FINAL REPORT

POWER VISION

Raising Awareness for Energy Consumption

European Project Semester
Spring Term 2014

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Contents

Appendices:

1. Mandate for Vasa Elektriska
2. Technical details on pulse output of the heat meter Multical 601
3. Data logger market research and rating
4. Informed consent for the focus group

1. Introduction

1.1 European Project Semester

European Project Semester is a programme offered by 13 universities (cf. Figure 1) in 11 countries in Europe. It was created to prepare engineering students with the necessary skills to face today's world, focussing on the design requirements of engineers. The projects are interdisciplinary and in English. Therefore all students with different backgrounds should be able to contribute something to the project.

Figure 1: EPS locations

1.2 Project vision and mission

VISION

The vision of this project is to create awareness about energy consumption. Information about Novia's energy consumption such as water, heat and electricity is presented in a way that catches the attention of the students and creates new ways of interaction between the students and the amount of energy they use, including e.g. a competition between different locations or rooms. Ideally this will lead to actual energy savings, not only in the Novia building but also in the private life of the students.

We have defined our vision of the system according to the scheme given in Figure 2.

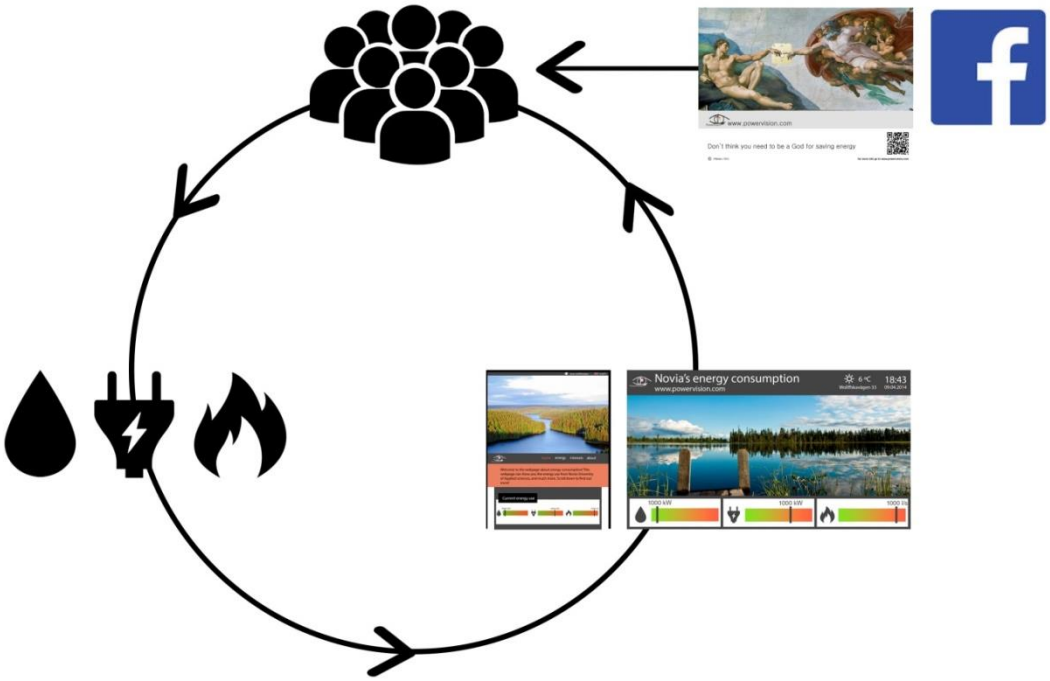


Figure 2: Scheme of the vision

This scheme includes all the factors that are part of the system. The system is presented as a circle where one thing can have impact on the others. We will start with the TV screen and the website. These two represent the amount of energy use. As students see the TV screen they will start thinking about their own consumption. They might start to turn off lights and such. As a result, the real life energy will drop. Next, this will be seen on the TV screen and the website. Here our circle is full.

There is however another input that is not part of the circle but is an important part of the system. These are the posters and Facebook. The reason these two are outside the circle is because they are more fixed. When the energy consumption drops, the posters will not change. Facebook is different from the posters because it might give comments about the energy use and the changes that might be made in the future.

MISSION

As to the mission, this project covers the development of the elements “interface” and “perception & motivation”, which are parts of the whole visualization system as shown in Figure 3. This includes:

- the identification of suitable communication channels (among others the information screens in the Novia building, a webpage and posters)
- a focus group evaluation and survey to get information about the interests and wishes of the students regarding information about energy consumption
- research about communication design and motivation

- the development of ways that allow an easy presentation of information, like charts and the illustrated explanation of consumption values
- "advertisement" for the system by means of posters and a Facebook page

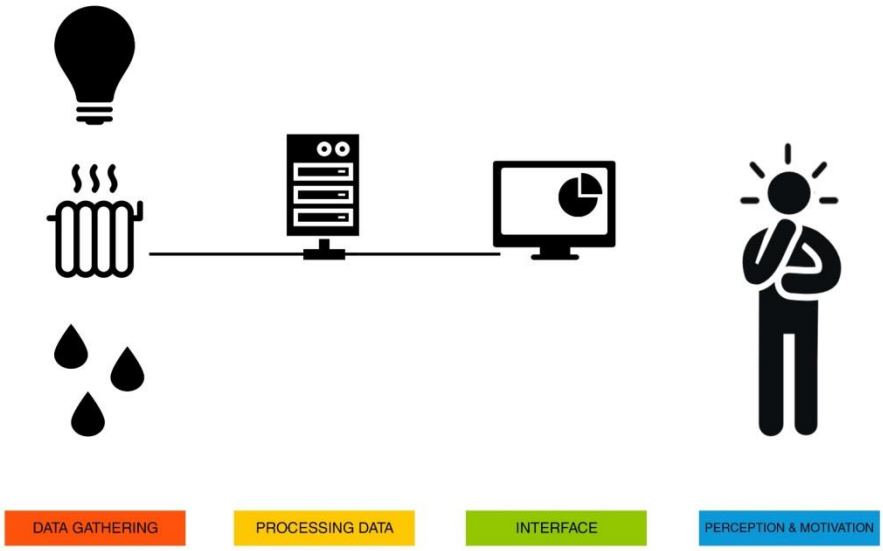


Figure 3: Scheme of the elements of the visualization system

1.3 Team and Logo

1.3.1 Team

The team consists of five members: Aleix, Bara, Loulou, Markus and Paola. A short presentation is given in Table 1.

Table 1: Presentation of the team members

Aleix	**Nationality: Spanish** **University: University of Lleida, Spain** **Hobbies: cycling, running, reading, travelling** **Belbin team role: coordinator, resource investigator**
Bara	Nationality: Czech University: Hochschule Zittau, Germany Hobbies: climbing, violin Belbin team roles: team worker, resource investigator, specialist

Loulou	Nationality: Belgian University: Universiteit Antwerpen, Belgium Hobbies: cello, sailing Belbin team role: plant, team worker
Markus	Nationality: German University: OTH Amberg-Weiden, Germany Hobbies: hiking Belbin team role: complete finisher, monitor evaluator
Paola	Nationality: Spanish University: Universitat Politécnica de Catalunya, Spain Hobbies: crafts, music Belbin team role: team worker, plant

1.3.2 Logo and project name

The logo, shown in Figure 4, represents our project. It is a windmill placed into an eye. The windmill represents the energy usage on the Novia campuses. The eye represents the visualisation part of the project.

The name chosen for our project is PowerVision. This name also represents both the energy part and the visualisation part in the project.

Figure 4: Project logo

2. Novia's involved parties and assignment of tasks

The involved parties of Novia UAS and their roles are shown in Table 2.

Table 2: Involved parties of Novia UAS

Name	Role	Position at Novia UAS
Roger Nylund	EPS coordinator	Senior Lecturer
Kristian Blomqvist	Project owner	Head of Novia R&D
Mikael Ehrs	Project supervisor	Senior Lecturer
Dennis Bengs	IT implementation	Project Researcher
Ulla-Maj Söderback	Language support	Senior Lecturer

Initially, the project goal was defined by Mr. Kristian Blomqvist to be a visualization of the consumption values of heat, water and electricity of the Novia building Wolffskavägen 33. As it turned out that a former logging system had been removed in the meantime, the project was supposed to cover the full range from data gathering and logging from the energy meters in the basement to processing, storage and display of the data.

On 14 March 2014 the project was revised by Mr. Blomqvist, leading to the assignment of parts of the project to other parties:

- Construction and implementation of a data logging system for water, electricity and heat meter: assigned to a project group of three Novia students, supervised by Mr. Mats Borg (Head of Department for general studies)
- Implementation of a server with a database for storing the logged meter values, and technical implementation of the visualization system: Mr. Dennis Bengs. The system has to be prepared for the connection of the other Novia campuses.

At the same time, the goals of the EPS project team were refined and narrowed down to the following:

- Creative design of advanced visualization solutions for an interactive website on the one hand and public screens on the other hand
- aim: raising awareness among students and the public for energy consumption and the connected environmental problems. Actual energy savings in the university buildings would be a nice side effect, but raising awareness and the "political statement" of highlighting energy efficiency ambitions has priority.

As a basic research regarding the data logging system and the visualization, solutions had already been conducted at the time of the handover to the other group. The according results of these, are also displayed in this report. Contacts to the persons in charge of the local energy providers stayed in the responsibility of our team, as a necessary mandate by Novia University had already been made out in our name.

3. Logging energy and water consumption

There are two basic ways of getting data on the energy and water consumption:

Firstly, additional sensors can be installed without altering the existing setup, for example current clamps to meter electrical current, or the logging of an electromechanical meter by optically counting the rotations of the disc. These solutions require suitable electronics for proper operation of the sensors, and are often used for inexpensive smart home electricity metering, working independently of the meters installed by the utility, or at least without the utility's consent.

Metering the water consumption would be more difficult, e.g. by strap-on supersonic flow meters for water pipes. To measure the heat energy this way would be challenging or even impossible, as temperatures and flow rates of the district heating would have to be measured without opening the piping.

Secondly, nearly all meters (regardless of whether they were installed by the utility for accounting, or installed by the owner especially for logging purposes) have various types of communication interfaces. Using these interfaces is often the preferred way of data logging, as it allows the use of reliable standardized industrial components and protocols. However, terminals for these interfaces are often sealed by the utility and optical and radio interfaces can be disabled respectively, so logging the utility's meters depends on the utility's goodwill.

3.1 Interfaces and protocols for energy meters

In the following the most commonly used communication standards for energy meters are introduced [1].

Pulse interface (S0[1])
By this very simple interface the meter provides a certain number of pulses per consumption unit (e.g. 1000 imp/kWh) by means of a mechanical or electronic, normally open switch. The supply voltage (usually in the range of 30V) has to be provided by the logger. The right polarity of the two pole connection matters for the transistor switched pulse output. The logger has to count the pulses continually, as only the current power or flow rate is transmitted. Loggers differ greatly in their maximum pulse rates and some can only read mechanical switched signals, accordingly not every logger matches every meter setup.

[1] Partially the term S0 is used only for transistor switched signals, as opposed to the mechanical/magnetic switch used e.g. in analogue water meters.

M-Bus (Meter-Bus), EN13757
Modbus (RS485)
EIB(KNX)
These standards are more sophisticated and used for bigger arrays of meters and for an easy interconnection, mainly in industrial environments. The protocol enables specific communication with every single meter for data transfer and also the programming of the meters. The connection is mostly wired (two-pole), but partially also radio or optical interfaces are used. A variety of meters and loggers exist for these standards.

Optical IR interface (also D0), EN62056-61
The advantage of the optical port is that it is easily accessible without asking the utility's permission (as long as the utility doesn't disable the optical port deliberately), as it is positioned at the front of the meter. An optical head can be attached magnetically to the interface. However, the standard describes only the physical properties of the optical components [2], whereas the used protocol language often obeys no standard, but is a customized solution of the meter manufacturer [3]. This requires the adaption of the logging software for every single meter type (often, the special PC software of the meter manufacturer has to be used) and by that inhibits the usage of the optical port with industrial data loggers.

3.2 Original state and meters in the Novia building

A logging system by the manufacturer Schneider Electric had been installed in the past, which had logged electricity, heat and water meter. However the system had been removed for reasons unknown between 2010 and 2013, and there is no documentation left. Cables are still visible at the position of the meters, but it is unclear where they lead.

In 2010 a previous EPS team [4] had worked on a visualization software for a webpage, but apart from the report with a few screenshots, there is no data left. The students had used an SQL server, Microsoft ASP.net and C#, but according to the report accomplished only a first demonstrational webpage with examples of charts, and they didn't go deeper into visualization concepts.

The following meters are installed in the basement of the Novia building (positions are depicted in Figure 5):

Water meter[2] (cf. Figure 6):
According to the water provider Vaasan Vesi [5], the reed contact is not used by them but is meant for the use of the customer, and it must not be removed from the meter. Consequently, the connected cable is left over from the Schneider Electric system and may be disconnected.

[2] Type Zenner MNK-N, Qn=6, existing reed contact acting as pulse output (normally open switch with 47Ω protective resistor, 1 pulse = 10 liter)

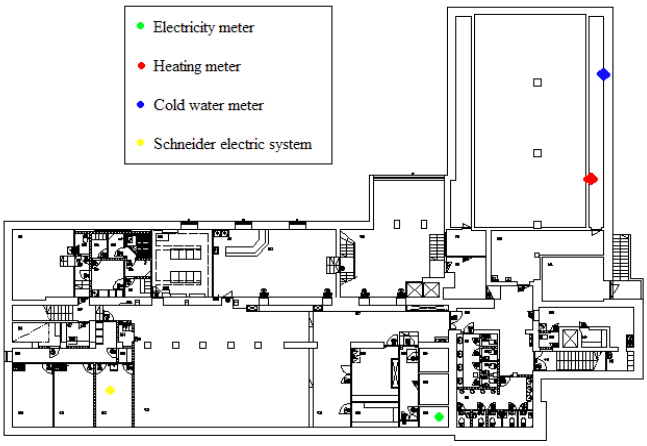


Figure 5: Position of the meters in the basement of Wolffskavägen 33 [4].
(The "Schneider Electric" logging system no longer exists.)

Electricity meter: Type Landis+Gyr Enermet E600 with EN200Gi interface unit.
According to Landis+Gyr support [2], no technical information is available, as Enermet doesn't exist any more. Usually, the optical IR interface is active by default with all Landis+Gyr meters, and the imprint on the meter front indicates here that the optical interface uses the DLMS protocol for communication.

Figure 6: Left side: Water meter with (blue) reed contact switch for pulse output on top of it.
Right side: Connection terminal next to the electricity meter (original state), where the pulse output was connected by the technician to the already existing telephone/signal cable.

The customer service of the energy provider Vasa Elektriska required a mandate by Novia (see appendix) before offering to provide us with the pulse output [6]. A technician was sent immediately to check the proper function of the output and if necessary to reconnect it to the terminal directly next to the electricity meter (cf.

Figure 6). The already installed two-pole signal cable is not used by Vasa Elektriska and probably a left-over from the former Schneider Electric logging system, which also used the pulse output of this, or a previous electricity meter.

Besides, Vasa Elektriska also offered to provide their remotely read meter values (for heat and electricity) electronically in the form of MSCONS messages, but as this would give consumption figures only once per day, it was considered to be of no use for the project.

It has to be taken into account that the meter uses current transformers, the frequency of the yellow calibration LED suggesting a transformation factor of 100:1. This would lead to an effective pulse rate of 500 imp/kWh, which has to be verified once the logging system is installed.

Heat meter: Type Kamstrup Multical 601 with remote reading by Vasa Elektriska via M-BUS from the top interface card [7] (probably via the Landis+Gyr E450 logging unit next to it).

The meter can be retrofitted with various interface cards (among others M-Bus, radio and analogue output), but only one of the two interfaces can be a pulse output [8]. Kamstrup support provided detailed information on the connection and features of the pulse output card [9], which can be found in appendix 2. The optical port could also be used for logging data to Excel with a free software provided by Kamstrup, but this would require a computer running next to the logger, so it would be a less-than-ideal solution [8].

Vasa Elektriska [7] offered to send an assembler to install a pulse output interface card in the meter for the heat energy and the water flow once we provide a cable with two pairs marked accordingly (the actual interface is behind the sealing of the meter). To be able to request this installation quickly, a terminal box was installed directly below the heat meter, so the technician could connect the meter interface to this terminal box (assignment: red: energy+, blue: energy-, yellow: flow+, white: flow-).

3.3 Research of applicable logging solutions

Logging possibilities can be classified according to the following areas:

- **“Industrial data loggers” for energy meters**

The advantage of industrial data loggers is that they probably provide stable long term operation. A market research was conducted, which led to the result that most industrial data loggers cannot transmit data automatically into a database in real time, but only create tables or send reports at bigger intervals. Of all researched models, only the pulse logger “WuT webcount energy” seems to meet the requirements for real-time transmission. The interaction with a database has to be implemented by an IT

professional. A comparative overview of the researched models can be found in Appendix 3.

- **Logging of meters with a PC and special software**

This requires stable 24/7 operation of a PC and of the software. It would greatly facilitate the direct transmission of the values into a database and offer the biggest freedom for data processing.

- **Special visualization solutions**

These systems are especially made for real time visualization and are often a complete solution including the whole chain from energy metering sensors to a display. Mostly, custom sensors like current clamps are used. Examples are the commercial system TED Pro 400 [10] or the open source project “Open Energy Monitor” [11]. The latter allows both the use of custom sensors and the connection to meter interfaces. Many other available “smart home” visualization devices are inexpensive, but most possess limited functionality.

3.4 Low cost solutions

These solutions are mainly based on open platforms which not only grant the possibility to modify them, but also to own the designs made for them. The dependence on third party solutions can be avoided.

These solutions consist mainly in a base that receives data packets from sensor nodes and sends them to a computer database, as shown in Figure 7.
The two main components of the system are briefly described below.

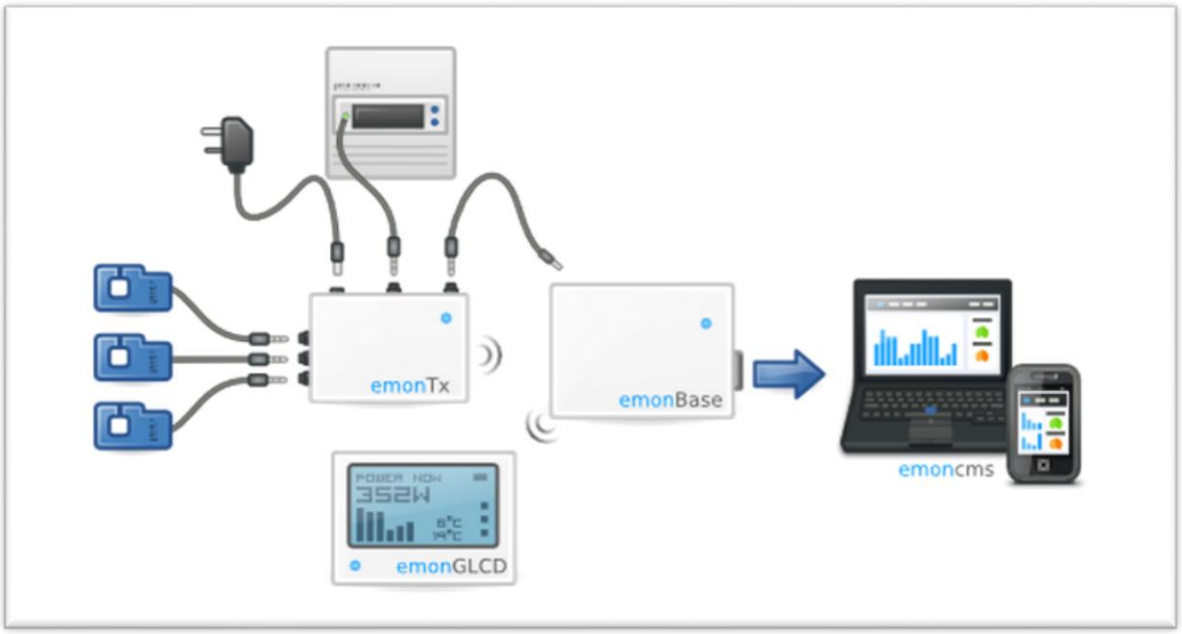


Figure 7: Scheme of the Open Energy Monitor platform

Base station

The base station is the part of the equipment that receives the data packets from the sensors. There are two types of base stations: System on a Chip ARM architecture based solutions, or Arduino based.

The ARM SoC ones are a card-type computers (see the RaspberryPi project), which behave like computer based in ARM architecture, meaning that they can run Linux distributions and Linux based OS modified distributions, some of them distributed freely over the Internet. They can also be used as servers, storing data in external hard disk drives, running MySQL servers, and being remotely accessed from the Internet or Local Area Networks.

Arduino based base stations, are built around an Arduino standard programmable board, which holds a programmable microcontroller (usually Atmel AVR, but can be also an ARM microcontroller). This microcontroller can forward the data packets via the built-in Ethernet connection to a remote server where they are processed and stored, meaning that the board is only behaving like a bridge connection between the sensors and the server.

Each solution has its own advantages and disadvantages; the SoC computer based solution can be used as a server and thus diminish the final price of the whole system, while the Arduino board needs an external server. On the other hand, microcontrollers can be programmed in multiple ways and can only do simple tasks. They are usually very reliable, flexible and customizable solutions for systems that have to work 24/7, while any system that uses an Operative System is prone to suffer from hangs or malfunctions.

Sensor nodes

The sensor nodes are the parts of the system that acquire data from the actual meters installed by the companies. These nodes can be connected to the base via wired connections or radiofrequency. They require a very small amount of energy in order to keep running, so it is only necessary to provide them with a 5 V DC source and a rechargeable battery to keep them running in case of an electricity supply malfunction.

All these sensor nodes run using programmable microcontrollers (Arduino platform included), and they are easily adapted to acquire data from different sources, optical, pulse, etc. Even data from proprietary interfaces can be acquired with the right software. It is also good to remember that all these sensors are really inexpensive, and ready to be attached to the sensor boards without major hardware modifications, only software adjustment is needed.

Also, because of their nature, near every existing sensor can be attached to them (temperature, humidity, Hall Effect, light, proximity, noise, etc.) and so, can be used to override some of the meters installed, or to get more precise and subdivided data. As an example, clamp-on non-invasive coil meters can be installed in every desired cable to measure the current and the power going through it.

4. Research of visualization software

A basic research was conducted to identify apt software solutions for creating graphical content from the logged values.

- Data logger with integrated visualization solution

Some data loggers offer the possibility to show basic charts directly on their web-interface, but these are of little use, as they cannot be adapted and processed further.

- Web service from logger manufacturer

There are data logger manufacturers who run their own web services for visualization (e.g. www.sensdesk.com for HWg gear and www.smart-me.com for EMU loggers). These services would provide easy implementation and partially even the possibility to create custom dashboard-style webpages, but their main disadvantage is the dependence on these companies keeping their services in operation. Besides, possibilities in visualization and design are limited and further costs for the web services might arise.

- Google Sites in combination with Google Charts

This solution could be implemented without much programming. It offers a wide range of different chart designs (similar to the former service “Google Power Meter”, which ceased operation in 2011). Charts could also be implemented into custom webpages. A connection to a SQL database would be possible, but as described above, the dependence on external service providers poses an imponderability.

- Drupal

Drupal is a free software package, used to organize, manage and publish content, with an endless variety of customization. Drupal runs on any computing platform that supports both a web server capable of running PHP and an SQL database to store content and settings. However, its use requires programming skills. Charts are partially provided via the Google Charts service.

- EMONCMS

This open source content management system for the Open Energy Monitor project is free, and can be installed on a custom webserver (Windows or Linux PC, RaspberryPI/Arduino), running independently of other web services. It processes values from a database (MySQL, PHP timeline or Timestore) and can work that way with different loggers. Implementation is possible even with a drag and drop dashboard editor, but probably programming skills are still required nevertheless.

- Proprietary consumption displays

There are many providers for simple “smart home” visualization devices as well as for more sophisticated displays for educational and industrial application, like There Corporation (Vaasa), Trane (USA) and Noveda (USA).

The best solution, however, is the in-house development of the complete system, as only this ensures maximum creative freedom.

5. Collection of ideas for the basic design of the system

5.1 Design principles

5.1.1 Interactive design

In order to capture the attention of the students we have to make an interface and webpage that is both attracting and informative. Capturing the attention and creating awareness outside this interface is also important. We started with researching a little about interaction as we thought that an interactive webpage would be more interesting for students. As we started browsing on the internet we found a lot of solutions for interactive design, but they were solely for materialistic products. We decided to take the useful info, hoping the solutions will prove themselves useful in the future.

Video is the only type of communication that can fully clarify a new product and its use. It can be used to ask new questions.

Prototyping is a good way of testing an interactive design. A prototype might not show something working but it will give ideas about the mistakes that can be corrected before the final product is produced.

Using **patterns and predictions** in a system (or product) will make the concept user friendly. Everything people do is pattern related. Therefor using a pattern structured system will be better than a system made up of random things. A good way of designing a pattern is to create scenarios to predict how users will interact with the design.

Tricking people is also a good way to f creating interaction. People always have certain expectations when doing something. When your design includes something that is the opposite of the expected result, it will create a place where people will wake up. At that moment you have their attention. A distraction also tricks people into thinking that the technology is faster than it really is.

There are other ways of getting people's attention, e.g. by using **metaphors**. The important thing is that you do not abuse the metaphors. Furthermore when giving info on a certain topic it is important to be a **humble expert**. Being an expert in a certain field but being a prick about it chases people away. When someone is humble about their

expertise people are more inclined to listen. Something important that will improve the role of being a humble expert is to seek your failures. When mistakes are made it is best to apologize for them and correct them.

When communicating with someone there are four important factors to take into account. Those are: the environment, the sender, the message and the receiver (cf.
Figure 8).

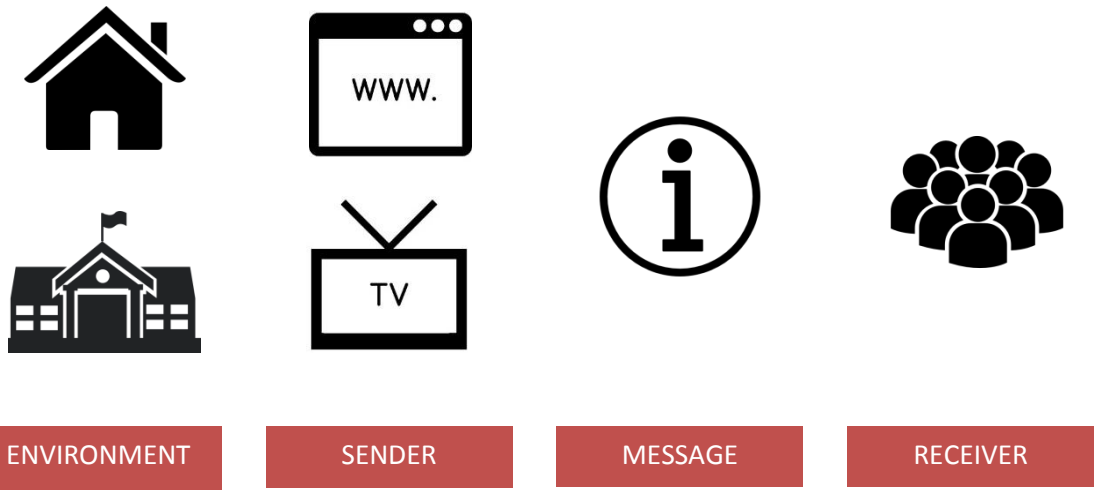


Figure 8: Communication roles

The **environment** is the place where the communication takes place. In order to send the message in a clear way it is important that this happens without (too many) distractions from the surroundings. Any distraction that happens while sending the message will cause a loss of the info that the recipient is supposed to receive.

The **sender** is the person who sends the message, in this case the sender would be a TV screen or a webpage. It is important that the sender has a clear structure and can communicate in an understandable manner.

The **message** is all the information that you want to give. The given information should be well structured and precise. A vocabulary that isn't too difficult should be used, so that everybody can understand what you are trying to say. When expressing something it is an advantage to make use of images to clarify what you are trying to say.

The **receiver** is the person who receives the message, in this case the students of Novia. When the recipient receives a message he is likely to give a reaction. It is considered to be important to listen to the reaction that recipients have. This suggests that some sort of feedback link is needed on the webpage.

5.1.2 Implement design using psychology

This section contains a number of aspects to consider in the design of a Web site, taking into account the behaviour and reactions of people. The information presented below is based on the study of the behavioural psychologist Susan M. Weinschenk [12], expert in the design and user experience fields.

5.1.2.1 SEE

What is the main point of a screen

People tend to look at the screen in the same way as when they read. That means that if they read in a language that moves from left to right the first thing they are going to look at is the left side of the screen. If they read from right to left, the other way around. However, normally people don't look at the top corners because they assume this space is usually used for irrelevant information such as logos or names (cf. Figure 9).

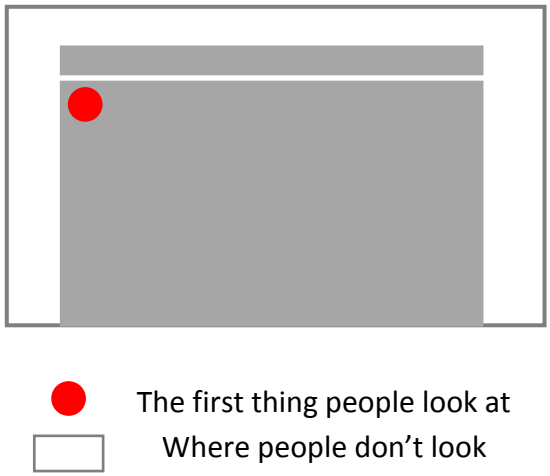


Figure 9: Different points of the screen

Affordances

The affordance is the way an object communicates with the user. It reveals what to do with the object in order to use it properly. Well-designed objects or interfaces are those that just by taking a look, the user knows how they work (cf. Figure 10).

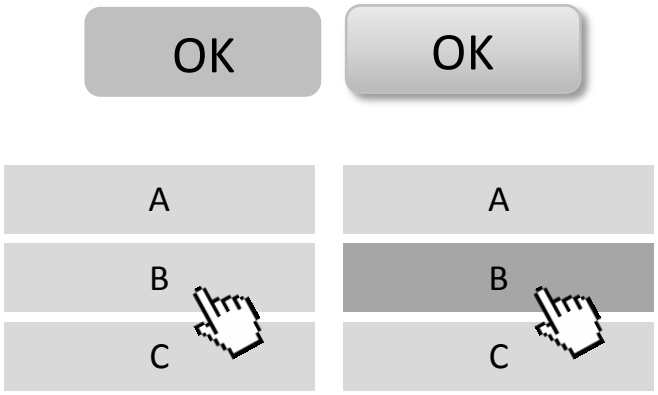


Figure 10: Bad and good affordances

Chromostereopsis

Chromostereopsis is a visual illusion in which the depths of the lines of different colour combinations are seen in two dimensions, making reading hard and tiring for the user (cf. Figure 11). Thus it is very important to keep this phenomenon in mind during the design of an interface.

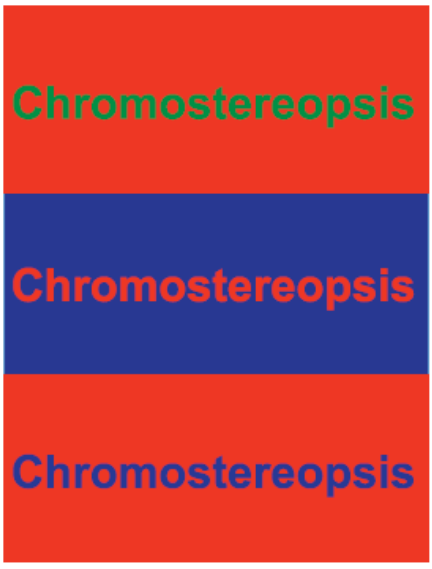


Figure 11: The main colour combinations of chromostereopsis [13]

Colour and text

When combining text and colour you have to take into account that not all the combinations can be done. Depending on the chosen background, there will be a most suitable type and colour of the text (cf. Figure 12).

Figure 12: Different examples of combinations of colour with text [14]

5.1.2.2 READ

Capital letters

Uppercase letters are not harder to read than non-capital letters. However, as people are not used to reading them, they will slow them down. Thus the use of capital letters should be restricted to headings and other elements to draw people's attention.

Reading vs. comprehending

Nowadays there are tools that calculate the readability of a text. An example of this is the Flesch-Kindcaid formula, which calculates both reading ease and grade-level and is available as a free online service [15].

Line length

Although tests show that we read faster with a longer line length (around 100 words), we prefer reading shorter line lengths (around 50 words). In addition, we prefer to read multiple columns better than a single wide column. However, this last option takes us less time to read through.

5.1.2.3 REMEMBER

How much do people remember

The number of items a person can remember at once will define the optimal number of tabs on a screen, data or categories. George Mandler (1969) developed a graphic that shows the number of items that a person can remember related to the percentage of items remembered (cf. Figure 13). This shows that the more items a person remembers, the more likely it is that he will forget them.

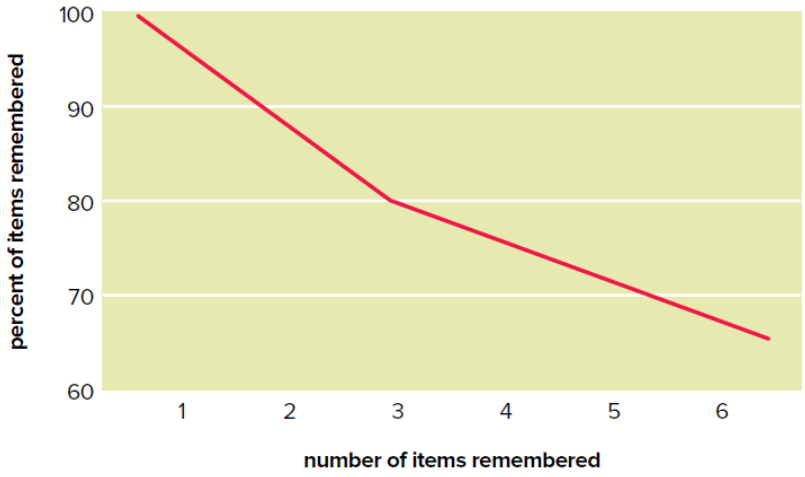


Figure 13: George Mandler's remembering graphic [12]

5.1.2.4 THINK

Progressive disclosure

Progressive disclosure is an interaction design technique that is used to maintain the user's attention and to improve the usability of the website by providing just the information needed at the moment. That means that the primary content appears immediately on the main page and is very easy to find (cf. Figure 14). Then the user has the chance to select different options depending on the information he or she is interested in. In this way we avoid overwhelming the users and we direct the information according to their needs.

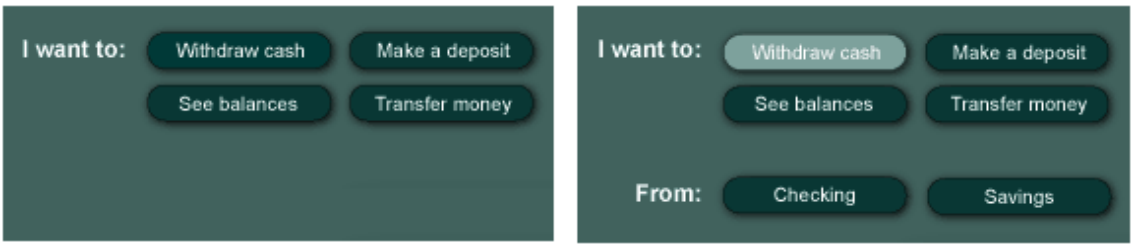


Figure 14: Example for progressive disclosure (ATM touchscreen) [16]

Mental processing

There are three basic loads that you can give a person and some are more challenging than others, as each one uses a different amount of mental resources. It is very important to bear this fact in mind while designing a webpage, to try and avoid the maximum mental resources as possible.

Different loads organized from most tiring to least:

Mental processing

+

-

- Cognitive (remembering)
- Visual (looking at something on a screen)
- Motor (pressing a button or moving a mouse)

Processing information: Stories

To make people easily understand given information, stories can help a lot because they are the natural way in which people process information. By making use of stories the information will become more understandable, interesting and memorable.

Examples

People find it more difficult to follow explanations rather than examples. So when making them learn it is important not just to give them the information, but also to show it to them. At this point it is very useful to use pictures or other visual media.

5.1.2.5 FOCUS ATTENTION

Attention in selective

If people do not have a goal while taking a look at a webpage, they will unconsciously scan for certain things such as their own name or messages about food, sex and danger. On the other hand, if they know what they want to find, they will just focus their attention on this thing only and ignore everything else.

Perceiving information

Before paying attention to something, people have to perceive it. To notice this stimulus we use our senses: sight, sound, smell, touch and taste.
Depending on whether there is a stimulus present and whether people detect it or not, there may be given different situations (cf. Figure 15).

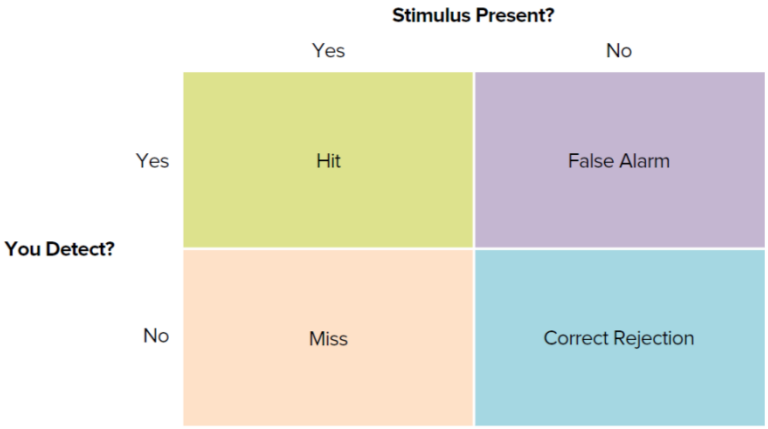


Figure 15: Signal detection theory [12]

5.1.2.6 MOTIVATION

Rewards

People get motivated if there is a reward at the end of the process (cf. Figure 16). For this to actually happen, the reward must be something that people really want. For this reason it is very important to study the target of the webpage so that we know their interests.

Figure 16: Example for a reward: Additional storage space on Dropbox for inviting friends [17]

Unpredictability

Unpredictability and uncertainty make people more interested. Not knowing when new information is going to arrive makes people addicted to seeking it. A clear example of the use of this resource are the social networks.

Laziness

Do not expect people to make big efforts. They will do things spending as little energy as possible. They will only use shortcuts if they are easy.

5.1.2.7 SOCIAL

Imitations and empathy

Our brain contains mirror neurons whom are in charge of making us react by imitation and empathy. For this reason, if you want to make people do something, then show somebody else doing the same thing.

Synchronous

People need synchronous activities during online interactions as well as in real life. That is because doing things together and having things in common brings people together. In online interactions this is difficult to achieve. However, it is very important to include any kind of synchronous activity into the product such as live video streaming.

5.1.2.8 FEEL

Anecdotes vs. data

Reading an anecdote is more persuasive than reading data. Therefore, in addition to data, anecdotes should be used to make people process information deeply. People will remember it longer and they might create an emotional connection.

Surprises

For most people a surprise generates a good feeling. In addition, surprises are a good way of capturing attention since they provide unexpected interactions.

Difficulty

People enjoy and feel better if the goal to achieve is difficult. That makes them feel proud of themselves.

5.1.2.9 MAKE MISTAKES

People make mistakes. Therefore when making the design of a webpage or display it is important to prevent people from making mistakes, but also to give them tools to solve problems caused by errors.

5.2 Brainstorm

A brainstorm session was held with all five team members. The goal of the session was to generate ideas that may not relate to the subject but can be used for the project. We started brainstorming by reciting words that for us were related to the project. There were no limits so the results were very broad as you can see below in Figure 17.

Figure 17: Brainstorm in group

Subsequently the generated words were divided into different categories that would later help us create a Mindmap (cf. Figure 18).

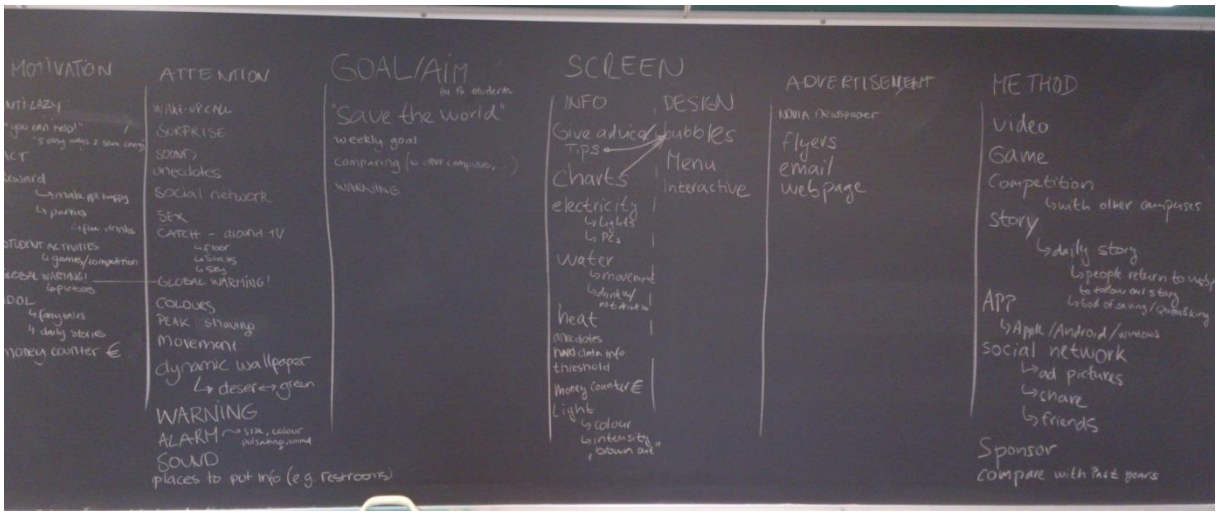


Figure 18: Categorized brainstorming results

Before finishing the Mindmap we developed more ideas and put these into the Mindmap. The Mindmap generated the ideas of making a questionnaire and a focus group which is shown in Figure 19.

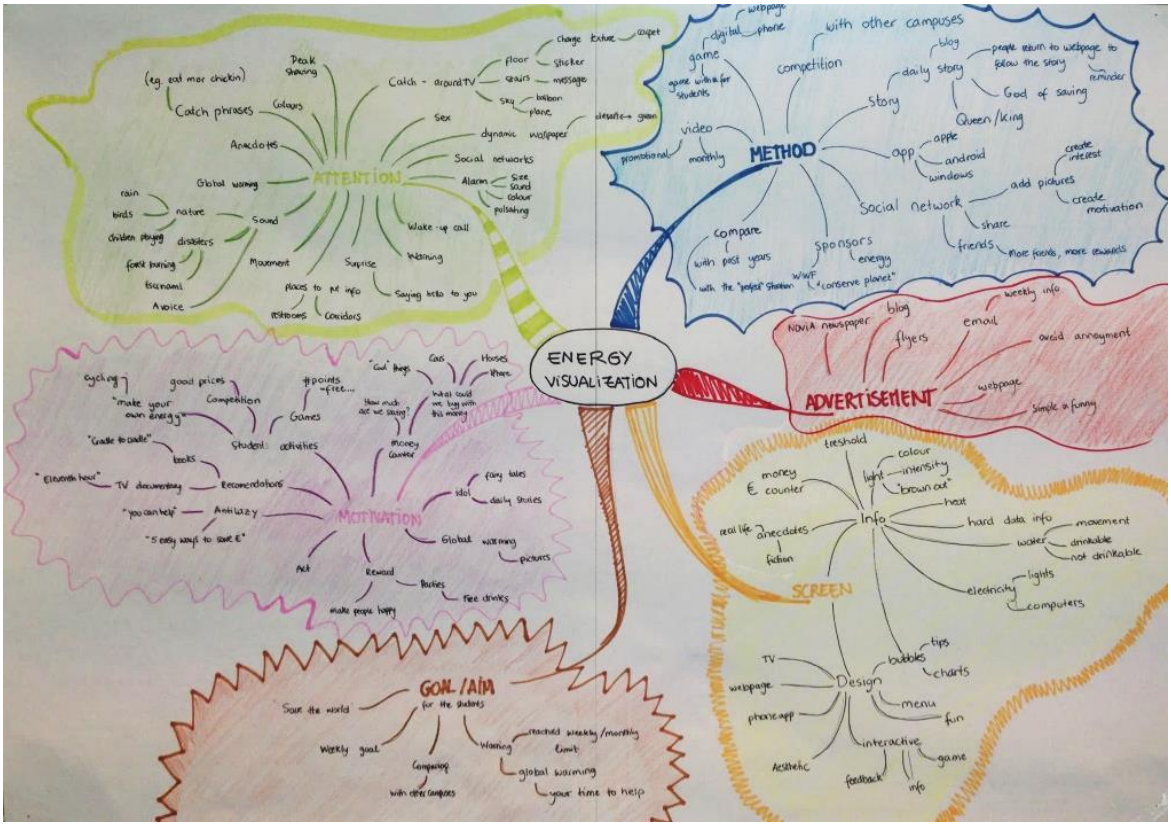


Figure 19: Brainstorming results in Mindmap

5.3 Questionnaire

The project team decided to make a questionnaire to know more about the interests of Novia's students. That would make it is easier to focus the design effort into the right direction.

So, as part of our research about the students studying at Novia we sent this questionnaire to all the students in all campuses. The purpose of this questionnaire is to find out more about Novia's students, e.g. how much do they care about energy usage and are they motivated to make changes. Furthermore, it has to give us some information about how to design the display and what information to show.

After keeping the questionnaire open for two weeks, 311 students between 19 and 58 years old have answered it, giving a sample of a respectable size, which can be considered reliable enough for our interests.

Summary

The first three questions show information about the sample. If the data acquired matches the known data for the population, it can be assumed that the questionnaire can be validated. As can be seen in figure Figure 20, Figure 21 and Figure 21 , the population consists of a mix around fifty percent of males and females, the main mother tongue is Swedish (around 75%) followed by Finnish and a residual amount of English speakers and other languages.

It can be noted that the provenance of the vast majority of students are found is Vaasa, covering almost 50% of the sample. This is good for the interests of the project, because for the moment it is focused on implementing the PowerVision system in theNovia's campus in Vasa (Campus Wolfkavägen). It also provides information about other campuses regarding their interests and thus, facilitating further implementation of the system in all Novia's campuses.

After checking the data regarding the population it can be assumed that the sample is representative, and serves the purpose of the study.

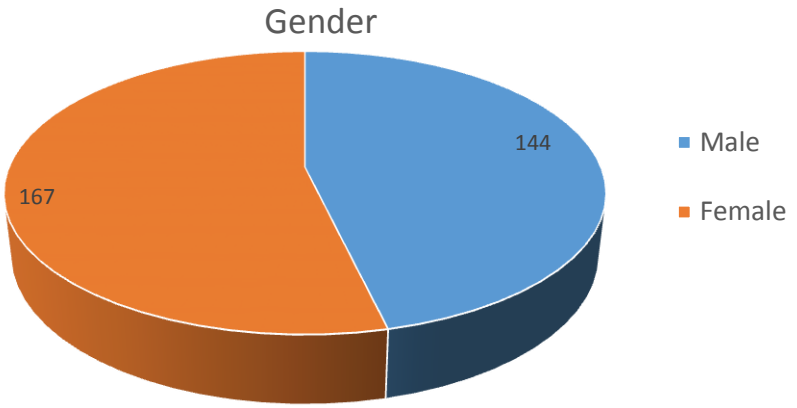


Figure 20: Question 1 - Gender distribution of the sample.

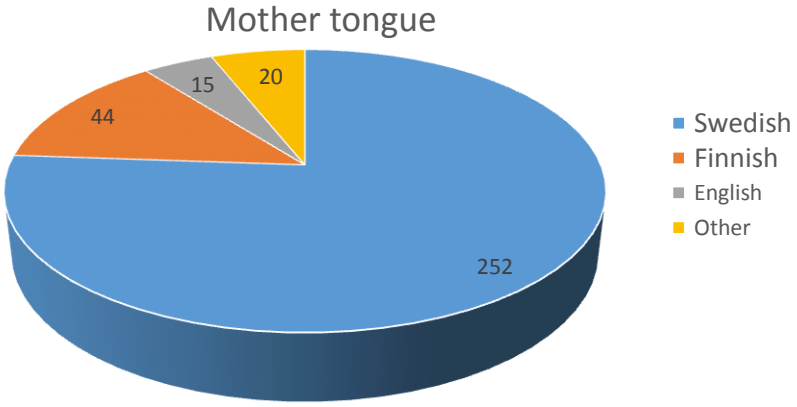


Figure 21: Question 2 - Mother tongue distribution of the sample.

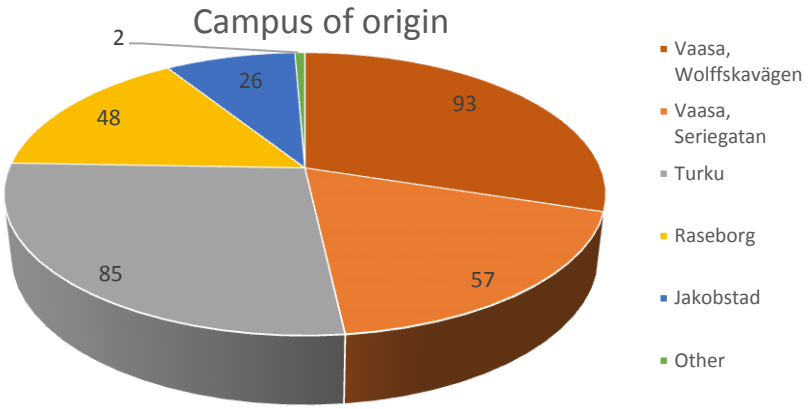


Figure 21 :. Question 3 - Campus of origin of the sample.

The followong questions are focused on obtaining important data regarding students' interests. In this way we can avoid orienting the display system to a non-working solution, and strengthen the points of the display that agree student's interests to boost the impact of it.

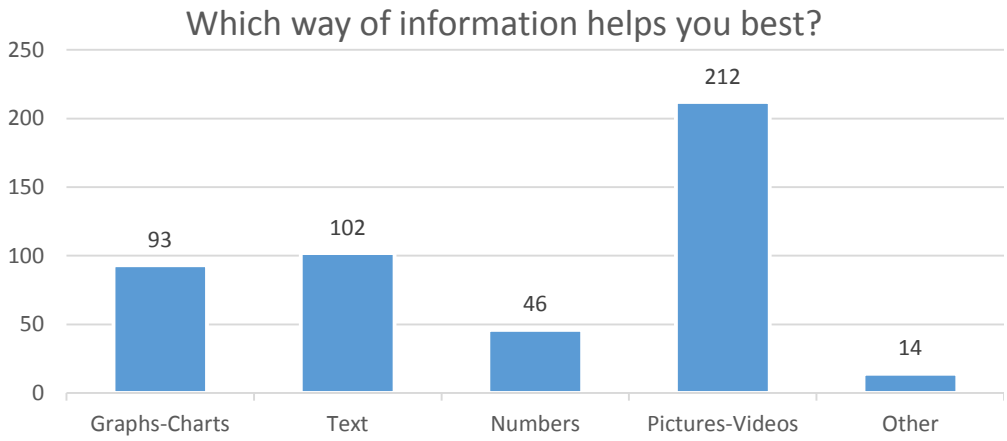


Figure 22: Question 4 - Which way of information helps you best?

As can be seen in figure Figure 22, students are mainly attracted by data presented in form of pictures and videos. Also showing data in form of graphs or charts and information in text seems to be interesting. According to the results, reading information (numbers and text) is only half as desirable as presenting it with graphical methods, so the results show that the project team has to focus the interface on a more graphical type instead of presenting data only with text and numbers.

Ratings

The next questions are categorized from one to seven (one being the lowest and seven the highest) and are thought to help the team realize about awareness of the students' energy usage, their interests and the predisposition to react to some kind of information.

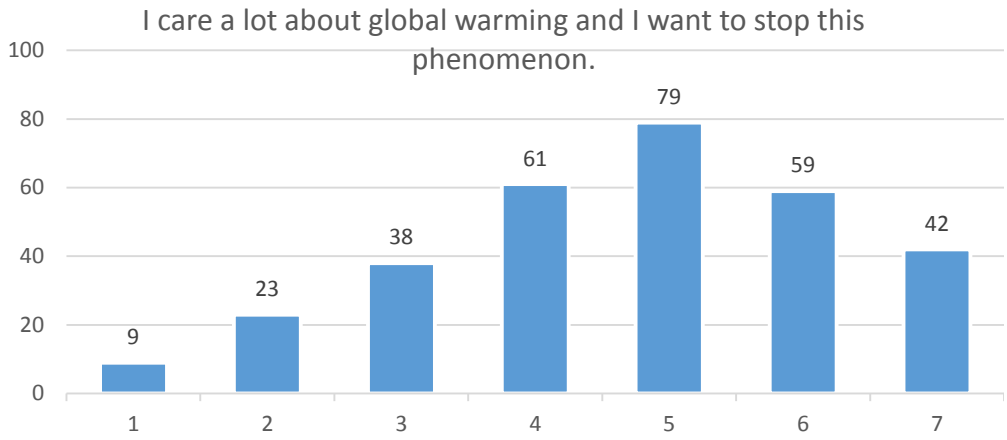


Figure 23: Question 5 - Global warming awareness.

The first question (Figure 23) inquires about the awareness of the global warming phenomenon. Looking at the results, the mean is 4,68.Based on this figure it can be considered that no further action is needed to make students aware of global warming. Some reinforcement of the message can be included using indirect ways when communicating information.

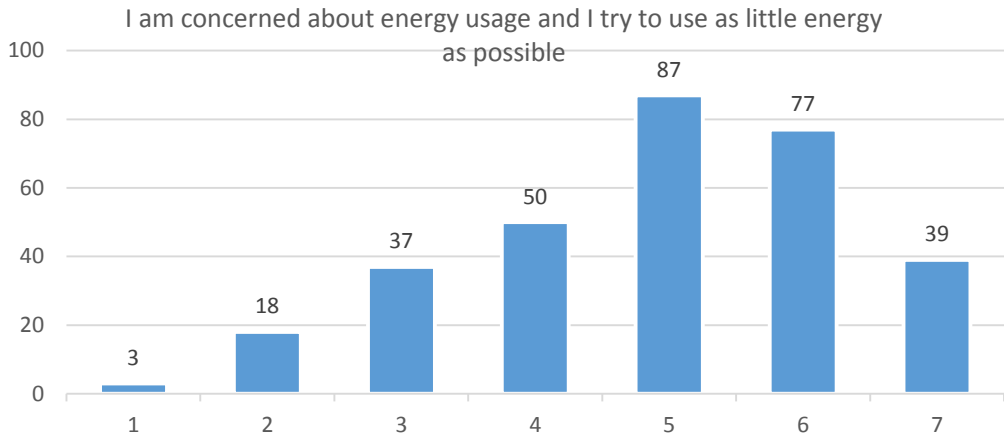


Figure 24. Question 6 - Energy usage awareness and habits.

Next question is about the energy usage awareness and habits of the students (Figure 24). The average is 4,88 which indicates that the project team doesn't need to spend a lot of effort trying to create awareness of the problems that bad energy management can cause. Nevertheless it is positive to reinforce the message.

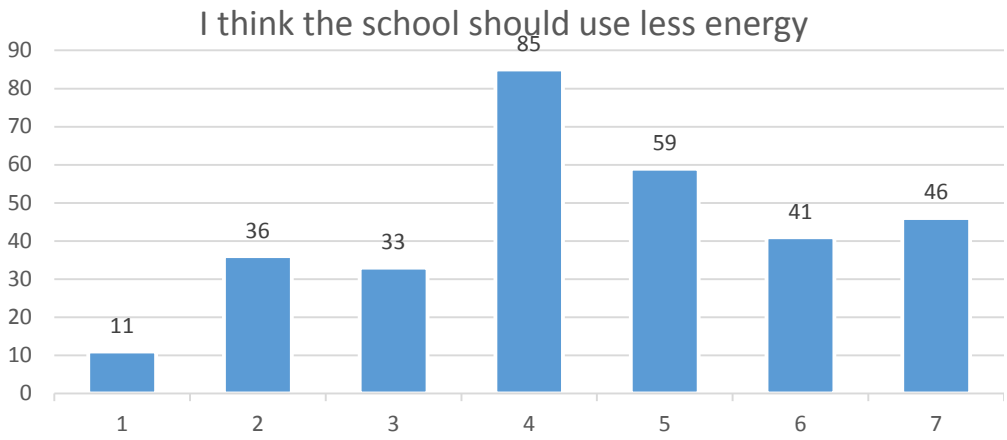


Figure 25: Question 7 - Opinion about energy usage of the school.

In Figure 25 we can see the opinions of the students regarding the energy usage of the school. The average is 4,45 which indicates that students think in a moderate way that Novia should reduce the energy usage. This result, has to be considered with care because students don't really know the amount of energy that Novia uses and in which way. Their answers are purely based on the perception they have regarding energy usage. The disparity in the answers also indicates that it would be good to give students a more accurate information regarding energy usage.

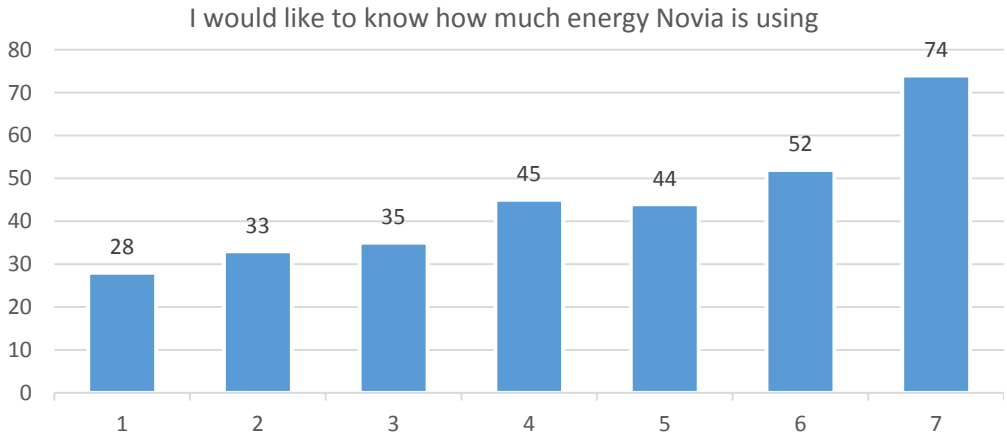


Figure 26: Question 8 - Interest in knowing more about Novia's energy usage.

Figure 26 the interests of the students regarding Novia's energy usage can be seen. The mean is 4,58. The distribution clearly states that students want to know more about how much energy is Novia actually using. The project should focus on giving them answers to this question, giving enough information without falling into the error of overcharging the display system with useless data.

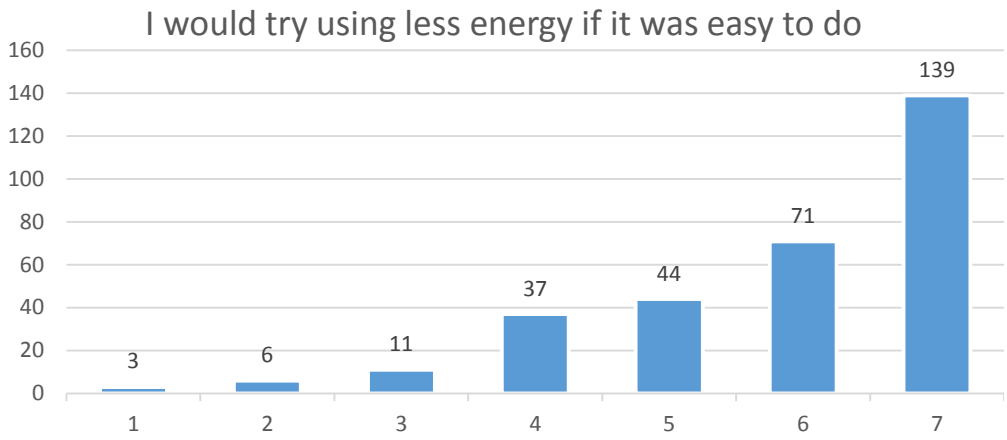


Figure 27: Question 9 – Will to reduce energy usage if help is provided.

In Figure 27 it can be clearly seen that the vast majority of Novia students are motivated to change their energy management habits if they are provided with easy ways to do it. It should be one of the main goals of the project to provide the students with ideas of how to save energy.

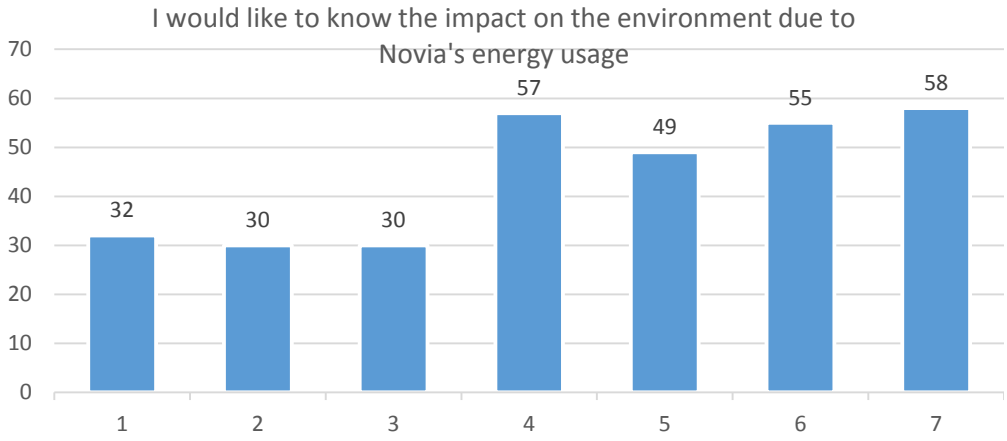


Figure 28: Question 10 – Will to have information about impact due to Novia's energy usage.

As for the wish of the students to know more about the impact on the environment due to Novia's energy usage (Figure 28), the results mean is 4,47. This indicates that the students are only moderately interested in this kind of data. Keeping in mind the goals of the project, creation of awareness of energy usage, it should be a good point to focus on to help students realise how their actions affect the environment, and thus, motivate them to improve their energy management policies.

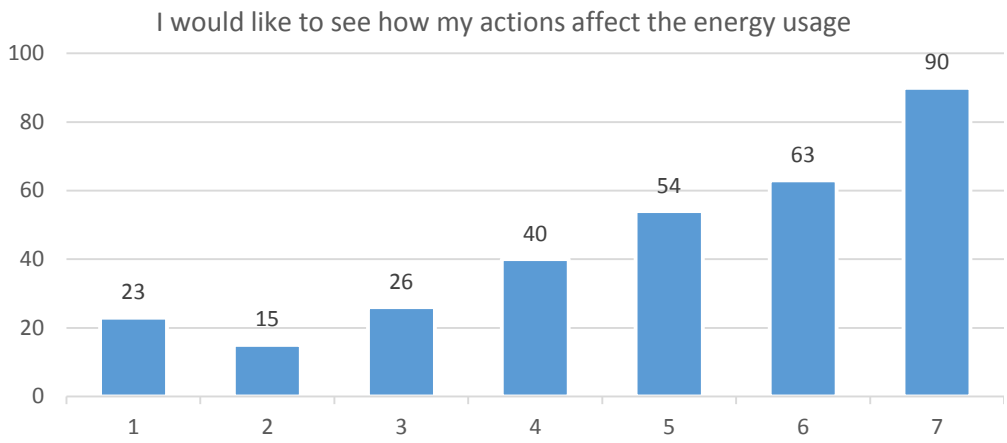


Figure 29: Question 11 – Will to see the impact of the actions taken.

Regarding Figure 29, it can easily be seen that students are eager to see how their actions affect the energy usage. For this reason the project team has to focus on coming up with a system capable of showing real-time data (or close enough to real-time), and compare them with stored data. In this way students may be able to see how their actions affect the real the energy usage, and how the improvement has been in comparison with their previous behaviour.

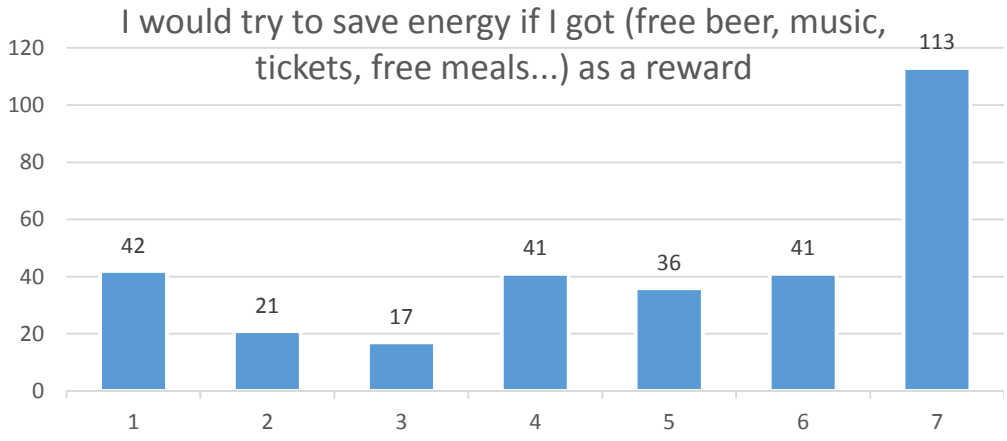


Figure 30: Question 12 – Motivation due to rewards.

In Figure 30, we can see that if students are provided with some reward, they are more prone to help reducing the energy usage. It is the task of the team to come up with some kind of reward that is suitable to give to the students.

5.4 Focus group

The other tool that has been used to learn about the requirements of the students is the Focus Group. We bring together a group of people to discuss about a specific topic led by a moderator.

5.4.1 Identify participants

Targeting criteria

The reduction of energy consumption on all Novia's campuses depends on the behaviour of three main User Profiles:

- **Students** from all the degrees taught on all Novia's campuses, mostly aged between 18 and 30 years. They are mostly Swedish speaking Finns, and the rest is a minority of exchange students.
- **Teachers:** specialized in particular fields.
- **Office workers:** engaged in clerical or administrative work making Novia run well.
- **General workers:** cleaning staff, the janitor and kitchen staff.

Inclusion and exclusion criteria

INCLUSION

- Students from different degrees and backgrounds.

EXCLUSION

- Teachers, Office workers and General workers aren't included in the Focus Group because this project is focused on the students.
- Exchange students because they don't spend long periods of time on the campus and are therefore irrelevant to this research and the project.

Gathering participants

The focus group session with the participants will take place on a Novia Campus in Vaasa. To make the participation in the Focus Group more attractive to the participants, they will be given a 'presentation letter' with all the information about the session. In addition, their participation will be thanked for with snacks and a coffee.

5.4.2 Presentation letter

POWER VISION

FOCUS GROUP

Do you care about the environment?

Would you like to help reduce Novia's UAS power consumption?

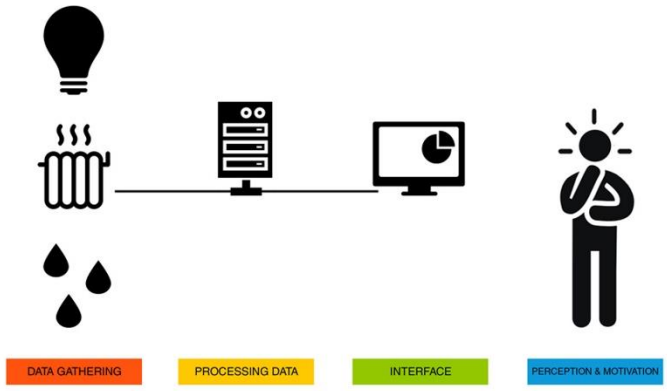
TAKE PART OF THE FOCUS GROUP!

WHO ARE WE?

We are a group of exchange students, with different backgrounds, participating in the European Project Semester here at Novia UAS. The aim of this course is to work with a team in a project, simulating a real working environment.

DESCRIPTION OF THE PROJECT

The aim of this project is to develop a visual system that alerts about the effects of an abusive energy consumption, which could work as a backbone for implementing energy efficiency for all of Novia's campuses.



AIM OF THE FOUS GROUP

A Focus Group is a technique that allows gettig to know and study and study the reviews and attitudes of a specific target. So a meeting of a group of people is organized to discuss about the topic of study, led by a moderator.

DATE: 20th March 2014
LOCATION: EPS Room
TIME: 16.00 h

General details of the Focus Group

Date	20th March 2014
Performing space	EPS Room, F4202
Duration	Max. 60 min.
Placement	Vaasa
Record type	Video and audio
Moderator	Loulou Dockx
Project	PowerVision
Aim	How to attract the interest of students and how to capture their attention.

Attendees

F1 Age: 30 Gender: Female Degree: Industrial Management & Engineering Year: 3	F2 Age: 22 Gender: Male Degree: Industrial Management & Engineering Year: 3
F3 Age: 20 Gender: Female Degree: Performing Art Year: 2	F4 Age: 22 Gender: Male Degree: Electrical Engineering Year: 2

5.4.3 Script Focus Group

Beginning of the session (between 5 and 10 min.)

(When all the participants are in the classroom, they will be given a post-it and the informed consent so that they can write their names and degree programmes. During this time they can enjoy snacks and coffee)

Welcome everybody to this Focus Group about the creation of a visual system that could work as a backbone for implementing energy efficiency at all of Novia's campuses. I will be the moderator of the session. My name is Loulou, I am a Belgian exchange student participating in the European Project Semester.

First of all, I would like to thank you, for attending this meeting. To begin with, I would like you to introduce yourselves.

(Introduction of the participants, the moderator can ask some questions to the participants.)

Project's presentation (between 5 and 10 min.)

Now that we know each other, we will present our project to you. The aim of this meeting is to talk and discuss about the energy use on the Novia Campuses and how it can be reduced by creating a visual system (web page and screens around the campus). We need your collaboration because we would like to take all your requirements and opinions into account, as you are the main factor to achieve this goal of creating awareness. Do you care about the environment? Could you contribute to the design of this new system and make it real?

This kind of meetings or Focus Group works like this. In order to discover necessities, feelings and to investigate the valuable information that the participants can bring us, we ask you to openly express your opinions about the subjects that we are going to suggest. Any contribution will help the development of our project. There are no good or bad reviews.
For this Focus Group to work it is very important to respect the right to speak. If this standard is not followed, the moderator will take action.

I will also like to inform you that this session will be recorded by camera for further review. On the other hand, the data collected will be only used as a part of our analysis. For this reason, we preserve the confidentiality of all the participants. That is why we will ask you to sign the informed consent.

(Sign informed consent)

Debate (aprox. 30 min)

If you don't understand the question, please don't hesitate to ask more!

a. Motivation

- Can you think of three things that motivate you to do something (e.g. ask for the things they like to do and why they like to do them)?

- Is it motivating for you to see the environmental impact of the energy production?

- How would you react if we made this project into a small competition between the different campuses, about trying to and reduce the energy usage? What do you think?

b. Design

- Which way do you prefer to receive information? Ways of info display: graphics, numbers, pictures, videos, text, etc.

- How do you prefer to receive the first basic information? Do you prefer a lot of info or rather a little?

- What information would you like to get about the energy consumption on the Novia Campuses?

c. Interests

- Where do you get information (on Campus) about events?

- How could we get you aware of energy consumption?

- We would like you to think about an advertisement you have seen somewhere, the first one that jumps to your mind. Tell us why you have remembered this particular advertisement.

- Would you like to see a comparison between different values? E.g. the values we have now and the values we should have, or the values from the previous years, etc?

Comments and conclusions (between 5 and 10 min.)

To sum up, we would like you to do one last exercise. Now that you have talked a lot about the display and the interface of the new systems, could you try to draw it? We are very interested in how you imagine it!

This is the end of the session. Your effort has helped us a lot. Thank you very much for your participation.

5.4.4 Conclusions

a. Motivation

- What motivates the students to do something

  - Getting better in something.
  - Having fun.
  - Beneficial things that makes them feel better (health and strength).

- Seeing the difference between the before and the after (e.g. losing weight).

- Environmental impact of the energy production

This subject is very motivating for them. When they see some of the negative consequences of this either in photographs or daily life situations, they really feel the necessity to improve the situation.

They gave a lot of examples of these negative situations:

- Pictures of melting glaciers (comparison between nowadays and the past).
- Dead coral reefs.
- Walk through Vaasa when the snow is melting and see all the trash people have been throwing away.
- Melting snow in Vaasa due to climate change.
- Black snow from a coal plant.
- Smog in Shanghai.
- Smog visible from the airplane while plane taking off or landing.
- Plastic waste in the ocean.

- Competition between campuses

They think this is a very good idea, as this would make them start doing something. It would be motivating even without rewards as you still feel good and proud.

They also gave the idea of not only competing between campuses, but also between buildings.

As a reward they suggested a newspaper advertisement for the winner; a patch for the party clothing of the student organizations.

b. Design

- Ways of receiving information

- Email: even though they are not sure whether they read the email, they think that it creates awareness anyway.
- Something in hallways: posters.
- On the TVs but finding a way of making people look at the screens.
- Facebook.
- In the elevator (e.g. “using this elevator, you are making a polar bear sad”).
- In the printer (e.g. “printing a paper kills a tree”).
- WAYS: making people scared, happy/sad polar bear, giving bad conscience.

- How to receive information

  - SCREEN: Not too much information, keep it simple, overall picture and writing down the web page to find out more information (e.g. “more information at www. …”).
  - WEBPAGE: Clickable images for more detailed information for those interested. Different options for different campuses (different information about how energy usage affects the subjects studied there).
  - POSTERS: Posters with the QR code so that people do not have to remember the web site. Posters showing the comparison of using the elevator or the stairs (e.g. sad polar bear in the elevator, happy polar bear in the stairs).

- Information displayed

  - How much kilograms of something is equal to the amount of printed paper printings. This should be clearer than giving a number in kWh, as not everybody can understand this data.
  - Figures of other campuses, at least daily updates.
  - Electricity, paper, food waste (by weighing bags), etc.

c. Interests

- Where do the students get information

  - Posters
  - Facebook

- How to get them aware of energy consumption

  - Going from classroom to classroom during lessons (choose the most interesting lesson, there will be more people, and interrupt it).
  - Lots of posters with easy messages at places where you usually stand still anyway (elevator or printer).
  - Lots of questions like “how much energy did you use today?”
  - Keep it simple and fast.
  - Language: Swedish would be more familiar and get more attention. In Technobothnia not all the students study in Swedish, so English would also be good. It is not a good idea to use all three languages.

- Advertisement that caught their attention

  The Volvo advertisement with Van Damme (cf. Figure 31). They suggested to do photomontage with other famous people such as Chuck Norris.

Figure 31: Advertisement recalled by the group [18]

Other ideas:

- Poster in the elevator, on the mirror. A whole cut out where you see your head in the mirror and below: “Environmental thief”, “abuse”, “wanted”, etc.
- Jokes, current jokes, funny, easy to watch, easy to take in.
- Constitute a one day or a few hours without electricity, to really see how much we take it for granted and depend on it, to raise awareness.

- Comparison between different values

They all agreed it was a very good idea.

Examples:

- Comparison between campuses.
- Something international such as comparing students in Vaasa with students in other countries.
- Differences between seasons.
- Comparing this year with the previous year or with 10 years ago.

d. Their vision

Finally, the session ended up with an exercise to discover how the participants imagine the new display cf: Figure 32 and Figure 33.

Figure 32: Draft of group A

Figure 33: Draft of group B

5.4.5 Implementation of the focus group's suggestions

In the following, an overview is given about which of the findings of the focus group were implemented in which way.

Motivation:

- *Having fun*: possibility to leave message on the webpage about "how did you save energy today?"
- *Feeling better*: showing images of nice sceneries and nature (alternating with information)
- *Competition, seeing differences*: not possible yet, as there is no data basis about past consumptions and about consumptions of other Novia campuses
- *Rewards*: not implemented, as there is no data basis yet to decide whom to reward
- *Showing the environmental impact*: not implemented; could be done by giving equivalences for the climate impact of consumption figures or by showing images
- *Making people feel bad, creating bad conscience*: not implemented (would be possible by showing the environmental impact)

Communication channels:

- *Going from classroom to classroom during lessons to advertise for the system*: to be done once when the system is up and running
- *Email*: to be done once when the system is up and running
- *Posters*: prepared
- *Information screens*: implemented
- *Webpage*: prepared
- *Facebook page*: implemented

Design and information:

- *Keep it simple*: implemented
- *Different information for different campuses (on webpage)*: no different contents produced yet
- *Giving equivalences for consumption data*: implemented
- *Figures of other campuses*: not implemented on the screen, but prepared for webpage
- *Consumption of paper and food(-waste)*: not implemented
- *Questions like "how much energy did you save today?"*: implemented only on posters
- *Jokes/funny things*: implemented only on posters
- *Comparison with other countries*: not implemented
- *Comparison between different seasons*: implemented in the form of yearly charts

6. PVE – Requirements and Wishes

After doing research about the *mind and matter* of Novia's students the conclusions were used from both the questionnaire and focus group to create something that is called a PVE. The PVE is used to set guidelines for the design process of the webpage. PVE is originally a Dutch word: Pakket van Eisen en Wensen, which literally means package of requirements and wishes.

The requirements are all the parts needed in the product in order to make a good product. The wishes can be seen as extras, i.e. they are not necessary to make the product but they might give the product certain advantages.

We have divided our system into three parts; the TV screen, a webpage and posters. These three parts all have their own goals and functions in the system. Therefore the PVE will need to be divided into three parts in order to define them as well as possible.

TV screen – to give some information about energy use and create awareness
Webpage – the purpose of the webpage is mainly to give more detailed info
Posters - to create awareness

6.1 General (for TV screen, webpage and poster)

Requirements

Language

- The main language will be English. There is a time limit so we will probably not spend time translating certain things into Swedish.

Wishes

Language

- Swedish alternative
- Attractive

Campuses

- To make a clear difference about the campuses and their energy use.

6.2 TV screen

Requirements

Displayed info

- The info displayed on the TV screen should not be too detailed. The receivers will use much time to look at the screen, so only basic information should be given. Furthermore we should not give too much info at the same time. Spreading the info over several “pages” would be good.
- A quick sketch was made as to what the screen could look like, which can be seen in figure X.

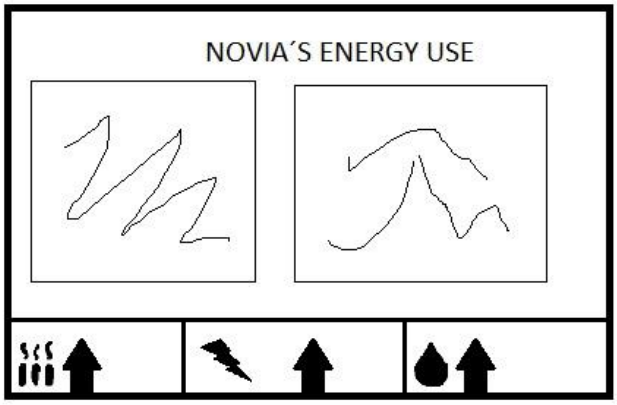


Figure X

    - The screen will contain three figures that represent the use of heat, electricity and water at all times.
    - The screen will contain a heading, the logo and the real life time at all times. The time will give the impression that the given data is very up to date.
    - In the centre of the screen there is place to show things such as:
        - tips on how to save energy
        - pictures to capture attention; before and after
        - graphs about the energy use
        - equivalences
        - facts
- Logo

Wishes

Real life data

- The data gets updated every hour

6.3 Webpage

Requirements

First of all the webpage should look good and attractive so that people have a rather pleasant feeling when visiting it.

Pages

- HOMEpage
  - The homepage of the website should consist of basic information. For those interested, clicking on certain images or graphs should give them more information.
  - The URL of the webpage should be something simple, so that people can easily remember.
  - Table of contents. This will make the navigation on the webpage easier.
- ENERGY page; giving info about the energy use on the campuses of Novia
  - Water
  - Heat
  - Electricity
- INTERESTS; This page should give information in all kinds of ways
  - Tips
  - Equations
  - Posters
- Info ABOUT project page
  - This page should give info about the project we have worked on. Why this webpage is created, under what circumstances it has been created, etc
- Webpage
  - clickable images
  - clickable graphs
    - more info when clicking on certain picture or graph

Information: The webpage should display info on two levels.

- The first level is the basic info level, which is easy to understand for everyone. However, this level should be capable of displaying more info than displayed on the screen. This is easily done by explaining a little more about the graphs etc.
- The second layer gives more detailed info for those who are really interested in the graphs. It gives more technical info.

Wishes

Pages

- HOME page
    - Should contain a button to change the language of the website
    - Should contain a button to change the campus
- FUN
    - Competitions between
        - Campuses
        - Buildings + descriptions of the different buildings, number of students
        - Student unions
    - Fun facts
- Link to facebook, being able to “share” with friends.

Buttons; in order to make navigation through the webpage easier.

- Feedback; important to get the message across.
- Search
- Capability to change locations (between the different campuses).
- Comparisons between different
    - Campuses
    - Seasons
    - Years/months/…

Saving money

- Using the saved money for
    - Events
    - Free meal
    - Student union
- Having a counter that states the amount of money saved.

6.4 Posters

In order to have visitors on our webpage it has to be made sure that people know that the page exists. Creating awareness can be done by using

- catch phrases
- QR code (to webpage)
- stickers
- photos

7. Production of content

7.1 Images

Images are used for the following purposes:

- Attracting attention and curiosity (mainly on posters)
- Giving positive impressions, creating identification with the environment (e.g. photos of beautiful sceneries)
- Creating emotions: Polar bears on melting ice, images of waste and natural destruction (however, it turned out difficult to be free-to-use “doomsday images”)

Illustrating text contents (e.g. photos of solar thermal collectors)

7.2 “Creative Commons” licenses of images

An illegitimate display of copyrighted images on the monitors inside the Novia building would probably not be noticed by the rightholders, but the use of images on the website requires solid licenses. As the definition of an educational vs. commercial use of pictures is unclear (advertising on posters could be seen as commercial use, and even the selling of goods at cost price seems to be considered commercial), only images with a license for commercial use are applicable for this project. Furthermore, the license to use unmodified images is often distinguished from the license to use and modify images (e.g. cropping or retouching).

There is a broad variety of commercial image licensers, but as the cost is often in the range of 100 euros per image, this is not an option for the majority of the used images.

One alternative is to use images that are free to use, which are mainly produced by private individuals or public servants. These images can be easily found by conducting a Google search for images, using the options “Search tools” - “Usage rights” - “Labeled for reuse with modification”. Most of the search results are hosted on Wikimedia and Flickr, and are free to use under the Creative Commons (CC) license. Besides, categorized images can be found directly on http://commons.wikimedia.org.

Different Creative Common licenses

The mostly used Creative Common licenses are:

- Attribution (abbreviation CC BY): The work may be used (commercially) and modified, as long as credit is given to the original creator. The resulting work may, but doesn't need to, be licensed under any desired license.

- Attribution-ShareAlike (CC BY-SA): The work may be used (commercially) and modified, credit has to be given to the original creator. Additionally, the resulting (modified) work (e.g. a collage that contains one image with BY-SA license) has to be licensed under the same BY-SA license (or later versions of BY-SA, but not e.g. BY or BY-SA-NC).

- Public domain (also described as CC0): The work is free to use without any conditions or restrictions (this often applies to images taken by US public servants, or very old works).

- Further license types forbid commercial use (NC) or modifications of the work (ND), details can be found on http://creativecommons.org/licenses.

Modifying images

For CC license versions prior to 4.0, modifications only need to be remarked when making creative adaptions of the work, as "derivative of…" (this applies to all images used in this project). From version 4.0 on, even the cropping of a photo needs to be remarked. Besides, it is defined by the applicable copyright law of the respective country if certain changes to a work are considered as a modifications, so there is no easy way of telling if a slightly changed image needs to be remarked as derivate.

Giving attribution in different media types

There are no clearly defined requirements for giving attribution, CC only states that attribution has to be "reasonable". It is regarded "pretty good" [19] when the author, source (link) and license are named, e.g. "(Derivate of) Photo by tvol / CC BY" as a link to the Wikimedia or Flickr page where the photo (and details on the license) can be found. The position is ideally directly at the image, but it is sufficient if all the attributions for any CC content used in a work are given at the bottom (or a special page) of a webpage, or e.g. at the end of a video.

For the display inside the Novia building it seems to be adequate to just provide a link to the website for further information, and on this website, a list with all image attributions should be given.

When pictures are used on posters or in emails, the attribution has to be given directly.

Licensing work made from Share-Alike content

As most of the images used in this project are licensed as CC BY-SA (this seems to be the default for Wikimedia images), it is necessary to license the (identical or modified) content under the same license. BY and public domain content can also be licensed under a BY-SA license, but not the other way round. Content may be licensed under the same

version or later versions of the BY-SA license (but not under former versions), so version 3.0 seems appropriate.

The following expression is often used at the bottom of websites or at the end of presentations or videos: “Except where otherwise noted, content on this site (in this video, respectively) is licensed under the Creative Commons Attribution Share-Alike License 3.0” (including a link to the license on the Creative Commons homepage).

However, this requires definite knowledge about which parts of the websites are maybe subject to other licenses (e.g. the templates used by the chart framework, or fonts), so it seems safer to license only the images themselves (regarding each as a separate work) by giving the statement “All images on this website which are marked as CC BY-SA are licensed under the Creative Commons Attribution Share-Alike License 3.0”. On the image platform flickr, the license is provided below each image with the text “CC BY, some rights reserved”, being a link to the corresponding license on the CC homepage.

For posters, where all the content is merged with images, it is necessary to give attribution on the bottom of the poster, and to state that the whole poster is licensed under CC BY-SA 3.0 (as the background image cannot be “pulled out” from behind the rest of the content again, but just used together with it). As it is impossible to give license details on a poster, it seems reasonable to state “Photos by Creator 1 and Creator 2. CC license BY-SA, some rights reserved.”

7.3 Explanation of energy units by giving equivalences

As most people don’t know how to interpret units like kW and kWh, it is necessary to give vivid examples for the consumption values of the Novia building. Even for people who are familiar with energy units, it is easier to take in a given comparison (e.g. “this is equivalent to the energy consumed when driving 1000 km in your car”), than to interpret an abstract figure (e.g. “1000 kWh”).

Besides, giving interesting comparisons is a good way of raising attention for the display. An illustrative image is displayed with each comparison, acting as an explanation and at the same time as an eye catcher.

In the following, different possibilities for presenting comparisons are shown:

Electricity consumption this year: 265,672 kWh
…this is equivalent to the electricity that a photovoltaic installation on the Novia building in Vaasa (300m² PV-modules) could produce within 1368 summer days.

(comment: The figures are too big, making the comparison incomprehensible. Besides, this example makes it difficult to take in the message. Firstly, the text is too long, and secondly the figures are displayed with too many valid digits.)

Electricity consumption today: 1734 kWh
=
29 hours of sunshine on the Novia rooftop

(comment: Short and easy to read, but detailed assumptions for the interested reader are missing. Among others, it remains unclear if "sunshine" means just the irradiation energy, or the electrical or thermal energy that could be produced from this sunshine.)

Electricity consumption today: 1734 kWh

Compare:
A photovoltaic plant on Novia's roof could produce every summer day: 194 kWh

(comment: This requires the observer to make his own calculations, and therefore could act as a deterrent, especially to people without knowledge of energy units.)

Based on the observations made above, it was decided to give all comparisons related to the daily energy consumption (last 24 hours), as this will facilitate developing comparisons with small, understandable figures (e.g. 8 days, not 1368 days). All comparative figures are rounded to two valid digits.

The core message is kept as short as possible. Additional information about the assumptions made is given at the bottom of the display for the interested reader, but in a small font. In that way it can't act as a deterrent, as it won't catch the observer's eye at first glance. It is only visible for those searching for additional information. On the webpage, the additional information is completed by links to information sources. The result is given in this form:

Electricity consumption today: 1730 kWh
…could be produced by a photovoltaic system on Novia's roof in 8.3 summer days.

detailed information shown on display:
(PV module surface 300 m² = 45 kWp, 194 kWh/summer day)

detailed information shown on wegpage:
1000m² flat rooftop, inclination 44°, module surface 300m²=45kWp, PVGIS (http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php): 40.5 MWh/a, 194 kWh/summerday, 14 kWh/winter day. Image: Fernando Tomás / CC BY

About 15 comparisons have been developed for both heat and electricity. They are transferred to the database and can be supplemented or corrected later on.

7.4 Tips and facts

Several tips and facts were defined which will be implemented into the system. The tips and facts will motivate students to save energy and at the same time raise awareness. As a result tips and facts about energy consumption and also about environmental care will be shown.

The team has built a list of tips and facts that are going to be randomly shown on the PowerVision display along the campuses television screens, mixed with other types of information such as actual energy consumption, pictures, etc.

In this way, students will know a bit more about what they can do to help improve the energy savings, not only at Novia, but also in their own houses.

The idea is to catch attention, and at the same time give the maximum amount of useful information. For this purpose the team has been putting effort into keeping these tips and facts short enough to fit in the screen, so that they can be read quickly in the display time given by the system. Showing them in a random and mixed pattern prevents them from becoming a boring thing to look at, and instead they can be considered as useful piles of information that you can obtain at just one glance.

7.5 Charts for the display

The charts that are shown on the display inform people about the current energy consumption, and at the same time give the possibility to compare the consumption of energy to previous hours or to previous days. The charts are kept very simple and clear to be understandable even for non-technicians. The charts will cover time intervals of 48 hours, seven days, 30 days and one year, whereas the current value is always displayed at the right most position, and the older data moves to the left with every update of the chart. Only the yearly chart will stay fixed to the period from January to December.

Only one sort of energy is displayed at a time. For the consumption of electricity, heat and water, identical charts are used with different colors for each category (electricity - yellow, water - blue, heat - red). This definition of colors is the same in every other kind of chart on the display, e.g. the gauges which are shown continuously at the bottom of the display.

It has to be noted that for lack of real data, the examples in the following figures use no real consumption values but fake (random) data.

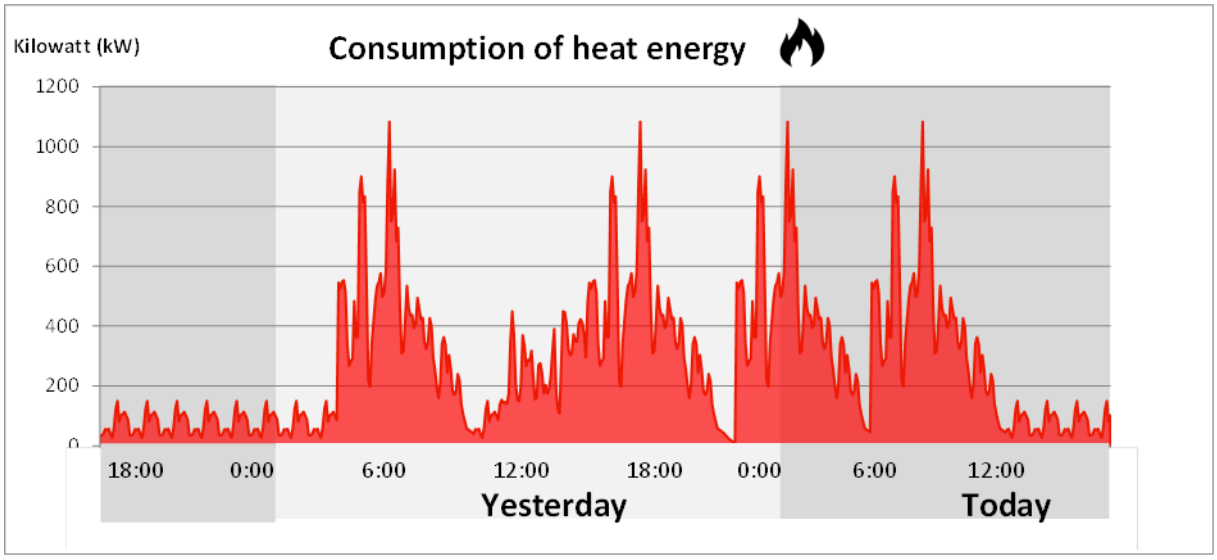


Figure 34: 48 hours chart

The chart in Figure 34 shows the consumption of heat energy (power in kilowatt; for water it would be liters per hour) the last 48 hours.
This chart was selected so that one full day is displayed in addition to the current (commenced) day. The consumption difference between day and night can be watched, and consumption peaks can be identified.

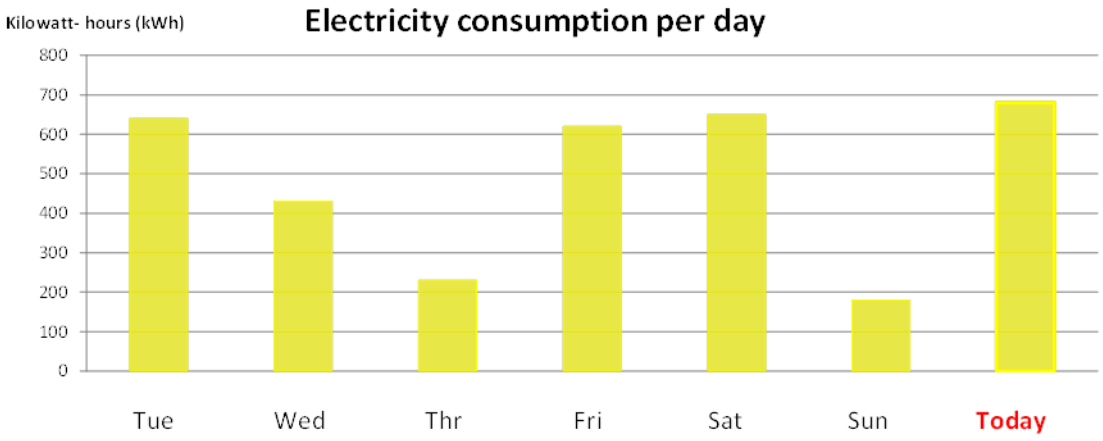


Figure 35: Seven days chart

Figure 35 shows the consumption per day over a seven day period. The used unit is here the kilowatt-hour (kWh) (for water, it would be liters). It is a unit of energy equivalent to one kilowatt of power used for one hour. A columnar chart giving daily consumption sums was selected, as a line chart displaying power like in the 48 hours chart would be too confusing.

In this way it is possible to compare very simply and clearly the consumption on previous days with the actual consumption. The weekend's days are drawn in a darker colour, so

that people can distinguish weekends and working days faster. This shows to what amount the consumption on weekends is lower than the consumption on working days.

The same design is used in the 30 days chart (cf. Figure 36). This chart gives a clear overview of the daily consumption over the last 30 days.

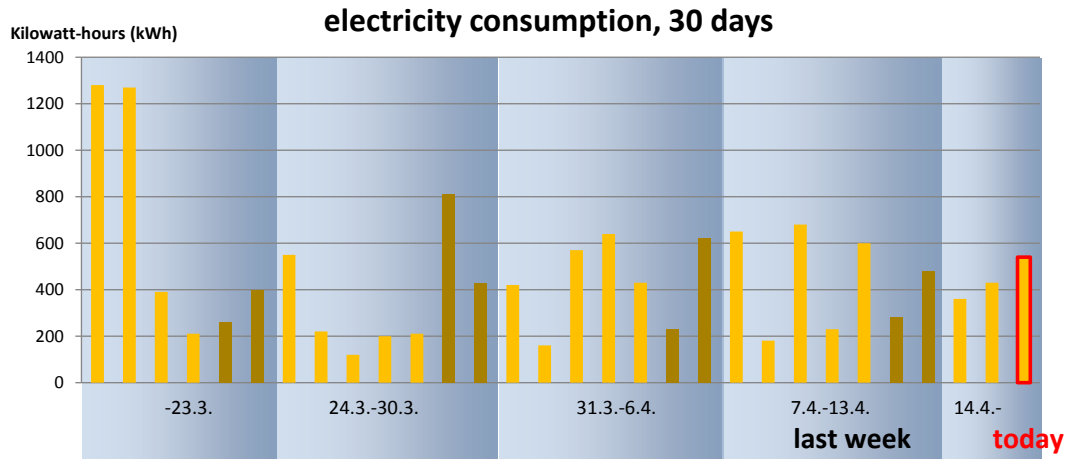


Figure 36: 30 days chart

The chart shown in Figure 37 is a yearly overview over the consumption of every week of the year. While the consumption of the current year is given as bars, the consumption of the last year is displayed in the form of a line. This allows for a comparison between the years and could be an important point in the future to motivate students to save energy, if they can see the changes in consumption since the previous year. Furthermore, this chart shows the difference in consumption between seasons, which will give an especially clear picture for heat energy.

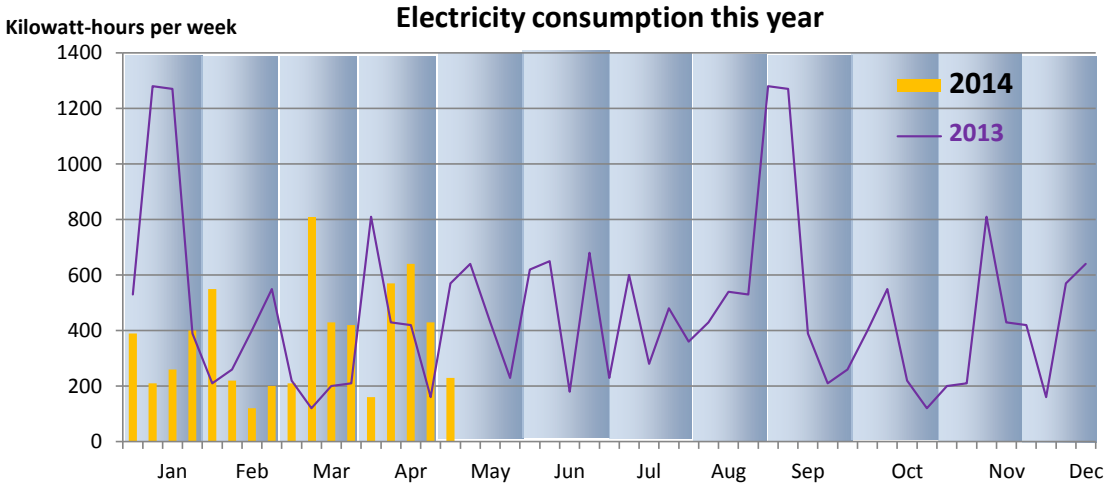


Figure 37: yearly overview

8. Paper prototyping

Before starting the design of the webpage and the TV screen a brainstorm session was held in order to generate some ideas. It is important that the TV screen catches attention and that the webpage is interesting and nice looking. The brainstorm generated the basic structure of the screen and webpage. During this brainstorm we agreed on certain points that should be part of the TV screen and the webpage.

The TV screen contains only the necessary things such as some tips, facts and equalities. There are some pictures that create awareness. The screen contains some info about the energy consumption at all times. There is more information, such as graphs (cf. Figure 38).

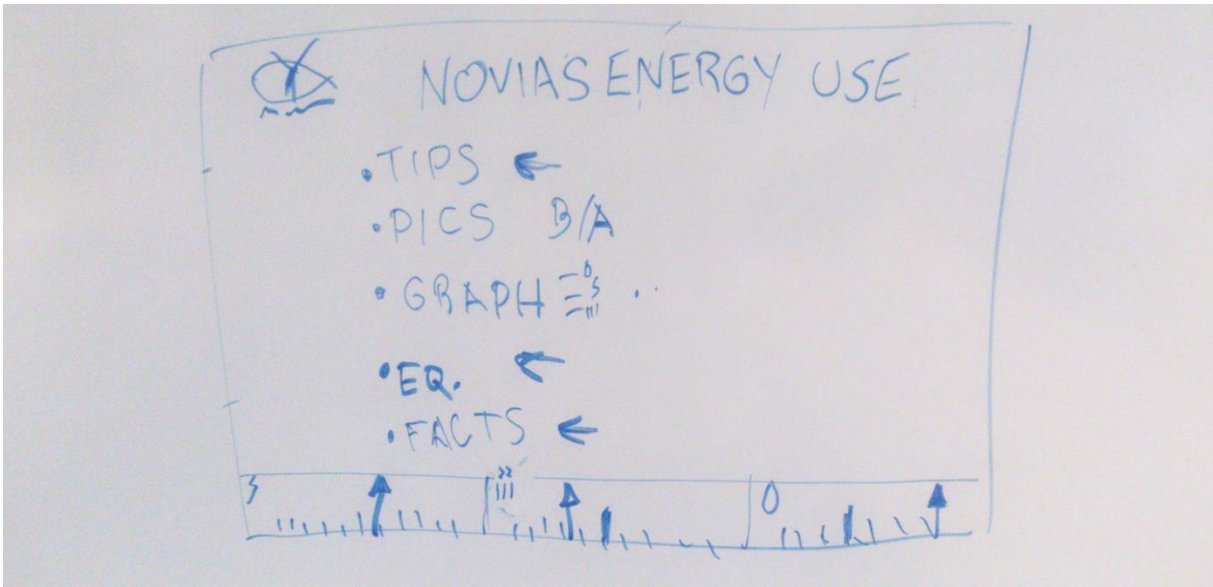


Figure 38: quick sketch of the screen

The webpage is a scroll down webpage with four different pages. One is a homepage where there is info about energy, tips, news etc. This info is linked to the other pages. Another page is about energy consumption and gives more detailed info than on the screen. People are able to search for the info that they find more interesting. There is a page where they can find all the tips, facts and equalities and also posters that are used. At last there is a page about the project. This page is for the visitors who are interested in knwing more about this project (cf. Figure 39).

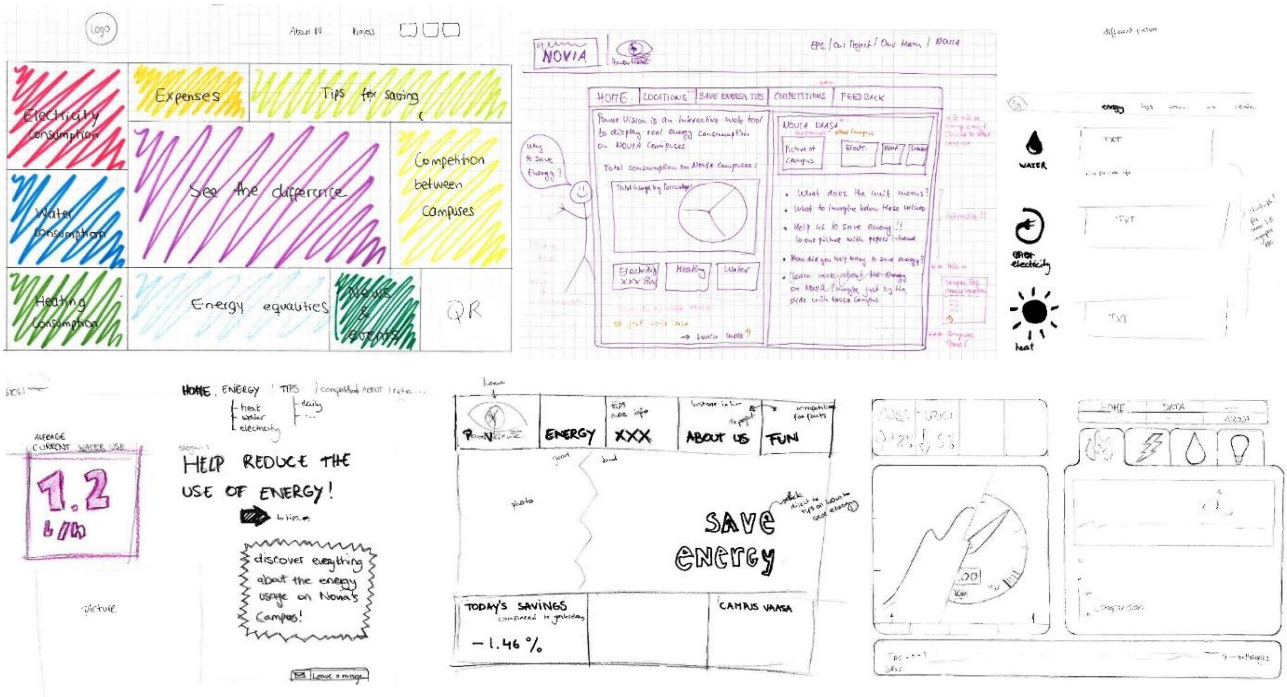


Figure 39: different sketches of possible webpages

9. Design of the display

One of the main elements of the system is the display, a device that allows showing visual information to the students. In the project at hand, the displays are the information screens distributed throughout the campuses of Novia UAS.

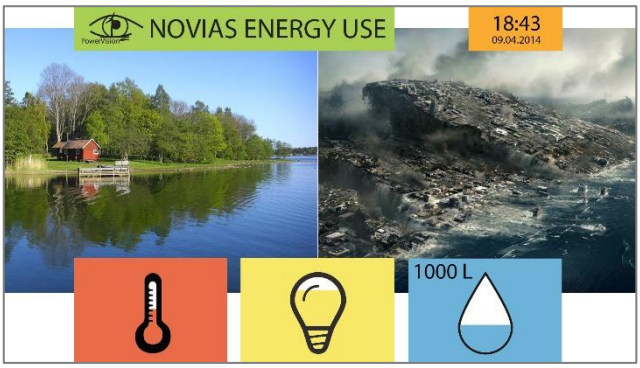
Before the creation and development of the interface of the display, as it is one of the main elements to create awareness about the energy consumption, some requirements were defined:

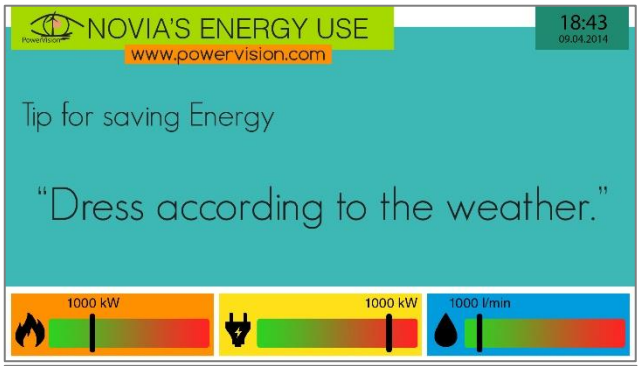
- It has to catch people's attention.
- It must follow the same aesthetic appearance as the web page.
- The information presented must be easy to read and to understand.
- It has to show real time energy consumption.
- It must be distinguishable from the other information projected on the screen.

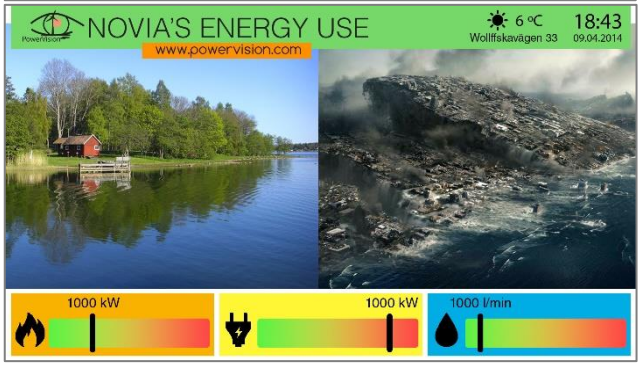
9.1 Evolution

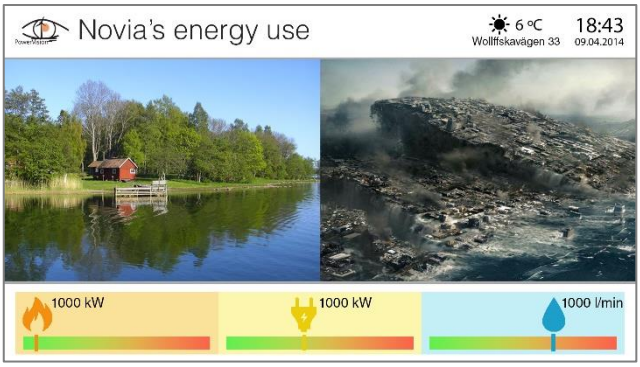
The design of the display's interface has been a long process which has gone from the first ideas to the final design. In Figure 40 some of the proposals are shown that have been contributing to reach the final version.

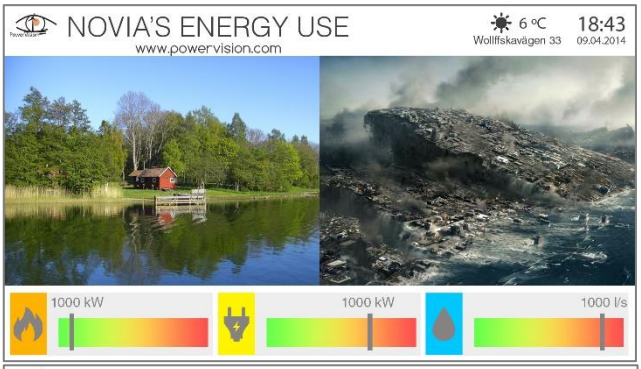
The differences between the proposals are mainly based on the application of colours, the good representation of energy consumption through the gauges and the clear distinction between the different parts of the display.

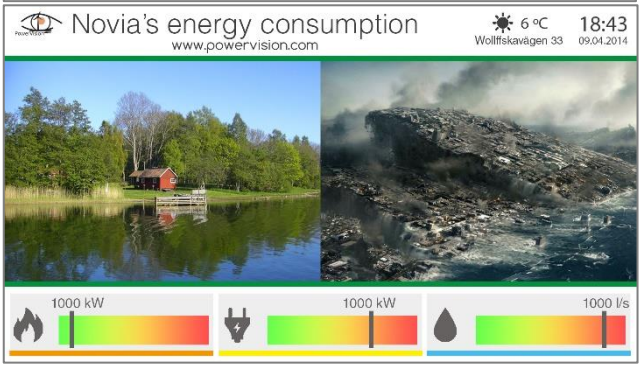



NOVIA'S ENERGY USE
www.powervision.com
18:43
09.04.2014
Tip for saving Energy
"Dress according to the weather."
1000 kW
1000 kW
1000 l/min


NOVIA'S ENERGY USE
www.powervision.com
6 °C
Wolffskavägen 33
18:43
09.04.2014
1000 kW
1000 kW
1000 l/min


Novia's energy use
6 °C
Wolffskavägen 33
18:43
09.04.2014
1000 kW
1000 kW
1000 l/min


NOVIA'S ENERGY USE
www.powervision.com
6 °C
Wolffskavägen 33
18:43
09.04.2014
1000 kW
1000 kW
1000 l/s


Novia's energy consumption
www.powervision.com
6 °C
Wolffskavägen 33
18:43
09.04.2014
1000 kW
1000 kW
1000 l/s

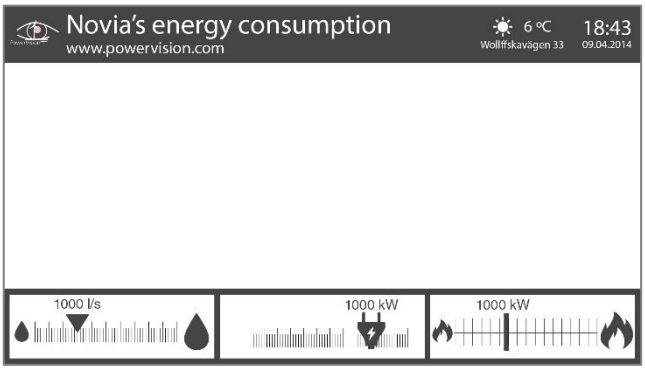


Figure 40: Evolution of the display design

9.2 Final design

9.2.1 Structure

The final version of the display's interface is composed of two static parts set in gray (cf. Figure 41).

Figure 41: Static elements of the display

Between the static parts, there is a central area for content which is changing regularly (cf. Figure 42).

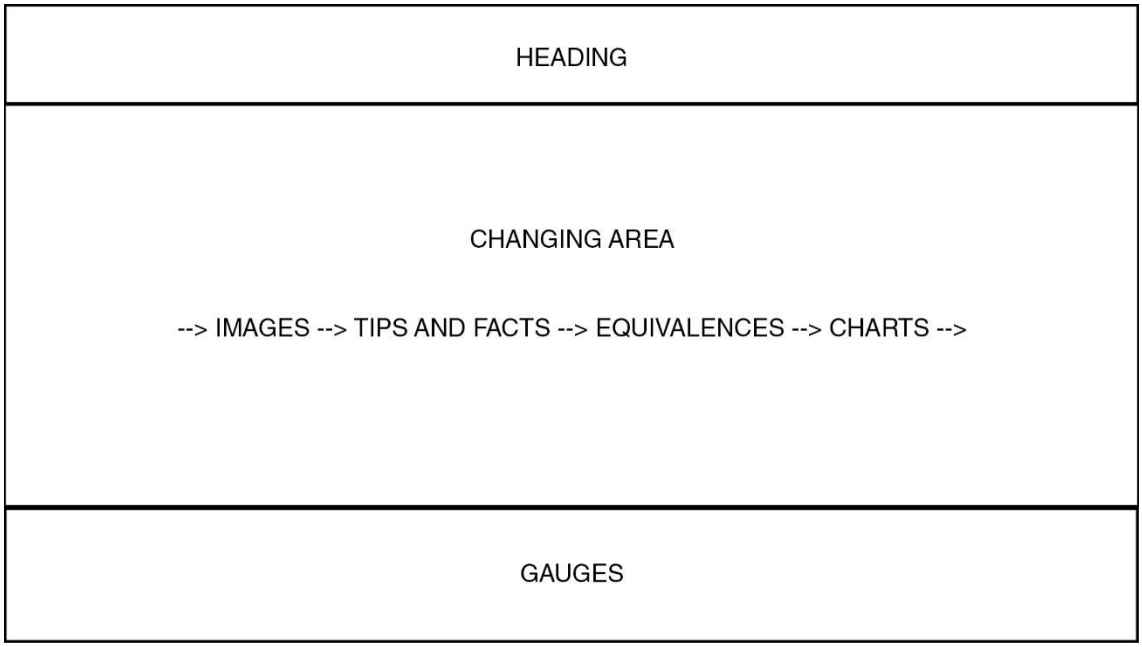


Figure 42 Scheme of the display sequence

The interface structure is given in
Figure 43.

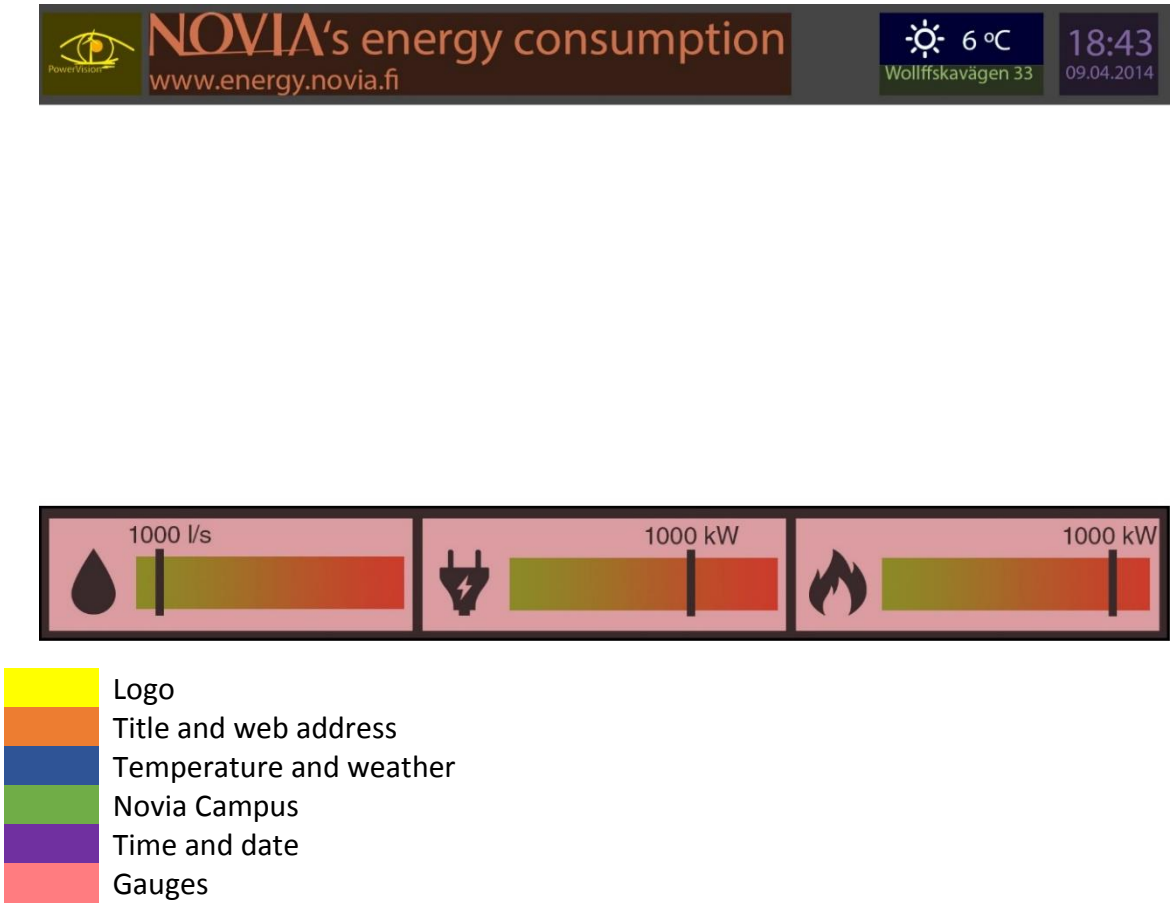
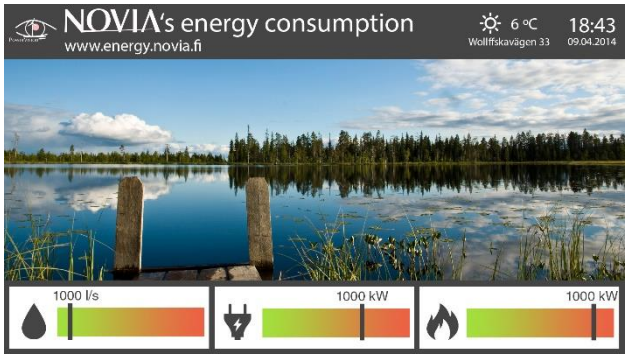


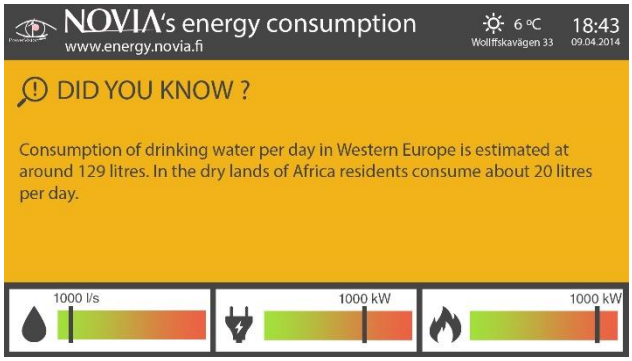
Figure 43: Interface structure

9.2.2 Contents

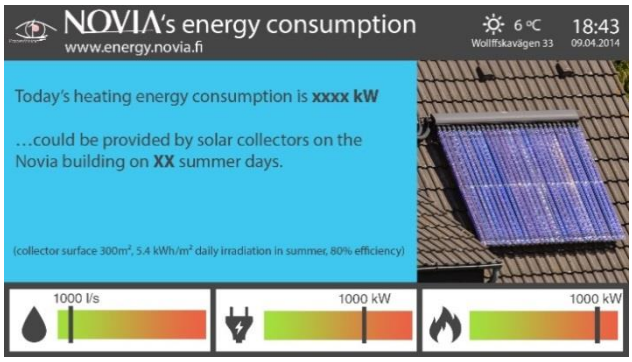
IMAGES
The display is going to show different images to catch people's attention and to touch them emotionally.



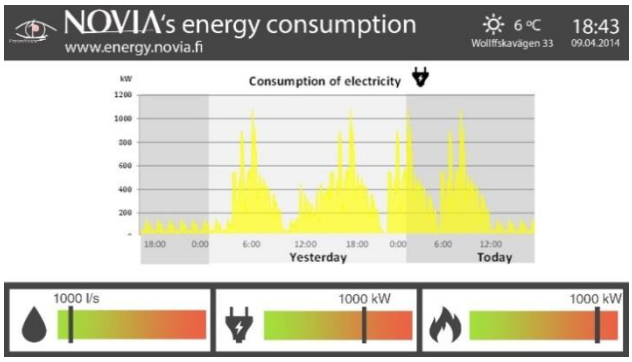
TIPS AND FACTS
In this section, tips and facts about energy consumption are shown. It is a way of teaching people and to provide them with interesting information.



EQUIVALENCES
To create awareness this section relates the energy consumption of the day to examples from everyday life. In this way it is easier for people to understand the data.



CHARTS
To give a very accurate value of the energy consumption there is another section with charts. In that way people can be informed about consumption differences at different times.



9.2.3 Typography and colour

This section talks about the typography and colour used in the design of the interface and the aspects that have been considered for their applications.

TYPOGRAPHY

The typography chosen has been Myriad Pro, as it is standard and easy to read.

Myriad Pro

Abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
1234567890

The font size varies according to the importance of the contents and readability on the television screen, as given in Table 3.

Table 3: Font sizes for different contents of the display

CONTENT	FONT SIZE
Title and web address	36 pt
Temperature	60 pt
Novia Campus	24 pt
Time	48 pt
Date	24 pt
Gauges	30 pt
Tips and facts	60 pt (heading) 40 pt (content)
Equivalents	40 pt (equivalents) 26 pt (footnotes)

COLOUR

#454545	#a3e03d	#ec6144	#ffffff
Text Heading and gauges background Energy Symbols	Positive energy values in the gauges	Negative energy values in the gauges	Text Weather symbols Charts background

#ff530f	#ffc801	#93c700	#0e99da
Tips, facts and pictures background Heating charts	Tips, facts and pictures background Electricity charts	Tips, facts and pictures background General charts	Tips, facts and pictures background Water charts

9.3 Hardware and technical limitations

The existing information screens in the Novia building and inside Technobothnia are used as a platform for the energy consumption visualization. Up to now only general information like timetables is displayed on these screens. The hardware consists of TV screens (in Technobothnia: Model Philips 55PFL6007/12, resolution 1920x1080p, aspect ratio 16:9) and a little computer directly behind the TV which delivers the image through a VGA connection to the screen.

To display information it has to be uploaded into the software "FirstView Server 2.0.0" (produced by the company firstview.fi) in the form of pictures. The interval after which the different images are changed can be set to e.g. ten seconds.

As it was difficult to make contact with the responsible IT staff, the following questions couldn't be solved conclusively:

- *Different screen models*: It is unclear whether all screens on the different Novia locations are of the same model. This matters especially regarding aspect ratio, size and colour rendering of the screen. The chosen design could be displayed in a blurred or even illegible way on different screen models.

- *Resolution*: The resolution is unclear. It could be limited by the FirstView software and/or by the VGA connection to the screen. For lack of data, the display design was produced in 1920x1080p (16:9), so it should be suitable for most contemporary TV models.

- *Moving elements*: The possibility to only display still images reduces the design freedom. Moving elements like fluctuating gauges, moving images, appearing font or light effects would create additional attention and give the observer the feeling that real time values are displayed. For example, water consumption could be illustrated by dropping water, and the current value in a chart could be highlighted by movement. The current design uses only still images, but moving elements could be added at a later time.

- *Display interval and sequence*: If the energy information could be displayed only at the same time interval as the general university information, it would require a compromise between the different kinds of contents.

- *Update interval*: As the energy visualization system depends on the possibility to display (nearly) live data, the FirstView software can only be used if it allows the automated upload of images at small time intervals. If this turns out not to be possible, a different solution has to be chosen or developed (which should solve the above mentioned issues as well).

10. Design of the webpage

10.1 Structure

In order to explain the design of the webpage, it is necessary to understand the basic structure of the webpage (cf. Figure 44).

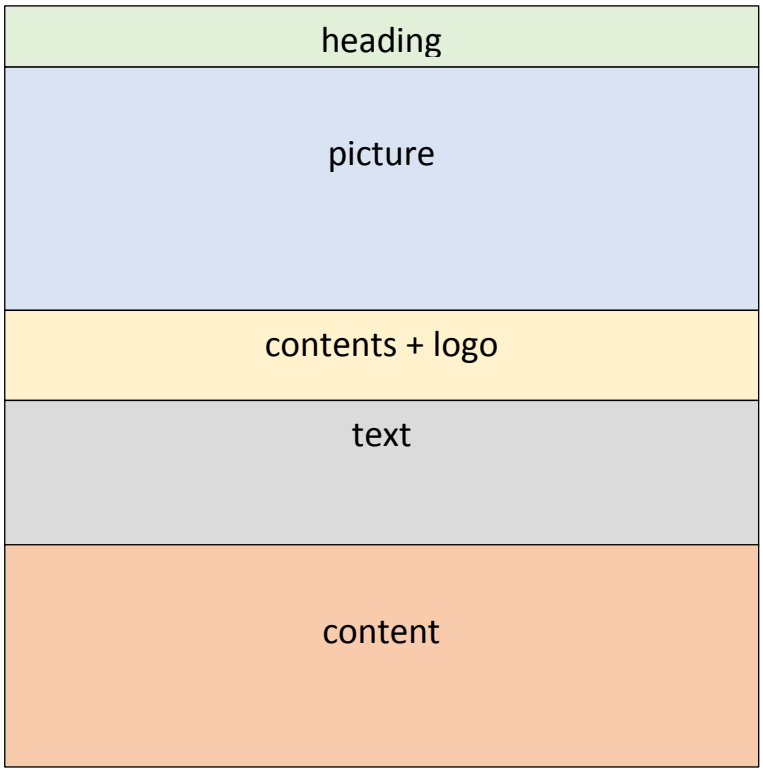


Figure 44: Structure of the webpage

heading

The webpage starts with a heading that contains two buttons. One gives the possibility to change the language of the entire webpage. With the other button you can change the campus you are visiting. This is convenient for seeing the amount of energy used, as this will be different in the different campuses. Obviously these two buttons are something that will be working in the future rather than the present. We only have data of energy use for one campus and we can't translate the website from English to Swedish or Finnish. This heading will look as shown in Figure 45.

Figure 45: heading

picture **logo + contents**

Under the heading there will be a picture. This picture is different for every page and is linked with the subject for every page. Under this picture, a table of contents can be seen. This table is visible on every page, which makes navigation through the webpage easier. On the left side you can see the PowerVision logo. From the middle to the right you can see four words representing the four pages that this webpage contains (cf. Figure 46).

Figure 46: logo + contents

text

Beneath the table of contents there will be a little text that shortly describes the contents of the page you are visiting. The background colour of this text box coincides with the rest of the page theme. Underneath the text the info on every page is given.

contents

At last there is place for the contents of the webpage. This will be defined in the following chapter.

10.2 Content

The content of the webpage is divided into four parts. These four parts are the homepage, the energy page, the interests page and the about page.

10.2.1 Homepage

The picture shown in homepage is a simple Finnish landscape. The text under the table of contents gives a short introduction of the webpage and invites people to browse through. “Welcome to the webpage about energy consumption! This webpage shows you the energy use at the Novia University of Applied Sciences, and much more. Scroll down to find out more!”

Beneath this inviting text there are three gauges that show the basic energy consumption of water, electricity and fire at that moment. This image is linked to the energy page. Right beneath the gauges you can find recent news. This news can be about anything related to energy. Clicking on the image directs you to the interests page where you can read the entire article. When you click on the URL you get redirected to the original article (if found on the web).

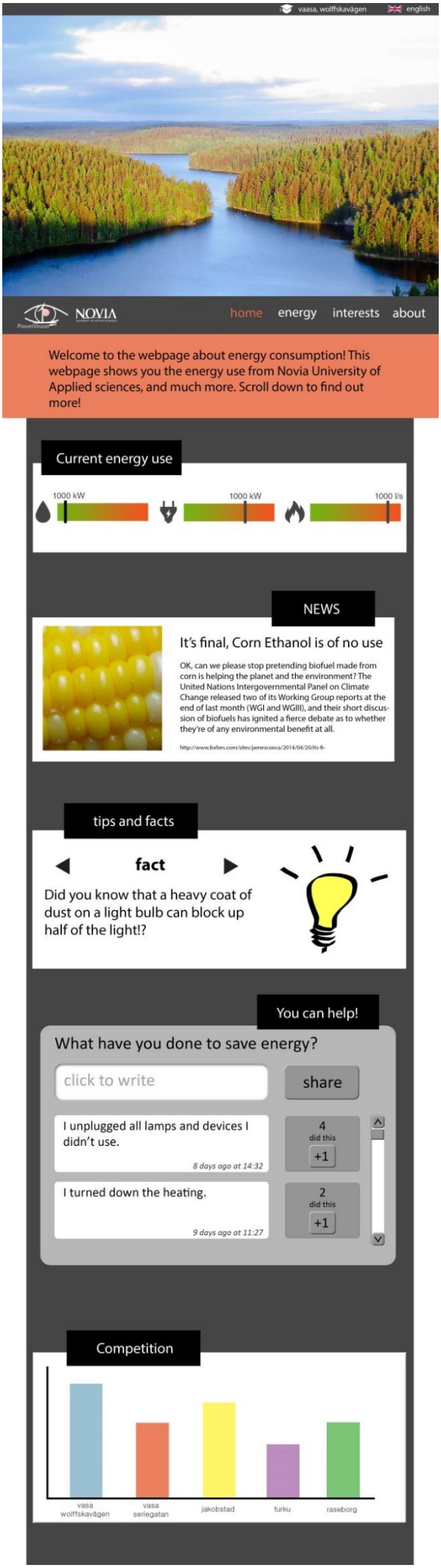


Figure 47:
Design of the homepage

Under the energy consumption you can find tips and facts. You can click left or right to find out more tips or facts. The tips and facts will be randomly distributed. Next up is a table where visitors can fill out what they have done to save energy. In the future this table might be connected to Facebook.

Next up is some info about the competition between the different campuses. In theory, the campus that uses the least amount of energy is the winner. Again this is something that might happen in the future since we do not have data for all campuses.
A quick design of how the homepage might look like can be seen in Figure 47.

10.2.2 Energy page

In the PowerVision webpage the team has prepared a section dedicated to show information about energy use in a more detailed than what is shown on the display. We have to be conscious of the importance of this section, because it comprises a very important part of the goals of the project.

This section is going to be organized in the same way as the whole webpage to keep the feeling of a unified webpage, however as we show different kinds of information here (mainly numerical data in charts), the “scroll down” behavior of the webpage is limited, so that section consists only of the common header for the sections of the webpage. When scrolling down, only one area with information will appear (cf. Figure 48).

Going deep in the shape description of the information area of that section, is going to be organized clearly in an ascendant way regarding the quality and the quantity of the information given. The simplest data is shown first, and to access more detailed data users can use a submenu. This way a user that is only curious about energy information is going to see the simplest data in the starting page, if he is really interested, he can dig further in the options and get all the data on screen.

The accurate description of the information area is as following (cf. Figure 48):

The starting page “live” (some sort of home tab) is a page with only the three metering gauges (heating, electricity and water) and below them some energy comparison statement related with the actual values of consumption. This gauges are going to show real time data about energy consumption in the selected building.

The second option in the menu, right after the home tab is “charts”. Clicking there means a change in the information area with new options appearing. The data shown in this submenu consists of graphs showing the energy consumption, with options to toggle between the timespan shown on the graph window (day, week, month, year) and also another option tab to toggle on/off between the type of data shown on the screen. Any user can see the behavior of the consumption in the timespan he chooses and also compare between heating, electricity and water consumptions.

The third tab “advanced” is an optional on/off toggled button. When toggled on, a window with charts appears with the same basic options as in the second tab. The difference is the addition of another sub-menu on top of the graph window, where the user can add different data in the graph area, choose the date of the data shown (searching through the database), compare it with data from another campuses, etc.

The additional menu consists of a checkbox to select from which campus the user wants the data, a calendar button to select the starting date, and a “plus” button to add the selection to the comparison list. The other options regarding the type of energy and the timespan remain unchanged. This way, the user can add to a list (that is below the charts window working as a legend) all the information desired, only needing to select type of energy, timespan, campuses and date. This is the most complex option, focused on showing advanced data to the users that are really interested in going deeper in the knowledge of the energetic behavior of Novia’s users.

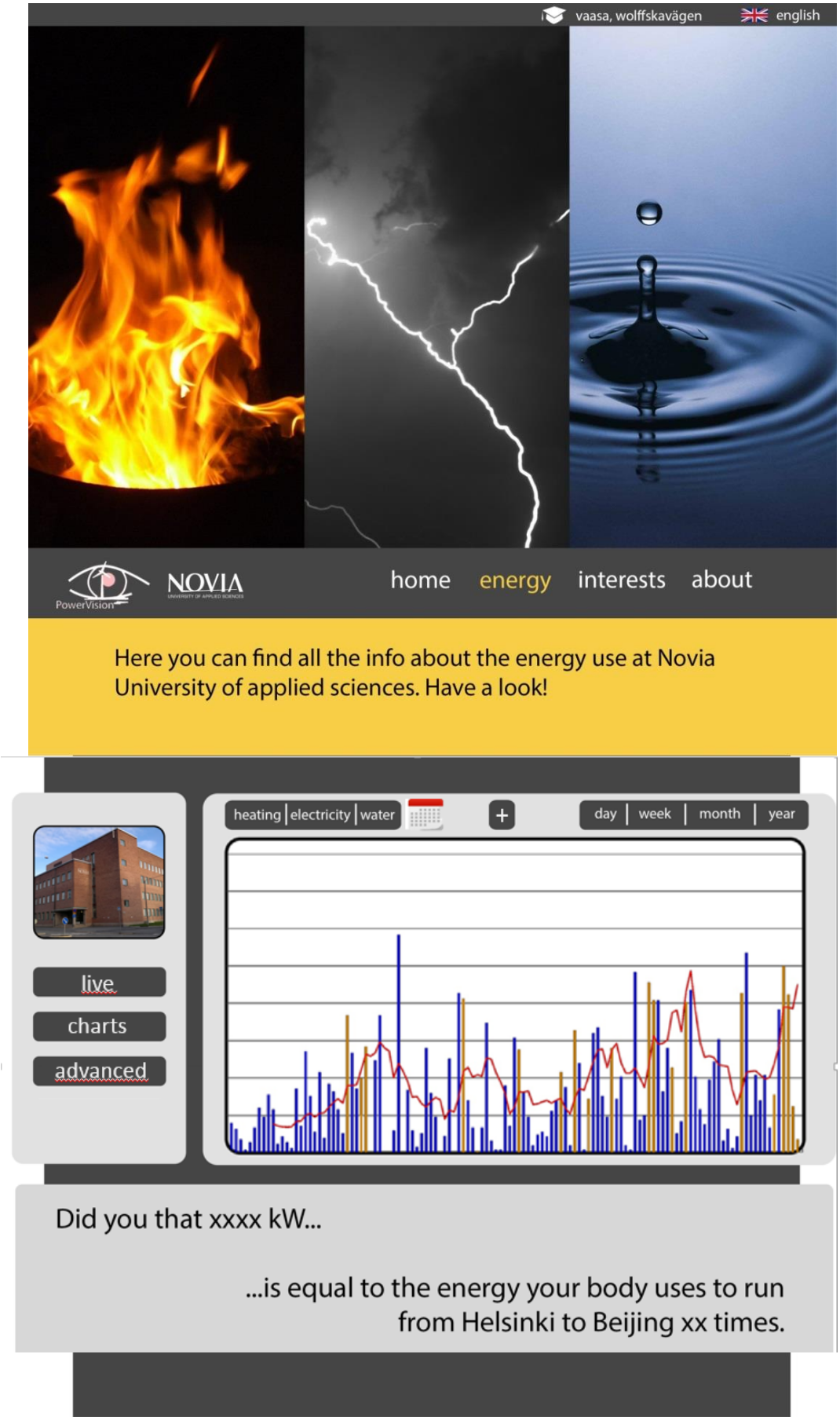


Figure 48: Energy page

10.2.3 Interests page

The pictures shown in the interests page is a landscape with the Northern lights. The text under the table of contents gives a short summary of this page.

“This project was created in order to make awareness about energy consumption in a fun and creative way. Here you can find some tips, facts, posters and other fun stuff!”

The page starts off with a tip shown in the same way as the homepage. The difference is that on this page tips and facts are separated. However, you can still scroll through the different tips or facts by clicking on the left or right arrow (cf. Figure 49).

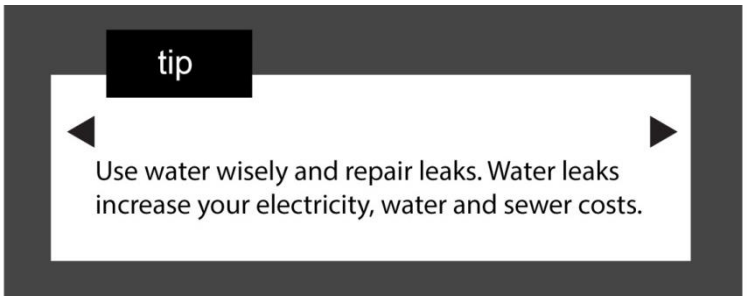


Figure 49: tips

Next up is the table “What have you done to save energy?”. This table allows you to fill out your own energy saving activity or you can simply scroll down and see what others have done. If you have done the same, you click on +1 and so more people can do the same activity. In this way you can see what activities are popular and which aren’t (cf. Figure 50).

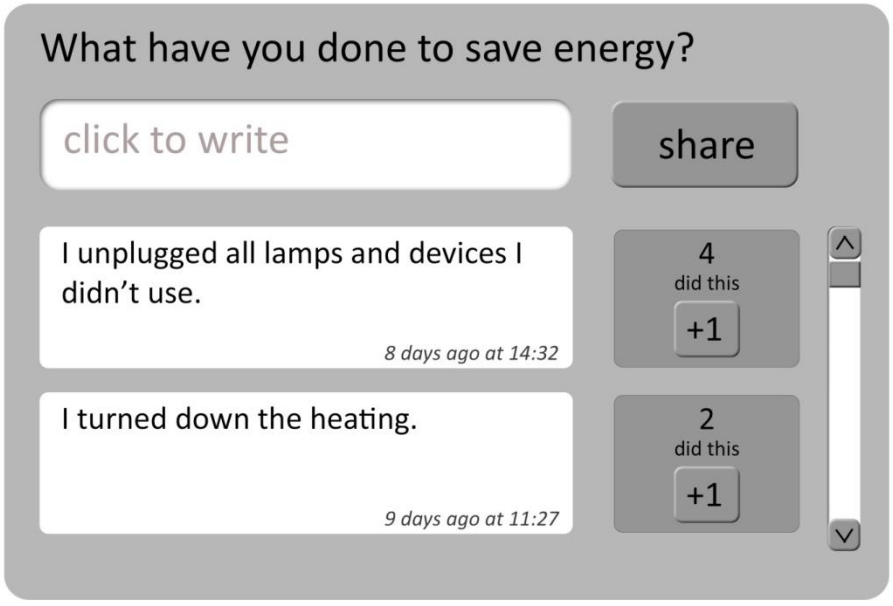


Figure 50: what have you done to save energy

The interests page also shows some equivalences. The equivalences work in the same way as the tips and facts do. You can scroll through them by clicking on the arrows left or right (cf. Figure 51).

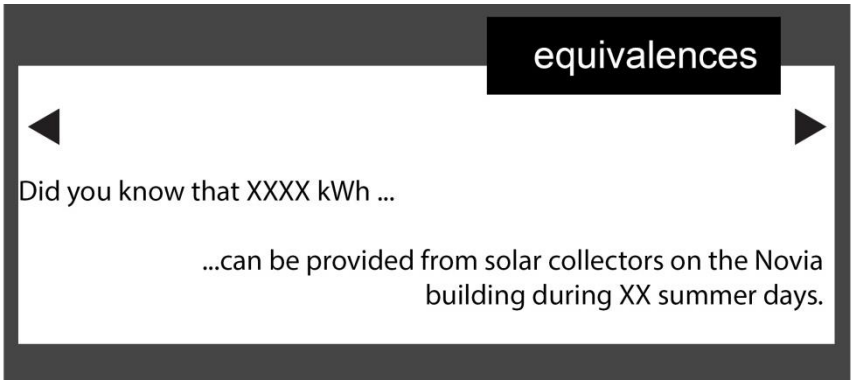


Figure 51: equivalences

On this page you can also find the posters that will be used to create awareness (cf. Figure 52).

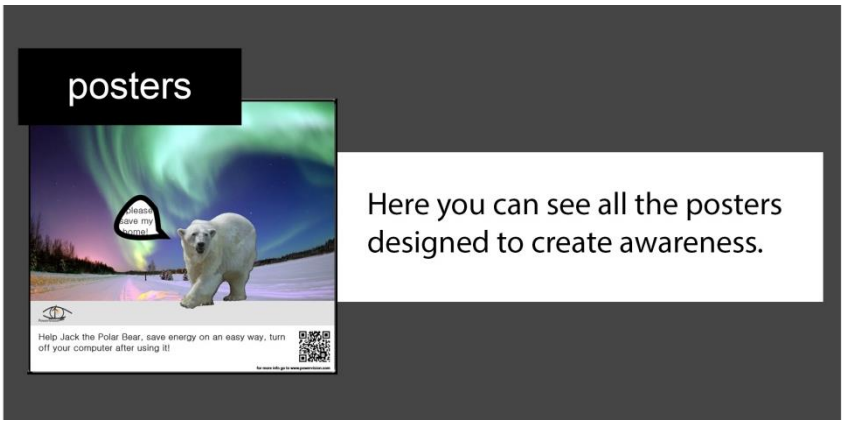


Figure 52: posters

10.2.4 About page

The About page is shown in Figure 53. The picture shown here is a picture of the group. People like to know the faces of the people working behind projects, on this page they will get the chance to find out more. The introduction text goes as follows:

“Coming from all around Europe, we met in Finland to work on the European Project Semester. After four intensive months we have developed a system named PowerVision wich displays the energy consumption of all Novia campuses.”

Next, the webpage gives more information about the project we have been working on.

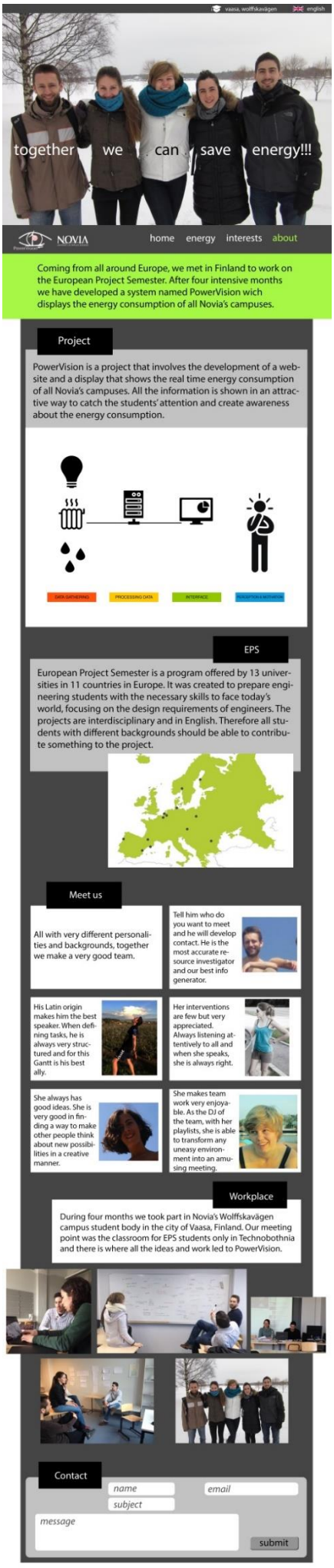


Figure 53: About page

“PowerVision is a project that involves the development of a website and a display that shows the real time energy consumption of all Novia campuses. All the information is showed in an attractive way to catch the student’s attention to create awareness about the energy consumption.”

We also describe EPS, after all this was the reason for why this project has been done: “European Project Semester is a programme offered by 13 universities in 11 countries in Europe. It was created to prepare engineering students with the necessary skills to face today’s world, focussing on the design requirements of engineers. The projects are interdisciplinary and in English. Therefore all students with different backgrounds should be able to contribute something to the project.”

Furthermore this page gives short info about the team members and the places we work. These two topics are filled with pictures of the team in their workplaces. There will be the opportunity to make contact, ask questions or give comments.

10.2.5 Image attribution page

The position for giving the attribution and source for an image is ideally directly at the image, but it is easier to give all the attributions on one extra page made especially made for this purpose. However, all other pages should bear a link “image attribution and licensing” at the bottom which leads to this attribution page.

The attribution page will include all images used in the project, regardless whether they are used on the webpage itself or just on the display or posters. However, public domain images will not be included here, as they don’t require attribution. To identify the image, a thumbnail of each image is given, and the attribution text (e.g. "Sami Keinänen / CC BY-SA") next to it is formatted as a link to the webpage where the image was originally found.

Furthermore, the following sentence has to be displayed at the top of the attribution page in order to comply with the Creative Commons “Share Alike” license:

“Images of this project which were obtained from Creative Commons licensed material are hereby licensed under CC BY-SA 3.0“, whereas the name of the license is a link to http://creativecommons.org/licenses/by-sa/3.0/ .

10.3 Interaction

The interaction of the webpage is about how the user interacts with the screen. It is important that this person knows if something is a button which you can click on, or if it is just text. In some cases you can click on the image, but not on all images. Here the detailed interaction will be shown.

10.3.1 Fixed menu bar

In order to have a good interaction with the visitors of the website we want them to not feel lost. This is why the website contains a bar with the basic contents on them. This bar should be visible at all times. The website is one that scrolls down but when doing this it is necessary that this bar is still

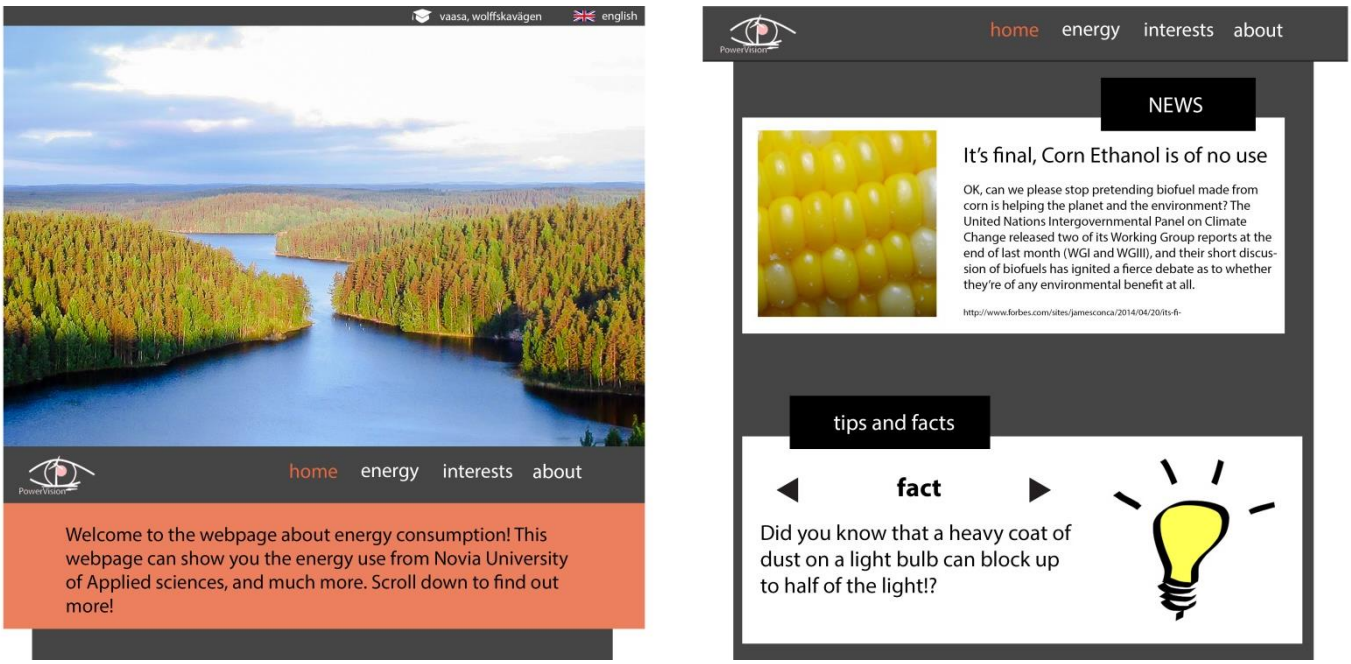


Figure 54: position of the page menu

Figure 54 is a picture of what the website will look like if you open it (left side). You can see a picture of a Finnish landscape. Above are the options to change language and location, under is the bar with the contents. When you scroll down a little you see the right side of Figure 54. In this image you can see that the bar with the contents has moved to the top of the page, where it will stay unless you scroll to the top of the page.

10.3.2 Mouse pointer

In order to let people know when they can click on something there needs to be a difference between arrows. Figure 55 shows the normal arrow that is used for all computer purposes (top) and the change into a pointing finger when the mouse is hovering over the news heading (bottom). This change shows people that you can click on "news" and it will lead you to a page with news.

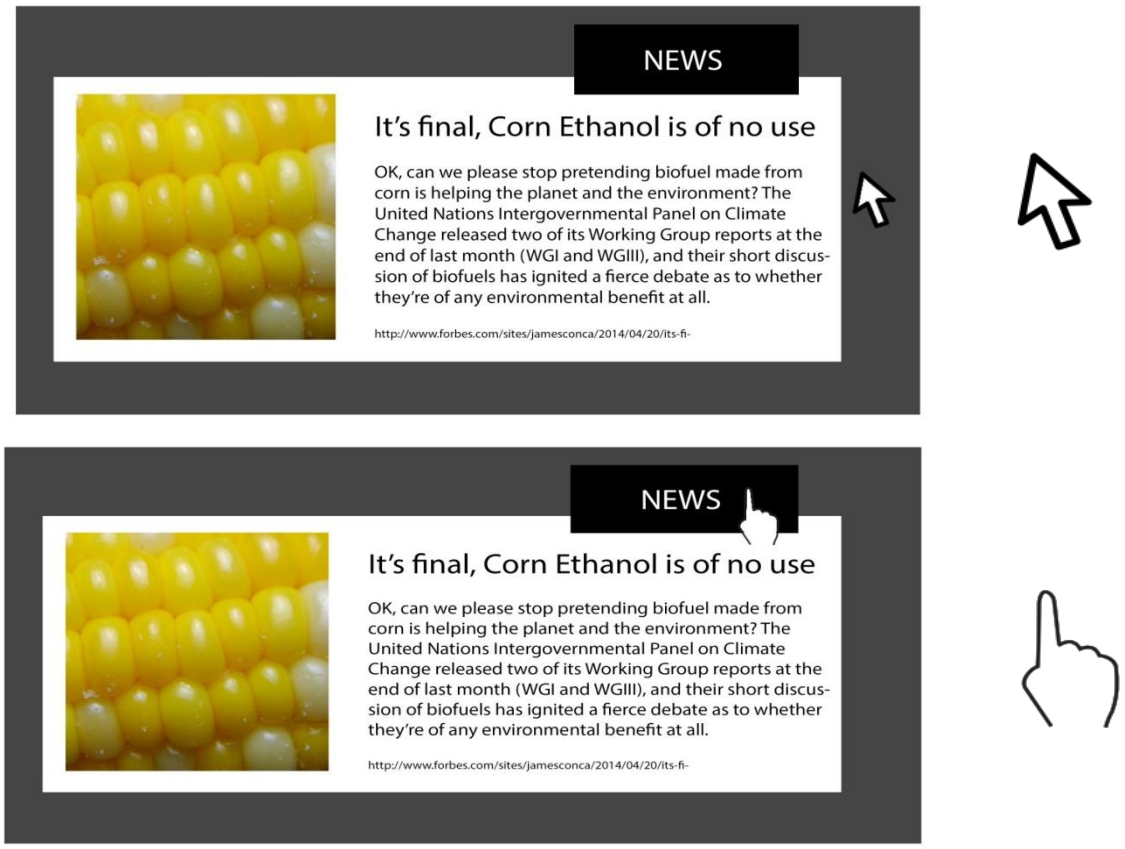


Figure 55: Change of mouse pointer when pointing to a link

10.3.3 Colour

Letting people know that something is clickable can be made on different ways. We have used colours. In Figure 56 you can see the table of contents when the mouse is hovering over "home". The mouse has changed into a pointing finger, and the colour of "home" has changed to red.

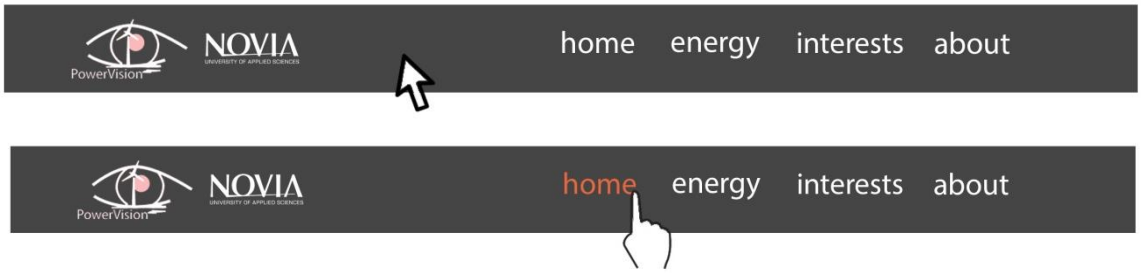


Figure 56: change of colour when mouse indicator is hovering

Every word has a different colour that coincides with the colours of the webpage. In Figure 57 you can see which colours were used.

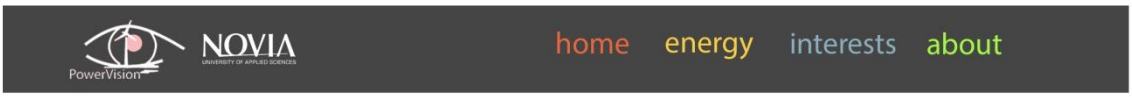


Figure 57: Colours of the menu items

10.3.4 Images

The webpage contains a lot of images. Some of them are clickable images. To see the difference between clickable and non-clickable images the two different arrows are used. If you can click on an image the arrow will change into a pointing hand. At the same time, the image will turn darker (cf. Figure 58).

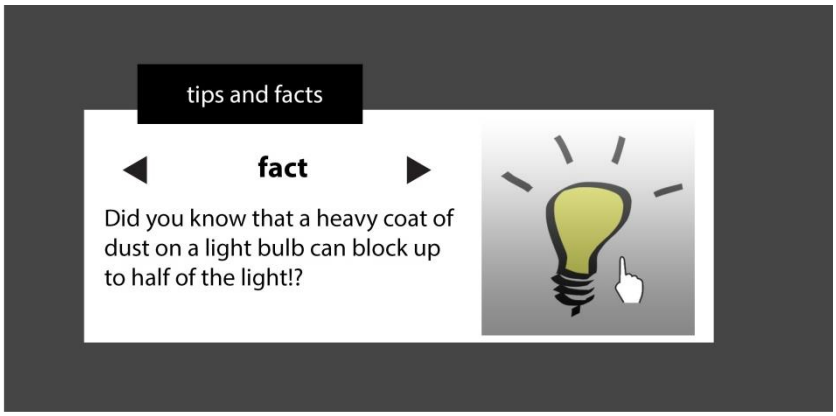


Figure 58: example for image on webpage

10.4 Typography and colour

Here the typography and colour used for the design of the webpage are discussed. This is an important factor of the design process, because typography and colour decide the readability of the webpage.

The used typography is Myriad Pro, as it is standard and easy to read. This is the same as the typograpghy used for the TV screen. Because of this similarity, there is a link between the screen and the website.

Myriad Pro
abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
1234567890

The font size varies according to importance.

CONTENTs	FONT SIZE
Headings	20 pt
Table of contents	18,25 pt
Place and language	10,65 pt
Text under picture	18 pt
Text for tips and facts	20 pt
News text	12 pt
Rest of text	18 pt

The used colours are given in the following:

#ec7f5d	#f7ce46	#99c1d3	#a6f746
home	Energy	Interests	about

#454545	#ffffff	#000000	
Background and table of contents bar	text white	Text black	

11. Posters

The next important element of the system are the posters. Their role is to advertise for the visualization system and to motivate people to save energy.

The posters are designed to attract the attention of people by using funny and colourful pictures. They are accompanied by tips about saving energy or by funny comments connected to energy consumption. Every poster is kept in the same format: Below the picture there is a slat with the logo of the project and a QR code, being a link to the website with more info about energy consumption on NOVIA. An example is given in Figure 59.

The posters will be situated in the corridors and in classrooms in the Technobothnia and Novia buildings. They will also be situated in places which are “unusual” for posters (for example inside the elevator).

A further point would be the use of stickers with short messages about saving energy for the computers or light switches.

Figure 59: Example of a poster

12. Facebook page

As a way to promote Powervision, a Facebook page has been created (cf. Figure 60). The idea of this professional Facebook profile is to inform students quickly, to give them the opportunity to comment and give suggestions and to link the webpage to Facebook.

The factor that will make people follow this platform is that it is always updated. For this reason, at least once a week, some publications should be made. For instance news, energy consumption progressions and other items of interests can be displayed.

To create this Facebook page a gmail account was created. So if in the future a mail account is needed, the same could be used.

Facebook and Gmail user and password:

- User Name: noviapowervision@gmail.com
- Password: powervision5

Figure 60: Screenshot of the facebook page

13. Conclusion

In this project, a visualization solution for energy consumption values at Novia UAS had to be developed, with the main goal of raising awareness among students about energy issues. The prototype is to be implemented for the building Wolffskavägen 33, but it is intended to install the system in all of Novia's campuses in the middle term.

As originally the logging of water, electricity and heat meter was part of the assignment, a basic research about these meters in the Novia building and about different logging possibilities has been conducted. As a result, using the pulse output has been identified as the most promising method of gathering consumption data. The pulse output of heat and electricity meters has been activated upon request by the local energy utility.

The logging had then been reassigned to a different group and the software section to Novia's IT specialist, so this project focused only on the design part.

A research of basic design principles has brought up the important factors of a good communication design. In order to respect the wishes and interests of the "target group" of the visualization system, a questionnaire and a focus group evaluation among students were conducted and analyzed. This led to the insight that it is desirable to show nice images as well as shocking images, explain energy values by giving comparisons, implement comparisons between different buildings of Novia (including rewards for the winner) and keep the whole system simple and fun.

As communication channels, the TV screens in the hallways, a webpage and posters in the hallways were selected. For each of these, the requirements and wishes were determined before starting the development.

Content for the system was produced in the form of images, equivalences for energy consumption values, tips and facts about energy consumption and charts showing energy consumption values in different time intervals. The used image licenses were explained.

The design of the TV screen display was developed, the evolution and the final structure were explained. The display consists of a fixed top and bottom elements where the live consumption values are shown, and a space in between which contains the changing content. Details on graphical design and typography were given. Technical limitations of the TV screens are discussed, whereas it remained unclear in what way the TV screen system can actually be used.

A webpage was designed, giving a layout, interaction structure and graphical design. In addition to the above mentioned contents, it includes more complex charts, the possibility to give social interaction, a page about the project and a page where the image sources and licenses are given. In addition, a Facebook group was created which is to be linked to the webpage, in order to promote the project in the social network.

Poster designs were created to advertise the project. They are comprised of an eye-catching image, a funny or thought-provoking message and a link to the project webpage (also in the form of a QR code for smartphones).

13.1 Conclusion on the team process

After completing the project the team members are satisfied with the results achieved taking into consideration the circumstances that surrounded the development of it. Our first and main goal was the creation of a system that would show real time information about the energy consumption at a Novia's building. We also wanted to raise awareness of energy usage on the campus.

In our opinion, we have achieved these two goals within the deadline for the project, but as always, during the development of it some problems appeared. To name a few, one of the most disturbing things that occurred was the change of the project goals. Originally we had to create the whole system including the data gathering part and data sorting and storage in servers, and of course, the visualization system design. After the first six weeks the project got cut down to the design of the visualization system which permitted us to focus our efforts into getting a more labored and detailed visualization system, at the cost of losing the time spent on other subjects at the start of the project.

The final result is good if we take into consideration the time limitation and our inexperience of this type of project. Nevertheless it leaves us with a bitter taste in our mouths when we think of the great things we could have achieved had the scope of the project been clearly stated from the very beginning. Even though the team managed to set the foundations of what can be a long lasting system working on the Novia campus, giving clear directions of how it should be developed in the future.

In brief, the team thinks that even if we could have achieved more in other circumstances, our results are satisfactory. Not only the results regarding the output of the project, but also the results of our own development as team workers and project managers. Having to deal with such problems put our team into a challenge that made us give our best for the project, and added some life experience that we are never going to forget.

13.2 Future outlook

Both display and webpage have to be programmed by Novia's IT specialist. This was not completed at the creation of this report, so the developed designs as well as parts of the content might still undergo adaptions in the implementation process.

In the following, an overview is given about pending issues and future possibilities.

Technical limitations of the TV screen system
If the current system (which only displays still images) would change, moving elements like wavering gauges or a live clock could be implemented, which would emphasize that actually live values are displayed. Besides, sequences and display duration of the different elements could be configured more flexible.

Advertisement for the system
Once the system is up and running, the prepared posters can be deployed. According to the focus group, the two other most influential ways of informing about the system are: Advertising by visiting the classes during lessons and explaining the system, and writing information emails.

Implementation of the system in all of Novia's campuses
Once the prototype is running satisfactory, the logging of energy meters in the other campuses have to be tackled. Also, comparisons between campuses can then be implemented.

Updating and production of content
The energy equivalences and tips and facts need to be updated over the years. Also, new content should be added over time to keep the system interesting for the students.

Competitions and target values
Competitions are only making sense when they are related to a common basis, like the consumption per square meter or per student of the campus. Finding a suitable way to compare campuses requires a data basis over at least one year for different campuses, to determine which target values or comparisons between campuses would make sense and to what extent students can influence energy consumption at all. The same goes for the definition of a target-performance comparison, which can also be a source of motivation to save energy.

Contact and social network supervision
The Facebook group has to be managed actively to keep it up to date and interesting. Also, the public comments which can be posted on the webpage have to be checked regularly.

Involvement of Novia's students
Many of the above points could be given as tasks to students, as it would keep them involved. Preferably, already first-year students could be assigned to e.g. the creation of new poster designs in a contest, as this would bring them in contact with the system early. Students should also be involved when it comes to the creation of competitions. The Student Union could be involved in the definition of rewards for energy savings (like parties or batches for the overalls), as motivating rewards are essential when starting competitions.

Maintenance of hardware and software
The IT systems from data logging to database to display and webpage require ongoing maintenance. As faulty values on the TV screens would instantly be seen by numberless students, this would require a quick repair in order not to affect the credibility of the system.

Showing data about CO2 emissions

As the system itself is designed to raise awareness, showing the data of the emissions value (in tons of CO2 for example) would be important. Implementing this feature is not a big problem if the consumption data is used along with the emissions amount per source of energy, data which is provided by the utility companies and the Finish government.

Equivalences for environmental impact

New equivalences for the environmental impact could work exactly in the same way as the equivalences for the energy consumption.

Paper use

The idea of showing the use of paper could be a good thing to implement, as the focus group showed interest in this topic. Data could be gathered through the printing system. It could be shown how much paper has been used monthly in a new section in the webpage, and also in the display.

Smartphone application

The phone application should show the basic data that the visualization screen also shows. This would include a section with the gauges, another with the same charts as in the display and another one for tips and facts.

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Appendices

Mandate for Vasa Elektriska

NOVIA
UNIVERSITY OF APPLIED SCIENCES

Mandate 5.3.2014

We hereby authorize the following persons to be given all necessary information about the heating- and electricity-metering and -consumption of our university building Wolffskavägen 33, Vaasa, to enable them to develop and construct an energy-consumption visualization system, which is reading out and displaying energy consumption in real time continually.

This includes, as far as procurable, any real-time consumption values as well as specifications about the used heating- and electricity-meters and meter-interfaces for remote-reading, the request for additional interfaces and the authorization to read out and log live values from interfaces.

- Kristian Blomqvist (project owner, head of Novia R&D unit), kristian.blomqvist@novia.fi
- Mikael Ehrs (project supervisor, senior lecturer), mikael.ehrs@novia.fi
- Markus Gailhofer (project staff, student), markus.gailhofer@novia.fi,
- Aleix Prim (project staff, student), aleix.rosellprim@novia.fi

We kindly ask you to inform Markus Gailhofer about who is the technical contact person in your company regarding remote reading and meter interfaces, so he could contact them if necessary.

Jonas Waller
Dean, Novia University of Applied Sciences
Campus Vasa Wolffskavägen

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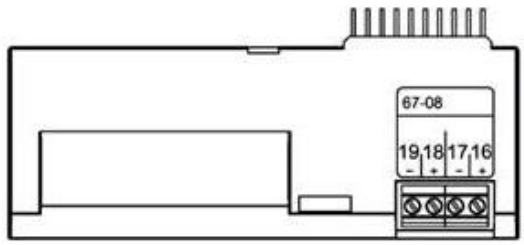
Technical details on pulse output of the heat meter Multical 601

FW: Technical support on Multical 601
From: Timo Sammalisto <tia@kamstrup.fi>
To: Markus.Gailhofer@novia.fi
Date: Thursday - February 20, 2014 12:53 PM
Subject: FW: Technical support on Multical 601

Hello
I think pulse output card is the easiest way to get energy and water capacity information.
MC601 Pulse output card is 67-08.
Card price is 48 eur vat 0%.
Pulse output connection is as follows:
-Transistor output.
-card have two output channel, energy and water capacity.
-Need the supply voltage from logger (5-30VDC).
-Supply voltage connect to terminal 16 and 18.
-Energy pulse going to terminal 17.
- Water Capacity pulse going to terminal 19.
-It gives out pulse, which is equal to the supply voltage.
-Pulse lengt is 32 or 100ms, it can be program.



Type 67-08: RTC + 2 pulse outputs for CE and CV + hourly data logger

This top module has two configurable pulse outputs, which are suitable for volume and energy pulses for heat meters, cooling meters and combined heat/cooling meters.

The pulse resolution follows the display (fixed in the CCC-code). E.g. CCC=119 (qp 1.5): 1 pulse/kWh and 1 pulse/0.01 m^3.

The pulse outputs are optoinsulated and can be charged with 30 VDC and 10 mA.

Normally, energy (CE) is connected to 16-17 and volume (CV) to 18-19, but other combinations can be selected via the PC program METERTOOL, also used to select pulse width 32 or 100 ms.

The module also comprises an hourly data logger, including registers such as daily logger (see paragraph 6.12 Data loggers).

See paragraph 10.1.3 concerning the function of the pulse outputs.

Ystävällisin terveisin / Best regards
Timo Sammalisto
Myynti-insinööri / Sales Engineer
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Data logger market research and rating

Logging M-Bus signal (converting S0 pulse signal to M-Bus first):

<table>
<tr><th>3x S0 to M-Bus-adapter:</th><th colspan="2">M-Bus-Logger:</th></tr>
<tr><td>3x Relay IM001GC = 230 €
(only max. 50 imp/second!)

alternatively:
3x Aquametro Ambus IS = 516 €
(unclear: S0? max. rate?)

alternatively:
Kamstrup pulse counter ??</td><td>Relay:
(total 850 €)

Aquametro:
(total 1700€)</td><td>MR005DL M-Bus data logger with keyboard and LCD for 3 devices, RS232C interface, 269 € (optional TCP001 RS232 to TCP/IP converter, with power supply, cables and software 139 €)
Transfer to database: 1. free software FSERVICE, but unclear if only to Excel and at which minimum interval, 2. software DOKOM CS (3 meters: 295 €): minimum readout interval 1s, internal database, but export only manually to Word, Excel, simple charts (?)

Ambus Log 20 (93108) 1437 € , readout options unclear, probably similar to Relay</td></tr>
<tr><td>alternatively
new M-Bus-meters:</td><td rowspan="2">HWg:
(total 700€)</td><td rowspan="2">HWg-PWR3: 383 EUR, HWg-PDMS-Software for readout (probably free for 3 sensors) exports automatically to Excel/XLM-sheets using templates. Support: "I am afraid that for display in your buildings it will be necessary to create an application capable of opening the report files created by HWg-PDMS. This application can create periodical reports which can be then used by other applications, but this software alone cannot open the created reports, that has to be done manually (or with a custom application)."</td></tr>
<tr><td>electricity ca. 400€
water ca. 200€
heat: probably not possible, 500€</td></tr>
</table>

Logging S0 pulse signal directly:

EMU Impulse logger (for 9x SO-input, max. 166 imp/s) ca. **400€**.
(Upload to FTP-server as SML file once per minute; transfer via email as CSV file once per minute)

WuT, „webcount energy“ 6-channel-impulse-counter, 500 imp/s, ca. **550€**
Support: ”to get the content of the logger, I suggest to transfer the data time controlled via FTP or TPC-message to a FTP or TCP-Server. There is no way to request the logger-content direct from your application. On the other hand you can request the current value periodically out of your application. This is possible by SNMP, ASCII-commands (TCP and UDP), OPC."

Kamstrup: "we cannot offer anything suitable"

OpenEnergyMonitor: 1 RaspberryPi (38€), 2-3 emonTx V3 (74 €/pc) (maximum pulse rate unclear, only 1 or 2 pulse counts per emonTx in basic configuration, up to 12 if altered).
question: constant voltage, so metering of current via CT-clamps is enough? (one emonTX can meter three phase current, but only one AC-voltage).
Database: timestore+ would be faster than MySQL or PHPTimeSeries (running on local disc on Raspberry PI, or on Windows-PC, or on Linux-PC).
Special source code for optical read out of Multical 601 exists, but has to be merged into the software.

Informed consent

(according forms where signed by all participants of the focus group)

Informed Consent [FOCUS GROUP RESEARCH]

EPS Programme

You are invited to participate in a research study about Energy Visualization. This study is being conducted by the EPS Program Group 2 (Dockx Loulou, Gailhofer Markus, Noguera Paola, Rosell Aleix, Zelulová). You are invited to participate in this study because you are a student at Novia University.

Participation in this study is voluntary.

If you agree to participate in this study, you would participate in a focus group with other Novia students. The focus group will be led by Loulou (moderator). The topics that will be discussed during the focus group include energy use on the Novia Campuses.

The focus group will last 60 minutes. The focus group will be video recorded to ensure accuracy. You can ask to pause the recording at any time.

Participating in this study may not benefit you directly, but it will help us learn about the perception of certain information and how to motivate students.

The information you will share with us if you participate in this study will be kept completely confidential. The researchers would like to remind participants to respect the privacy of your fellow participants and not repeat what is said in the focus group to others. Reports of study findings will not include any identifying information. Only the project members mentioned earlier, the project client (Kristian Blomqvist) and the project supervisors (Ehrs Mikael and Nylund Roger) will be able to view the recording or read the typed version of the recording.

Your signature on this consent form indicates your agreement to participate in this study.

I have read the consent form and all of my questions about the study have been answered. I understand that the focus group will be recorded. I agree to participate in this study.

Name: _____

Signature: _____

Date: _____