Skeppsholmen and Kastellholmen Energy Data Analysis

KTH Working Force

CDE Project Report 2019 Skeppsholmen Energy Data Analysis		
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1. Abstract

The present work aims to develop energy data analysis about two islands located in Stockholm, Sweden. Both islands, Skeppsholmen and Kastellholmen, are owned and maintained by SFV - The National Property Board of Sweden. The first part of the work will consist of a deep understanding of the structure for data acquisition, finding possible mistakes in the system setup or meters miss function. For this part, the group will cross-check all the information provided by SFV and Sweco with the real situation on the islands. Data analysis will be developed at different levels, such as transformers versus main meter and buildings-level versus smart meters data.

The second part of this study will focus on proposing possible solutions in order to increase the energy efficiency of the whole island.

2. Nomenclature

Here are defined the main acronyms used in this project.

Table 1 - Acronyms used in the project

D	Dewater System
DSO	Distribution System Operator
El or MX	Electricity
FV(f)	District Heating (flow)
HM	Main Meter
KV(F)	Tap Water (Flow)
kWh	Kilowatt-hour
MF	Flux of Energy
MQ	Heating Energy
MWh	Megawatt-hour
T1 / T2/ T3 / T4 / T5 / T6	Transformers
VP	Primary Heating System
VS	Secondary Heating System
VV(F or C)	Warm Water System (Flux or Circulation)

Contents

3. Introduction

3.1. Introduction and the background of the Project

The National Property Board Sweden (in swedish: *Statens fastighetsverk*, SFV) is a board-led authority formed in 1993 that reports directly to the Swedish Ministry of Finance. The Board manages more than 2,300 properties, with approximately 3,000 buildings, including residences, embassies, institutions, and historical buildings among others.

Sweco is one of Europe's leading architecture and engineering consultancy companies with projects in the fields of construction, architecture, and environmental engineering in over 70 countries.

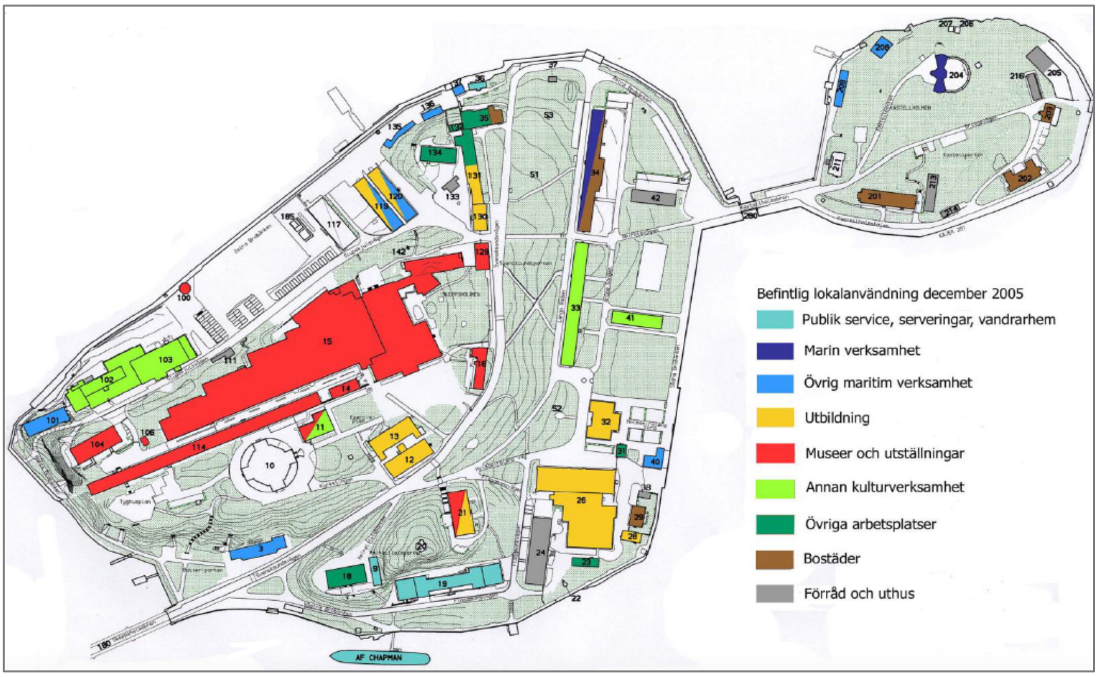
Skeppsholmen and Kastellholmen, the main focus of this project, are two islands owned and maintained by SFV and located in Stockholm.

Location: Skeppsholmen and Kastellholmen, Stockholm - Sweden (59°19'32.5"N 18°05'03.2"E)

The islands are positioned strategically at the Baltic Sea entrance to Stockholm, therefore they used to be a navy base, i.e. they have traditionally been the location of several military buildings.

Nowadays, these islands are gaining great attraction mainly due to the Moderna Museet and by many types of activities which focuses on art and culture.

Skeppsholmen and Kastellholmen are unique neighborhoods where the state owns and SFV manages roads, buildings, lands along with the entire network system of grids. These islands cover the area of 93,500 m² with 63 buildings distributed over them. The islands have an internal heating network with a common connection point to the district heating and a coolant system which uses lake water.



The National Property Board is committed to sustainability development and have found out that the heavier environment item, i.e., the one that presents the biggest improvement opportunities is related to reduction of energy consumption. Therefore, according to the SFV, they have been working extensively on energy efficiency at Skeppsholmen. They have made investments in technical systems of the buildings through which they saved 2,000 and 3,000 MWh of electricity and heat, respectively as compared to 2013-2018.

Moreover, the SFV believes that the collaboration with tenants is a decisive factor for the energy efficiency work. Since most of the buildings on the islands are very old, some historical, opposition to changing fundamental things of buildings is an issue

The energy consumption of all the buildings and services on the islands are monitored with smart meters and analyzed by Sweco. All data is available in two main online systems, Vitec and Grafana with a detailed level of different information which works well at the building level. However, Sweco and SFV have found out that the data sometimes do not match with real consumption and therefore, the smart metering usage needs improvement. Data analytics will be run in order to investigate possible causes of inconsistencies and suggestions on how to improve the smart metering usage shall be provided. The biggest challenge SFV and Sweco are facing is in terms of analyzing energy that comes into the island and goes to the transformers where it is distributed to the buildings. SFV and Sweco wish to be able to know the total amount of energy that passes through each transformer station and then compare it with the total amount of energy measured in the buildings.

3.2. Introduction of the Project team and stakeholders

Team Members:

Beatriz Costa Roza

Previous studies:

- Bachelor's degree: Environmental Engineering by Federal University of Rio de Janeiro - UFRJ (Brazil) and by the University of Stuttgart (Germany).
- Post-graduation: Safety Engineering by Federal University of Rio de Janeiro - UFRJ (Brazil).
- MBA: Marketing by Fundação Getúlio Vargas (Brazil).

Working experience: 7 years of experience in corporate sustainability focused on strategy, climate change and energy issues. Worked in big corporations, factories and consulting companies.

Felipe Salgado

Previous studies:

- Bachelor's degree: Materials Engineering by Federal University of Santa Catarina - UFSC (Brazil).
- Post-graduation: Business Administration by Fundação Getúlio Vargas (Brazil).
- MBA: Marketing by Fundação Getúlio Vargas (Brazil)

Working experience: Professional with more than 10 years' experience in corporate sustainability, team management and project development.

Juo-Yu Liao

Previous studies:

- Transportation and logistics management by National Chiao Tung University

Working experience: Project management, sales representative in trading and automation equipment industry

Kynan Tjandaputra Abdullah

Previous studies:

- Bachelor's Degree: Mechanical Engineering by University of Indonesia

Working experience: Environmental Control System Division summer job (3 months) in PT. Dirgantara Indonesia (Indonesian Aerospace Co.) & Solar Engineer intern (2 months) in PT. Selaras Daya Utama (EPC company)

Ramachandran Swaminathan

Previous studies:

- Bachelor's Degree: Mechanical Engineering

Working experience: Intern in a Mettur Thermal Power Station (2 months), worked as a Design Engineer in Emerson Automation Solutions.

Rahima Rafiq

Previous studies:

- Bachelor's in Physics with a specialization in theoretical physics

Working experience: Experience in School administration and management along with the focus on revising academic curriculum.

Shu-Jung Liu

Previous studies:

- Bachelor in Material Science and Engineering

Working experience:

- Kingston HyperX Design Engineering Intern
- Undergraduate Research: membrane material

Ziky Teguh Farhan

Previous studies:

- Bachelor in Electrical Engineering

Working experience:

- Electrical engineer, Project Manager

Stakeholders:

This project has three main stakeholders SWECO, SFV (National Property Board of Sweden) and KTH Royal Institute of Technology. A brief description of each one will be presented in this section.

Sweco AB

Sweco AB is a European engineering consultancy company, active in the fields of construction, architecture, and environmental engineering. Sweco has taken the important role as the point of contact between the team and other stakeholders and guided the project team in this project.

SFV - National Property Board of Sweden

The National Property Board Sweden is a board reporting to the Swedish Ministry of Finance. The head office is situated in the capital Stockholm. The six transformers and connected buildings which are monitored and analyzed in this report are their property. Their interests in this report is to find the electricity losses which may be led by data error, meter malfunction, or any other mistakes in the meter systems.

KTH Royal Institute of Technology

KTH Royal Institute of Technology, abbreviated KTH, is a public research university in Stockholm, Sweden. KTH conducts research and education within engineering and technology and is Sweden's largest technical university. Its role in this project is as a host university for the InnoEnergy SELECT Master's Programme. Dr Peter Hagström is the course responsible and examiner for MJ2415 Project in Energy Systems Analysis.

4. Objectives and scope of the project

The main goal of this project is to enhance the two islands' sustainability by offering energy efficiency suggestions of improvements. The challenges of the project derive from two different causes:

- Low reliability on the energy data from smart meters;
- Historical context of the islands that limits physical changes in the buildings.

Therefore, in order to achieve the ultimate goal of the project, the group will perform the project two different phases:

1. Data validation from the smart meters and systems

This phase is mainly related to data analysis and data management. Both islands make intense use of smart meters and the information is monitored and processed in two different software (Vitec and Grafana). However, currently, the software do not offer reliable consolidation of the data for varied reasons, such as: inconsistent math or configuration in the software, meters showing measurement of buildings that they are not related to etc.

Since most of the energy data present some source of deviation, the group will invest probably half of the total project effort is this phase. The validation of the data is crucial for the following phase, since the suggestions for improvement must be based on reliable data.

2. Proposals for energy efficiency improvements

During this phase, the group will look for best practices in energy efficiency that can be applied in buildings and equipment installed in the islands. It is relevant to mention that the historical context of the islands might pose a bigger challenge as that will probably mean few or no physical changes in the historical buildings.

The main boundary of the project is that the technical analysis of the meters is not the focus of this project.

5. Methodology used for the project

In order to validate the data acquired from the smart meters spread all over the island, the working group has been making deep investigations, comparisons and built maps and flowcharts of the islands.

Sweco and SFV provide two licenses for the software Vitec used for energy data management at Skeppsholmen island. This software gathers data and information about different energy sources in varied meters from almost all the buildings located on the islands. The second software used in this project was Grafana, a web software that can monitor several parameters of three of the transformers installed in the islands (T4, T5 and T6).

During the initials meetings the group received some information regarding the basic functionalities of both systems. Moreover, during the kick-off meeting the group had an opportunity to walk around both islands and better understand the structure of some buildings, the district heating system and the cooling water system. As mentioned in the introduction section, both islands were used as navy base and so most of the facilities are old and as a consequence, with few updated available technical information.

5.1. Nomenclature of the meters

Inside Vitec, all the buildings follow a pattern, i.e., they are codified AB183XXX, where 183 means the local area where they physically are, Skeppsholmen island, and three different numbers in the end are the building code as follows:

SKEPPSHOLMEN

3	HÖGVAKTEN
9	UTHUS TILL KASERN I
10	SKEPPSHOLMSKYRKAN
11	MARKETENTERIET
12	BÅTSMANSKASERNEN, KASERN II
13	ATELJEHUSET
14	ARRESTEN
15	MODERNA MUSEET/ARKITEKTURMUSEET
16	PRÄSTGÅRDEN
18	AMIRALITETSHUSET, KASERN I
19	HANTVERKSKASERNEN
20	VATTENTORN
21	SJÖKARTEVERKET
22	VATTENSTÅNDSMÄTARHUSET
23	KOMPASSKONTROLLHUSET
24	INTENDENTURFÖRRÅDET
26	KONSTHÖGSKOLAN, KASERN III
28	FD KASERNSLÖJDEN
29	KASERNBEFÄLSHAVARBOSTÄLLET
30	RIVET
31	FD SJÖVÄRNSKÅREN
32	GAMLA SJÖKRIGSSKOLAN
33	V BOSTÄLLSHUSET
34	Ö BOSTÄLLSHUSET
35	GAMLA BADANSTALTEN
36	BOSTADSHUS
37	OMFORMARSTATION
38	SOPSTATION
40	UTHUS TILL KASERN III
41	UTHUS TILL V BOSTÄLLSHUSET
42	UTHUS TILL Ö BOSTÄLLSHUSET
51	MINNESSTENEN SVENSKSUND
52	VEGASTENEN
53	KAJSA RULTAS PUMP
100	STYCKEKRANEN
101	RÅSEGLARHUSET
102	MINDEPARTEMENTET
103	TORPEDDEPARTEMENTET
104	TORPEDFÖRRÅDET
106	UTHUS
111	FÖRRÅD
114	TYGHUSET, ÖSTASIATISKA MUSEET
117	KANONVERKSTADEN
119	N FUNDAMENTET
120	S FUNDAMENTET
129	ÄMBETSHUS BAO, VÄSTRA KANSLIHUSET
130	ÄMBETSHUS CÖVS, ÖSTRA KANSLIHUSET
131	BYGGNADSDEPARTEMENTET
132	SANITETSBYGGNAD
133	SPRUTBOD
134	SJÖRESERVENS KASERN
135	BECKBODEN
136	ÅRBOD
137	FÖRRÅD
142	KLOCKSTAPEL
180	SKEPPSHOLMSBRON

KASTELLHOLMEN

201	HANTVERKARBOSTÄLLET
202	UNDEROFFICERSBOSTÄLLET
203	FLAGGKONSTAPELBOSTÄLLET
204	KASTELLET
205	KOLSKJULET
206	KRUTHUSET
207	FOSFORFÖRRÅDET
208	SJÖVILLAN
209	KANOTHUSET
211	SKRIDSKOPAVILJONGEN
213	UTHUS TILL 201
214	TVÄTTSTUGA OCH UTHUS TILL 201
216	UTHUS TILL 203
280	KASTELLHOLMSBRON
281	KAJER

In most of the buildings, there are meters connected to provide electricity, district heating and water. Every meter that are listed on the map and Vitec system will have its characteristic name. Through the name of the meter, we can easily sort out what kind of data it is recording inside.

The first classification of the meters is the abbreviation we encounter after the building's name. As aforementioned, we already know that every building inside Skeppsholmen and Kastellholmen will be named as AB183XXX. In the second part of the meters' name, it is divided by the systems inside the islands.

For the electricity meters, the name will start with AB183XXX-(A to F)-XXXX, which the A to F will represent the Transformers 1 to Transformer 6, which A will indicate the connection to transformer 1, B will indicate that it receives electricity from Transformer 2, and so on. We can take one of the electricity meters as an example: if the meters named as AB183019_E-1101_MX0010, it means this building's electricity is provided by Transformer 5.

For the heating system, there are two different categories, which is VP and VS. VP is represent the primary heating to the system, which means this data is the real-time heating consumption of this building. For the VS, it stands for secondary heating, which means the heat that this meter is counting is from another meter. The secondary heating would happen in the situation when the building's heating system is connected to another building.

The last part of the name of the meter represents the different sorts of energy measured by different types of meters that are analyzed in VITEC:

1.MQ is related to heating energy (kWh, MWh)

2.MF is related to flux (m^3/s)

3.MX is related to electricity (kWh,MWh)

In conclusion, we can simply sort out the meters inside the map by those nomenclature. On the table below building 117 has been taken as an example:

HUS 117		
Name of the meter	**Representative**	**Remark**
AB183117-VV1101-MF4501	Warm Water Flux for Building 117	
AB183117-KV1101-MF4401	Tap Water Flux for Building 117	
AB183117-E_1101-MX4601	Electricity Energy for Building 117	From T5
AB183117-E_1101-MX4701	Electricity Energy for Building 117	From T5
AB183117-E_1101-MX4702	Electricity Energy for Building 117	From T5
AB183117-VP1101-MF4401	Primary Heating Flux for Building 117	
AB183117-VP1101-MQ4401	Primary Heating Energy for Building 117	

5.2. Classification and codes inside Vitec

In section 3.1, we have discussed about the name of the meters to identify the system and the sort of energy. There are also some naming methods inside the sheets of Vitec that help categorize the whole building. For each building, we will see these categories inside the database, which are as follows:

El: electricity (KWh)

- Fastighetsel (Building Electricity): Electricity used to “run” the buildings, e.g.: pumps, emergency exit signs etc.
- Verksamhetsel (Operational electricity): For the tenants use.

FV: District heating (MWh)

FVf: District heating flow (m^3)

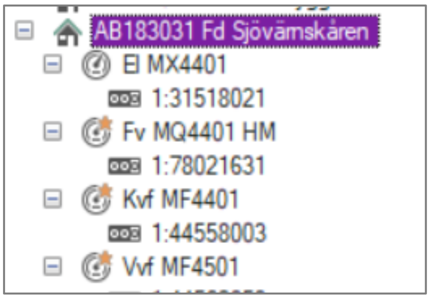
VVF: warm water flux (m^3)

VVC: warm water circulation

KVF: tap water flux (m^3)

HM: stands for the main meter, means that this meter should sum the data for all the meter connected to it.

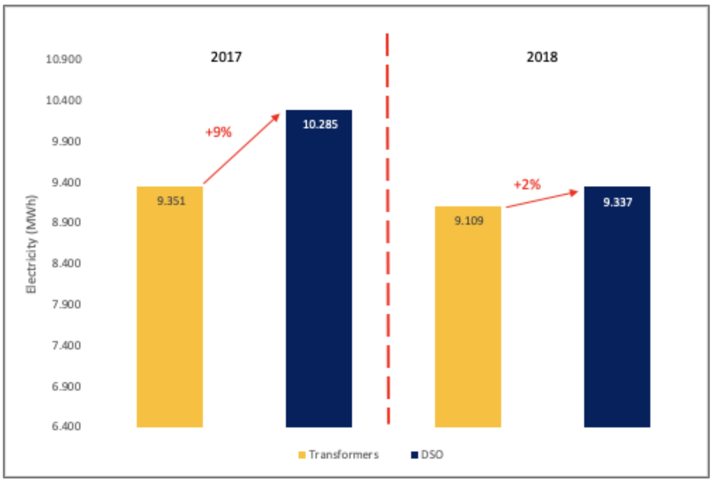
The figure below shows the data structure inside the list of Vitec, which represents all the data sheets here.



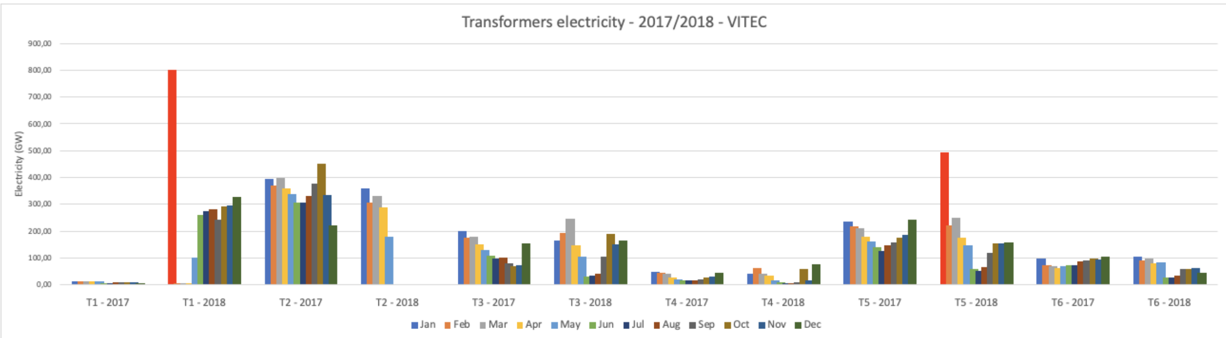
5.3. Methodology

Since much of the data in Vitec is not considered reliable, the group was oriented to consider that the only trustable data would come from the DSO meter (AB 183000 El Timme). Theoretically, this main meter sums all the electricity consumption on the islands, i.e., electricity supplied to each of the six transformers.

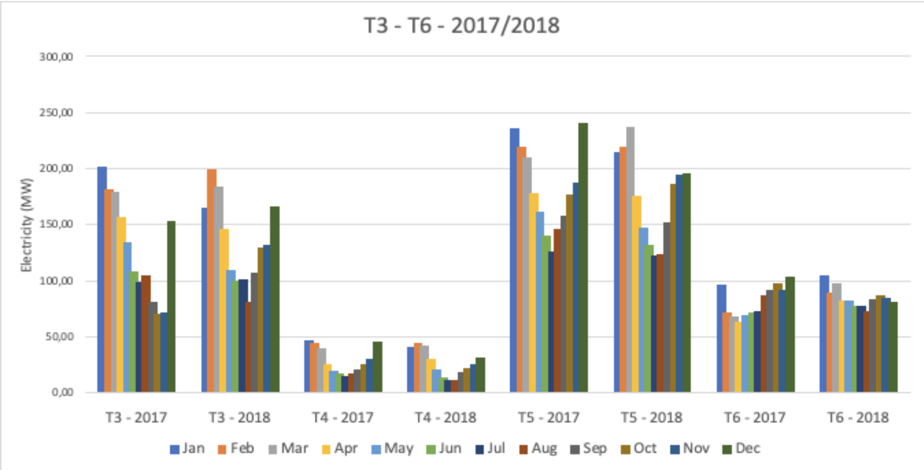
In the beginning of the project, the only information the group had was that T1 and T2 worked as back ups for each other and would only serve the biggest electricity consumer on the island, the building where the Moderna Museum is located. Therefore, in order to perform a first analysis, the group compared the data of electricity supply by all the transformers with the total measured in the DSO meter.

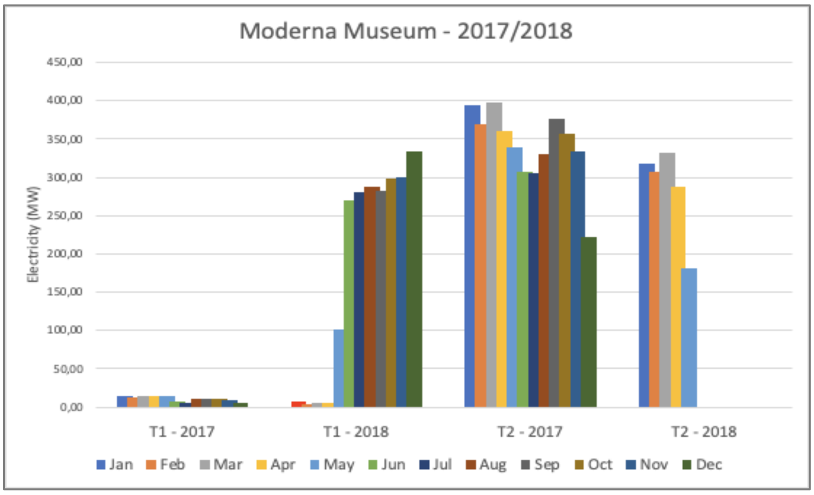


As the sum of the transformers and the DSO meter presented a significantly difference, a deeper analysis was made in the transformer level. The next graph shows the electricity that monthly passed through each of the transformers during 2017 and 2018.



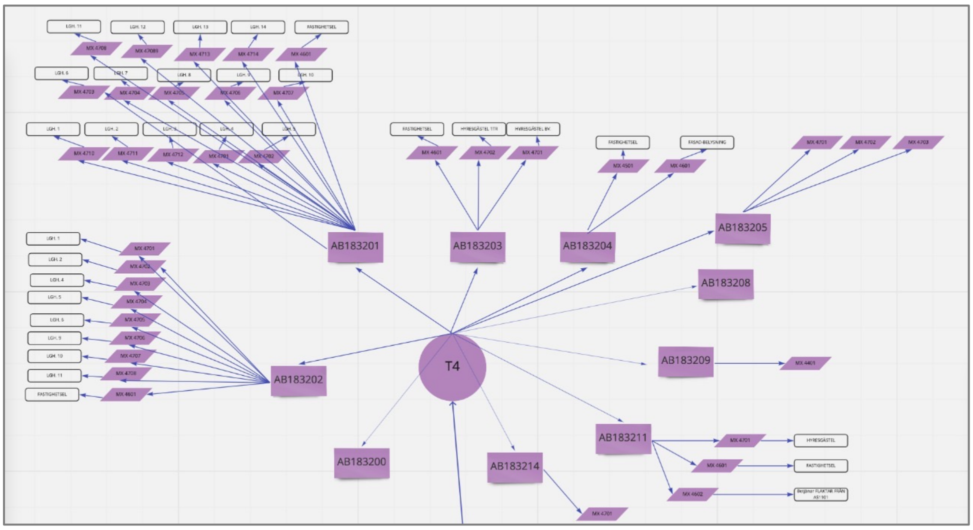
The result of the first analysis is presented in the graph above showed peaks consumption in T1 and T5 during January 2018. These two atypical values were presented to the supervisor in order to understand the possible reasons. After some analysis, the solution for those situations was to refresh all the data calculations for transformers level inside the software Vitec. As a result, the two peaks disappeared, and the updated correct values are presented in the two graphs below.





Therefore, apart from T1 and T2 (both dedicated to Moderna Museum), T5 seemed to present the biggest electricity demand. But instead of starting the study with this transformer, the working group align with the supervisor to use T4, with the smallest demand, to apply one pilot method solution. If the results of the first pilot satisfy the expectations, the methodology will be applied to the other transformers and also to other energy sources, i.e. heating.

The methodology that will be tested in T4 is based on mapping all the consumers connected in this specific sub-station and how they are linked to each other. First, a flowchart of each building connected to T4 had to be built. In order to elaborate such flowchart, documentation from SFV together with data from Vitec were considered. The image below is an illustrative representation of how this flowchart has been organized:



The flowchart will be validated with SFV, Sweco during visits to the islands. Once the flowcharts represent a reliable and helpful resource, the group will create maps for each of the 6 transformers and suggest changes and improvements in Vitec in order to represent better the structure and organization in reality.

Another step was performed in order to validate data and understanding of buildings/meters/transformers structure.

First, all the consumers on the island were listed according to Vitec in a long list, a total of 72. The group then tried to match each consumer to one of the six transformers, as presented in Appendix 1. As a result, most of the units that are buildings were correlated successfully with a transformer, but some remained to be checked with SFV or in loco. Moreover, through this analysis we were also able to find out that not all the consumers are the buildings on the islands. Some of them, instead, are simply meters related to varied consumption outside a building, such as garbage house, lubricant storage house etc.

In parallel to that, we are analyzing big numbers for electricity consumption of the biggest consumers on the islands. This part of the project, the group will be mainly looking for missing data, peaks, weird profiles etc that can somehow divert results. The list of the ten biggest consumers in the island is presented below:

Electricity (MWh)		
	Name of building	2018
1	AB183015 Moderna och Arkitek	618,00
2	AB183182 Bergrum	334,73
3	AB183026 Kasern III	167,92
4	AB183103 Torpedöversynsverks	104,54
5	AB183114 Tyghuset Östasiatis	84,71
6	AB183185 Pumpstation	73,40
7	AB183034 Ö.boställshuset	52,56
8	AB183021 fd Sjökarteverket	51,27
9	AB183024 Intendenturförrådet	49,07
10	AB183033 V.boställshuset	47,52

6. Presentation of the Project Solution

As mentioned in the objectives and scope of the project, in this first phase we are trying to validate the smart-meter data and information we can retrieve from Vitec and Grafana. Since there is so little data that we can rely on, from the beginning we were told to proceed by using the DSO meter (AB 1830000 El Timme) as the trusted data in which we can compare and validate to sort out the issues that lies within the software.

After some trial and error on trying to solve this issue from different perspectives, and with the guidance from Sweco to keep us on track, we have a project solution for the first phase in which we can proceed on and complete.

The solution is to figure out the flow of electricity from Transformers to the building level, we can find this information from the map available in Vitec and from Sweco map documentation of the island (older version). From this information we can build our own map (flowchart) to further understand and double check the existing meters/buildings from Vitec to both of the map, also to figure out which meters/buildings are interconnected/correlated.

In the map flowchart we can also list out the amount of electricity value we have retrieved from Vitec and Grafana from meter, building, transformer level. Through this way we can validate and figure out if the amount of value in the meters level are equal with the value from the transformers level. If the values are not equal, we can address this issue and pinpoint where the problem is located through our map.

6.1. Project Proposals

The proposed project plan for the solution is to start with a transformer which has a relatively small number of buildings/meters connected to it and a small amount of energy demand, using only one month of data retrieved from both Vitec and Grafana to be validated in the flowchart map. This way we are reducing the risk in which if this solution turns out to be not a feasible way to proceed.

The transformer which we have chosen on is T4. If we manage to sort out and validate the data of this transformer, we can proceed with this solution according to the transformer's which looks odd/showing big anomalies.

This is the clearest and effective way in hoping to find and pinpoint where the losses are occurring in the island.

7. Justify your proposed solution

In order to provide energy solutions to the buildings in both the islands, we need to straighten the system and sort out where the losses occur. This can be done only by validating the data from Vitec and Grafana. Since the data from Vitec is not as reliable as the data from Grafana, we are using the DSO meter data as the trusted one to compare and correct the flaws in the software.

We are working on a map flowchart to understand the flow of electricity from DSO level to the Transformers and to the building meter level and then we can pinpoint where the losses are. Once we finish plotting the map/flowchart, we can easily figure out the losses in each stage (Transformer/building/meter level) of the energy flow(electricity/heating).

8. Key issues for continued

As mentioned above, one of the key issues we face is the non-reliability of the data from Vitec system. We managed to point out some of the peaks in electricity consumption at the transformer level and were discussed with the supervisor. It was then observed that we can force recalculate the data at the building/transformer level in the Vitec system in such cases.

For plotting the map flowchart, we are relying on the maps from Vitec system and also from Skeppsholmen documentation. Lack of documentation for some buildings in the Vitec system slows us down from finishing the map flowchart. Moreover, some of the buildings are interconnected and the main meter is connected one of the connected buildings. Sub-Meters are installed in such cases and connected to the main meter of those buildings. But in some cases, there is no sub-meter installed in the interconnected buildings and the ratio of the energy consumption between the buildings is mentioned in the main meter with a formula, which was formulated during the installation of the meters.

It is very important for us to validate the data from the smart meters in the Vitec system before proposing any energy solutions to the buildings on the islands.

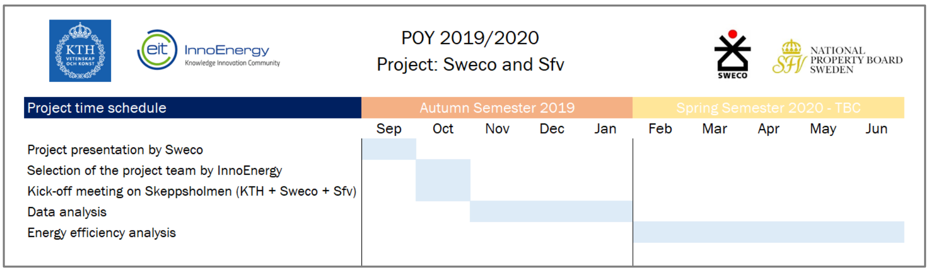
9. Lessons learned from this project

During this first part of the project, the group could experience some difficulties related to communication, especially because the main source of information for the data analysis is a Swedish software that does not offer English translation. This fact increased the level of difficulty both for the data extraction and comprehension of values.

Another obstacle that the group members had to deal was related to the way each person understand the concept of team working. Some situations during the working period contributed to a deep reflection for all the team members. At this point, the variety of nationalities and cultures of the group's components provide a good exchange and enrich the learning process. On the other hand, it also requires flexibility to adapt to different points of view and ways of working.

10. Project schedule comparing with actual progress

The summarized project schedule is as follows:



During the first semester of the project (Autumn 2019), the working group has been focusing on data analysis in order to investigate inconsistencies and their possible causes. The group will also be counting on field visits to get to know in detail some of the buildings that present the biggest consumers on the island and understand better both the islands and the meters structure, position and logic.

Compared to the previous project schedule presented, we have postponed the energy efficiency analysis phase. The group realized more time will be required to analyze data and understand the logics of both systems in details.

Most of the energy data from both islands presents some source of deviation, either caused by malfunctioning of the meter, inconsistent math / configuration in the software or even by meters showing measurement of buildings that they are not related to. Thus, the group has been dedicating a greater amount of time investigating deeper data from the islands.

This part of the project must take place before the energy analysis proposals anyways, since the suggestions must be based on reliable data.

11. Conclusions

The main conclusion that the group could get from the work performed so far is the relevance of data management and data analysis. It became very clear that the installation of smart meters alone is not enough to support energy management or energy efficiency initiative Reliability on data and system set up and configuration are also fundamental.

In summary, the project team is aiming to deg deeper of mismatch between Vitec system data and meter maps which may lead to the incorrect electricity consumption values understanding. After cross checking of both monitor system, Vitec and Grafana, the inconsistent data will be fixed in order to improve the reliability of the monitor systems.

Besides discovering the missing data, the importance of building a system in well-organized, logical, and traceable becomes a priority of system construction.

All data and system checking will be continued to the next stage of work.

12. References

- Information from Sweco/SFV;
- Data available in Vitec and Grafana;
- Field visits.

Appendices

Appendix 1: List of all consumers and the transformers that they are connected

	Name of building	T1 / T2	T3	T4	T5	T6
1	AB183000 Skepps- och kast.holm					
2	AB183003 Högvaktsbyggnaden				■	
3	AB183009 Annex				■	
4	AB183010 Skeppsholmskyrkan					■
5	AB183011 fd Marketenteri					■
6	AB183012 Kasern II KKH				■	
7	AB183013 Ateljehuset (fd skj				■	
8	AB183014 Arrest				■	
9	AB183015 Moderna och Arkitek	■				
10	AB183016 Prästgården				■	
11	AB183018 Amiralitetshus				■	
12	AB183019 Fd Hantverkskaserne					■
13	AB183020 Vattentorn				■	
14	AB183021 fd Sjökarteverket				■	
15	AB183022 Vattenståndsmätarhu					
16	AB183023 Kompasskontrollhus				■	
17	AB183024 Intendenturförrådet				■	
18	AB183026 Kasern III				■	
19	AB183028 Fd kasernslöjden				■	
20	AB183029 Personalbyggnad				■	
21	AB183031 Fd Sjövärnskåren				■	
22	AB183032 Kanslihus (fd sjökr				■	
23	AB183033 V.bostÄllshuset		■			
24	AB183034 Ö.boställshuset		■			
25	AB183035 Badanstalt				■	
26	AB183036 Bostadshus				■	
27	AB183037 Omformarstation		■			
28	AB183038 Sophus				■	
29	AB183039 Paviljong				■	
30	AB183040 Uthus till kasern I				■	
31	AB183041 Uthus till v. bostä		■			
32	AB183042 Uthus till ö. bostä		■			
33	AB183043 avlopps pumpstation		■			
34	AB183100 Styckekran					
35	AB183101 Råseglarhuset				■	
36	AB183102 Mindepartementet				■	
37	AB183103 Torpedöversynsverks				■	
38	AB183104 Torpedförråd				■	
39	AB183106 Sophus					
40	AB183111 Oljeförråd					
41	AB183114 Tyghuset Östasiatis					■
42	AB183117 Kanonverkstaden				■	
43	AB183119 N. fundamentet				■	
44	AB183120 S. fundamentet				■	
45	AB183129 Ämbetshus BAO				■	
46	AB183130 Ämbetshus CÖVS				■	
47	AB183131 Byggnadsdepartement				■	
48	AB183133 Sprutbod (förråd)				■	
49	AB183134 Sjöreservens kasern				■	
50	AB183135 Beckborg					
51	AB183136 Årbod				■	
52	AB183137 Förråd				■	
53	AB183182 Bergrum					■
54	AB183183 Batteristerna					■
55	AB183184 Splitterskyddsrum		■			
56	AB183185 Pumpstation	■				
57	AB183200 Pumpgrop Kastellhol			■		
58	AB183201 Boställshus			■		
59	AB183202 Boställshus			■		
60	AB183203 Boställshus			■		
61	AB183204 Sth skeppsh kastell			■		
62	AB183205 Kolskjul			■		
63	AB183207 Kruthus					
64	AB183208 Fosforförråd			■		
65	AB183209 Båt- och kanothus			■		
66	AB183211 Skridskopaviljongen			■		
67	AB183213 Uthus till 201					
68	AB183214 Tvättstuga och uthus			■		
69	AB183216 Uthus till 202					
70	AB183243 Avloppspumpstation					
71	HUS 282???					
72	AB183300 Mark					

Appendix 2: Layout of Skeppsholmen and Kastellholmen