PROGRA M

STUDENT:UNA NADAREVIC
SUPERVISOR:TINE HEGLI

BITS, BYTES AND BATHS:
data center and public swimming pool creates synergies in Åkrehamn

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The Oslo School of Architecture and Design

TABLE OF CONTENTS

- Thesis

01 BACKGROUND

01.1 INTRODUCTION
- the server and the web
- sustainability
- why is this a design task

01.2 SYMBIOSIS : HEAT AS A RESIDUAL PRODUCT
- why do data centers produce so much heat
- cooling

01.3 SITE CRITERIA : DATA CENTER
- : a list

01.4 SYMBIOSIS : THE COMPUTER AND THE POOL
- A pool facility is not always profitable
- Social benefits of a pool facility

-TIMELINE : social history of pools
-TIMELINE : history of computers, the internet and data centers

01.5 SITE CRITERIA : A POOL FACILITY
- : a list

02 FINDING THE SITE

02.1 WHY NORWAY
- MAP: Analysis southern Norway
- MAP: Analysis northern Norway

02.2 ROGALAND

02.3 STAVANGER

02.4 THE SITE: ÅKREHAMN, KARMØY

03 REFERANCE PROJECTS

03.1 DATA CENTER
- facebook Luleå
- Kolos
- Greenmountain

03.2 POOLS AND THERMAL BATHS
- Leca Swimming pools

03.3 SYMBIOTIC PROJECTS : INDUSTRY+RESIDUAL PRODUCT
- Project Rhizome
- Uitikon sports center and computer center
- The blue lagoon geothermal spa and svarsengi power plant

04 FURTHER WORK

Semester plan and deliverables

Helpful documents and reading

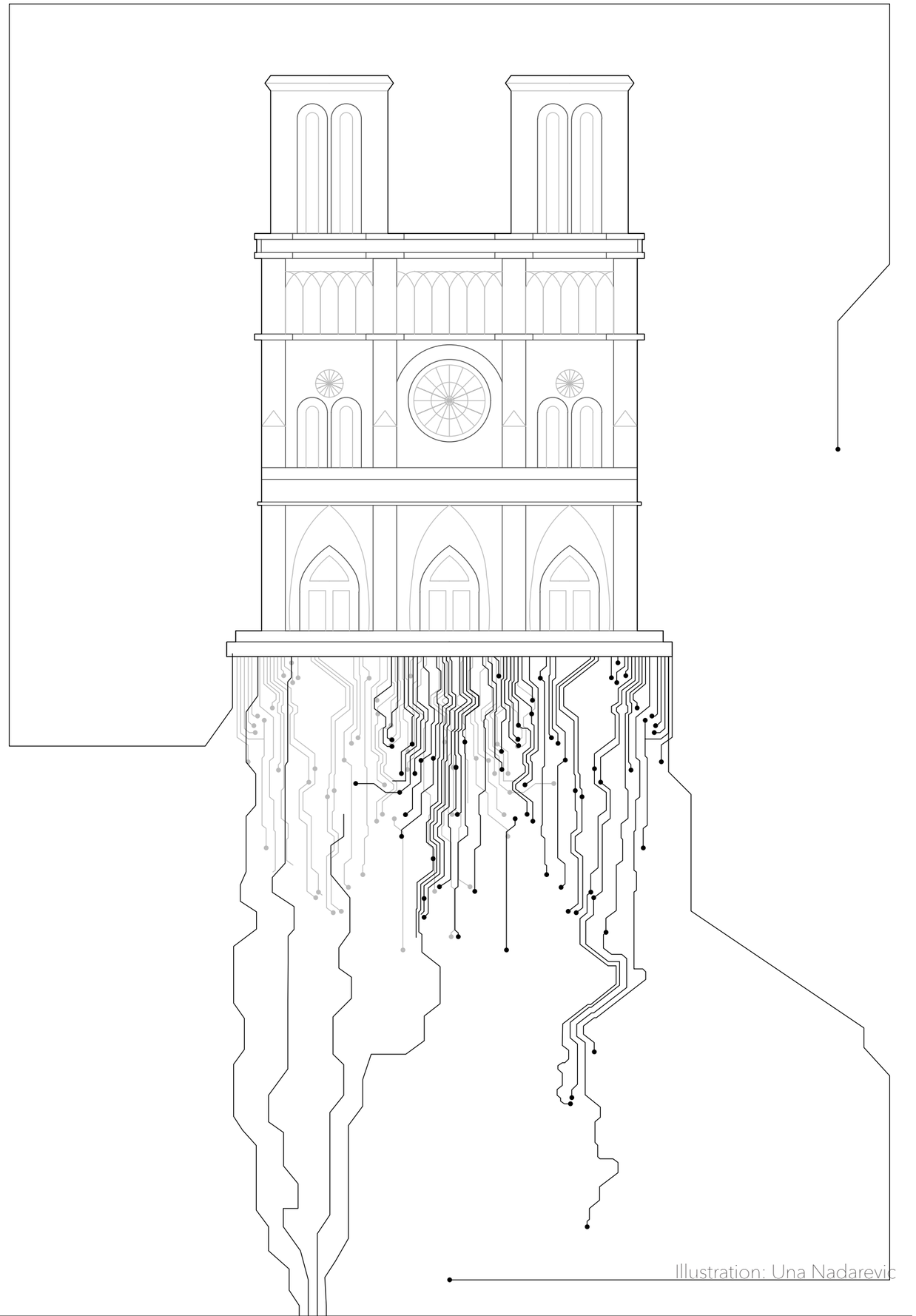


Illustration: Una Nadarevic

THESIS

As students of architecture we often search for the Zeitgeist - the spirit of our time - and the means to communicate it spatially. What are the cathedrals of our time? All our contemporary advances have been enabled by our ability to extract and store data. Today we store this information in data centers.

In my diploma work I wish to investigate an architecture that through a synergy of functions can support city development and where excess heat can power social interaction. In my attempt I will focus on the data center in synergy with a public pool.

IMAGE: https://unsplash.com/photos/xxeAftHHq6E

https://www.bbc.com/future/article/20160624-the-machines-that-run-the-internet

01 BACKGROUND

01.1 INTRODUCTION

To someone oblivious to the technologies behind self driven cars, cloud storage, airdrop and the Internet; the world we live in today must seem like a magical one. Yes, we all know that under it all lays "technology", but what does it mean?
One afternoon I was gifted a server for all my terabytes. It was from a very different type of architect than myself - a system architect - and our two worlds had close to no correlation. As a student of spacial architecture in this time I consider myself an avid user of the world wide web and cloud storage. Now I know that was barely on a surface level. For the longest time the world of computers, servers and internet was remote to me and I was happy to leave it at that. If I were to use this box instead of continuing using various free trials for cloud services I had to learn. My first questions were: WHAT IS THE CLOUD AND WHERE DOES THE CLOUD LIVE?

THE SERVER AND THE WEB

When sending information from one personal computer to another there are a dozen other computers working as a bridge to connect the two. All of these linked computers make up the "internet"; the basic computer network. This connection between computers are a mixture of the old copper cables, the newer fiber-optic cables, wireless radio connections and satellite links. By these the internet moves computerized information from place to place, in packets. The packets can flow through many routes around the world in pieces. But in between, all the photos, videos and Wikipedia articles, needs to be stored somewhere. This is where the servers are introduced. Server computers are the dynamic force of any network. They provide the shared services we need to process and store web services. On the next page you can see a simplified illustration describing how information moves.

DID YOU KNOW?
The digital age is an FYI-culture where we send many unnecessary emails. We do not only answer a ton of emails just for the "message recieved", we also copy and forwoard a lot of mails. This comes at an expense. One email on average emits 1 g of CO2 emissions to send and 10 g CO2 emissions to be stored a year. Source: https://cleanfox.io/blog/digital-pollution-en/digital-pollution-emails-and-carbon-emissions/

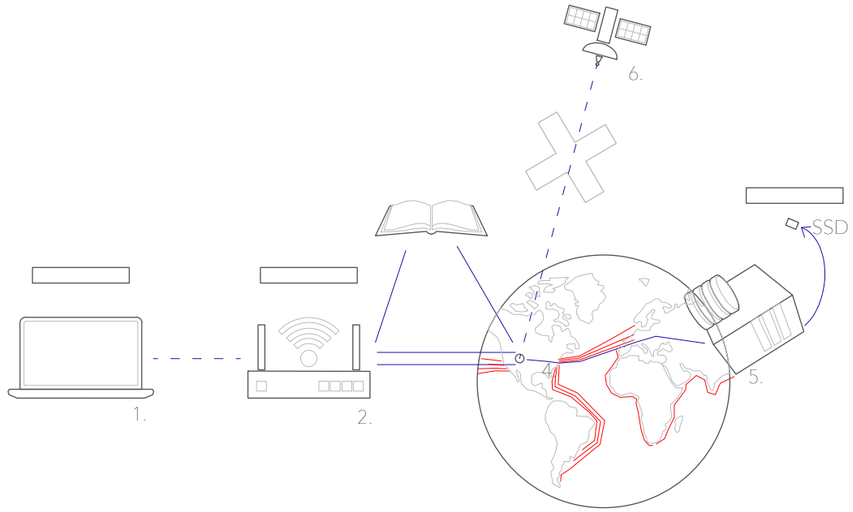
SUSTAINABILITY

The reality is that these servers that connects us and stores data for us need enourmous ammounts of energy to keep running. Contradictory they need almost the same ammount of energy to cool the servers, as they need to keep them in operation. This makes data centres account for 2% of global power demand[1]. Not a big surprise when you know that in 2020 the global need for storage is 44 zettabytes (21 zeros). There are a handful of enviormental challenges connected to data centers. There are many things that need to be modified on both a smaller and larger scale; something that will connect various professions. The issue of energy extraction and utilization and is one of the clearest issues when we are now trying to cut our carbon footprint. In my diploma I have chosen to tackle this issue.

1 https://www.researchgate.net/figure/Global-electricity-demand-of-data-centers-2010-2030_fig2_275653947

WHY IS THIS A DESIGN TASK

Why is this a design task? "Because design is deliberate"[1] What we are striving to do is to capture the human condition in a spatial structure. We wish to amaze, beautify, and ease our lives. Whenever a historic structure is discovered we try to understand how this particular structure captures the society's they represent. We have pyramids, colosseums, cathedrals, cities carved out of mountains, what was the ritual these people valued the most?
In our time, hardly anything we do would be possible without the data centers. If I was to choose one structure that represents our society, the cathedral of our time, I would pick the data center. If this so strongly influences our way of life and our culture, why do we not see them around? These are high-security storage spaces, but so is the national archives that are located in cities across the country.
I wish to make an example of a data center that is visible in our society and a place that is physically for the use of society it inhabits.



1. Someone is searching an article online on a laptop. The laptop, and every other device connected to the web has an IP adress - a series of numbers that acts as a shipping address. BUT often the consumers will use a domain name such as youtube.com instead of the complicated numbers. As you search, you send a packet of information.
2. At home the packet is often travelling wirelessly to for example a router.
3. The router will send it to an DNS server, which works as a phonebook. When it finds the IP adress it will send it back to your personal computer, which will then send the packet to the web pages respectable data center via the fiber optic cables.
4. The fiber optic cables sends the packets as pulsating light.
5. When your requests enters the data center it will find its way to the right IP address and retrieve the information from the right SSD (the internal memory of the server).
   A server has the capability to store several websites, but larger companies will most commonly need to use an entire data center just for themselves.
6. What about satellites? For the information to travel through satellites is an easy option, but not commonly used for internet traffic because it can cause huge latency, because of the large traveldistance.

1 Page 55, "A changmakers guide to the future, by Anders Lendager, Ditte Lysgaard Vind

EXPLANATORY VIDEOS
https://www.youtube.com/watch?v=x3c1ih2NJEg
https://www.youtube.com/watch?v=zpR_m2_7XDI
https://www.youtube.com/watch?v=PIhD4T4tayM

01.2 SYMBIOSIS : HEAT AS A RESIDUAL PRODUCT

In the SUSTAINABILITY portion it was mentioned that one of the biggest challenges of a data center is the heating and cooling. A data center can use 1/3 or even 1/2 of its energy consumption just for cooling. In my task I wish to tackle the heat residue issue of a data centers and use this to create something that gives added value the community.

WHY DO DATA CENTERS PRODUCE SO MUCH HEAT?

The main heat generators in a data center is the servers. In the servers it is the central processing unit (CPU), the part that crunches the numbers and directs the flow of bytes wihin the machine. This means that volume-wise, the part that rewires most of the cooling is only a fraction of the volume that a typical data center commands.

Why do CPUs get so hot that we need to artificially cool them?
Moving bits around is work that require energy (electricity) and inevitably results in some heat as byproduct. Billions of microscopic transistors that alternate between the state of 0 and 1 at the rate of millions of times per second. Think of the heat your laptop produces while you are reading this. Now imagine a room full of thousends of thousands of even more powerful computers working at full speed non-stop.

The problem with the heat is that it makes the servers malfunction, shut down or need help to restart. That might yield catastrophic consequences and affect all their clients. A data centre needs to be available every second of the year. If a centre goes down it will affect an unfathomably large ammount of people.

COOLING

A typical data centre today uses air as the cooling agent, just as a laptop, and aims to maintain an optimal working temperature within the centre between 20-25 degrees celsius.
To achieve this the server room is arranged in isles, half of them being "cold" isles and half "hot" isles. Cool air gets fed into the "cold" isles from underneath a raised floor of the facility. This then enters the servers thus cooling them. Then the air gets sucked out into the "hot" isles on the other side of the racks. From there it travels to the air handling unit (AHU), and gets re-conditioned to optimal temperature and humidity. Then the cycle repeats.
This is where data centres get its bad reputation from. They are cooled by heat exchangers containing chilled water, and running chillers that condition the water is very energy intensive. This is why some data centres use as much energy to cool the servers as running them.

PUE

PUE is what what compares the total energy consumption of a data center to the energy consumed by computing alone. A PUE of 2 would mean the center uses as much energy for performing computations as it does for other functions such as cooling. A figure of 1.2 PUE is considered good and 1.05 fantastic. An optimal PUE save both the environment and
money for the operators. Some good solutions for a low PUE using natural resources for cooling is Facebook´s data center in Lulea, Sweden. Which you can find in the reference projects.

COOLING BY LIQUID

The attempt to cool data centers using liquids has so far been limited to supercomputers and data centers for bitcoin mining. A project later presented in the document the Kolos data center is an example of using this technique. Liquid is 4000 times more effective than air. There are a few examples of using water for cooling and then use the same water for
heating.
Yandex´s data center in Finland will provide heating to the nearby village[1]. In Zurich IBMs supercomputer is heating the buildings on ETH´s Zurich campus[2], and in Uitikon the public pool is heated by the nearby server center. The last example will be presented in the
reference projects.

1 https://www.datacenterdynamics.com/en/news/dcd-at-cebit-heat-reuse-worth-more-than-pue-yandex/
2 https://www-03.ibm.com/press/us/en/pressrelease/32049.wss)

01.3 SITE CRITERIA: DATA CENTER

To make the evaluation process of finding a site easier I am making lists of criteria for both a data center and a pool facility.

STABLE ENERGY ACCESS: Data centers and the internet run on electricity, and stable energy access is a given. The internet has no closing hours and a client that stores its information in a data center must be able to trust being able to access its data as if it was there on their desk at all times.

SECURE INTERNET ACCESS: This is just as important as the energy source. Damage rarely happens and new forms of transport of information, such as todays fiber cables are running along the older solutions that are left to run until decay.

STABLE CLIMATE: Data centers are built almost all over the world, but the efficiency is clearly reflected by the climate they are built in. Heat may cause computers to malfunction and restart. Therefore it can be more efficient to run a data center in a cooler climate where they do not have to be as heavily cooled and the risk of malfunction is high.

ACCESS TO RENEWABLE ENERGY: For a long time renewable energy has been viewed as a privilege and not a criteria. Now it is more a tool for green-washing for many companies. A data center could function off of electricity produced from coal, but it is not aligned with my idea. I wish to find a place where the electric grid is as green as possible.

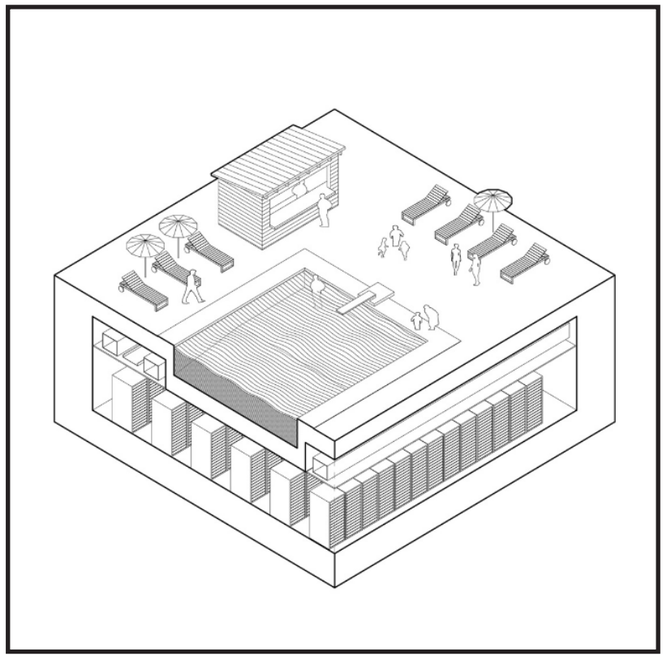


Illustration by project rhizome. See the referance part for more info about this.

01.4 SYMBIOSIS :THE COMPUTER AND THE POOL

The idea of my diploma project is to create a synergy, where excess heat from a data center can be used to heat another program. There are several ways to do this. It can be commensalistic (like the blue lagoon in Iceland), parasitic (Uitikon) or mutualistic (project rhizome). I wish to make a mutualistic project where the data center can cooperate in heat and cooling exchange with a more direct and public program.

A study from the university of Glasgow[1] suggests health benefits related to having pool facilities close to home. In Norway the discussion about public pools are often concerned by the high fares because of the large cost of operation[2,3]. I view a public pool as a nice all year round offer, and have decided for this to be my public program.

In my preperation for a diploma I have choosen a community for my site, but not the final plot. When the diploma starts I wish to further look into what the place has to offer before deciding if it will be a more urban, rural or by the sea.

HOW IS THE SITUATION IN NORWAY TODAY?

I corresponded with Erlend Alstad, an advisor for construction projects for Norges Svømmeforbund.
They claim that there are two issues for them to cover the demand of swimming activities and that is the lack of facilities and that there is a problem to gain access to the existing facilities, because of the standard. Almost every town in Norway has a small 25 meter pool built in the last century. In the mid 80s Norway had more pools than Sweden and Denmark combined. Today many of these old facilities either need heavy work to meet todays standards or the work is so comprehensive and overdue that they will have to be demolished.

1 https://pdfs.semanticscholar.org/e953/2546b926bb957f97955cf094c4b9fae03e9f.pdf
2 https://www.dagsavisen.no/fremtiden/lokalt/kostbart-a-drive-norges-storste-bad-1.278902
3 https://www.aftenposten.no/osloby/i/8w88x/har-ventet-45-aar-paa-en-svoemmetur-til-250-kroner

A POOL FACILITY IS NOT ALWAYS PROFITABLE

The maintenance of a public swimming pool is expensive and not always profitable. One of Norway's most popular swimming facilities; Drammensbadet costed 1 million NOK a week to run in 2014, heating being a major expense. This is reflected in the high ticket fares.

In Norway the balance between a profitable and unprofitable swimming facility seems to be whether the facility has interesting, fun and varied offers other than one simple 25-meter swimming pool[1]. According to Asplan Viak the market for swimming pools were saturated in the 80s with simple 25-meter pools and diving boards. Over the years the interest in the market changed and people wanted a place to stay all day as a family with entertaining offers such as Østfoldbadet in Askim.

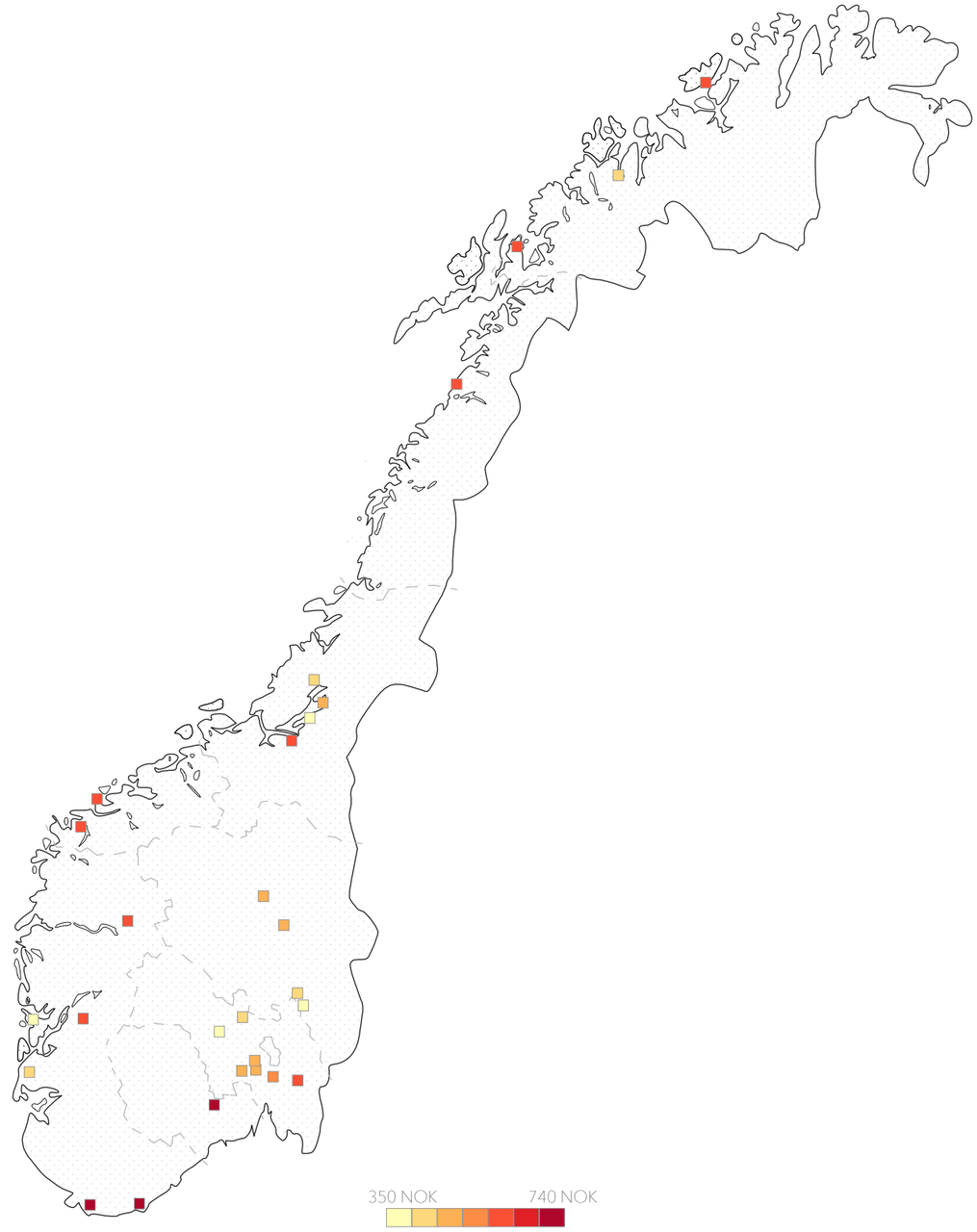
So to make a swimming facility more profitable, we need to cut the cost in heating and make the facility more interesting and make it an interesting space you would want to spend a Saturday.

Kostbart å drive Norges største bad

DRAMMEN: Byen har bare én svømmehall, men den er til gjengjeld landets største. Johan Baumann (H) mener prisene står til tilbudet.

1 https://www.asplanviak.no/aktuelt/2013/03/10/tidligfaseutredninger-av-badean-legg/

This map shows the very varying prices for a family of four to enter some of the largest pool facilities in Norway. Here the 29 members of the "Badelan-dene" is represented.



https://www.nrk.no/vestfoldogtelemark/pris-pa-billett-i-badeland-varierer-mye-_-mange-barnefamilier-ma-sta-over-1.14867658

SOCIAL BENEFITS OF A POOL FACILITY

The idea of using the excess heat of a data center can be applied to everything from heating homes to food production. As previously mentioned my wish was to connect it to a direct social program. This program will be a swimming facility, and one of the reasons I chose this was because of

The study carried qualitative data from two areas of south Glasgow to assess the health impact of neighborhood swimming pool and leisure facilities. It found additional health benefits to local swimming facilities other than physical health, and points at some important design features for how to establish the facilities presence and make it a perceived safe space in the neighborhood.

Some reports were made that the pool area impacted the perceptions of safety. This was because of it being a lit up area with the occasional pedestrian. [1]
The study also shows that the pool to be important to facilitate for social contact with friends and neighbors[2]. This was directly linked to mental health. The social contact was reported to be a stress relief and reducing isolation. Further investigation suggested that the later lack of swimming arena resulted in other challenges. Especially mothers of young children, those living alone and elderly were reporting as especially in need of the facilities. The pool facilities were considered especially essential where the was not much secure public spaces, housing was not spacious. The pools in the test areas were linked to both areas of higher and lower income, but people of both areas reported the same benefits and needs of the arena. Among people there was greater emphasis on the mental health benefits associated with the pool
facilities than physical health. The studies of the heath impact were complicated and composed, which made them hard to prove.
The conclusion of the study was therefore that it suggests that the obvious health impact of a public swimming pool and leisure facility, like physical activity, may not be the most profound health impact on the local neighborhood. It was rather the facilitation of social contact and that secondary functions to the pool facility were necessary.

1 https://pdfs.semanticscholar.org/e953/2546b926bb957f97955cf094c4b9fae03e9f.pdf page 7
2 https://pdfs.semanticscholar.org/e953/2546b926bb957f97955cf094c4b9fae03e9f.pdf page 9
source:
STUDY :ASSESSING THE HEATH IMPACT OF LOCAL AMENITIES : A QUALITITATIVE STUDY OF CONTRASTING EXPERIENCES OF LOCAL SWIMMING POOLS AND LEISURE PROVISION IN TWO AREAS OF GLASGOW
https://pdfs.semanticscholar.org/e953/2546b926bb957f97955cf094c4b9fae03e9f.pdf

TAINAN SPRINGS / MVRDV
This is a transformation project of a mall into a social gathering space. The mall was built on top of the old city harbor.

READ MORE : https://www.archdaily.com/935346/tainan-spring-mvrdv?ad_source=search&ad_medium=search_result_all

01.5 SITE CRITERIA:POOL FACILITY

To make the evaluation process of finding a site easier I am making lists of criteria for both a data center and a pool facility.

LIMITED ACCESS TO BATHING FACILITIES: I wish to do the facility in a place where maybe the access is limited or non-existent. I am looking through all options; a community with nothing, a community with high demand but the demand is not met by the existing structure, or where the existing structure is in bad shape.

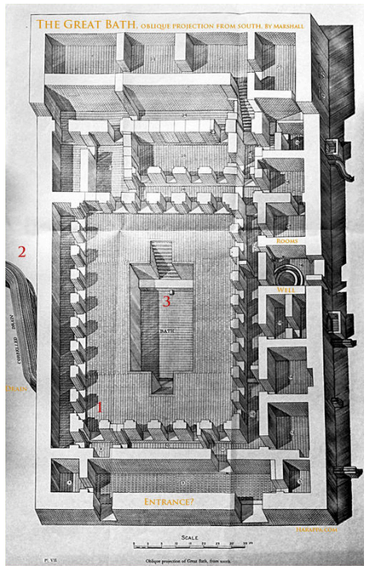
NATURE: I think that having an indoor-outdoor facility would be nice.
Not necessarily having the pool being outdoors, but the possibility to go outdoors and offer some alternative qualities.

AN AREA IN NEED OF WORKPLACES: This is also for the data center portion of the project. I wish to create workplaces for both people with an education in IT and younger generations.

TIMELINE

POOLS AND THEIR SOCIAL CONTEXT

The earliest records of people swimming are much older than where I choose to start the timeline. This is not a complete timeline, but more an introduction to the most interesting facilities.



https://www.facebook.com/AncientPakistan.pk/

3000 BC

The earliest public water tank in the ancient world is the "great bath" in the Pakistani city settlement of Mohenjo-daro. It measures approximately 12 meters noth-south (with a starcase in each end) and 7 meters wide with a maximum depth of 2.4 meters. Most scolars agree that the tank was used for religios functions to purify and renew the well being of the bathers.

(https://www.swimmingpool.com/pool-living/pool-history-facts-and-terms/the-history-of-pools/)

1300 - 1100 BC

The palace complex of Knossos is maybe one of the oldest, western known baths. The greek established baths and showers for relaxation and personal hygiene. Pools were a place of healing. The spartans developed team baths.

https://en.wikipedia.org/wiki/Knossos#Palace_complex

1300 - 1100 BC

In the 6th and 8th century BC, the Greeks had "Palaestras", which were open courts for wrestling, boxing, ball play and other exercises, but most importantly there were pools for swimming, bathing and socializing. These areas were also used to physically train for war.

600 - 800 BC

36 BC

Japanese historic records describing the first known swimming competitions.

https://www.cirruspools.com/swimming-pool-history/

https://www.tes.com/lessons/sukP-gABL6HMFPQ/per-4-all-roads-lead-to-rome-group-3

AD 305

In AD 305 The Romans built an over 80 000 m2 for bathing. Roman baths varied in size, arrengement and decoration, but most contained apodyterium - a room inside the entrance for storage of clothes, tepidarium (warm room), calarium (hot room) for a steam and then the frigidarium (cold room) with a tank of cold water. The houses had three entrances for seperation between men, women and slaves. They also often had Palaestras or courtyards and sometimes these contained a pool. Pools were also present in homes, but bathing was also a communal activity. The public pools were for socialization, courtship, sealing buisness deals.
Communal baths were also present in temples.

1800 -

Before the 1800s it was not all that common to bathe the whole body in Norway. As late as in 1922 it was still discussed if a bathroom should take up valuable space in ones home. It was not until the development of drabantbyer in the 1950s that an in-house bathtub became normal. Therefore public baths were long important insitutions in a society. These did not yet have a large pool like the romans and greek.

1920-1921
When Bislet bad in Oslo was built with a hall for swimming it became widly popular and many parts of the city wished to have one. This also quickly spread to other parts of the country and started a race that lasted until the 1980s.

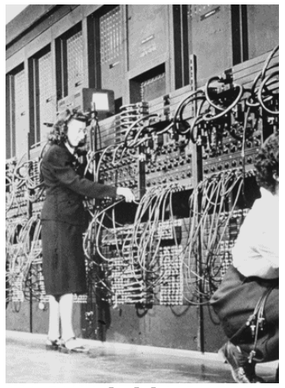
https://www.swimmingpool.com/pool-living/pool-history-facts-and-terms/the-history-of-pools/

https://no.wikipedia.org/wiki/Torggata_Bad

TIMELINE

COMPUTERS, INTERNET AND DATA CENTERS

This is not a complete timeline, but more an introduction to the most important dates in computer, internet and data center history to understand the development and how they relate to each other.

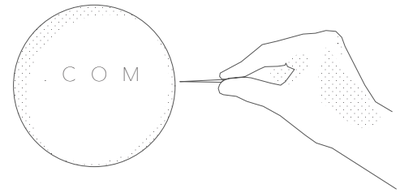


AN ENIAC COMPUTER
IMAGE: https://snl.no/ENIAC

UNTIL 1970

Until 1970s there were two main categories of computers; minicomputers and mainframe computers. The mainframes could fill an entire room and were used by several people at once. The minicomputers were about the size of a fridge. Mainly they were for military purposes.

In the year between 1970s and 1980s we see the clients develop into personal computers.



1943-1944 | 1965 | 1971 | 1980 | 1990 | 2000

1943-1944

Data centers are not a new invention made to sustain today's internet traffic, in fact the way a data center is actually more like the first computers made and what made personal computers possible. They have their origin in the ENIAC (Electronic Numerical Integrator and Computer) which was the first electronic general-purpose digital computer.

1965

THE INTERNET IS BORN

when two computers at MIT Lincoln Lab communicate with one another using packet-switching technology. But the concept of data communication predates the introduction of the first computer with mediums such as radio and electric wire communication.

1971

THE MICROPROCESSOR

With the invention of the microprocessor computers could now become smaller. A version of the Unix systems, a family of multitasking, multiuser computer operating systems, were called "servers". Then a part of the work could be outsourced into clients (as our personal computers today) while the server would be in a specific room inside the company. Soon these clients could move further away from the server, but would still need to connect to the server where information was stored. This was a step to make computers lighter and more user friendly. The term "data center" was a term used for the server rooms.

https://www.computerhistory.org/timeline/1933/

1980s

A COMPUTER BOOM

In the 1980s we see a boom in the microcomputer industry when computers became more common, operating requirements were often neglected. As IT (information technology) operations started to grow in complexity organizations grew aware of the need to control IT resources.

1997-2000

DOT-COM BUBBLE

The true boom of data centers came during the dot-com bubble of 1997-2000. Companies needed fast internet connectivity and presence on the internet. Because not many companies lacked the knowledge and personnel to operate, large companies started building Internet Data centers (IDCs) could work as a crossover backup.
The term Cloud Data centes (CDCs) was for the smaller companies where they would rent space for their webpage. But the division of these terms is today almost disappeared and now all web storage is called "data center" and is where the cloud lives.

DATA | ECONOMY

NEWS ECONOMY BUSINESS MARKETS LEADERSHIP INDUSTRY LIFE & ARTS

By João Marques Lima | **PUBLISHED:** 11:57, 15 August, 2017 | **UPDATED:** 12:45, 15 August, 2017

Site expected to create up 3,000 jobs and support up to 15,000 more.

A giant data centre, which will be the "**world's largest**", is making its way to Ballangen, a Norwegian municipality of just over 2,600 inhabitants in the **Nordic region**.

https://data-economy.com/norway-lands-worlds-largest-data-centre-1000-mw-6-5-million-sqf/

02 FINDING THE SITE

So far in the document Norway has been pointed out as the host of this project without really explaining why Norway could be a good site for the project.

SITE CRITERIA:DATA CENTER

The data center criteria are, on a fundamental level, even more important than the ones of a pool. This is for the center to run efficiently. The electric grid in Norway has some overlapping points, making it secure from power shortage. The fiber connection is relatively good[1] because of existing and planned under-sea cables and connection to the vast Swedish grid. Also the relatively stable climate and temperature. These are the basic criteria.
Another criteria is access to renewable energy sources. As previously mentioned the electric consumption of even a smaller data center can be enormous; especially if it has to be cooled by air conditioning. Here the physical Norway tunes in. Because of a dramatic topography Norway is a country of many climatic zones. By the coast: humid and temperate, and right next to it; the polar mountains of the midlands. This gives many opportunities in using
natural cooling systems.

POLITICS

Facebook recently opened a large center in Lulea, Sweden[2], based on these criteria.
Another reason was the political situation, and these also applies to Norway: the political stability.
In Norway there is an ever ongoing discussion on what the national economy will be based on if the government were to step away from the extraction of oil and gas in the North Sea. Or even deeper; how will Norway keep its global position when this happens? When discussing data centers and their importance, establishing Norway as a bank for the global connection could be an idea.

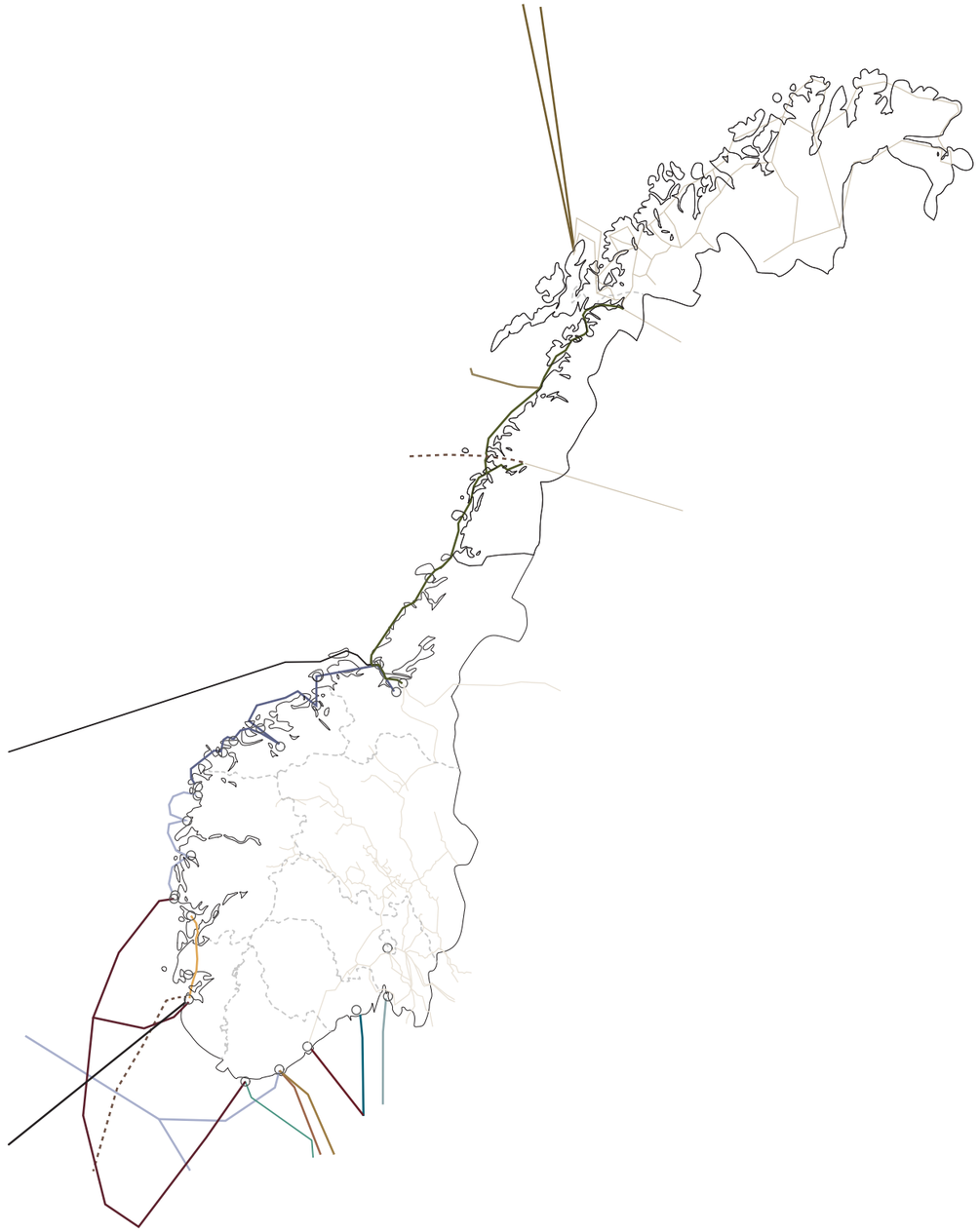
POLITICS:LOCAL

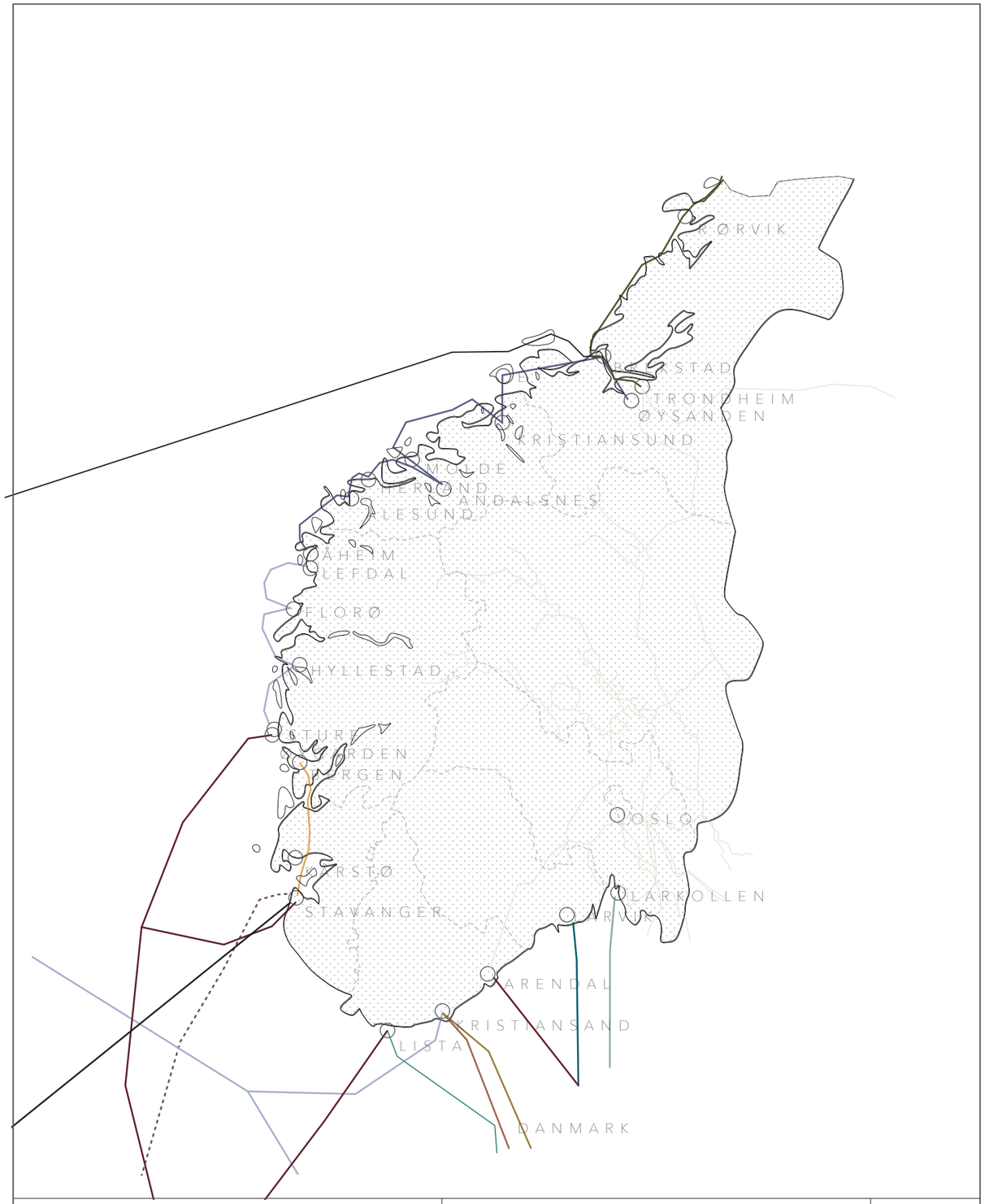
Locally, it will create jobs for a growing group of highly educated IT workers. If the site also is chosen carefully; it can bring life to a district and be a small seed that can bring people to re-inhabit the rural areas that are struggling today, or reintroduce life in the declining workforce of i.e. Stavanger. An area that will be heavily affected by the decline in the oil and gas industry.

CRITERIA:POOL FACILITY

The core idea of the pool and the data center as a synergy is to make the data center being cooled by the pool and the pool to be heated by the data center. Connected to a community it will be a place for socializing. Therefore I value areas that do not have an existing facility more than an area that already ha a pool facility in need of an upgrade. Both are very fitting for Norway where there is a tradition from the last century where there

1 https://seasia.co/2019/07/12/rank-of-countries-with-fastest-and-slowest-internet-in-the-world-2019
2 https://www.bbc.com/news/business-22879160





MAP : SOUTHERN NORWAY

This is a map showing the subsea internet fiber cables and under ground fiber cables on the mainland.

MAP : NORTHERN NORWAY

This is a map showing the subsea internet fiber cables and under ground fiber cables on the mainland.

02.2 ROGALAND

From mapping out the possibilities in Norway of secure and fast internet access, stable and green energy access, access to more entertaining pool facilities and some other points I will mention here I ended up with Rogaland as my site. The internet access, climate and access to renewable energy is relatively well-covered in most of Norway, but Rogaland has some extra good factors. I will go through the criteria here.

ACCESS TO ENERGY

Stable energy access is one of the factors. In Rogaland they have a delivery reliability of 99,994 %[1] a year on a statistic normal. What happens in case of emergency? KBO (Kraft og beredskapsorganisasjon) is responsible for that and their are responsible for watercourse regulation, transmission and distribution of electric power and district heating for their own facilities. This is good because even in case of an emergency the energy can be green and not depend on gas. About 5 % of energy supply in Rogaland is gas, and the costumers are mainly in the industry section. Even though KBO does not rely on gas and the region is trying to limit the use of gas, the offer needs to be present in case of a grave emergency.

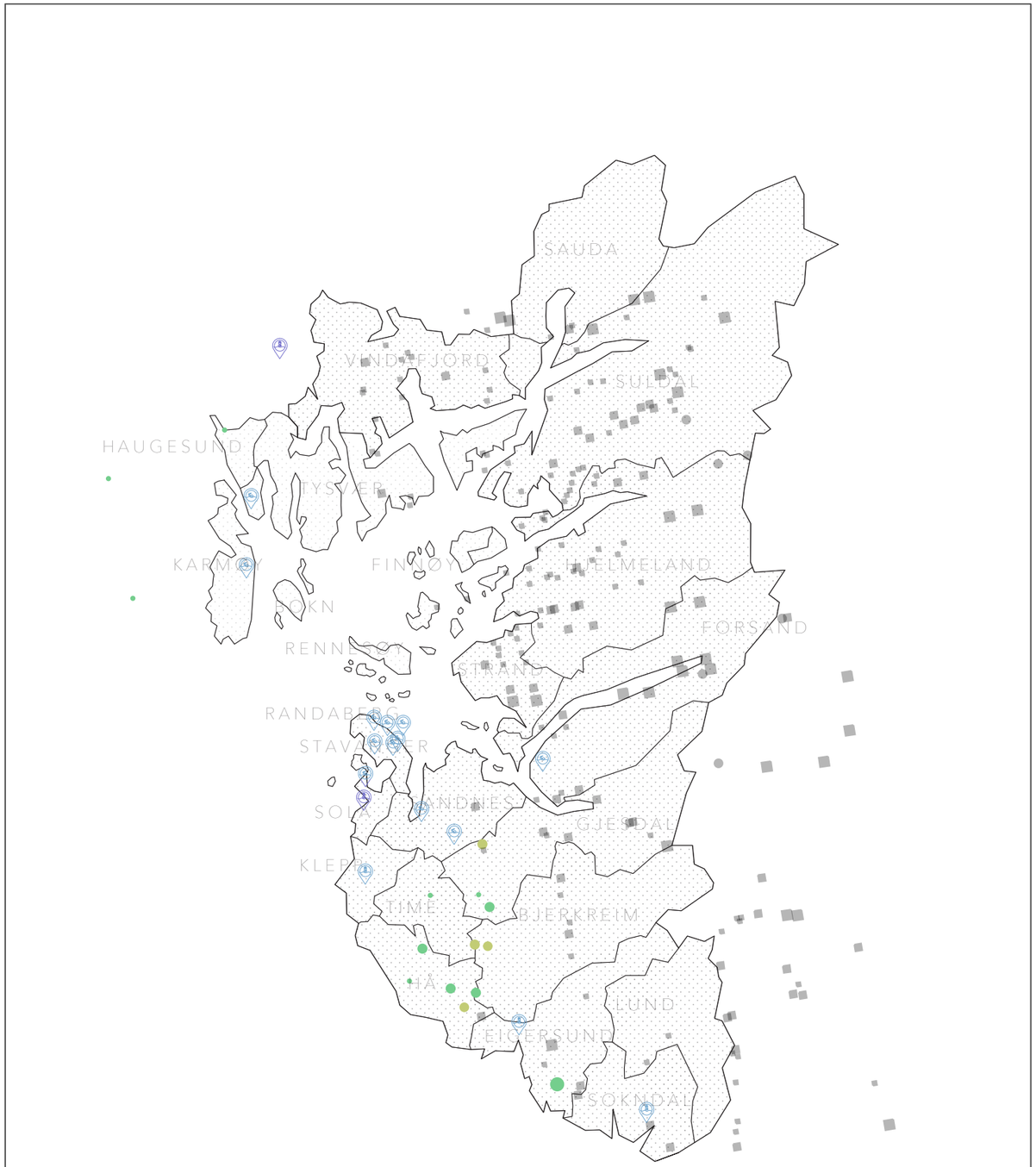
SECURE INTERNET ACCESS

According to telenor´s survey from 2018 Bærum was the municipality in Norway with the fastest and safest internet access with 95,51 Mbit/s, while Stavanger was at second place with 93,43 Mbit/s. Rogaland has an average of 76,16 Mbit/s making it the fourth fastest in Norway. This is not bad considering that it is an average and the regions topography and islands. There are two sub sea cables connecting Stavanger to the rest of the world, soon to be three, and then there is one to Kårstø. This is just to secure fast access, but is also a good backup should something happen to one of them, which is uncommon but
happens. Here I draw some conclusions from a study for a data center built for Mo I Rana. Also, the whole region has access to fiber optic network.

STABLE CLIMATE

Rogaland is not well-known for a stable climate, but for a data center anything below
The core temperature of the computers should not exceed 28*C.
On the cost the average temperature during the warmest month is august with an average of 15*C, and the coldest February with an average of 2*C[2]. The average wind speed is 5 m/s all year around, which accounts for nice, stable cooling. The only challenge can be the air
humidity.

1 https://prosjekt.fylkesmannen.no/ROS-Rogaland/Samfunnskritiske-funksjonar-i-Rogaland/Kraftforsyning/)
2 https://www.timeanddate.no/vaer/norge/stavanger/klima



MAP: OF HYDROPOWER, WIND POWER AND SWIMMING FACILITIES IN ROGALAND

VANNKRAFT
https://temakart.nve.no/link/?link=vannkraft
VINDKRAFT

BUILDT
> 100 MW
10 - 100 MW
<= 10 MW

PLANNED AND DECIDED
> 100 MW
10 - 100 MW
<= 10 MW

SWIMING POOL
SPA WITH SWIMING POOL

Pump
Vannkraftverk > 10 MW
Vannkraftverk 1-10 MW
Vannkraftverk < 1 MW

ACCESS TO GREEN ENERGY

Rogaland is a region of large energy production, where most of it is renewable energy, and significantly larger than the regions own consumption. The region also has a potential to increase their production so the problem does not lie in the production. The regions electric production from hydro power is 10 percent of the total production in Norway.
From the regional plan[1] the region had a goal to reduce its energy consumption by 20 percent from 2010 to 2020. i could not find if the goal was met, but the regions green house gas emissions did fall by 8,3 percent from 2017- 2020[2], mainly because of the transition to
renewable energy, which make me suspect that maybe the energy consumption has risen. Not even mijødirektoratet keeps a record of energy emissions. According to NVE the energy consumption will have to rise in Norway, and will undoubtedly because of the wish to stay away from fossil fuels and transition to green energy.[3] 95% of the regions energy production in 2018 was from hydro power[4]. The region produced 147 057 GWh where 139 704 GWh was from hydro power. While they consumed 136 908 GWh.
All the regional goals have been based on moving from fossil fuels to green energy[5] and therefore I think that presenting an example that will streamline the energy consumption of two facilities; a pool and a data center.

LIMITED ACCESS TO BATHING FACILITIES

The region has relatively good access to places to take a dip both indoor and outdoor, but all of them are by the shore. The standard is also not so great. They are neither especially enjoyable or for competitive swimming so what are they for?
They are mostly connected to schools and the teaching of swimming. The overlapping problem is if you look at the Norwegian map it is the underrepresented region in having no water park - like offers and few 50 meter pools for competitive swimming.

1 https://www.rogfk.no/_f/p1/id0ea6447-ed40-43cf-ad86-ba4a9b51fa74/regionalplan-for-energi-og-klima-i-rogaland.pdf
2 https://www.aftenbladet.no/meninger/debatt/i/zGPPp5/klart-vi-kan-fa-ned-klimautslippene
3 http://publikasjoner.nve.no/rapport/2018/rapport2018_87.pdf
4 https://www.ssb.no/energi-og-industri/statistikker/elektrisitet/aar
5 https://www.stavanger.kommune.no/siteassets/samfunnsutvikling/planer/strategier/energi-og-varm-estrategi-jaren.pdf

VIEW ON SUSTAINABILITY WITHIN THE REGION

Many regions, municipalities and cities claim to be serious about sustainability, but what does it actually mean? It means willingness to restructure and in some cases it can lead to great sacrifice. In Rogaland there is the paradox of the extraction of oil and gas; which makes a huge impact on the regions economy and population, as seen by how the immigration and emigration shifts with the challenges in the international market. This has lead to some new priorities when planning for new urban development in Jæren, and sadly in most regional plans for Rogaland it is Stavanger and Jæren which is in focus. You can read more about the shift in the next chapter Stavanger and Stavanger Smart city, which is an interesting focus for my project.
This has caused the region to claim to focus more on renewable energy for its city development. [1] As many other places in Norway they focus on bio gas, public transport and development of dense-low building structures and assume that the reduction in the number of single-family homes will fix the problem of burning of firewood and heat loss. Rogaland has a higher than average number of people per household than elsewhere in the country. At the same time, the area per household is larger, because of the large number of single-family housing.
Another example is Forus Næringspark[2]. It is first and foremost an industrial area for work and production but it is focused on being an energy-neutral area; which encapsulates everything from vehicle construction and energy production. it is a test bed for future buildings and cities.

1 https://www.stavanger.kommune.no/siteassets/samfunnsutvikling/planer/strategier/energi-og-varm-estrategi-jaren.pdf
2 https://www.forus.no/vil-gjore-forus-energinoytralt/#startPos

02.3 STAVANGER

Studying the map and the social reasons behind this project; Rogaland, and especially Stavanger stands out. Not only has the city guaranteed access to power by being covered by several grid systems, but it is also one of the top hubs for renewable energy sources[1]. These sources consists of hydro power plants, wind power plants and bio energy.

Stavanger is the second city on the list of the fastest internet in the country[2]. Internationally, it is also one of the worlds leading infrastructures for internett access.
It is also directly connected to the British isles by a submarine cable and indirectly connected to Denmark and The British isles through Øygarden. In the future a new connection to Newcastle[3] is planned.
It is also an extra factor that makes Stavanger a politically correct choice.

THE OIL CAPITAL

Over the past decade the movement in the whole region has been heavily reflected by the movement in oil prices and available jobs. Actually all of the three biggest cities in Norway (Stavanger, Bergen, Trondheim) are experiencing an emigration the past three years[4,5]
Even Oslo is experiencing an large emigration out to the regions around the capital. While its large immigration is said to be caused by people moving in from out of Norway.
The region reports having making shifts in the market and for a couple of years now trying to focus the market on IT-workers[6].
The problem in Rogaland, and Stavanger especially is that all the eggs have been put in one basket. First it was herring, then shipping, then canning, and at last oil. Readjustments is clearly an underlying motivator for this project:

STAVANGER SMART CITY

Earlier it was mentioned that Rogaland has worked hard towards a green shift, expectations that have come from the government and from outside of Norway. Many of its changes that affect people´s everyday life are focused on Stavanger, the regions capital. Together with Eindhoven and Manchester, Stavanger is part of Triangulum, an innovation and demonstration project in search of smarter cities and communities. The lighthouse towns in the Triangulum will work to integrate energy, mobility and IT into new solutions towards a sustainable future. This makes Stavanger the perfect testbed for my project. But many of the projects are affecting also the greater region. I.e. In-house energy management (Lyse AS), new energy central (Stavanger Kommune), battery driven buses (Rogaland fylkeskommune) data gathering from projects (UiS) and then a greater collaboration through dissemination of project experiences.

1 https://www.aftenbladet.no/meninger/debatt/i/1avEG/rogaland-er-norges-california-innen-fornybar-energi-og-smartby
2 http://www.mynewsdesk.com/no/telenor/pressreleases/her-faar-du-raskest-nett-2672374
3 https://www.digi.no/artikler/englandskabel-i-lopet-av-2021/485860
4 https://www.ssb.no/statbank/table/05471/
5 https://www.estatenyheter.no/2018/08/24/folk-flytter-fra-de-store-byene/
6 https://www.naeringsforeningen.no/nyheter/store-endringer-i-arbeidsmarkedet/

02.4 SITE : ÅKREHAMN, KARMØY

I became interested in areas where people commute from to Stavanger. The availability of swimming pools in the Stavanger area is saturated south of Stavanger. North of Stavanger the availability and standard is worse. One of these areas is Karmøy municipality. It is the biggest municipality in Nord-Rogaland. That makes Haugesund its regional center. Throughout the years the community has been accustomed to change. It was prominently a fishing communities here, until the 1960s when the fish dried out and people started working at the aluminium factory, and later in the 1970s within the oil industry[1].

FUNDING

The municipality of Karmøy has of 2020 put aside 40 million Norwegian Kroner for city development in Skudeneshavn, Åkrehamn and Kopervik[2]. The funding is derived from the Norwegian Governments "Sammen om sentrum" program"[3] which is about how to bring back life and community to abandoned city centers.

POPULATION

Åkrehamn is an old fishing village and a power center in the viking age. The small town has had many growth spurts over the years mainly in connection to different forms of industry. The town was granted city status when the last growth spurt started in the turn of the century. The city's structure is very loose with no clearly defined center.

FINAL SITE

I am still working on circling in on the final site. Åkrehamn has several interesting plots, which I will look closer into.

In 2020 a new sports hall opened in Åkrehamn, but without a swimming pool.

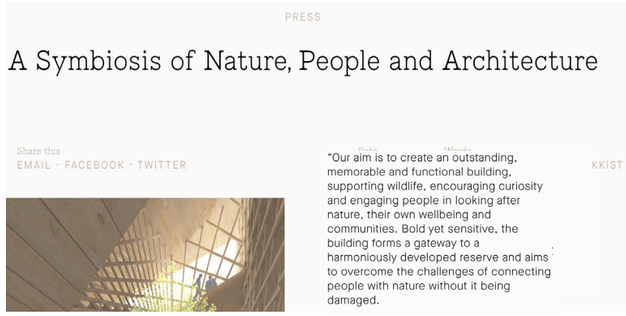
https://www.nrk.no/rogaland/offisiell-apning-av-akrahal-len-1.14885818

1 https://fiskeribladet.no/nyheter/?artikkel=62185
2 https://karmoynytt.no/gi-virksomhetene-i-sentrum-et-fasadetilskudd/19.05-01:38?fbclid=IwAR29KKJvsryMhM4IEukGHgnbmY0qnWp-2HGtx6Bf4eoQKthwgwmurfSoN8A
3 https://www.regjeringen.no/no/dokumenter/sammen-om-sentrum/id2680842/?ch=2

FACTS

Granted city status in 2002
No swimming pool
8000+ inhabitants
- Highest growth in Karmøy

https://unsplash.com/photos/jTeQavJjBDs



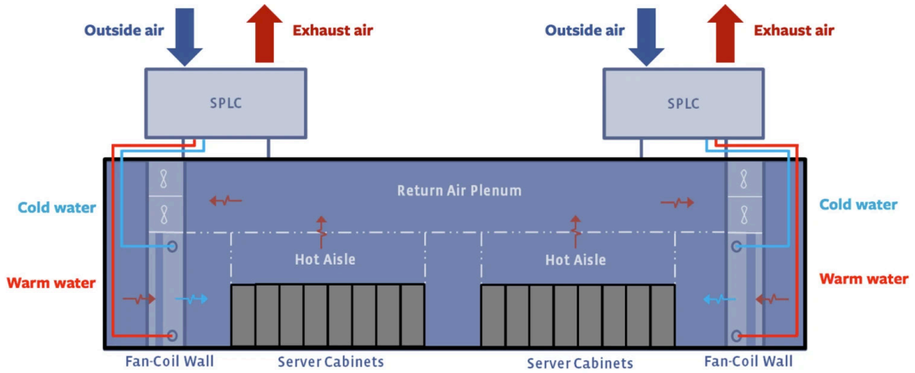
https://www.ekkist.co/journal/a-synergy-of-nature-people-and-architecture/

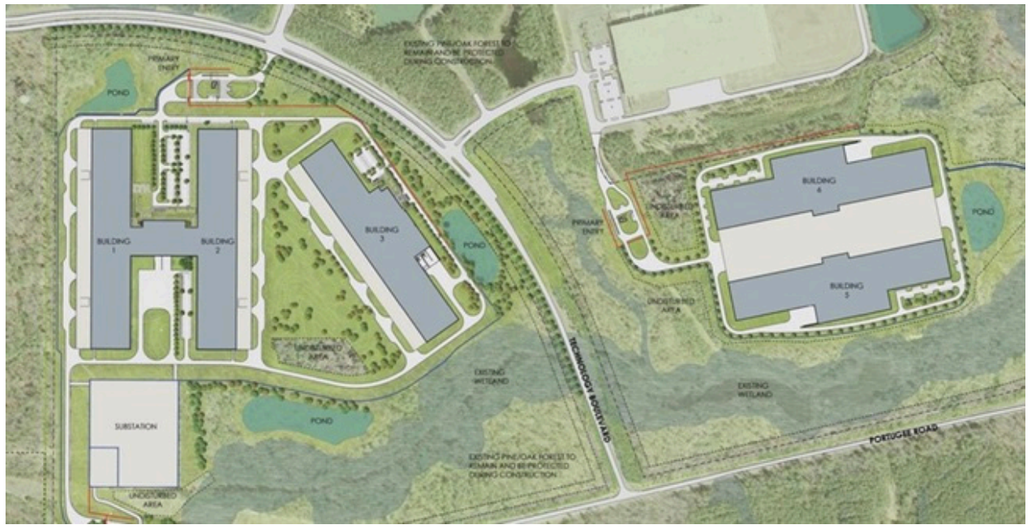
03 REFERANCE PROJECTS

FACEBOOK, LULEÅ
DATA CENTER

CATEGORY: Data center
LOCATION: Luleå, Sweden
CLIENT: Facebook
ARCHITECTURE: Karen W. at Asia Pacific
TEAM OF ENGINEERS:

SIZE DATA CENTER: 27 000 m2
COMPLETED: 2013





FACTS

Because of new technology the facility is apparently 10 percent more efficient than traditional data centers and uses 40 percent less electricity. Open compute project is an organization founded by facebook with the goal to optimize server performance. It has been joined by several important players in the data center world such as AT&T and Equinix. The facility is in a cold enough area to use ambient outdoor air, augmented by evaporative cooling during warmers seasons to cool down the servers. This approach cuts down carbon emissions because of less need of artificial cooling. But it is still dumping exhaust heat into the atmosphere.The upper level of the data center serves as a cooling system, with fresh air entering the building through louvers and then passing through several chambers that will filter and cool the air. Then the air enters the server area on the lower floor. The wall of fans helps maintain pressure to guide the air through filters.

THE STUDENT´S COMMENTS

This project is well known in the data center industry and has many valid points in why Scandinavia or even more Norway is a good place for data centers. It was discussed if maybe this and the google center should have been in Norway. During the discussion Norway was behind on the technology needed and the answers from Stortinget were not clear. The Swedish and Danish governments were much more interested in these collaborations and were much quicker on updating their network. Today Norway is more up to speed and has some of the worlds most stable and secure lines.
Map of facebook data ceters https://baxtel.com/data-centers/facebook

SOURCES +IMAGES

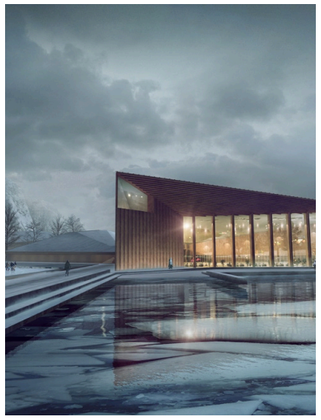
https://www.datacenterknowledge.com/inside-facebooks-lulea-data-center
https://www.facebook.com/careers/life/meet-the-woman-behind-data-center-design-at-facebook
IMAGES
https://e24.no/internasjonal-oekonomi/i/rLajAw/slik-er-facebooks-hoeyteknologiske-sverige-anlegg

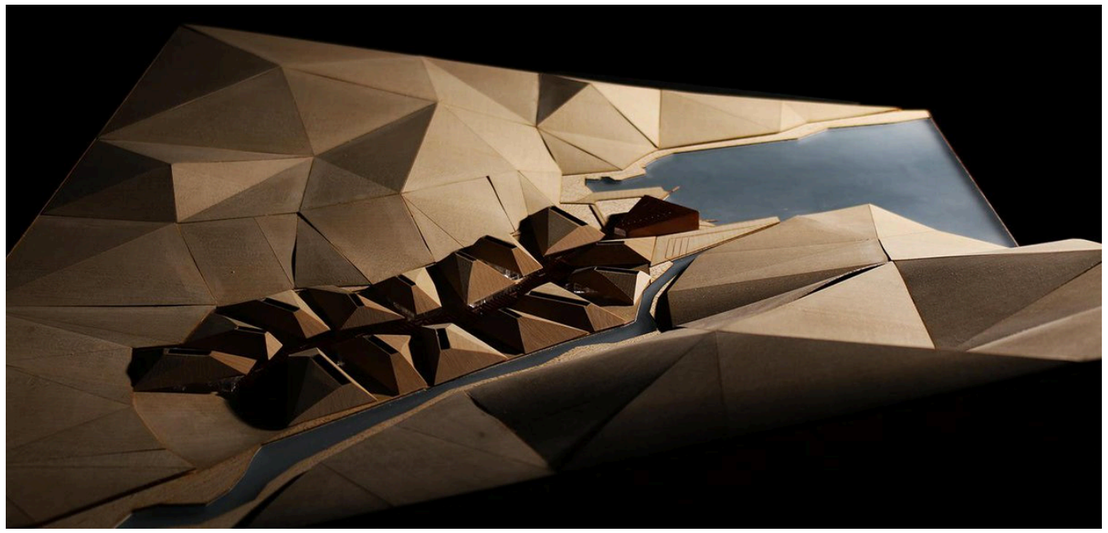
KOLOS

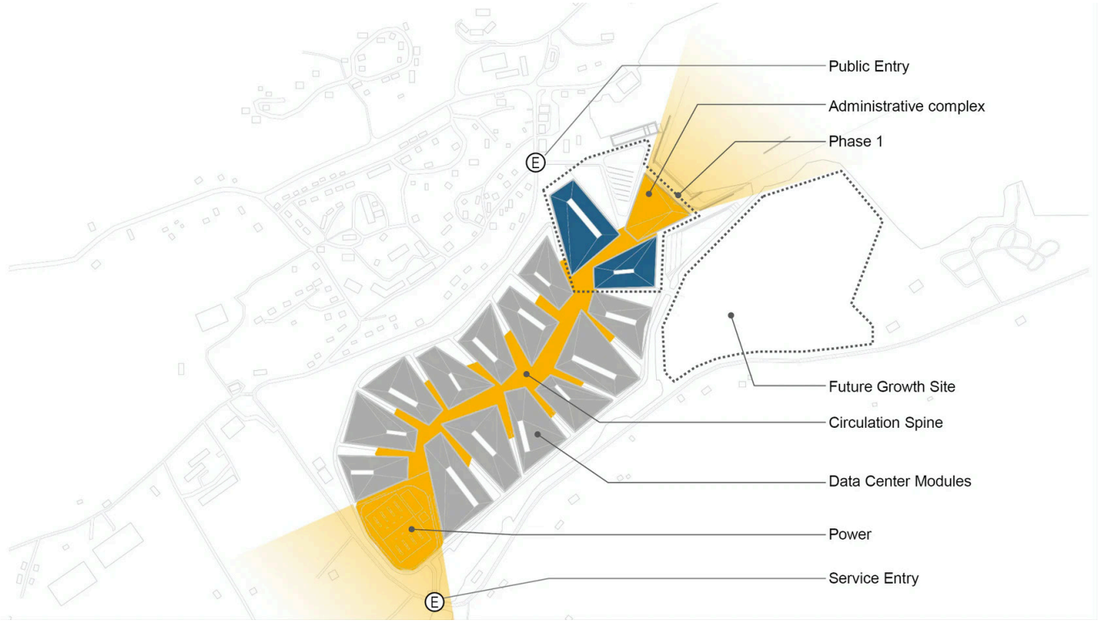
03.1 DATA CENTER

CATEGORY: Data center
LOCATION: Ballangen, Norway
CLIENT: Kolos
ARCHITECTURE: HDR
TEAM OF ENGINEERS: HDR

SIZE DATA CENTER: 600,000 m2 (will be the worlds largest.)
COMPLETED: no







FACTS

Kolos' co-chief executive Mark Robinson said in an interview with bbc that Norway is chosen as the site because of the accessibility renewable energy and the most stable power grids in the world. It will be connected to the high performing fiber from Sweden and serve Europe and reach as far as the American east coast.

The building is described to mimic a glacier´s movement as it displaces swaths of land. " At the base, the spine creates a collision of landforms reinterpreted to become modular data halls that are secure, scalable and connected and feature green roofs. At the terminus on the water, the central spine emerges as a public element clad in copper, a reference to the area's copper mining history. This architectural gesture articulates the entrance to the data center while acting as a gateway to the public waterfront promenade – a physical expression of the company's commitment to the community."
The project is unbuilt, but has won two architectural prizes.

THE STUDENT´S COMMENTS

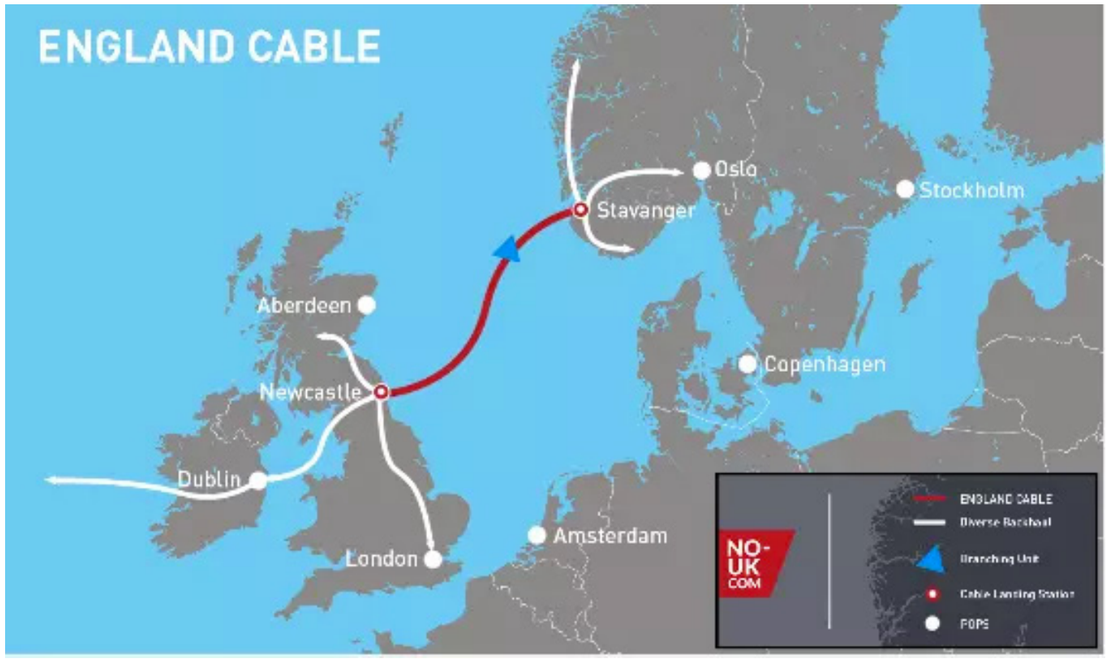
Why I find this project is mostly because the company and the architects have tried to create a project that will add value to the small community by adapting to the landscape, camouflaging the building and create public spaces. Adding a large structure like this in a small community can easily seem very threatening.

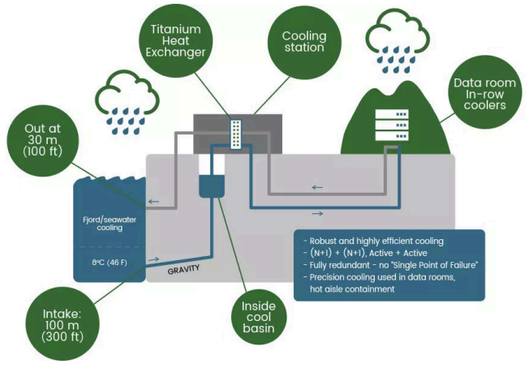
Sources + images
https://www.hdrinc.com/au/portfolio/kolos-data-centre
https://www.archdaily.com/877826/plans-unveiled-to-construct-the-worlds-largest-and-most-secure-data-center-in-northern-norway

GREENMOUNTAIN COMPANY

03.1 DATA CENTER

In the map “Southern Norway” one of the mapped out sub sea cables is one planned cable that connects Stavanger to Newcastle. The company behind this cable is the company Green Mountain.
What the company mainly does is build Data Centers, but also consulting in Data Center building. They have delivered three data centers; DC1-Stavanger at Rennesøy, DC2-Telemark at Rjukan and DC3-Oslo just 20km outside the capital. These are co-location data centers which means several businesses can rent space within the center. Their costumer base is banks, energy, IT service providers, government agencies and other enterprises. They seem like a company trying to be adaptable to future changes and possibilities in the industry, where for example DC2-Telemark is designed with modularity in mind.
They also focus on keeping their facilities connected to green energy, and within a stable grid of hydro energy suppliers.





DC1 - STAVANGER 22 600 m2

This facility is situated at the island Rennesøy near Stavanger and is supplied by three independent grip suppliers, which are each fed from multiple hydro electric power plants. This facility also has several different server room sizes. The facility is located inside the mountain reusing a NATO facility and keeping the servers cool.

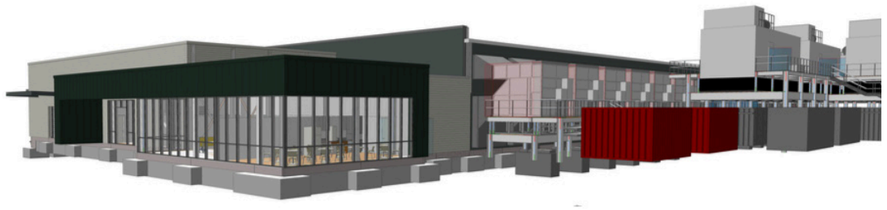
VR tour through DC1-Stavanger
https://greenmountain.no/dc1-vr/

DC2 - TELEMARK 40 000 m2

This facility has client specific server rooms out for top-security and possibility for expansion. The facility has already had to expand. There are 6 hydroelectric plants in the valley, 2 of them are located less than 1 km from the site. Because of the deep valley, little sun exposure and a median temperature of 13 *C. This gives them the possibility of natural cooling systems.

VR tour through DC2-Telemark
https://greenmountain.no/dc2-vr/

https://green-mountain.



DC3- OSLO 75 000 m2
This facility started construction in september 2019 and is expected completed in september 2020. The new data centre site has two independent power grid suppliers and is located in the vicinity of several hydropower plants. The local climate in Oslo will ensure natural cooling 95% of the year.

LECA SWIMMING POOLS

PUBLIC POOL

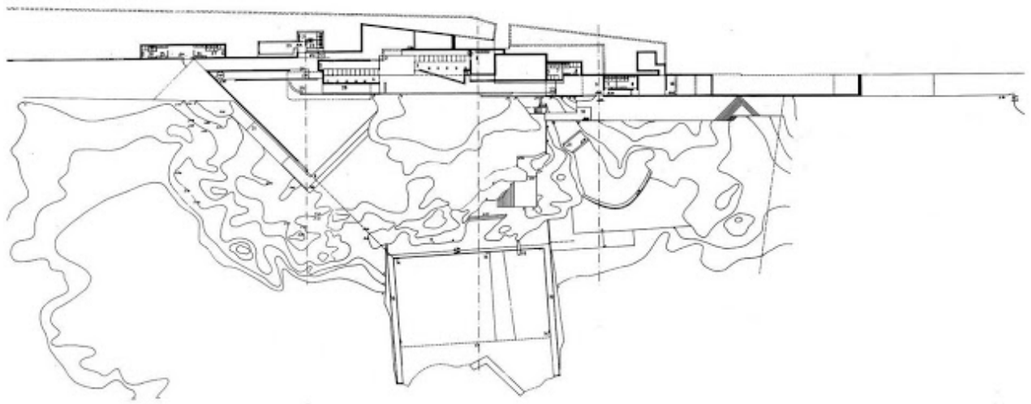
CATEGORY : Pool
LOCATION : Matosinhos, Portugal
CLIENT :
ARCHITECTURE AND INTERIOR : Alvaro Siza
TEAM OF ENGINEERS :

SIZE POOL :
POOL FACILITIES : one adult swimming pool, one childrens
COMPLETED : 1966

From dark to light, different layers of privacy

The bridge one goes under to get to the childrens pool

Contrast



FACT

These saltwater pools are sunken and integrated in the landscape, hidden from the coast-line road. The architectural forms are sharp and contrasting to the landscape. The facility is entered through a ramp from the road. The changing rooms are in the dark and a series of stations. When exiting them you move outside on different platforms and bridges. To enter the children's pool as an adult you have to duck under the bridge.

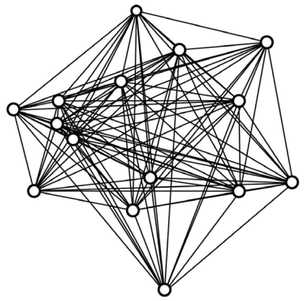
THE STUDENT'S COMMENT

I chose to include this project because of how it is devided into zones and the way you move through it; the division of zones and blend with the nature.

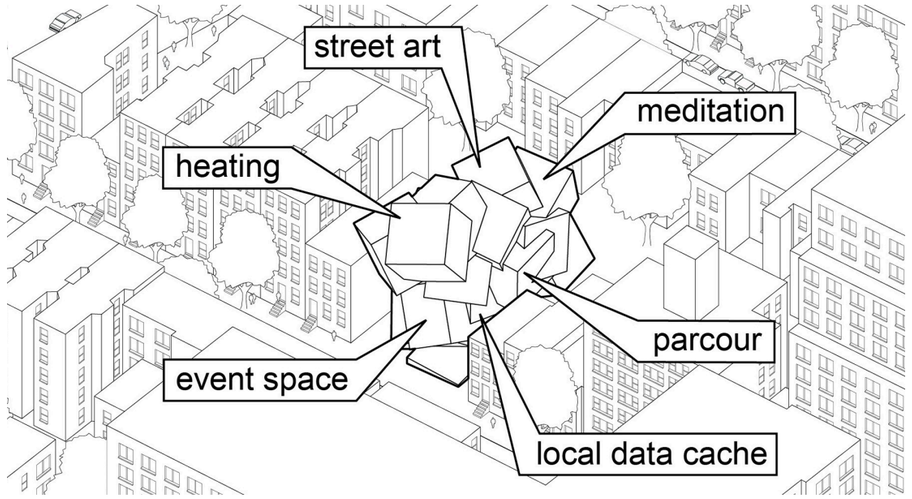
Source: http://architectuul.com/architecture/leca-swimming-pools
images: https://arquiscopio.com/archivo/2012/07/03/piscinas-naturales-en-leca-da-palmeira/
https://twitter.com/archillect/status/754714793077014528
https://divisare.com/projects/96492-alvaro-siza-vieira-fernando-guerra-fg-sg-piscina-de-leca-da-palmeira
https://divisare.com/projects/336380-alvaro-siza-vieira-atelier-xyz-leca-swimming-pool

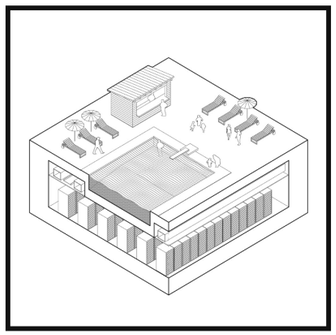
PROJECT RHIZOME
SYMBIOTIC PROJECT

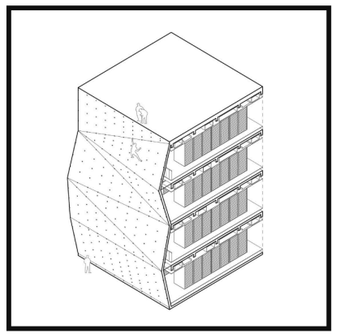
CATEGORY: Conceptual work, blog
LOCATION: -
CLIENT: -
ARCHITECTURE AND INTERIOR:
TEAM OF ENGINEERS:

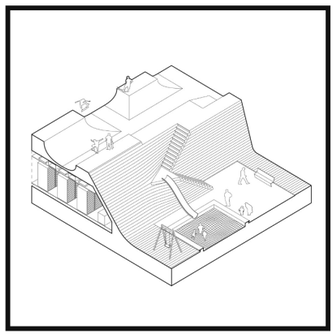


PROJECT RHIZOME









FACTS

The project was founded as an idea bank for the data center industry. It offers consulting and architectural design services to crate attractive urban environments. It is mostly a social media platform with a web page, facebook page and blog posts. The project wishes to incorporate the data center in the city and give it “the dignity it deserves”.

THE STUDENT´S COMMENTS

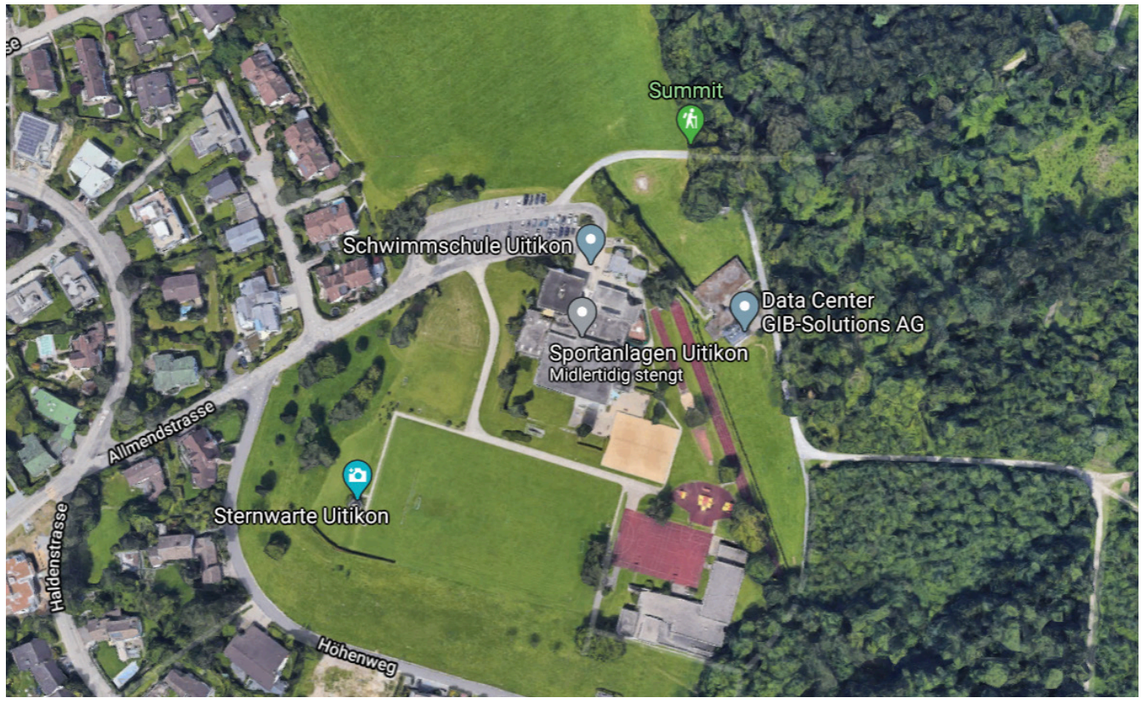
This is more of a set of ideas of how to make symbiotic projects out of computer centers. It has no physical projects, but the web page, facebook page and blog contains useful information and ideas of how this can be done. It is lead by architects and written in an understanding language for someone who is not a computer engineer.

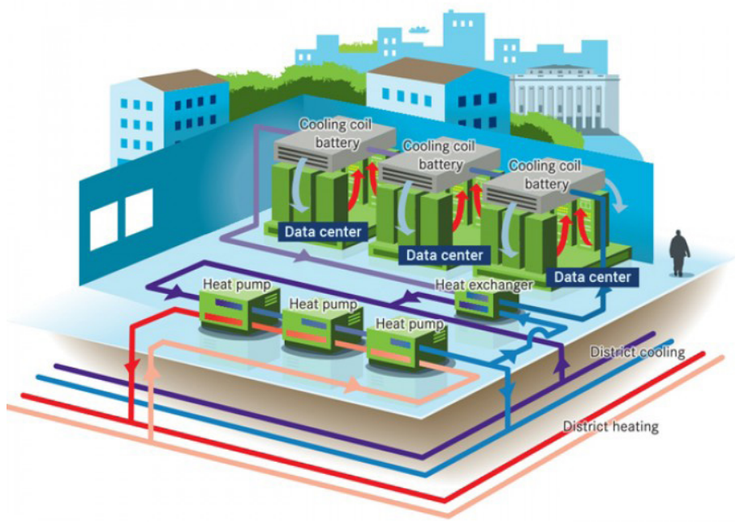
https://medium.com/@ProjectRhizome

UITIKON SPORTS CENTER AND COMPUTER CENTER
SYMBIOTIC PROJECT

CATEGORY: Data center and pool
LOCATION: Uitikon, Switzerland
CLIENT: Uitokon municipality
ARCHITECTURE AND INTERIOR:
TEAM OF ENGINEERS: IBM

SIZE DATA CENTRE: 200 m2
SIZE POOL:
POOL FACILITIES: 25 m pool + connected childrens pool, non-swimmer pool/warm water pool, sauna
COMPLETED: 2008/2009





FACT
Data Center GIB-solutions AG was built by IBM as part of their "Project Green" for GIB-Services, a Swiss IT co-location company. The Data Centre is inside a former military bunker (7 meters under ground) and has direct heat exchange between the center and the villages already existing public swimming pool. Early calculations showed that the center would produce 2,800 MWh of wasted heat per year while operating on full capacity. This energy enough to supply up to 80 houses with heating and warm water in the same period; or to heat a pool.

HOW DOES IT WORK
In this particular case, air conditioners cool down the data center and hot air is collected in a storage area where it heats up the water that is piped to a heat exchanger at the pool facility. Then the heated water raises the temperature of the pool water. The process repeats itself to sustain the right temperature of the pool water with the heat exchanger; which exchanges heat from one part of the water to another.

"Theoretically it is possible to reuse up to 90 percent of the electric power required for the operation of the data center as heat energy. Through reclaiming the heat, approximately 130 tons of carbon emissions can be saved. This corresponds to the carbon dioxide discharge of mid-size cars driving 500,000 miles."

THE STUDENT'S COMMENT
This project was very important for me to find, because it proves that one data centre can in fact produce enough heat for a public pool. It is also more tecnically than architechnically interesting.

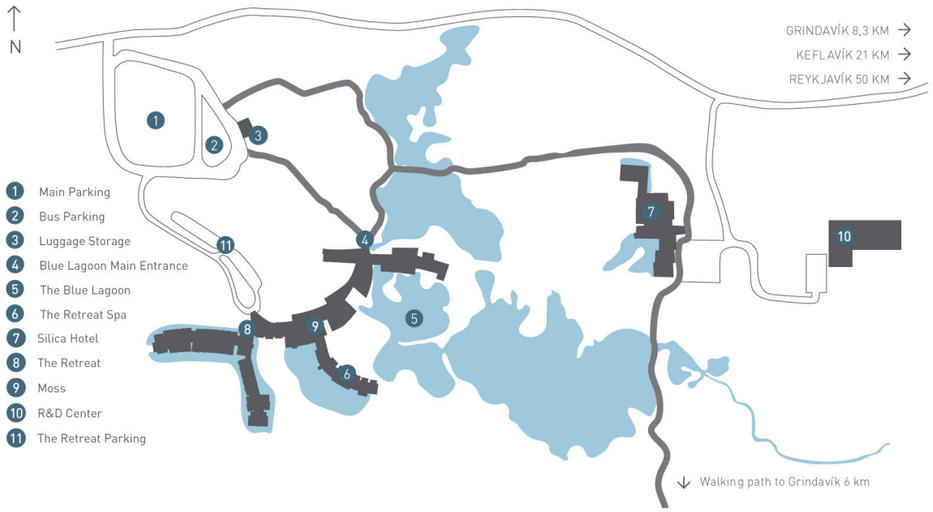
sources:
1.https://www.datacenterknowledge.com/archives/2008/04/02/data-center-used-to-heat-swimming-pool
2. https://www.networkworld.com/article/2277915/swimming-pool-heated-by-data-center-s-excess-heat.html
GIB-Services CEO Hans-Rudolf Scharer.

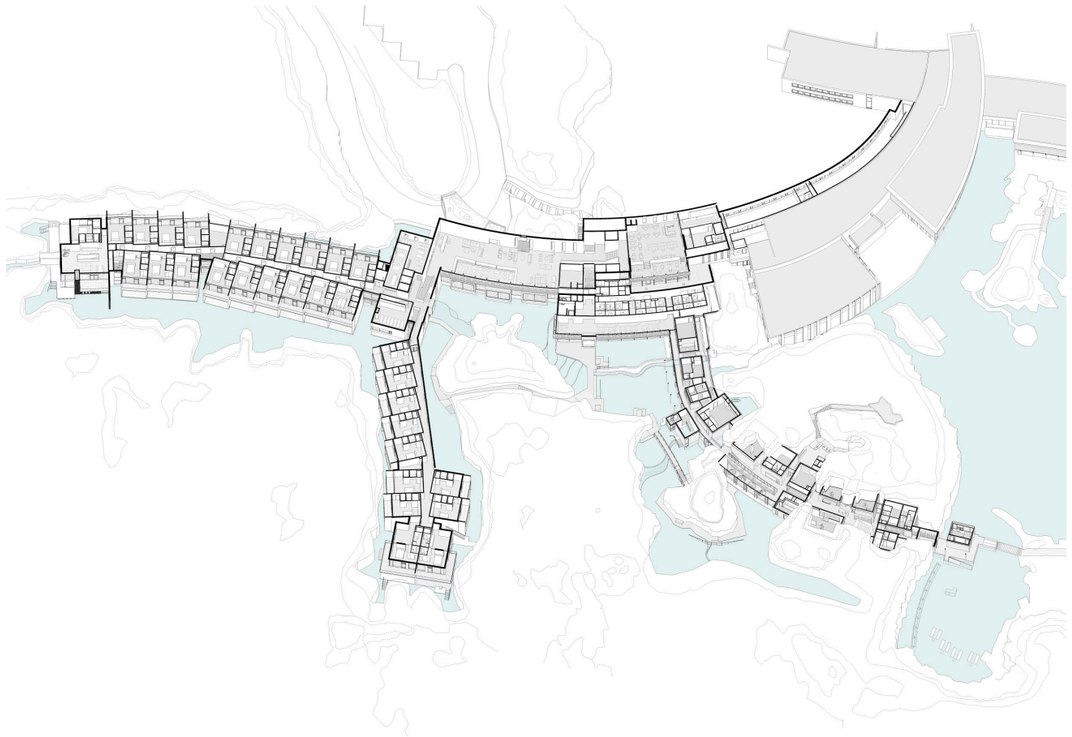
THE BLUE LAGOON GEOTHERMAL SPA AND SVARTSENGI POWER PLANT

SYMBIOTIC PROJECT

CATEGORY: symbiotic projects: industry + residual product. More a Commensalistic project.
LOCATION: Grindavík, Iceland
CLIENT:
ARCHITECTURE: The retreat at Blue Lagoon: Basalt Architects, 2018
TEAM OF ENGINEERS:

SIZE POOL:
POOL FACILITIES: Outdoor pool
COMPLETED: Svartsengi Power Plant, 1976
Blue Lagoon geothermal spa, 1992
The retreat at Blue Lagoon, Basalt Architects, 2018





FACT
The blue lagoon spa is supplied with hot water - a byproduct from the nearby Svartsengi power plant. The heated water originally comes from a lava flow that is used to run turbines and generate electricity. The pools therefore first appeared after the opening of the power plant and are not natural. Today the water of the plant is used to provide the municipal water heating system before being let out into the spa. The water renews every two days and has a temperature of 27 - 37 °C. The waters milky blue color is caused by the high silica content.

THE STUDENT´S COMMENT
This project I chose to include because it is an example of a renewable energy power plant with a recreational program based on the plant's byproduct of heat.

Source: https://en.wikipedia.org/wiki/Blue_Lagoon_(geothermal_spa)
images:
https://guidetoiceland.is/best-of-iceland/blue-lagoon-the-ultimate-guide
https://miesarch.com/work/4013
https://miesarch.com/work/4013

04 FURTHER WO

SEMESTER PLAN

AUGUST	Make a situation model for sketching, prepare maps, site analysis, The "wiring".
SEPTEMBER	Sketch phase, in model and drawing
OCTOBER	Production of plans, digital models etc
NOVEMBER	Plans should be more or less set by mid-month Start the story - do renders, views, start model-making
DECEMBER	complete story tie in loose ends

LIST OF HELPFUL DOCUMENTS AN D READING

HVAC COOLING SYSTEMS FOR DATA CENTERS

https://www.cedengineering.com/userfiles/HVAC%20Cooling%20Systems%20for%20Data%20Centers.pdf

ABOUT THE HEATING SYSTEM AT UITIKON

Tony Pearson - Inside System Storage: Volume II - https://books.google.no/books?id=tWmHAwAAQBAJ&pg=PA313&lpg=PA313&dq=uitikon+swimming+pool&source=bl&ots=QdbzXD-Yua&sig=ACfU3U1y6AMCocvHxk0wU1ZbMcnGrb_a6g&hl=no&sa=X&ved=2ahUKEwjIsoeJ74_pAhVtBhAIHWxSClYQ6AEwCnoECAwQAQ#v=onepage&q=uitikon%20swimming%20pool&f=false

REDIEFINING SUSTAINABILITY IN DATA CENTERS

https://www.gigabitmagazine.com/brochure/26382

STEDSANALYSE ÅKREHAMN

http://akrehamn-vekst.no/wp-content/uploads/2013/09/Stedsanalyse-Akrehamn-2011-01-19.pdf

EVIDENCE FOR THE SYNERGY:

Schumacher, Brian. (2014) nvestigations Into The Program and Typology of a Contemporary Public Thermal Bath House (master) University of Massachusetts Amherst. https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=2225&context=theses

PUBLIC THERMAL BATH

Investigations Into The Program and Typology of a Contemporary Public Thermal Bath House - Brian Schumacher University of Massachusetts Amherst

https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=2225&context=theses