of Facebook data centres in Denmark, Ireland, and Sweden", file:///C:/Users/eirikg/Downloads/The-economic-contribution-of-Facebook-EU-data-centres-with-cover-image_final.pdf
[7] Menon Economics AS, mai 2017, "GEVINSTER KNYTTET TIL ETABLERING AV ET HYPERSCALE DATASENTER I NORGE», https://www.menon.no/wp-content/uploads/2017-39-Gevinster-knyttet-til-etablering-av-et-hyperscale-datasenter-i-Norge.pdf

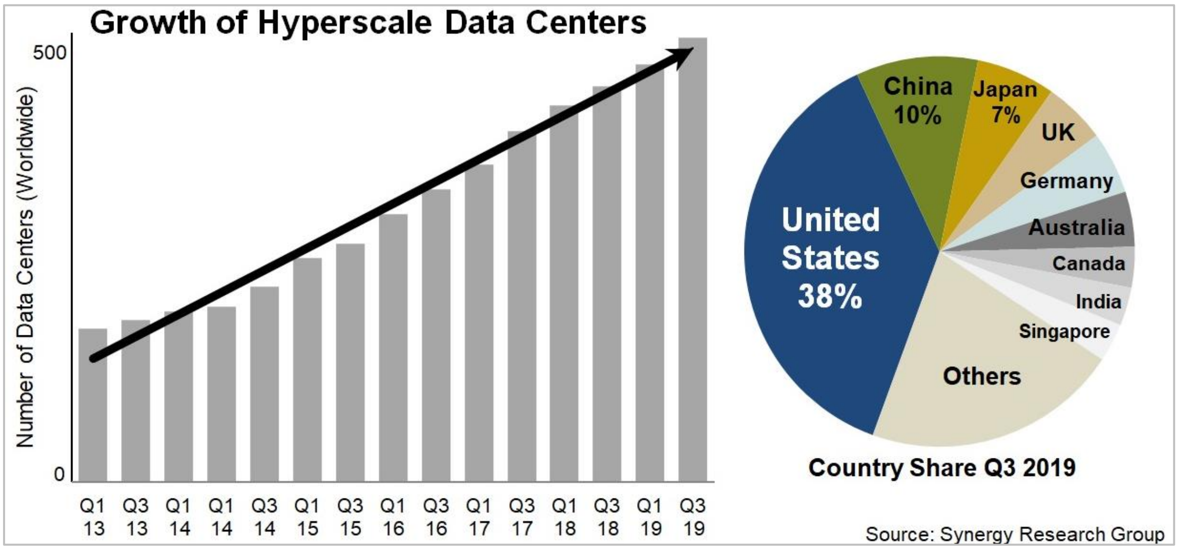
Therefore, the mere existence of one important datacentre will spur further establishment of other datacentre companies. This, combined with marketing efforts by the region, is probably one of the main reasons why the Luleå region today has 19 datacentres constructed since Facebook established their datacentres there 2011.

6.1 Hyper Scale Datacentres

The large international IT services providers such as Google, Microsoft, Facebook, Apple, Amazon, Alibaba build and operate their own very large datacentre facilities. Some smaller companies such as Twitter, eBay, Baidu and others also build such centers.

If a datacentre consuming around 40 MW of power or above, International providers prefer to build on their own. For smaller datacentres (i.e. below 40 MW), they will contract a colocation provider to build and operate for them.

In 2019 the total amount of Hyperscale datacentres passed 500 centers globally. Microsoft and Amazon representing more than 50% of the new builds, all according to a study done by the Synergy Research Group. US represents 38% of the centers in 2019 which is down from 44% in 2017, indicating a massive growth internationally, particularly in Asia and Europe. The growth is expected to continue with "no end in sight to the data center boom" according the research group.



It should be noted that the Hyperscale datacentres are also built to different standards depending on the purpose of the datacentre and its end clients. For example, a datacentre by Microsoft providing services for clients operating critical services for the public sector and other businesses will have a higher degree of complexity and criticality than an installation by Facebook. Consequently, a hyperscale datacentre from Microsoft will create significantly more jobs than a datacentre by Facebook. A reasonable estimate could be around 15-20% higher job creation for the complex and critical hyperscale datacentres.

Figure 9: Photo of Microsofts datacentre in Quincy, Washington state (100 MW)

6.2 Enterprise

Traditionally, large companies have built their own datacentres for internal purposes. The last decade this has changed dramatically, as they have migrated their systems partly into colocation datacentres and partly into cloud environments. At the same time the technology and communication systems has developed such that it allows for location off site from their main production facilities.

6.2.1 Industry groups

Many large international industry groups are extensive users of IT-systems for design and development of their products. An example of this is the automotive industry that use advanced methods to calculate and simulate their design before start of production. Also, the strong drive towards autonomous vehicles is an important driver for this privately owned Enterprise datacentres. Several companies are currently in the market looking for location for their future datacentres (Volkswagen group, Ford, Daimler, BMW, Volvo and others are all potential clients).

6.2.2 IT-systems providers

A second group of clients are the large IT-systems providers that does not reach the level of Hyperscale. They will typically deploy sites of 10-30 MW of IT equipment. Clients could be companies like Content Providers, IT-systems providers and gaming providers.

- Example of Content providers: Netflix, Hotels.com, Booking.com, Dropbox etc.
- Example of IT-system: Oracle, Adobe, Salesforce, etc.

All of these are potential targets for Enterprise datacentres.

Again, the datacentre requirements will differ immensely depending on the client, however the requirements are generally higher with regards to complexity and criticality than a Facebook equivalent type of datacentre.

6.2.3 High Performance Computing

A third group of clients could be companies that requires high computational capacity, often non-critical, but may also be some critical systems (High Performance Computing – HPC).

These datacentres often have less complexity with regards to power infrastructure and cooling, but on the other hand has some added complexity due to power density (ie. more power per m2 of dataspace). Some of these datacentres will allow power to be turned off directly if the grid fails, but often parts of the infrastructure has critical load. Split could be for example 30% critical load and 70% non-critical load.

The use of Artificial Intelligence in general is utilizing HPC capabilities and is as such an important driver for Enterprise datacentres.

Figure 10: A 15 MW datacentre site in the US (Vantage Data Centers)

6.3 Colocation

The most common type of datacentres being built at present is the colocation datacentre. In these datacentres a multitude of companies place their IT-equipment and share the Datacentre infrastructure. Several hundred companies can operate their business from the same datacentre. The client size can vary from customers requiring 1 rack of data space, or even just a part of a rack, to clients requiring several hundred racks.

The client base is typically broad, from a small local IT provider to the large international provider. Even, hyperscale operators buy space with the Colocation providers when their requirement in a region is below 30 MW.

In Norway, Green Mountain and Digiplex (Oslo based) are the two largest colocation space providers. Internationally there are several colocation companies that operate chains of datacentres across the globe. This some of the largest colocation companies are: Equinix (US), Digital Realty (US), Cyrus One (US), QTS (US), NTT com (JP), CoreSite (US), Global Switch (UK), Data4 (FR) etc.

EQUINIX DIGITAL REALTY Data Center Solutions CyrusOne NTT DATA4 GROUP

6.4 Other datacentres

There are some special purpose type datacentres that does not fit any of the descriptions. Most notable was the recent investment surge into crypto currency mining. This was very simple and energy wasting datacentres being built based on “speculative purposes” to mine crypto currency. These centers were built for one purpose only, access to low cost power and thus compute power. They require very limited fibre connectivity.

In Norway this type of datacentres has had a negative impact of the reputation of the datacentre industry in the public opinion.

7 Green Support Industries

The large international companies we are seeking to attract to the region are looking for ways to make their business greener. Consequently, it is essential for the project to take into account a holistic view, i.e. not only providing renewable power but also find and establish efficient solution for utilization of the generated heat from the datacentres. In this context the existence of a regional gas distribution, district cooling and district heating infrastructure is very important.

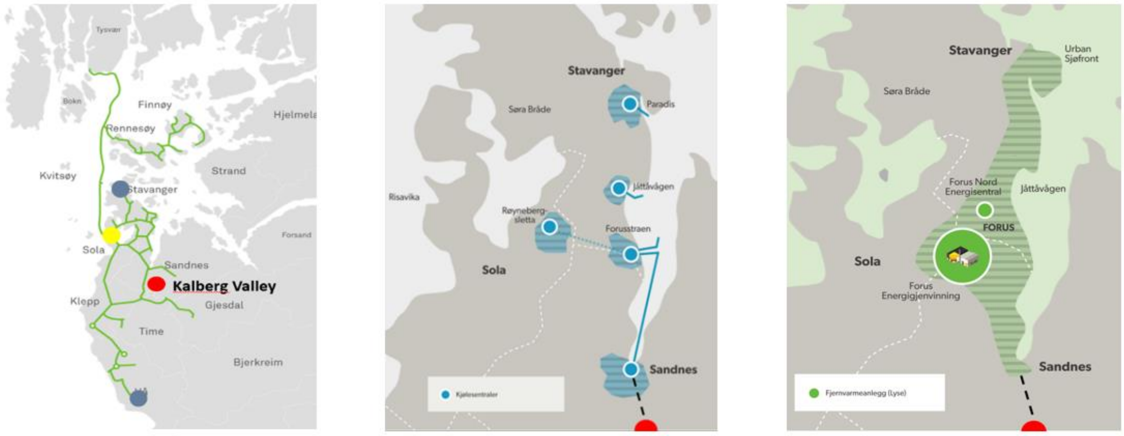


Figure 11:Overview of gas distribution net, district cooling and district heating

This combined with the intensive agriculture production in the region opens for use of the heat from datacentres to assist in the production of biogas from manure.

Furthermore, this allows for development of food production from industries such as vertical greenhouses and farming of fish and/or crustaceans utilising the excess heat from the datacentres. This is described in a separate study done by Lyse[8].

[8] Lyse, 2020, Kalberg Valley Datacenter site, Additional Industry and CO2 Footprint Reduction Opportunities