Project Description

Bachelor Project - Electricity Recording Assistant

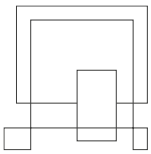
Supervisors:

Michael Viuff

Students:

Gais El-AAsi - 279910

Marcel Valentijn Daniel Notenboom - 279963



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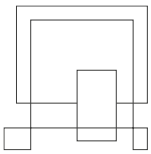

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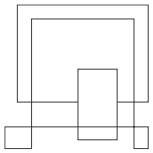


Background Description

Throughout history, electricity has become one of the pillars of the modern world. A series of fundamental discoveries made by Hans Ørsted, André-Marie Ampère, Michael Faraday and Georg Ohm has paved the way towards electricity becoming an essential part of society. (Institute for Energy Research, 2021)

As the electricity started being produced in larger amounts, and commercialized, the need for measuring its consumption rose. The first meter was patented in 1881 by Thomas Edison. It was an electrolytic meter that used a copper strip which was weighed at the beginning and end of the billing period; and used the gained weight as its basis for consumption calculation.

Fast forward a few decades to the 1960's when the idea of remote monitoring spark, initially using remote pulse transmission and gradually being replaced by various protocols. Nowadays, meters have complex functionality, usually based on the ever-evolving latest electronic technologies. (Smart Energy International, 2006)

In early 2000's the idea of *Smart Homes* [1]started to become more popular and affordable. Powered by the development of *IoT*[2] and the "need" to control, oversee and automatize elements of a house remotely, more and more parts of a home were innovated. From sound systems to home security to appliances and anything that comes to mind. (Assosiation Franco-Chinoise du developpment urbain durable, 2021)

Another important trend that contributed to a higher degree of close monitoring of the electricity consumption is eco-friendliness and the idea of monitoring and controlling how electricity is used more closely. It is done so to reduce unneeded electricity consumption, to try to optimize how the electricity is used and to identify energy vampire devices. (Mohammed Ghazal, 2015)

[1] Smart Home – a home equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer.
[2] Internet of Things – is a network of physical "things", which are incorporated with sensors, software and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

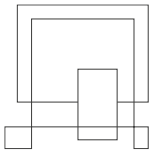
Given the foundation described above, the idea of a *Smart Plug* [3] was inevitable. The first attempts to better control the electricity usage per outlet, even if not yet *smart* per say, were *Plug-in Time Sockets*. These devices were simplistic, more often than not, mechanical devices that allowed to stop electricity consumption without having to be present or unplug the device itself – Figure 1.

Figure 1 - Mechanical Plug-in Time Socket

Nowadays, there are various types of truly Smart Plugs that one can choose from, with different functionality and relatively affordable prices. These devices usually have one or more of the below presented capabilities/characteristics: provides remote scheduling, control and IFTTT[4]; real time or/and non-real time remote electricity consumption monitoring, can be used with home assistants (Google Home, Alexa, etc.); suited for indoor or/and outdoor usage; requires or does not a hub/bridge for connection; use WIFI or/and LTE for connection to a network; can be controlled using a smartphone application or/and web-based access; is subscription based / one time pay; connect directly in the socket or to the electrical panel; have other special functionalities - (ex. Protocols for connecting other proprietary sensors); usually come with certain limitations for maximum load.

A quick look at what is currently on the market - a sum up of the most recommended devices by various reviewers as *PCMag, TechRadar, CNET and Wired UK* - offers an overview of most common features present in the offerings. All the devices were compatible - a device was marked as compatible if it supported at least one assistant - with home assistants like

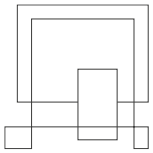
[3] Smart Plug – a device that allows to control and/or monitor the usage of electricity per electric outlet.
[4] If This Then That – Is a functionality that offers a user the possibility to define a response to various internal or/and external events



Alexa and *Google Assistant.* Other common features were usage of WiFi, IFTTT and Controlling/Scheduling functionality.

Less common, were Power Consumption Monitoring (17%) - even so, many only offered basic functionality like: real-time on “sport”, or only simple reports given that it was accessed via mobile application; possibility of using LTE connection or a web application to monitor data (Appendix B).

Following above, a problem area can be identified, as many tools only focus on the ease of use and mobile application “trend”, making it hard to find a solution that will offer proper monitoring of the consumption and activation of the data. A gap can be identified between industrial/professional devices that are hard to use/install and require deep domain knowledge - meters used by the energy suppliers - and extremely simplistic devices - previously mentioned *Smart Plugs* - that do not offer meaningful monitoring of electricity consumption for the general population.



Problem Statement

Background Description gives a brief perspective on the current state of the *Smart Plug* and general public electricity consumption meters. Following it a main problem and supporting sub-questions can be formally defined.

Main Problem

The existing general population solutions for monitoring electricity consumption are limited in only offering basic insights about it, due to improper presentation of the collected data that do not capitalize on the use of desktop screen size and user interface capabilities.

Sub-problems

- How raw data will be aggregate, transformed and presented to the user so that it provides richer (compared to current solutions) insights about the electricity consumption?
- How to ensure security of consumption and user data?
- How to ensure high availability (little down-time) of the monitoring system so that the user can explore the consumption at any time without restrictions?
- How to configure the device without having to directly program it (network configurations)?

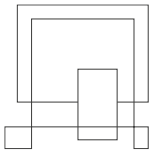
Definition of purpose

This project aims to provide a **comprehensive** and **detailed** method with focus on data **drill-down** for **monitoring**, **analysing**, **activating**, **visualising** and **reacting** to data about the **electricity consumption** of a plugged-in device.

Delimitation

To understand and limit the scope of this project, a set of delimitations are needed in place:

- The project will not consider mobile applications (either Android or iOS) as part of its scope;
- The project will not focus on exploring the possibility for integration with *Home Assistants*;



Methodology

Main Software Development Framework

After considering different options it was decided that the best software development process that will allow the team to operate at its fullest potential will be a continuous development setup using Kanban Software Development as the support framework.

Reasoning

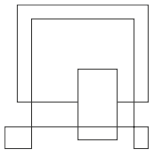
The main reasons for using this system as the development methodology for this project are:

- A relatively small team consisting of only two members which makes it inefficient and hard to take full advantage of ceremonies and artifacts defined by larger frameworks like Scrum;
- The flexibility of the Kanban Methodology by having iterations, based on needs rather than fixed size allows the team to work more efficiently and deliver consistently, as well as taking advantage of changing number of hours for a week dedicated to the project;
- Being only 2 people in the team it is easier to communicate and have the overall picture as well as the small details shared between us, in addition the rules defined in Section 3. Management of the Group Contract (Appendix A) fit perfectly with Kanban's No pre designed roles policy, which rather focuses on having cross-functional teams that auto-manage themselves;
- As a final reason, the relatively small amount of time for this project means that Kanban cadence based on continuous workflow and delivery keeps the teams focused and ready to fit the changing priorities, which makes it great with a rather small amount of time for a project;

Application

When it comes to how the team will operate there are a few points to underline:

- There will be estimations (hours) done based on the proposed time schedule that will be discussed in the next section as well as available time when the product backlog is ready (in its first form);
- Work in progress principles will be used to define a limited number of tasks that the team will be working at any given time as well ensuring that each task is completed before starting a new one;



- Meetings will be made to ensure a proper development, it will include: Planning Sessions, Weekly Status Meetings, Progress Reviews (including logging and Retrospective meetings);

The board Kanban Cheat Sheet by *eylean* (Appendix C) will be used as a guideline for how to work with Kanban Methodology, as well as other guidelines.

Other Frameworks

The Unified Software Development Process

UP will be used to allow an iterative and incremental development of the system when considering a certain cycle and/or task. It will also be used to define what a completed task is.

Work Breakdown Structure

WBS will be used for breaking down the items from the Product Backlog into smaller tasks, making them more easily achievable, trackable and shareable between the members of the group based on the needs.

Time schedule

Project Workload

The ability to track the progress of the project will be given by comparing the actual progress against the proposed schedule and the resources burn-out. The project is allotted a total of 825 hours (given the number of people and ECTS for the project). There will be two main periods:

- First period coinciding with the semester period, were a lower per week burnout will occur;
- “Only project” period which will be at the end of the project period with a higher burn-out per week;

The workload will be distributed evenly between the members of the group, each member having a total of 412 hours.

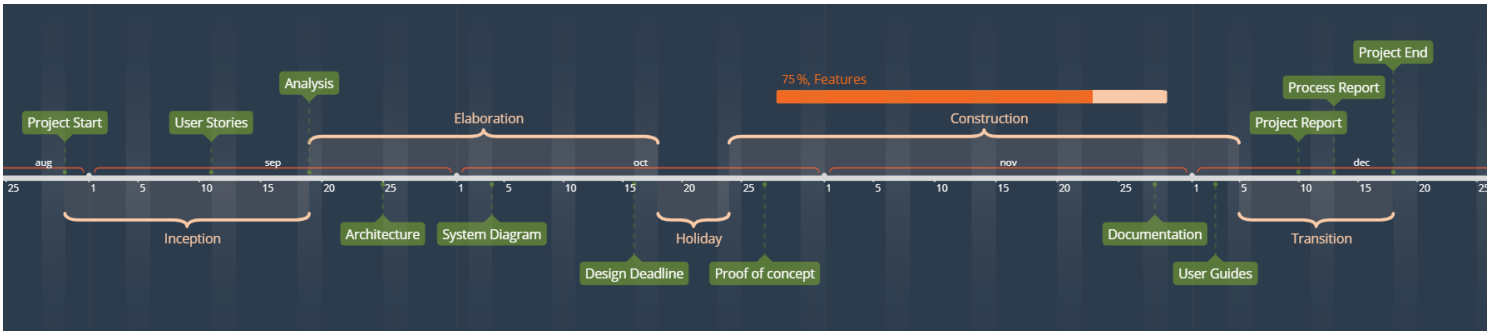
Project Deliverables and Milestones

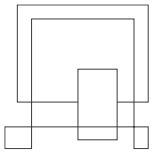
Deliverables and Milestone will allow to monitor the progress of the project. In addition, it will serve as a confirmation that the project is on time (or behind) with the proposed schedule. The main milestones and deliverables consist of:

Table 1 - Deliverables and Milestones

ID	Date	Type	Name	Comments	Phase
1	30th of August	Milestone	Project Start	Start of the project period	Inception
2	11th of September	Milestone	User Stories	Re-iteration over the user stories	
3	19th of September	Milestone	Analysis finalisation	Re-vision and final approval	
4	24th of September	Deliverable	Architecture	First formal version of the Architecture	Elaboration
5	4th of October	Deliverable	System Diagram	First formal version of the System Diagram	
6	15th of October	Milestone	Design finalisation	Re-vision and final approval	
7	26th of October	Deliverable	Proof of Concept	First working skeleton	Construction
8	27th of November	Deliverable	Documentation	Final revision of the documentation	
9	2nd of December	Deliverable	User Guides	Final revision of the user guides	
10	9th of December	Deliverable	Project Report	Final revision of the Project Report	Transition
11	12th of December	Deliverable	Process Report	Final revision of the Process Report	
12	18th of December	Milestone	Project End	End of the project period	

Figure 2 - Time Schedule



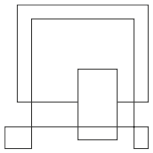


Risk Assessment

Table 2 - Risk Assessment

ID	Description	Risk Impact			Prevention Plan	Identifier	Contingency Plan
		L[5]	S[6]	P[7]			
1	Deviation from project purpose	2	4	8	Keep comparing the current project status with the problem statement. Internal & External continuous feedback	Unfavourable feedback in regards to the current state and direction of the project compared to initial purpose. Significant differences between the current state of the project and the initial purpose.	Identify the point of deviation, and redirect the focus of the project towards its purpose
2	Missing/not functioning hardware component	2	2	4	-	Missing hardware to be used in the development, testing and demo	Prepare and use a simulation of the hardware and will have the same/very close behaviour to the hardware
3	Corrupt/Unusable Data	4	3	12	Prepare testing tools/methods to compare if/when data gets corrupt	Data “doesn’t make any sense” and/or provides false negatives or true positives.	Follow the data pipeline and identify where the data is being corrupted
4	Improper visualisation of the data	5	2	10	Follow established guidelines in visualising/presenting data. Continuous Internal & External feedback	Even if the visual representation of the data is correct, it does not provide any insights or an objective overview of the state	Find better tools and/or methods for presenting the data in a more meaningful way

[5] L - Likelihood - The probability of the risk occurring (1 - 5 scale)
[6] S - Severity - The impact which the risk will have if occurring (1 - 5 scale)
[7] P - Product - the overall weight of the risk needed for priority considerations (1 - 25 scale)



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Appendices

Appendix A – Group Contract

THIS GROUP AGREEMENT (this *Agreement*) is made as of the 8th day of February 2021, by and between

- 279910 - Gais El-AAsi
- 279963 - Marcel Valentijn Daniel Notenboom

further referred to as *Group Members* for the bachelor project that will take place during the 6th and 7th semesters.

WHEREAS, upon the formation of the Group, the Group Members are aware of the fact that this agreement is a binding document and governs the Group until receiving the final grading for the underlined project. If the Group separates, or a member decided to leave from the Group, the Group's agreements remain intact for the remaining party.

WHEREAS, having a Group Member voluntary leave or being removed may cause work responsibilities to shift between the remaining Group Members.

THEREFORE, it is mutually agreed as follows:

SECTION 1

Absence

1.1. In the situation of a Group Member failing to be physically or/and digitally present on a day in which work is due, the Group Member informs the Group in good time, depending on the situation. In addition, the Group Member is bind to have all the work that the Group Member is responsible for turned in.
1.2. All Group Members must adhere to the provided work distribution having their share of work completed on time. If there will be an unexpected absence, the Group Member is to complete the work individually and inform the Group Members about the absence as well as turning in the completed work.
1.3. In the situation of impossibility to complete the share of work distributed to the Group Member due to absence, the Group Member must inform the Group as soon as possible so that counteractions can be made to ameliorate the situation and control the damage.
1.4. Failing to inform the Group about absence as well as failing to turn in the work share due to absence will be reprimanded.

SECTION 2

Work Policy

2.1. Any Group Member that is able to prove the incapacity to complete by themselves their share of work, due to Group accepted reasons, may acquire assistance from other Group Member(s) as long as it will not negatively affect the overall progress of the project.
2.2. Each Group Member will work to the best of their ability, ensuring a high quality of the completed work as well as respecting the Group's proposed deadlines.
2.3. If a Group Member commits plagiarism, the Group Member is solely responsible for his/her actions and will incur the reprimand by himself/herself.

2.4. Any Group Member is required to request assistance when proving, with reasons accepted by the Group Members, that they do not have the capacity to complete the work until the imposed deadline or that the quality of the work will not be of the imposed quality.
2.5. Any Group Member is bound to do their best in assisting other Group Member(s) unless it will affect their own work share. Rejecting to provide assistance or intention of deserting from assisting a Group Member will result in severe reprimand unless reasons accepted by the Group are provided.
2.6. Failing to inform in good time the Group about incapacity if completing the work within the deadlines or incapacity of completing the work to the imposed quality will be reprimed unless reasons accepted by the Group are provided.
2.7. The main online communication platform for the Group Members is **Discord** and all members must be reached on it within reasonable time, other online communication tools or methods are not accepted as being official and cannot be used as proof of any kind.
2.8. Each Group Member is responsible to stay informed about the state of the project during the entire period, via the project management software (TBD).

SECTION 3

Macro management

3.1. The hierarchical structure of the Group will follow Valve's policy, name *Flatland,* in regard to this issue that is described in the *New Employee Handbook by Valve*. The Group will not have any type of formal management and nobody (Group Member(s)) is bound to *report to* anyone. Any Group Member has the same equal right and responsibility to the management of the Group without any regard to their personal achievements, contributions to the overall progress of the project, physical strength, etc. An illustration can be observed in the bellow figure.

Figure 1 - Management

3.2. In the situation, of a Group Member emerging as the *lead* for certain parts or phases of the project, the Group Member's role will not be of a traditional managerial one, but rather the Group Member will have the role of a clearinghouse of information, with responsibility of keeping the whole part of

the project/phase in their sight so that other Group Members can use them as a resource to check decisions against.

3.3. In the situation of different roles emerging (not imposed) in the Group for different parts and/or phases of the project that will suit the team, it is important to underline that the Group Members themselves are solely responsible for crafting the description of the role that will fit best their vision for the role. The description of the role is not fixed and can morph without any reasoning. An illustration can be observed below.

Figure 2 - Group Roles

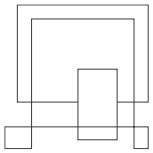
3.4. The mistakes[1] of the Group Member(s) are not subject to reprimand with the exception of certain situations that will be addressed further. It is important to underline that everyone has the opportunity to make decisions which will inevitably result in mistakes being made. The mistakes will be treated by the Group Member(s) as an opportunity to learn.

3.5. Bad decisions are represented by the cases of a Group Member repeating the same mistake (not necessarily previously made by the Group Member in question) over and over again. Ignoring the shreds of evidence (especially peer's and supervisors' feedback or advice), particularly when it underlines that the Group Member is about to commit a bad decision will be reviewed and potentially reprimanded.

3.6. Anyone has the right to review/give feedback to any other member on any matter with or without approval or/and request in any non-extreme violent forms (Passive-Aggressive, memes and gifs are accepted).

3.7. The decisions that have a consequence on the overall development of the project will be made using a democratic voting system where the majority will decide.

[1] Not to be confused with a bad decision. The mistake was something one did without intention; the bad decision was made intentionally—often without regard for the consequence



SECTION 4

Micro management

4.1 Each Group Member is responsible with micro managing themselves, in a way or style that fits them best, given that the deadlines and quality of the submitted works is not compromised.
4.2 Any Group Member is obliged to keep their calendar updated and available for other Group Members to ensure a transparency.
4.3 Any personal or/and non-project activities that are in the calendar must be logged in the calendar and presented to other Group Members in a written form.
4.4 Failing to log in the calendar or/and inform other Group Members in good time will result in the activity being disregarded. Good time being defined as:

$$2 \times lenght\ of\ the\ activity\ (\min 1\ day)$$

SECTION 5

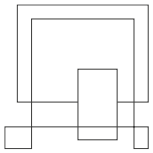
Conflict resolution and member dismissal

5.1 A Group Member cannot and will not be dismissed from the Group unless it is Group Member's own decision to leave or if the Group Member is forced to do so by other reasons.
5.2 In cases of conflicts, a resolution will be agreed upon after a series of debates and voting on the subject.
5.3 In cases where the conflict resolution does not satisfy a party, **after** informing the other members of the Group, a member can prepare a description of the conflict and submit to other members of the group, on the next day being allowed to submit it to a third-party (supervisors) for review.
5.4 Any discussions with a third-party (especially supervisors) that involve the Group's situation, will be disregarded as official if it will not follow the steps described in Article 4.3. as well as will be subject to reprimand.
5.5 If a member decides to request an individual assessment for the project, it shall first inform the Group Members about the decision, in written form, describing the reasons in detail including pieces of evidence, etc.

By **SIGNING** this **AGREEMENT**, the following Group Members abide by the articles listed here. If any member fails to abide by the articles of this contract counteraction will be made.

MVD Notenboom
Marcel V. D. Notenboom

Gais El-A'Asi
Gais El-AAsi



Appendix B – Small Research of the Smart Plugs

ID	Name	Assistant Ready*	IFTTT	Scheduling Control	WiFi	LTE	Smartphone Application	Web Application	Usage monitoring*	Hub	Max Load (A)
1	Wemo WiFi Smart Plug	YES	YES	YES	YES	NO	YES	NO	NO	NO	15
2	TP-Link Kasa Smart Wi-Fi Plug Lite HS103	YES	YES	YES	YES	NO	YES	NO	NO	NO	12
3	TP-Link Kasa Smart Outdoor Plug KP400	YES	YES	YES	YES	NO	YES	NO	NO	NO	15
4	Wyze Plug	YES	YES	YES	YES	NO	YES	NO	NO	NO	15
5	Lutron Caseta Dimmer Plug	YES	YES	YES	YES	NO	YES	NO	NO	YES	3
6	TP-Link Kasa Smart Wi-Fi Plug, 2-Outlets	YES	YES	YES	YES	NO	YES	NO	NO	NO	15
7	TP-Link Kasa Smart Wi-Fi Power Strip	YES	YES	YES	YES	NO	YES	NO	NO	NO	15
8	Teckin Smart Power Strip	YES	YES	YES	YES	NO	YES	NO	NO	NO	10
9	Gosund Smart Plug	YES	YES	YES	YES	NO	YES	NO	NO	NO	10
10	Amazon Smart Plug	YES	YES	YES	YES	NO	YES	NO	NO	NO	15
11	Belkin WeMo Insight Smart Plug	YES	YES	YES	YES	NO	YES	NO	YES	NO	15
12	Samsung SmartThings Wifi Smart Plug	YES	YES	YES	YES	NO	YES	NO	YES	YES	15
		100%	100%	100%	100%	0%	100%	0%	17%	17%	

Appendix C – Kanban Cheat Sheet

KANBAN CHEAT SHEET

PROCESS

Kanban projects run on need based iterations during which the team produces incremental value to the end product.

ROLES

Kanban does not have any predesigned roles, but focuses on a cross-functional team to plan and complete the work.

ITERATIONS

Kanban iterations are planned on the need basis and ended once a team feels they have added substantial value to the product.

ESTIMATION

Optional, usually done in hours or broad size metrics, such as small, medium & large.

WORK IN PROGRESS

Limits the number of tasks the team can work on at any given point. Guarantees each task is completed before the next one is started.

SCOPE LIMITS

Work In Progress (WIP) limits the current work amount.

TASK SIZE

There is no particular size a task should fit, instead it should have a clear goal for a team member to complete.

TASK ASSIGNMENT

Team members pull tasks from priority columns based on their skillset.

NEW TASKS IN ITERATION

New tasks can be added to a running iteration.

TERMS

Planning Trigger
Based on the number of tasks left in the backlog, alarms the team to arrange planning session.

Bottleneck
A task or another obstacle that prevents the team from making further progress within a project.

Lead Time
Total time from the initial customer request to the final product delivery.

Cycle Time
Total time it takes to finish a task once the team has started working on it, including delays.

Cumulative Flow CFD
A stacked line chart that shows the quantity of work in a given state - arrivals, queue, departure.

Swim Lane
A horizontal lane along which cards flow on the board. Represent categories, features, etc.

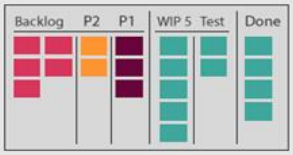
MEETINGS

All Kanban meetings are held once the team needs them and do not occur on a planned schedule.
Planning Session – set off by a planning trigger is for filling the backlog and prioritizing tasks.
Daily Standup – a 15 minute standup where team members present what they have done and will do.
Iteration review – presentation of the completed work to see if the set goals were met.
Retrospective – discussion between the team members about the process and how it can be improved.

PRIORITIZATION

Optional. Done through priority columns in the backlog.

BOARD



Usually combined out of 3 sections:
1. Backlog for planned and prioritized tasks.
2. Work In Progess for tasks the team is working on.
3. Done for completed tasks.