Designing an informative visual tool to explain the application of Vehicle to Grid (V2G) in business parks

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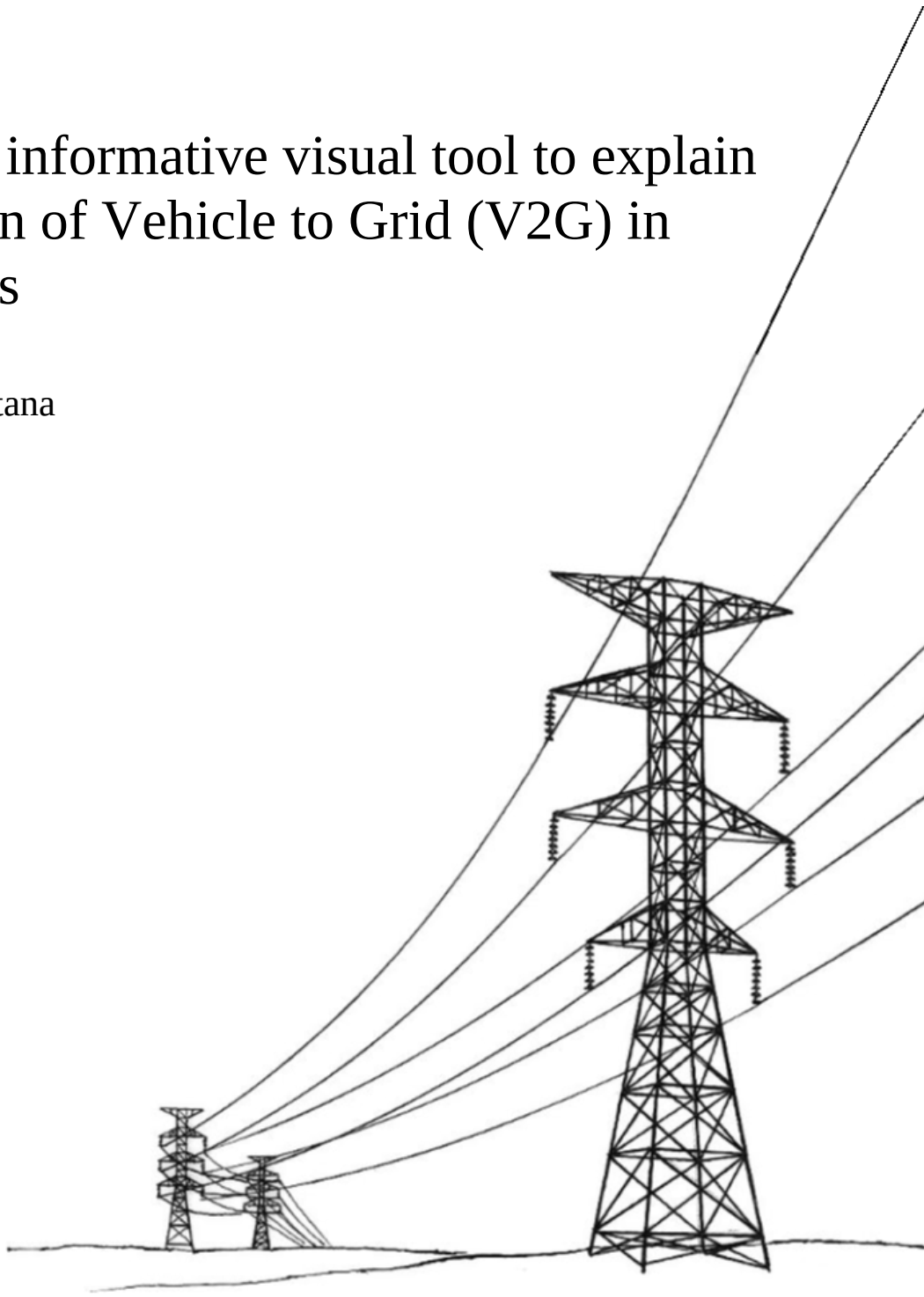

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Abstract

This research aims to discover how to visually and informatively communicate the application of V2G in a business park towards Dutch sustainability officials and entities with a large-scale PV installation under supervision of Enodes, client of this research. At the start of the project, the constraint that the tool should be both *visual* and *informative*, was given.

Within the research, it was investigated how the implementation of V2G works within a business park, which was depicted in figure 4 and 5 accordingly. Research showed that, to convey this information properly through a visual and informative tool, the aspects clarity, coherency, conciseness, engagement, unity were important to consider, when creating the animation. It was also found that EV owners should be approached as an additional main stakeholder, as this group needs to be willing to participate in order for V2G to work.

To convey the story, an animation has been created, which is called 'Can V2G solve net congestion?' The animation includes the definition of net congestion and V2G. It sketches the energy flow and peak shaving in a business park, once V2G is used. Both advantages and challenges with regard to V2G in business parks have been mentioned to provide an unbiased, and therefore informative story.

The animation was positively received by the client, Enodes. They think that the animation serves its purpose by showing the relevance of V2G, when implemented in a business park. They stated that the animation was very clear, coherent and visually attractive. Through user evaluations with Dutch sustainability officials, EV owners, entities with a large-scale PV installation, a V2G expert, and an expert in storytelling and oral communication, the product was evaluated. These evaluations showed that most of the requirements were successfully implemented in the final product. It was noted that especially sustainability officials found the animation very relevant. The overall animation rating from EV owners, entity owners with large-scale PV installation and an V2G expert, was an 8,6. All in all, the animation was perceived as a promising final prototype.

Acknowledgement

First of all I want to express my sincere gratitude to both Sylvain van Ligtenberg and my two supervisors, Erik Faber and Richard Bults. They provided me with good and critical feedback through all of the project and have supported me very much during my entire process. It has been a pleasure to work with you. I am also very grateful for the time that Bart Peeters, expert in visual communication, and Robin Berg, expert on V2G, have cleared to do an interview for the sake of this graduation project. I'd also like to thank all the EV owners who have helped me by giving their honest opinion about V2G and for evaluating my product. In addition a last special thanks to Charissa Geul and Naud Keen for advising me to do a step back sometimes to see everything clearer again.

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Chapter 1: Introduction

This chapter will provide an introduction to this graduation project. Firstly, the context will be globally explained. Secondly, the problem statement will be provided. Then, the main research question and sub-questions will be presented. The chapter will be concluded by presenting the structure of this report.

1.1 Context Analysis

Nowadays the topic of sustainable energy is high on the agenda of the Dutch government, especially with the current increase in electricity and gas prices. In the Netherlands, electricity is mostly created by gas sources [1]. As sustainability is becoming increasingly important in our daily lives, renewable sources need to be considered for the production of electricity. This report will focus on the Dutch society and more specific to solar power systems, which will be referred to in this report as *photovoltaic (PV) sources*.

Currently, more and more companies are producing energy through PV sources and offer this energy to the Dutch electricity grid. A disadvantage of PV sources, however, is that they cannot store any electric energy. In addition, they are intermittent, which means that they are weather dependent. In the case of PV installations, this means that they mainly produce energy during the day on *solar peak moments.* The term *solar peak moments* will be explained more in-depth in *section 2.1.1*.

The Dutch electricity grid has originally been built with the idea of receiving a constant amount of energy. As there is almost no storage and therefore buffer capacity to support the electricity grid, energy demand and energy supply need to be matched and balanced. Now that the amount of renewable intermittent installations is growing, energy is supplied at certain peak moments [2]. If the supply is higher than the demand in such a situation, it is important to store this sustainable electric energy somehow.

As large-capacity batteries are fairly expensive, many companies choose to connect their PV source to the electrical grid. In the current situation, however, grid managers, such as Liander [3], are slowly getting to the point that there is not enough capacity to connect new large-scale PV electricity suppliers [4]. In the case that there is more electrical energy added to the grid than it can handle, *net congestion* would occur, resulting in slower energy transfer and energy loss. *Net congestion* refers to the fact that the electricity grid does not work as promised due to energy overload [2]. To prevent further development of *net congestion*, grid managers have currently restricted entities with a large-scale PV installation to connect new PV installations to the grid. This is a very unfavorable situation for entities with a new large-scale PV installation. It becomes less attractive for these entities to invest in a PV installation, resulting in a brake on the Dutch energy transition concerning RES implementation.

A potential solution to *net congestion* and the *'capacity problem'* could be peak shaving. Peak shaving refers to the method of balancing overall peak demands concerning electricity use [5]. 'Vehicle to grid' could be a potential solution to peak shifting. Vehicle to grid (V2G) is a technology that enables a bi-directional energy flow from both the grid to an electric vehicle (EV), which is defined by battery charging, as well as a flow from an electric vehicle to the grid, which is defined as battery discharging [6] [7]. Figure 1 illustrates a clearer meaning of this concept.

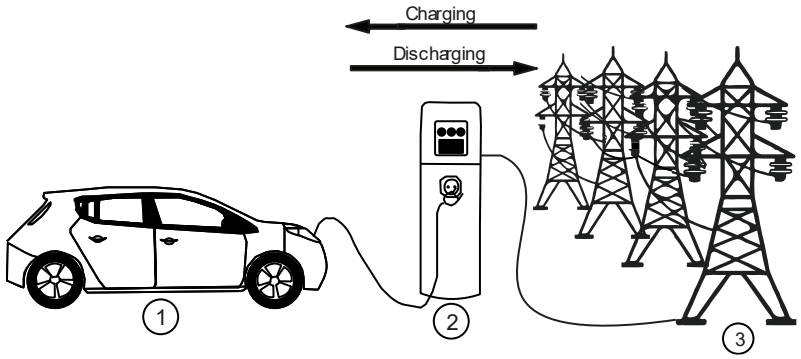


FIGURE 1: DEFINITION OF VEHICLE TO GRID.
1: ELECTRIC VEHICLE, 2: CHARGING STATION, AND 3: DUTCH ELECTRICITY GRID

The client of this graduation project is Enodes [8]. Enodes is a company that contributes to society by providing advice to make real estate more sustainable in the Netherlands. Enodes got an assignment on behalf of the municipality of Lelystad to look into Noordersluis, a business park located in Lelystad. They were asked to look for ways to supply as much electricity as possible to Noordersluis from PV sources, despite net congestion, and to look into a good business case for this. V2G was one of the options that Enodes looked into.

1.2 Problem description

Vehicle to grid is still a fairly new concept and is therefore not widely known. It is a concept that could raise many questions when people learn about it. Enodes, the client of this project, also experienced this during the earlier stated project with the municipality Lelystad with the Dutch sustainability officials. Besides Dutch sustainability officials, it was concluded by Enodes that there were many other stakeholders involved in the implementation of V2G in business parks as well. For V2G to work, more awareness should therefore be created on the topic among stakeholders that have much influence concerning the actual implementation of V2G in business parks.

Dutch sustainability officials can advise making the switch towards RES, meanwhile, companies with large-scale PV installations have influence in making the choice of specifically implementing V2G out of all options. Therefore, Enodes suggested to come up with a *visual informative tool* that explains the features of Vehicle to Grid (V2G) when implemented in a business park towards these two target stakeholders. Two constraints within this graduation project coming from Enodes are that the end product should be both ***visual*** and ***informative***. It should provide a comprehensible explanation of V2G in business parks.

1.3 Research Questions

The main research question of this research is:

> *"How to visually inform entities with a large-scale PV installation and Dutch sustainability officials about features of vehicle to grid in business parks?"*

To answer the main research question, the following sub-questions have been formulated:

1. What does Vehicle to grid entail and how can it be implemented in business parks?
2. How to provide the main stakeholders with an informative impression of what V2G could offer through a visual tool?
3. What could V2G offer Dutch sustainability officials and entities with a large-scale PV installation?

In order to fully inform the main stakeholders about the features of V2G in business parks, searching for literature on this topic is necessary. Sub-question one has been defined for this purpose. In addition, all the obtained information from the previous sub-question should be provided in the form of a visual informative tool. Visual communication and informative communication techniques should therefore be considered in order to provide an answer for the second sub-question. Finally, the visual informative tool will only become interesting once it provides relevant information for them. Therefore, it is necessary to get a better understanding of why V2G in business parks could be interesting to the two main stakeholders. Sub-question three has been formulated for this reason. In order to create a form of a visual tool that is most likely to achieve the maximum comprehensiveness about what vehicle to grid could offer, these three things are necessary to research.

1.4 Thesis outline

This graduation project follows the following steps in order to get an answer to the main research question and a suitable end product.

- Chapter 2: State of the Art
  This chapter provides four sections: 'literature', 'consultations with experts', and 'state of the art'. The last section contains a conclusion of the previous sections.

- Chapter 3: Method and Techniques
  This chapter will provide information about the design method and about design techniques that will be used throughout the graduation project.

- Chapter 4: Ideation
  In this chapter, stakeholders will be identified and analysed. Then, requirements are determined based on the stakeholder interests and requirements that are found and based on literature from chapter 2. Furthermore, several concepts are presented. From these concepts, a final concept will be chosen.

- Chapter 5: Specification
  Within specification, Personas, visualisation requirements, storylines and final requirements will be presented. Based on these aspects, the final concept of chapter 4, will be translated into a final storyboard.

- Chapter 6: Realisation
  In this chapter, the final storyboard will be converted into an actual product, which will be an informative visual tool in this case. A suiting program will be used to create this tool.

- Chapter 7: Evaluation
  Once the product has been realised, it will be evaluated. In this chapter, the product will be shown to the client, target stakeholders and experts. Feedback from these stakeholders will be used for the evaluation.

- Chapter 8: Conclusion
  In this chapter, the whole research will be summarised and a conclusion will be drawn.

- Chapter 9: Future Work
  Within this chapter, suggestions for future work will be made about better ways to create an informative visual tool for entities with large-scale PV installations and municipalities.

Chapter 2: Background research

Chapter 2 is divided into four sections: literature research, consultations with experts, state of the art, and conclusion. The first section, literature research, will be focused on the Dutch electricity grid infrastructure, vehicle to grid, and informative and visual communication. The second section contains consultations with experts and user interviews. The third section will present the state of the art. A conclusion from these three sections will be drawn in section four.

2.1 Literature research

2.1.1. Dutch Electricity grid infrastructure

The electricity grid can be defined as a network of connections and nodes over which large amounts of electricity can be transported over long distances. The electricity flow within the networks is managed by several grid operators. Grid providers, in general, ensure a reliable supply of electricity to consumers, businesses and industries. Within the Dutch electricity grid, Tennet is responsible for the national high-voltage grid (150 kV or more), whereas numerous other grid providers are responsible for the low-voltage regional electricity grid (150 kV or less) [9]. Examples of regional grid providers within the Netherlands are Enduris, Enexis, and Liander [10].

The Dutch electricity grid has originally been built with the idea of receiving a constant amount of energy. There are no large-scale energy storage facilities available in the Netherlands, mainly due to the absence of geographically favourable locations in the country [11]. As a consequence of having no large-scale 'buffer' capacity to support the electricity grid, energy demand and energy supply need to be matched and balanced as depicted in figure 2. When the demand is higher than the energy supply, there would be an electricity shortage. In the theoretical case that there is more energy added to the grid than there is demand and when it is more than the grid can handle, we would be dealing with *net congestion* [2]. When net congestion occurs, this could result in energy loss. This situation will be referred to as the ***'net congestion problem'*** within this report. In order to avoid this from happening, a good balance between energy supply and demand should be maintained.

FIGURE 2: FUNDAMENTAL DUTCH ELECTRICITY INFRASTRUCTURE

Electricity for the Dutch electricity grid is produced by *power plants*, which are industrial facilities that generate energy from primary sources, such as sun, wind, or gas. The Dutch energy supply is currently still dominated by natural gas and coal [1], which are polluting in terms of air pollution and pollution due to transport. Burning gas to produce energy results in the production of carbon dioxide which is the most significant greenhouse gas [12].

In order to minimize the impacts of climate change and to achieve global energy goals, a great number of *renewable energy sources*, also known as *RES*, are to be integrated into the electricity grid. Unlike fossil fuels, renewable energy sources are infinite sources, which means that they cannot be depleted. This report will focus on *photovoltaic power sources (PV)*, which are known as solar panels. Photovoltaics (PV) is the conversion of light into electricity by using semiconducting materials [13].

The amount of PV sources that are being used in the Netherlands has increased over the years [14]. They are considered an important renewable energy source for meeting renewable energy targets [14] [15]. A disadvantage of PV sources, however, is that they cannot store any electric energy. In addition, they are *intermittent*, which means that they are weather dependent. Intermittent installations refer to installations that are irregularly producing energy, which makes them hard to predict. In the case of PV installations, this means that they mainly produce energy in the *solar peak moments* [6]. When this *solar peak supply* is provided to a business building, this results in a general net consumption as presented in figure 3 [16]. This is different than in the situation where a PV source is connected to a household. This is due to the fact that energy in households is often consumed more at night time, meanwhile, within business buildings, it is mostly consumed at day time.

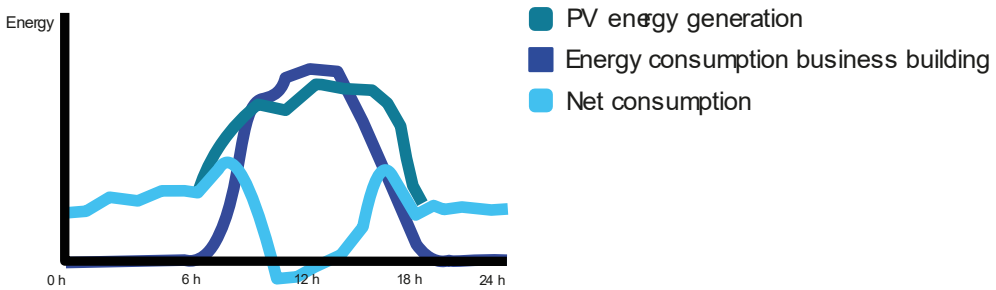


FIGURE 3: ENERGY PROFILE FROM A BUSINESS BUILDING THAT IS CONNECTED TO PV SOURCES.

Due to the earlier mentioned quick transition towards renewable energy sources and due to their *intermittency*, grid managers, such as Liander, are getting to the point that there is a risk of shortage of capacity on the electricity grid. [4]. This problem of shortage will be referred to as the ***'capacity problem'*** within this report. In order to prevent any further increase in peak energy supply, grid managers are currently restricting entities with a large-scale PV installation to connect new renewable power sources to the grid. This is a very unfavourable situation. A large-scale installation is defined as an electrical connection of more than 3x80 Ampère [17].

In order to solve the '*net congestion problem*' and the '*capacity problem'*, the electricity grid will have to be expanded at a high rate. However, since expanding takes a lot of time, other solutions regarding storage buffers need to be considered. This should be done at a quick pace so that there will be no stall on sustainable developments that need to be made. A potential solution to both problems could be *peak shaving*. Peak shaving refers to the method of balancing overall peak demands with regard to electricity use [18]. Figure 4 depicts peak shaving in a situation where energy is stored in a buffer just before the PV solar peak occurs. The image has been created based on consultations with Enodes.

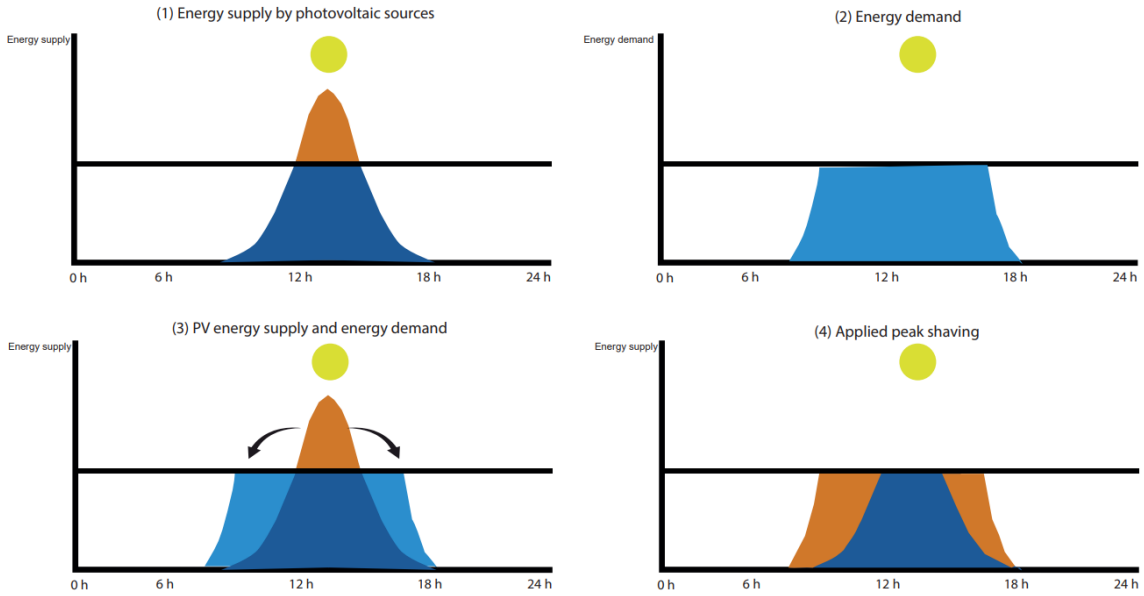


FIGURE 4: ENERGY SUPPLY, DEMAND, AND PEAK SHAVING (1)ILLUSTRATES AN EXAMPLE OF ENERGY SUPPLY BY PV SOURCES DURING SOLAR PEAK MOMENTS AND (2) DESCRIBES THE ENERGY DEMAND. IMAGE (3) COMBINES THE LATTER TWO IMAGES TO SHOW THE DIFFERENCE. IMAGE (4) SHOWS WHAT PEAK SHAVING COULD OFFER AND HOW IT WOULD ALTERNATE THE PV ENERGY SUPPLY BY MAKING USE OF BUFFERS.

2.1.2. Vehicle to Grid

2.1.2.1 General features of V2G

Electric vehicles (EV's) can be used for *peak shaving*, through the method of *Vehicle to Grid*. In 2021, car sales were approximately 6,6 million worldwide, representing close to 9% of the global car market [19]. It is expected that this number will be ever-increasing in the upcoming years. EV's are stationary approximately 95% of the time [6]. During these stationary moments, the battery could be used for bi-directional charging. If used within the right moments and with the right amount of available electric vehicles, this could result in peak shaving. Hence, these vehicles could serve a bigger purpose by adding an extra dimension to them; apart from it being a form of transportation, they could also serve as a form of storage of electrical energy.

'Vehicle to grid' can be defined as the *bi-directional electricity flow* between plug-in EV's and the electricity grid [7]. When making use of a bi-directional electricity flow, cars can both be charged and discharged of electricity. Electric vehicles could serve as a buffer for the electricity grid since excess electricity generated by photovoltaic sources could be stored within electric vehicles at times of low electricity demand and excess electricity production. With vehicle to grid, the opposite will also be possible, which is discharging the electricity from the electric vehicle, when there is little electricity available elsewhere on the electricity grid. See figure 1 for a better understanding of the mechanism of V2G in general. Figure 5 depicts V2G in combination with PV-sources when connected to several buildings. This figure has been created based on expert conversations with Enodes, the client of this project.

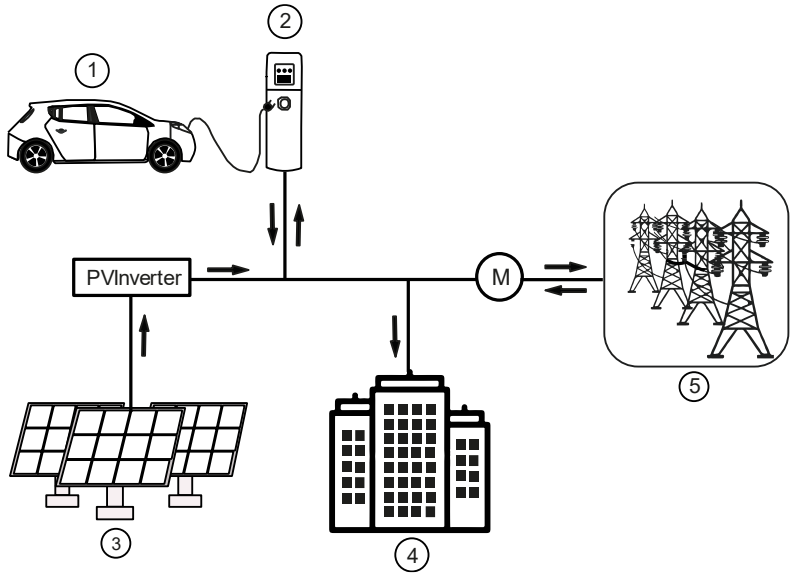


FIGURE 5: V2G EV INFRASTRUCTURE OF BUILDINGS, PV SOURCE AND ELECTRICITY GRID
1: EV, 2: CHARGING STATION, 3: PV SOURCES, 4: BUSINESS BUILDINGS, 5: DUTCH ELECTRICITY GRID

Should V2G be implemented, this could result in several advantages. For example, when using V2G, this could result in a reduction of annual energy bills. This is because of the fact that energy can be sold to the Dutch electricity grid in moments of a lower energy supply than energy demand from business buildings situated in the business park. In addition, energy demands can be managed at peak times once again due to the effect of the earlier mentioned peak shaving that V2G can cause [20]. Also, if V2G would be implemented on large scale in a business park, the companies within the business park could become less dependent on the electricity grid . Lastly, if V2G would be implemented in large scale in general, this indirectly also stimulates the integration of RES sources into the electricity grid. This is because of the fact that it could help with both the 'capacity and net congestion problem' and therefore also with the brake on the energy transition.

There are currently numerous pilots with V2G taking place worldwide. The developments with regard to V2G have been mapped by [21]. Currently, none of these implementations are within business parks. Therefore, it was needed to do an interview with an expert to find out how V2G works, when implemented in a business park in order to answer sub-question one. The result of this conversation is depicted in figure 5, as earlier mentioned.

Throughout the phase of obtaining information about V2G, there appeared to be several ways to explain the value of V2G by looking at literature. Most papers looked from the perspective of PV sources in combination with the '*net congestion problem*' [6] [22]. Some papers contained information from the perspective of the Dutch electricity grid [23]. Some started their paper by writing about the rising amount of EV's [18]. Recognition of this situation is of value for this research, as the final product needs to informatively explain the concept of V2G. The right approach is of essence to present an interesting story to the main stakeholders. The approach will be based on the interests of the main stakeholders in *Chapter 5.*

2.1.2.2 Challenges of V2G

In order to make V2G feasible in the Netherlands, there are four potential challenges that need to be considered regarding infrastructure, with a specific focus on EV's. These challenges are important to consider as these challenges could have influence in whether V2G can be implemented. The challenges could be added within the visual informative tool. The following challenges will be considered:

1. The quantity of bi-directional chargeable EV's
2. The willingness of EV owners
3. Bi-directional charging stations
4. Using V2G at the right moments

1. The quantity of bi-directional chargeable EV's

The first potential challenge regarding implementation of V2G, is that there need to be enough EV's on the market that are able to facilitate bi-directional charging. EV's that are able to make use of bi-directional charging have the potential to absorb the excess electricity produced by the PV sources. Many car manufacturers are aiming to produce cars that facilitate this mechanism as soon as possible. However, this should be done at quick pace in order to keep the implementation of vehicle to grid in motion. As of May 2021, some of the models that are compatible for V2G are: Nissan Leaf 40kWh, Nissan e-NV200 (van), Mitsubishi Outlander PHEV, Mitsubishi Eclipse Cross PHEV, etc. Furthermore, Volkswagen stated that as of 2022 most of their cars on the modular electric drive toolkit platform would be bi-directional [24].

In addition, as true change for the electricity grid can only be achieved if there are enough EV's available to discharge, the quantity of available EV's is also an important challenge to consider. So far, there is no reference for the right amount of electric vehicles that would be needed. Nevertheless, only if EV's can be utilised in large numbers, true flexibility of the Dutch electricity grid could be accomplished. This, however, may well become the case since it is to be expected that the number of electric vehicles will be significantly growing in the near future.

2. The willingness of EV owners

EV owners need to be willing to participate with V2G in order to succeed. Research has been conducted with seventeen participants that tested V2G has shown that the main prejudgments coming from EV owners were the uncertainty associated with battery state-of-charge, the increased need for planning charging and trips, the uncertainty about reaching the destination, economical and performance effects of V2G on the battery of the EV and the fear of obtaining less freedom with their personal vehicles [25]. Additional research on the willingness and prejudgement of EV owners about participating with V2G has been conducted within this Thesis research. The results of this research are in correspondence with the previously mentioned research from [25]. The results will be mentioned within the requirements of Chapter 4.

3. Bi-directional charging stations

A Bi-directional charging station is an advanced EV charger capable of two-way charging. This product converts power from AC to DC, unlike a regular unidirectional EV charger that charges using only AC. During the conversions of power in a bi-directional charging station, some of the energy may be lost due to the efficiency. For example, the Nissan Leaf power conversion is 87% in efficiency [26]. In addition, bi-directional chargers only work with EV's that have a bi-directional charging mechanism. These are needed for V2G to work.

4. Using V2G at the right moments

Once enough EV's are available for bi-directional charging, they can only make an actual change for the electricity grid if V2G is used in the right moments. Matching the supply of PV sources with EV's can be a challenging combination. This is because PV sources produce a peak energy load during the day, of which the excess produced energy could be stored in EV's. These vehicles could use this energy at a later time, when there is less peak energy load. Only when using bi-directional charging in a coordinated way, V2G could be a solution to the previously stated 'net congestion problem' and the 'capacity problem'.

2.1.2.3 Conclusion on literature section of the Dutch infrastructure and V2G

Obtaining information about the Dutch energy infrastructure (*section 2.1.1)* and about features of V2G (*section 2.1.2.)* was essential in this project. This is because of the fact that V2G needs to be visually and informatively explained and in order to do this, information about V2G is needed. From the obtained information can be concluded that the term *net congestion* is a phenomenon which is very important to explain. This is due to the fact that V2G could potentially solve net congestion if used on a large scale. Therefore it should be included in the visual informative tool end result. In addition, *peak shaving* is also a topic which is important to explain. When using V2G in combination with PV sources, it results in peak shaving which is favourable for a company building. Thus, this should be included as well.

It was found that V2G can be explained from three different starting points: sustainability, PV sources and EV's. Choosing a correct approach with regard to the main stakeholders is essential for the end result to be interesting. The correct approach will therefore be chosen in chapter 4 as stakeholder interests will be investigated there. In addition, four challenges regarding the implementation of V2G were encountered. It should be considered whether these challenges need to be mentioned in the video based on the final requirements that will be defined in *section 5.3.*

2.1.3. Principles of informative communication

As the information from the previous sections needs to be presented as a visual informative tool, the following two sub-sections will focus on informative and visual communication. The information obtained from these two sub-chapters will be used to answer sub-question two of this research.

One of the common perceptions of informative communication is that it concerns improving the understanding of a targeted audience on a particular issue by attempting to give a truthful and unbiased view of the issue being considered [27]. As a consequence, the audience is able to form an educated opinion about the subject. However, other sources mention that the latter definition presents a common confusion [28]. According to them, informative communication involves presenting a format for a subject for which correct organisational formatting has been chosen and that will naturally appeal to people's minds [28]. There are many different proposals available for the definition of informative communication which all differ as it is difficult to address an exact definition of correct informative communication. It is, however, necessary to work with one specific definition as a starting point. Therefore, within this project, the following definition of informative communication will be employed [27] [28]:

> *"**Informative communication** entails improving the understanding of a targeted audience on a particular issue by attempting to give a truthful and unbiased view of the issue being considered. Effective informative communication is achieved by presenting a format that is logical for the subject and that will naturally appeal to people's minds."*

Informative communication is fact-based and does not have the purpose to persuade the audience. Within informative communication, there are four main communication forms, namely: defining, descriptive, explanatory, and demonstrative communication [27] [29]. These forms are demonstrated below in figure 6.

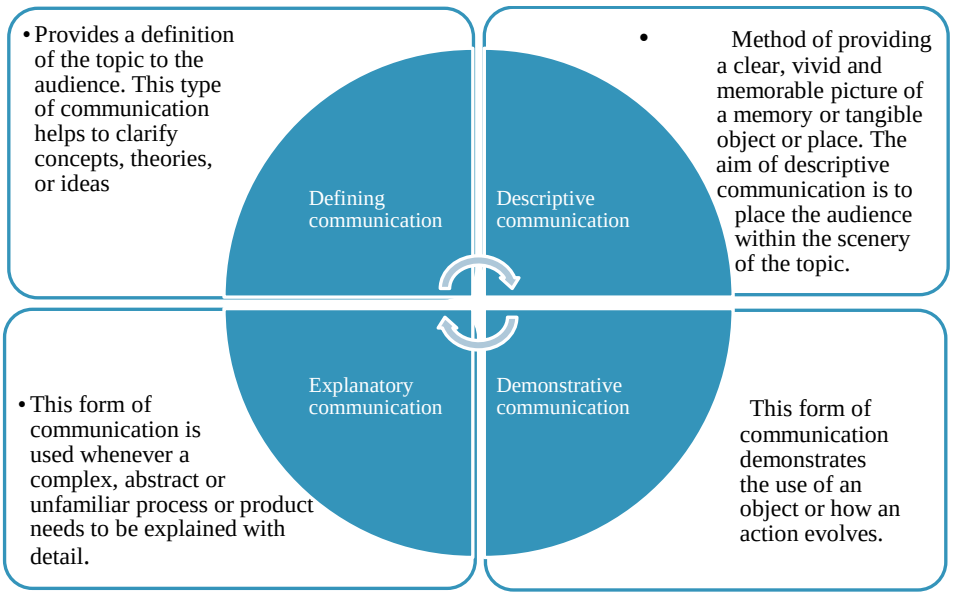


FIGURE 6: FOUR PILLARS OF INFORMATIVE COMMUNICATION

The final aim of this project entails raising awareness about the potential features of V2G when implemented in a business park. Since vehicle to grid is not widely implemented yet and is therefore difficult to exhibit in real life, demonstrative communication is the least suitable option. The other three communicative options can all be applied given that they would all result in creating more awareness. The only difference between one another is that explanatory communication is a lot more detailed than definitional communication. The level of detail of descriptive communication lies in between the latter two communication styles.

As mentioned before, the aim of the visual tool is to create more awareness of the potential features of vehicle to grid. So, in order to accomplish this, the concept vehicle to grid and the potential features should be explained globally and not in-depth. Thorough explanation would not be fitting within this project because of the fact that audiences are often not able to remember a big amount of information after having listened [30]. Therefore overloading the audience with data, would work counterproductive within informative communication. It is therefore needed to focus on content that matters, where the problem, purpose and central idea play a role. In addition, whenever an audience is engaged with the message, the message is more likely to be remembered. This could be achieved by, for instance, by placing the audience within the scenery of the topic. All in all, engaging the audience and a focused message appear to be most effective within this graduation project. Therefore, it has been decided to continue with *descriptive informative communication.* The definition of *descriptive informative communication* has been provided below [29].

> *"**Descriptive informative communication** refers to the method of providing a clear, vivid and memorable picture of a memory or tangible object or location. The aim of descriptive communication is to place the audience within the scenery of the topic."*

The definition of "*descriptive informative communication*" states that there are three main aspects that are considered important, namely: Providing clear, vivid and memorable messages. In order to achieve this, information related to these main aspects will be addressed below.

A. Clarity: Message length & Complexity of sentences

There is a common belief that informative communication holds that using short, familiar words and short sentences will increase the effectiveness of all informative messages [28]. However this depends on every different situation. Some ideas could be more difficult to understand due to reasons that have nothing to do with sentence length. Thus, the message length does not necessarily need to be short in order for people to understand the message more clearly [28]. Difficult terms need to be explained well in order for the audience to understand it. Furthermore, in order for the message itself to be clear, unimportant information needs to be filtered [31]. It should be provided to the viewer in a logical order.

B. Vividness: Engaging message

In order to get people engaged with the story, meaningful concepts, such as recognizable actions, events and attributes, should be used within the message. Aesthetics is also an important factor [32]. In general, people become more engaged recognizable aspects.

C. Memorability: emotional message

Often, a message or visual image is used to evoke an emotional state that will let the viewer open up to receive the message targeted at them [33]. Designers of the informative message are then able to create a persuasive message [33]. However, as the message should be truthful and non-biased, emotional impact should not be used with the purpose of convincing people by emotion.

The previously mentioned aspects that should be taken into account in the design process, are summarised in the table below. These will all be considered as requirements within *chapter 4.*

Term	**Aspect**	**Fitting the terms in the scope of this project**
Verbal	Clarity	The topic is technical, so difficult terms should be explained well. Sentences do not need to be complex in order to achieve this.
	Engagement	As a message becomes more engaging through recognition and 'meaningful concepts'. Therefore, sufficient meaningful actions, events and attributes that are recognizable should be included.
	Emotional impact	The message should be truthful and non-biased, which is why emotional impact should not be used with the purpose of convincing people by emotion.

TABLE 1: SUMMARY INFORMATIVE COMMUNICATION

2.1.4. Principles of visual communication

Effective visual communication should be both appealing and informative. Visual information helps with better comprehension of information, which could help with difficult unknown subjects, such as V2G [33]. Enodes, client of this research, suggested to come up with an *informative visual* tool. Therefore, it is critical to address the definition of *visual communication*. The definition that will be considered in this project has been illustrated below.

> ***Visual communication*** *is the practise of using visual elements to convey a message or to trigger emotions. The message can be transferred from 'sender' to 'receiver' through, for instance, signs, typography drawing, graphic design, illustration, advertising, animation, etc.*

The success of visual communication depends on the ability to reach a targeted audience and elicit a desired response. As earlier stated in *section 2.1.3.* often, visuals are also used to evoke an emotional state that will let the viewer open up to receive a message targeted at them [33].

As visual design is a very broad term, this project will be focused on graphic design in specific. This is due to the fact that the Bachelor Creative Technology, for which this thesis is written, is especially focused on visual design within the domain of graphics. In order to achieve visual communication, some information related to this will be addressed below.

A. Visual attractiveness

Within visual attractiveness, it is important to choose a graphic design style that will resonate with target audience [34]. The more attractive a visual tool, the more engaged people become with the message.

B. Unity

A viewer will always seek unity in a message. Without it, the viewer will lose interest. Unity is achieved when all the design elements relate to one another and project a sense of completeness. Designers use ideas drawn from Gestalt theory to help unify their designs. Gestalt theory is a process by which a viewer unites separate design elements into a whole form that is greater than the sum of its parts [33]. Thus, in the case of the visual informative tool, for example, colours, shapes, etc. should be used the same way in the whole tool.

C. Visual hierarchy

Visual hierarchy is the arrangement of all graphic elements according to emphasis. Since people do not spend much more than a few seconds glancing at an ad, the principle of visual hierarchy needs to be considered for good facilitation of communication. The principle of visual hierarchy refers to arrangement of elements to show their order of importance [33]. Emphasis indicates the most important element on the page based on the message. It's the element that stands out and gets noticed first. The most emphasized visual element in a design is called a focal point because it attracts the viewers' attention first. Emphasis can be created most by taking an element and making it bigger, bolder or brighter, by putting it in a contrasting colour or by surrounding it with white space [33].

D. Unique visuals

Creating unique content is critical today when people expect entertainment or information. Montage needs to be carefully cut and edited together to create a unique whole. A unique overall visual design and styling should include unique styling including graphic elements, a colour palette, etc. [35].

The previously mentioned aspects that should be taken into account in the design process, are summarised in the table below. These will all be considered as requirements within *chapter 4.*

Term	**Aspect**	**Fitting the terms in the scope of this project**
Visual	Visual attractiveness	The more attractive a visual tool is, the more engaged people get with the message. This is why the 'looks' of the visual tool should resonate with the target audience.
	Unity	Unity should be maintained in order to keep the interest of the viewer. This should be done according to the Gestalt theory.
	Visual hierarchy	When using visual hierarchy, emphasis can be made. With emphasis, the most important element will get noticed first by the viewer.
	Unique visuals	The audience could become more engaged with the message by using unique visuals. Therefore, uniqueness should be one of the goals with regard to realising a visual tool.

TABLE 2: SUMMARY VISUAL COMMUNICATION

2.2. Consultation with Experts

Throughout the research, two experts have been approached. Multiple meetings have been conducted with Enodes, the client of this research, in order to get a better understanding of how V2G works, when implemented within a business park. In addition, the company 'We Drive Solar' has been interviewed about features of V2G that were uncertain, such as the battery degradation, their opinion on whether V2G will be feasible within a business park, etc.

2.2.1 Consultation with Enodes about the implementation of V2G in a business park

As earlier stated in *section 2.1.2,* V2G has not yet been implemented in a business parc with a large-scale PV installation. Therefore, interviews with Enodes were necessary to get a clear picture of what this would look like and to get an idea of how everything is connected . After various consultations with Enodes, it became clear how V2G would look in a business park. This situation is illustrated in figure 5.

Then, as there was not very much information to be found for peak shaving for interconnected company buildings as well, this was also a topic that needed to be discussed. As earlier stated in *section 2.1.2,* households often actively use electricity from around 6 a.m. to 10 a.m. and from 5 p.m. to 11 p.m., while companies actively use electricity from around 9 a.m. to 6 p.m. Figure 4 shows what the energy consumption and supply would look like in the situation of a business park with V2G and a large-scale PV installation. This could be beneficial for the visual informative tool as it could give a better picture of what peak shaving entails.

2.2.2 We Drive Solar: Expert Vehicle to Grid

'We Drive Solar' is a Dutch company that encourages the transition towards more accessible cleaner mobility [36]. The company can be seen as one of the pioneers regarding implementation of V2G. They have constructed the V2G system in the 'Witte Vrouwen' neighborhood in Utrecht, which is situated in the Netherlands. As they are one of the first companies that were able to build a working system, they are assumed to be experts in the domain of V2G. Battery degradation, an overrule button for stopping V2G, and the feasibility of V2G in a business park were topics on which contradictory or no information could be found. Therefore it was advantageous for the project to ask questions about these things.

According to them, there is almost no battery degradation when V2G is used. This is a negligible factor that does not need to be taken into account. Furthermore, they state that an overrule button is already being implemented in several models. Utilization of an overrule button refers to the method where discharging the EV can be overruled by using some sort of button or application. For example, this can be used by an EV owner once he or she needs to leave quickly with the EV. We Drive Solar mentioned that they thought it was a good idea to implement V2G in business parks as it could provide a good business model as well with bi-directional lease cars.

2.2.3 Conclusion consultations with experts

From consultations with Enodes and We Drive Solar, it became clear that the implementation of V2G in a business park seemed feasible to We Drive Solar. Figure 4 was created to show how peak shaving looks, when V2G is implemented in a business park with a large-scale PV installation. Figure 5 was created to depict the connections between all elements in the V2G set-up within the business park. These illustrations can both be used to explain the topic of V2G towards the main stakeholders. The facts that battery degradation is negligible and that an overrule button is possible, are potential features that can be mentioned in the visual informative tool to reassure the main stakeholders.

2.3. State of the Art

There are currently various visual tools that explain V2G. By analysing the message and the form in which the message is presented, much can be learned. Information from section 2.1.3 and section 2.1.4 about visual informative communication will be used to analyse these tools in order to see what storyline and form of presentation might be good to consider in a later stage of this project.

2.3.1. Renault Campaign

Renault created a video to shortly present how V2G works with an EV [37]. It a provided a message below the video that they will introduce a fleet of fifteen Zoe vehicles with V2G capabilities. Therefore the video has been created for commercial purposes.

A. Storyline

Within this video, no voice over has been used so the story had to be read through only the visual communication. The structure of this video is provided in the scheme below. The video has a duration of 35 seconds and only highlights the process of using V2G. This video excludes all the other features, benefits, prejudgments and obstacles. It can be seen as demonstrative and informative, seeing that it is not intended to convince people to use V2G, but by providing the process only. As there were not more than three meaningful actions in the video, the video was not very engaging.

FIGURE 7: STRUCTURE RENAULT CAMPAIGN VIDEO

B. Form of presentation

The video is a form of animation. The layout of the video is shown in figure 8 below. As earlier mentioned, V2G is currently not widely implemented yet and is therefore somewhat more difficult to demonstrate and explain. Therefore usage of animation video could be a technique that explains interactions around V2G in detail. With regard to this specific video, there is great sense of unity as there are no changes in setting. However, when looking at visual hierarchy, the woman and car do not stand out. The background is quite distracting the viewer this way.

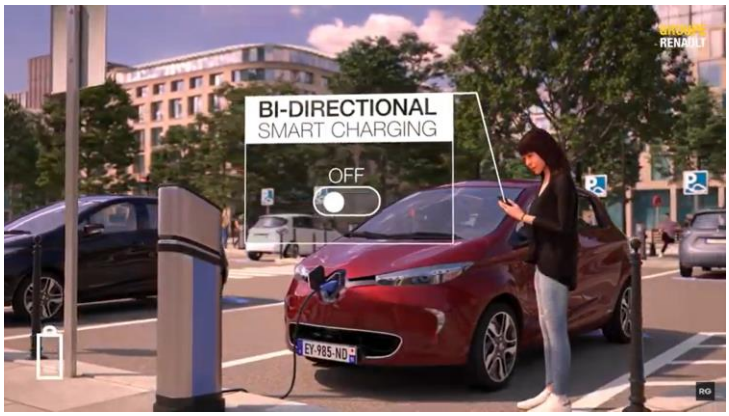


FIGURE 8: RENAULT CAMPAIGN VIDEO

2.3.2. Virta

Virta is a company who tried to make a platform on which people can be informed about the possibilities of V2G [38]. One out of two video's that are included on the website, describes that there is a collaboration between E.ON, Virta and Nissan.

A. Storyline and form of presentation

Virta has created a website on which six questions have been answered, which are:

1) What is vehicle to grid?
2) Why should you care about V2G?
3) How does vehicle-to-grid work?
4) The benefits of vehicle-to-grid
5) How will vehicle-to-grid become mainstream?
6) Additional resources

In the first question, a video is added in which interviews of several experts were combined with explanatory video fragments. This video uses experts to make statements about V2G. However, should the target audience not understand everything, the interview video could work counterproductive. Statements could be difficult to understand. Furthermore, in the storyline, only advantages have been mentioned, which makes the story one-sided and biased. This video can therefore be described as argumentative instead of informative, which also applies for the rest of the website.

In the third question, which is '*How does V2G work?',* Virta has placed another video that explains the interaction between user and EV with V2G included. A person shows how fast and easy the interaction is through a vlog and shows the three actions that are needed: connecting the EV to the charger, opening the app and choosing when to leave and then swipe to charge. This second video was a vlog that showed many meaningful actions, which made it engaging to watch. However, it is challenging to obtain a bi-directional EV and -charging station in combination with an app for this. Therefore, a vlog might be less suiting.

A website that has two video's for explanatory purposes appears to be a good way to explain V2G. It is concise, clear and does focus on providing meaningful information and actions. Therefore, it would be good to consider this type of tool in a later stage of this project.

FIGURE 9: FRAGMENT I VIDEO OF VIRTA

FIGURE 10: FRAGMENT II VIDEO OF VIRTA

2.3.3. Ovo Energy

The video has been produced by OVO energy [39]. OVO energy is a company that strives for zero carbon emissions. Together in a collaboration with Kaluza, they have realized an app for V2H in which the ability to overrule charging and discharging is added.

A. Storyline

Ovo energy has created a short animation video of 1:28 that explains many features of V2H, which is Vehicle to Home. V2H entails using electricity that has been stored in the battery of the owners' EV and using that same energy later on within their home. The energy that is left over, can be sold to the electricity grid. The mentioned aspects of V2H in the storyline are illustrated in figure 11 below. The video shows a complete story about a daily situation of a person who is the owner of an EV and owner of a bi-directional charger at home and is very engaging. The story only provides the advantages and is therefore argumentative and not informative. However, there are no phrases within the story that mention to really go and install V2H to the viewer. The story is very complete and compact and keeps viewers engaged while watching it as images continuously change. It is a very good example of an animation.

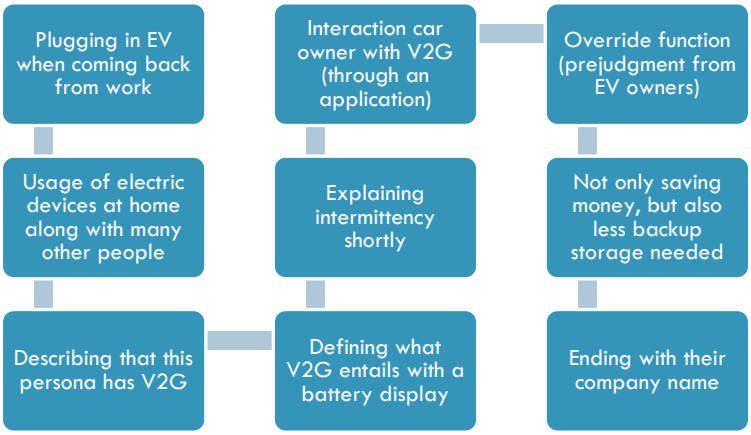


FIGURE 11: STORYLINE OVO ENERGY ANIMATION

B. Form of presentation

Animation has been used to create this video. The video itself contains a strong sense of unity, visual hierarchy and is very visually attractive. The figure below illustrates a frame of the animation.

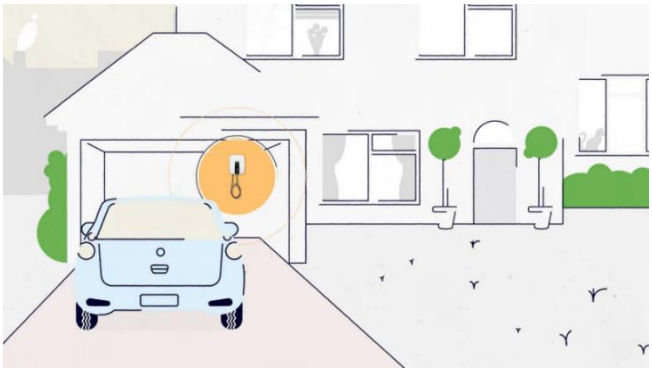


FIGURE 12: OVO ENERGY VIDEO

2.3.4. The Vox network

The Vox network is an organisation that created a video with real life camera footage to explain V2G [40].

A. Storyline

The storyline of this video is depicted in figure 13. The goal of this video is to define V2G and to highlight its features. It therefore belongs within the defining pillar of informative communication. The story is clear and concise and is explained in 4:35 minutes. The video is overall visually attractive. However, as they use footage of different videos, such as footage from the OVO energy animation, the video does not contain a sense of unity, which is distracting. Combining various forms of video (animation, film, images, etc.) is not suiting for this project because of the lack of unity.

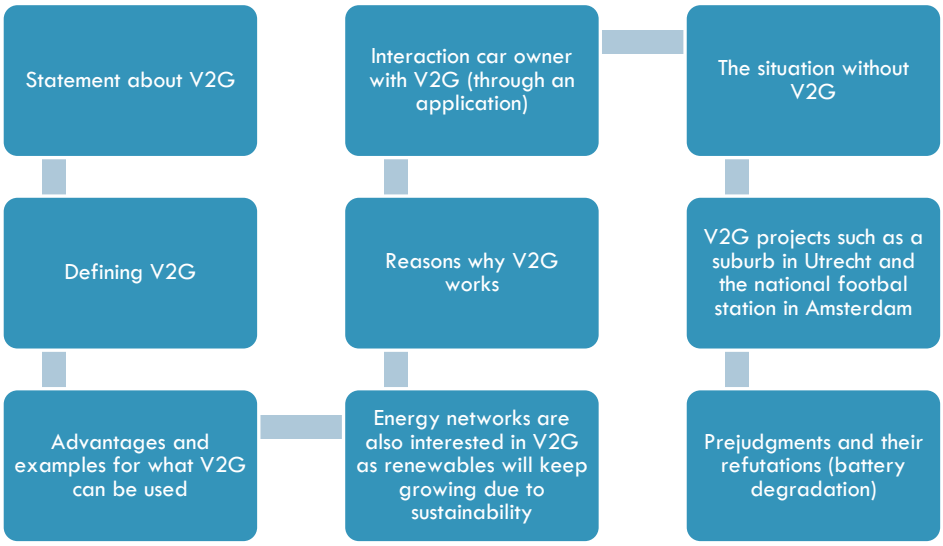


FIGURE 13: STORYLINE THE VOX NETWORK VIDEO

B. Form of presentation

The video appears to synchronise the footage with the messages that are being said, which allows for a situation where the viewer is engaged. This is an aspect that could be used within this project.

FIGURE 14: THE VOX NETWORK VIDEO

2.3.5. Conclusion state of the art

There are quite some video's and information platforms, such as websites available that explain the meaning of V2G. However, no information is available yet on V2G, when implemented in business parks. Different types of tools were compared with literature about visual and informative communication to see what would be good to consider for this project as well. Some things that could be noted from the four tools that were considered, was that the most engaging tool, appeared to be an animation that had a strong coherency, clarity and unity. Many sufficient actions appeared in the video which made it interesting to watch. It was also noted that audio was also an important thing which should match with the images. Interactive website was also an interesting form of tool which could be considered in the choice for an informative visual tool in this project. Lastly, it was noted that vlogs and expert interviews with information that is rather difficult to understand do not work very well. This should be avoided in the design of the final prototype of this project.

2.4. Discussion and Conclusion

Within this chapter, conclusions can be drawn on two fronts, firstly, with regard to the content, and secondly, with regard to communication. In *sections 2.1.1. and 2.1.2.*, the literature in relation to V2G has been reviewed. It was noted that the Dutch electricity network is under pressure. This is due to the rapid emergence of photovoltaic sources, with which the Dutch electricity network cannot keep up resulting in net congestion. Along with the emergence of photovoltaic sources, electric vehicles have become increasingly popular. This offers opportunities. Electric vehicles are stationary 95% of the time and can be used for an additional functionality during this time; in this case, as a buffer for the Dutch electricity grid.

Vehicle to grid offers many advantages and only a few disadvantages. It could offer flexibility to the electricity grid, economic benefits and more independency from the electricity grid. The challenges mainly have to do with the non-existent technology and proper communication between user and provider. These positive and negative issues can be incorporated into the content of the video in order to dispel the questions that people have about the subject.

Section 2.1.2 showed that explaining the meaning of V2G can be approached in various ways. The story could be initiated from the 'capacity problem' of the Dutch electricity grid, the rise of PV sources and therefore solar peak moments or the often stationary electric vehicles. These three starting points are illustrated in figure 15. The image represents is a triangle which depicts that, in order to get to the core, which is V2G, entry needs to be done at one of the outer three triangles. As the main stakeholders within this project are Dutch sustainability officials and business owners with a large-scale PV installation, a good balance will need to be found between the starting points PV sources and the Dutch electricity grid.

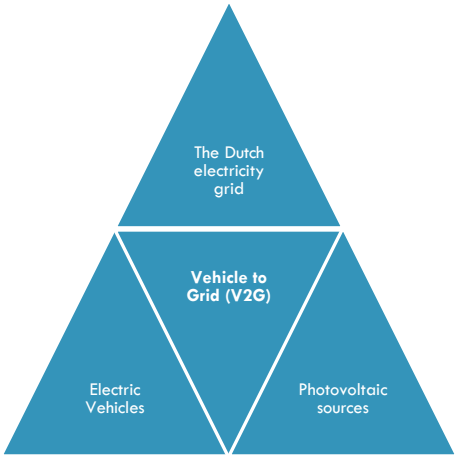


FIGURE 15: V2G EXPLANATION APPROACH FORMS A TRIANGLE

In *visual descriptive informative design*, a clear, concise and coherent message should be given. The message should be truthful and non-biased, which is why emotional impact should not be used with the purpose of convincing people by emotion. In addition enough meaningful actions should be shown in order to engage the audience. Furthermore, the final product should be visually attractive, should strive for unity and uniqueness and should empathise the most important aspects to keep the viewers' attention. Lastly, unimportant material should be filtered.

Combining the state of the art with the literature and the consultations with experts shows that, even though V2G is quite new, there are already some explanatory visual tools available. The tools that were most engaging were video's that contained unity, coherency and a clear story. Using auditive information that is supported by visual communication would also be good to apply in the product of this graduation project as this allows for an engaging story.

Chapter 3: Method and Techniques

This chapter provides the methods and techniques used in this graduation project and also reasons why certain methods have been chosen. The chapter has been divided into two sections: Design method and techniques. First, the design method of the project will need to be considered. In this case, the Creative Technology Design Process will be used. The second section will contain the techniques that have been used within the whole process.

3.1 Design method

For this project, the Creative Technology design method has been chosen [41]. This process has been parted into four phases, namely: ideation, specification, realization and evaluation. The illustration added in Appendix A depicts the process and how the different phases relate to one another. Within each of these phases, it is always possible to go back to an earlier phase, as it is iterative. The iterative aspect of this design method is useful considering the fact that the visual informative tool should be improved during the design process based on the feedback from different stakeholders in this project. Only then, a visual informative tool logical to the main stakeholders can be created.

3.2 Design techniques

3.2.1. Stakeholder identification technique

In order to identify the stakeholders, the method presented by [42] has been utilised. When asking stakeholders on their agreement on commitment and deal of knowledge on the topic V2G, active stakeholders can be separated from less active stakeholders. In this case, four versions will be separated from one another by the following features: active, conscious, alerted and inactive.

Within this table, active stakeholders are considered to have a great deal of knowledge about the problem. They often have a high degree of commitment. Secondly, conscious stakeholders often have a great deal of knowledge about the problem, but they differ from active stakeholders due to their commitment. Conscious stakeholders often have no direct interest but are often well-informed and highly educated. Thirdly, alerted stakeholders have little knowledge about the problem. However, their involvement is high since there is a form of importance to them. They may become alerted by several factors, personal experience, through the media, or they have been specifically alerted by an action group, political party, etc. Fourth, inactive stakeholders have both little knowledge and low commitment. They are somewhat involved but may be satisfied already with the situation. In addition, they might not find it worthwhile to be actively involved in the matter. Another reason for inactive stakeholders not to feel the urge to be involved could also simply be that they do not think that anything could be done to change the existing situation.

3.2.2. Stakeholder Analysis technique

Once stakeholders have been identified, they are to be analysed. First, it is needed to get an understanding of what interests these stakeholders have in this project [43]. This is needed in order to understand what the main stakeholders would want to know within the visual informative tool. Secondly, it is needed to understand what information and practices are needed from each stakeholder, what the perceived attitudes are and the risks when the stakeholder is not engaged [43]. This is needed so that important aspects to specific stakeholders will not be overlooked.

3.2.3. Requirement elicitation and categorization

Within the ideation phase, requirements need to be elicited. Thus, a fitting method is needed in order to do this. The MoSCoW method could provide this and will therefore be used within this project [44]. This method refers to a categorisation technique for managing the requirements that are to be found in the entire process. It is a four-step approach, whereby aspects will be categorised under the four terms: '*must have', 'should have', 'could have' and 'would have'.* Within this prioritisation, requirements categorised under '*must'*, have to be incorporated in the final product in order to be acceptable. The rest of the requirements should be incorporated in the product based on their rank.

3.2.4. Brainstorming Techniques

It is needed to use several brainstorm sessions in order to create different concepts. Within the brainstorming sessions, it is needed to look at two different aspects. The first one is to look at the available techniques with which a visual informative tool can be generated. For this, a mind mapping method will be used (*section 3.2.4.1*). Then, it is needed to conduct a brainstorm session about the content, which will be done with the star bursting method (*section 3.2.4.2*).

3.2.4.1. Mind mapping

Mind mapping helps connect links between different ideas [45]. By starting with one centred topic and expanding it into branches off the centre, ideas could be generated by looking at different subsections within each idea. Focusing on key ideas and looking for connections between one another can result in mapping visually understandable knowledge. This method will be used to think about different strategies to create the visual informative tool.

3.2.4.2 Star bursting method

The star bursting method helps with exploring ideas by asking specific questions about the brainstorming topic [46]. Within this method, six questions are centred at each point of the star. The questions entail: '*Who?, What?, Where?, When?, Why? and How?'*. These questions need to be finished with questions that have to do with the topic. This way, a broad view of the questions that people could have with the topic can be generated. It might be best to do it with (an)other student(s) that do not know anything about the topic, as the questions could then be more representative for someone that does not have an idea about the topic yet.

3.2.5. Interview techniques

This project relies on the feedback of the client, EV users and experts. Thus, a clear approach for obtaining feedback is essential. Before designing the visual informative tool, it is important to get a good understanding of the requirements. Requirements will come from stakeholders, therefore, interviews will need to be conducted. Within interview techniques, there are three different versions, namely unstructured, semi-structured and structured [47].

For the interviews in this project, semi-structured interviews are the most suitable option. This is due to the fact that a researcher can ask further questions in an interview, once it is noted that there is more to the answer of the participant. This is suiting for the consultations with supervisors, Enodes, the user research with EV owners, and the expert in V2G as it is needed to get a good understanding of their actual opinions and knowledge. The only interview that is chosen to be different than semi-structured, is the user evaluation of the product. The evaluation will be further explained in detail in *section 3.2.6.* However, the approach of an online questionnaire has been chosen so that the participants feel free to express their opinion without feeling like they could hurt the feelings of the researcher. Results would otherwise be biased. The stakeholders, with whom research is of added value to the goal of this thesis, are listed below along as well as method of research used to gather information.

Subject	Method of research
Supervisors	Face to face semi structured interview
Client Enodes	Face to face semi structured interview
Users of Electrical Vehicles	Online semi-structured interview
Expert Vehicle to Grid	Online semi-structured interview
Expert Oral Communication	Online semi-structured interview
Evaluation EV owners, company owners with a large scale PV installation and sustainability officials	Online questionnaire combined with looking at the final product

TABLE 3: INTERVIEW METHODS

3.2.6. Evaluation methods

After realizing the product idea, it needs to be evaluated. This will be done in three different ways. The final product will be proposed to the client after which it will be evaluated through a feedback session to understand whether the product indeed met the expectations of the client. Then, a user evaluation will be conducted with the target stakeholders: EV owners, entity owners with a large scale PV installation, and Dutch sustainability officials to understand if the product has reached its purpose of visually informing them. A V2G expert and oral communication expert will also be asked to evaluate the product based on content and story to understand if the story is both truthful and interesting. Lastly, earlier stated functional- and non-functional requirements will be judged on their integration in the result [41]. The requirements will be marked with one to three stars based on their integration. One star refers to almost no integration, meanwhile three stars means success in integration of the requirement in the final product.

Chapter 4: Ideation

In this chapter, various techniques that have been discussed in Chapter 3 will be used for concept generation. First, stakeholders need to be identified and analysed. Their interests in the project can be categorized based on their commitment. The interests can then be converted into requirements and will be prioritized according to the MoSCoW method. Lastly, based on gathered knowledge from Chapter 2 and the requirements, concepts will be presented. A final concept will then be chosen and explained in further detail.

4.1. Stakeholder needs and requirements definition

4.1.1. Stakeholder identification

Stakeholders are actors who have an interest in V2G, who are affected by net congestion or who, because of their position, have or could have an active or passive influence on the decision making and implementation process [48]. The stakeholders will be identified and analysed by making use of techniques that have been mentioned in *Chapter 3*. First, in order to identify the stakeholders, the involvement method has been used, which means ordering stakeholders based on their involvement. It has been based on the question

'To what extent does the stakeholder wish the visual informative tool to be produced and how active is the role of this stakeholder within this process?'

The technique has been applied and illustrated in the table below.

Involvement stakeholder	**Stakeholder in the scope of this project**
Active stakeholders	- Enodes - Researcher of this project (Alessia Bertana) - Supervisors (E. J. Faber and R. Bults)
Conscious stakeholders	- Dutch municipalities - Car manufacturers - Energy suppliers (Liander) - Charging station producers
Alerted stakeholders	- EV owners (own EV's) - Entities with a large-scale PV installation that want to connect their installations to the Dutch electricity grid
Inactive stakeholders	- EV users (lease EV's)

TABLE 4: STAKEHOLDER IDENTIFICATION

Within this project, Enodes, the researcher of this project and the two supervisors will play an important role with regard to the production of the visual informative tool. Most direct requirements will come from these three parties. Energy suppliers and Dutch municipalities, could have a direct interest in the visual informative tool as they experience people complaining at their desks because of the problems with the Dutch electricity grid. V2G is one of the solutions that could help with regard to this problem and could therefore be interesting for creating more awareness.

4.1.2. Stakeholder Analysis

Now that the stakeholders have been identified, they need to be analysed based on their interest and power by using table 5 and 6. As there are a lot of stakeholders involved within this project with many different interests, the stakeholders will be grouped as listed below.

Stakeholder	Interest in visual tool with regard to V2G
University	University refers to Erik Faber and Richard Bults are both supervisors of this research project. They deliver constructive feedback throughout the project, based on the information they receive.
Client	Enodes is interested in receiving a visual informative tool that explains the features of V2G in a business park. They have an interest in this because it could be used to explain V2G in their own project with municipality Lelystad. They would also like to create more awareness for the topic. An additional interest is that the tool could be good for marketing purposes, once their name is added in the tool.
Researcher of this project	Alessia Bertana is responsible for obtaining enough relevant information to form a fundamental basis for forming the end result.
Dutch sustainability officials	Sustainability officials have a great interest in this project as they need to encourage people to make the transition towards greener sources. However, entities with a large-scale PV installations cannot connect their PV sources to the electricity grid and batteries are still very expensive. V2G could offer a solution for this mismatch and could support their advice towards these entities that ask for advice.
Grid managers	Grid managers have a lot interest in V2G, since they are the people who are facing both the *capacity and net congestion problem* on the electricity grid. They will therefore be open to all new suggestions, including V2G. A visual informative tool to enhance the awareness of V2G, could make the transition faster, which is in their advantage.
Entities with large-scale PV installations	This specific group of stakeholders is mainly affected by the *'capacity problem'*. They cannot connect their large scale PV installations to the electricity grid and batteries are currently still costly. Information on V2G could therefore be of value to them.
Technical providers (with regard to V2G)	This group refers to the developers of bi-directional charging stations and EV manufacturers. These two groups are critical in order to make V2G feasible on a large scale within society. They already know what V2G is and could only be interested in the tool for their own marketing purposes.
Car owners	This group exists of both EV owners and EV lease car users. The people within these groups will be the final users of the EV's and are therefore also an important group to consider. They should be willing to participate in charging their EV. An informative visual tool would therefore be a good way for them to understand V2G in an easy way.

TABLE 5: STAKEHOLDER INTERESTS

Furthermore, to get a better idea of the intentions and the risks carried by the stakeholders, an overview has been generated below.

Stakeholder	**What is needed from them**	**Perceived attitudes**	**Risk if not engaged**
University	Feedback on the research process.	Close involvement as they give active feedback on the process.	A wrong perception of the graduation process can be obtained, which could result in a less favourable process. In addition, the requirements and thoughts of the supervisors must also be taken into account as their opinion counts toward the final visual tool.
Client	Preliminary requirements and feedback on the design of the product.	Willingness to share knowledge about V2G and willingness to give feedback on the product.	Whenever there is a miscommunication about the goal and their requirements, the visual informative tool could become something they did not wish for.
Researcher of this project	Conducting the process and obtaining relevant information about V2G and communication.	Working according to the Create design process and keeping close contact with the stakeholders involved.	If the researcher is not engaged, many things could go wrong. As a result of lack of information on the topic or lack of motivation, the end result could end up as a failure to the client and supervisors or could even be missing.
Dutch sustainability officials	Information about their knowledge of V2G and net congestion.	Not actively involved with the visual informative tool, but interested.	The problem could be wrongly perceived and as the visual informative tool is directed to this stakeholder, this could lead to a visual tool that does not attract the attention of the target audience.
Grid managers	Information about the problem concerning the electricity grid.	Not involved with the production of the visual informative tool, but interested.	The problem of the electricity grid could be wrongly perceived. However, as this group is not part of the target audience, it is not a problem if this group is not actively engaged.
Entities with large-scale PV installations	Information about their knowledge of V2G and net congestion.	Not actively involved, but might be interested about what V2G entails.	The problem could be wrongly perceived. As the end result is directed to this stakeholder, this could lead to a visual informative tool that does not attract the attention of the target audience.

Technical providers	Information about their current advancements in the production of items required for V2G to be feasible.	Willingness to share information about what their plans are with regard to V2G items.	It is not a problem if this group is not engaged as they are not actively involved and as they are not part of the target audience.
EV owners	Information about their prejudgements and willingness with regard to V2G	Are not actively involved, only alerted as their EV could be used.	It is important to consider the opinion of EV owners as they will be the final users. If their questions concerning V2G are to be forgotten in the story, this could be a missing piece. This stakeholder group needs to agree in participating, otherwise, the whole concept will not work.

TABLE 6: STAKEHOLDER ATTITUDES TOWARDS PROJECT

Table 6 shows that stakeholders that need to be managed closely are the client Enodes, Project supervisors, EV owners, and researcher of this project. Dutch sustainability officials and entities with large-scale PV installations belong to the target audience. They do not have as much power as the previously mentioned stakeholders, however, they do have a high interest in the final result. It was found that EV owners should be informed and monitored. As they are the final users of V2G, their opinion should also be taken into consideration for the visual informative tool. Their opinion is of great essence in order for V2G to work so the group EV owners, which is both EV owners and EV users (lease), should be added to the list of main stakeholders. In short, it was found that the third main stakeholder in this project will be EV owners.

4.1.3. Stakeholder needs

Based on the previously analysed stakeholders, two types of requirements have been established. First the requirements with regard to the visual informative tool in general have been analysed based on the requirements of the groups: *University, Researcher of this project and the client*. These requirements have been labelled and therefore ordered based on the MoSCoW analysis in table 7.

In addition, the requirements of EV owners concerning the willingness of users to participate with V2G were identified during interviews that have been conducted with EV owners. The requirements that were often mentioned within this research were the overrule button, the minimum threshold battery percentage, need for compensation, need for transparency and the battery degradation. These have been added to table 7. Having enough parking spots, was only mentioned once and will therefore not be taken into account into this table.

Requirement -	Must	Should	Could	Would
- Not include high costs	X			
- Be easy to reproduce or repeat	X			
- Be easy to distribute online	X			
- Be informative	X			
- Be directed towards Dutch sustainability officials	X			
- Be directed to entities with a large-scale PV installation	X			
- Be focused on V2G in business parcs	X			
- Be under five minutes of duration	X			
- Be explained in Dutch by audio	X			
- Contain English subtitles	X			
- Explain the definition of V2G	X			
- Be visually attractive		X		
- Be unbiased and truthful		X		
- Maintain unity		X		
- Engage the audience		X		
- Explain difficult terms		X		
- Show both advantages and challenges of V2G		X		
- Contain sufficient actions, events and attributes that are recognizable to the target stakeholders		X		
- Be unique			X	
- Inform people about the future perspective of to V2G			X	
- Mention the possibility of an overrule button			X	
- Mention the possibility of a minimum battery threshold for the EV			X	
- Mention battery degradation			X	
- Mention compensation for using V2G			X	
- Mention the need for transparency between EV owner and entity			X	
- Illustrate the energy flow				X
- Show the interactions of the EV owner when using V2G				X

TABLE 7: PRELIMINARY REQUIREMENTS

4.2. Concepts

This section will show the process that has been conducted in order to obtain several concepts. First, the brainstorming sessions will be explained. Second, the concepts based on these brainstorm sessions will be presented. Finally, at the end of this section, the final concept is provided and explained in further detail.

4.2.1. Brainstorm

As previously mentioned in *section 3.2.4*, various methods have been used in order to come up with as many concepts as possible. First, mind mapping has been done in order to get a better idea of what techniques could be used to provide a visual informative tool. Various possibilities for visual tools were examined. The result is shown in the image in appendix B Second, in order to understand the questions that may arise in relation to V2G, a brainstorm with a fellow Creative Technology student was conducted. The result of this brainstorm has been depicted in figure 16.

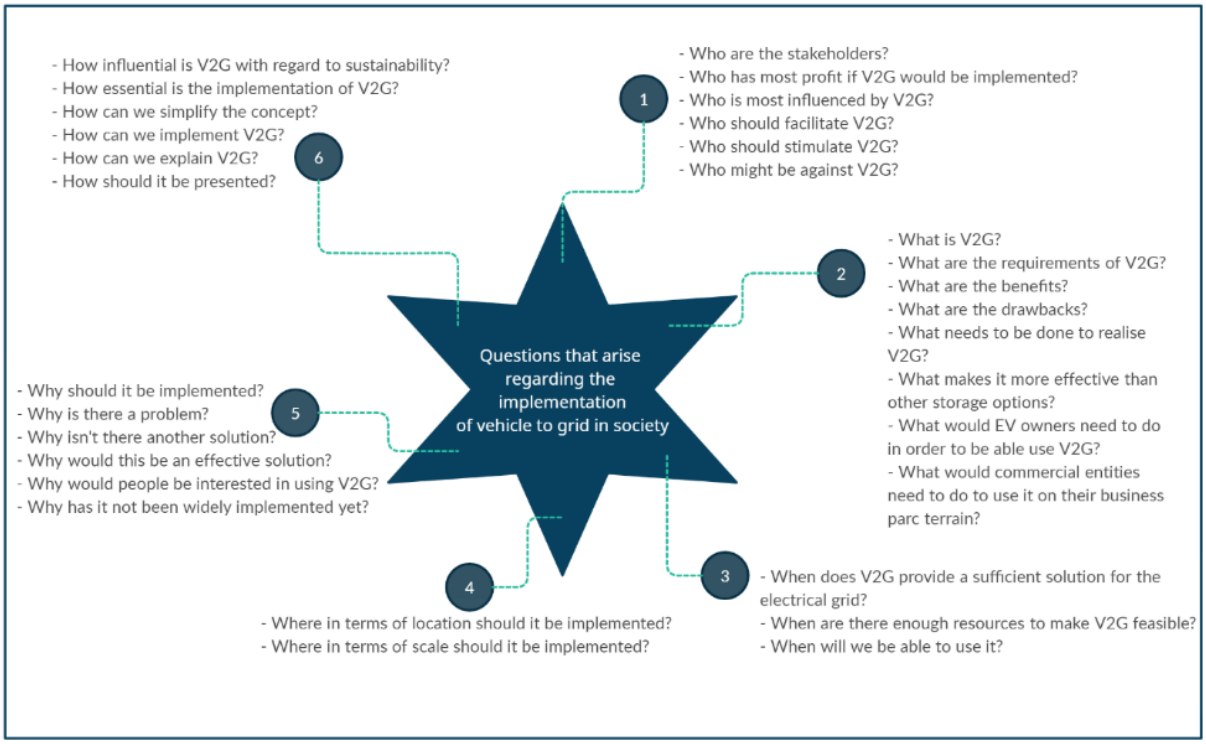


FIGURE 16: STAR BURSTING METHOD BRAINSTORM WITH ANOTHER CREATIVE TECHNOLOGY STUDENT

The star bursting method provided many questions that one could ask him- or herself when wanting to know more about V2G. Based on the stakeholder interests table 8 in *section 4.1.2.*,, the following questions should be taken into account for the storyline:

1) What is V2G?
2) Why should it be implemented?
3) Why is there a problem?
4) Why would people be interested in using V2G?

Now that options for visual tools have been mapped and storyline questions have been determined, concepts will be made in *section 4.2.2.-4.2.6* concerning the visual tool.

4.2.2. Concept 1: Interactive animation

Interactive animation could be an option to show different stories for the three main stakeholders based on their interests in V2G. The viewer can, for instance, right from the start choose between three different point of views, namely between: an EV owner, a Dutch sustainability official or an entity owner with a large-scale PV installation. The story will then continue with the chosen point of view. Within each point of view, the question *"what's in it for them?"* will be described for the chosen stakeholder. Auditive support is often used in combination with animation.

4.2.3. Concept 2: Animation

In animation, without any interaction possibilities, a story that is relevant for all three target stakeholders needs to be presented. This needs to be thought through as the interests of all main stakeholders need to be mixed into one storyline. Animation is a tool with which all types of interactions can easily be depicted. Auditive support is often used in combination with animation.

4.2.4. Concept 3: Doodle video

A doodle video could also be an option as visual tool. Objects and text can be drawn by a hand in order to convey a story. This type of technique needs to be combined with auditive information as some people might otherwise get confused about the story around some of the drawings.

4.2.5. Concept 4: Stop motion video

Stop motion videos are video's in which many images that are slightly different, are put in a quick pace on top of each other. This way, it seems as if the objects in the video move. It should also be used in combination with auditive support to convey a story that is understandable to the viewer.

4.2.6. Concept 5: Interactive informative website

In this concept, a website will be taken as basis. It should become a dynamic and interactive space where people could get informed about everything that has to do with V2G. An example of this is the previously mentioned website in state-of-the art *section 2.2.2. Virta.* However, in this concept, it will be presented differently. On this website, V2G will be the centre and the aspects that are to be explained are placed within circles around the centre.

4.2.7. Evaluation of the concepts

All concepts have been evaluated with Enodes and the project supervisors. After the evaluation, the following decisions have been made. The client suggested that the third concept, which was the *doodle video*, was a playful concept which consequently could come across as less serious towards the target stakeholders. He felt that this form of video might convey a less informative message and that it is often more focused on entertainment. The client suggested that concept 5 could be less effective, as people often find it more of a barrier to click constantly in order to learn about the subject. Furthermore, concept 4 did seem interesting to the client, however, concepts 1 and 2 were preferred over this concept.

Both the client and the University stakeholders appeared to be enthusiastic about the first and second concept because of the fact that it could become something independent and informative. One drawback of concept 1 however, was that people often do not want to spend too much effort, especially with a difficult topic such as this. The amount of actions by clicking on boxes should therefore be carefully considered, should concept 1 be chosen. *Animation* follows one general storyline which should be directed towards both Dutch municipalities and entities with large-scale PV installations. Two stakeholder needs and interests need to be conveyed within one storyline which could be a daunting task. After both drawing concept 1 and concept 2, it was that concept 2 was the best fit for this project. Main reasons for this were that the video should be perceived as easy to watch, without too much effort.

4.3. Final Concept

The final concept, which came from concept two, is an animation. This final concept is depicted below in figure 17 and 18. The story is written below the images in Dutch, however, as the requirements mention, the auditive part will be in Dutch and the subtitles in English.

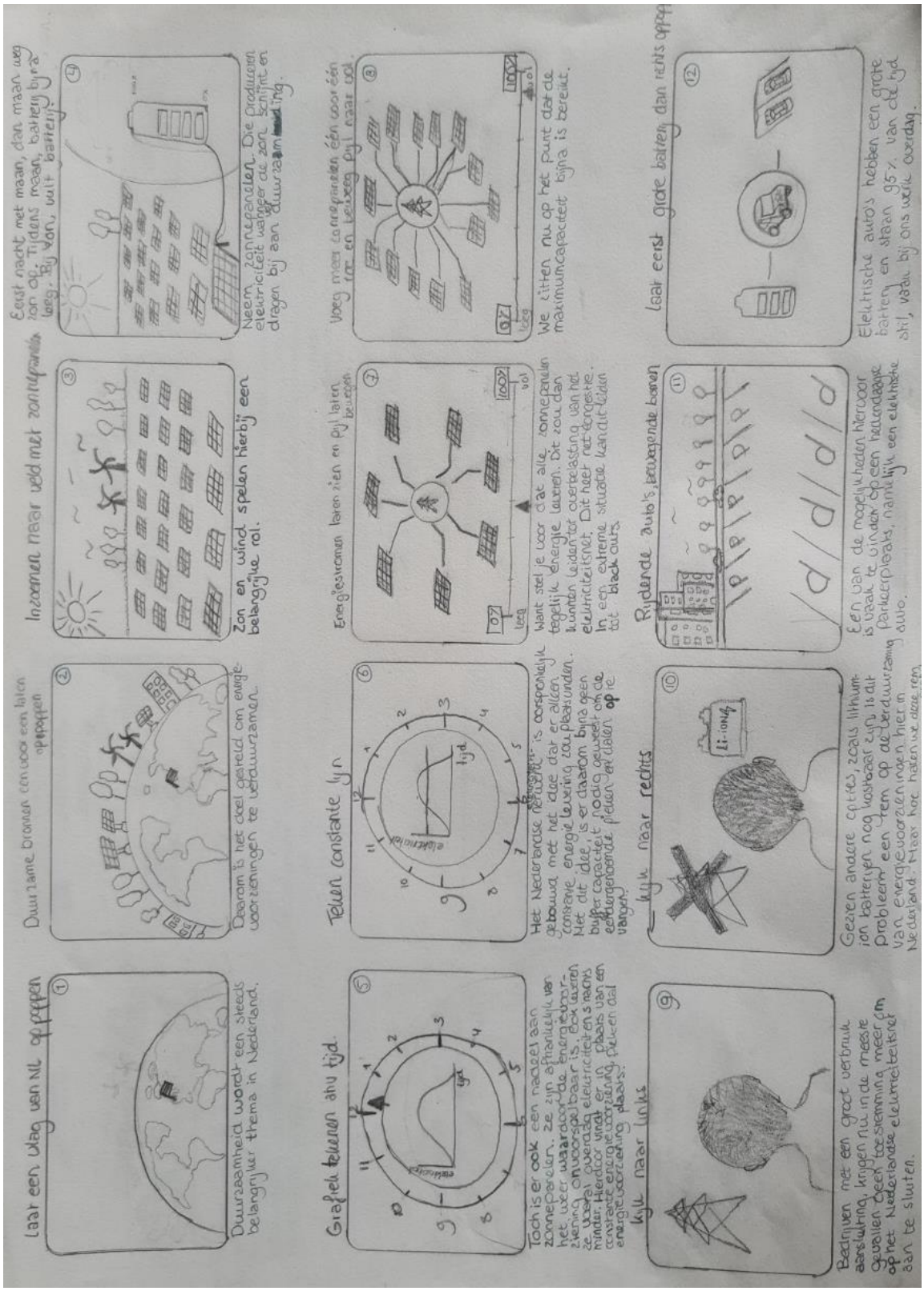


FIGURE 17: FINAL CONCEPT ANIMATION (I)

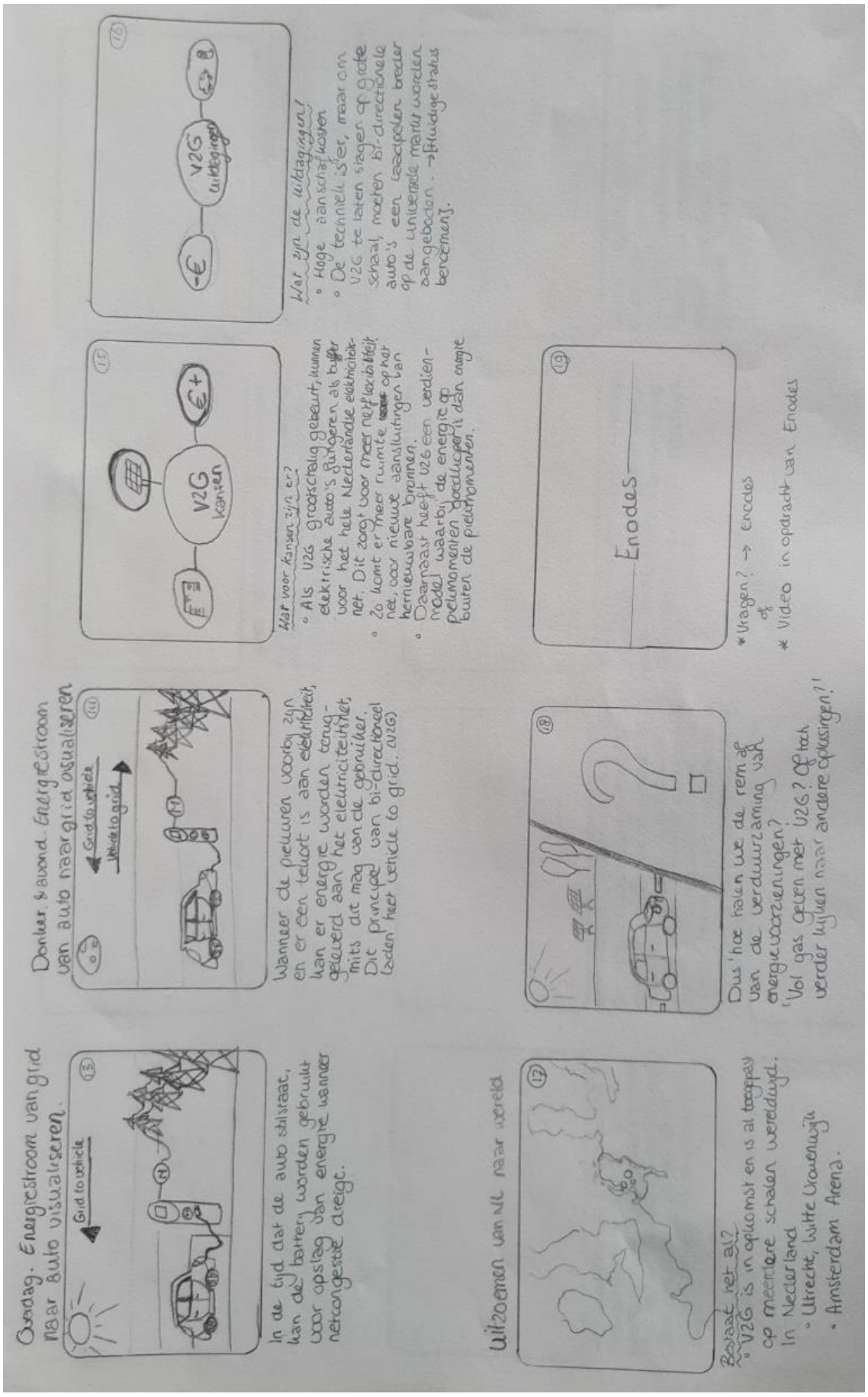


FIGURE 18: FINAL CONCEPT ANIMATION (II)

Chapter 5: Specification

Within the specification phase the final concept from *Chapter 4* will be specified further in detail. In order to do this, the first step is to provide persona's for the story. Then, visualisation requirements will be established, which will be important to keep in mind before realizing the storyboard. Then, based on the literature requirements, stakeholder requirements and personas, the storyline will be provided with detail. The last step will be to illustrate the storyline in a storyboard visually.

5.1. Personas

5.1.1. Persona 1 – Business owner with a large scale PV installation

The first persona has been defined based on one of the main stakeholders, namely a business owner with a large scale PV installation. In this case the persona is a person who is very ambitious and confident. He started his own business when he was younger and this company is now successful. When he heard about the business model of solar panels, he was very sceptical at first. However, after thinking much about it and about the advantage of becoming less dependent on the Dutch electricity grid as well, he invested in a large-scale PV installation. His company is very big and has therefore been categorised as large-scale PV installation. There was only a minor detail that he did not know about. He was not able to connect the PV sources to the Dutch electricity grid due to his large-scale PV installation. He needs to wait until there is enough capacity on the grid available for his solar park. He is very frustrated as he now invested in something for which he needs to wait. See figure 19 for this persona.

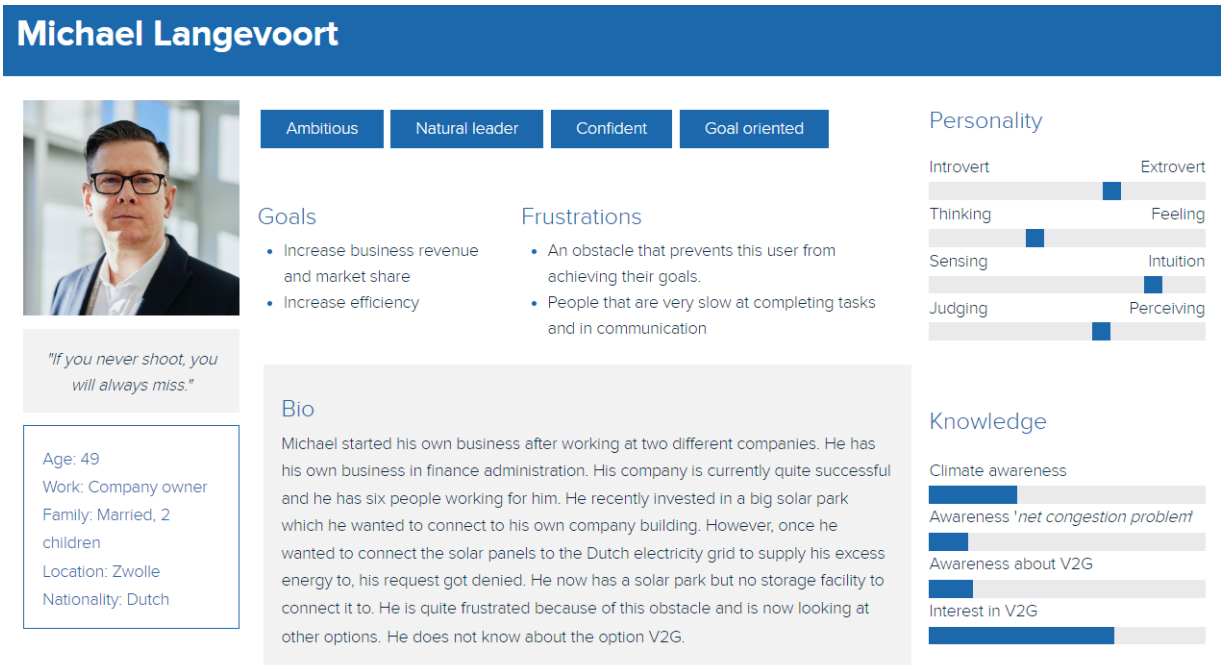


FIGURE 19: PERSONA BUSINESS OWNER WITH A LARGE SCALE PV INSTALLATION

5.1.2. Persona 2 – Sustainability official at a Dutch municipality

Persona 2 has been defined based on the second target stakeholder, which is a sustainability official at a Dutch municipality. She is a woman who has always been very interested in sustainability topics. She therefore knows quite much with regard to new sustainable innovations. However, she does not know the specifics with regard to the techniques behind these innovations. She only knows about their existence and purpose. This is also exactly what is necessary for her job. As an official, she needs to often advise people on certain matters within sustainability. This includes storage possibilities, such as V2G, once a person such as persona 1 comes by and asks for other options.

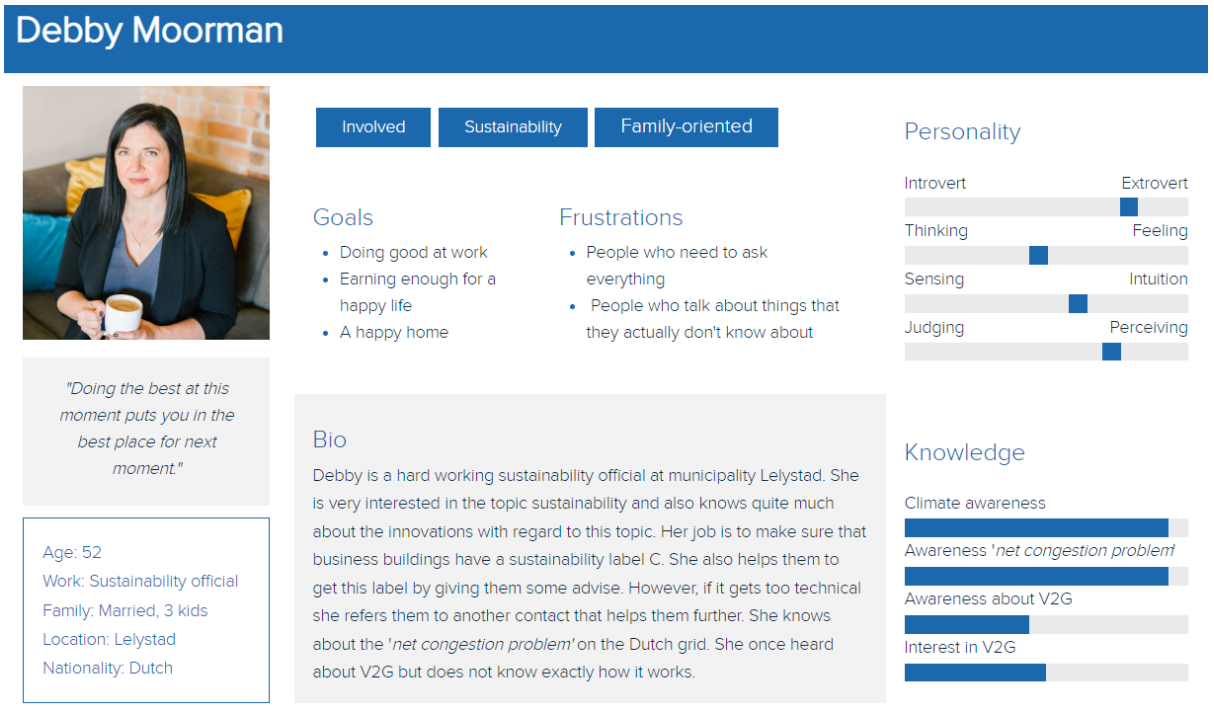


FIGURE 20: PERSONA SUSTAINABILITY OFFICIAL

5.1.3. Persona 3 – Electric vehicle owner

The third persona that is also important to consider, is an EV owner. Should a business owner decide to implement V2G, then they should be willing to let their EV be charged and discharged at certain hours. The third persona is called Tjeerd and works at the company of persona 1. Tjeerd has been asked if his electric lease vehicle can be used for V2G. Tjeerd, however, never heard of it before and is hesitant. His judgements are in correspondence with the prejudgements of EV owners obtained from the user research in Chapter 4. Figure 21 depicts this persona.

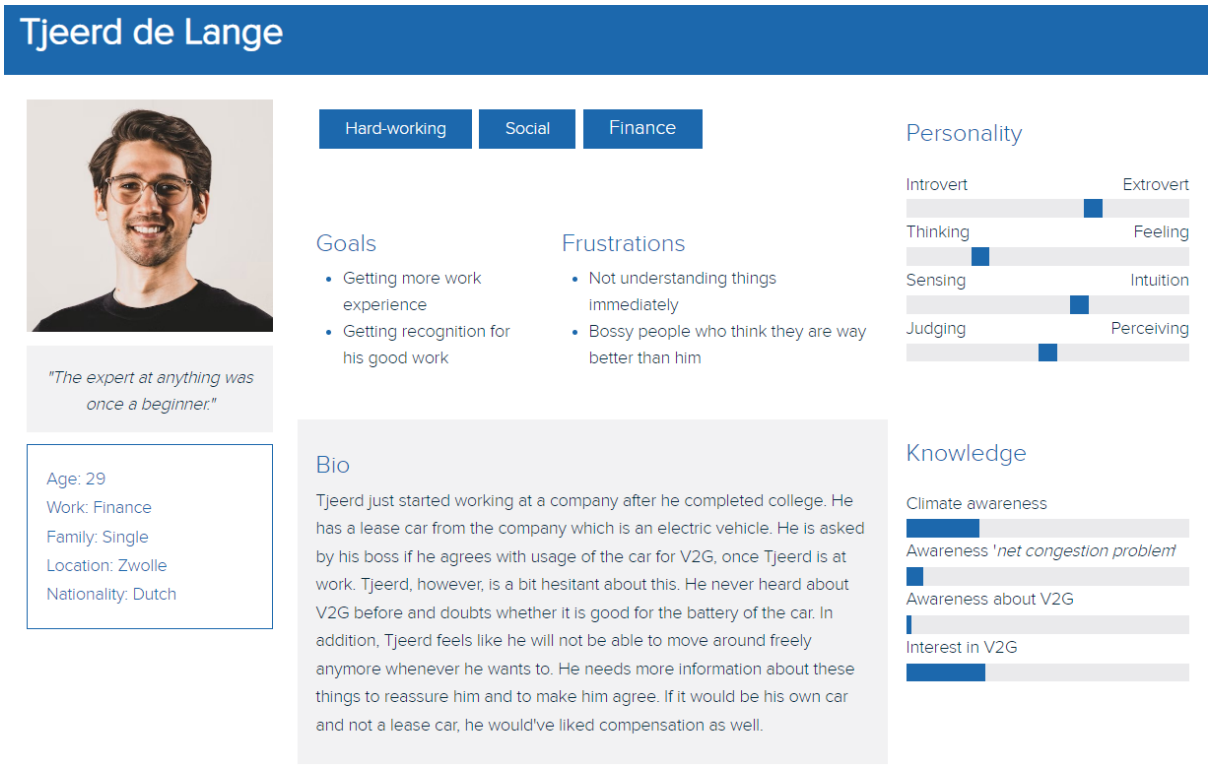


FIGURE 21: PERSONA EV OWNER

5.2. Storyline scenarios

Three scenarios have been generated in order to get a better idea of situations what the personas from previous section would want to see in the animation video. This is relevant as it might give new insights about the interests of all main stakeholders and based on this, a choice can be made about the choice in whether the video should start to explain V2G from the approach of explaining PV sources, rise in EV's, or the 'Dutch electricity grid'. Both these insights can help with creating the final storyline and storyboard.

5.2.1. Scenario 1: Business owner Michael and understanding V2G in business parks

Scene 1: A person is driving in the car to work. The story is about the boss of the company. The point of view will be taken from inside the car. He or she drives past large-scale photovoltaic parcs towards his or her company building.
Scene 2: He or she tells about the problem he or she faces as he or she just invested large scale in photovoltaic parcs. The problem will be explained with regard to the capacity problem of the Dutch electricity grid. Sustainability, renewables and intermittency will briefly be explained by the person driving the car.
Scene 3: Then, he or she arrives at the office and mentions that he heard about V2G and tried it out.
Scene 4: Interaction, advantages and disadvantages will be provided.
Scene 5: The video will end with a question to let people think and form their own opinion.

5.2.2. Scenario 2: Sustainability official Debby and understanding V2G in business parks

Scene 1: The first illustration that is shown is the world. The voice over mentions that sustainability becomes more and more important and that the purpose has been set to use more sustainable energy sources. The animation will then zoom in to a field in the middle of the Netherlands where windmills and solar panels are placed in the scenery.
Scene 2: Then will be shortly mentioned that connecting large-scale PV installations is not easy at the moment. They either get the choice of connecting their PV renewable to either the electricity grid or batteries.
Scene 3: However, as batteries are very expensive and as the electricity grid has now reached a maximum capacity, other solutions need to be considered.
Scene 4: One of these solutions is Vehicle to grid. Then V2G will be explained.
Scene 5: The main advantages and main challenges will be mentioned.
Scene 6: Then the story will end with a question to let people think and form their own opinion.

5.2.3. Scenario 3: EV owner Tjeerd wants and understanding V2G in business parks

Scene 1: A persona will be used that drives to work.
Scene 2: Once she or he attaches his or her EV to the charging station, an electricity flow is shown in the car at bright daylight.
Scene 3: Then the sun will go down, and the animation shows an electricity flow from the EV back to the surrounding company buildings.
Scene 4: Then, the advantages and challenges around V2G will be mentioned.

5.3. Preliminary storyline

Based on the stakeholder analysis in *section 4.1.2* and the storyline scenarios from *section 5.2,* the question can now be answered that was found in *section 2.1.2.1.* about where to start in the triangle. Enodes was asked which stakeholder they found more important of the three main stakeholders. They mentioned that to them, it was Dutch sustainability officials. Therefore Scenario 2 from *section 5.2.2.* and therefore starting with the rise of intermittent PV sources is most fitting within this project. When looking at V2G, sustainability officials are less concerned about the EV's. They are more interested in the fact that there is a brake on the energy transition due to the intermittency of PV sources.

Now that it has been determined to start the story with the intermittency of PV installations, a preliminary storyline can be made based on scenario 2 from *section 5.2.2.* The story will treat different features of V2G and is therefore divided into eight scenes (*section 5.3.1-5.3.8.)*

5.3.1. Scene 1: Introduction

A voice over talks through all of the animation about the animation illustrations. The first illustration that is shown is the world. The voice over mentions that sustainability becomes more and more important and that the purpose has been set to use more sustainable energy sources. The animation will then zoom in to a field in the middle of the Netherlands where windmills and solar panels are placed in the scenery.

5.3.2. Scene 2

The voice over will then refer to the solar panels and will explain how they work shortly by attaching a battery to them. The voice over will mention their disadvantage of 'intermittency'. This will be explained by showing an energy graph within a clock. Then the current situation on the Dutch will be explained in this picture as well by adding a constant line in the graph, showing that the electricity grid is actually built to receive a constant amount of energy throughout the day.

5.3.3. Scene 3

Then the topic net congestion will be linked to what has been mentioned in scene 2. A grid logo will be displayed in the centre of the screen and will be attached to several solar panels that deliver energy. The voice over mentions that the peak energy supply by all the solar panels results in much excess energy during noon. It will mention that the maximum capacity has currently almost been fully reached and that therefore net congestion more often occurs.

5.3.4. Scene 4

Scene four will show the effect of scene 3 for a business owner with large-scale PV installation. Due to the previously mentioned problems, people with a large scale PV installation do not get permission to attach their PV installation to the Dutch electricity grid. This is depicted by a man who is looking left at a grid icon, which gets a cross through it once it is stated that that is not possible for him. Once the man looks right, he looks at other storage options, which are too expensive. This icon of a storage battery therefore also gets a cross.

5.3.5. Scene 5

Scene five will provide a potential solution to the problems stated above by showing an illustration of a parking lot. There will be zoomed in on a car. It will be mentioned that they have a big battery and that they are stationary 95% of the time.

5.3.6. Scene 6

Scene six will explain how V2G works and when it is used. This is done by showing a car connected to the electricity grid. Directions of energy flow will be presented by usage of arrows.

5.3.7. Scene 7

Scene seven mentions the chances and challenges of V2G by showing icons that represent these challenges and chances. Once the voice over talks about a chance or challenge icon, the video will zoom in on it.

5.3.8. Scene 8

The video will end by showing a road with a car and a question mark. The voice over will state: 'So how do we take the brakes off the sustainability of energy supplies? Going full speed ahead with V2G?'

5.4. Consultation with expert in storytelling and oral presentation

The information needs to be presented visually towards Dutch municipalities and companies with a large-scale PV installation. Therefore, Bart Peeters, expert in storytelling and oral presentation, has been interviewed for advise on how to present the information of section 2.1. During an unstructured interview, the preliminary storyline was presented in the first version of a storyboard. Bart's main feedback was that the story seemed rather argumentative instead of informative. He thought that some of the words, such as net congestion, needed more explanation while other parts needed more complexity. For example, the part about how solar panels work seemed rather easy to him. He therefore mentioned that it was a good idea to take another look at what type of words are generally known to my stakeholders and what is unknown. In addition, it needed to become more clear from the storyline what questions the main stakeholders had for the topic V2G. Something that Bart liked of the storyline was the quote about the brake on the energy transition and that V2G is actually a way to give gas once again. Lastly, he mentioned that the questions of EV owners were also important to consider.

5.5. Visualization Requirements

The persona's, scenarios and the consultation with Bart Peeters show critical insights about the requirements that the visual informative tool should include in terms of features and visual aspects. These features and visual aspects can be translated into functional and non-functional requirements. Functional requirements refer to what the system should do. Non-functional requirements on the other hand state how the system should do this. The MoSCoW method will be used for prioritisation of both requirement tables. Literature requirements and stakeholder requirements are added in the tables as well.

5.5.1. Non-functional Requirements

Requirement -	Must	Should	Could	Would
- Not include high costs	X			
- Be informative	X			
- Explain difficult terms		X		
- Make people aware of the problem concerning the Dutch electricity grid		X		
- Be visually attractive		X		
- Be unbiased and truthful		X		
- Maintain unity		X		
- Engage the audience		X		
- Be unique			X	

TABLE 8: NON-FUNCTIONAL REQUIREMENTS

5.5.2 Functional Requirements

Requirement -	Must	Should	Could	Would
- Be easy to reproduce or repeat	X			
- Be easy to distribute online	X			
- Be under five minutes of duration	X			
- Be explained in Dutch by audio	X			
- Contain English subtitles	X			
- Add the Enodes logo	X			
- Be directed towards Dutch sustainability officials	X			
- Be directed towards entities with a large-scale PV installation	X			
- Explain the definition of V2G	X			
- Be focused on V2G in business parcs	X			
- Show the relevance of V2G		X		
- Show both advantages and challenges of V2G		X		
- Not be timebound		X		
- Contain sufficient actions, events and attributes that are recognizable to the target stakeholders			X	
- Inform people about the future perspective of V2G			X	
- Mention the possibility of an overrule button			X	
- Mention the possibility of a minimum battery threshold for the EV			X	
- Mention battery degradation			X	
- Mention compensation for using V2G			X	
- Mention the need for transparency between EV owner and entity owner			X	
- Illustrate the energy flow				X

TABLE 9: FUCTIONAL REQUIREMENTS

5.6. Colour choices

In order to keep unity within the video, a colour scheme has been used as guideline as well. The colour scheme is illustrated in the figure below.

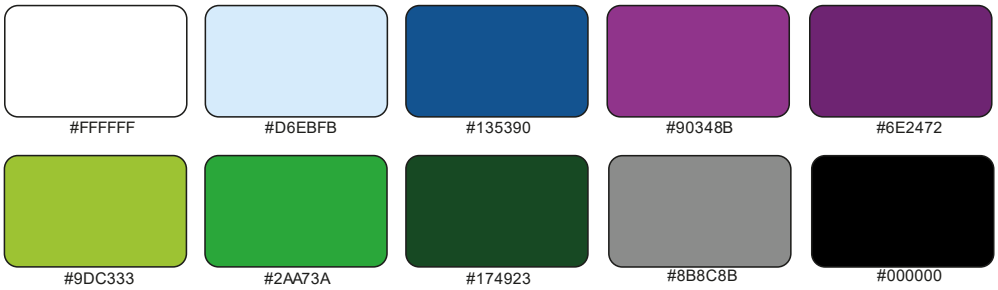


FIGURE 22: COLOUR SCHEME

5.7. Final storyboard

Based on the functional and non-functional requirements, the preliminary storyline and a feedback interview with Bart Peeters, a final storyboard has been created. The storyboard is presented in figure 23. All images contain a number which corresponds with the voice over script presented in Appendix C.

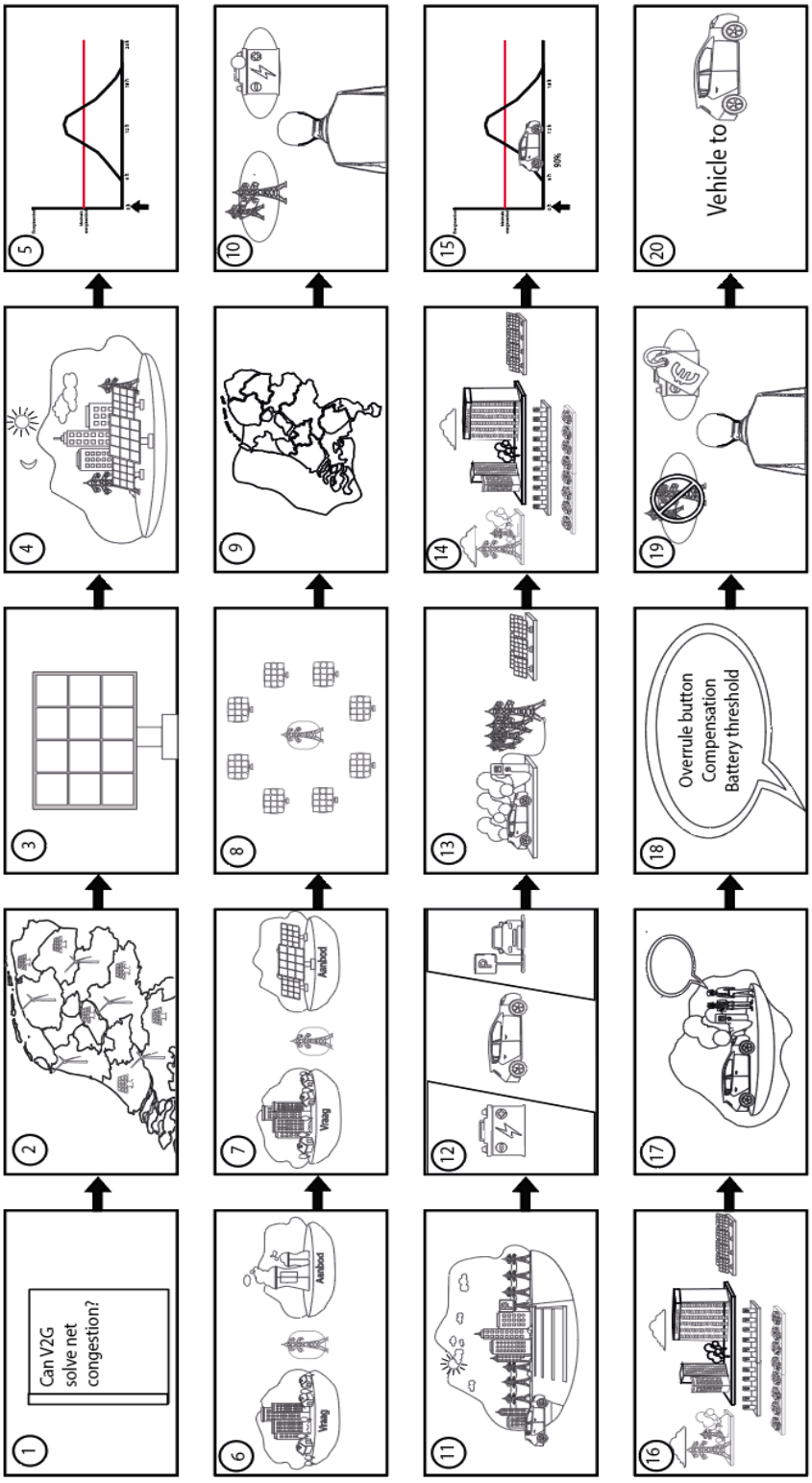


FIGURE 23: FINAL STORYBOARD

Chapter 6: Realisation

In the realisation phase, the final storyboard will be converted into an animation by usage of several suiting programs and tools. First, the choices for certain tools will be explained. Then, the process of making the animation will be explained in further detail.

6.1. Tools

6.1.1. Visual Tools

In order to create a professional animation, two programs have been used. The visual images in the animation have been constructed by using Adobe Illustrator 2022 [49]. Adobe is a platform that has many different programs to create various forms of visual tools. An advantage of this platform is that these images can easily be transferred into another program, which in this case was Adobe After effects [50].

Adobe After Effects is a program in which all elements of an image can be animated in many ways. Tutorials and helping tools are available within this program, which made it very straight forward to make a high end product. The English subtitles have also been generated in After Effects.

Once the animation was finished, it needed to be compiled. However, as the images and animations together resulted in a big file, it was needed to make the file smaller. The document needed to be reduced in size without changing the quality or shortening the video. For this, the programme Adobe Media Encoder had been used [51].

6.1.2. Auditive Tools

Another important aspect which needed to be considered was the program that needed to be used for the audio. At first, text-to-voice programs were considered. However, the voices spoke without much continuity and emotion. Therefore, a live recording was made through a general Samsung phone voice recorder by the author of this research. The sound of this voice over was later on used within the animation as the sound was good enough and due to time management.

6.1.3. Online platform of distribution of the video

The end result was to be placed on YouTube [52]. YouTube is an online platform on which it is easy to distribute a video. The option was chosen of distributing the animation to people that have a YouTube link to the video. Once the project comes to an end, the video will be distributed online without such an anonymous link.

6.2. Animation

Once the tools had been chosen, making the illustrations was the first step in the realisation phase. The storyboard from *section 5.7* has been used as guideline for this. Images have been created by drawing with the pen tool in illustrator and by filling these elements with colours from the image above. The colour #D6EBFB has often been as background to make emphasis on images in the centre of the screen. An example of such a situation is shown in the figure below.

FIGURE 24: SNAPSHOT OF AN IMAGE WITH A CENTRED BACKGROUND TO CREATE EMPHASIS

Some of the illustrations that were rather difficult to make, such as the red car elements above and the humans at the end of the video, have been copied from copy-right free websites such as Unsplash, FreePik, etc. Adobe Illustrator has the function to trace images. These few images that were difficult to make, were traced and have been used. However, most elements of the video have been created by the researcher.

Once all the illustrations were ready, they could be animated in Adobe After Effects. Size, transparency and positions were often changed in time to create the animation effect. Graphs and energy stream lines, however, were made differently. The function 'trim paths' has been used for these two things. This function allows the editor to decide how much of an image can be shown throughout time.

During the process of animation, the audio was added to Adobe After Effects. This was needed as the animation effects should be executed based on what the voice over says. The subtitles have been carefully added once all of the animation of images was done.

Chapter 7: Evaluation

In this chapter, the final product will be evaluated in several ways. First, the product is evaluated by the client through a semi-structured interview. Then, an evaluation is conducted with EV owners, business owners with a large-scale PV installation and an expert on V2G. This part will focus on three aspects, namely the comprehensiveness of the story, visual attractiveness and effectiveness for learning about V2G and net congestion. Lastly, both non-functional and functional requirements will be evaluated on their integration in the final prototype.

7.1. First iteration evaluation with client, supervisors and sustainability officials

7.1.1. Client evaluation

The representatives of Enodes watched the animation in person on a big screen and were asked to give feedback. An unstructured interview in group setting was used, as the first impression was measured. For most of the representatives, it was the first time ever hearing and seeing the animation. Their first reaction was very positive. They seemed to be proud about the animation and considered it very visually attractive. The animation was said to be very clear and understandable. Furthermore, it was considered as a coherent story.

After asking for the first impressions, feedback about improvements for the video was asked. These improvements have been stated below, however, as the evaluation was done on time, it was possible to implement most feedback in the animation. The feedback with an arrow has been incorporated in the final prototype. The feedback with a dot, have not been incorporated.

- ➢ Write a sentence in the beginning of the video stating what someone is going to see and what he or she can expect by watching the video.
- ➢ Adjust the time schedule of the energy solar peak graph
- ➢ Show what happens with the battery of the car that drives through the graph.
- ➢ Show the word ‘net congestion’ for a longer amount of time.
- Work on the voice over intonation
- Do not show the back of the business owner, instead show the face.

7.1.2. Evaluation with supervisors

The form of evaluation conducted in *section 7.1.1.* has been conducted as well with the supervisors of this project. The first impression of the supervisors was similar to the reactions of the Enodes representatives. It was mentioned that the video was visually beautiful and that it contained a clear storyline. From that moment, many suggestions for improvements were made. Based on the suggestions, the animation got to its current form. All suggestions have been implemented, such as deleting the part about battery degradation. Once the video was viewed, even more questions concerning the battery degradation came up for both supervisors. There was also not enough time left for the video to be under five minutes to explain this aspect properly so it was decided to skip this part. The only suggestion from the supervisors that could not be implemented do to time constraints was the suggestion to make a new voice over.

7.1.3. Evaluation with sustainability officials

Dutch sustainability officials are one of the main stakeholders in this project. Therefore, it was important to include them as well in the evaluation. However, due to the fact that the researcher did not know any officials, only a presentation could be done in front of three sustainability officials. After watching the animation, the first reactions were written down by the researcher and it was asked whether the officials had any additional comments or questions about the animation.

The first reaction of all three sustainability officials were positive. Directly after watching the video, one of them stated the following quote

> *"I did not know what V2G was before watching the animation, and now I do."*

This was a very interesting statement, as it showed that the story was both effective and comprehensive. Another statement that was made, was that it was very clear. Lastly, it was asked by one of the officials if the animation could be used in their upcoming meetings. This shows that they trusted the video to be truthful. The only questions that popped up were concerning battery degradation and the impact of how many cars could help with how much capacity on the electricity grid. Overall, sustainability officials gave very positive feedback and found the video to be relevant.

7.2. Second iteration evaluation

An evaluation has been conducted through a Google forms document with eight participants in order to evaluate the animation. This group consisted of seven EV owners and one entity owner with a large-scale PV installation.

Before watching the animation, participants had been asked to fill in questions about pre-knowledge on net congestion and V2G. Then, they were asked to watch the animation. Three sections with questions in the forms needed to be filled in after watching the animation, namely 'animation content', 'visual attractiveness' and 'general'. In the animation content, comprehensibility of the content of the animation was evaluated. Within the 'visual attractiveness' section, the 'looks' of the animation were evaluated. Lastly, in the section 'general', the pre-knowledge questions were compared to the question whether they thought they learned more about the topics V2G and net congestion. By doing this, effectiveness of the animation was evaluated. Requirements that could not be evaluated with Enodes or the supervisors below have been incorporated into the questions. The results have been shown in *section 7.2.1-7.2.4.*

7.2.1. Evaluation of animation content

The results of the evaluation forms are depicted in the diagrams below. Circle diagrams have been used to show the percentages in combination with the opinions of the eight people who participated in the evaluation. There were two questions added after the first evaluation was conducted, which is why these percentages cannot be divided by eight, as they were conducted with seven participants.

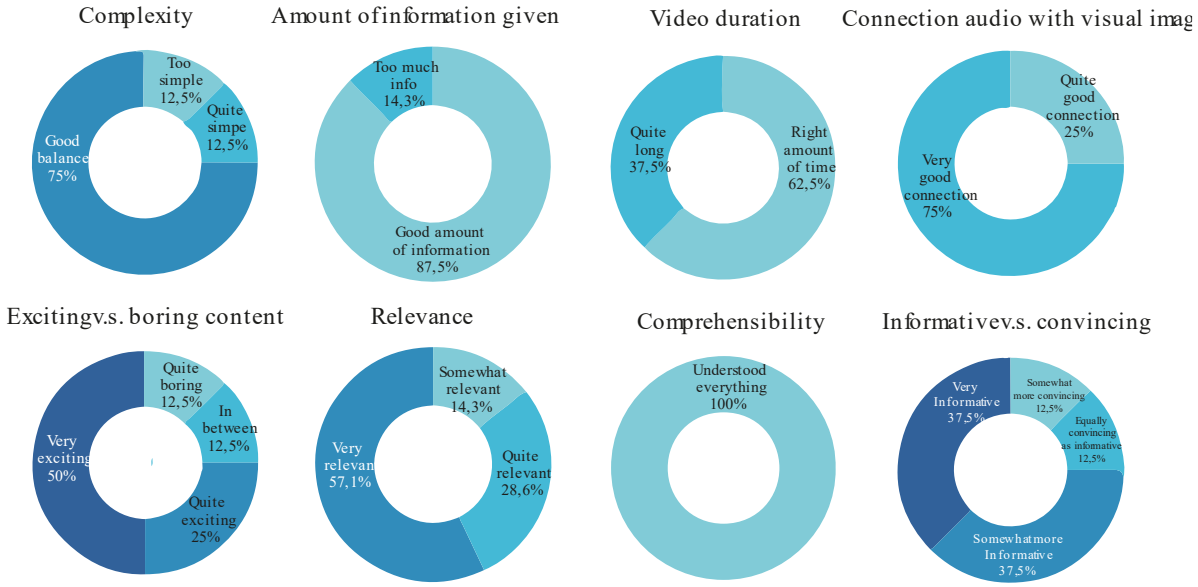


FIGURE 25: EVALUATION RESULTS ON THE TOPIC CONTENT

These graphs show that the animation was really good within the domains comprehensibility, complexity, connection between audio and visual images and amount of information. According to some of the participants, the video was a bit too long. Furthermore, the opinions on the aspect 'exciting content' were quite diverse. A direct conclusion on this aspect can therefore not be made from this chart. The aspect relevance was asked in order to get an understanding whether the target stakeholders find the topics V2G and net congestion relevant to them. Most of the participants did see the relevance of the video. Lastly, participants overall thought the video vas more informative than of convincing nature. 75% of the participants thought was more informative, which means that one of the main goals has been reached.

7.2.2. Evaluation of visual attractiveness of the animation

The second main topic, visual attractiveness, was evaluated by asking questions on three different aspects: visual attractiveness of the animation in general, boring versus engaging visuals and actions in the animation. According to most of the participants, there was a good balance of actions in the animation. Actions refer to the movements and changes within the animation. The opinions on 'boring versus engaging visuals' were rather diverse, which is why no direct conclusion can be drawn for engagement. According to the participants, the animation was visually attractive, however, it did not score a 100% on this topic.

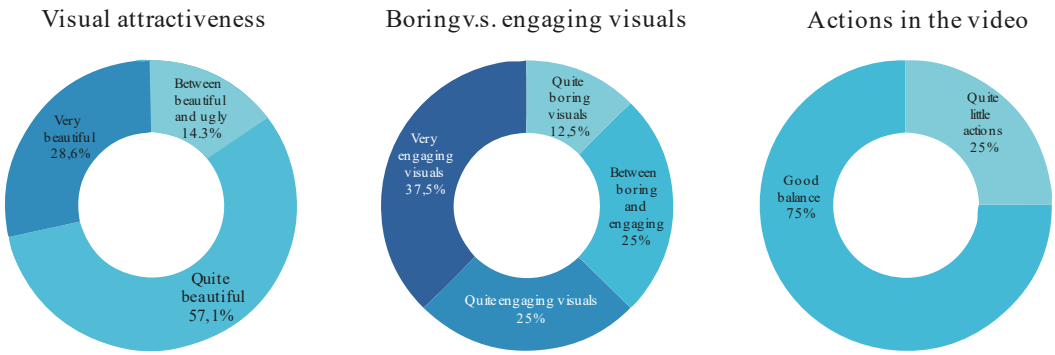


FIGURE 26: EVALUATION CHARTS BASED ON VISUAL ATTRACTIVENESS

7.2.3. Evaluation of effectiveness of the animation

The effectiveness of the animation has been evaluated by letting the participants rate themselves regarding their knowledge on net congestion and V2G. After watching the animation, the participants are asked if they feel like they learned anything new on those who topics due to the animation. The results are demonstrated in the figure 27. All participants stated that they were somewhere in the range from 'I learned a lot more about the topics' to 'I have learned something about the topics'. The animation can therefore be seen as effective, as it needed to inform people visually on the features of V2G when implemented in a business park with large-scale PV installations.

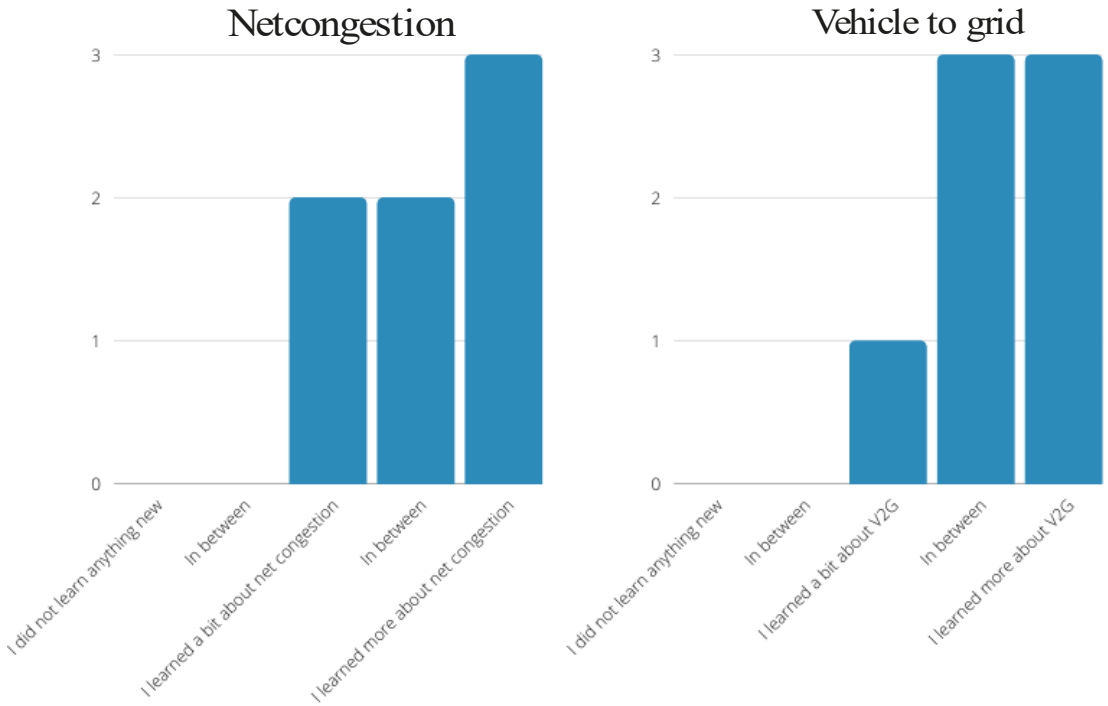


FIGURE 27: LEARNING FROM THE VIDEO

7.2.4. Overall rating animation

An overall animation rating was asked within the forms. The results from this have been illustrated in the figure 28. The average score of the animation according to these results is 8.6. Both the entity owner with large-scale PV installation and the EV owners gave a score higher than an 8. This means that both these stakeholders thought that, overall, it was a good animation.

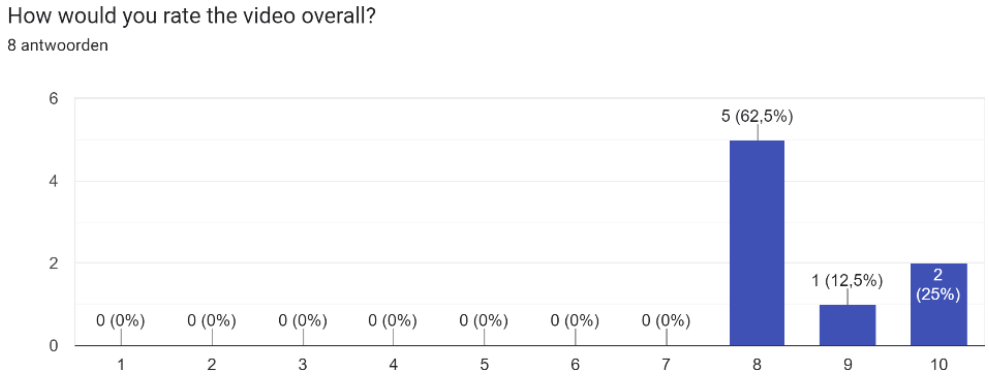


FIGURE 28: OVERALL RATING FINAL PRODUCT

In addition to the user evaluation, V2G expert We Drive Solar was contacted once again. He was asked to rate the animation as an expert on the domain of V2G. He gave an 8 for the animation and gave two final remarks as well that are demonstrated below.

- In the example where a car drives through the energy graph, discharge the battery only in the morning and not in the evening, after working hours, when the sun is gone. This makes the added value even clearer
- I would change Reject button to overrule button
- The Nissan leaf does not have a relatively large battery and is therefore less suitable for V2G. Using another EV with a larger battery would be more convenient.

Should the first comment be implemented, this would indeed put more emphasis on the added value of V2G. However, as this graduation project requires the situation in a business park, where EV's will only be parked during working hours, it would not be suitable for this specific animation. The second and third comment would have both been good to implement and are very good suggestions for this specific project.

7.3. Third iteration evaluation storytelling and oral presentation

In an earlier stage of this project, Bart Peeters, expert in storytelling and oral communication was asked to look at the storyline at that point. This was described in *section 5.4.* Now that the product is in the state of a final prototype, he was contacted once again to give feedback on the video through the same forms as in the user evaluation.

Some interesting things that could be noted from the answers, was that it was mentioned that the animation was very good, especially when comparing it to the previous time the storyboard was viewed. In the additional remarks, it was suggested that the video does what it should do, however, that there could be improvements within the voice over. It was mentioned that the voice over was somewhat objective and distant, which was why the video also appears less accessible and exciting. From the answers it was also noted that clarity, coherency, unity, and showing relevance of V2G were three topics that have been implemented very well. Two aspects for which the rating was slightly lower, were visual attractiveness, which was rated neutral between ugly and attractive, and engagement of video, which he mentioned to be fine and not outstanding.

7.4. Requirements Evaluation

The tables 10 and 11 contain the functional and non-functional requirements from *section 5.5*. The requirements within table 10 and 11 are evaluated based on the results from both the first and second iterative evaluation. The requirements in with *** represent the requirements that are successfully implemented into the product, whereas the requirements with ** represent the aspects that have not been incorporated into the animation. The requirements with a * have not been tested in one of the previous evaluations and can therefore not be answered or were not successful for a reason. Some requirement evaluations are explained in table 10 and 11.

7.4.1. Non-functional Requirements Evaluation

Requirement -	**Execution**	**Must**	**Should**	**Could**	**Would**
- Not include high costs	***	X			
- Be informative *This topic was tested during the evaluation in section 7.2. Most people found the animation to be more informative than convincing.*	***	X			
- Explain difficult terms *This topic scored 100% in section 7.2.2. and is therefore rated three stars.*	***		X		
- Make people aware of the problem concerning the Dutch electricity grid *Comparing the question in the beginning about net congestion and at the end, most people filled in to that they had gotten a better idea of what net congestion is. Some people also wrote this in the comments.*	***		X		
- Be visually attractive *Both Enodes and supervisors (section 7.1), mentioned the animation to be beautiful in their first overall reaction. Results from the user evaluation (section 7.2), showed that 75% of the people thought the video more beautiful than ugly. The rest thought it was ugly or in between. Expert in storytelling and oral communication rated the animation neutral on this aspect. It did therefore not score perfect on visual attractiveness.*	**		X		
- Be unbiased and truthful *The animation was shown to both a V2G expert and an expert in storytelling and*	***		X		

oral communication. The V2G expert mentioned that animation to be truthful, while the expert in storytelling and oral communication mentioned the video to be unbiased and professional.					
- Maintain unity *The expert in storytelling and oral communication mentioned the story to be a whole and that it contained unity.*	*		X		
- Engage the audience *According to section 7.2, 62,5% of the participants thought the video was more engaging than boring. The rest of the participants found the animation boring or between boring and engaging. As this is no convincing result, this topic has been rated with two stars.*	**		X		
- Be unique *Uniqueness is a term which is rather difficult to examine. Therefore, this topic was excluded from the evaluation.*	*			X	

TABLE 108: NON-FUNCTIONAL REQUIREMENTS EVALUATION

7.4.2. Functional Requirements Evaluation

Requirement -	**Execution**	**Must**	**Should**	**Could**	**Would**
- Be easy to reproduce or repeat	***	X			
- Be easy to distribute online	***	X			
- Be under five minutes of duration	***	X			
- Be explained in Dutch by audio	***	X			
- Contain English subtitles	***	X			
- Add the Enodes logo	***	X			
- Be directed towards Dutch sustainability officials *The animation was shown at Municipality Lelystad. Most officials mentioned that they only heard about V2G but that most of them had learned from the video. They found the video relevant.*	***	X			
- Be directed towards entities with a large-scale PV installation *During the evaluation session of 7.2, the animation was also shown to an entity owner with a large-scale PV installation.*	***	X			

He already knew about V2G as he already read much about it. He mentioned that the video confirmed what he already knew, which is a good thing. It was mentioned within the comments that he saw the relevance but that it was not new to him.					
- Explain the definition of V2G	***	X			
- Be focused on V2G in business parks	***	X			
- Show the relevance of V2G *An extra question concerning the relevance of V2G was added in the forms for the expert in storytelling and oral communication. He mentioned that the animation shows the relevance well.*	***		X		
- Show both advantages and challenges of V2G	***		X		
- Not be timebound	***		X		
- Contain sufficient actions, events and attributes that are recognizable to the target stakeholders *This topic scored high in section 7.2.2. and is therefore rated three stars.*	***			X	
- Inform people about the future perspective of V2G *This requirement contradicts the requirement 'not timebound'. Therefore, the client was asked what was more important. The animation not being timebound was more important. Future perspective was therefore not added.*	*			X	
- Mention the possibility of an overrule button	***			X	
- Mention the possibility of a minimum battery threshold for the EV	***			X	
- Mention battery degradation *This aspect was deleted based on conversations with the supervisors and Enodes.*	*			X	
- Mention compensation for using V2G	***			X	
- Mention the need for transparency between EV owner and entity owner	***			X	
- Illustrate the energy flow	***				X

TABLE 11: FUNCTIONAL REQUIREMENTS EVALUATION

7.5. Conclusion evaluation

In this chapter, the animation has been evaluated with several different stakeholders. First, the animation was evaluated with Enodes, the supervisors and Dutch sustainability officials. Due to the fact that this was done early in time, most of the feedback could be implemented in the animation before the user evaluations. Second, user evaluations have been conducted with eight participants. Seven of the participants were EV owners and one was an entity owner with large-scale PV installation. Many results were obtained from these user evaluation with regard to the topics: comprehensiveness, visual attractiveness and effectiveness.

From this evaluation could be concluded that the topics, clarity, comprehensiveness, relevance of V2G, sufficient actions, right duration of animation were some of the requirements that scored high in the user evaluations. From these user evaluations could be noted that viewers got more aware about the problems on the Dutch electricity grid and about the meaning of V2G. Therefore the animation can be perceived as effective about conveying the information about what V2G when implemented in a business park.

In addition, the video was perceived as informative rather than convincing, which means that this constraint has been implemented well within the final prototype. According to expert in storytelling and oral communication and V2G expert We Drive Solar, the animation was both unbiased and truthful. Thus, the animation can be perceived as a success on the domain of informative communication.

Engagement and visual attractiveness scored between neutral and good. It became clear from some of the additional remarks from expert in storytelling and oral communication that this could be due to the voice over. Other remarks from the user evaluation stated that it could be because of the fact that the animation would become better once there would be more ‘flashy’ animations. Within the research, a constraint was that the message needed to be conveyed visually. It can be concluded from these previous statements that this requirement scored between neutral and good.

Uniqueness was not checked because of the fact that uniqueness is an unclear aspect, of which the meaning could differ much among different participants. Furthermore, the future perspective concerning V2G and battery degradation were not added in the animation. Mentioning the future perspective of V2G contradicted the requirement ‘not timebound’. Based on a conversation with the client, the future perspective was left out. Based on the fact that the topic battery degradation only left viewers with more questions, it was decided with supervisors and the client, to leave this requirement out as well.

The video got an overall rating of 8.6 from the participants in the user evaluation and an 8 from Robin Berg, expert on V2G. Additionally, Dutch sustainability officials also appeared to be very excited about the video based on the question if it could be used in their future meetings. This means that the video was overall received very well among all main stakeholders. The client and supervisors were pleased with the final prototype.

Chapter 8: Conclusion

By commission of Enodes, this research aimed to investigate how V2G, when implemented in business parks, can be *visually* and *informatively* communicated towards Dutch sustainability officials and entities with a large-scale PV installation. To be able to reach this goal, information about V2G in business parks, literature about *visual* and *informative* communication, and 'what's in it for the stakeholders' needed to be understood.

Consultations with Enodes and a V2G expert revealed the situation of V2G in a business park, as there was no literature to be found about such an implementation (figure 4 and 5). Then, methods for *visual* and *informative* communication were examined to understand how this message could be conveyed towards the target audience. Unity, meaningful concepts, and visual attractiveness, were found to be important to convey a visual message. The informative message needed to be coherent, clear, concise and non-biased. These aspects needed to be incorporated as much as possible in the final prototype.

The stakeholder analysis gave insights about an additional main stakeholder, namely the EV owner. This group needs to be willing to participate as they are the final users of the product, otherwise V2G will not work. A user research was conducted with this group to understand their needs for the product. These wishes were taken into account in the design of the final prototype. Additionally, it was noted from research that there are three approaches to explain the importance of V2G. The approach was chosen within the specification phase. According to Enodes, sustainability officials were the most important target audience out of the three. It was therefore chosen to start the story by explaining the increase of PV installations in the Netherlands, and therefore, intermittency.

After consultations with Enodes, it was decided that *animation* was the most suiting way to communicate the message about V2G. This decision was based on the requirements: easy reproduction, distributable online, professional, and informative. The animation starts with the story of PV installations and mentions the problem that entities with large-scale PV installations have. The animation includes the definition of net congestion and V2G. It sketches the energy flow and peak shaving in a business park, once V2G is used.

Together with Enodes, all main stakeholders, a V2G expert, and an expert in storytelling and oral communication, the product was evaluated and requirements were checked. The client was very pleased with the animation. According to them, the animation was very clear, coherent and visually attractive. Additionally, the animation was well received by EV owners, sustainability officials and entity owners with a large-scale PV installation as well. Sustainability officials found the video very relevant and asked if it could be used in future meetings. An entity owner with large-scale PV installations did see the relevance, however, it was already known to this participant. EV owners overall thought the video was very comprehensive. All in all, the animation was perceived as a promising final prototype.

In short, the research question '*How to visually inform entities with large-scale PV installations and Dutch sustainability officials about features of vehicle to grid in business parcs?'* can be answered by the following statement. Content wise, by providing a coherent, clear, concise and non-biased message focusing on both the '*capacity problem of the Dutch grid'* and the '*PV sources and their solar peak moments'.* Meanwhile for visual aspects, by making a visually attractive animation with engaging visuals and that focuses on the aspects unity, uniqueness and sufficient actions.

Chapter 9: Future work

Though the animation was perceived as a successful product by the client, target stakeholders and the V2G expert, there is room for improvement. However, as the animation will be distributed online at the end of this project, the focus in this chapter will be about giving recommendations for a new visual informative tool that explains the features of V2G in a business parc to Dutch sustainability officials and entities with a large-scale PV installation.

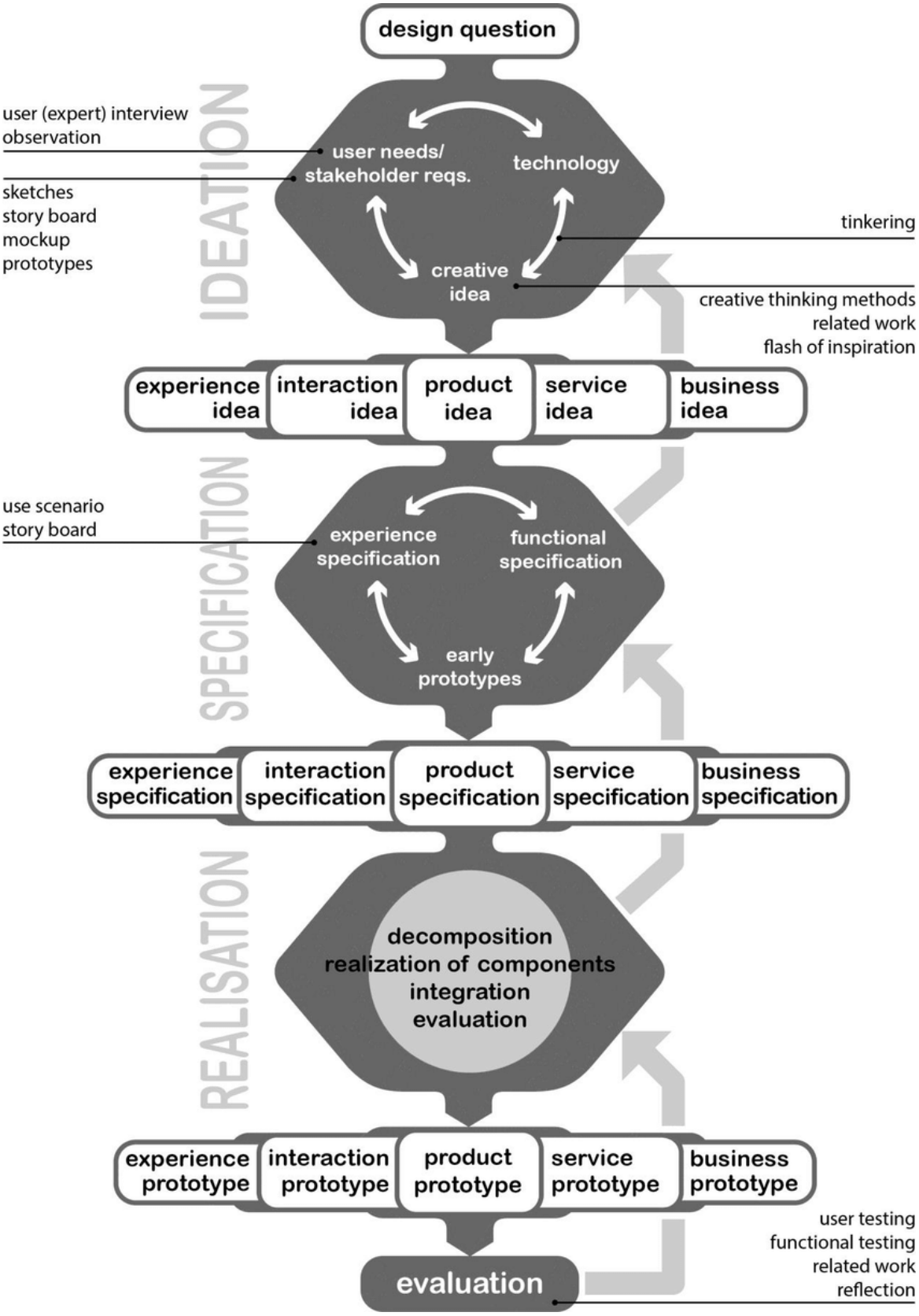
Firstly, the aesthetics of the video could be improved. The evaluation showed that some visuals of the animation appeared to be less attractive and less engaging. As one of the additional comments in the user evaluation, was that the video should have more actions, more research could be done about how long certain images need to be depicted for an animation to be engaging. Furthermore, literature on colours could also be beneficial for the animation as this aspect is often important for the opinion on visual attractiveness. Additionally, an extra evaluation could be done by showing several sketches of storyboards to the Dutch sustainability officials and entity owners with a large-scale PV installation. They could give feedback on what they find more appealing and engaging.

Secondly, once there is more information available on the implementation of V2G in business parcs with a large-scale PV installation, the actual impact of V2G could be shown in the animation. For example, numbers of how many EV's can relieve the electricity grid of how much capacity. This could be very interesting to electricity grid managers, municipalities and also a bit interesting for business owners with a large-scale PV installation and interest V2G. In addition, for business owners with a large-scale PV installation, it could also be interesting to show prices of the whole system. However, as the requirement in this research was 'not making the video timebound' and as prices keep changing, this would not have been able for this particular research.

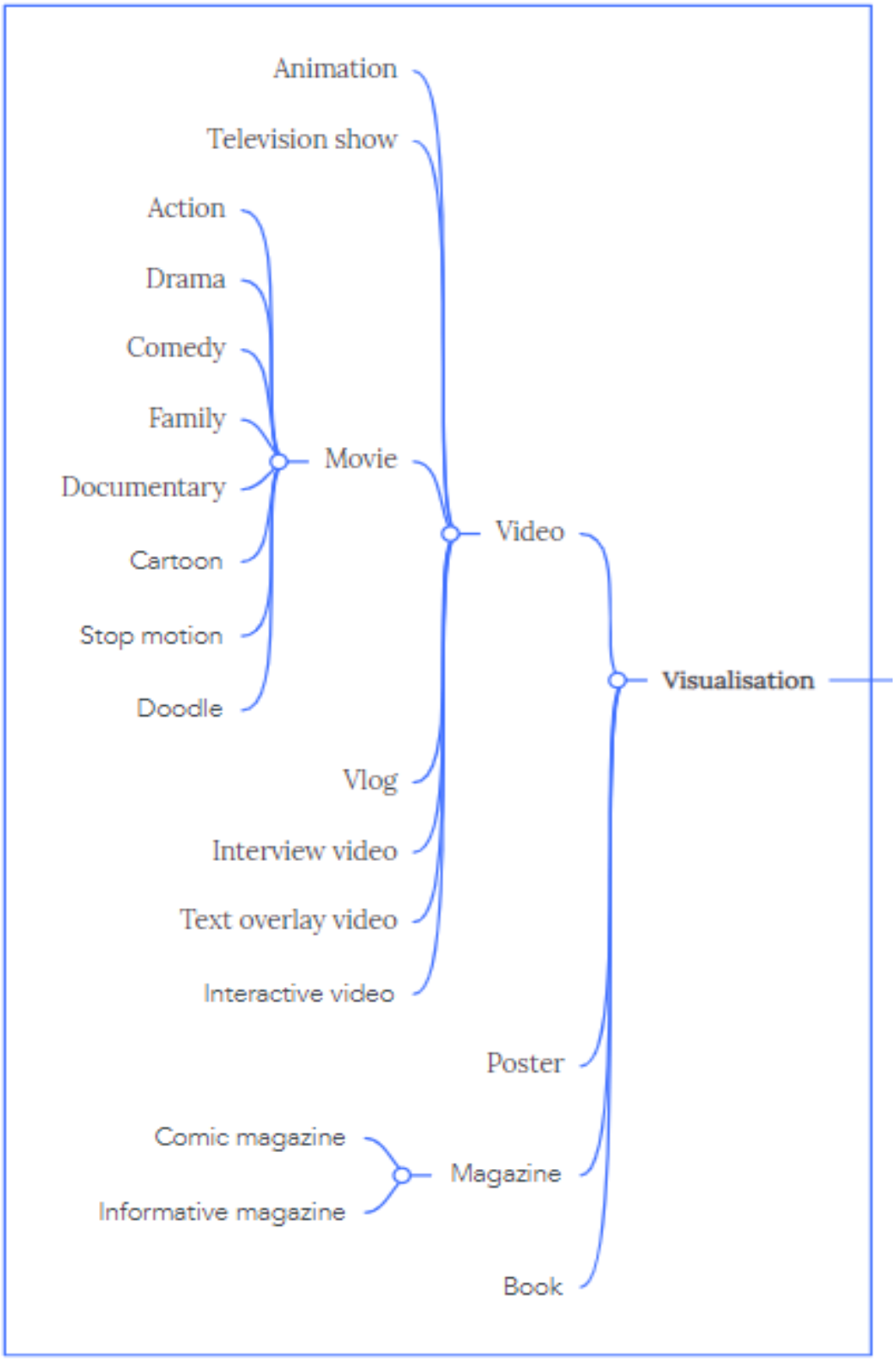
Thirdly, the voice over was found disturbing at moments by the client due to sound inconsistency. Therefore, better hardware would be recommended to use. In addition, the audio should be recorded in one go, instead of changing just a tiny fraction of the audio later on in the process.

With regard to the user evaluation of the product, a bigger sample size should be taken for the user evaluation. Should this be done, a significance test could be conducted to see whether some of the results were actually significant. This would make the evaluation even more reliable then it currently is. Lastly, the participants in the user evaluation were especially EV owners and only one entity owner with large-scale PV installation, which made the evaluation one-sided. In a future user evaluation, Dutch sustainability officials should be included. In addition, the opinions of the three different stakeholder groups: EV owners, entity owners of a large-scale PV installation and sustainability officials should be presented separately. By separating their opinions, it would become more clear from the evaluation if the animation was actually informative, visually attractive and effective to all main stakeholders.

Appendix A - Creative Technology Design Process



Appendix B – Visual tools brainstorm mind map



Appendix C – Final voice over script

SCENE	SCRIPT
1	- Making electric power generation more sustainable, in other words the energy transition, is high on the government agenda in the Netherlands.
2	- Therefore, more and more renewable energy sources are being installed across the country. - Solar panels, wind turbines and biomass in particular have a large share in renewable energy generation.
3	- Take solar panels
4	- Solar panels produce electricity when the sun shines and not at night.
5	- This results in peaks and troughs in solar power supply.
6	- The Dutch power grid is designed with the idea that supply is matched to demand. - With the help of power plants, this does not create extra capacity that is not needed.
7	- With sources whose energy supply cannot be influenced, however, this is different.
8	- Imagine that there is a lot of sunshine and, as a result, all the solar panels supply a lot of energy at simultaneously. - The current electricity grid cannot handle this supply, causing the grid to overload with the consequence that the sustainably produced energy supplied is lost.
9	- This overload is also known as net congestion.
10	- Unfortunately, the maximum grid capacity has now been reached in many places in the Netherlands. - As a result, business owners with a new park of solar panels often no longer get permission to supply energy to the Dutch electricity network. - One alternative is energy storage of solar energy, unfortunately this is still costly at present. - Together, this results in a brake on the energy transition. - But how can this brake be removed?
11	- A quick and adequate solution to this problem is currently being sought. - One of the options for this can be found in the car park, namely the electric car.
12	- They have a large battery and are stationary 95% of the time, often during working hours.
13	- During these working hours, the batteries of electric cars could act as energy buffers, storing excess solar energy in them. - There is also the possibility of discharging the cars' batteries, supplying energy from the electric car (itself). - This principle of bi-directional charging is called Vehicle to Grid.
14	- Suppose there is a business park with a large-scale PV installation. - The solar panels of the established businesses will mainly provide a lot of energy around noon. - Vehicle to grid can be deployed here during working hours. - This is because the peak moments of energy supply from these solar panels fall within these working hours. - This will now be explained with an example
15	- Imagine that an employee arrives at the company premises with his electric car in the morning with a battery percentage of 70%. - The electric car's battery is then discharged prior to the solar peak to, say, 30%, thus supplying some of its energy to the grid. - Subsequently, the batteries of electric cars can be charged more the peak moment and thus capture the excess solar energy. - This allows the car to drive away with a full battery at the end of the working day. - This creates a more even supply of renewable energy from solar panels. - This results in reducing net congestion.
16	- In short, thanks to V2G, less peak energy goes to the power grid, which in turn creates more space to

	connect additional solar farms with less risk of overloading. - Another advantage is that these farms are also less dependent on the Dutch electricity grid.
17	- But what needs to happen to get V2G working? 1) Electric cars need to be modified so that they can be both charged and discharged. The technology for bi-directional charging already exists - Renault and Volvo, for example, are already working on bi-directional cars 2) Furthermore, bi-directional charging poles need to be installed. 3) Electric car users must also give approval for discharging the car. Transparent and clear agreements need to be made between users and companies for this.
18	Research has shown that electric car users highly value a battery percentage threshold (or the minimum value up to which the battery can be discharged), an overrule button (so as to be able to drive off whenever the user wants) and about compensation, for example. In addition, many electric car users worry about battery damage from vehicle-to-grid. However, this is not the case.
19	- So returning to the question 'how do we take the brakes off the energy transition?' 'And how do we ensure that companies are allowed to reconnect their parks of solar panels to the Dutch electricity grid?'
20	Full speed ahead with vehicle to grid?

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