Rami Alfasfos

Water Efficiency Enhancement in Myyrmäki and Leppävaara Campuses

Helsinki Metropolia University of Applied Sciences

Batcher's Degree

Environment Engineering

Batcher's Thesis

17th May 2013

Instructor: Antti Tohka Senior Lecturer

Author(s) Title Number of Pages Date	Rami Alfasfos Water Efficiency Enhancement in Myyrmäki and Leppävaara Campuses 41 pages + x appendices 17 May 2013
Degree	Bachelor's Degree
Degree Programme	Degree Programme In Environmental Engineering
Specialisation option	Renewable Energy Systems
Instructor(s)	LicSc (Tech). Antti Tohka

Water is the secret source of life and considered as the main component of the living cell. Humans have recognized this fact since existence. Therefore, acquiring water resources has been related with settling, energy, economic growth and even war. Thus, monitoring and researching water sources, usages and discharges are must for all nations.

This thesis introduces the available methods used in monitoring water consumption such as water footprint which is an empirical indicator showing total volume of fresh water used by individual, society or companies for production and consumption purposes, for example for food, paper and heat and enabling the user to keep track on location, time and volume of water usage.

Water Efficiency Enhancement follows Smart Campus project's targets to increase the energy efficiency at the Myyrmäki (Leiritie1) and Leppävaara (Vanha maantie 6) campuses of Metropolia University of Applied Sciences. The project is estimated to reduce water consumption in both campuses from 20 up to 60 percent of water used in both campuses. Moreover, the thesis contributes to the knowledge of consumption rates by investigating bills, metres, sensors and inventories using a historical approach. It also provides an environmental engineering interpretation for water basics of fluid mechanics and introduces new available techniques such as water flow rate-monitoring sensors.

Keywords	Water Footprint, Water Consumption, Water Demand Management (WDM).

Preface

When you reach the summit, look below you to see the people who helped you there, then look up to the sky to ask the god to keep your feet strong enough to stay. What a wonderful saying to describe this moment, and to expand my vision to see even further, searching for other summits.

First and foremost, I would like to express my gratitude to my instructors LicSc (Tech). Antti Tohka, Dr. Minna Paananen-Porkka, Head of the Environmental Engineering Degree Programme Dr. Esa Toukoniitty and Programme Coordinator Jenni Merjankari for their guidance, support and valuable inputs throughout the entire bachelor's period.

Furthermore, I would also like to thank ''Smart Campus'' Project Manager Asko Kippo and Veikko Koivumaa, who awarded me this honourable opportunity to conduct such an amazing thesis project. I would also like to extend my gratitude to every teacher and staff members from the degree programme in Environmental Engineering at Helsinki Metropolia University of Applied Sciences. To all of you, I salute your energy and passion in everything you do.

Finally, I thank Palestine, Finland, my parents and all my friends for their patience and encouragement, without their support I could not have completed this great journey.

Rami Alfasfos
Vantaa, Finland

Contents

Appendices

1 Introduction

Water consumption measurement in any facility is performed through the reading of water volume running through the main pipes. Water passes through a mechanical metre which converts the water flowing into a, whether it is a public building or a household, into value numbers then it’s collected manually by inspectors or automatically using water sensor. Metres measure the volume of water collected as data that is sent into the main server to be interpreted as diagrams or instantaneous numerical data. More details of the measurement process will follow throughout the following chapters. Understanding water consumption measurement process is the first step into saving environment and cost in this sector.

There are many methods to predict water usage of a household in community scale or nation scale. The indication of water usage shows the total volume of water consumed for any reason, such as washing, drinking, watering. Hoekstra has defined this process as ‘Water Footprint’. (Hoeskstra, 2003)

Improving efficiency, whether it is energy, water or ecological conditions in a building, starts by understanding the essential factors that efficiency depends on, such as historical data related to construction’s condition, level of occupancies’ awareness and usage behaviour of the available techniques as well as the climate.

Smart Campus is a European Commotion Project CIP (Competitiveness and innovation framework programme), which aims at a significant reduction in energy consumption in four European universities. In addition, it aims to improve the learning environment and wellbeing of both occupancies. The Smart Campus project duration was planned to last for 2.5 years and start by 2011 but it started in Metropolia campuses after the summer vacations of 2012, with an overall budget of 4.6 million. (Castro, 2011)

Data gathering platforms integrate energy management systems to monitor the consumption behaviour for the purpose of increasing the awareness of users, also to create a learning process which allows interaction between the users and the building in more energy efficient way.

The target of Smart Campus project could be achieved by using ICT (Information and communications technology), which is used essentially for teaching purposes, by transmitting knowledge, ''particularly to students who are not highly motivated to learn or to interpret information'' (Carnoy, 2004). ICT services will provide guidance that leads user behaviour transformation towards more energy efficient practices and awareness of users' energy consuming habits in the targeted building.

Behaviour transformation is expected to contribute with a 15 percent of energy saving, while the total saving would be up to 20 percent in the targeted universities, which are located in Luleå, Lisbon, and Milan.

1.1 Water Footprint

Hoekstra introduced the water footprint concept, for the first time in 2002 to replace the indicator of water use concept (Hoeskstra 2003). Hoekstra is known as the initiator and co-founder of Water Footprint Network. Hoekstra defined water footprint of an individual, community or business to be ''an empirical indicator of how much water is consumed, when and where, showing the total volume of freshwater used to produce the goods and services consumed by the individual or community or produced by the business''. Water volume consumed, evaporated or polluted is then measured and calculated per time unit and location. The scale of water footprint indication for a consumer could be done for an individual, for a family, or for a state and a nation.

The unique criteria of water footprint go beyond the direct use into the indirect use of water of all types. Water types are three main categories: blue water (use of ground and surface water), green water (use of rainwater) and grey water (polluted water). Each one of the above mentioned water types have their own water footprint. In addition, there are different types of water footprint for consumers and for production purposes.

1.2 Project Statement and Objectives

Smart Campus project focuses on upgrading the efficiency of energy in general, using various methods as described above. In that context the project aims to deal with direct energy related issues such as lighting and HVAC. The project does not handle the water consumption and water footprint in the investigated area separately from energy usage; being energy efficient requires also being water efficient. Users should not think of saving or increasing the awareness of energy without involving water consumption. It is considered to be an attuned relation between water and energy, for example, 40 to 45 percent of all domestic water used is heated water, which means any increasing in energy price, would lead to increasing in water prices. (HSY)

The cost of water in Finland is much cheaper than the cost of electricity or district heat; thus, many consumers would not care enough about water saving. Nevertheless, high electricity bill is in one way or another related partially to the amount of consumed water, since pumping heating, treating and sorting water are energy dependent processes. In conclusion, saving water will eventually have a great impact on electricity cost and environment.

Metropolia University of Applied Science was chosen as a subject for research to enforce the scopes of Smart Campus project (SCP). The thesis covers the part, which was absent from SCP; the current situation of water consumption in both campuses was analysed and the areas that have an excess of water and equipment in use were spotted.

The overall purpose of the project was to achieve the main targets of Smart Campus project in the given duration for both campuses (Myyrmäki and Leppävaara); those goals were defined as increasing the water consumption efficiency and the awareness of users. Several steps were conducted starting by analysing the current situation of water consumption in targeted areas, documenting all facilities which utilise and/or have access to water, and identifying the equipment and machines used for that purpose. Historical data of water consumption was also investigated in order to interpret the changes to be able to identify the problem and its causes, which makes it easier to find the suitable techniques for further implementations.

Furthermore, this thesis discusses water consumed, user behaviour, and technologies used in data collection. Also the two campuses are compered regarding areas, number of occupancies and year of foundation. Using inventories and data collection will help the researcher to make accurate conclusion and decisions to find best suitable techniques used in similar projects, and also, to specify water footprint in based-line reading (day, m^3, occupancy).

2 Area of Investigation and Methodology

Metropolia University of Applied Sciences, Finland's largest university of applied sciences in Helsinki, was one of the targeted universities in which the Smart Campus project was to be conducted. Among all departments of Metropolia, two campuses were selected for this purpose: Myyrmäki and Leppävaara. The first is located in Leiritie 1, Vantaa region, while Leppävaara campus is located in Vanha maantie 6, Espoo region. Both of the campuses have a building consisting of two connected wings: A and B. As described in previous chapters, the A building is around 15 years older than the B building. More details will be illustrated in the following paragraphs. The campuses accommodate multicultural students, since Metropolia in total has 16000 students from which 900 foreign degree students, nearly 90 nationalities in both campuses.

Myyrmäki campus consists of two attached main wings: A and B. B wing has three floors consisting mainly of teachers' rooms, two large auditoriums, also a number of computer rooms and classes used for teaching purposes and for public use and practical labs such as physics lab. Moreover, two hallways connect the B wing with the first and second floors of A wing that consists of two floors of mainly classrooms and offices; it has also a large auditorium in the centre of the building which is under renovation at this moment. The first floor in A building includes heavy water consumers, such as kitchen and laboratory; the second floor has a similar structure except that there is no kitchen there. Nevertheless, the Myyrmäki campus has also a sports Hall consisting of a gym, washrooms, sauna and storage room/bomb shelter, and a house called Eco-House, which is basically a detached house, used as offices, in addition to two detached classrooms built in a container. Leppävaara campus more or less has a similar construction design to that of Myyrmäki, some differences will be discussed further later in this thesis. (Helsinki Metropolia UAS, 2010)

This study was started on 19th of October 2012 to achieve its targets by the end of February of the year 2013. Different approaches of investigations were followed for that purpose; a focused project plan and timelines were determined benefiting from similar study cases together with group discussions to help in defining objectives of the project.

A primary data collection started by contacting stakeholders, collecting blueprints, reading books and webpages, and also by requesting water bills. This helped in gaining a general overview of the current situation of water consumption in each campus.

Subsequently, a secondary data collection started using an individual direct observation of the targeted locations. The project utilized the data collected by a group of around 24 Environmental Engineering students when they were making an intensive inventory of Myyrmäki campus as part of life cycle assessment course project. The survey used different equipment and methods (cameras, Excel sheets, interviewing occupancies and internet). An inventory for Leppävaara campus was done similarly as an individual effort by the author of this thesis. The collected data was aggregated, filtered, verified and consolidated as Data Collection and Project Proceeding chapter shows.

The data was collected using some engineering techniques such as a volumetric flow metre, highly sensitive thermometer and the calculation of flow rate to illustrate the practical and theory principles of fluid mechanics and sensors functioning to identify the problems.

3 Literature Review

‘Water is the secret source of life’, this comes from our natural understanding of how water is an essential factor of our life. This fundamental value of water also was expressed well by Amy Vickers. ‘’As we peer into the 21st century, water conservation is looking far more like an imperative than an option" (Vickers, 2001). She also summarized the importance of water conservation in a related issue such as water pollution. Growing of the populations means a dramatic increase in the demand of fresh water, for example. A school will be in a smaller scale than whole population as water is associated with energy resulting in high electricity bills. In a country with more than 300000 of lakes, fresh water is not the most critical issue normal people face everyday life. However, introducing the concept in a different way related to financial calculations will certainly matter to provide an easy way for water conservation and upgrading the level of awareness and self-responsibility of saving water for better future for us and for our coming generations.

3.1 Water Demand Management WDM

Water Demand Management is defined as ‘’the adaptation and implementation of a strategy by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and political acceptability’’ (S.A. Government Online, 2000).

This definition supports aims and scope of this project; since the WDM concept can be simply illustrated by applying the following slogan (use as much as you need not as much you have), and it includes increasing the awareness of users and the efficiency of water consumption. Application of WDM means measuring the right individual or total campus amount needed of water per period of time, similarly termed as Water Footprint (WFP).

3.2 Historical Consumption Data Acquisition

Some important tools for water consumption empirical data collectors in both campuses were measurement metres, heat exchangers, bills, and Ryhti software, Following Ryhti 3.13 chapter will discuss these tools in more detail. Knowledge of the methodology of collecting data and how transferring data into bills and diagrams was also required. The collected data was used to determine the current situation of water consumption in the targeted campuses, which led subsequently to identification of some important technical problems.

3.2.1 Water Metre and Data Measurements.

HSY, which is a Finnish acronym for (Helsingin Seudun Ympäristöpalvelut (Helsinki Region Environmental Services Authority), the provider of water for both campuses, advice customers to read their water metres at least twice a year and requests to report any leakages around the metre or any difficulties in reading the metres and other various instruction and information related to this topic (HSY, n.d.).

To be able to understand the working principle of water metre, basics of fluid mechanics should be gone through. The campuses receive, discharge hot and cold water through huge domestic pipelines; hot water comes with a temperature of around 100 degrees Celsius into the heat exchanger where it is distributed into the buildings' radiators, hot taps and ventilation. The water circulates in the building and returns with a temperature of 33 degrees Celsius as was recorded during a visit to the water distribution facility in the Myyrmäki campus.

3.2.2 Water Metre

A water metre is a device installed after the water-service pipe, which comes from supplier and before the inlet building distribution pipe; it measures the volume of water that passes through those pipes into a building. Water volume is directly related to the amount of the water consumed in that building: if there were any leakage after the metre, it would be calculated as water consumed by the users.

Figure 1 below demonstrates a water metre or registers metre's working mechanism. Water flows from the water-service pipe and it passes the water metre which consists of a wheel or rotator which has an attached spindle with a small gear on the top that rotate clockwise continuously whenever the water flows. The top gear binds with other similar gears responding in different scales to the motion of the top one, ending to the reader of the metre to indicate the consumption per litters in digitalized circles with small spindles. Other metres have one of the gears fixed with a chain of five numbered from 0 to 9 pedals that show the consumption per cubic metre as illustrated in Figure 2. (Meadville Area Water Authority, 2012)

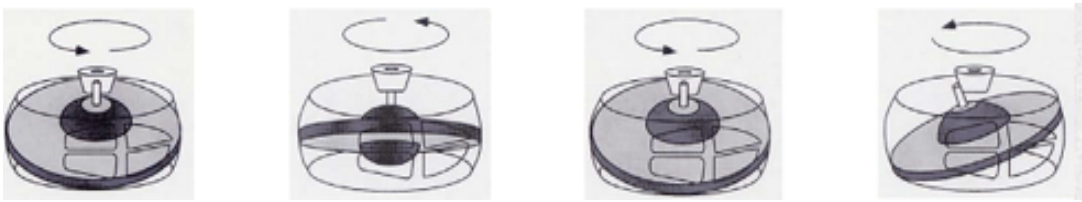
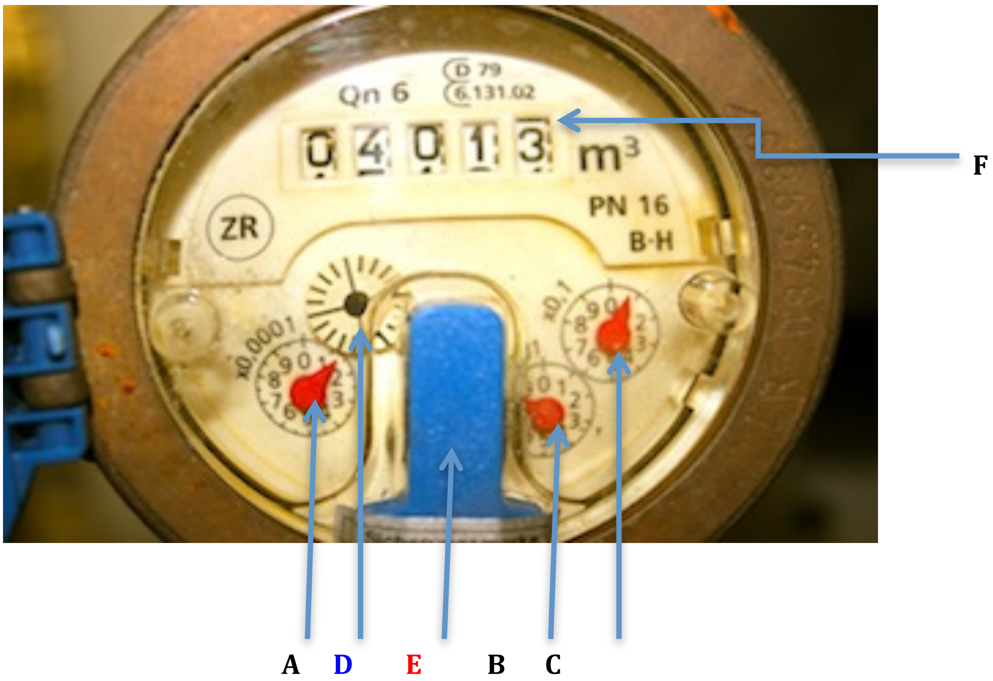


Figure 1. Working Principle of Water/Register Metre (Meadville Area Water Authority, 2012).

3.2.3 Water Metre Readings

HSY recommends consumers to read the water metre at least twice a year to make sure that the bills are accurately calculated and to explore any possible leakages. However, reading the metre require an understanding of the metre mechanism (HYS, 2006).

Figure 2 shows one of water metres located at Myyrmäki campus water distribution room. The five-digits number indicates the water consumed per cubic metre. Red indicators from the right to left (A, B, and C) represent the water consumption per litres, tens and hundreds of litres, respectively, while the black Indicator D represent the changes per cubic metre (one cubic metre equals 1000 litres). Indicator A in Figure 2 below is a fast flow indicator for usage in litres; the rate at which the indicator flows depends on the instant usage of water. Indicator A makes ten rounds, and Indicator B moves one rotation clockwise. The same occurs with indicators B and C, which indicate 100 of litres consumption. Indicator D is a slow indicator rotating after one cubic metre has passed through the metre. A change of the first digit from the right of the five digits (marked as F in the same Figure), will take place whenever indicator D rotates, and this is the water consumption per cubic metre the bill is based on. This number is collected manually each month and transferred into a bill (bills' Data).



A: Indicator for water consumed per litre.

B: Indicator for water consumed per tens of litres.

C: Indicator for water consumed per hundreds of litres.

D: Indicator for water consumed per cubic metre.

E: Electronic devices transfer the reading into platform outside the room (not in use).

F: The five digests demonstrate the consumption per cubic metre.

Figure 2. Reading Principles of Water/Register Metre

According to HSY (2006), the reading accuracy of this kind of metre is about ±5%. Metres are regularly changed every 10 years by the water government or the water supplier.

3.2.4 Bills

Water bills are one of the most important methods in analysing the current situation of water consumption in the targeted locations. Bills for different durations were requested from the supplier and then analysed for comparison with each other and with Ryhti data of water consumption to determine the reliability of data collection and the functions of Ryhti, which is used to determine of the volumetric usage of water per defined factor (year, month, day, occupancies).

Water bills are calculated based on the monthly water volume passing through the main water metre, which is located on the main water-receiving pipe coming from the supplier (HS, 2006). The supplier sends data collectors monthly to read the water metre and register this data into computer software in order to calculate the consumed water cost in Euros. Afterwards, bills are distributed through post or emails upon agreed time (usually every two to three months). Each of those bills contains main detailed information concerning costs and the building classifications.

Consumers should notice that they are not charged based on the amount of water consumed but also based on the waste water and other factors such as the classification of building. According to ''HSY's water services rates: Espoo'' published on July 2010, ''the usage rate is charged separately for water, acquisition and sewerage'' (HSY, 2012). This is not contrary to the discussed matter, but it means that water acquisition and sewage have different price rates that are added on the water usage rate.

Tables 1 and 2 below illustrate the water and waste water rates according the same source. Each customer connected to the water supply network is charged a basic rate *s* which is in Metropolia' case is equal to *s*=1 according to the floor area and type of property and the use of services which are classified for both campuses as Table 3 illustrates. In addition, basic type of property in both campuses and their factors *p* is equal to *p* =1.6 since the campuses are classified under *public building* (primary use: other than as an office).

The basic rate *B* €/month is calculated as follows according to the HSY published service rate sheet. (It is good to mention at this point that VAT for the year 2013 has increased to be 24% instated of 23%) (HSY, 2012):

$$B = p * BAJ * s \qquad (1)$$

Where *p* is property type factor (1...3), *BAJ* is fixed basic rate (€/month) according to floor area class (A...J), and *s* is service factor.

Table 1. Water Rate €/m^3

Without Tax	With Tax (VAT 24%)
1.04	1.29

Table 2. Waste Water Rate €/m^3

Without Tax	With Tax (VAT 24%)
1.27	1.57

Table 3. Floor Area and Payment Class (€/month) for Both Campuses.

Campus	Floor Area m^2	Payment Class	€/month Without Tax	€/month With Tax (VAT 24%)
Myyrmäki	> 10,000	J	186	228,78
Leppävaara	> 10,000	J	186	228,78

On the basis of the details given in table 1,2 and 3 above, the basic rate *B* (€/month) is calculated using equation (1) above:

$$B = 1.6*186*1 = 297.6 \text{ (without tax)}$$

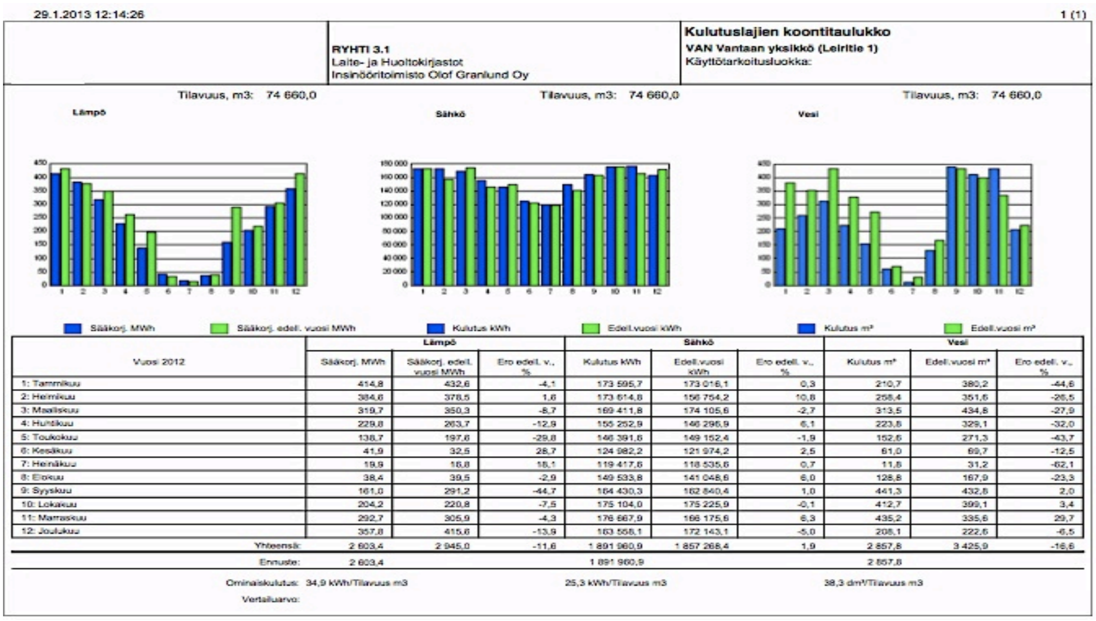
It is very important to read water metre and compare it with the bill to identify a miscalculation. Any leakage will be considered if the consumption more or less is the same with high bill; most likely the there is a leakage after the water metre. In that case a report is a must immediately. (HSY, 2012)

3.2.5 Ryhti 3.13

Ryhti is an applications' web operating with CMMS (Computerized Maintenance Management System*)* software for hourly energy consumption monitoring since 1992; it has been developed by Grandlund Engineering Company, which is an expert company in developing software to enhance the energy efficiency. Metropolia uses Ryhti 3.13 to monitor their energy efficiency. Part of the data used in this thesis was based on collected data from this application (Granlund, 2011).

The main operation principle of Ryhti 3.13 web is to collect large amount of various data concerning a targeted building for monitoring purposes, to be used afterwards as free text demonstrated on Ryhti web for reporting purposes and detecting consumption deviations whenever a new consumption figure is added. Ryhti web simply provides the user with wide range of information of targeted building, monthly database platforms of figures, diagrams and tables used for comparing some current usage of energy sectors such as electricity, water, and district heat. In addition, it establishes a comparison of the previous parameters with another duration usually previous year's consumption also provides the users with percentage indicators of the current consumption as Figure 3 below demonstrates. Moreover, Ryhti discloses a chart enables the user to keep track on any maintenance procedures or plans.

One of the main targets of this project on both campuses is to provide the users of Ryhti 4 and the occupancies of the campuses with instantaneous or hourly of consumption demonstrated on platform screens from specified locations.



29.1.2013 12:14:26 1 (1)

RYHTI 3.1
Laite- ja Huoltokirjastot
Insinööritoimisto Olof Granlund Oy

Kulutuslajien koontitaulukko
VAN Vantaan yksikkö (Leiritie 1)
Käyttötarkoitusluokka:

Tilavuus, m3: 74 660,0 — Lämpö
Tilavuus, m3: 74 660,0 — Sähkö
Tilavuus, m3: 74 660,0 — Vesi

Säākorj. MWh — Sääkorj. edell. vuosi MWh — Kulutus kWh — Edell.vuosi kWh — Kulutus m³ — Edell.vuosi m³

Vuosi 2012	Lämpö			Sähkö			Vesi		
	Sääkorj. MWh	Sääkorj. edell. vuosi MWh	Ero edell. v., %	Kulutus kWh	Edell.vuosi kWh	Ero edell. v., %	Kulutus m³	Edell.vuosi m³	Ero edell. v., %
1: Tammikuu	414,8	432,6	-4,1	173 595,7	173 016,1	0,3	210,7	380,2	-44,6
2: Helmikuu	384,6	378,5	1,6	173 614,8	156 754,2	10,8	258,4	351,6	-26,5
3: Maaliskuu	319,7	350,3	-8,7	169 411,8	174 105,6	-2,7	313,5	434,8	-27,9
4: Huhtikuu	229,8	263,7	-12,9	155 252,9	146 296,9	6,1	223,8	329,1	-32,0
5: Toukokuu	138,7	197,6	-29,8	146 391,6	149 152,4	-1,9	152,6	271,3	-43,7
6: Kesäkuu	41,9	32,5	28,7	124 982,2	121 974,2	2,5	61,0	69,7	-12,5
7: Heinäkuu	19,9	16,8	18,1	119 417,6	118 535,6	0,7	11,8	31,2	-62,1
8: Elokuu	38,4	39,5	-2,9	149 533,8	141 048,6	6,0	128,8	167,9	-23,3
9: Syyskuu	161,0	291,2	-44,7	164 430,3	162 840,4	1,0	441,3	432,6	2,0
10: Lokakuu	204,2	220,8	-7,5	175 104,0	175 225,9	-0,1	412,7	399,1	3,4
11: Marraskuu	292,7	305,9	-4,3	176 667,9	166 175,6	6,3	435,2	335,6	29,7
12: Joulukuu	357,8	415,6	-13,9	163 558,1	172 143,1	-5,0	208,1	222,6	-6,5
Yhteensä:	2 603,4	2 945,0	-11,6	1 891 960,9	1 857 268,4	1,9	2 857,8	3 425,9	-16,6
Ennuste:	2 603,4			1 891 960,9			2 857,8		
Ominaiskulutus:	34,9 kWh/Tilavuus m3			25,3 kWh/Tilavuus m3			38,3 dm³/Tilavuus m3		
Vertailuarvo:									

Figure 3. Ryhti 3.13: District Heat, Electricity and Water Consumption of Myyrmäki. 2012-2011 (Granlund, 2013)

3.3 Data Collection and Project Proceeding

Data collection need to be discussed in more detail, for example how the author gathered, analysed, filtered, aggregated and consolidated the relevant data. Also, a comparison between the two campuses will be provided. The diagram below helps in visualising and illustrating the pathway of data collection.

The Pathway of Data Collection Procedure

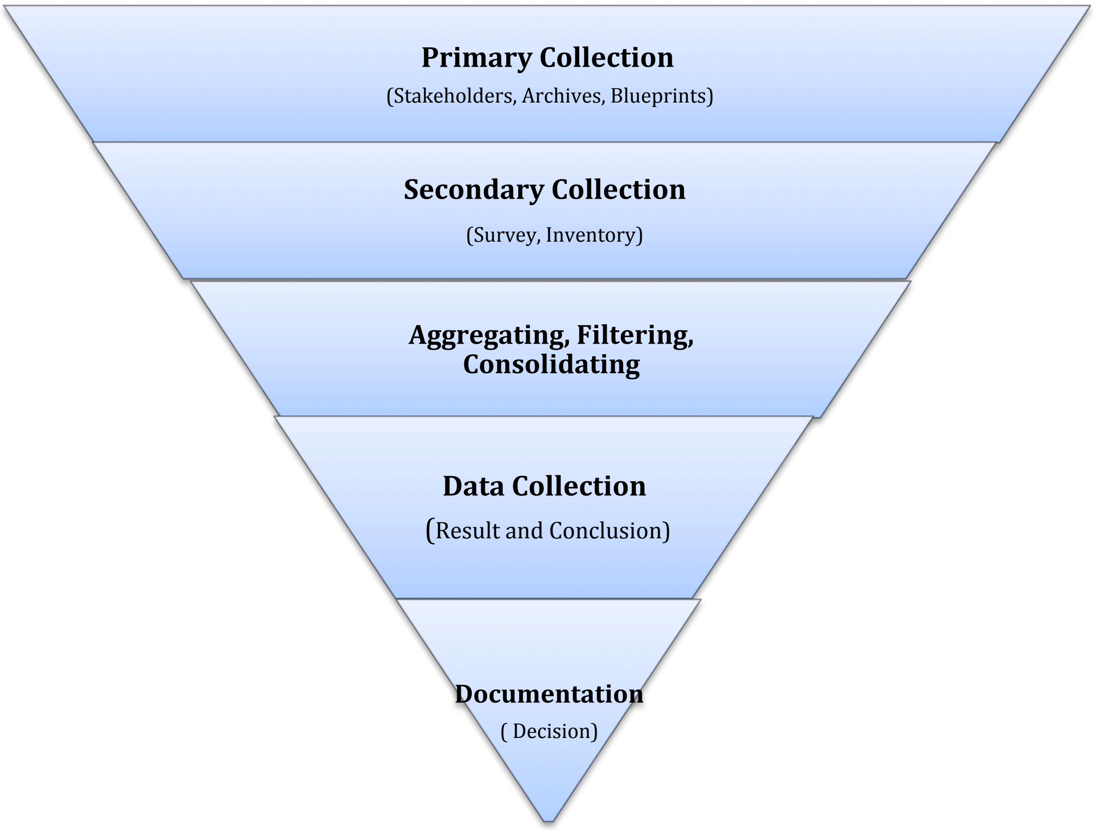


Figure 4. Pathway of Data Collection Procedure

Data collection procedure was derived from similar projects and thesis studies which have been conducted in different locations around the world. Investigating references of any field concerning this project was also considered as part of the primary data collection where the researcher should start with a basic understanding for the subject and then collect as much information and as many contacts as available within defined duration.

3.3.1 Primary Data Collection (Methods and Observations)

Primary data collection should start after drafting a Water Management Plan (WMP), where a simple project plan is made to identify the necessary actions and data resources. These essential procedures were already taken into practice as the first kick-off meeting of this project was held.

Primary data collection is the project's strongest base. One of the most challenging parts was finding the reliable data recourses and references; therefore the researcher went through most of the available books in the library concerning this subject and trustworthy similar projects.

Furthermore, the collected data and blueprints of the buildings was analysed to find where all the areas which have access to water were located to survey them in the secondary data collection phase explained in the following chapter.

3.3.2 Secondary Data Collection (Survey, Inventory)

All the profound targets that primary data collection could achieve was neither enough to grant a positive conclusion nor enough details to come up with the right recommendation. A research group of 25 students was established to create an inventory database and were provided with the main objectives of Smart Campus project aiming to motivate them to be involved in implementing the project in their campus. Table 4 below shows the types of the collected data used to determine the most water-consumed facilities and also any suspended equipment and to visualize the selection approach for implementations.

Table 4. Example of Collected Secondary Data

Extra Notes	FLOOR /WING	NUMBER	TYPE	ACCESS TO WATER Y/N	TAPS' TYPE	WC SEATS (Number)	LEAKAGE Y/N	NUMBER OF LEAKING TAPS	Radiator (ON/OFF)
	F/A	103	Classroom	Y	Hot/cold	0	N	No	ON
	F/A	104	Classroom	N	N	0	N	No	2*off
	F/A	105	Teacher's room			0			
	F/A	106	Classroom	Y	Hot/cold	0	N	No	ON
	F/A	107	Teacher's room	N		0			ON
	F/A	108	Teacher's room			0			
	F/A	109	_	Y		0			ON
	F/A	110	Classroom	N		0			Off

Secondary data collecting lasted for three days during this time three groups of students were formed, provided with cameras, a copy of the Excel sheet and also extra paper for note taking. To ensure the reliability of the results, the researcher guided the group work. The results of this inventory are shown in the next chapter where the results were filtered. The survey Excels files with extra details can be found in Appendix 1.

3.3.3 Aggregating, Filtering and Consolidating Collected Data

Survey sheets from the three groups were collected and aggregated into one Excel sheet. Filtering data made it easy to detect the unreliable data and also to locate the missing datum from the returned sheets. A comparison among the data that have been collected from the field and another interpreted from the blueprints borrowed from campus archives and the data on Ryhti 3.13 webpage helped in solving the problem and completing the missing data. Co-operation with maintenance personal covered the extra remarks concerning the leakage type of equipment.

Consolidating data has been done side-by-side with the filtering step since each investigated facility where checked twice first by student groups then by author. In addition, numbers and locations of equipment were rechecked according to the blueprints, as was also the historic maintenance schedule of the campus. Lists of findings and results containing types (brands), codes ‘numbers, locations of equipment were gathered in tables in the same Excel sheet. The survey for kitchen was done separately by the author, due to its importance as heavy water consuming location in the campus.

Primary and secondary data collection was applied only on Myyrmäki (Leiritie 1) campus. Similar data collection techniques for Leppävaara (Vanha maantie 6) campus were applied later by the researcher LCA groups. On the basis this available data, a clear picture of the current situation of two locations was formed that show the heavy water consuming facilities, which build a baseline for comparing the two campuses depending on various factors that will be discussed in the Summary and Comparison Analysis chapter.

3.4 Data Collection Results and Conclusions

Table 5 below demonstrates numbers, types and locations of water equipment, which are in use in Leppävaara and Myyrmäki campuses, these details in Table 5 were used to assist in discussing whether there is a problem that should be solved and establishing an implementation schedule as it is discussed in the Recommendation chapter 6.

Table 5. Results of Secondary Data Collection

First Step of Implementation (Testing Step)				
Leppävaara		1.2.2013	**Myyrmäki**	
Total Number of Taps	208		Total Number of Taps	353
Total Number of Toilet & GYM (Oras)	110		Total Number of Toilet & GYM (Oras)	130
Total Number of Toilet Seats	73		Total Number of Toilet Seats	93
Single Flush	58		Single Flush	45
Double Flush	10		Double Flush	18
Manual Urinal Flusher	10		Manual Urinal Flusher	25
Sensor Urinal Flusher	0		Sensor Urinal Flusher	10
Showers	12		Showers	8
A			A	
Total Number of Toilet Seats	63		Total Number of Toilet Seats	60
Total Number of Taps	153		Total Number of Taps	264
Double Flush	62		Single Flush	37
Single Flush	10		Manual Urinal Flusher	13
Toilets' Taps	75		Toilets' Taps	75
Other Facilties Taps	78		Other Facilties Taps	189
B			B	
Total Number of Toilet Seats	10		Total Number of Toilet Seats	19
Total Number of Taps	55		Total Number of Taps	88
Single Flush	18		Double Flush	18
Manual Urinal Flucher	1		Single Flush	1
Toilets' Taps	23		Sensor Urinal Flusher (Oras Electra)	9
Other Facilities Taps	32		Toilets' Taps	37
			Other Facilties Taps	51

On the basis of the comparison between the results of data collection procedures made in both campuses and in the above-mentioned chapters, the concluded water consumption percentage estimations based on the facilities are shown in Figure 5.

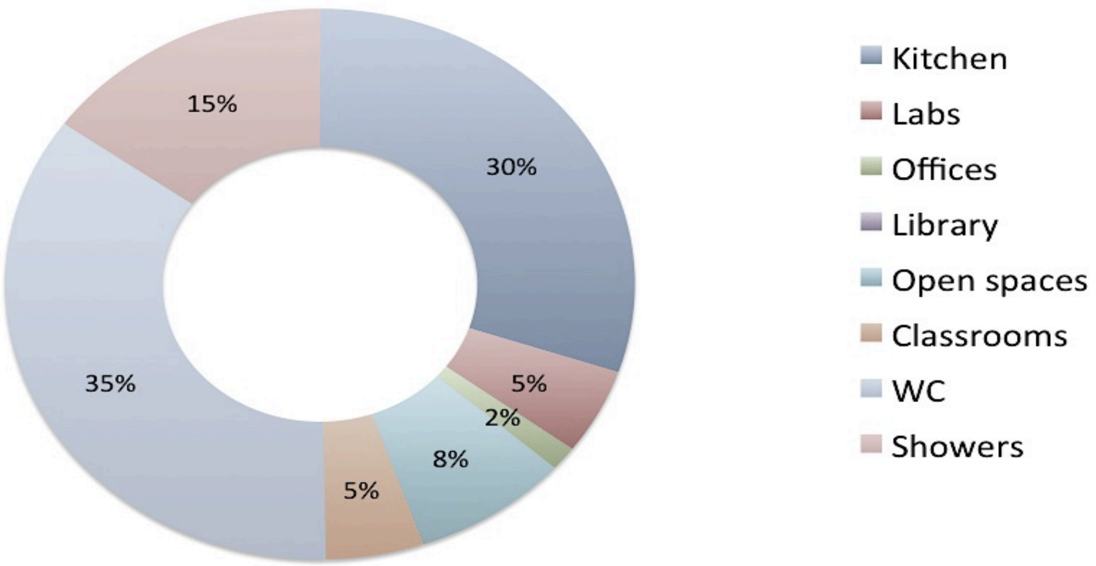


Figure 5. Estimation of Water Consumption Facilities Dependence

Figure 5 shows that the most water consuming facilities are: toilets, kitchen and showers respectively. Library and offices shows the least water consumption.

4 Summary and Comparison Analysis

At this level this chapter will highlight the actual numerical water consumption in both campuses taking into account its correlations with number of occupancies and area. In addition, it will investigate difference types of water equipment used in each campus.

Placing data on platforms that display progressing evaluation of energy and water savings will create a competition factor between the two campuses. In addition, it is necessary to analyse and compare both campuses in order to draw a clear conclusion.

4.1 Myyrmäki vs. Leppävaara

Metropolia UAS campuses offer various bachelor's degrees such as: IT, business, technologies, and media engineering, also both Finnish and English languages are used in teaching those degree programs; for these reasons, students are attracted to enrol into Metropolia campuses especially Myyrmäki and Leppävaara, which have almost one third of Metropolia enrolled students (Helsinki Metropolia UAS, 2010). Nevertheless, number of enrolled students is usually proportional with the amount of consumed energy (water, electricity, heat…) level. Table 6 shows an increase in Myyrmäki students' enrolment, while it is the opposite in case of Leppävaara campus.

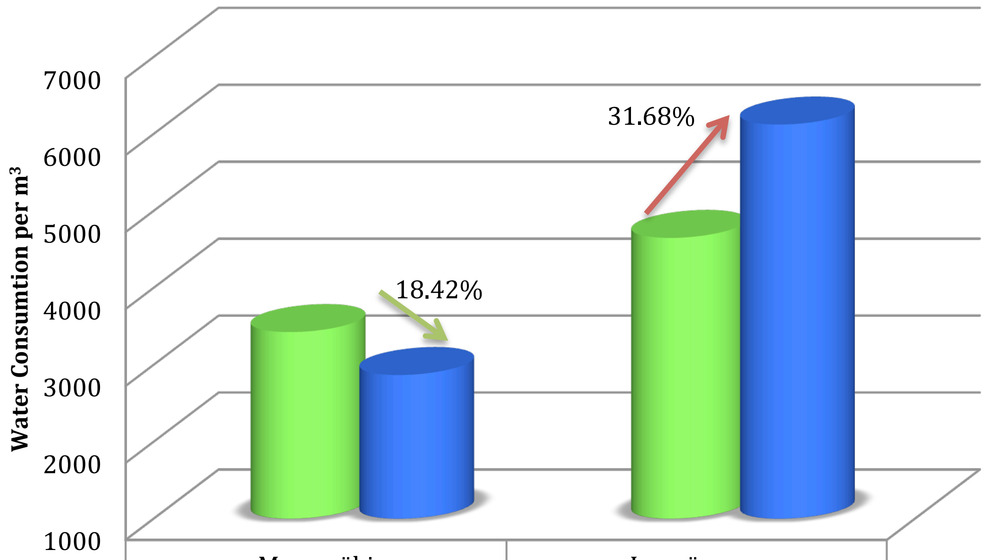
Table 6. Students Enrolment in Myyrmäki and Leppävaara. Comparison 2011-2012.

Campus/Year	Myyrmäki	Leppävaara
2012	2766	2693
2011	2579	2780

Leppävaara campus has larger surface area and enrolled students than Myyrmäki campus; thus a higher level of water consumption is expended in Leppävaara campus than it is in Myyrmäki campus.

The drop in total water consumption in 2012 at Myymäki campus was about 20% of the water consumption in 2011, while Leppävaara campus had about 32% increase in the total water consumption in the same time period, as it is shown below in Figure 6.

The pervious paragraph shows unexpected results of water consumption in both campuses since, as explained above, the number of enrolled students should be proportional to water consumption. In 2012, Leppävaara campus had 3% less students than it had in 2011; at the same time, Myyrmäki campus had an increase of about 7 %. Possible causes of these results are explained in the following paragraphs.



	Myyrmäki	Leppävaara
2011	3425	4649
2012	2867	6122

Figure 6. Water Consumption per m^3 In Both Campuses. Comparison 2011-2012.

Leppävaara and Myyrmäki campuses' water consumption bills were checked, and they showed almost the same results as Figure 5. This procedure was made to ensure that there was no misreading of water metre in both campuses during 2011-2012.

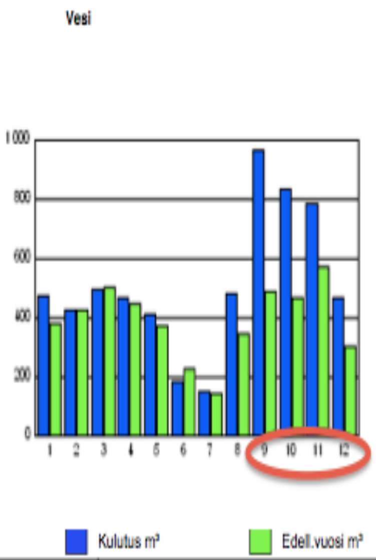
Leppävaara

Kulutuslajien koontitaulukko

ESP Espoon yksikkö (Vanha maantie 6)

Käyttötarkoitusluokka:

Tilavuus, m3: 75 000,0



Sähkö		Vesi		
)ell.vuosi kWh	Ero edell. v., %	Kulutus m³	Edell.vuosi m³	Ero edell. v., %
175 978,6	-10,5	475,7	373,9	27,2
178 313,3	-61,2	428,1	427,5	0,2
184 915,0	-60,0	493,1	501,5	-1,7
180 954,4	82,2	466,2	443,3	5,2
185 371,1	-11,1	408,2	368,5	10,8
154 437,0	-7,5	181,0	222,2	-18,5
152 204,2	-2,2	146,5	140,1	4,6
166 748,2	-2,0	481,0	342,5	40,4
180 796,9	-4,7	965,4	490,3	96,9
182 653,1	-5,5	831,4	469,7	77,0
187 130,0	-10,2	781,8	570,0	37,2
142 774,4	9,8	464,2	300,3	54,6
072 276,3	-7,4	6 122,7	4 649,6	31,7

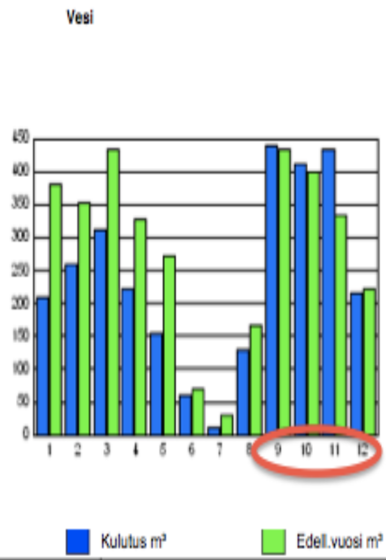
Myyrmäki

Kulutuslajien koontitaulukko

VAN Vantaan yksikkö (Leiritie 1)

Käyttötarkoitusluokka:

Tilavuus, m3: 74 660,0



Sähkö		Vesi		
)ell.vuosi kWh	Ero edell. v., %	Kulutus m³	Edell.vuosi m³	Ero edell. v., %
173 016,1	0,3	210,7	380,2	-44,6
156 754,2	10,8	258,4	351,6	-26,5
174 105,6	-2,7	313,5	434,8	-27,9
146 296,9	6,1	223,8	329,1	-32,0
149 152,4	-1,9	152,6	271,3	-43,7
121 974,2	2,5	61,0	69,7	-12,5
118 535,6	0,7	11,8	31,2	-62,1
141 048,6	6,0	128,8	167,9	-23,3
162 840,4	1,0	441,3	432,8	2,0
175 225,9	-0,1	412,7	399,1	3,4
166 175,6	6,3	435,2	335,6	29,7
172 143,1	-1,9	217,6	222,6	-2,2
857 268,4	2,2	2 867,3	3 425,9	-16,3

Figure 7. Leppävaara and Myyrmäki Monthly Water Consumption 2011-2012. (Ryhti 3.13)

Ryhti 3.13 tables and diagrams, as shown in Figure 7, are tracking the water consumption in Leppävaara and Myyrmäki campuses for the current year (*Kultus*) and previous year (*Edell.vuosi*). They also show the difference of water consumption of tracked years percentage. Nevertheless, water consumption usually reaches its peak as school starts at the end of August; then it starts to fluctuate in the following four months. In February water consumption starts to decline until it reaches the bottom level as the school holiday starts at the end of May, and it stays at that level for the following three months. Figure 6 shows unusual water consumption at peak time between August and December since water consumption almost doubled in Leppävaara campus, while it stayed more or less the same in Myyrmäki campus.

Myyrmäki water consumption declined in 2012 as a result of adjusting water flow in the main supplying pipes. This procedure was meant to reduce water flow rate in the outlets, such as taps and showers. Water flow adjustment was not applied in Leppävaara campus; in addition, possible leakages in Leppävaara A building might have caused the increase of water consumption in 2012.

4.2 A Building vs. B Building

It is known that modern buildings are generally following higher energy efficiency than older buildings. The B wings in Leppävaara and Myyrmäki campuses were built in 2002, while the A wings are about 15 years older than the B wings in both campuses. The use of new techniques and equipment in the B wings explains the efficiency of water usage as is shown in Figure 7. The A wings in Leppävaara and Myyrmäki campuses are considered as heavy water consumers, in comparison with the B wings because the A wings are still utilizing 26-year-old equipment. The surface area and number of occupancies are larger in the A wings and in the B wings in Leppävaara and Myyrmäki.

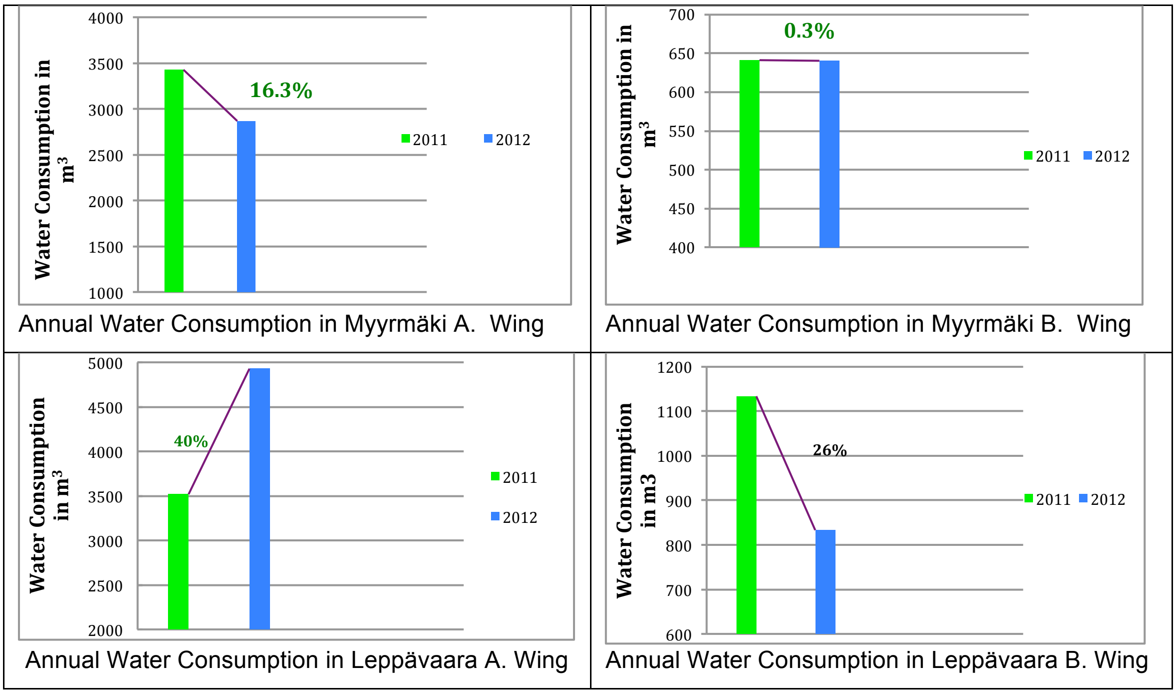


Figure 8. Water Consumption Comparison Between the A and B Wings in Myyrmäki and Leppävaara Campuses in 2011-2012.

4.3 Identifying a Division for Action (Scope)

Wheeler and Ganji have expressed the importance of performance testing step as an essential part of any engineering experimentation (Wheeler and Ganji, 2004). A Large numbers of water equipment is in use in Leppävaara and Myyrmäki campuses as is shown in Table 5. The efficiency enhancement plans focused on specific locations and equipment in order to find the most cost effective solutions with a limited budget.

5 Approach Selections for Implementations

This chapter will discuss monitoring and optimizing the water consumption techniques followed and proposed in Leppävaara and Myyrmäki campuses. Installing new devices and equipment, such as water sensors, shower-headers and replacing older water system with more efficient ones also will be argued for.

5.1 Sensor Techniques and Monitoring System

Manual or online monitoring provides the users with the current water consumption of a building, which also means the flowing water into and out of the building.

A water supplier inspector, who monthly collects water metre readings in a building, achieves manual monitoring. These readings are then used to calculate water bills, which are sent to the users. The regular manual monitoring does not contribute to the objectives of this thesis since the status of water consumption in Leppävaara and Myyrmäki campuses needed be read instantaneously.

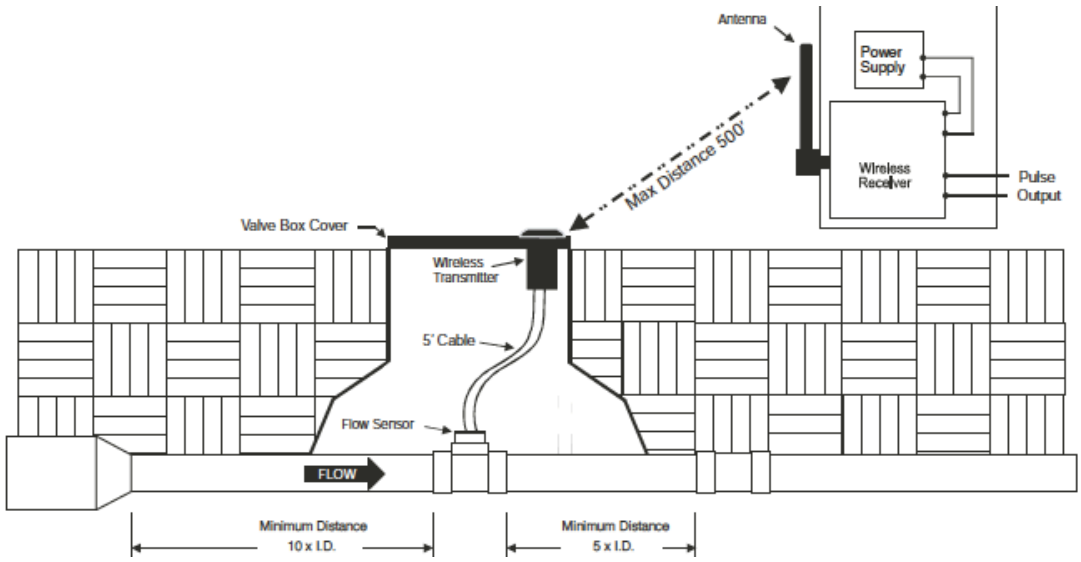
PT878 portable flow metre was tested in Myyrmäki campus for teaching purposes, and it offered a new approach using ultrasonic waves to measure the flow rate of liquid that runs though a pipe. PT878 portable is assembled directly on the surface of a pipe and it calculates the flow, then it saves the collected data in a continuous manner or over any selected time period. The PT878 portable collected data are transferred using an IR (infrared) port, which transfers the data log into a computer, but it should be placed very close to the computer to achieve a good data transfer; therefor, using PT878 portable was not feasible in this thesis project. Myyrmäki campus already has a PT878 portable flow metre, which could be used as backup flow metre for monitoring the functionality of the water metre or other flow-metre sensors in the buildings due to its high accuracy and simple use.

Online monitoring of water consumption was regarded as a practical option to achieve the water efficiency enhancement target of this thesis. A fixed water flow sensor assembled on main pipe before the water metre sent a constant signal into an installed computer software which kept track on water flowing into a building and provided the readings as numbers or graphs in main campus screen platform.

Picture 1 below describes the working principle of a water flow sensor. The 228PV is an example of a wireless flow sensor system produced by Badger group.
The 228PV flow sensor is connected to a wireless transmitter, which sends the readings of water flow rate as a signal to a receiving software installed on the PC outside the water distribution room. (Badgermetre, 2009)

Water flow with sensor techniques provides the users with instantaneous data to determine the efficiency of water usage, and also the time and place of water consumption. More developed sensors can even send an alarm as SMS to the users, if there is a possible leakage or a high peak of consumption.

.



Picture 1. Wireless Flow Sensor System (Badgermetre, 2009)

Some Finnish public buildings similar to those on Leppävaara and Myyrmäki campuses, such as Viikki Environment House also Ala-Malmi Elementary School are already using Water Flow sensors to track their water consumption.

5.2 Optimization the Water Pressure (Flow Rate)

Water is distributed into a public building facilities and equipment uses water by means of a hydraulic capacity process. HSY is supplying Leppävaara and Myyrmäki campuses through a standardized dimension of distribution pipes, which could handle a flow rate of <2. m/s. The standard level of a pressure in the main supply pipe, which distributes water into a building, is between 10-15 bars (HSY, 2012).

Lowering the pressure in the main supplying pipe reduces the flow rate in outlets, such as taps and showers. In another words the water column will be less, and this can reduce the total water consumption of the outlets in every use.

Maintaining the water systems in Leppävaara and Myyrmäki campuses occurs twice a year: once in spring and once in autumn. The maintenance procedure includes changing old un-efficient or broken equipment, fixing leakages. In the previous summer maintenance, Myyrmäki campus set its main supply pipe pressure to 10-11 bars, which reduced the flow rate in water output. About 20 % reduction of total water consumption in 2012 was the result of optimizing the pressure at Myyrmäki campus. Darcy Equation below explains how the pressure optimizing affects the flow rate in a pipe (Çengel and Cimbala 2006).

$$P = f \times v^{2} \times \frac{\rho}{2} \times \frac{L}{D} \qquad (2)$$

Where P is the pressure difference, f is Dracy friction factor, ρ is the density of a fluid, L and D in the length and the diameter of a pipe, and v is the flow velocity. All the factors in Darcy Equation are constant except pressure and flow velocity; lowering the pressure will reduce the velocity of the fluid running through the pipes, which also means reducing the flow rate in outlets as shown in the flow equation 3 (Çengel and Cimbala 2006).

$$Q = v \times A \qquad (3)$$

Where Q is the volumetric flow rate, v is the velocity of flowing in a pipe, and A is pipe's cross-sectional area.

Moreover, optimizing water flow should consider not affecting the quality of water neither the convenience of the users.

5.3 Toilet Seat Implementations

Classifications of toilet seats in use in Leppävaara and Myyrmäki campuses will be presented (Table 7 and Table 8). Also a demonstration of implementation with possible results and challenges will be given nevertheless, the financial analyses of toilet seat implementations will be discussed in the Propositions Financial Analysis and Recommendations chapter.

Table 7. Toilet Seats and Urinal Flusher Leppävaara and Myyrmäki Campuses.

Myyrmäki Campus. Leiritie 1.		**Leppävaara Campus. Vanha maantie .6**
Total Number of Toilet Seats	93	73
Type 1 Single Flush	45	58
Type 2 Dual Flush	18	10
Type 3 Manual Urinal Flusher	25	10
Type 4 Sensor Urinal Flusher	10	0
Minimum Estimated Yearly m^3 Of Water Consumption	1100	1400
% Of Total Consumption	Almost 31%	Almost 31 %

According to the author's estimation given in Table 7, toilet seats and urinal flushers are estimated to consume about 31 percent of the total water consumption in each campus Leppävaara or Myyrmaäki.

Table 8. Comparison of Single and Dual Flush Toilet Seats.

Single Flush Toilet Seats		Dual Flush Toilet Seats
		
Type:	IDO / Arabia (Single Button Flush).	IDO (Dual Button Flush).
Water discharge:	9 – 11 litre/Flush	3 litre/Flush for the small press 6 litre/ Flush for the big press
Required pressure for clean flush:	170 -250 kpa	170 -250 kpa

Single flush toilet seats used in Leppävaara and campuses are either Arabia's or I IDO's old brand. Arabia is an old brand name of IDO products used before Arabia changed its name into IDO at the beginning of nineties (IDO, n.d). Thus, single flush toilet seats are old types, which are not found in modern buildings. For that reason, single flush toilet seats are found mainly in the A wings in Leppävaara and Myyrmäki campuses. Dual flush toilet seats are found only in the B wings of the campuses.

Table 8 shows one push of a button in the single flush system is enough to discharge 11 litres of water, while only 3-6 litres of water- depending on whether you push the small button or the big one - are discharged using the dual flush seats. Hence, the dual flush toilet seat would be an absolute option sooner or later for water conservations in a public building.

The following subsections will present suggestions on how to more efficiently Implement the toilet seats in Leppävaara and Myyrmaki campuses:

5.3.1 Replacing Toilet Seat From Single Flush to Dual Flush

Renewing old equipment is always a tough option on ownership, especially if the breaking-even point is around 10 years, as the Propositions Financial Analysis and

Recommendations chapter will explain. The low prices of water in Finland, makes replacing toilet seats less convenient for building owners. Nevertheless, the replacing option is still valid because, as part of maintenance procedures, any broken single flush could be replaced with new dual flush.

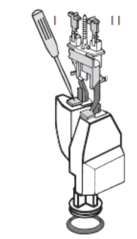
5.3.2 Optimizing the pressure

Lowering the pressure to its optimum level can give a very good result, as mentioned in Optimization the Water Pressure (Flow Rate) section. It is a costless option and easy to apply, even though clean toilet seat flushing should always be taken in account; for instance, the final pressure for a clean flushing in single and dual flush toilet seats, must be in the range of 170-250 kpa as is shown in Table 8. A lower pressure than 170 kpa will cause inconvenience for the user.

5.3.3 Adjusting the Water Storage Tank of Single Flush

Adjusting the water storage tank of a single flush toilet seats is a widely used technique to enhance the efficiency of water consumption, especially in public buildings, offices and private households. According to IDO (n,d.), adjusting the tank of a single flush could save 5 litres per flush; also, adjusting water tank of a dual flush reduces the water consumption to 3.8 litres/flush for II flush and to 2.3 litres/flush for I as is shown below in Figure 8.

Including the adjustment technique in the regular maintenance plan in Leppävaara and Myyrmäki makes it a feasible and costless option. However, levelling the water storage tank is a vital procedure, since at the same time, the adjustment of the toilet seat is checked for any possible leakage and any possible problems inside are repaired.


GB Adjustment tables

WC Trevi E 95, 98 WC 958E, WC 950E		
Float rod scale cm	Small flush l	Big Flush l l
0		3.3
0.5		3.6
1		3.8
1.5		4.0
2	2.4	4.2
2.5	2.6	4.4
3	2.8	4.6
4	3.2	5.1
5		6.0

Other Trevi E models		
Float rod scale cm	Small flush l	Big Flush l l
0		3.8
0.5	2.3	4.0
1	2.5	4.3
1.5	2.7	4.5
2	3.0	4.7
2.5	3.2	4.9
3		5.1
4		5.5
5		6.0

Due to ceramic manufacturing tolerance table accurancy is ±0,3 litres.

Figure 9. Adjustment Tables of IDO Toilet Seat Dual Flush (IDO, n.d)

5.4 Taps and Showers Implementation

The implementation of taps and showers was a major interest of the water enhancement process. Besides toilet seats Taps and showers are the most important water equipment, which are in almost daily use by the occupants of the buildings. Myyrmäki and Leppävaara campuses have over 550 taps mostly supplied by Oras Company, except for the special type of taps in laboratories and kitchen. Most of the used taps are situated either in WC rooms or in shower areas while the taps in offices of classrooms are rarely used. Moreover, each campus has 10 showers of Oras type, which are used daily. Table 9 classifies main types of taps and showers used in Leppävaara and Myyrmäki campuses.

Table 9. Classifications of Showers and Taps in Leppävaara and Myyrmäki Campuses.

Type	Flow rate		Pressure
Shower thermostat	0,2 dm^3/s	12 l/min	130 kpa
Shower single lever faucet	0,2 dm^3/s	12 l/min	130 kpa
Basin single lever faucet	0,1 dm^3/s	6 l/min	130 kpa

Taps and showers in the campuses are high quality equipment and have been manufactured according to the Finnish standard of flow rate and pressure, which flows the quality and environment sanders ISO 9001, ISO 14001 (Oras Oy, 2013). However, damaged taps and unnecessary excessive water usage are the main reasons for water loss in Leppävaara and Myyrmäki campuses.

5.4.1 Changing the Behaviour and Increasing the Awareness

Changing the behaviour to a more efficient water usage could work as well as any modern efficient techniques. Educational programmes, brochures or notifications stickers could achieve an increase in the awareness of water saving among the users. Most efficient equipment is usually made to replace the human misuse of equipment However, changing the behaviour depends on the equipment efficiency; for example, whatever a user of a single flush toilet will do, a large amount of water is discharged, while you could save more than 50% of water if you install a dual toilet seat and provide the users right instructions of its use.

5.4.2 Aerators and Showerheads and/or Adjusting the Pressure

Taps and showers in Leppävaara and Myyrmäki campuses are functioning in a high pressure standard which means optimizing the main flow will not affect the water flow of taps and showers. However, adjustment of the flow rates using a screwdriver would reduce the water flow of the taps to any desired level. In addition, showerheads with an eco-button or aerators for the taps and showers can also regulate the water flow (Picture 2).

According to Oras Oy (n,d.) and similar studies done by the Australian governments (Quinn and Munzinger et al., 2006) on increasing efficiencies of water usage, manual adjustment of water flow rate or the external parts for the showers and taps, such as showerheads with an eco-button or aerators, can save between 30% up to 50% of the total water consumption in a public building.

Picture 2. Three Types of Taps Aerators (Faucets, 2013)

5.4.3 Sensors and/or Automatic Push-Button

Running water for an unnecessarily long time from showers and taps is a current problem in Myyrmäki and Leppävaara campuses. Touchless and automatic push buttons are proposed as a solution for the misuse of water. Implementing approaches try to keep changes within the user's level of conventions for that reason, touchless and automatic push buttons do not change the flow rate of showers and taps while they reduced water-using time, with a push button pressed by the user or with a touchless option operated by an electronic sensor system

Pressurized button allows water running for an adjusted time period, for example 7-12 seconds for taps and 20-30 seconds for showering; electronic sensor taps can achieve up to 70 % reduction of water per use (Autotaps, 2013).

Taps and showers with the motion sensor technique have three main features, which are also considered as targets of Smart Campus Project:

1. Most saving
2. Most hygienic
3. Convenience for the utilizers

A total of 12 of *Oras Electra 6150F* Touchless washbasin faucets were selected to be distributed in Myyrmäki campus as a first testing step. Three locations estimated to be the most water consuming areas In Myyrmäki campus first floor A wing were selected to start the testing step. Six toilets next to the main entrance and the dining area were targeted for the testing step.

The *Oras Electra 6150F* faucet was selected among different types and brands of sensor taps because of its good properties, such as price and quality. A comparison has been made to illustrate main differences between this type and the washbasin faucets, which are in use (Table 10).

Table 10. Comparison Between Basin Single Lever Faucet and The 6150F

Type	**Flow Rate**		**Pressure**
Oras Electra (6150F)	0,1 dm^3/s	6 L/min	200 kpa
Basin Single Lever Faucet	0,1 dm^3/s	6 L/min	137 kpa
 Basin single lever faucet	 *Oras Electra 6150F.* (Oras, 2013)		

Table 11. Oras Electra 6150F. Estimation of Possible Reduction

Type	Basin Single Lever Faucet	Oras Electra 6150F
Flow Rate /sec	0.1 litre/sec	0.1 litre/sec
Consumed water (Litre per use)	1 litre/use	0.5 litre/use
Estimated water consumption Litre per person	2 litre/ person	1 litre/ person

Table 11 shows that if the taps are used twice a day and each time the water runs for 10 seconds and at a flow rate of 0.1 litre/sec, one basin single lever faucet would consume two litres of water per day. In a similar time and at a similar water flow rate, *Oras Electra 6150F*, would consume only one litre per day, which means a 50 % saving of water when using the motion sensor tap *Oras Electra 6150F.*

The following data are used in calculating the actual benefits of using 12 *Oras Electra 6150F* taps in Myyrmäki campus first floor:

- There are approximately 170 studying days per year.
- Myyrmäki has more than 2500 students; the minimum average attendance per day is 1500 students.
- Each student is estimated to utilize water on average twice a day.

Therefore, the annual taps water consumption of Myyrmäki campus students using basin single lever faucet is as follows:

$$=170 \text{ days}*1500 \text{ students} * 2 \text{ (litre/use)}= 510 \text{ m}^3 \qquad (4)$$

According to the Table 11, 510 cubic metres of water would be halved in case of using *Oras Electra 6150F* the motion sensor technique in showers and WC is estimated to cut the consumption by approximately 650 m^3/year, which is almost 20% of the total water consumption if it is applied in all showers and taps in Myyrmäki campus.

5.5 Kitchen

As shown in Figure 5, kitchen equipment to consume over 30% of the total water consumption on each campus – Myyrmäki or Leppävaara according to the author estimations. The Kitchen is a considerably heavy water consumer thus the kitchen was set as top priority in the implementing plan.

Metos OY supplies most of the kitchen equipment, which are in condition and set on an energy and water-efficient mode. Dishwashers in Leppävaara and Myyrmäki campuses are considered as the most water-consuming kitchen equipment. There are three main typesof dishwashers used to wash different types of dishes used on both campuses: WD-PRM90 Pre-Rinse machine, WD-90GR dishwasher for large utensils and the main dishwasher machine WD-211E.

Moreover, equipment misuses have been recorded in the kitchen; lack of monitoring and guiding the users of kitchen machinery are also causing energy and water losses in the kitchen. For instance, WD-90GR dishwasher can load 6 large trays in one batch and consumes 11.4 KW of electricity and 5 litres of water in each cycle. The same amount of electricity and water will be consumed whether it is loaded with one or the six trays.

The location of the dishwasher and the returning area of empty trays and dishes are very important in enhancing the efficient sage of dishwashers. They should be designed so that they are easy to access for both the returner and to the loader.

5.6 Laboratories

Leppävaara and Myyrmäki campuses contain a number of different laboratories that are consuming water during the experiments and by washing the laboratory equipment. Those two labs have a various types of faucets and machinery used for research and teaching purposes. In fact the laboratories have been designed for a delicate purpose, which is research therefore, negligible changes or implementations could be made in that sector. However, regular maintenance and monitoring could help in keeping the equipment operating with high efficiency. Nevertheless, the rest of the labs have no or limited access to water, for example computer and physics labs.

6 Propositions Financial Analysis and Recommendations

This chapter will discuss the estimated cost and payback period for the on going implementations. To start with toilet seats, small changes might give superb and almost cost-free results, in particular, the adjustment of volume of flushed water. Similar procedures could be applied to faucets and showerheads to optimize the flow rate or even the main flow in the supply pipe; these techniques should be included in the regular maintenance plan. Lowering the flow rate in faucets and showers would cause inconvenient results for the users, since the ones in use in Leppävaara and Myyrmäki campuses have already a good level of water flow rate.

Replacing the inefficient equipment should be a top priority if noticeable changes are observed. However, many building ownerships would avoid this step because of its high cost and would prefer a step-by-step plan.

As an example, replacing 45 of IDO single flush with dual flush in Myyrmäki campus would cost over 20 thousands Euros, which means it would take at least 10 years to pay the cost back. Nevertheless, replacing damaged single flush toilet seats into dual flush and dramatic increasing of water prices would make this implantation option feasible. Likewise, replacing some of the toilet seats in the most consuming locations will have a remarkable impact in total consumption of a building

$$=170 \text{ days} * 1000 \text{ students} * 10 \text{ (litre/use)} = 1700 \text{ m}^3 \qquad (5)$$

Equation 5 estimates the yearly discharged water in Myyrmäki campus in case of using single flush toile seats, this would cost over 4400 Euros. Dual flush toilet seats would halve this cost of discharged water, as mentioned in Toilet Seat Implementations chapter, which means almost 2200 Euros of saving per year.

The total cost of replacing 12 Basin Single Lever Faucet into *Oras Electra 6150F* as a first testing step is 2250 euros. The next implementing step is a part of a bigger plan to replace 42 taps in Myyrmäki campus with a total cost of 7800 euros. The financial analysis of assembling 42 *Oras Electra 6150F* in Myyrmäki campus is shown in Table 12.

Table 12. Financial Analysis of Assembling 42 *Oras Electra 6150F* in Myyrmäki Campus

Financial Analysis of Assembling 42 Oras Electra (6150F) in Myyrmäki Campus			
Estimated Taps' Water Consumption m^3/year	Possible Water Reduction Using Oras Electra (6150F) m^3/year	Total Number of Suggested Taps for Implementation	
1360 m^3/year	544 m^3/year	42 Taps	Payback time/year
Total Consumption* Water Price = 1360 m^3*(1.29+1.57) €/m^3	Possible Reduction * Water Price = 40%*(1.29+1.57) €	Taps' Number*(Tap's Price + Installation Cost) = 42*137.50€*50€	↓
3889.40 €	1555.00 €	7875.00 €	5.5 Years

Myyrmäki campus total water consumption in 2011 was about 3400 cubic metres, but installing taps are estimated to consume 1360 cubic metres annually of about 40 % Myyrmäki campus water consumption. The campus pays 2.86 € for each cubic metre that runs into the building 1.29 €/m^3 for incoming water and 1.57 €/m^3 for the wastewater as Table 1 and Table 2 shows. According to the expected water saving, replacing 42 taps will payback the cost in 5.5 years.

7 Conclusions

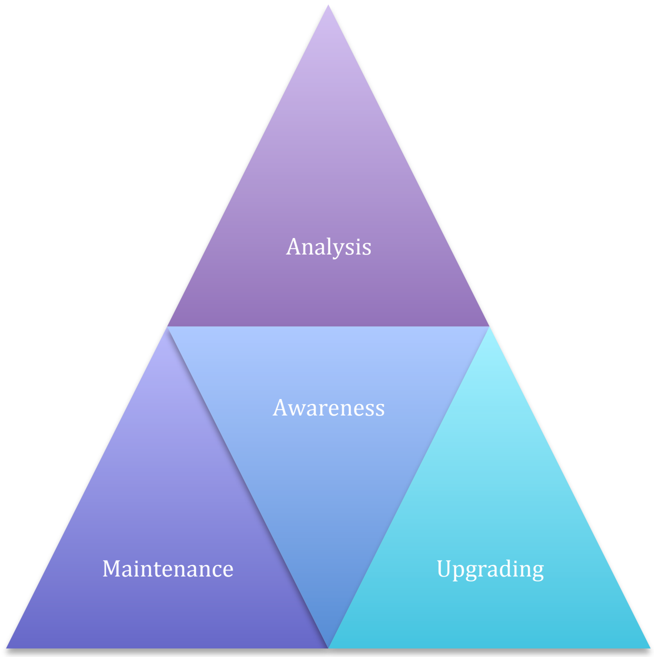
The old water equipment in the A buildings in Leppävaara and Myyrmäki campuses operate with less efficiency than the ones in the B buildings, which leads to huge waste of water. In addition, a certain amount of water is wasted in a direct way by misusing the equipment, for example by keeping the water tap or shower open and in an indirect way by improperly using the kitchen machinery that consumes a large amount of water.

Motion sensors and automated systems are suggested to solve the problems caused by users' misusing water equipment; it is also a very economically efficient approach for the heavy water-consuming water equipment. Replacing taps in Myyrmäki campuses could prove the feasibility of replacing old equipment into new ones; it could also be a good example for installing water equipment in new built buildings.

Using sensor metres in tracking the change would give a better and constant review of the current consumption

There are many inexpensive tools that could be used to achieve the target of this thesis in enhancing the water efficiencies in public buildings, ranging from monitoring equipment condition to repairing leakages and optimizing the water flow rates. Another effective method would be to increase the users' awareness of water conservations, which gives the users the responsibility of saving water.

Graph 1 summarizes the main strategies in enhancing water efficiency in Myyrmäki and Leppävaara campuses.



Graph 1. Main Strategies of Water Efficiency Enhancement in Myyrmäki and Leppävaara Campuses

8 References

Autotaps, 2013. *WHY ELECTRONIC TAPS?*. [online] Available at: http://litre.autotaps.com/why-electronic-taps.html [Accessed: 29 May 2013].

Badgermetre.Inc., 2009. *Wireless Flow Sensor System*. [online] Available at: http://litre.badgermetre.com/Badger-Files/PDFs/Industrial-Products/DTB-068-Series-228PV-Wiriess-Tech-Brief.pdf [Accessed: 15 May 2013].

Badgermetre,Inc., 2009. *Wireless Flow Sensor System*. [image online] Available at: http://litre.badgermetre.com/Badger-Files/PDFs/Industrial-Products/DTB-068-Series-228PV-Wiriess-Tech-Brief.pdf [Accessed: 15 May 2013].

Castro S., 2011 *SMART CAMPUS: SMART CAMPUS - Building-User Learning Interaction for Energy Efficiency*. European Commission - Information Society and Media (2011). [online] Available at: http://ec.europa.eu/information_society/apps/projects/factsheet/index.cfm?project_ref=297251 [Accessed: 16 May 2013].

Carnoy, M., 2004. *ICT in Education: Possibilities and Challenges*. [online] FUOC. p.10-12. Available at: http://litre.uoc.edu/inaugural04/eng/carnoy1004.pdf [Accessed: 16.5.2013].

Faucets., (2013) *Tap Aerators-cheap Water Saving Regulator*. [Image online] Available at:http://bathroom-kitchen-faucets.com/tap-aerators-cheap-water-saving-regulator/ [Accessed: 16 May 2013].

Granlund., 2011. *Ryhti*. [online] Available at: http://litre.ryhti.net/eng/?x117983=159287 [Accessed: 15 May 2013].

Granlund., 2013. *Ryhti*. [online] Available at: http://litre.ryhti.net/eng/ryhti-login/ [Accessed: 15 May 2013].

Çengel, Y. and Cimbala, J., 2006. *Flow in Pipes*. [e-book] The McGraw-Hill Companies. Available at: http://ingcivilutp3.files.wordpress.com/2011/09/cengel_cimbala_solutions_chap08.pdf [Accessed: 29 June 2013].

Helsinki Metropolia UAS., 2010. Metropolia in . *About us* .[online] Available at: http://litre.metropolia.fi/en/about-us/ [Accessed: 15 May 2013].

Hoekstra, A., 2003. *Virtual water trade Proceedings of the International Expert Meeting on Virtual Water Trade IHE*. 12. [report] Netherlands: The Netherlands, p.14-15. [online] Available at: http://litre.waterfootprint.org/Reports/Report12.pdf [Accessed: 16 May 2013].

Helsinki Region Environmental Services Authority, HSY., 2006. *Read your own water metre*. [online] Espoo: Available at: http://litre.hsy.fi/en/waterservices/customer_service/water_metre_reading/Pages/default.aspx [Accessed: 15 May 2013].

Helsinki Region Environmental Services Authority, HSY., 2006. *How much water do you consume?*. [online] Espoo: Available at:

http://litre.hsy.fi/en/waterservices/domestic_water_issues/Pages/water_consumption.aspx [Accessed: 24 May 2013].

Helsinki Region Environmental Services Authority, HSY., 2012. *HSY's water services rates: Espoo as of 1 January 2012*. [online] Available at: http://litre.hsy.fi/vesi/Documents/Hinnat_sopimusehdot/Hinnat%202012/HSY_WaterServicesRates_Espoo_2012.pdf. [Accessed: 15 May 2013].

IDO., (n.d.) *IDO*. [online] Available at: http://litre.ido.fi/fi-FI/Corporate/Company/History.aspx [Accessed: 15 May 2013]

Komulainen, T., 2011. *Saving water and energy with modern tap wear technology without reducing comfort of living*. *REHVA HVAC.* [*Journal*], 3, p.73-76. Available at: http://litre.rehva.eu/fileadmin/hvac-dictio/03-2011/rj1103.pdf [Accessed: 15.5.2013].

Meadville Area Water Authority., 2012. *How Your Water Metre Works*. [online] Available at: http://www3.goywp.com/sites/upi/cusi/mawa/view/52 [Accessed: 15 May 2013].

Oras Oy., 2013. *Oras Electra (6150F)*. [Image online] Available at: http://litre.oras.com/fi/professional/products/pages/productvariant.aspx?productcode=6150f [Accessed: 16 May 2013].

Quinn, R. and Munzinger, M., et al., 2006. *WATER EFFICIENCY GUIDE: OFFICE AND PUBLIC BUILDINGS*. [e-book] Sydney: Commonwealth of Australia. p.25 -. Available through: The Department of the Environment and Heritage in Australian government http://litre.environment.gov.au/sustainability/government/publications/pubs/water-efficiency-guide.pdf [Accessed: 15.5.2013].

South Africa Government,SA,, 2000. *WATER CONSERVATION AND WATER DEMAND MANAGEMENT STRATEGY FOR THE WATER SERVICES SECTOR*. [online] Available at: http://litre.info.gov.za/otherdocs/2000/waterforest.pdf [Accessed: 15 May 2013].

Southern Water., (n.d.). *Your metre reading*. [online] Available at: http://litre.southernwater.co.uk/at-home/your-water/water-metres/your-metre-reading/ [Accessed: 15 May 2013].

Vickers, A., 2001. Handbook of Water Use and Conservation: Water Flow Press. Boston America: Marketing Association, p.446.

Wheeler, A., and Ganji, A. 2004. *Introduction to Engineering Exterminations* . 2nd ed. New Jersey : Pearson Pretice Hall , p.202.

Appendix 1. Secondary Data Collection. (Survey, Inventory) Excel file. (Enlarge the attached file for better resolution).

Abbreviation

O	Obvious
H	horizontal
V	vertical
L	Estemated length (diameter)
S	Seat
F	Flush
INV	Disabled people

1 Takes notes
2 Take pictures: types of taps/machinery (machine Type)
3 Take pictures if there are different types radiators
4 At least two ideas to Reduce the Water Consumption + (references)
5 Access to facilities (Y/N) and where

Extra Notes	FLOOR /WING	NUMBER	TYPE	ACCESS TO WATER Y/N	Number OF TAPS	TYPE OF TAPS	WC seats (number/ type)	LEAKAGE Y/N	NUMBER OF LEAKIN	Radiator (ON/OFF)	Radiator pipes (O/H/V/L	Remarks
	F/A	103	Classroom	Y	1	Hot/cold	0	N	No	ON	O/V/H	
	F/A	104	Classroom	N	N	N	0	N	No	2*off	d=2cm; l=2,5m	
	F/A	105	Teacher's room				0					
	F/A	106	Classroom	Y	1	Hot/cold	0	N	No	ON	d=1cm/l=3m	
	F/A	107	Teacher's room	N			0			ON	H/V/3m	
	F/A	108	Teacher's room				0					
	F/A	109		Y	2		0			ON	O/V/d2cm/l=2m	
	F/A	110	Classroom	N			0			Off	O/V/5m	
	F/A	a/b111	Classroom				0					
	F/A	112	Teacher's room	N	N		0					
	F/A	113	Teacher's room	N	N		0					
	F/A	114	Teacher's room	N	N		0					
	F/A	115	Teacher's room	N	N		0					
	F/A	116	Classroom				0					
	F/A	117	Teacher's room	N			0					
	F/A	118	Cleaning room	Y	1	N	0	N	No	N	N	
	F/A	121	Classroom				0					
	F/A	122	Cleaningroom	N			0					
	F/A	123	Classroom	Y	1	Hot/cold	0			On	d=2cm; l=3,5m	(rusting)
	F/A	124	Classroom	Y	1	Hot/cold	0			On	l=3,5m;d=2cm	
	F/A	125	Classroom				0					
	F/A	126	Teacher's room	y	1	N	0	N	No	N	N	N
	F/A	127	Teacher's room	N	N	N	0	N	No	N	N	
	F/A	128	Teacher's room	N	N	N	0	N	No 2	Off	O/V/Diameter 2cm/2m	
	F/A	119	STUDENT AFFAIRS	N	N	N	NA	N		On	(in pic)	
	F/A	-	INFO	?			0					
	F/A	101	A-Auditorium	Y			0	N	No			
	Labs	102	Lab	Y	1							
		134	Labs	Y								
		135a	ENVIRON	Y	8	6;H / 2;C	N	NA	ON / OFF	2	N ; 4m	1 shower
		135b	ORGANIC	Y	28	(6; Hot/Cold) / 22C	N	-	NA	3	1hot ; 2 cold (in pic)	1 shower (radiater types Greem and white pipes)
		136	Teacher's room	NA	NA	NA	N	NA	NA	NA	NA	
		137	Teacher's room	NA	NA	NA	N	NA	NA	NA	NA	
		141	Process	Y	6	4;C / 2 Hot/Cold	N	NA	NA	3	O;d=3cm/l=4m	
		142	CHEMIST	Y	29	24;C / 5;Hot/Cold	N	N	N	2	O;d=2cm/l=3m	
		144	BIO	NA	NA	NA	N	NA	OFF	NA	NA	
		145	INORGANIC	Y	26	18;C / 8;Hot/Cold	N		ON	2	d=2cm/l=2m	
	F/A	-	INFO	Y	1 (in pic)	NA	NA			On	H /d=2cm/l=2m	
	F/A	151	BIO	?								
	F/A	159-180		Y	11		2					
			CAFETERIA		3					3	d=2cm/l=2m	
			KITCHEN	Y	12					2	d=2cm/l=1m	
	S/A	251	MOLECULAR	Y	14	ORAS				ON	H	
	S/A	252	BIO	Y	9	ORAS		N				
	S/A	238	AUTO	Y								
	S/A	247	TEK	Y	6	ORAS		N		ON	V+H	
	S/A	214	Auditorium Corner	Y	1	ORAS		N		ON	H	
	S/A	232	HEALLTH NURSE	Y	3	ORAS	1	N			H	
	S/A	228	LIBRARY	NO								
	S/A	201	TECH TEACHING OFFICE	?								
2S	S/A	202-206	TEACHERS ROOM	Y	6		2					
	S/A	207	Classroom		1							
	S/A	208	Classroom		1							
	S/A	209	Teacher's room	N	0	0	0	N	0	ON	V	
	S/A	210	Classroom	Y	1	ORAS	0	N	0	ON	V	
	S/A	211	Teacher's room									
	S/A	212	Teacher's room									
	S/A	213	Teacher's room									
	S/A	215	Classroom		1							
	S/A	216	Classroom		1							
	S/A	217	Classroom									
	S/A	218	Classroom		1							
	S/A	219	Classroom		1							
	S/A	220	Teacher's room									
	S/A	221	Teacher's room	Y	1	ORAS	0	N	0	ON	H	
	S/A	222	Classroom		1							
?	S/A	223	Classroom	N	0		0	N	0	ON	H	
	S/A	224	Classroom	Y	1	ORAS	0	N	0	ON	H	
	S/A	225	Teacher's room									
	S/A	226	Cleaning room	Y	1		0	N		ON	H	
	S/A	227	LIBRARY	N	0	ORAS	0	N	0	ON	H	
	S/A	228	LIBRARY	N	0		0	N		ON	H	
?	S/A	233	Classroom									
?	S/A	234	Classroom									
	S/A	235	Teacher's room									
	S/A	236	Teacher's room		2		1					
	S/A	237	Teacher's room									
	S/A	239	Teacher's room									
	S/A	240	Teacher's room									
?	S/A	241	Classroom									
	S/A	242	Teacher's room	Y	1							
	S/A	243	Teacher's room									
?	S/A	244	Teacher's room	N	0							
?	S/A	245	Classroom	N	0							
?	S/A	246	Classroom	N	0					on	O/H	
?	S/A	248	Classroom									
?	S/A	249	Classroom	Y	2	ORAS				OFF	O/H	
	S/A	259		Y	1							
	S/A	269	WC	Y	1		1					
Nothing	B	136.135	Nothing									
		215	Teacher's room	N						1	3.1	
		216	Teacher's room	N						1	3.1	
		217	Teacher's room							1	3.1	
		218	Teacher's room							2	3.1	
		219	Teacher's room	N						1	3.1	
		220	Teacher's room	N						1	3.1	
		221	Teacher's room	N						1	3.1	
		223	Staircase									
		224	Tuthimustila(office)	Y	1		N	N		1	3.5	L,H=1m
		225	Säteily lab	N						1	3.5	L,H=0,5m,L,V=3,5m
		226	Physics Lab	Y	2					3	3	L,V=7m,L,H=3m
		227	Physics Lab	N						0		
		228	Physics Lab	N						0		
		229	Physics Lab	N						0		
		230	Varasto	Y	1					0		
		231		Y	1							
		232		Y	1		1	1S				
		233		Y	1							
		244	Computer Class	Y	1					2	1ON=3, 1=OFF	L,V=8m,L,H=3m,D1=3mm,D2=10mm
		246	Hallway	Y	1	Cold						
		247	Electri.tuotantolab	y	1					0		
		248	Hallway	N								
		249	Clas Room	Y	1	Hot/Cold				3	3	L,H=1m,L,V=6m,D=15-22mm
		250	Teacher's room	N						1	2.3	L,V=2,5,D=20mm
		123	Staircase	N								
		152	Staircase	N								
		123	Staircase	N								
		134	Lab	N		Hot/Cold				3	3	L,H=2m,L,V=7,5m,D,L=10mm,D.V=20mm
		140	Hallway	N								
		142		Y	1					1		D=10mm,L,V=2m
		145	Lab	Y	1	Hot/Cold				1		L,V=8m,D=20mm
		146	Lab	y	1					1	3	
		145	Lab	Y	1	Hot/Cold				1		L,V=8m,D=20mm
		147	Lab	Y	1	Hot/Cold				0		
		148	Lab	Y	2	Hot/Cold				2	3	L,V=8m,D=20mm
		149	Lab	Y	1	Hot/Cold						
		150	Hallway	N								
		152	Staircase	N								
		154	Hallway	Y	1	Cold						
		165	Dressing Room	N						0		
		166	Toilet	Y	1	Hot/Cold	1			0		
		167	Shower	Y	1	Hot/Cold	1			0		
	Radiator Covered	124	Lab	Y	1	Hot/Cold				1		
		125	Työ huone	N						1	3	L,V=7m
		126	Teacher's room	N						1	3	L,V=8m
		127	Lab	Y	1	Hot/Cold				2	3.1	
		128	_	Y	1							
		129	_	Y	1		1					
	Nothing	153	Yötetila	N								
	2S	155-167	_	y	5		2					
		162	Pututila	N								
		163	Toilet	Y	1	Hot/Cold	1(IDO)			0		
		164	Suihku	Y	1	Hot/Cold				0		
		116	Teacher's room	N						1	Max	
		117	Teacher's room	N						1	Max	
		118	Teacher's room	N						1	Max	
		119	Teacher's room	N						1	Max	
	Nothing	137										
		142		Y	1					1		L,V=2m,D=10mm
		330	Computer Class	Y	1	Hot/Cold				2	3.1	L.H=3m,D,H=10mm
		331	Computer Class	Y	1	Hot/Cold				2	3	L,H=3m,D=10mm
		332	Computer Class	Y	1	Hot/Cold				2	1	L,H=3m,D=10mm
		324	Computer Class	Y	1							
		325	Computer Class	Y	1							
		326	Computer Class	Y	1		1					
		253	Sähkö	Y	1							
		101	Auditorium		1							
		314	Hallway	Y	1	Juoma Allas						
	There is a sink	327	Computer Class	Y	1							
		340	Computer Class	Y	1					2	3,1&5	
		341	Helpolis									
		344	Computer Class	Y	1					3	3	
	There is a sink	345	?	Y	1							
		348	Computer Class	Y	1	Hot/Cold				2	3	L,H=1m
		349	Computer Class	Y	1					2	3.1	L,V=5m,L,H1=2m,D,V=20mm,D,H1=10mm,L,V2=10m,D2
		155	Varasto	Y	1	Cold				0		
		120		N	0					3		
	electric heater	133	Teacher room	N	0					0		
		115	teacher room	N						3	on	obvious, horizontal, vetticle
		121	Teacher room	N						3	on	
		122	Teacher room	N						3		l=7 and D= 15-20 mm
		143	project room	N								
	electric heater	151	international office	N								
		235	Fysikin demo	Y	1					3	on	L,H =2 L,R = 3,5 . D = 15-20 mm
		236	project room	N								
		243	classroom	Y	1	Hot/Cold				2	3.2	L,H = 1.5 m, L,R = 35 mm
		245	office	N								
	Auditoriums/Meeting rooms											
	Toilets											
guys	308-10b	308	Toilet	Y	6		6	3 S 3 F				
girls	304-7b	304	Toilet	Y	6		3	3 S				
guys	208-11b	208	Toilet	Y	7		6	3 S 3 F				
girls	202-8b	296	Toilet	Y	6		3	3 S				
guys	108-111b	108	Toilet	Y	6		6	3 S 3 F				
girls	102-107b	102	Toilet	Y	6		3	3 S				
guys		115 a	Toilets	Y	3	Hot/cold	3	1S;single2 F	N	-		
girls		117 a	Toilets	Y	4	Hot/cold	2	2S	N	-		
guys		119a	Toilets	Y	1	Hot/cold	1	1S	N	-	N	-
girls		120a	Toilets	Y	1	Hot/cold	1	1S	N	-	N	-
guys		130a	Toilets	Y	1	Hot/cold	1	1S	N	-		-
girls		131a	Toilets	Y	1	Hot/cold	1	1S	N	-		-
guys		138 a	Toilets	Y	3	Hot/cold	3	1S;single2 F	N	-		
girls		139 a	Toilets	Y	4	Hot/cold	2	2S	N	-		
guys		157 a	Toilets	Y	3	Hot/cold	3	1S;single2 F	N	-		
girls		158 a	Toilets	Y	4	Hot/cold	2	2S	N	-		
INV		159 a	Toilets	Y	1	Hot/cold	1	1S				
guys		214 a	Toilets	Y	3	Hot/cold	3	1S;single2 F	N	-		
girls		215 a	Toilets	Y	4	Hot/cold	2	2S	N	-		
guys		218a	Toilets	Y	1	Hot/cold	1	1S	N	-	N	-
girls		219a	Toilets	Y	1	Hot/cold	1	1S	N	-	N	-
guys		229a	Toilets	Y	1	Hot/cold	1	1S	N	-		-
girls		230a	Toilets	Y	1	Hot/cold	1	1S	N	-		-
guys		238 a	Toilets	Y	3	Hot/cold	3	1S;single2 F	N	-		
girls		239 a	Toilets	Y	4	Hot/cold	2	2S	N	-		
guys		257 a	Toilets	Y	3	Hot/cold	3	1S;single2 F	N	-		
girls		258 a	Toilets	Y	4	Hot/cold	2	2S	N	-		
-		269 a	Toilets	Y	1	Hot/cold	1	1S				
		250a	Toilets	Y	2	Hot/cold	3	2 S 1 F				
Labs F/A	Toilets		Staff Toilet	Y	1	1 ;H/C		N	N	NA	NA	Single flush
			Toilet 1	Y	2	2 ; H/C		General	N	N	N	
			GYM	Y	18	Hot/Cold	9	7 S 2 F			O/H	
			Total N of Taps		**353**	**Total N of WC**	**93**					
			Showers (GYM)		**8**							
						ARBIA Seats Single Flush	**37**					
					A Building							
						Manual Urinal Flusher	**13**					
						Types	Manula Flushing (AQUA & FRANKIN)					
						Sensor Urinal flusher(not working w	Teachers' meeting room WC (250 a)					
						IDO Seats Double Fulsh	**18**					
					B Building	IDO SeatsSsingel Fulsh	**1**					
						Total	**19**					
						Sensor Urinal Flusher (Oras Electra)	**9**					
					GYM	Shower (Oras)	**8**					
						ARBIA Seats Single Flush	**7**					
						Manual Urinal Flusher	**2**					

Appendix 2. Locations of The Targeted Toilets for implementations At Myyrmäki Campus.