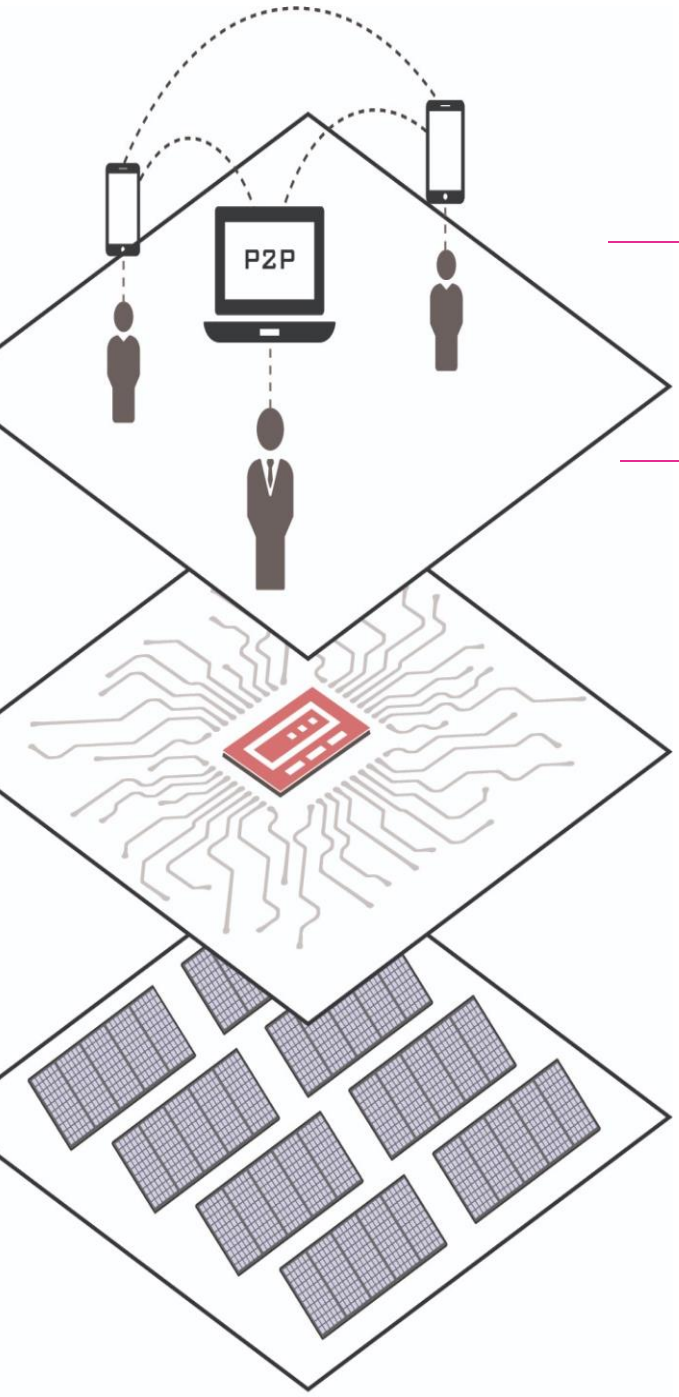


Designing a Just Peer-to-Peer Energy Trading System

An exploration of actions to be performed by the Municipality of Rotterdam to approach a just peer-to-peer energy trading system for the community of Bospolder-Tussendijken

A. Darmawan

This page is intentionally left blank.

Designing a Just Peer-to-Peer Energy Trading System

An exploration of actions to be performed by the Municipality of Rotterdam to approach a just peer-to-peer energy trading system for the community of Bospolder-Tussendijken

Master thesis submitted to Delft University of Technology in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

in

Complex Systems Engineering and Management
Faculty of Technology, Policy and Management

by

A. Darmawan
Student number: 4737687

To be defended in public on September 30, 2019

Graduation Committee

First Supervisor	: Prof. dr. mr. ir. N. Doorn
Second Supervisor	: Dr. ir. E. H. W. J. Cuppen
Advisor	: M. J. Galeano Galván

TU Delft

This page is intentionally left blank.

Acknowledgements

> "they have greatly oppressed me from my youth, but they have not gained the victory over me."
>
> *Psalm 129:2*

Before you lies the Master thesis "Designing a Just Peer-to-Peer Energy Trading System". It is a product of extensive reading, interviewing, and interpreting for about six months. It also marks my final assessment as a Master student of Complex Systems Engineering and Management, Delft University of Technology. Among others, this is the assessment that I enjoyed working the most. I would spend the entire day sitting at the TU Delft library just to continue working this thesis out. As I am happy with all the hard work and the results of this thesis, I hope others could be as happy to read this document.

I most certainly would not have been able to complete this thesis without the help of others. First, I would like to thank Jesus Christ for all the blessings and strength which He has bestowed upon me for these past two years during my Master study. Second, I would like to express my sincere gratitude to my graduation committee who have guided me from the very start of this thesis. In particular, I would like to thank Maria Galeano Galvan for her total dedication as my advisor. I really appreciate her efforts at reading every "messy" document that I sent to her thoroughly. Her handwriting comments in almost every page of the document indicates how much she cared about my project and how keen she was on improving both me and my work. I want to thank Dr Eefje Cuppen as well for all the staggering inputs she gave me in every meeting we had. She never ceases to amaze me with her on-the-spot solutions. It is still a mystery for me how she could come up with brilliant ideas in split-second, which make everything seems so easy. I also would like to thank Prof. Neelke Doorn for her availability and immediate response to all my inquiries despite her tight schedule. Additionally, I want to thank Dr Udo Pesch and Christine Milchram for their availability to share their conception of energy justice and to Mattijs Taanman who helped me to demarcate my thesis and to check my initial results a couple of times.

I also would like to thank the Faculty of TPM and Prof. Zofia Lukszo who have trusted the Faculty Scholarship on me. Also, thanks to all my friends who have kept my sanity intact. Lastly, I sincerely thank my mother, father, and brother who always worry about my foods and milk.

Adam Darmawan
Delft, September 2019

This page is intentionally left blank.

Executive summary

Introduction

The rapid development of renewable technologies has opened the opportunity for households to produce their own energy and to either self-consume or sell it. In the Netherlands, it is projected that not less than 7 GW of solar PV capacity will be installed in 2020. Therefore, the Netherlands is expected to experience abundant energy supply from solar generation in the near future.

Energy sharing can be a reliable method to manage a great number of solar PV production, which also promotes local market solutions. It involves multiple parties in which not only the consumers could responsively adjust their consumption according to the changing electricity prices, but they could also distribute their excess production directly to their neighbours. Additionally, this direct sharing will reduce the strain and improve the stability of the main grid because it lessens the power to be transported and balanced across the main grid. More precisely, when there is a connection between the main grid and the microgrid, the direct sharing provides another option to spread the excess power across the distribution grids (microgrid) instead of feeding it back immediately to the main grid. Such energy sharing method is also known as **peer-to-peer (P2P) energy trading**.

Despite its potential benefits, the implementation of P2P energy trading in society is rather problematic. The pre-established requirements to perform P2P energy trading, especially with regards to the technologies that are used, can be perceived unjust for some communities. As an illustration, P2P energy trading by design requires people to own certain resources to generate distributed power, such as solar PV, in which not everybody could afford it economically. Therefore, a set of actions to address such "unjust pre-established requirements" has to be formulated to approach a juster P2P energy trading system, in which the poor communities, like the community of Bospolder-Tussendijken in Rotterdam-West, can also participate and be benefited herewith.

As opposed to the technical functionalities of which the designers strive for clarity, the roles of values are frequently made implicit in the engineering design. Accordingly, the value of justice can be considered somewhat missing within the concept of P2P energy trading. Nevertheless, the increased demand towards more user-centred products, where the users become the main focus of the products, has stimulated the idea of *design for values*. The idea expects the designers to put more efforts at collecting needs, concerns, and values of the users, and then incorporate them explicitly into the products. Additionally, the support from the (local) government as a regulatory body which authorises the products that can be used by the society is inherently needed to materialise the ensuing idea.

Addressing the issue of the value of energy justice that is still implicit or somewhat missing in the design of P2P energy trading, **this research is aimed at specifying a set of norms for P2P energy trading system that can guide the system a step closer to be a just energy innovation.** The respective research objective is subsequently translated into the following Main Research Question:

"What norms can be developed to approach a just P2P energy trading for the community of Bospolder-Tussendijken, and what do they imply to the Municipality of Rotterdam?"

Literature review

Design for Values methods: value-hierarchy & value dams

Value-hierarchy is a conceptual framework that can be used to translate a value into a set of norms. It suggests that the relation between values and norms can be hierarchical (top-down). Meanwhile, value dams demonstrates that there are possibilities of people opposing or having different opinions about a value/attribute.

The value of energy justice

The framework of triumvirate/tripartite model of energy justice can be an alternative to conceptualise energy justice value. It distinguishes the respective value into three different tenets, namely distributive, procedural, and recognition. First, the distributive tenet concerns about fair allocation of goods/objects among stakeholder. Second, the procedural tenet concerns about the inclusion of stakeholders during the design process of an energy project under non-discriminatory principle. Third, the recognition tenet concerns about the acknowledgement of local communities' existence.

Methodology

The Main Research Question is broken down into four sub-questions. From consecutively answering sub-question 1 to sub-question 4, and interpreting the findings, the grand answer to the MRQ could be approached. The first and the second sub-question are about identification of P2P energy trading from a socio-technical perspective and translation of energy justice value into justice norms for P2P energy trading, respectively. Subsequently, the third and the fourth sub-question are about exploration of the conflicts for the implementation of the developed norms in Bospolder-Tussendijken and of the actions for the Municipality of Rotterdam to support their realisation, respectively. The first two sub-questions are intended to be the conceptual work of this research, in which the data gathering was mainly done by desk research, and the other two sub-questions are intended to be the empirical work, in which the data gathering was mainly done via stakeholders interview.

The conceptual work was grounded in the framework of *value hierarchy*. The framework was then operationalised in two sequential steps, as illustrated in Figure 1 below. The first step was about investigating what information/items about socio-technical characteristics of P2P energy trading that could be relevant to the domain of energy justice, and the second step was about specifying the justice norms for P2P energy trading which contain that information/items. Additionally, the grammatical rule of institutions, ADIC, was applied to construct the justice norms for P2P energy trading. Concerning the empirical work, four interviewees who know and have a connection with

Bospolder-Tussendijken were asked to assess the developed norms. Their judgment and ideas to the norms were then interpreted to explore the conflicts and to structure a set of actions for the Municipality to carry the norms. Additionally, the Likert-scale was used as a tool for assessing the norms.

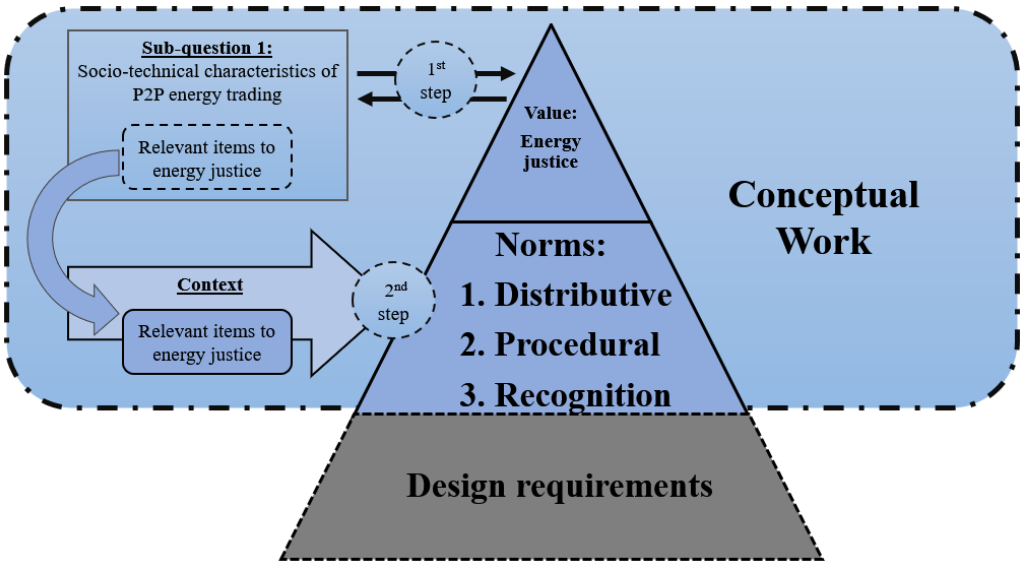


Figure 1: Two general steps of value-hierarchy operationalisation

Results

Identification of P2P energy trading system from a socio-technical perspective

By adhering to the principle of a socio-technical system which suggests that there are interactions between human behaviours and the technologies, P2P energy trading could be defined accordingly from its three different layers, namely physical, cyber, and business layer. Firstly, from the physical layer, P2P energy trading is a system which requires serious consideration of solar PV and energy storage investment. The investment costs could become a barrier to the succession of the entire system when they are soaring. On the other hand, it is also a system that potentially increases the financial wealth of the users. Additionally, it is a system which influences the organisation of distribution grids. Therefore, cooperation with the DSOs is as good as inevitable. Secondly, from the cyber layer, P2P energy trading is a system in which multiple stakeholders in the electrical system will demand access to the data from the trading to support their operation. It is also a system that opens the possibility for new emerging actors, such as aggregators, to take part. Thirdly, from the business layer, P2P energy trading is a system that requires digital platform as a medium for the users to make the transaction. The way the users transact within the platform is highly dependent on the concept of the platform that is drawn by its owners/developers.

Translation of energy justice value into justice norms for P2P energy trading

The justice norms for P2P energy trading could comprise four distributive norms, three procedural norms, and two recognition norms as follow:

Distributive norms	Procedural norms	Recognition norms
1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;	1. Representatives of communities must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;	1. Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;
2. Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	2. Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	2. Communities must be free from any physical, emotional, and distorted financial threat when they propose or reject technical arrangement to distribute specific goods in P2P energy trading.
3. Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;	3. Households and other stakeholders in electrical system must receive meaningful information that is necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading.	
4. Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.		

Exploration of the conflicts for the implementation of justice norms for P2P energy trading in Bospolder-Tussendijken

The specific setting of Bospolder-Tussendijken can cause the implementation of justice norms for P2P energy trading to be conflicting with several other attributes. More precisely, the implementation of the first to the fourth distributive norm might be conflicting with the attribute of **freedom of choice (democracy)**, **feasibility**, **physical capacity/availability**, and **consumer protection/safety**, respectively. On the other hand, the implementation of the first recognition norm might be conflicting with the attribute of **feasibility** as well.

Exploration of actions for the Municipality of Rotterdam to support the realisation of just P2P energy trading

Considering the realisation of the justice norms for P2P energy trading in Bospolder-Tussendijken might face a challenge, supportive actions from the Municipality of Rotterdam as a regulatory body with extensive financial resources might be needed. **In general, the Municipality can exploit**

its regulatory power to cooperate with or regulate other actors who are involved in the (electrical) system, administrate or organise the items available in P2P energy trading, and advocate the community in particular, aggressively. However, looking back at the conflicting attributes, any action that the Municipality undertakes may have typical consequences or drawbacks, such as dishonouring one of the tenets of energy justice, discouraging the external investors, and delaying the projects.

Conclusion

"There are four distributive norms, three procedural norms, and two recognition norms that can be developed to approach a just P2P energy trading system for communities in general, including the community of Bospolder-Tussendijken. However, the realisation of those norms in the respective neighbourhood is rather challenging and problematic as some of the norms are clashing with several other attributes, given the neighbourhood's specific setting. Consequently, those norms require the Municipality of Rotterdam to perform several actions to support their realisation and to make a well-thought decision, considering there are typical consequences or drawbacks of their actions."

Reflection

1. The framework of *multi-layered energy system* can be operationalised with technology-focused approach to characterise energy systems/innovations, including P2P energy trading, by assigning one technology driver to each available layer. However, the framework is lacking the information about how the technologies in each layer should be examined. This research has proposed that those technologies could be discussed under several relevant topics/themes in which the selection is based on several designated criteria that are highly dependent on the researchers.

2. The framework of *value-hierarchy* does an excellent job in distinguishing between values, norms, and design requirements, and how they can be related to each other. However, it does not provide enough information about the systematic steps to construct a norm from a value. This research has proposed an alternative, as well as a critical step to operationalise the framework, that is by adapting the principles that have been promoted by other authors who made somewhat related research to the items that are discussed or aimed to be organised. However, such an adaption technique requires extensive interpretation of the researchers, which may vary from one to another.

3. This research has proposed that the threshold that was developed from the conceptualisation of value dams and applied in the Likert-scale to assess the severity of harms can be adapted to assess the relevancy of norms. Additionally, this research has proposed that the framework of value-hierarchy and value dams can be connected in a way that people may oppose or have different opinions not only about the values but also about the norms as the derivative of the values according to value-hierarchy.

Recommendation for the Municipality of Rotterdam

1. The Municipality of Rotterdam can exploit its regulatory power to organise the items available in P2P energy trading to optimise the tenet of distributive in particular. Such an organisation that is highly regulated seems to be effective for almost all items in P2P energy trading that are relevant to the tenet of distributive. However, an overly-regulated organisation has a high potential to impair the tenet of procedural.

2. For the sake of procedural justice, the Municipality of Rotterdam should issue the regulation, which entails rules and incentives, to ensure that the involvement of the community of BoTu in the design process of P2P energy trading is safeguarded. However, the Municipality also needs to decide whether or not some of the people from the community who are considered as the worse-off will receive special treatment during the deliberation.

3. For the sake of justice as recognition, the Municipality of Rotterdam should issue the regulation that orders the project initiators of P2P energy trading to conduct in-depth social research addressing all social groups of BoTu as part of their feasibility study. However, the Municipality also needs to consider the extra time that is needed for doing such social research which in turn could escalate the costs of the project or even discourage the initiators from advancing the project.

Recommendation for future research

1. The findings of the conceptual norms in this research can be specified further into more concrete design requirements;

2. The identification of P2P energy trading system can be further advanced by examining more technologies besides solar PV, smart meters, and digital platform;

3. The empirical work of this research can be repeated with other stakeholders in the electrical system as the problem owner.

Contents

Abbreviations

BoTu	Bospolder-Tussendijken
BRPs	Balance Responsible Parties
DGss	Distributed Generations
DSOs	Distribution System Operators
ISPs	Independent Service Operators
P2P	Peer-to-Peer
TSO	Transmission System Operator

This page is intentionally left blank.

Chapter 1

Introduction

This chapter sets the cornerstone of the research. It begins with section 1.1 introduces the concept of P2P energy trading as one kind of socio-technical systems in association with the principle of (energy) justice. Afterwards, the concept of Design for Value as the lens to approach the problem of injustice within a design is promoted in section 1.2. Following that, the knowledge gap in the problem, as well as the research objective are elaborated in section 1.3. After that, the research question and its following sub-questions are introduced in 1.4. Subsequently, the relevance of the study and the scope of the research are presented in section 1.5 and 1.6, respectively. At the end of this chapter, the outline of the research is provided in section 1.7.

1.1 Justice in P2P energy trading system

The rapid development of renewable technologies has opened the opportunity for households to produce their own energy and to either self-consume or sell it. These technologies gain their popularity because of several reasons, such as growing population which increases the demand for energy, depletion of conventional energy sources such as crude oil, and multiple environmental concerns such as global warming (Ellabban, Abu-Rub, & Blaabjerg, 2014). Among currently existing renewable technologies, solar PV is the fastest growing and the most promising renewable technology to be installed on households level (Group, n.d.). In the Netherlands, it is projected that not less than 7 GW of solar PV capacity will be installed in 2020 (Versteeg, 2018). Therefore, the Netherlands is expected to experience abundant energy supply from solar generation in the near future.

Energy sharing can be a reliable method to manage a great number of solar PV production, which also promotes local market solutions (Long, Wu, Zhou, & Jenkins, 2018). It involves multiple parties in which not only the consumers could responsively adjust their consumption according to the changing electricity prices, but they could also distribute their excess production directly to their neighbours. Additionally, this direct sharing will reduce the strain and improve the stability of the main grid because it lessens the power to be transported and balanced across the main grid (Zhu et al., 2013). More precisely, when there is a connection between the main grid and the microgrid, the direct sharing provides another option to spread the excess power across the distribution grids (microgrid) instead of feeding it back immediately to the main grid. Such an energy sharing method is also known as **peer-to-peer (P2P) energy trading** (Lakshminarayana, Quek, & Poor, 2014;

Long et al., 2018; Tushar et al., 2018).

P2P energy trading can be a cost-effective solution to optimise decentralised power systems which exploit small distributed generation units such as solar PV. With P2P trading, households are economically incentivised to reduce their electricity consumption because they may have more solar generation surpluses that can be sold to their neighbours if they reduce their consumption. In this respect, the benefits of P2P energy trading become three-folds: first, it stimulates more energy savings; second, it provides more energy supply for others; and third, it fosters local economic growth. Furthermore, Liu et al. (2017) conduct an experiment within a microgrid to find the impact of energy sharing on the electricity bill of PV owners. The result demonstrates that PV owners will experience greater total cost reduction when they share their surpluses amongst the households than when they sell it to the grid operators. With all potential benefits that P2P energy trading could offer, it may become an attractive energy innovation to be realised in the decentralised power systems.

On a different note, P2P energy trading can be classified as a community-based innovation because it involves and allows community partnership (Kellett, 2007). It empowers the community to organise and make their own decisions (Finley-Brook & Holloman, 2016; Liu et al., 2017). With P2P energy trading, society will have more options for where they could obtain their energy to be consumed or what they could do with their production. Besides selling the energy to the grid operators, the suppliers could also sell their excess production directly to their neighbours at the agreed upon price (Morstyn, Farrell, Darby, & McCulloch, 2018). Therefore, P2P energy trading can be considered socially desirable because it promotes empowerment by providing people with more options that they can decide on. In addition, P2P energy trading can fit into the definition of *socio-technical system*, considering there are interactions between the employed technologies in the system and complex human behaviours represented by the communities' behaviours (Aslaksen, 2009).

Despite its promising benefits and potential to empower people, the implementation of P2P energy trading in society is rather problematic. The pre-established requirements to perform P2P energy trading, especially with regards to the technologies that are used, can be perceived unjust for some communities. As an illustration, P2P energy trading by design requires people to own certain resources to generate distributed power. This may imply that those who wish to participate in P2P energy trading must be wealthy enough to afford, for example, solar PV panels, and to own or rent a space that is wide enough to install the panels.

In reality, however, not all households could afford all the pre-requisites technologies and their supporting components to engage in P2P energy trading. There are poor people or people without private roofs who may find it difficult to satisfy those requirements. If such a fact is kept being overlooked, P2P energy trading might rather foster social disparity than empowering people. It may end up as an exclusive innovation where its benefits are only experienced by wealthy people. Even worse, those poor people who do not receive the benefits may also contribute to paying the infrastructures that are needed to facilitate P2P energy trading such as distribution grids. At this rate, P2P energy trading will be, not only exclusive for the rich but also harmful for the poor. Therefore, a set of actions to address such "unjust pre-established requirements" has to be formulated to approach a juster P2P energy trading system where poor communities can also participate and be benefited herewith.

Furthermore, a representation of poor communities as the study case is needed to help evaluate the prescriptions for actions, or also known as norms, that are more content-specific (Van de Poel, 2013). Bospolder-Tussendijken in Rotterdam-West is one of the top five deprived areas in the Netherlands (Times, n.d.). It is characterised by high poverty and unemployment rates. Energy transition by means of P2P energy trading can be used as an alternative to help the Municipality of Rotterdam to achieve social development (Architecture, n.d.). Accordingly, it is interesting to prescribe a set of actions for the respective municipality to approach a juster P2P energy trading system that can be implemented in this community.

1.2 Design for Value of justice

As opposed to the technical functionalities of which the designers strive for clarity, Van de Poel (2014) argue that the roles of values are frequently made implicit in engineering design. His statement is proven to be relevant since in section 1.1, the value of justice is also implied somewhat missing within the concept of P2P energy trading. Nevertheless, the increased demand towards more user-centred products where users become the main focus of products has stimulated the idea of *design for values* (Vermaas & Hekkert, 2014). The idea expects the designers to put more efforts at collecting needs, concerns, and values of users, and then incorporate them explicitly into the products.

Van de Poel (2014) distinguishes values in engineering design into *instrumental values* and *intrinsic values*. The former refers to those values that are pursued for the sake of other values, while the latter refers to those values which are pursued for their own sake. The distinction suggests that the intrinsic values are more essential than instrumental values. He further argues that values that are perceived essential in a product or system may vary from one engineering discipline to another. They may as well be more domain-specific. For instance, Pesch, Correljé, Cuppen, and Taebi (2017) indicate that energy justice is one of those intrinsic values in the energy domain. They show that perceptions towards unfairness are likely to coerce protests against energy projects. Therefore, the value of energy justice should be honoured and protected for its own sake within those energy projects. Such a concern that the value of (energy) justice needs to take place and be honoured in P2P energy trading can then be confirmed.

Van de Poel (2014) further incorporates various roles of values in different design stages. In general, design processes follow similar stages, starting with analysis, synthesis, simulation, evaluation, choice, embodiment, and eventually prototype testing (Eekels & Roozenburg, 1991). Specific to the analysis stage, values may influence the way designers perceive and frame the problem. They could also become a source to formulate design requirements of a product. For such a purpose, Van de Poel (2013) indicates that the values need to be translated through two consecutive steps, starting from translating the values into the norms, and then into the design requirements. These consecutive translations also suggest that, through the lens of Design for Value, norms are the preliminary point that is important before arriving at a set of design requirements of a product. Accordingly, Design for Value may become an alternative to approach the initial design stage, which is especially useful when we strive to initiate a juster P2P energy trading system.

1.3 Knowledge gap and research objective

The previous section has made known that there are potential injustice problems within the pre-established requirements of P2P energy trading. By using Design for Value as the lens to approach the problems, a further conclusion can be drawn that the value of energy justice is still not made explicit in the design. Although several researchers have constructed a framework to define and conceptualise the value of energy justice more concisely, as shown later in section 2.2, **it is still unclear as to how this conception or framework can be made explicit in specific design requirements**. Additionally, **the implications of the specific setting of Bospolder-Tussendijken to the implementation of those design requirements are also unclear** that empirical research must be conducted.

However, as indicated in section 1.2, **a set of norms needs to be prescribed first before the respective design requirements can be formulated**. Furthermore, specifying the norms can also be as challenging and as unclear as specifying the design requirements. Accordingly, a research objective has been formulated to address the knowledge gap and the problem that were described earlier. The research objective is articulated as follows:

To specify a set of norms for peer-to-peer energy trading system that can guide the system a step closer to be a just energy innovation

1.4 Research question

Given the objective of this study presented in section 1.3, with also taking into account the Municipality of Rotterdam as the problem owner, as discussed later in section 1.6.4, a Main Research Question (MRQ) has been formulated as follows:

"What norms can be developed to approach a just P2P energy trading for the community of Bospolder-Tussendijken, and what do they imply to the Municipality of Rotterdam?"

Subsequently, the MRQ can be broken down into four sub-questions to construct systematic steps to approach the answer. Those sub-questions and their explanation are presented below.

1. **What is peer-to-peer energy trading system from a socio-technical perspective?**
   This sub-question aims to gather the information about P2P energy trading and describe its socio-technical characteristics as a resort to defining the respective system.

2. **What items in P2P energy trading system that can be relevant to the energy justice domain and what norms can be developed accordingly?**
   This sub-question aims to provide the context to specify the value of energy justice into a set of justice norms for P2P energy trading by first analysing the connection between the P2P energy trading system, that is defined in the previous sub-question, and the energy justice.

3. **What does the specific setting of Bospolder-Tussendijken imply to the developed conceptual justice norms for P2P energy trading?**
   This sub-question aims to assess and evaluate the relevancy of the justice norms for P2P

energy trading, that are specified in the previous sub-question, against the specific setting of Bospolder-Tussendijken. The focus here will be about exploring the potential conflict(s) that could occur when implementing the justice norms for P2P energy trading in BoTu.

4. **What can the Municipality of Rotterdam do to support the realisation of a just P2P energy trading in Bospolder-Tussendijken?**
   This sub-question aims to explore and suggest several actions for the Municipality of Rotterdam to realise the justice norms for P2P energy trading in Bospolder-Tussendijken, taking into account its specific setting and the associated conflicts that are made known in the sub-question three.

1.5 Relevance of the study

This research has both practical and theoretical relevance. First of all, this research is relevant to the study of CoSEM which focuses on the design of socio-technical systems. This research aims to initiate intervention to the concept of P2P energy trading by placing justice as the main objective of the design, and the norms will be formulated respectively to approach such an objective.

Technically, the real P2P energy trading, where the households are allowed to share their production directly to their neighbours, does not yet exist in the Netherlands. Therefore, the findings in this research may partly contribute to the realisation of the fair concept or practice of P2P energy trading, especially in the poor neighbourhoods. This research also focuses on a specific poor neighbourhood, namely Bospolder-Tussendijken. Therefore, the findings in this study can partly contribute to the plan of the Municipality of Rotterdam that wants to develop the social conditions of the respective neighbourhood by means of energy transition. On top of that, this research is meant to raise social awareness that communities deserve to have a just energy innovation.

This research also has theoretical relevance. By cross-studying between two different fields, which are justice and renewable technology innovations, this research could contribute to the fundamental knowledge regarding the formulation of norms for specific energy innovation. To my best knowledge, there has not been any research that specifically prescribes a set of norms to approach a juster P2P energy trading system as a result.

1.6 Scope of the research

In this section, the boundary or limitations of this research will be drawn to clarify the focus.

1.6.1 P2P energy trading system demarcation: one microgrid connected to wholesale markets

In general, P2P energy trading can be structured in two ways. The first option is to have a group of people locally exchange energy within a clearly defined grid boundary (microgrid) that is detached from the main grid. They are required to be self-sufficient with their own electricity production. Another way is to have similar concept but with the addition of connection to the main grid. This interconnected structure allows a wider geographical electricity trading between several

interconnected microgrids (Pouttu et al., 2017).

Stedin and Energy21 (2018) developed a concept of electricity trading under the name of *layered energy system* (*LES*). The concept adopts the interconnected P2P structure with also taking into account the socio-technical characteristics of the Dutch electrical system. The most striking feature being proposed in their concept is that it allows people within a microgrid or local market to purchase the electricity from the wholesale markets instead of direct trading between microgrids. However, they claim that the way households make the transaction in their model fits better to the idea of peer-to-market rather than peer-to-peer.

To ensure compatibility and consistency, P2P energy trading in this research will still be defined according to Stedin's concept, considering their concept is developed within the setting of the Dutch electrical system. More precisely, the physical structure of electricity trading drawn in Stedin's concept will be followed. The demarcation of the P2P energy trading in this research is illustrated in Figure 1.1 below. The respective boundary rules out the complex interaction between multiple interconnected microgrids or local markets.

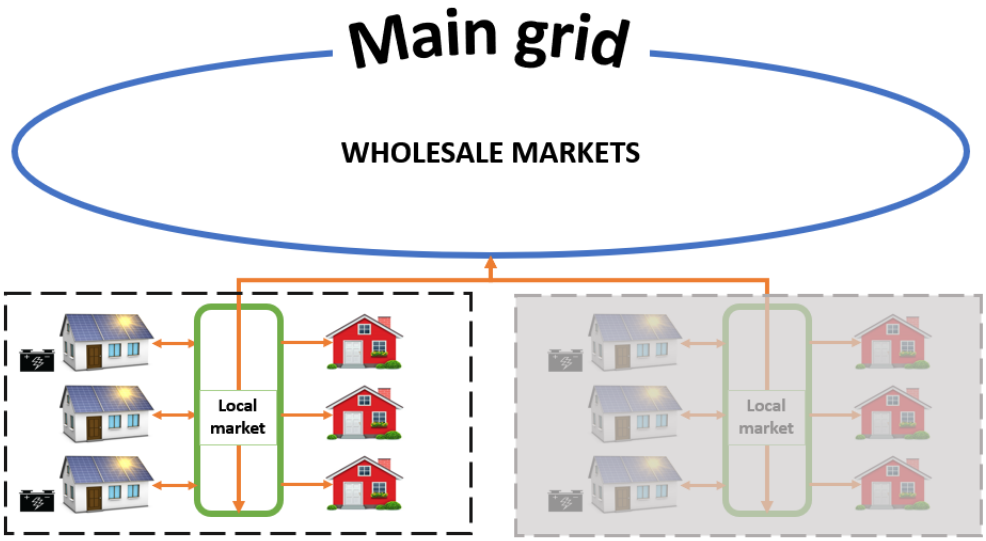


Figure 1.1: Demarcation of P2P energy trading in this research (adapted from (Stedin & Energy21, 2018))

1.6.2 Selection of P2P energy trading main technology drivers: solar PV, smart metering system, P2P platform

This research only considers three kinds of technologies that drive the P2P energy trading system, namely solar PV, smart metering system, and P2P platform. The selection departs from the framework of multi-layered smart energy system which will be elaborated further in Chapter 4.

1.6.3 Selection of social context level: community level

As explained later in section 2.2.1, consideration towards justice can be approached from different levels of social context. The phenomenon of (in-)justice can be observed on the level of international, national, community, or even individual. This research, however, only considers or observes the justice on the level of a community for two reasons:

- Firstly, it is aligned with the definition of P2P energy trading in this research of which it focuses on and isolates only one microgrid or community;
- Secondly, research about justice on the other levels of social context may require different approach or logistics. For instances, such cooperative international research might be needed when observing (in-)justice on international level, or several municipalities might need to be selected and studied when observing (in-)justice on national level.

1.6.4 Problem owner: the Municipality of Rotterdam

This research will deliver the final prescription for actions to the Municipality of Rotterdam and it will be the entity that is expected to carry the formulated norms. The reason is that this research is partly interested in the empowerment of the poor community, specifically the community of Bospolder-Tussendijken, and it is aligned with the vision of the Municipality of Rotterdam that wants to develop the social quality in this area. In addition, the Municipality of Rotterdam is also considered as a powerful entity that can carry and specify the formulated norms further into design requirements. The Municipality can specify design requirements with less concern about regulatory and funding matters considering its authority and resources.

1.7 Thesis outline

This thesis book comprises 9 chapters that are structured as follows. Chapter 2 contains literature review of theoretical knowledge that are important for the work of this research. It is followed by the methodology that was applied in this research in Chapter 3. Subsequently, Chapter 4 describes P2P energy trading system from a socio-technical perspective. In Chapter 5, a set of conceptual norms for a just P2P energy trading is promoted. Following, Chapter 6 introduces a set of conflicts or conflicting attributes for the implementation of justice norms for P2P energy trading in Bospolder-Tussendijken. Afterwards, a set of actions that are suggested for the Municipality of Rotterdam to support the realisation of just P2P energy trading in BoTu is discussed in Chapter 7. In the end, the answer to the Main Research Question is concluded in Chapter 8, and the reflection and recommendation of this research are available in Chapter 9.

In addition, a research flow as guidance to proceed to the next chapter, more precisely from Chapter 4 to 8, is given in Figure 1.2 below.

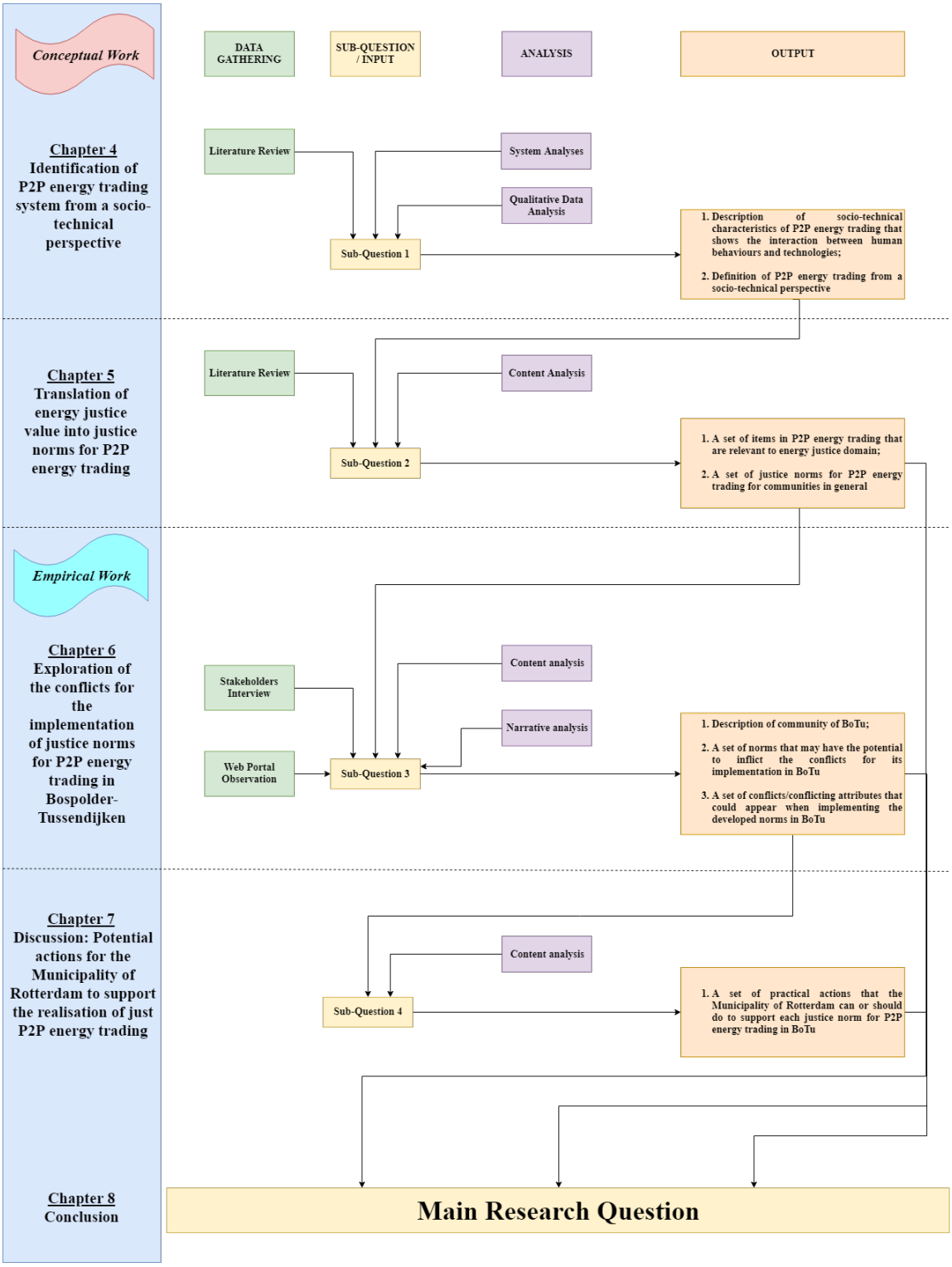


Figure 1.2: Research flow

Chapter 2

Literature Review

This chapter provides theoretical knowledge that are important for the work of this research. Section 2.1 provides a short review of the methods used in Design for Value, namely *value-hierarchy* and *value dams*. It is followed by the conceptualisation of the value of energy justice from several authors' point of view in section 2.2. In section 2.3, the existing Dutch electrical system will be described briefly. Lastly, section 2.4 introduces the components in the smart metering system.

2.1 Design for Value methods: value-hierarchy & value dams

In the following two sub-sections, the concept of both value-hierarchy and value dams as the methods used in Design for Value will be introduced.

2.1.1 Value-hierarchy

Van de Poel (2013) introduces value-hierarchy as a framework to translate a rather abstract value into a set of concrete design requirements. As shown in Figure 2.1, the framework suggests that values, norms, and design requirements may have a hierarchical relationship. Although hierarchical, the relationship between them is not immediately deductive.

Elements in the lower level are more concrete than the upper, and they inhibit specific context. To understand how the lower-level elements are derived from the higher-level elements, therefore, the context has to be known. Furthermore, the relation between two different layers can be either *"for the sake of"* or *"specification"*. The former refers to bottom-up relationship that we make sense the lower level elements with respect to the higher level elements. The latter refers to top-down relationship that the higher-level elements are translated to lower-level elements.

Concerning top-down relationship, there are two general steps to formulate design requirements from values, which are:

1. Translating a general value into a set of norms;
2. Translating the obtained norms into a set of design requirements

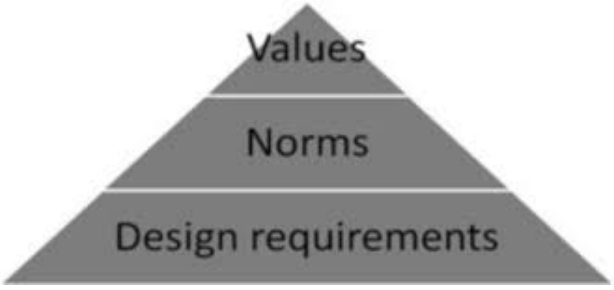


Figure 2.1: Hierarchical relationship between values, norms, and design requirements (Van de Poel, 2013)

For the first step, value conceptualisation has to be done prior to the specification. Value conceptualisation is by large a philosophical activity where the meaning of values is clarified, and their applicability, as well as the concern in which they are most interested in, are analysed. A value might be interpreted in different ways. Accordingly, the most proper definition, where the value can be justified valuable, needs to be selected first before proceeding to the next step of translation.

After selecting the most proper definition of the value, it is further specified by inserting content. The content itself is domain-specific. Consequently, it is mandatory to have sufficient domain-specific knowledge to specify values into a set of norms. Translating values into norms also means moving from evaluative domain into prescriptive domain. While the values are used to evaluate whether certain objects or actions are worthwhile or acceptable, the norms are used to prescribe some actions. Furthermore, it is important to ensure that each norm that has been developed can be regarded as an appropriate response to the value, and collectively, they are sufficient to respond to the value (Van de Poel, 2013). Put differently, they should be correct and complete.

Having ensured that a set of norms is correct and complete, it can be further specified into specific design requirements. The norms, which describe actions or means to be undertaken, by or to whom these actions are to be done, or goals to be achieved, are added with more information. Accordingly, design requirements are more specific than norms in terms of scope of applicability, ends that are pursued, and means to achieve respective ends.

Within the creation of the value-hierarchy framework, Van de Poel (2013) provides an example of how value of animal welfare may be specified into design requirements of the chicken husbandry. However, instead of using the framework to formulate a set of (new) design requirements, he rather uses the framework to evaluate the existing design requirements for the chicken husbandry. He comes into conclusion that the existing design requirements for the chicken husbandry that are specified by EU regulation are not complete to honour or for the sake of animal welfare. As shown in Figure 2.2, he argues that those existing design requirements are derivation of only one norm out of four norms that can be derived from the value of animal welfare according to available literature.

2.1.2 Value dams

Miller and Friedman (2007) define *value dams* as both technical and organisational attributes that

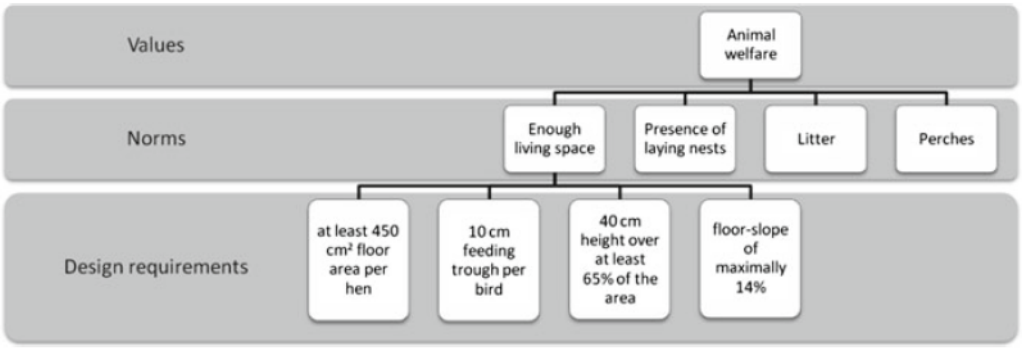


Figure 2.2: The specification of animal welfare in EU Council Directive 88/116/EC (Van de Poel, 2013)

receive strong opposition, for whatever reason, from even a small number of people in a group. Accordingly, value dams can impair system appropriation in extreme case. They further develop value dams as a new design method to deal with *value tensions* or *friction between values* within a design.

Furthermore, they implement the method in an online survey to evaluate the potential harms of a system. The respondents are asked whether they agree with the displayed harms. If the percentage of the respondents who agreed with a specific harm surpasses the threshold that is set to that harm, then that harm will be identified as a value dam. It means that such a harm is particularly undesirable and would likely to impair the system appropriation if the system has the potential to cause that harm. However, the authors do not elaborate further on how the thresholds should be determined. Rather, they formulate the threshold for the harms arbitrarily based on their intuition.

With regards to the friction between values, Davis and Nathan (2015) argue that such a friction may occur in different forms. They present two forms of this friction occurrence as examples. The first friction occurs when an individual's values are conflicting with values that are shared by a group. For instance, an open calendaring system can be perceived as a tool to support collaboration and accountability between members in a group. On the other hand, some members might find the system intrusive given the fact that people can access someone else's schedule. Therefore, there is friction between collaboration, accountability, privacy, and identity in this system.

The second friction occurs when a societal value is conflicting with an organisational value. For instance, a system which supports collaboration will become problematic when it is installed within an organisation which honours competition. Collaboration as the societal value may be clashing at some point with competition as the organisational value.

2.2 The value of energy justice

The concept of energy justice was derived from another domain of justice which priorly appeared as a modern concern, namely environmental justice (Pesch et al., 2017). Although both may be

argued to share similar philosophical ideology, environmental justice focuses more on environmental degradation and its resolution from social justice perspective whilst energy justice leans its focus toward energy system and energy policy (Pesch et al., 2017). Furthermore, McCauley et al. (2013) argue that the work of energy justice aims to realise affordable and sustainable energy for every individual across all regions. Meanwhile, Sovacool and Dworkin (2015) posit that the pursuit of energy justice should, in the end, establish a global energy system where it distributes both costs and benefits fairly and allows impartial decision-making for all individuals.

Several authors have attempted to operationalise the concept of energy justice. Sovacool and Dworkin (2015) demonstrate that energy justice is not only valuable for conceptual working where scientists debate for the philosophical meaning of the value. Rather, it also can be used as *analytical* tool to approach the solutions for common energy problems. They subsequently define eight energy problems where energy justice becomes a useful tool to seek for the solutions, namely energy efficiency, energy externalities, human rights and social conflict, energy and due process, energy poverty, energy subsidies, energy resources, and climate change. Similarly, Gramatikov and Laxminarayan (2008) use energy justice as an analytical tool by developing the index of access-to-justice to assess the costs of justice, quality of the procedure, and quality of the outcome.

Apart from the analytical tool, Sovacool and Dworkin (2015) also give an idea of using energy justice as *decision-making* tool to assist the actors in energy sector to make better energy choices. They prescribe eight design principles of energy justice in which they believe should be promoted by the established energy system. These principles, in complexity order, are shown in Table 2.1 below:

Principle	Explanation
Availability	People deserve adequate high-quality energy resources
Affordability	All people, including the poor, should not pay more than 10% of their income for energy services
Due process	Countries should respect due process which seeks to ensure that the potential for stakeholder participation in their production and use of energy
Transparency and accountability	All people should have access to high-quality information about energy and the environment and fair, transparent, and accountable forms of energy decision-making
Sustainability	Energy resources should not be depleted too quickly
Intragenerational equity	All people have a right to fairly access energy services
Intergenerational equity	Future generations have a right to enjoy a good life undisturbed by the damage our energy systems inflict on the world today
Responsibility	All nations have a responsibility to protect the natural environment and minimize energy-related environmental threats

Table 2.1: Energy justice principles for decision-making tool (Sovacool & Dworkin, 2015)

The authors further suggest starting adopting or considering the most accepted principles such as availability and affordability in the system design before continuing to the more debatable ones such as intragenerational equity and responsibility. On related research, Sovacool, Lipson, and Chard (2019) use some of those principles to assess several existing energy innovations. They compare the affordability, sustainability, and equity of *energy service contracting*, *battery electric vehicles*, *solar PV panels*, and *low carbon heat* to see whether they can be considered as a just innovation.

Another approach to operationalise energy justice is introduced by Sovacool et al. (2019). They developed a more concise conceptual framework of energy justice. The framework focuses on several key elements, which are:

1. The way costs, hazards, or externalities are distributed across society;
2. The way benefits, ownership, or access to modern energy systems and services are distributed across society;
3. The way decision-making in energy projects could honour due process and representation of all affected parties;
4. The way energy projects are assessed to acknowledge their impacts to the worse-off people.

Similarly, Jenkins, McCauley, Heffron, Stephan, and Rehner (2016), Heffron and McCauley (2017), Finley-Brook and Holloman (2016) also develop the framework of energy justice as a way to help operationalise the value of energy justice. Their framework distinguishes three tenets of energy justice which commonly known as *triumvirate* or *tripartite* model of energy justice. These tenets are *distributive justice*, *procedural justice*, and *justice as recognition*. The domain and distinction of the three tenets will be further discussed below.

2.2.1 Distributive justice

Distributive justice is mainly concerned with a fair allocation of benefits and ills as well as their associated responsibilities (Jenkins et al., 2016). Its scope of discussion is also inherently spatial context (McCauley et al., 2013). Many discussions regarding distributive justice take into account the injustice phenomenon between different locations.

On higher level, González-eguino (2015) observe that affluent countries usually have easier access to multiple high-quality energy sources while the poor countries do not. Consequently, those poor countries experience very high-cost energy services and are restricted in choosing their energy sources as they have limited options. On lower level, Finley-Brook and Holloman (2016) argue that in the US, the affluent areas composed by white people are less likely to be exposed with excessive pollution and waste from the green technology production than the poor areas where people with colour reside. Paben (2018) further stipulates that even for the same type of facility with the same capacity to manufacture green technology, the facility built in affluent areas would produce less waste than the one built in the poor areas.

Furthermore, Sovacool and Dworkin (2015) as well as Pols and Spahn (2015) suggest the structure of which distributive justice should be operationalised. It should comprise three main aspects of distribution, which are:

1. The goods or objects to be distributed (what should be distributed?);
2. The entities of which the goods or objects are going to be distributed (who are the recipients/donors?);
3. The underlying principle which governs the distribution of the goods or objects, such as based on the capacity of an individual, on need, on merit, or something else (how is the pattern of distribution?);

Related to point 3 above, Bianchin and Heylighen (2018) promote Rawls' principle of social justice as the principle to govern the distribution of items when designing an artefact or system.The principles address two main points, which are (Rawls, 1971):

1. First principle:
   "Each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all";

2. Second principle:
   "Social and economic inequalities are to be arranged so that they are both: (a) to the greatest benefit of the least advantaged, consistent with the just savings principle, and (b) attached to offices and positions open to all under conditions of fair equality of opportunity"

2.2.2 Procedural justice

Procedural justice is mainly concerned with inclusion of stakeholders during the decision-making process of energy projects under non-discriminatory principles (McCauley et al., 2013). With respect to local community development projects, Bianchin and Heylighen (2018), Nieusma and Riley (2010), and Pols and Spahn (2015) promote non-discriminatory principles to govern such decision-making process. Their principles can be grouped within three different dimensions, as shown in Table 2.2 below.

Dimensions	**The main principle for fair decision-making process in community development projects**
Position	The decision-making process is fair if the position of the worst-off is maximised when deciding for a solution while individual freedom and fair equality of opportunity are protected
	The decision-making process is fair if the power imbalances between stakeholders are minimised/compensated
Involvement	The decision-making process is fair if there is a proportional composition of representative from all affected stakeholders in the organisation
	The decision-making process is fair if there is substantial and central involvement of the communities
Resource	The decision-making process is fair if stakeholders are endowed with equitable information which enables them to make instrumental reasoning and rational decisions
	The decision-making process is fair if it allocates time for public trust development through public consultation, workshop, deliberation, etc

Table 2.2: Main principle for fair decision-making

2.2.3 Justice as recognition

The third tenet of energy justice, justice as recognition, is mainly concerned with equal appreciation of the people who are affected by energy projects (Milchram, Hillerbrand, van de Kaa, Doorn, & Künneke, 2018). McCauley et al. (2013) further distinguish participation of the people from recognition. They define recognition as *"manifestation of process of disrespect, insult, and degradation that devalue some people and some places identities in comparison to others"*. Additionally, Jenkins et al. (2016) posit that justice as recognition should address diversities in society that are originated from social, cultural, and belief differences. They bring forward the issue of misrecognition of society as a result of taking the attributes of diversity in society for granted.

In related work, Pesch et al. (2017) identify justice as recognition as one driver of local opposition towards energy projects. When the locals feel that their concerns are not heard by the authority or that the energy projects could harm their position or whatever they collectively consider as important, overflowing or social conflicts may occur (Cuppen, 2018; Pesch et al., 2017). Therefore, acknowledgement of local's identity becomes a prerequisite for a smooth realisation of energy projects.

2.3 Overview of the Dutch electrical system

The Dutch electrical system consists of three main segments, namely generation, networks, and load. All the segments were vertically integrated and locally monopolised before 1989. Only after the issuing of Energy Act 1998 which aimed to encourage the competition, the attempt to unbundle the system and make it more liberalised begun (Damme, 2005). As a result, ownership and management of the system were restructured to separate the competitive and monopolistic part. The competitive market model was introduced and most relevant to the generation part. On the other hand, competition is still not applicable to the networks as they impose economies of scale. The competition within the generation has stimulated the growth of Distributed Generation (DG). Consequently, it drives the Dutch electrical system into a more decentralised structure which requires a different way of management from the traditional centralised structure.

De Vries, Correljé, and Knops (2018) characterise the Dutch electrical system as a socio-technical system comprising both physical and institutional layer. They visualise the integrated model of the system as in Figure 2.3 below. The physical layer constitutes the supply-chain of electricity from generation, transmission, distribution, up to the load or consumption. On the other hand, the institutional layer specifies relevant entities partaking in each chain, as well as the direction of electricity trading. The following sub-sections provide the break-down of electricity supply-chain and the interaction of each chain with its corresponding institutional components in more detail.

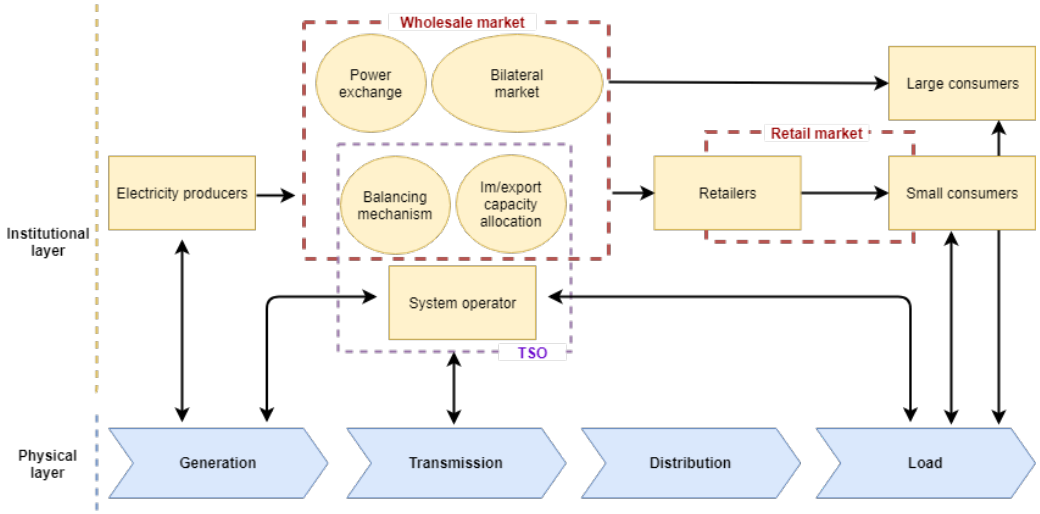


Figure 2.3: Socio-technical visualisation of the Dutch electrical system (De Vries et al., 2018)

2.3.1 Supply-chain: Generation

Power supply in the Netherlands is characterised by a large proportion of the fossil-fueled generation. Due to its high availability, natural gas has become the main resource for power generation, contributing to more than 50% of the total generation in the past decade. Following the natural gas, hard coal power plants supply approximately 25% of the total electricity consumption in the land. Meanwhile, the renewable energy sources (RES) as the alternative of fossil accounted for nearly 13.8% of the share in 2017 (Centraal Bureau voor de Statistiek, 2018). Although the number is still relatively low, the share of RES increases steadily every year. The composition of RES is dominated by wind energy, which accounted for 60% of the share. Biomass holds the second place with an approximate share of 30%, while solar contribution is about 13% of the share (Centraal Bureau voor de Statistiek, 2018).

As much as 60% of the electricity in the Netherlands is generated centrally by large power plants, leaving 8% of the electricity imported from neighbour countries and the other 32% is generated by decentralise facilities (Van den Hoven, 2018). With regards to decentralise facilities, they are dominated by Combined Heat and Power plants (CHP), accounted for about 60% of the total decentral generation capacity. Most of these CHP plants are fueled by natural gas, and only a small portion of the plants is fired by hard coal or biomass (Frontier Economics, 2015). Another form of distributed generation is small unit solar PV. Solar PV generation is even applicable up to the level of households because its efficiency does not change significantly between large and small unit (Schleicher-Tappeser, 2012).

As depicted in Figure 2.3, electricity producers are the main entity within the institutional layer interacting with generation chain. Their main role is generating electricity to meet the demand for consumption, either centrally or decentrally. After being generated, they will offer their production to the electricity market and the market will set the price and quantity of electricity that these producers may sell.

The Dutch electricity market can be distinguished into 2 types, namely wholesale market and retail market. As shown in Figure 2.3, the wholesale market in the Netherlands consists of bilateral market, power exchange, balancing market, and export/import capacity allocation. In the bilateral market, the electricity is traded directly from power generating companies to their customers, and the transaction is based on a non-disclosure agreement. About 85% of the electricity in the Netherlands is traded within the bilateral market (De Vries et al., 2018). Meanwhile, power exchange operates as a spot market where the electricity is transacted on an hourly basis for the following day. The Netherlands only has one power exchange, namely APX (De Vries et al., 2018). Furthermore, the export/import capacity allocation is made possible through the interconnection of the electricity networks with neighbouring countries.

Another electricity market belongs to the wholesale market is balancing market. However, because of its function and the main entity behind its mechanism, this market would be best described in the next supply-chain: transmission. As depicted in the Figure 2.3, the wholesale market only makes direct transaction with large consumers. On the other hand, small consumers transact their electricity with retail companies, such as Eneco, Nuon, and Essent, in the retail market. These retailers will buy a great amount of electricity from the wholesale market and then resell them to their consumers, such as households and small- to medium-sized companies. In order to reach the

market and eventually to the consumers, the generated power need to be transported through the networks, or usually referred to as electricity grids.

2.3.2 Supply-chain: Transmission

For the power generated at centralised large power plants, they are first transported via transmission grids next to the generation. They usually transported over a great distance, incurring losses which are proportional to the distance travelled. To minimise these transmission losses, the generated power need to be sent through high voltage lines. There are four levels of high voltage lines used in the Netherlands, which are 380 kV, 220 kV, 150 kV, and 110 kV (TBM, n.d.). The voltage of the generated power has to be stepped-up first by transformers to meet the voltage level of these lines, and only then they can be transported through.

The Dutch transmission grids are owned and managed by one Transmission System Operator (TSO), namely TenneT. It has three critical functions that are important to be safeguarded. Therefore, their roles are irrelevant to competition. These functions are (De Vries et al., 2018):

1. Managing the high-voltage electricity grids;
2. Managing the interconnection capacity for import/export allocation.
3. Balancing the power that are injected or withdrawn to/from the transmission grids;

The first and second above-mentioned function are related to the network management in which TenneT is responsible for the adequacy of the network capacity, the voltage and frequency stability of the network, as well as network congestion management. On the other hand, the third function entails network energy balance. When there is a mismatch between electricity supply and demand, TenneT must immediately balance the network to avoid severe system damage or black-out. This balancing function can be carried via the balancing market.

Within the balancing market, the producers offer generation capacity as reserves that can be called immediately by TenneT whenever unbalance occurs. These producers must be able to fulfil their reserve capacity obligation that they have indicated in their energy programs or else they will be fined. On the other hand, the consumers must buy the power from the balancing market whenever their consumption exceeds their energy programs, typically at a higher rate than spot market rate.

2.3.3 Supply-chain: Distribution

Within the traditional scheme where the electricity is generated centrally by large energy companies, distribution grids only function as the connector between the transmission grids and the consumers. The main difference between transmission and distribution grids lies in their voltage level, in which the distribution grids have lower level compared to the transmission grids. Consequently, the power from the transmission lines must be stepped-down by a transformer to meet the voltage level of distribution lines. Only then, these distribution lines can forward the power to small households.

The rapid growth of small DG units has caused the distribution grids to carry new function. Instead of forwarding electricity from transmission lines, distribution grids will receive the power

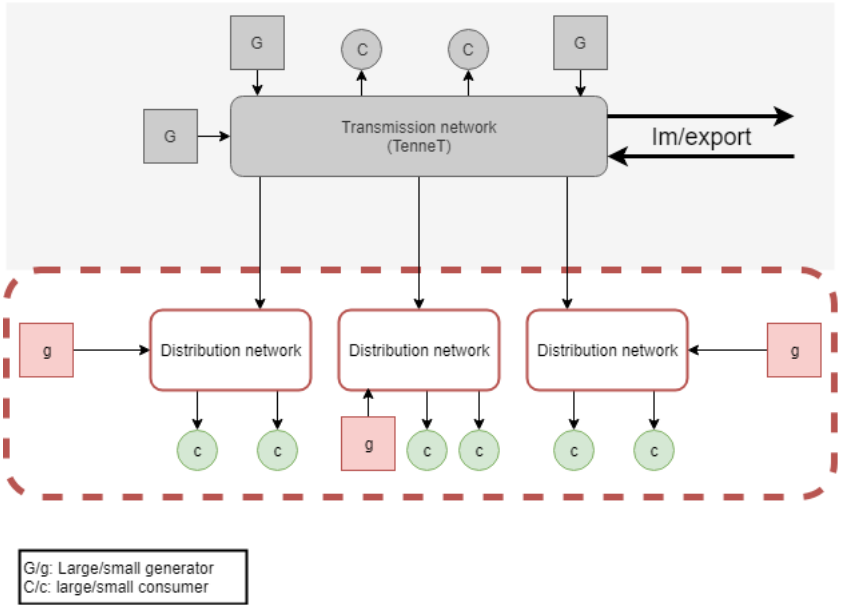


Figure 2.4: Distribution network as local transportation services (De Vries et al., 2018)

from these DGs immediately. Therefore, nowadays, they are also active in facilitating local transportation services as illustrated in Figure 2.4 (De Vries et al., 2018).

The electricity that flows through the distribution grids and received by the end-consumers needs to be recorded by meters. Only the companies that are authorised by TenneT may carry this metering function (TenneT, n.d.). Subsequently, the acquired information in the meters are important for several purposes, such as:

1. The information may indicate points in the grids where congestion occurs. Accordingly, the system operator will decide how and where the investments are required;
2. The information may stimulate consumers to improve their energy use;
3. The information is used by both producers and retailers to bill their consumers;
4. The information helps producers decide on investment for new generation capacity;
5. The information helps the system operators identify the mismatch between the energy programmes registered by *programme responsible parties* and their realisation.

The distribution network is managed by Distribution System Operators (DSOs). In the Netherlands, there are 6 DSOs, namely Cogas Infra Beheer, Enduris, Enexis, Liander, Rendo, Stedin, and Westland. Each one of them has its specific operational area as depicted in Figure 2.5. Such division occurs because their criticality is comparable to TSO, as such their activities are monopolistic. They are responsible for keeping the distribution network secure, stable, and resilient. They are also accounted for optimising the whole system and ensuring the adequacy of distribution capacity. Additionally, they have to facilitate the markets with transparent data and non-discriminatory access to their services or infrastructure (Energy Networks Association, 2017).

Figure 2.5: Operational area of Dutch Distribution System Operator (Energieleveranciers.nl, n.d.)

2.3.4 Supply-chain: Consumption

The last chain in the electricity supply-chain is consumption. Consumers are the main entity within the institutional layer interacting with this chain. After being generated and transported over the networks, consumers in the other end of supply-chain will receive the power via certain trading mechanism. These consumers can be distinguished into large consumers and small consumers.

The large consumers are those who apply for connection capacity above 3x80 Ampere, while small consumers are those who sign up for capacity lower than or equal to 3x80 Ampere (Sijm et al., n.d.). These large consumers can purchase power directly from the wholesale market. Furthermore, depending on their business operation and equipment to be supplied, some large industries, such as steel industry, may receive the power immediately from the transmission lines. On the other hand, small consumers can only buy the power from the retail market and obtain power from distribution lines.

As a result of rapid penetration of small DG units, the role of consumers is slightly diversified. These consumers, for instance, may install solar PV on their roofs and generate power for self-consumption. Subsequently, when there are excess from their production, those power may be fed back to the grid which practically makes them similar to the producers. This emergent phenomenon has paved the way for a lot of energy innovations, including P2P energy trading.

2.4 Smart metering system components

When households behave as mere consumers who only receive power from the grid, the electrical metering devices only need to record how much power that are delivered and consumed by them. However, these devices must be augmented when the households employ distributed generation and could feed their production back to the grid, similar to producers. The devices need to record not only the energy that households receive from the grid but also the energy that they inject to the grid. Put differently, the metering devices must be upgraded from unidirectional metering into two-way energy metering. This two-way energy metering is a fundamental principle of smart metering (Ekanayake, Jenkins, Liyanage, Wu, & Yokoyama, 2012; Pekka et al., 2008).

As illustrated in Figure 2.6, smart metering requires three main components, namely smart meter, communication network, and database. The smart meter functions as the interface device that is installed at houses. Meanwhile, the communication network operates as the conduit for information, and the connector between multiple stakeholders. On the other hand, the database is used to store and process information. The following sub-sections describe the operation or functions of each component in more detail.

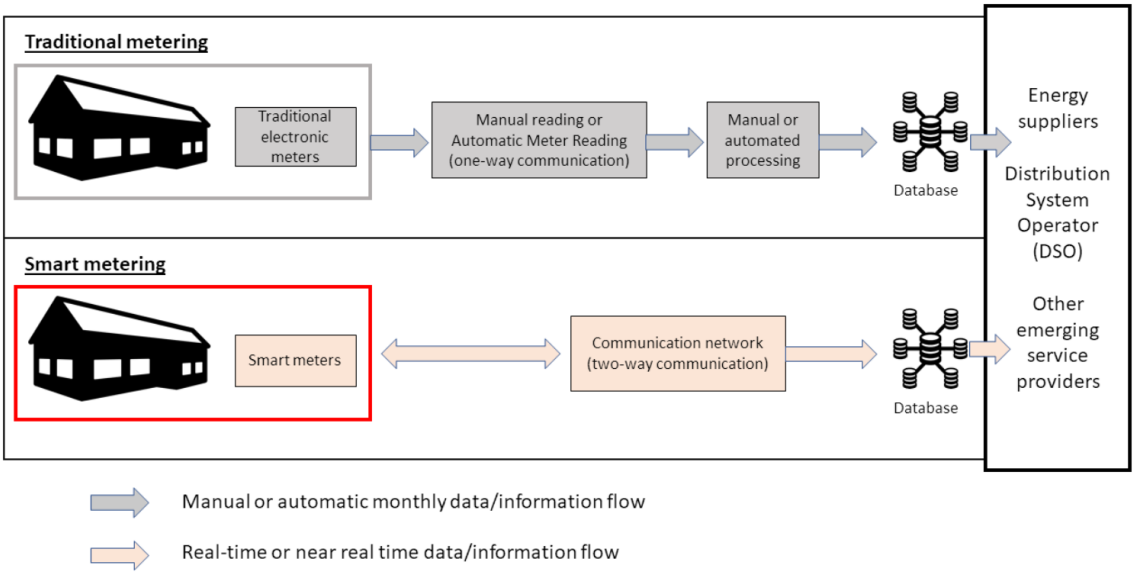


Figure 2.6: Components in smart metering systems in comparison to the traditional metering (Ekanayake et al., 2012)

2.4.1 Smart meters

Smart meters are the improved version of traditional electronic meters which can measure a lot of electrical parameters within a shorter time interval, such as energy consumption, voltage, frequency, and reactive power. As suggested by New England Clean Energy (2017), smart meters can be developed in 3 ways. There are dual meter, net meter, and bi-directional meter which operate in different fashions as described in Table 2.3 below.

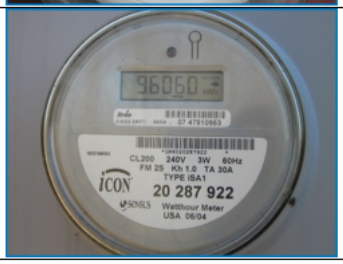
Type of smart meter	Device representation	Function
Dual meter		The device comprises two different meters that do not interact. One meter acts as the *usage meter* to record the electricity that is drawn from the utility and the other meter functions as *generation meter* to measure the excess solar production that is sent to the distribution grid.
Net meter		The device does not display the information with regards to the excess solar production. It immediately indicates households' net electricity usage. This net usage is simply calculated by subtracting the electricity received from the utility from their excess production.
Bi-directional meter		Apart from the amount, this device will also indicate the direction of the power flow by certain notation or codes, whether the power are coming in or going out.

Table 2.3: Comparison between three types of smart meter (New England Clean Energy, 2017)

For any type of smart meters, it must satisfy The Dutch Smart Meter Requirements (DSMR) that are specified in *Nederlandse Technishce Afspraak 8130* by *Nederlands Normalisatie Instituut* (Aubel & Poll, n.d.). The DSMR have influenced the way smart meters in the Netherlands have to be manufactured. They ought to have five different ports undertaking different communication functions (Aubel & Poll, n.d.; Capodieci, Pagani, Cabri, & Aiello, 2011; Netbeheer Nederland, 2018). These ports and their corresponding functions are explicated in Table 2.4 below.

Port	Connected object	Description of functions
P0	-	Used for local communication during the installment and maintenance of the meter.
P1	Meter-Local appliances	Used for communication between the meter and up to five appliances that are installed at the consumer's house. This port only works as a reading interface and cannot be used to send data to metering system.
P2	Meter-Other metering instruments	Used for communication between the meter and up to four other metering instruments such as smart gas meter or grid operator equipment.
P3	Meter-Central System or DSO	Used for communication between the meter and the Central System (CS). CS is a centralised server that saves the consumption data that are obtained from all connected smart meters.
P4	Central system-Energy supplier and Independent Service Provider (ISP)	Used for communication between the CS and energy supplier as well as Independent Service Providers (ISP). ISP are external party which provide additional services, such as giving advice on how to save more energy, given the consumption pattern. This port also allows energy supplier and ISP to receive measurements from P3.

Table 2.4: Functions of five mandatory ports on smart meters in the Netherlands (Aubel & Poll, n.d.; Capodieci et al., 2011; Netbeheer Nederland, 2018)

2.4.2 Communication network

The second key component in the smart metering system is the communication network. Similar to the electricity, the data received and processed by smart meters travels and circulates within a network. Ekanayake et al. (2012) draw a typical communication network for smart metering. It consists of three communication interfaces as depicted in Figure 2.7, namely Wide Area Network (WAN), Neighbourhood Area Network (NAN), and Home Area Network (HAN). These interfaces connect households with several other stakeholders in the electrical system. The functions of each interface are elaborated further in Table 2.5 below.

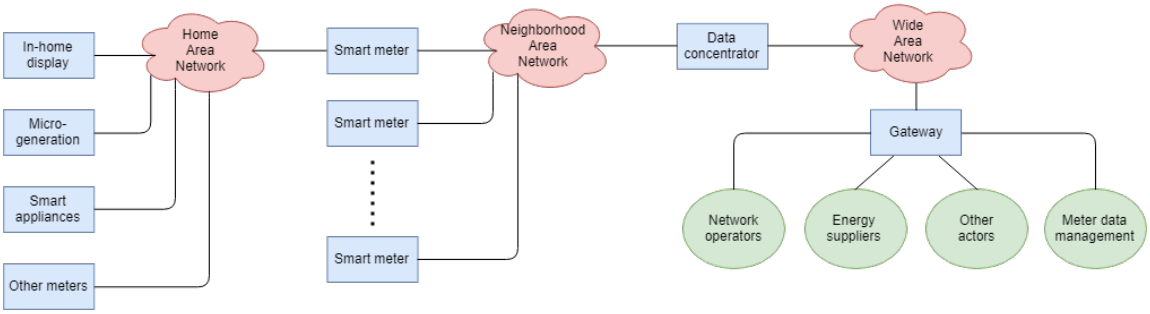


Figure 2.7: Typical communication network of smart metering system (Ekanayake et al., 2012)

Communication interface	Connected object	Function(s)
Home Area Network (HAN)	Smart meter – {smart appliances, in-home display, smart appliances, solar PV system, other meters}	1. Facilitate centralised energy management such as energy monitoring and smart appliances supervision; 2. Provide different services to improve consumer's comfort such as remote operation of smart devices
Neighborhood Area Network (NAN)	Data concentrator – smart meter	1. Forward the consumption data from multiple smart meters to be aggregated in data concentrator; 2. Provide diagnostic messages, firmware update, and near-real-time messages to support power system
Wide Area Network (WAN)	{Central System/DSO, energy supplier, Independent Service Provider} – Data concentrator	1. Deliver the aggregated data from data concentrator to multiple parties involved in smart metering system; 2. Coordinate bi-directional transportation of data; 3. Monitor the conditions of the smart meters.

Table 2.5: Functions of communication interfaces in smart metering network (August, 2015; Ekanayake et al., 2012; Zhang, 2017)

2.4.3 Database

The last key component which builds smart metering system is the database, or also known as Meter Data Management System (MDMS) (Ekanayake et al., 2012; Zhang, 2017). Besides for data storage, this database also facilitates multiple data processing services such as data acquisition, validation, adjustment, and calculation to provide refined information that is inquired by various parties in the system.

The major concern about designing MDMS lies in the way to secure the data while keeping the database open and accessible for various parties. It may become difficult to monitor who takes which data from the database when a lot of people are granted access to the database. On the other hand, the functions of the database become less significant if there is only a few data to be stored and processed as a result of tight restriction of access.

2.5 Conclusion

In this chapter, several key-concepts that are important for this research have been elaborated.

Design for Value methods: value hierarchy & value dams

Value-hierarchy is a conceptual framework that can be used to translate energy justice value into a set of norms. It suggests that the relation between values and norms can be either bottom-up or top-down. For the latter, a value is translated into a set of norms by means of conceptualisation and specification. However, the framework does not provide the systematic steps to construct the norms. On the other hand, the concept of value dams demonstrates that there are possibilities of people opposing or having different opinions about a value/attribute. As a result, there might be tensions between several attributes or values which need to be resolved. Analogously, people might as well have different opinions (multiple interpretations) about the norms considering they are derivative of the values according to the value-hierarchy.

The value of energy justice

Adhering to the framework of value hierarchy, value conceptualisation is required before specifying a value into a set of norms. Among various conception promoted by different authors, the framework of **triumvirate/tripartite model of energy justice** can be an alternative to conceptualise the respective value. The framework has a strength in the clarity with regards to the distinction between the tenets of justice (distributive, procedural, recognition). Therefore, the concept can be applied in practice more conveniently given the clear definition or instruction.

Overview of the Dutch electrical system

The Dutch electrical system is a socio-technical system comprises both physical and institutional layers. It is also a system or infrastructure where the P2P energy trading (sub-)system will be embedded within. Therefore, it is expected that P2P energy trading partly shares similar socio-technical components such as the actors involved and the supply-chain of the electricity itself. It is also expected that the practice of P2P energy trading might alter the current setting of electricity supply-chain.

Smart metering system components

The smart metering system enables two-way energy metering, which is crucial for the households to trade electricity as they need to record the amount of electricity that they deliver to their neighbours. Additionally, the smart metering system is the technology that may modify the current setting of electricity supply-chain further, considering it is the technology that modifies the "dumb" grid into the smart grid in general.

Chapter 3

Methodology

This chapter elaborates the methodology that was applied to approach the answer to the research question. As indicated in Chapter 1, the Main Research Question is broken down into four sub-questions. The first two sub-questions are intended to be the conceptual work of this research, while the other two sub-questions are meant to be the empirical work. For each segment and its respective sub-questions, the steps that were taken to arrive at the answer will be explained, which entails the way the data was gathered and how it was processed. As a reminder, the Main Research Question was constructed as follows:

> **What norms can be developed to approach a just P2P energy trading for the community of Bospolder-Tussendijken, and what do they imply to the Municipality of Rotterdam?**

3.1 Methodology for conceptual work

As previously mentioned, the conceptual work addresses the first and the second sub-question of this research. The methodology of both sub-questions will be elucidated in a separate sub-section.

3.1.1 Sub-question 1

> **What is peer-to-peer energy trading system from a socio-technical perspective?**

To approach the answer to the question above, a technology-focused approach was taken as the first step. An attempt was made to distinguish the main technology drivers that are used in P2P energy trading. Subsequently, the first desk research was conducted in the database of TU Delft Library to learn about the system architecture of P2P energy trading, which at the same time, displays the technologies that build the system. The keywords that were used during the desk research and the final set of literature that was taken as the reference to meet the mentioned purpose are provided in Table 3.1 below. In addition, due to the limitation on language, only English literature was included.

Keywords	Final set of literature taken as the reference upon iterative review
"p2p energy trading" + "peer-to-peer energy trading"	Bompard, e. (2012). Emerging electrical system as interacting dynamic multilayers complex systems, 1–37 Zhang, C., Wu, J., Zhou, Y., Cheng, M., & Long, C. (2018). Peer-to-Peer energy trading in a Microgrid. *Applied Energy*, *220*(February), 1–12.

Table 3.1: Keywords and the final set of literature to learn about the system architecture of P2P energy trading and its main technology drivers

Both of the paper listed in Table 3.1 develop an architecture of multi-layered energy system. However, the second-listed literature specifically addresses the architecture for P2P energy trading purpose, which is more aligned to the objective of the first desk research. Therefore, the information provided in the second-listed literature is more applicable or relevant to this research. Having understood that P2P energy trading is formed by multiple layers consist of physical, cyber, and business layer, one technology was deliberately assigned to each layer. The selection of the technologies was based on the interpretation of the description of the layers in P2P energy trading. In addition, the authors of the second-listed literature also provided some examples of technologies that fit for each layer, which partially influenced the selection. From this step, **three main technology drivers** that cover major aspects in the operation of P2P energy trading were distinguished.

Upon the selection of the three technologies which entail on-grid solar PV system, smart metering system, and P2P platform, an attempt was made to characterise them under several topics/themes. Such an approach is necessary because the discussion of particular technologies, especially ones that comprise multiple sub-components, can be very broad and extensive that it can be distracting as a result. Subsequently, different topics were distinguished for each technology, in which the selection was based on several designated criteria. An overview of the topics that were assigned to each technology, together with the criteria that were used to select them are given in Table 3.2 below.

As indicated in Table 3.2, the same criteria were used to distinguish the topics that can help to characterise solar PV and smart metering system. However, a different approach was applied to characterise P2P platform. Instead of describing the characteristics of P2P platform based on several topics, three P2P platforms that have been developed in the Netherlands were reviewed and compared, and their characteristics were concluded accordingly. The comparison was mainly about the transaction mechanism in the platform. Such a decision was taken because, unlike solar PV system and smart metering system, there is only a single component to be observed in the P2P platform, which is the platform itself. Therefore, its main function to facilitate electricity transaction could already be considered as a focused topic that is helpful to draw its characteristics. Additionally, the P2P platform is the technology belongs to the business layer, which is more localised or content-specific. Therefore, examining the existing P2P platforms from various developers in the

Technologies	Criteria used to distinguish topics/themes	Selected topics /themes
On-grid solar PV system	1. The topics should be able to indicate the changes to the current setting of electricity supply-chain as a result of performing electricity trading or demonstrate important elements that are changing or changeable; 2. The topics should focus more on the changes in the consumption supply/chain; The topics should address some aspects related to consumers/communities; 3. The topics should not from the beginning show the potential to distract/obscure the value of energy justice	Investment and ownership; Profitability; Local flexibility
Smart metering systems		Data utilisation in communication network; Reliability of automatic smart meters
P2P digital platform	(adapted from the main task/function of the technology in the electricity trading)	Transaction mechanism

Table 3.2: An overview of the topics to help characterise each technology used in P2P energy trading and the criteria to select the topics

Netherlands would be a better approach and could lead the research to more relevant characteristics.

From the step above, **three topics about solar PV, two topics about smart metering, and one topic about P2P platform** were distinguished. Those topics gave the guidance in reviewing the literature that had appeared in the first desk research. Subsequently, the information in the literature that has a connection to those topics was sorted.

During the review, the references that are cited in the literature that was being reviewed were visited, and kept being repeated to the subsequent "references literature". The search suddenly became an iterative "references-visit". That is also the reason of why the desk research was not repeated multiple times with different keywords. Although the method was not very systematic, it was useful to gather and grasp the relevant information/literature quickly as the information in the next literature (the references) could be judged or predicted from the context of the literature that was being reviewed.

In addition, some course materials from the study of CoSEM were also used. Three courses were intensively consulted for this sub-question, namely SEN1521-Electricity and Gas: Market Design and Policy Issue, SEN1541-Sociotechnology of Future Energy System, and ET4376 Photovoltaic basics. The first course was helpful to discern the socio-technical components of the Dutch electrical system, which are also relevant to the P2P energy system. It was also helpful to demarcate the initial physical conception of P2P energy trading. The second course provided literature/information about social aspects of the recent energy-related technologies, of which some of it partly covers the topics and technologies that had been distinguished. On the other hand, the third course provided extensive information about solar PV from the technical and economics side.

As a result of the literature review from the step above, **the description of socio-technical characteristics of P2P energy trading that shows the interaction between human be-**

haviours and technologies, as well as the definition of P2P energy trading from a socio-technical perspective was distinguished.

3.1.2 Sub-question 2

What items in P2P energy trading system that can be relevant to the energy justice domain and what norms can be developed accordingly?

The work to approach the answer to the question above was grounded in the framework of *value hierarchy*. In general, two steps were taken to operationalise the respective framework. The first step was investigating what information about socio-technical characteristics of P2P energy trading from the previous sub-question that could be relevant to the domain of energy justice. Afterwards, an attempt was made to specify the justice norms for P2P energy trading which contain that information/items. Those steps are illustrated in Figure 3.1 below, and each step will be elaborated in more detail shortly.

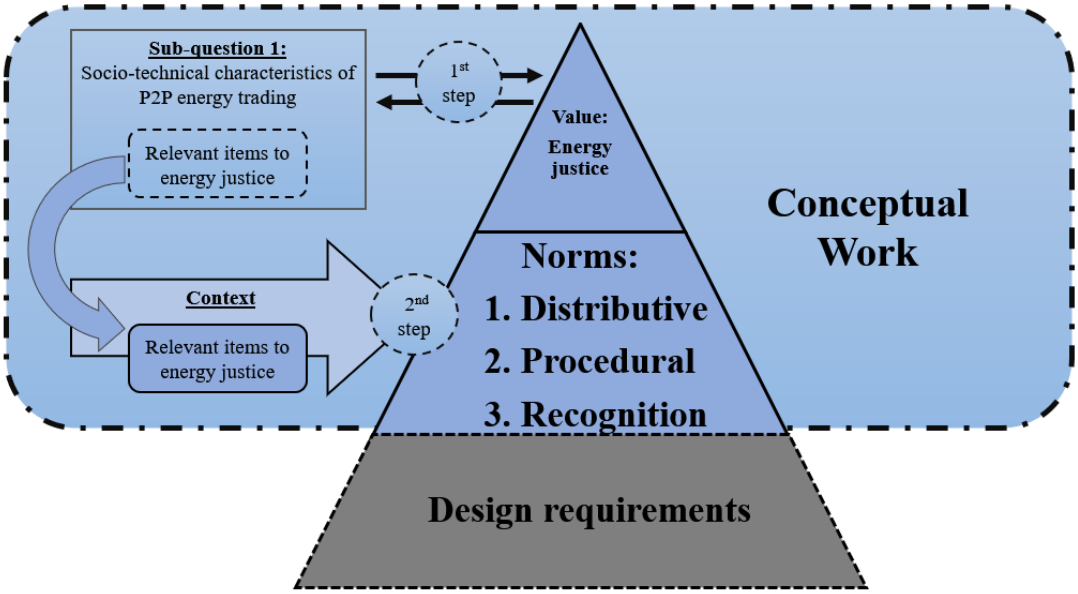


Figure 3.1: Two general steps of value-hierarchy operationalisation to answer sub-question 2

Step 1

For the first step, the conception of energy justice that could be considered suitable to this research must be selected. Accordingly, the second desk research was conducted to gather the information about energy justice in particular. **"Energy justice"** became the only keyword that was used in the TU Delft Library portal to search for the respective literature. Similar to the first desk research,

the references cited in the literature that was being reviewed were visited recursively. The result of the literature review is presented in section 2.2.

Furthermore, the selection process of the energy justice concept to be followed by this research was iterative. The reason is that back-and-forth reflections were needed to ensure that the chosen conception of energy justice value can justify that the energy justice is indeed valuable and it can accommodate some issues or items in P2P energy trading. In the end, **the concept of triumvirate/tripartite model of energy justice was referred because of its practicality.**

Due to its clarity, the chosen concept can be applied more easily to highlight the items in the P2P energy trading system that can be relevant to the description of each tenet of justice. Having decided on the particular concept of energy justice, an attempt was subsequently made to make the description of each tenet more operable. Accordingly, a set of criterion was derived from the interpretation of each tenet, as shown in Table 3.3 below.

Tenet of energy justice	Derived criteria
Distributive	Attributes/goods/events that can be distributed/allocated/divided
Procedural	Attributes/goods/events that can be organised/deliberated together with communities or that are needed to conduct such deliberation
Recognition	Attributes/goods/events where their organisation can be influenced by the characteristics/identity of the communities

Table 3.3: Guiding criteria used to highlight the items in the P2P energy trading system that can be relevant to the energy justice domain

It turned out that pieces of information/items available in sub-question 1 which have a connection to the respective criteria could be distinguished. Therefore, besides validating that choosing the conception of tripartite model of energy justice for the value conceptualisation was a right decision, **the items in P2P energy trading that are relevant to energy justice domain** could also be distinguished from the step above. In addition, those items were grouped to the specific tenet of energy justice and were used as the input to formulate the respective norms (distributive, procedural, recognition norms) in the next step.

Step 2

The second step was about specifying a set of justice norms, taking into account the relevant items in the P2P energy trading system as the context. In this step, a problem appeared immediately as the framework of value hierarchy does not provide the systematic steps to construct a norm. The reason is probably that different values may need different technique of operationalisation so that there cannot be grand systematic steps that are fit for all values. Consequently, the steps to be taken, or even the built of the norm itself seem to be really dependent on the researchers and the value that is being observed. Accordingly, this research resolved on formulating the norms with self-developed arrangement.

For all the tenets of energy justice (distributive, procedural, recognition), rather similar steps and rules were applied to specify the norms. Those steps and rules were:

- Determine the goal for the formulation of each group of norms (distributive norms, procedural norms, and recognition norms), which is what each group should address, or what to be achieved through the formulation of each group of norms;
- Find the principles that have been developed by other authors as the starting point to govern the identified items in each group of norms. Those principles must be somewhat related and, with some adaptions, applicable or relevant to govern the organisation of respective items;
- For practical reason, only select and adapt the principles that are introduced within the context of design of products/systems;
- Formulate the norms in a way they could have the potential to approach some of the design principles promoted by Sovacool and Dworkin (2015) in section 2.2, whenever possible. Although they introduce those principles as a tool to make choices, which is more of design requirements domain, some norms can already be directed in a way to increase the potential of succeeding design requirements to satisfy some of those principles.

Confronted with the arrangement above, the third desk research was conducted in the Scopus database to explore and to select those initial principles. Upon the review, the final set of literature which contains the initial principles that satisfy the rules above, as well as the keywords to find it, are given in Table 3.4 below. In addition, similar to the first and the second desk research, the references that are cited in the paper that was being reviewed were visited, and it was repeated in the subsequent paper. That was how the final set of literature could be collected.

After selecting and adapting the initial principles to properly govern the organisation of the items identified in the previous step, an attempt was made to structure the complete norms. Accordingly, a set of norms was formulated by using the grammatical rule of institutions: **ADIC**. It stands for **A**ttributes (to whom does a rule apply), **D**eontic (permission, obligation, or prohibition), a**I**m (actions or expected outcomes), and **C**ondition (when or where are the actions or outcomes permitted). The main benefits of using such a format are that it increases the consistency of the formulated norms, and the governing principle can be quickly identified. From there, **a set of justice norms for P2P energy trading** was distinguished eventually, and the conceptual work of this research also ended here.

3.2 Methodology for empirical work

After successfully promoting a set of justice norms for P2P energy trading, the conceptual work was advanced by evaluating and assessing the relevancy of those norms against the specific setting of Bospolder-Tussendijken. It also marked the beginning of the empirical work. The empirical work itself addresses the third and the fourth sub-question of this research. Similar to the conceptual work, the methodology of both sub-questions will be elaborated in a separate section.

Group of norms	Keywords	The final set of literature taken as the reference upon iterative review
Distributive	(TITLE-ABS-KEY ("distributive justice")) AND (("design")) AND ("system")	Bianchin, M., & Heylighen, A. (2018). Just design. *Design Studies*, *54*, 1–22.
	(TITLE-ABS-KEY ("distributive justice")) AND ((("design")) AND ("system")) AND (cost)	Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435–444.
	(TITLE-ABS-KEY ("distributive justice")) AND ((("design")) AND ("system")) AND (benefit)	Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *American Economic Review*, *100*(3), 641–672.
	(TITLE-ABS-KEY ("distributive justice")) AND ((("design")) AND ("system")) AND (access)	Fahlquist, J. N., Doorn, N., & Poel, I. van de. (2017). Design for the Value of Responsibility, 1–15.
	(TITLE-ABS-KEY ("distributive justice")) AND ((("design")) AND ("system")) AND (responsibility)	
Procedural	(TITLE-ABS-KEY ("procedural justice")) AND (("design")) AND ("system")	Bianchin, M., & Heylighen, A. (2018). Just design. *Design Studies*, *54*, 1–22.
	(TITLE-ABS-KEY ("procedural justice")) AND ((("design")) AND ("system")) AND ("involvement")	Nieusma, D., & Riley, D. (2010). Designs on development:Engineering, globalization, and social justice. Engineering Studies (Vol. 2).
	(TITLE-ABS-KEY ("procedural justice")) AND ((("design")) AND ("system")) AND ("position")	Pols, A., & Spahn, A. (2015). Handbook of Ethics, Values, and Technological Design. *Handbook of Ethics, Values, and Technological Design*, 1–24.
	(TITLE-ABS-KEY ("procedural justice")) AND ((("design")) AND ("system")) AND ("information")	
Recognition	(TITLE-ABS-KEY ("recognition justice")) AND (("design")) AND ("system")	Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research and Social Science*, *11*, 174–182. McCauley, D., Heffron, R. J., Stephan, H., Jenkins, K., Gillard, R., Snell, C., & Bevan, M. (2013). Advancing energy justice: the triumvirate of tenets and systems thinking. *International Energy Law Review*, *32*(3), 107–110.

Table 3.4: Keywords to find the final set of literature which contains the desired initial principles, and the results

3.2.1 Sub-question 3

What does the specific setting of Bospolder-Tussendijken imply to the developed conceptual justice norms for P2P energy trading?

Three activities were performed to approach the answer to the question above. The first activity was identification of the specific setting of the community of BoTu. The data was gathered through stakeholders interview and web portal-observation. The second activity was norms assessment by

four interviewees, the same people from the first activity. The last activity was exploration and analysis of conflicts. Before going into more detail to each activity, the role of the stakeholders who were interviewed, as well as the list of questions for the semi-structured interview will be provided first.

Interviewees selection and role of the interviewees

The objectives of this semi-structured interview were three-fold: first being to gather information about the situation or specific setting of the community of BoTu; second being to assess the conceptual justice norms for P2P energy trading that have been developed; third being to explore the potential conflicts that may occur if those norms are implemented in Bospolder-Tussendijken.

The selection of interviewees had to be done in such a way that those abovementioned purposes could be satisfied. Accordingly, two criteria were set to help the selection. The first criterion was the interviewee must have a connection with the neighbourhood or at least work nearby the neighbourhood. The second criterion was the role or affiliation of the interviewee with the community must be different from the other interviewees. The second criterion was important to obtain quite a diverse perspective for the norms assessment and conflicts exploration.

Having decided on the objectives and criteria for the interviewees, four stakeholders were interviewed eventually during the period from 03-07-2019 to 29-07-2019. A summary of the selected interviewees is provided in Table 3.5 below.

Interviewee	Role	Date of interview	Medium of interview
Interviewee 1	Engineer in Stedin (one of distribution grid operators in the Netherlands) for Rotterdam area	03-07-2019 (11:00-12:00)	Face-to-face
Interviewee 2	*Adviseur Duurzaamheid* (sustainability advisor) for the Municipality of Rotterdam	19-07-2019 (11:00-12:00)	Face-to-face
Interviewee 3	Local resident and energy initiator in Bospolder-Tussendijken	23-07-2019 (10:00-11:00)	Face-to-face
Interviewee 4	Smart grid expert/engineer in Wolfpacks (a design, innovation sciences, and business development firm based in Rotterdam nearby Bospolder-Tussendijken)	29-07-2019 (13:00-14:00)	Video-call

Table 3.5: A summary of the selected interviewees

Semi-structured interview guideline

Given the objectives of the interview, four exploratory questions and one guiding question (instruction) for the norms assessment were formulated as shown in Figure 3.2 below. The first question is intended for the first activity, which is identifying the specific setting of BoTu, and the second to the fourth question are intended for the third activity, which is exploring and identifying conflicts.

The answers to question 2 to question 4 were used as an additional help to interpret the comments or judgments of each interviewee during the norms assessment. Those answers were also used as a reference to learn the interviewees' motives in bringing the conflicts/conflicting attributes forward (if there is any). Additionally, all of the interview sessions, including the norms assessment, were voice-recorded. The interviewees' answers to the listed questions were transcribed and can be visited in Appendix B.

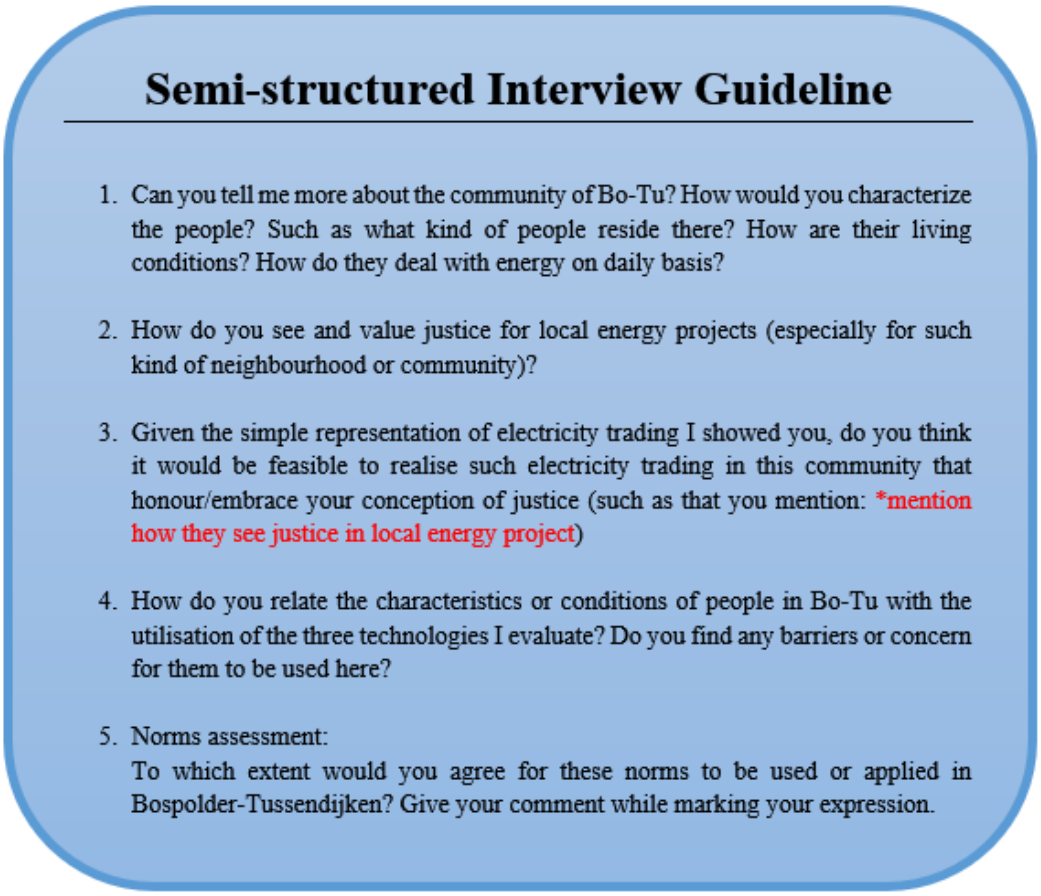


Figure 3.2: Semi-structured interview guideline

Activity 1: Identification of the community of BoTu

The first activity was aimed at helping understanding the empirical situation in BoTu as the base or context for the next activities. *Gemeente* Rotterdam's web portal in `"https://wijkprofiel.rotterdam.nl/nl/2018/rotterdam/delfshaven/bospolder?toon=alles"` was visited to collect the data of demographics and social conditions in Bospolder-Tussendijken. The portal provides several indicators that can be referred to obtain a general description of the respective community.

Subsequently, the information from the web portal was enriched (and confirmed) by the interviewees' answer to the first interview question, and also by the data from a *grey-document* that was shown by the 3rd Interviewee. As a result, **the description of community of BoTu which entails demographics and social conditions in the neighbourhood, as well as the energy awareness of the community** could be distinguished. Additionally, besides to enrich and confirm the data from the web portal, the interviewees were intentionally asked to describe the community of BoTu at the beginning of the interview to direct their answer to the remaining questions to be more content-specific for BoTu.

Activity 2: Norms assessment

The second activity was aimed at pre-identifying whether or not the developed conceptual norms, according to the best knowledge of the interviewees, have the potential to trigger any type of conflicts in BoTu. Accordingly, the developed justice norms were shown to the interviewees, and they were asked to express their opinion about having such norms be enforced in BoTu by marking one of the expressions in the Likert-scale as illustrated in Figure 3.3 below. They were also encouraged to provide commentary on their expression. They could write it down on the available boxes or they could just vocalise it. Two assumptions were applied to their comments:

1. The interviewees have the best experience with or knowledge of the setting of the community of BoTu;
2. Triggered by the first interview question, the interviewees, in any case, always connect their comments/judgment to their knowledge of the setting of BoTu.

The implications of the assumptions above are that their judgment or comments, in any case, are considered reliable and contextually specific to the setting of BoTu.

After having all the interviewees marked their expression for every norm that was shown to them, their expressions per norm were combined and were compared to the rule or *threshold* that was modified from the work of Miller and Friedman (2007) with respect to the value dams discussed in section 2.1.2. The threshold was:

If there are one or more interviewees marked the expression of either *"neither agree nor disagree"*, *"somewhat disagree"*, or *"strongly disagree"* towards a particular norm, the respective norm will be highlighted as having the most potential to evoke conflicts or to have conflicting attributes for its implementation in BoTu.

"Within the context of P2P energy trading project, these norms are relevant/realistic for the community in Bo-Tu and should be pursued"

Distributive justice (fair distribution of goods/objects among stakeholders)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading	○	○	○	○	○	

Figure 3.3: Illustration of Likert-scale for norms assessment

An illustration of how the threshold above was applied in the norms assessment is provided in Figure 3.4. The yellow-highlighted norm indicates that it is non-singular in how it is interpreted (**multi-interpreted norm**). Therefore, it is most likely to be in conflict with other attributes. From this activity, **a set of norms that may have the most potential to evoke conflicts for its implementation in BoTu** was distinguished. Subsequently, the focus was given to that set of norms for the next activity of exploring the potential conflicts.

Conceptual norms	1st interviewee	2nd interviewee	3rd interviewee	4th interviewee
Distributive norms				
• Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;	Strongly agree	Strongly agree	Strongly agree	Neither agree nor disagree
Procedural norms				
• Representatives of communities must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;	Somewhat agree	Somewhat agree	Strongly agree	Somewhat agree

Figure 3.4: Illustration of the application of the modified threshold in the norms assessment

Activity 3: Exploration and analysis of conflicts

The way the conflicts were explored here was by learning their (**interviewee(s) who expressed disagreement to any norm**) comments during the norms assessment. Their comments were contextually interpreted, and the potential conflicts or other attributes that they considered important, which at the same time causing the conflicts, were highlighted. Figure 3.5 illustrates how the potential conflicts/conflicting attributes from their comments were highlighted. Subsequently, their conception of justice and their expectation for P2P energy trading to be implemented in BoTu was

Multi-interpreted norms	Comments			
	1st interviewee	2nd interviewee	3rd interviewee	4th interviewee
Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;				"…So, first I said neither agree nor disagree, and then I said strongly agree, also depends a bit on what "must" mean: are people forced to join this peer-to-peer market, I do not think so. I strongly agree if it is voluntary but neither agree nor disagree if it is regulatory…"

Figure 3.5: Illustration of how potential conflicts/conflicting attributes from interviewees' comments were highlighted

consulted to learn their motives in introducing the conflicts/conflicting attributes further.

Their conception of justice (for local energy projects) was generated from the second interview question. For all the interviewees, their narrative of what they perceive as justice in the energy projects was contextually distinguished and it was localised to either one of the tenets (distributive, procedural, or recognition). In doing so, two steps of classification were undertaken. The first classification was done by using a group of words that had been developed in Figure 3.6 as guidance. For instance, their narrative will be interpreted as to potentially emphasise the tenet of distributive if they mention the code "profit". However, as ones may notice, some of the keywords are still overlapping. Therefore, the second classification was needed and done, in which the information is localised by interpreting the context that was emphasised by each interviewee.

Distributive	Procedural	Recognition
Access, advantage, balance, benefits, bill, burden, buy, cheap, costs, income, invest, investment, job, money, pay, poor, profit, responsibility, responsible, return, rich	Bottom up, choose, citizen, community, contribute, contribution, decide, decision, information, involve, option, organise, organisation, participate, participation, poor, process resident, rich, together, vote	Approach, background, communities, cultural, culture, diversity, hear, listen, prefer, preference, social, tradition, underestimate, want, wish

Figure 3.6: Keywords to pre-classify the narrative of interviewees into one of the tenets of energy justice

On the other hand, their expectation for P2P energy trading to be implemented in BoTu was generated from the third and the fourth interview question. Their answer to the third question was interpreted and distinguished into two main topics, namely *challenges/concerns* and *possibilities/suggestions*. Additionally, their answer to the fourth interview question was synthesised as technologies evaluation to highlight challenges for the application of either solar PV, smart meters, or digital platform in BoTu.

Connecting all the information that had been gathered from activity 1 to activity 3, an attempt was made to describe the conflicts and to make sense of them. Figure 3.7 illustrates the way all the information from activity 1 to 3 was connected and how the conflicts were described accordingly.

Multi-interpreted norms	Observed conflicting attribute	Observed indicator of the setting of BoTu that plays a role/motivates the conflict	Description
Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;	**Freedom of choice (democracy)**	**Household income;** **Lifestyle**	**Forcing the norm to be applied in BoTu may force the rich to involuntarily bear the costs of the poor to make those affordable while at the same time, there are not many rich people in BoTu. They will be burdened as a result of such of force;** **Although the community, in general, has high social participation, it is still uncertain that those few rich people in BoTu will be fine to bear the extra costs of the rest who are poor.**

Figure 3.7: Illustration of how all the information from activity 1 to 3 was connected and the way the conflicts were described accordingly

Finally, **a set of conflicts/conflicting attributes (and their description) that could appear when implementing the developed justice norms for P2P energy trading in BoTu** was distinguished. With the respective finding, the answer to the sub-question 3 could be concluded.

3.2.2 Sub-question 4

What can the Municipality of Rotterdam do to support the realisation of a just P2P energy trading in Bospolder-Tussendijken?

The answer to the question above was approached by exploring and openly discussing the possible actions that the Municipality can perform as a regulatory body. An attempt was made to transform the possibilities and challenges of implementing the justice norms for P2P energy trading in BoTu, that made known in the previous sub-question, into practical actions that the Municipality can do, given its role in society. I tried to **comprehend and reflect the information that had been gathered from the conceptual work and the information that was disseminated by the interviewees** to formulate my best suggestion of actions for the Municipality of Rotterdam.

The actions were developed in such a way to insist on the realisation of each developed norm in BoTu. Four *hypothetical assumptions* were applied when developing those actions:

1. The Municipality of Rotterdam is a supreme regulatory body that can impose any regulation on any actor;
2. The Municipality of Rotterdam always acts as the leader or central actor in the deliberation process, regardless of whoever initiated the project, which makes the relation between the actors involved inherently hierarchical instead of a network of actors;
3. The Municipality of Rotterdam has extensive financial resources;
4. The Municipality of Rotterdam has a very high interest in developing the community of BoTu that it will take care of all recommendations.

The implications of abovementioned assumptions are that a lot of the recommended actions were about regulating other actors, and administrating or organising items. The exhaustive interaction between the actors who are involved in this kind of system changes, and how the tasks or responsibilities are distributed among them could also be disregarded. Therefore, there were more spaces to generate practical actions that might be on the plate of the Municipality.

Additionally, the conflicts/conflicting attributes that made known in the previous sub-question were linked to the suggested actions whenever possible. Such an attempt was helpful to foresee the consequences or drawbacks of undertaking the recommended actions. Subsequently, alternatives of actions to address or compromise the conflicting attributes were provided. An attempt was also made to articulate the consequences or drawbacks of undertaking those alternatives whenever possible. Such an effort was made to make this work fair that all actions may have consequences or drawbacks, and to remind the Municipality of Rotterdam to always make a careful decision.

However, because I could not link all the recommended actions to the apparent conflicting attributes, I was unable with my current knowledge to foresee the consequences or drawbacks of doing some of the actions, as illustrated in Figure 3.8 below. To those actions, they were left open for others to discuss. Finally, from taking a set of the steps above, **a set of practical actions that the Municipality of Rotterdam can or should do to support each justice norm for P2P energy trading in BoTu** was distinguished.

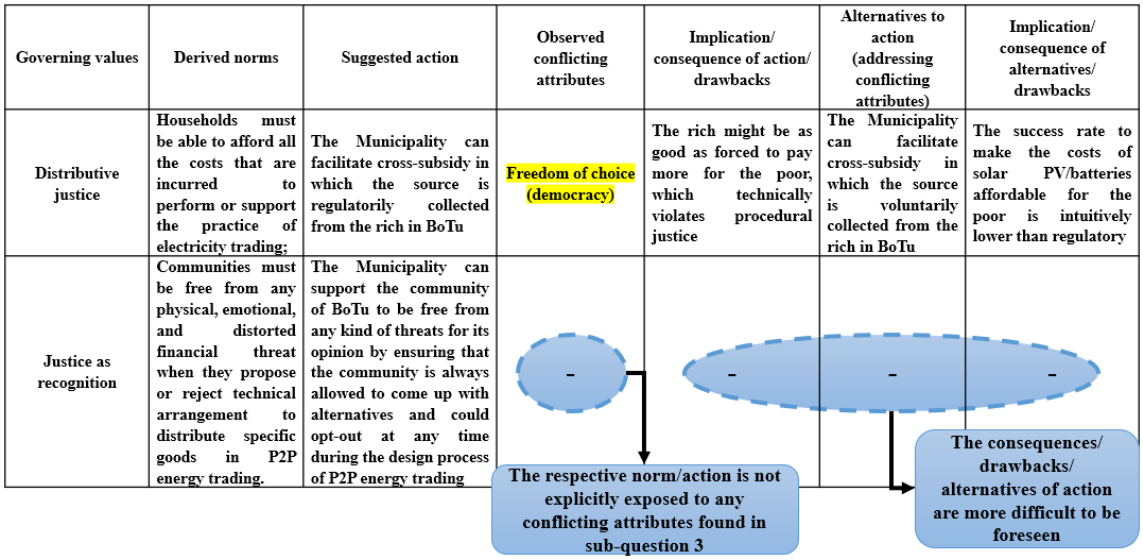


Figure 3.8: The way the suggested actions were linked to the conflicting attributes found in sub-question 3 to foresee the consequences/alternatives of actions

3.3 Methodology for Main Research Question

To approach the answer to the Main Research Question, all the findings in sub-question 1 to 4 were integrated and interpreted further. From the answer to the sub-question 1 and 2, a half part of the MRQ was resolved, that a set of justice norms for P2P energy trading for the communities in general was developed. By interpreting the finding in sub-question 3 further, a justification to the developed norms that they can also be implemented in Bospolder-Tussendijken under a certain condition, which is they can evoke conflicts, was made. Lastly, by interpreting the finding in sub-question 4 further, the previous justification can be completed that such a condition requires the Municipality of Rotterdam to undertake several actions to support the implementation of those norms in Bospolder-Tussendijken.

3.4 Conclusion

This chapter has demonstrated the steps that were taken to approach the answer to the Main Research Question. To begin with, the Main Research Question was broken down into four sub-questions. From consecutively answering sub-question 1 to sub-question 4 and interpreting the findings, the grand answer to the MRQ was promoted. The sub-questions were grouped into two types of work. The first and the second sub-question are intended to be the conceptual work of this research, in which the data gathering was mainly done by desk research. On the other hand, the third and the fourth sub-question are meant to be the empirical work, in which the data gathering was mainly done via stakeholders interview.

The conceptual work was grounded in the framework of *value hierarchy*. The framework was then operationalised in two sequential steps. Additionally, the grammatical rule of institutions, ADIC, was applied to construct the justice norms for P2P energy trading. For the empirical work, on the other hand, the modified threshold was introduced to distinguish the norms that most potentially evoke conflicts for their implementation in the community of BoTu. Additionally, the Likert-scale was used as a tool for assessing the norms.

Chapter 4

Identification of P2P energy trading system from a socio-technical perspective

This chapter aims to answer the first research sub-question, that is:

"What is peer-to-peer energy trading system from socio-technical perspective?"

The answer to the sub-question above will be approached by evaluating the main technology drivers that are used in P2P energy trading from a socio-technical perspective. Therefore, those technologies will be first determined through the help of multi-layered of smart energy system framework in section 4.1. Upon the selection of the technologies, each technology will be evaluated under specific topics/themes, as will be elaborated further shortly in section 4.2, 4.3, and 4.4. From the evaluation and discussion of each technology, the general vision over the characteristics of P2P energy trading or the definition of P2P enegry trading from a socio-technical perspective can be concluded.

4.1 P2P energy trading main technology drivers

Bompard (2012) proposes a multi-layered smart energy system framework comprises four main layers, namely physical layer, cyber layer, social layer, and environmental layer. Similarly, Zhang, Wu, Zhou, Cheng, and Long (2018) promote a more specific multi-layered framework for P2P energy trading that is adjusted from the smart energy system framework. It leaves out the environmental layer and inserts control layer as an addition. It also modifies the social layer into business layer. Given the fact that Zhang et al. (2018)'s framework is already developed specific for P2P energy trading concept, it will be used as a point of departure to select the main technology drivers of P2P energy trading system.

The physical layer encloses all the hardware responsible for the physical flow of electricity. On the other hand, cyber layer entails component responsible for the flow of information regarding the operation of the system and market-related data. Whereas business layer deals with the trading mechanism between households. The control layer, however, is rather complementary to the physical layer. It is dedicated to controlling the physical properties of the electrical system, such as voltage

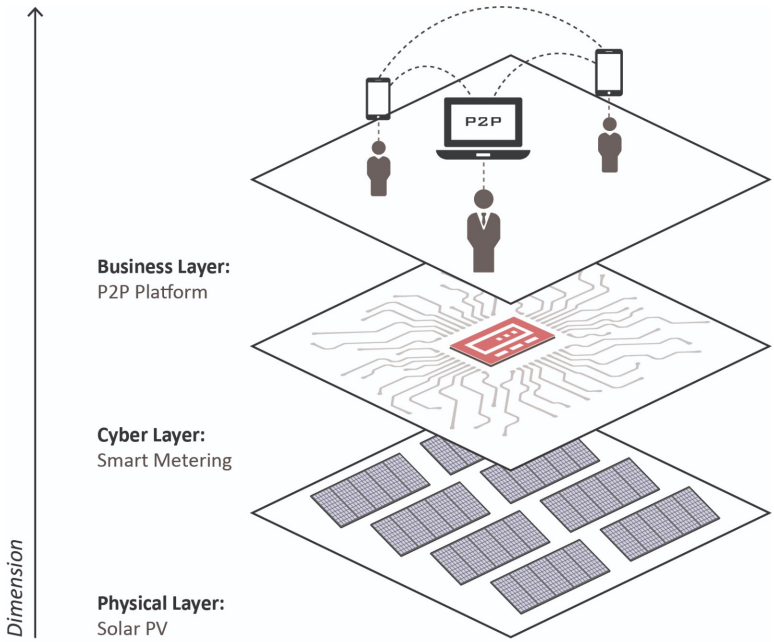


Figure 4.1: Multi-layered framework of P2P energy trading for this research adjusted from (Zhang et al., 2018)

and frequency. For that reason, only technologies within physical, cyber, and business layer will be evaluated further.

To perform P2P energy trading, first and foremost the electricity should exist. Accordingly, households need the technology which allows them to produce their own electricity to be traded or else the trading will never happen. Therefore, distributed generation is one of the core in P2P energy trading with regards to the physical form of electricity. Stedin and Energy21 (2018) mention two specific distributed generation technologies in their *LES* whitepaper, namely wind and solar technology. However, they always refer to solar technology when it comes to small households. Accordingly, solar PV system is selected as the technology responsible for the physical layer of P2P energy trading given that: First, it is considered as a mature technology which implies easier access to information (International Energy Agency, 2010). Second, it is an extremely scalable technology which allows a wider range of adoption than wind technology. Wind technology needs to have a relatively large structure and requires large open space to be able to accommodate an efficient capacity (Schleicher-Tappeser, 2012). Therefore, it is more difficult to establish wind technology on households level when there is relatively small availability of the open space.

With regards to information in the cyber layer, P2P energy trading will modify the flow of information from unidirectional to bidirectional similar to the flow of power. Smart metering system is the technology that can effectively read and record these bidirectional information flow. As a matter of fact, it is the technology which augments the "dumb" grid into the smart grid in general. Considering its criticality, the smart metering system is chosen as the technology responsible for the

cyber layer of P2P energy trading.

Regarding trading mechanism in the business layer, technology to facilitate the transaction between households is crucial, if not imperative. Although the idea is developed for peer-to-market, Stedin and Energy21 (2018) suggest that the transaction for electricity trading should occur in a platform which functioning as a local market organised by legal representation of peers. Bauer (2014) further demonstrates that platform as a local market may reduce the transaction costs among peers. Furthermore, Zhang et al. (2018) explicitly promote platform as the technology responsible for the business layer.

In summary, three main technology drivers in P2P energy trading have been highlighted here, namely **solar PV system** for the physical layer, **smart metering system** for the cyber layer, and **P2P platform** for the business layer. Accordingly, the characteristics of each technology will be evaluated to approach the characteristics of P2P energy trading system as a whole.

4.2 Characteristics of solar PV system as an instrument in P2P energy trading to generate electricity

Reflecting on the existing setting of the Dutch electrical system, several topics that can help to characterise on-grid solar PV system as an instrument in the P2P energy trading system will be distinguished. The first topic is related to investment and ownership. Investing and owning generation technology were only the concern within generation supply-chain. However, the use of solar PV generation by households suggest this concern is now extended to consumers supply-chain. Therefore, this topic meets the criteria displayed in Table 3.2 as it demonstrates changes with respect to activities or interests of consumers.

The second topic is regarding profitability. Concern about profits was not relevant to actors in consumption supply-chain. However, with the ability of households to generate electricity by solar PV and basically act as producers, consumers may now earn profits. Therefore, this topic is chosen because it addresses changes in terms of interest or opportunities of consumers.

Lastly, the third topic is about local flexibility and grid balance. The current setting of the Dutch electrical system suggests that the actors in transmission and distribution supply-chain are responsible for the balance of the grids. However, by becoming both consumer and producer, households may actively maintain the balance of the grids and are expected to be more flexible because they are now in control of two activities which conjointly determine the grid (im-)balance. Therefore, this topic is chosen because it meets the criteria in Table 3.2 that it discusses changes with regards to consumers' activities or tasks.

In summary, three main topics that, according to the developed criteria in Table 3.2 in subsection 3.1.1, are relevant to help the characterisation of on-grid PV system from a socio-technical perspective have been highlighted, namely **investment and ownership**, **profitability**, and **local flexibility**. In the following three sub-sections, the characteristics of solar PV system as part of P2P energy trading will be described from each selected topic.

4.2.1 Investment and ownership

Solar PV used by households to generate electricity is more than just solar panels as one might think. Rather, it is a system which requires a set of other hardware to operate. Typical solar PV system can be categorised into two kinds, which are grid connected or also known as on-grid PV system and stand-alone PV system (Smets, Jager, Isabella, van Swaaij, & Zeman, 2010). For the former, as the name implies, the system is connected to the distribution grid, while the latter works as an independent generator and detached from the grid. Therefore, only the first type is relevant for P2P energy trading since the second type can only be used for self-consumption.

Typical on-grid solar PV system for households consists of PV panels or modules and supporting components, also known as Balance of System (BoS). This BoS comprises inverter, DC-DC converter, mounting structure, and cables. A simple representation of on-grid solar PV system is given in Figure 4.2. Furthermore, each component in the on-grid PV system has variation in terms of technology or configuration. Consequently, selecting and investing in the optimal technology options or configuration that are available in the market become one challenging matter. Appendix A describes the function of each component, including its available technology variation in more detail.

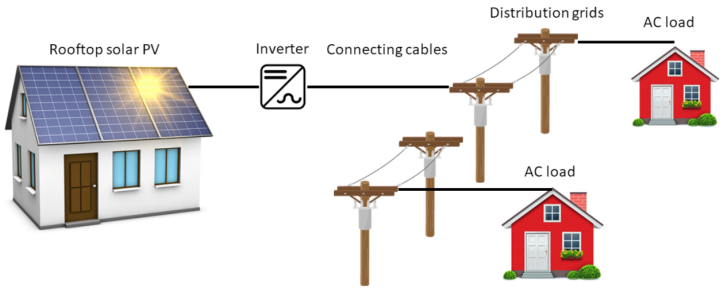


Figure 4.2: On-grid solar PV system (Smets et al., 2010)

Costs are an important parameter for people or investors who are making a decision for which solar PV technologies to be invested. They need to invest in a set of on-grid PV technologies that, in the end, can bring benefits for them. This partly means that the investment has to be recoverable throughout technologies' lifetime. Therefore, the total costs from PV panels and BoS components that are installed for electricity trading should not then exceed the potential revenue which people could earn from supplying the electricity.

Investing in solar PV can be problematic not only because of the up-front costs that may become very expensive, considering there are several components that must be set together, but also because of the difficulty to own solar PV. By default, the solar PV system can be privately owned and installed in a private roof. However, limited availability of private roofs in certain neighbourhoods can be a significant barrier for this type of ownership. The Dutch postal code area regulation, known as *postcoderoosregeling*, provides an alternative of ownership to address the respective issue. With *postcoderoosregeling*, it becomes possible to own solar PV that is installed in other people's properties or roofs within the same postal code (Proka, Hisschemöller, & Loorbach, 2018).

Although *postcoderoosregeling* may promote local cooperation, the prescribed spatial restriction can be harmful at the same time. When a postal code constitutes a very small area, the electricity trading may become very exclusive if it is only allowed to be performed within that postal code. Consequently, only a small number of people could be benefiting from electricity trading. Moreover, it could contrast the social disparity within a narrower scale if one postal code happens to have residents who together able to provide both property and solar PV whilst its adjacent postal code areas cannot. Then all of a sudden there are affluent and poor postal code area. As the pre-defined P2P energy trading in this research also requires a clear defined boundary, the size of a postal code area to support the respective type of ownership must then be planned carefully.

Postcoderoosregeling also suggests that communities need to be flexible in adding or removing members from the system or market of P2P energy trading. There is a possibility that old residents leave and new residents enter the neighbourhood. This mobility may result in overwhelming administrative issue to allow new residents to access others' property while at the same time prohibiting the former residents. The mobility may also confuse others in, for instance, trading or paying the right person when they are not really aware of the actual situation in the neighbourhood. Therefore, the way information is disseminated and received by the residents or communities might become an important key-factor to support the flexibility of communities to deal with members mobility.

4.2.2 Profitability

The concern about profit and investment is closely related. As implicitly indicated in sub-section 4.2.1, a feasible solar PV investment is by large determined by whether the resulting profits could recover the investment costs. Accordingly, incorporating economic analyses within the investment plan becomes imperative. These analyses should reflect the real condition of where and for whom the system is planned to be installed. One of the most important economics analyses, especially for households, to make a recoverable investment is regarding compensation schemes (Smets et al., 2010). There are two compensation schemes for small PV instalment in the Netherlands, namely *Net Metering* and *Feed-in tariffs* (eclareon GmbH, 2012).

With regards to Feed-in tariffs, the Netherlands has its own programme called SDE+ (*Stimulering Duurzame Energieproductie*) scheme. Under this scheme, the households will be subsidised by the Dutch government when the market price of electricity drops below the cost price (Frontier Economics, 2015). High Feed-in tariffs, however, may discourage people from doing peer trading. It allows them to simply receive a high amount of money without having to deal with the hassle of community or market interactions. Therefore, it is necessary to adjust the Feed-in tariff scheme, if not suspend it, to the level that can motivate people to make peer trading.

Further, both Net Metering and Feed-in tariffs scheme are perceived to be partially responsible for transforming the distribution grids into a compensating buffer. Without time consideration for the reward, people are being incentivised to overfeed the grids with the power during the day although the peak consumption is in fact in the evening. Consequently, the grids become more vulnerable to the voltage fluctuation where the voltage rises during the day as they receive additional power from solar PV and suddenly drops in the evening (Karimi, Mokhlis, Naidu, Uddin, & Bakar, 2016).

P2P energy trading scheme may become an alternative that can provide better incentive to maintain the grid balance in comparison to both Net Metering and Feed-in tariffs. Within P2P energy trading, the reward from excess production can be obtained only when there is demand for electricity from other households. Put differently, the rewards are arranged in occasional or timely manner. Therefore, people will not be incentivised to overly supplying the grids during the day if there is no actual consumption which provides the rewards at the time.

4.2.3 Local flexibility and grid balance

It has been demonstrated in sub-section 4.2.2 that people may earn profits from solar PV system through compensation schemes and P2P energy trading. Relative to the discussed compensation schemes, P2P energy trading might also provide a better incentive with respect to the grid balance. Even so, it is still important to control the amount of power to be traded via distribution grids. That is because the grids still have certain capacity limitation and very intense electricity trading in large volume could accelerate grid defection instead. Consequently, DSOs may need to reinforce the grids at the cost of higher connection tariffs, causing the wholesale electricity prices in general to increase (Koirala, Koliou, Friege, Hakvoort, & Herder, 2016).

As mitigation, energy storage can be applied for flexibility to relieve the tension in the grids from electricity trading (Bouffard & Kirschen, 2008). Such energy storage provides households with more opportunity to control their electricity distribution and give them a wider space to manoeuvre their trading. Furthermore, energy storage may induce a new form of coordination between households and DSOs. For instance, DSOs may indicate the households that the grids are overloaded at the moment. Energy storage then allows households to respond to the signal by postponing the trading instead of having it terminated. DSOs may also coordinate with the locals to procure flexibility from the local energy storage and then pay them with the price higher than the normal energy price in the market (Stedin & Energy21, 2018).

Regardless of all the potential benefits, adding the storage into the system may also incur several uncertainties ultimately to the realisation of P2P energy trading. First off, the profitability and the return of the PV system in general shrink when it is complemented with a large size battery. This is because every addition of kilowatt-hour in battery capacity will raise the total cost of the PV system quite significantly (Bruch & Müller, 2014). Secondly, provided with more flexibility to control electricity distribution, people might be tempted to exert harmful strategic behaviour. Purely driven by profitability, people may be incentivised to hold their production and refuse to make a trade when they do not find the market prices very attractive. Accordingly, the agreement between households for the goals to be achieved and correct incentives from the regulator might become necessary to prevent such strategic behaviours.

The presence of energy storage in the on-grid PV system for flexibility might be essential for the DSOs to balance the grids that are disrupted by P2P energy trading. However, Stedin and Energy21 (2018) demonstrate that the role of *Balance Responsible Parties* (*BRP*) is also equally important to support the grid balance when the practice of electricity trading happen. They will need to harmonise the P2P energy trading plan with the wholesale market process and communicate it to the system operator for grid balance management (Koirala et al., 2016). Furthermore, they need

to ensure that the actual electricity traded between households follow the plans that are registered.

To support the novelty of P2P energy trading concept, communities are expected to be *balance responsible*, and the role of *BRPs* should be then taken over by them (Koirala et al., 2016; Stedin & Energy21, 2018). Otherwise, it will never be a pure P2P energy trading as some external parties still have partial control over the trading. However, this proposal requires the communities to comprehend all responsibilities and market processes set for BRPs, which might be difficult for such regular communities.

4.3 Characteristics of smart metering system as an instrument in P2P energy trading to manage data flow

Similar to solar PV system, several relevant topics to the criteria displayed in Table 3.2 will be determined to help characterise smart metering system. The first topic is about data utilisation in communication network. Within the review about the distribution supply-chain in sub-section 2.3.3, the flows of electricity are recorded by meters and the data are used by several actors for various purposes. Subsequently, the transformation from unidirectional metering into bidirectional metering mentioned in section 2.4 indicates that households may need or use the data of electricity differently. Additionally, the data utilisation may also change for other actors who are connected through the communication network as a result of P2P energy trading. Therefore, this topic is chosen as it may portray changes in the interests of actors in the electrical system towards the data. In addition, this topic may be, to some extent, related to the issue of privacy, which is one of the important concerns in smart meter technology in general. However, this research is more interested in the value of energy justice and not privacy, which is another type of intrinsic value (Van de Poel, 2014). Therefore, the privacy in smart meters will not be included in the discussion.

The second topic is regarding reliability of automatic smart meters. This topic is chosen because: first, it focuses on a component in the smart metering system that directly interacts with consumers as stated in section 2.4; second, it discusses changes in households' expectation or concern about their electricity metering devices particularly in regard to performing electricity trading. In addition, unlike privacy, reliability is considered as an instrumental value and not an intrinsic value (Van de Poel, 2014). Therefore, this topic does not necessarily obscure the value that this research most interested in, since reliability may still be pursued for the sake of energy justice.

In summary, two topics that, according to the developed criteria in Table 3.2 in sub-section 3.1.1, are relevant to help characterise smart metering system from a socio-technical perspective have been highlighted, namely **data utilisation in communication network**, and **reliability of automatic smart meters**. In the following two sub-sections, the characteristics of smart metering system as part of P2P energy trading will be described from each selected topic.

4.3.1 Data utilisation in communication network

The typical communication network of the smart metering system specifies that at least three actors in the electrical system are connected at both ends of the network to share data. These actors are DSOs, energy suppliers, and households. To allow electricity trading to happen, DSOs must provide

households access to their grids. However, it may become a concern for them to do so because P2P energy trading may impair the stability of the distribution grids at a certain point. For that, the DSOs might need the data of electricity trading to anticipate and balance the grid from the resulting disturbances and accordingly determine the service fee to be imposed to the households.

The pre-defined P2P energy trading in this research still allows traditional energy suppliers to provide energy to communities through the wholesale market. Therefore, they may need to have or receive data from electricity trading for various purposes. Zhang et al. (2018) suggest that energy suppliers, together with the DSOs, may use the data to determine whether it is feasible to proceed certain electricity trading, taking into account the physical limitation of the grids and their own production. Alternatively, they may use the data from electricity trading to adjust their production accordingly such that the maximum capacity of the grids will not be exceeded. The energy suppliers may also use the data for research and development to come up with innovations that can complement or enhance P2P energy trading further.

On the other hand, the dual position of households as both consumers and producers suggest modification of data utilisation with respect to billing purposes. Acting solely as consumers, households only need to know the data regarding their energy usage to see how much money they must pay to their energy supplier accordingly. For P2P energy trading, however, they may also need to have the data which can allow them to bill their neighbours. In other words, they will need to have the data that are similar to what energy suppliers or producers have.

Although several existing actors in the electrical system who may have a stake in the P2P energy trading system and get connected through the communication network can be distinguished already, the new actors could still emerge and engage in the system. Zhang et al. (2018), Morstyn et al. (2018), and Koirala et al. (2016) submit the role of *aggregators* as an emerging actor in the P2P energy trading system to aggregate production as well as flexibility of the households. As suggested in sub-section 4.2.3, the households might as well take over the role of *BRPs*.

With regard to the emerging actors, it is more difficult to predict how they should be connected in the communication network and which data should be provided to them. That is because their operations or services are still new, and perhaps still changing, so that there is not much reference for those. As their activities and intentions are still practically unknown, these emerging actors may further insist on having access or on collecting sensitive data more than they actually need in disguise of delivering better services.

The uncertainty regarding data access, in combination with the shady behaviour of some actors, may potentially lead to data misuse that put communities' privacy at the risk of being compromised. Therefore, a thorough analysis to investigate proportional data sharing and regulation which clearly specifies which stakeholder may collect and utilise which data may become more important to anticipate such data misuse. Additionally, the communities may as well organise and secure their data of electricity trading locally. This would make it easier for them to monitor who could access their data, thus reducing the risk of data misuse and increasing communities' trust towards the system.

Additionally, in great numbers, the involvement of emerging actors in data sharing could aggravate the data traffic in the network, especially when the trading has gotten more intense. Consequently,

the performance of the network might get depleted and cause the entire communication services to be slow (Boycom, n.d.; Sytek, n.d.). Similar to the distribution grids discussed in sub-section 4.2.3, the network owner may need to expand the network capacity to accommodate those (new) stakeholders eventually. This network expansion may, in return, increase the tariff for all other communication services.

4.3.2 Reliability of automatic smart meters

In the Netherlands, DSOs are the only legal body who has the authority to distribute smart meters (Milchram et al., 2018). In comparison to the smart meters distributed in the United Kingdom, smart meters in the Netherlands are not featured with in-home display and are expected to be fully automatic. The decision to make smart meters fully automatic may erode the barrier of data literacy as the users do not need to understand and process the resulting data by themselves. Everything related to the data is projected to be algorithmically computerised. However, the side effects of being fully automatic are that households will need to trust the operation of smart meters entirely and they will have little means to inspect the algorithm or whether the meters operate accurately or not. For that, the reliability of smart meters in the Netherlands may need to be contested, especially when there is only one entity who is allowed to distribute the meters.

Zhang et al. (2018) demonstrate that within P2P energy trading, smart meters may indicate a different amount of electricity that is received by a household from what has been agreed with her supplier neighbours. With that kind of possibility, it becomes more important to contest the reliability of smart meters. Communities need to be reassured that the smart meters do not make a false recording when there is such discrepancy. Otherwise, it will create distrust to the entire system when the discrepancy happens.

Additionally, the automatic smart meters are perceived as more reliable when they can be integrated with multiple other smart appliances or meters. The data that are recorded and can be processed by the meters will be richer and more meaningful when they can be connected to many devices. For instance, smart meters that can be connected to Electrical Vehicles are then able to record the electricity used by the vehicles for charging. Similarly, the meters are then able to record the electricity supply from vehicles when they discharge the electricity that is stored within their battery. Accordingly, it can help households to trade electricity with their neighbours better as they know more about their actual energy flow.

4.4 Characteristics of platform as an instrument in P2P energy trading to facilitate the transaction

P2P energy trading platform is the technology which could facilitate a secure and efficient marketplace for local people to buy or sell energy (Pouttu et al., 2017). A simple representation of a P2P platform facilitating energy exchange is shown in Figure 4.3. Morstyn et al. (2018) submit three novel values offered by P2P energy trading platform, namely energy-matching, reduction of uncertainty, and preference satisfaction. As a marketplace, several basic operations are embedded within the platform, including *user authentication, account verification, transaction summarising,* and *settlement* (Pouttu et al., 2017).

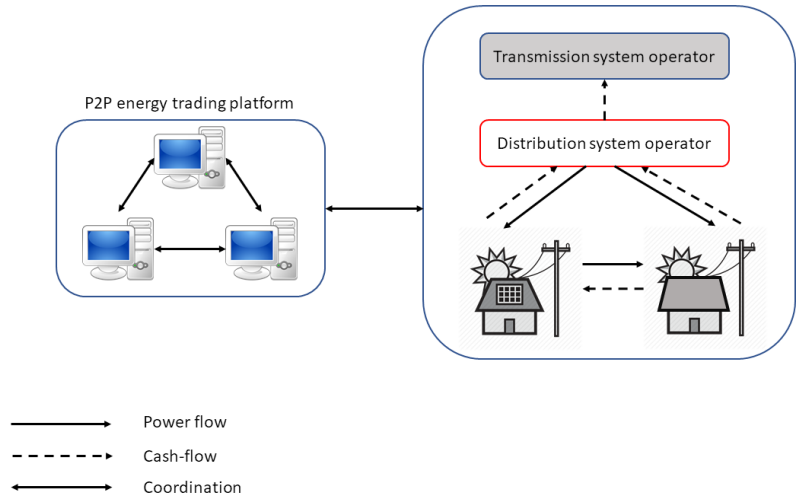


Figure 4.3: Simple representation of a P2P energy trading platform (Morstyn et al., 2018; SIA Partners, 2018)

Several energy companies or local energy communities in the Netherlands have initiated P2P energy trading pilot project, such as Engie NL, Vandebron, and GridFlex Heeten. They also developed their own P2P platform for the members to make transaction. Interestingly, their platform demonstrates different business model one to another. Engie NL seems to adopt a more Top-Down model, whereas GridFlex Heeten adopts a more Bottom-UP model, while Vandebron is rather somewhere in between. Additionally, both Engie NL and Vandebron have already established their P2P business as for now, while GridFlex Heeten is still a running pilot project. An overview regarding key differences between their P2P energy trading platform is presented in Table 4.1 below.

Engie NL establishes P2P energy trading platform that works for collecting and managing the solar production from the households. Nonetheless, these households' production are still supplemented by Engie NL. More precisely, Engie NL will generate the electricity from its own renewable generation had the households' production is insufficient. Put differently, both the households and Engie NL may behave as suppliers and they cooperate to deliver energy to all consumers in the platform. Furthermore, Engie NL sets contracts with the households to determine the prices of electricity for sale in the platform. Other members may then purchase the electricity at this contract-based price (SIA Partners, 2018). In short, Engie NL develops a platform which invites the households to become co-supplier (ENGIE, n.d.; SIA Partners, 2018).

On the other hand, Vandebron does not retain any physical energy assets nor involved in supplying energy. Alternatively, it develops a platform to connect renewable energy producers with other members who behave as consumers. The responsibility to supply energy to consumers is then fully shifted to those producers. The renewable energy producers are mainly farmers with a quite

Key parameter	Engie NL (established project)	Vandebron (established project)	GridFlex Heeten (running pilot project)
Main concept	Collaboration with local producers while maintaining its position as retailer (Top-Down)	Community-oriented connecting local producers to local electricity demand	Full community P2P energy trading where households manage and organise their electricity production and consumption by themselves (Bottom-Up)
Role of supplier	Both Engie NL and households act as supplier	Only farmers behave as supplier	All households may behave as suppliers
Peers	Households + Engie NL – Households	Farmers – (Vandebron) – Households	Households-Households
Supply mechanism	Primary supply comes from households' production, the shortage will be filled by Engie NL's renewable generation	Households are fully responsible to supply the demand. In case of shortage, they need to purchase the remaining needed electricity from other suppliers	Households are fully responsible for electricity supply in community. Energy storage is featured to improve self-reliance from main grid
Transaction settlement	Contract-based	Contract-based	Flexible-pricing mechanism
Benefits for members	Management obligations are mostly taken care by Engie NL, primarily during shortage	Vandebron sets up a competitive electricity pricing for the members	Communities/members take full control of the organisation

Table 4.1: Comparison between Engie NL's, Vandebron's, and GridFlex Heeten's P2P energy trading platform

significant capacity of wind turbines. Vandebron allows these farmers to independently set the prices of their production, while also encouraging them to make the prices competitive for other members (ENA: Energy Network Association, 2015). In the meantime, it also enables those other members to choose and track the origin of the energy they purchase (Morstyn et al., 2018). When there is a match between a supplier and consumer, it will arrange and settle the transaction through a contract. Additionally, as Vandebron is not involved in energy supply, the members are forced to buy electricity from external suppliers when there are shortages in production. In short, Vandebron develops a platform which connects local renewable energy producers and the local electricity demand (SIA Partners, 2018; Sigl et al., 2018).

The trading mechanism formalised by both Engie NL and Vandebron within their platform suggests a rather indirect peer-to-peer trading. Both companies are still endorsing or carrying the role of retailer (ENGIE, n.d.; Morstyn et al., 2018). This is even more obvious for Engie NL. It may still sell its own supply to the households within its platform. Moreover, it is still involved in determining the electricity prices together with the households. Combining both privileges make it indifferent to

traditional retailers.

Vandebron, on the other hand, already gives full prerogative to the farmers to set the prices. Ones may categorise the farmers as households-alike so that farmers selling their production to other members can still be seen as a peer energy trading. However, there is still a clear distinction between the role of producers and consumers within Vandebron's platform. The transaction only occurs one way in the sense that farmers may sell their production to other members but not the other way around, while ideally, all members should be able to perform both selling and buying. Consequently, the platform mainly functions as mediator between the farmers as sellers and the rests as buyers. This makes Vandebron as the platform owner an implicit retailer.

Compared to both Engie NL and Vandebron, GridFlex Heeten is a more recent P2P energy trading pilot project in the Netherlands. It was initiated in 2017 and only in late 2018 households started exchanging electricity (Laan, 2018). It incorporates energy storage to give more flexibility for the households to trade their production, as well as to increase the independence from the main grid. A platform is deployed to display the imported data from smart meters regarding the amount of electricity each household generates, consumes, and stores. It is also used by the households to transact the electricity stored in the local batteries. Unlike Vandebron, every household may sell the electricity to others depending on how much electricity they have stored individually. Instead of contract-based, the households will adopt flexible pricing to set the prices of the electricity. However, this flexible pricing is still under research and finding optimal flexible pricing is, in fact, one of the objectives of the project (Enexis Netbeheer, 2017).

In summary, the transaction between households to exchange energy could be facilitated by a specific platform. This platform subsequently operates as a local P2P market. The important characteristic of P2P platform is that the way transaction happens within the platform might differ from one to another, and it is highly dependent on how the platform owners conceptualise it. Therefore, it might be confusing for some users as a side-effect. The currently known and established P2P platform in the Netherlands, hence omitting GridFlex Heeten from the list, only offer an implicit peer trading, preserving the role of retailers. A real P2P energy trading platform should have dismissed the role of intermediaries to set the prices, and revoked the exclusive right to sell electricity.

4.5 Conclusion

From the evaluation and discussion of the main technology drivers in three different layers of P2P energy trading (physical, cyber, and business), the socio-technical characteristics of the system that show *the interactions between human behaviors and the technologies* can be described. For the physical layer, P2P energy trading will require the electricity to be generated first so that it can be traded among households. For doing so, solar PV and its supporting components have to be procured. Therefore, consideration of investment and ownership becomes important. Investment of those technologies must consider the potential revenue which people could earn from supplying the electricity so that the costs can be recovered. Owning solar PV also can be difficult due to the limited availability of private roofs. The Dutch regulation of *Postcoderoosregeling* may alleviate the problem partly, but it requires consideration towards the size of the area that a postcode represent,

as well as the mobility of the residents. Apart from that, P2P energy trading may also disrupt the balance of distribution grids. Consequently, DSOs may need to reinforce the distribution grids at the cost of higher connection tariffs for all households. Energy storage can be used as mitigation for grid disturbance. However, it can escalate the costs for P2P energy trading system and may incentivise people to exert strategic behaviour.

For the cyber layer, P2P energy trading deals with bidirectional flow of data. Smart metering system is capable of recording this type of data. However, the utilisation of the recorded electricity data from P2P energy trading is still uncertain. To support or as a result of P2P energy trading, the existing actors in the electrical system may use the data of electricity differently from usual. Furthermore, P2P energy trading may call for new actors to emerge and engage in the system. It makes the data utilisation becomes more uncertain and problematic. Consequently, P2P energy trading calls for proportional data sharing investigation and the regulation which clearly specifies which stakeholder may collect and utilise which data. Apart from that, the reliability of smart meters must be contested to ensure such a trustworthy electricity trading.

For the business layer, P2P energy trading should use a platform as a local market given the fact that it may reduce the transaction costs among peers. Within the platform, the way transaction happens between the members highly depends on how the platform owners conceptualise it, which can be confusing to some users. Some P2P platforms may rather promote indirect electricity trading. A real P2P energy trading platform should rather dismiss the role of intermediary for setting the electricity prices and revoke the exclusive right to sell electricity.

Answering the first sub-question:

"What is peer-to-peer energy trading system from socio-technical perspective?"

"By adhering to the principle of a socio-technical system which suggests that there are interactions between human behaviours and the technologies, P2P energy trading could be defined accordingly from its three different layers, namely physical, cyber, and business layer. Firstly, from the physical layer, P2P energy trading is a system which requires serious consideration of solar PV and energy storage investment. The investment costs could become a barrier to the succession of the entire system when they are soaring. On the other hand, it is also a system that potentially increases the financial wealth of the users. Additionally, it is a system which influences the organisation of distribution grids. Therefore, cooperation with the DSOs is as good as inevitable. Secondly, from the cyber layer, P2P energy trading is a system in which multiple stakeholders in the electrical system will demand access to the data from the trading to support their operation. It is also a system that opens the possibility for new emerging actors, such as aggregators, to take part. Thirdly, from the business layer, P2P energy trading is a system that requires digital platform as a medium for the users to make the transaction. The way the users transact within the platform is highly dependent on the concept of the platform that is drawn by its owners/developers."

Chapter 5

Translation of energy justice value into justice norms for P2P energy trading

This chapter covers the first step of value-hierarchy operationalisation. The abstract level of energy justice as a value will be translated into a more concrete set of norms. The framework of tripartite model of energy justice will be used to conceptualise the energy justice value. Consequently, the definition of *distributive*, *procedural* and *recognition* justice will be considered, and the attributes/goods/events in Chapter 4 that are relevant to any of those tenets will be distinguished in section 5.1. Subsequently, a set of norms to govern those items will be formulated by using the format of **ADIC** (**A**ttributes, **D**eontic, a**I**m, and **C**ondition) in section 5.2, 5.3, and 5.4. In the end, all the items found in Chapter 4 that can be relevant to the energy justice domain, and all the norms to govern those items will be restated to answer the second sub-question, that is:

"What items in P2P energy trading system that can be relevant to the energy justice domain and what norms can be developed accordingly?"

5.1 Items in P2P energy trading system that are relevant to energy justice domain

To answer a half part of the second sub-question: " *What items in P2P energy trading system that can be relevant to the energy justice domain...*", the objects/goods/events in Chapter 4 that are relevant to the energy justice domain have been highlighted under the guidance of the criteria in Table 3.3, sub-section 3.1.2. The list of respective items is provided in Table 5.1 below.

On-grid solar PV system			**Smart metering system**		**P2P platform**
Investment and ownership	Profitability	Local flexibility and grid balance	Data utilisation in communication network	Reliability of automatic smart meters	Transaction mechanism
The presence of investment costs to procure solar technologies and BoS	The presence of profit from compensation scheme (Feed-in tariffs)	The presence of cost for distribution grids' reinforcement which results in connection tariff adjustment	The presence of cost for communication network expansion	The need for information regarding reliability of the smart meters (e.g. accuracy of smart meters and which appliances/ devices can be connected)	The need for access to important features in P2P platform (i.e. purchasing and selling electricity)
The need for information to make recoverable investment	The presence of profit from supplying electricity/selling excess production	Batteries as a means to balance the grids but rather costly	Potential of emerging actors (e.g. aggregators) which indicates new job opportunities for communities	The need for communities' trust in the operation of smart meters	Designation of transaction mechanism/ principles highly depends on the platform owners
Private ownership which requires access to a private rooftop		Potential income for communities from offering local flexibility services via batteries	The need for access to the data from electricity trading for multiple stakeholders		Households become responsible for setting the electricity prices in the platform
Postcoderoosregeling ownership which requires access to people's property/rooftop		Potential of households to be balance responsible for their own electricity consumption/production	The need for access to the communication network as well as to the DSO's grids		
The need for area size setting of a postal code to support Postcoderoosregeling ownership		Potential of strategic behaviour which requires an agreement for the goals to be achieved and some incentives (subsidy/tax) as the mitigation	Potential of local database management/ organisation		
The need for information to support mobility/changing ownership					

Table 5.1: Attributes/goods/events in the P2P energy trading system that can be relevant to the energy justice domain

5.2 Distributive norms for P2P energy trading

Re-arranging Table 5.1, several types of goods that can be distributed were grouped. As shown in Table 5.2, those types of goods are costs, benefits, access to public goods/services, as well as responsibilities.

The ultimate goal for the formulation of the distributive norms is to define the pattern or principles to fairly distribute those types of goods listed in Table 5.2. Accordingly, for the distribution of costs and benefits, the principles that are promoted by John Rawls will be adapted. Although he does not explicitly address his principles for design of product/system, other authors, Bianchin and

COSTS	ACCESS
• Investment costs to procure solar technologies and BoS • Investment costs to procure batteries • Cost for distribution grids reinforcement • Cost for communication network expansion	• Access to other people's properties/roofs • Access to the communication network and DSO's grids • Access to data from electricity trading • Access to important features of P2P platform (i.e. purchasing and selling electricity)
BENEFITS	**RESPONSIBILITIES**
• Financial profit from compensation scheme/subsidy (e.g. Feed-in tariffs) • Financial profit from supplying electricity/selling excess production • Financial profit from local flexibility services via batteries • Benefit from new position/job opportunities (e.g. aggregators)	• Responsibility for the balance of electricity production and consumption • Responsibility for managing/organising local database • Responsibility for setting the electricity prices in the platform independently • Responsibility for the new emerging actors

Table 5.2: Attributes/goods/events in the P2P energy trading system that can be distributed/allocated/divided

Heylighen (2018), promote his principles to be used to distribute items when designing an artefact or systems. However, they are still rather general when stating about these items. Sovacool and Dworkin (2015), on the other hand, promote Rawls' principle for the distribution of welfare (which I interpreted as being related to the costs and benefits) in the energy system. With respect to the distribution of access, the principle that is promoted by Ostrom (2010) will be adapted. In her work, she discusses distribution of the right of access to common goods within the context of self-governance and social-ecological system (SES) design. Meanwhile, for the distribution of responsibilities, the principle that is promoted by Fahlquist, Doorn, and van de Poel (2017) from their work in design for the value of responsibilities will be adapted.

Elaboration for each aforementioned principle and how it is adjusted, incorporated, and transformed into distributive norms for P2P energy trading are given in sub-sections below.

5.2.1 Distribution of costs

Table 5.2 suggests that households or other entities must finance the procurement of solar PV together with its supporting components and energy storage. The costs to procure those technologies, especially for the batteries, may become very high that such costs may close the opportunities of some people to become part of the system. Consequently, those who do not have adequate financial means will be allocated zero opportunity as they simply do not have the means to own the pre-requisite technologies to begin with.

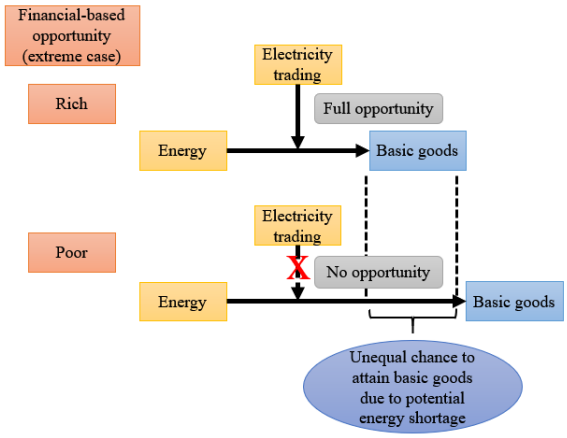


Figure 5.1: Illustration of inequality to attain basic goods between the rich and the poor in association with their financial capacity to perform electricity trading referring to Rawls (1971)'s principles

Financial means should not be the attribute to segregate the opportunity among people to be part of P2P energy trading. Rather, the opportunity should be distributed equally to people regardless of their financial capacity. Sidortsov and Sovacool (2015) argue that energy is a required substance for many basic goods of which people are entitled. Accordingly, electricity trading is a means to provide sufficient energy to other households so that they could satisfy those basic goods. It is then practically unacceptable if the worse-off people do not have any opportunity to participate in electricity trading just because no one in the neighbourhood owns solar PV or there is not enough solar PV in there. This makes them have unequal chance to attain their basic goods due to potential energy shortages (that could have been subdued by electricity trading) (Rawls, 1971).

Aside from the cost to own technologies, Table 5.2 also suggests the existence of externality costs that will be burdened also to those who do not engage in electricity trading. There are costs for distribution grids reinforcement and communication network expansion to be exact. As national or public infrastructure, the resultant costs from their reinforcement or expansion are likely to be socialised irrespective of the financial capacity of the people. Socialising the costs without careful consideration for this particular case can be very harmful to those financially disabled. Not only they do not engage in the system, but they will also pay for something which perhaps they do not volunteer for or beyond their capacity.

Nevertheless, those costs provided in Table 5.2 may be inevitable and must be covered to realise P2P energy trading. The main issues regarding those costs, in the context of energy justice, are they have high potential to become a barrier for some people to join the P2P energy trading system, and might even be harmful to some. In order to resolve the barrier, and to protect people from harmful externality costs, a norm for P2P energy trading can be structured as follows:

> ***"Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading"***

The norm prescribes the distribution of costs among households to be not excessively burdening that the households can afford those. There has to be an effort to reduce the costs of technologies to make those sufficiently low for various people so that the costs will no longer become a prominent barrier, and the opportunity for the people to engage in the system can increase. The norm also addresses the possibility of households paying to support electricity trading practice regardless of their participation stance. Those people who choose to seclude themselves from the system need not feel burdened with the socialised costs such as with network reinforcement costs. Therefore, when they can afford the externality costs, they might be less likely to feel burdened, and the costs are no longer harmful to them. Additionally, the formulated norm has the potential to direct its succeeding design requirements to contain or promote the principle of *affordability* and *availability*.

5.2.2 Distribution of benefits

Table 5.2 suggests that people who can supply electricity for the trading may increase their financial wealth. The amount of financial wealth that people could earn from electricity trading is likely to be proportional to their capacity to supply the electricity (which is also the case with Feed-in tariffs, only the rewards come from the authority, and not directly from the communities). Put differently, the more the electricity they could offer to their neighbours, the more financial wealth they could gain. However, when we are being sceptical with the difference in energy use, and assume everybody uses electricity at the same level, rich people are the most likely to attain the most financial wealth. This is because they are already at a better position to finance a larger capacity of solar PV, which enables them to offer more surpluses, something that poor people simply cannot afford.

The financial wealth does not solely come from supplying electricity for the trading. Table 5.2 also indicates the possibility of a new service emerges, which is local flexibility services via batteries, of which people could exploit to gain more profit. However, irrespective of the sources, they rather face a similar situation where the rich are already at a better position to gain more financial wealth to begin with. To be exact, the rich are likely the one who could provide that flexibility service and then gain the profit accordingly, considering the expensive cost of batteries which the poor simply cannot afford.

As indicated above, the poor may have little to even zero means to afford a large capacity of solar PV (including its supporting components) or batteries because of their limited income. This implies that the fair equality of opportunity between the rich and poor for the position of the same level supplier is absence. Judging from the second principle of Rawls' justice theory, the resulting economic inequality from having the rich attaining more wealth from electricity trading or local flexibility service is therefore unacceptable in this case. In fact, such economic equality may promote the infamous phenomenon of *the rich getting richer*.

Apart from financial wealth, Table 5.2 shows that P2P energy trading may offer more job opportunities as the benefits since there will be new actors or positions emerge, such as with the *aggregators*. However, there is also potential that this type of benefits would also rather favour those who are already better-off. It may be the case that the poor also could not afford enough education to allow them to fill those new positions. Hence, finding the proper underlying principle to govern

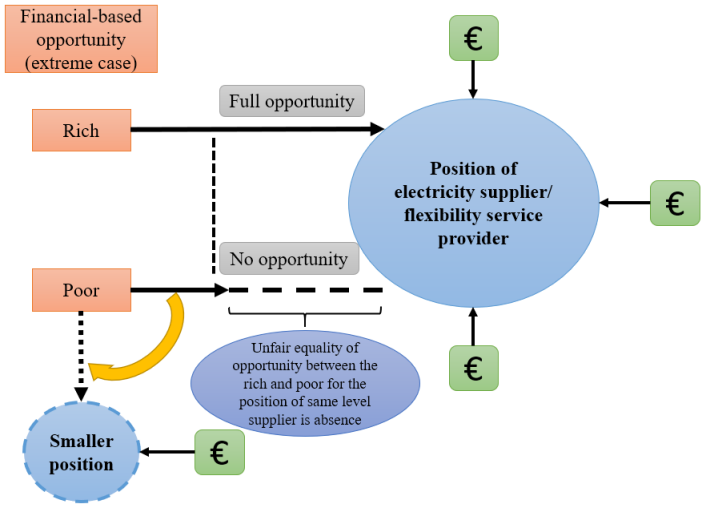


Figure 5.2: Illustration of unfair equality of opportunity between the rich and the poor for the position of the same level supplier which makes the resulting economic inequality unacceptable according to Rawls (1971)' principles

the distribution of benefits under a circumstance where the rich are already at a beneficial position becomes the main challenge to structure the respective norm.

The principle needs not to disregard the fact that economic inequalities as both driver and outcome are as good as inevitable. The attainable rewards or benefits would or should differ from one another. Referring to Bianchin and Heylighen (2018)'s interpretation of Rawls' justice theory, the social and economic inequalities are only allowed if they are arranged to the greatest benefit of the least advantaged members of society. Therefore, contrary to the principle for the costs that everybody should be able to afford the costs regardless of their financial or social condition, the principle to govern the distribution of benefits should rather consider them. Aligned with Rawls' proposal, a norm to distribute the benefits listed in Table 5.2 can be structured as follows:

> ***"Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off"***

The proposed norm addresses the issue of some people might receive the benefits differently, that some might receive more wealth than others, for instance. Accordingly, the norm suggests that the worse-off should receive more from the respective difference. It then supports the idea of re-allocation of benefits from the most advantaged to the least advantaged people. Additionally, the formulated norm has the potential to direct its succeeding design requirements to contain or promote the principle of *intergenerational equity*.

5.2.3 Distribution of access to public goods or services

Apart from the utilisation of technologies that could be owned privately such as solar PV, Table 5.2 also suggests the use of public goods or services in P2P energy trading, which are distribution grids and communication network. These public goods or services do not always have to be provided by regulated parties such as DSOs or the government. Communities could also provide a similar type of goods or services. As indicated in Table 5.2, households could offer their properties/roofs to be installed by solar PV of others as a common service under the *postcoderoosregeling* scheme.

For public or common goods/services, access right is an important property to be thought about besides the costs (Ostrom, 2010). With private solar PV or batteries, owners have full access right to the items, and they could exclude anybody else with no problem. However, the same condition does not apply to common goods/services. Rather, access right oftentimes becomes fuzzy since many people may claim for the right.

Ostrom (2010) further elucidates that the right of access to common goods or services must be accompanied by another property right, namely exclusion. It is the right to decide who will have access to those goods/services. However, Ostrom does not specify in more detail regarding the principle to govern such a decision. This, however, leaves plenty of room for context adjustment, considering the proper principle might be different from one goods or case to another.

Finding proper principle to regulate access right also becomes the challenge in P2P energy trading as there are various common goods or services involved. It is also worth to remember that not all goods in P2P energy trading are tangible. Furthermore, not every goods can be easily classified as either private or public goods, and they could even shift class.

The data from electricity trading is intangible and could be argued as a private goods belongs to those who make the trading. However, there is a possibility that multiple other stakeholders demand this data in order to operate or deliver services to support P2P energy trading. For instance, the DSOs may need the data to balance the grids or traditional energy suppliers may need the data to adjust their investment or production. Subsequently, when the data loses its property of excludability because multiple stakeholders can access it, and then it becomes hard for the original or the true owners to distinguish who access which data, the data becomes no longer a private goods (Doorn, 2019).

Reflecting on access to distribution grids, the DSOs are mandated to provide the access equally and non-discriminatory to all households. This is due to distribution grids hold critical function for electricity supply-chain. Without the access right, the chance for people to receive sufficient energy is minuscule. Put differently, access to distribution grids is simply imperative for households to obtain and consume electricity. Analogous to this, a norm for public and common goods/services in P2P energy trading can be structured as follows:

> ***"Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading"***

The proposed norm specifies that access to particular public goods or service must be granted if they hold important function to enable or support electricity trading. Access to distribution grids and communication network are essential for electricity trading despite the technical challenges. Access to others' properties/roofs would also be essential for those who do not have space to mount their solar PV in order to perform electricity trading. The norm also addresses the goods that is intangible, hard to classify, or could shift the class of goods, which is the data from electricity trading. The data must be accessible if it is for enabling or supporting electricity trading. Similarly, households must be given access to the features in the P2P platform that allow them to both sell and purchase the electricity. Without the access right to both features, it becomes less likely for them to perform electricity trading since they would not have the medium to facilitate the transaction. Additionally, the norm has the potential to direct its succeeding design requirements to contain or promote the principle of *intergenerational equity*, and *sustainability* since it prescribes action which supports wider solar PV adoption through the *postcoderoosregeling* scheme.

5.2.4 Distribution of responsibilities

As a system that will be embedded in the electrical system, several stakeholders who may be affected by or involved in the P2P energy trading, besides the households, can be identified already. Table 5.2 indicates that the role of DSOs is still essential to support the electricity trading as they are the one who is in charge to provide access to the distribution grids. They may also need to cooperate with traditional energy suppliers to balance the electricity production and consumption when there are shortages in local generation.

Table 5.2 also shows that the practice of electricity trading is still open to the possibility that new stakeholders emerge and get involved. Whether they are already known or emerging, however, those stakeholders must carry their own responsibilities to ensure electricity trading can function as desired. Failure of one stakeholder in undertaking its responsibilities might harm the entire system because there is a high dependency between stakeholders for the operation of electricity trading, as illustrated with the cooperation between the DSOs and traditional energy suppliers. Therefore, (re-)assigning proper (new) responsibilities is crucial under this circumstance.

As there is a possibility that new actors emerge in the P2P energy trading system, a proper principle to fairly assign or allocate responsibilities for these actors need to be defined. Besides the new actors, the possibility of new responsibilities being added to the existing actors in the electrical system also needs to be anticipated. This should be obvious given the fact that households must carry a new responsibility to supply the electricity to begin with. Table 5.2 also shows the possibility that households may take the responsibility to manage or organise their own data from electricity trading, as well as setting the electricity price in the platform, which are new for them.

Fahlquist et al. (2017) provide a comprehensive analysis of design principles to distribute responsibility. They argue that the design of a system should allocate responsibilities in a fair way across individuals. However, they are also aware that people intuition towards fairness could differ between one to another. Therefore, it is important to reflect on the context and accordingly structure the norm which could represent a fair way of distributing responsibilities.

With regards to responsibility, a technocratic approach can be applied, in which the P2P en-

ergy trading system is considered more as a technical system. For a technical system, functionality becomes one important aspect to be safeguarded. A responsible actor must be qualified to execute certain tasks to maintain the functionality of the system and keep it running. Fahlquist et al. (2017) further substantiate that individuals' capacity should be examined to allocate responsibilities. They have to be able to reflect on their actions and behave responsibly on their own. Additionally, van Hooft (2006) defines a responsible person as one who is willing to make sacrifices for something they signed up for. This condition is likely to be satisfied when the responsibility addresses his/her interest. Based on this consideration, a norm for the distribution of responsibilities in P2P energy trading can be structured as follows:

> ***"Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest"***

The proposed norm entails the judgment towards the capacity of actors for certain responsibilities. It prescribes the avoidance of giving too much burden or tasks to certain actor which could risk the operation of electricity trading when they fail to undertake those tasks. It also values the interest of actors towards a specific part of electricity trading where they want to be responsible for. Additionally, the norm has the potential to emphasise consideration towards the principle of *responsibility* when choosing for the design requirements in the later step.

5.3 Procedural norms for P2P energy trading

P2P energy trading system that is defined for this research has an emphasis on the role or participation of communities or locals, although it still allows the wholesale market (traditional energy suppliers) to supply the energy. As such, it can be considered as a community development project. The principles of procedure presented in Table 2.2 (sub-section 2.2.2) can then be relevant to the context of this research. Therefore, the norms for P2P energy trading derived from procedural justice sub-value can be formulated to address the dimension of involvement and position of stakeholders, as well as the resource with respect to the required information.

The goal for the formulation of procedural norms, in all three dimensions collectively, is to define a just procedure for the design process of the P2P energy trading system. In this context, the design process refers to the meeting where people deliberate how things can or should be organised. Re-arranging Table 5.1, several items in the P2P energy trading system that can be deliberated/organised together with the communities were grouped in Table 5.3. It also shows important information worth known by the communities to organise respective items.

The way the principles in Tables 2.2 are adapted, incorporated, as well as transformed into procedural norms for P2P energy trading are presented in the following subsections.

5.3.1 Procedure for involvement and position

Bianchin and Heylighen (2018) bring forward two general considerations for a just design, namely *design for all* and *design with all*. They argue that totally designing for all is nearly unrealistic

ITEMS FOR DELIBERATION	IMPORTANT INFORMATION
• Size of postal code • Feed-in tariff level/compensation scheme/subsidy • Grid connection tariffs • Data sharing/data access • Concept of P2P platform (features to be embedded or associated for the users)	• Information regarding investment for the technologies/infrastructure • Information regarding ownership administration (to support mobility/changing ownership in *postcoderoosregeling* scheme) • Information regarding the reliability of the smart meters • Information regarding the functions of each feature in the P2P platform and the instruction to operate the features

Table 5.3: Attributes/goods/events in the P2P energy trading system that can be deliberated/organised with the communities and important information worth known by the communities to organise respective items

(although it still could be approached through the optimal application of distributive justice norms). They further indicate that the second consideration is rather more important when striving for a just design. The concept of a just system is more attainable if the focus is shifted into enabling the people to deliberate how the system should operate instead of forcing the system to be operable for everyone. If after the deliberation they found out that the system indeed cannot function for all and some sacrifices are required, the equal opportunity for the position of decision-makers is at least can be honoured (Rawls, 1971).

Since P2P energy trading system in this research emphasises the role of communities, and given the specific goods/items to be organised in Table 5.3, the involvement of communities in the design process becomes even more crucial to avoid arriving at unjust P2P energy trading system. The involvement of communities in arranging the size of postal code for *postcoderoosregeling* scheme may help overcome the issue of a postal code ended up being filled by only poor residents. Their involvement can give the authorities real illustration of the composition of the residents, and the authorities can directly observe types of people who reside in a particular postcode, and see or hear whether it already has a mix composition for a juster *postcoderoosregeling* scheme.

Similarly, the involvement of communities in arranging Feed-in tariffs, subsidy, and grid connection tariffs may help prevent the authorities trapped in their own assumption at the expense of the communities. The authorities can immediately hear whether the level of tariffs or rewards being proposed is perceived just or reasonable by the communities. Even further, they can co-formulate those tariffs or rewards to approximate a level that is perceived just by or for the communities.

The involvement of communities in arranging data sharing is equally important to make the P2P energy trading system just. The authorities can hear directly from the communities whether they want to share or have a problem in sharing their data from electricity trading to particular

parties. Accordingly, they can respond to it by adjusting the related policy or even issuing a new one to address or protect communities' interests.

It is important to involve the communities during the creation of P2P platform. It can reduce the potential of missing some features to be used by the communities that can lead to an unjust P2P platform business model since the communities can directly share what they want to do or have within the platform. In addition, the authorities can evaluate the concept or business model in the P2P platform through the help of the communities later on. The authorities can hear from the communities, whether the platform owners or developers already provided features that allow them to sell and purchase the electricity equally.

Although the normative principles which give direction in distributing prevailing goods in P2P energy trading have been promoted in section 5.2, the detail technical arrangements to distribute or organise specific goods/items in Table 5.3 still require deliberations with the communities. As an illustration, the authorities can grant a subsidy to help the people to afford solar PV and batteries. Table 5.2 distinguishes this subsidy as a benefit, which therefore should be allocated more to the poor according to the norm in sub-section 5.2.2. However, in what form, to what extent, and from whom this subsidy originate, still need to be deliberated together with the communities to achieve a juster system.

Furthermore, it is unlikely that all the communities could be gathered in a single room to have deliberation at a time and the main challenge in designing with all is indeed determining who should be invited for the deliberation. Alternatively, Pols and Spahn (2015) suggest a more democratic way of deliberation by rather inviting a sufficient number of representatives. Adhering to their suggestion can make the design process in this context more feasible as there are fewer people to be gathered and the essence of locals' involvement can still be safeguarded through their representatives.

The selection of these representatives might differ across communities and is very context-dependent. It can be up to the communities on how they will choose their representatives. However, in general, the representatives must be the member of the communities, and they must know what communities expect from P2P energy trading, and willing to defend the interest of their communities to have fair treatment in P2P energy trading.

Addressing the issue of designing with all within the context of P2P energy trading that deals with the organisation of specific goods/items listed in Table 5.3, a procedural norm can be structured as follows:

> ***"Representatives of communities must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading"***

The proposed norm specifies the involvement of communities during the design process of P2P energy trading which needs to be secured. Although the principles for the distribution of goods that can be used as guidance to approach a just system have been proposed, communities still need to deliberate how things must be organised on a more practical or technical level. The norm also addresses the democratic way of deliberation, which at the same time increases the feasibility of

deliberation that involves the communities. In addition, the norm has the potential to emphasise consideration towards the principle of *due process* when specifying the design requirements in the next step.

Pols and Spahn (2015) further substantiate frequent issue in a democratic deliberation where all representatives from different stakeholders cannot reach consensus. This issue may also happen during the design process of P2P energy trading that communities have a conflicting say against DSOs or traditional energy suppliers. For instance, the DSOs and communities may have a debate regarding to what level new grid connection tariffs should be set as a result of grid reinforcement and who should bear the additional costs to make the new tariffs affordable for all. That is a distribution issue on a more practical or technical level where conflicts between stakeholders may jeopardise the consensus. Nevertheless, a deliberation must still result in an agreement. Therefore, such a negotiation with compromise-oriented model has to take place.

Oftentimes, some parties have to give up or sacrifice something during this negotiation, depending on how they can bring themselves during the discussion. Parties with better resources are likely able to defend their argument better so that they can push forward their interest. However, this will, at the same time, press the worse-off parties in an unfavourable position, whereas according to Rawls' theory of justice and the principle in Table 2.2, the least advantaged party should be given priority or favoured position. Accordingly, a norm to address the position of the worse-off in P2P energy trading can be structured as follows:

> ***"Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading"***

The norm proposed above specifies that the design process of P2P energy trading should be arranged to the greatest benefit of the worse-off. In addition, the norm has the potential to direct its succeeding design requirements to promote the principle of *availability* and *affordability* for the worse-off in particular.

5.3.2 Procedure for resource

With regards to a just procedure, Bianchin and Heylighen (2018) underline the importance of stakeholders' ability to make a rational decision. A just procedure is not only about providing equal opportunity for all stakeholders to partake in deliberation, but it also concerns the process during the deliberation and how the outcomes are eventually decided. Put differently, it is not enough to allow all the stakeholders to engage in the deliberation alone. They also need to be able to argue for their interest, make instrumental reasoning, and finally decide for what they think the best for them after the deliberation. Such premises will make their participation more meaningful (Jenkins et al., 2016).

Adhering to Bianchin and Heylighen (2018)'s idea, the technical arrangement to distribute specific goods in P2P energy trading must then be proposed by rational stakeholders. However, such rationality should not be used as the main criteria to distinguish which stakeholders can be involved

in the design process through their representatives and which cannot. Rather, rationality should be something that is fostered to all stakeholders.

Jenkins et al. (2016) claim that disclosing greater information is an effective means to foster the rationality within stakeholders. With more information, people can examine things more comprehensively. Therefore, they can make better judgment towards whether or not the decision and the whole process behind it are just or acceptable. Additionally, more information also allows people to reason and defend their interest better. In short, more information, although not always, can develop people to be more rational.

Addressing the issue pertaining to information, Sovacool and Dworkin (2015) and Jenkins et al. (2016) suggest that only high-quality information should be disseminated. They argue that the information should be able to make participation of each stakeholder in the deliberation process more meaningful. As indicated in Table 5.3, there are some types of information which could make the participation of the stakeholders in the electrical system, particularly the households, in the design process of P2P energy trading more meaningful.

The households may need to know what kind of investment (and to what extent) the DSOs must make as a response to the increased volume of the electricity being traded so that the households can better judge whether the formulation of new grid connection tariffs is just. The households may also need to know from whom the DSOs will finance and recover their respective investments so that they can decide on the form of subsidy and the right party to earn it. It is also important for the households to know what exactly the solar PV ownership via *postcoderoosregeling* is and what the following administrative issues are before being invited to participate in the scheme. Having that information beforehand can make their contribution in arranging the size of postal code more significant.

Table 5.3 also suggests that the information regarding the reliability of the smart meter is meaningful for the households. The households could trust the organisation of data sharing better by knowing the respective information. Consequently, they might be more willing to discuss how the data should be distributed in practice and to assess whether it is already just. In addition, distrust to the system from the beginning can rather nullify all the potential of communities' involvement.

The information regarding the functions of each feature in P2P platform is also meaningful for the households so that they can evaluate whether the whole concept of P2P platform drawn by the developers is already just. It is also important for the households to be able to follow the instructions to operate the features in P2P platform so that they can actually experience the features. It can improve the contribution of the households in the design process as they can better propose the alternatives features or new features to be added coming from their own experience.

Having understood that there is some meaningful information that can increase the possibility and the quality of households/communities' participation in the design process of P2P energy trading, a procedural norm which addresses the dimension of resource can be formulated as follows:

"Households and other stakeholders in electrical system must receive meaningful information that is necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading"

The proposed norm specifies the need for every stakeholder to receive adequate information to make a fine decision. The norm also has the potential to direct its succeeding design requirements to promote the principle of *transparency and accountability*.

5.4 Recognition norms for P2P energy trading

P2P energy trading that is defined for this research emphasises the involvement of the communities and locates them at the centre of the system. Furthermore, as substantiated in Chapter 1, a local community in Rotterdam was deliberately selected for the empirical/case study. Based on those two facts, the norms for P2P energy trading system that are derived from justice as recognition sub-value might as well be formulated to recognise the existence of those local communities. Subsequently, two categories of which the local communities could or should be recognised in the P2P energy trading project can be distinguished, namely by *acknowledging local's diversity with respect to their socio-cultural identities* and *respecting locals' opinion*.

To formulate the recognition norms, the principles that are promoted by Jenkins et al. (2016) and McCauley et al. (2013) will be adapted since they introduce their principles within the context of design process of energy systems (i.e. design process for turbine in the isle of Lewis and design process for wind farms). On a different note, the procedural norms and recognition norms may share some similarities as both are rather meant to govern the design process (and not the physical design including its functions themselves).

Despite the similarity, both Jenkins et al. (2016) and McCauley et al. (2013) further suggest that the principles of recognition must address socio-cultural aspects of the communities in the design process of energy systems. Accordingly, the goal for the formulation of recognition norms, in all two categories distinguished above collectively, is to incorporate socio-cultural aspects into the design process of P2P energy trading system. Recalling the design process in this context refers to the meeting where people deliberate how things are or should be organised. For such a purpose, the same list of specific goods/items in Table 5.3 will be considered. As will be substantiated shortly, those items can also be relevant to be organised in association with socio-cultural aspects (the characteristics/identity of the communities).

Elaboration for recognition principles proposed by Jenkins et al. (2016) and McCauley et al. (2013), and how they are adjusted, incorporated, and transformed into recognition norms for P2P energy trading are provided in the following subsections.

5.4.1 Recognition of diversity

One of the categories for recognising the local communities in the P2P energy trading project is acknowledging the diversity with respect to their socio-cultural identities. This category is induced by Jenkins et al. (2016) who draw the phenomenon of injustice with respect to *misrecognition* to

the communities in the energy projects. They argue that energy projects oftentimes, if not always, fail to capture specific needs or motivations of various groups of people. Therefore, capturing or acknowledging the diversity in the communities can be a form to recognise them which, in contrast, draw the phenomenon of justice.

Jenkins et al. (2016) further substantiate that energy projects within a community tend to make assumption or generalisation from similar works without actually consulting to the residents of where the project is established. They provide an example of how energy poverty in a community is typically associated with knowledge deficiency. This generalisation or stereotyping has many times, resulted in little effort to find the real motives of why certain communities experience energy issues. Eventually, it leads to misrecognition to certain communities as their issues, together with the motives, are not properly recognised.

The phenomenon of misrecognition to the community gives a lesson that different communities should not be immediately identified as the same when they experience similar issues. Rather, Jenkins et al. (2016) imply that each community may own distinctive socio-cultural identities where they motivate and play a significant role in energy-related issues. It may be true for some "energy poor" communities that they happen to have a social issue with respect to knowledge deficiency. However, it is not always the main motive for other communities to be "energy poor", and hence should not be used as universal identification.

Traditional communities, in spite of knowing the potential rewards, may intentionally choose to be "energy poor" because the energy technologies that are introduced to them could modify their cultural landscapes or are against their custom. The campaign of NIMBY (not-in-my-backyard) where farmers refuse to have more energy supply from wind generation provides a solid illustration to this matter. For them, alteration or destruction to their pristine landscape is unacceptable and cannot be exchanged with more energy supply (Smith & Klick, 2008).

Similarly, the (re)-organisation of the size of postal code for *postcoderoosregeling* scheme may potentially modify the existing landscape of the communities. An organisation of a postcode which strives for mix composition between the rich and the poor may indeed prosper the number of installed solar panels. However, the increased number of solar panels on the roofs may induce the feeling of discomfort for some communities They may feel that "blue roofs" are unfamiliar and that it will change the way their surroundings have always looked from the start. They may, therefore, against the entire idea of *postcoderoosregeling* scheme and revoke themselves from the design process of the postal code.

Apart from the landscape, the possibility of the P2P energy trading system modifies the existing organisation or the custom of the local communities, to which they may find it culturally undesirable, needs to be anticipated. The way the local communities normally communicate or interact may get affected by the designation of transaction via P2P platform. Regardless of the efficiency that a platform could offer, traditional communities may oppose the idea of transacting or communicating via digital platform because they are accustomed to interacting verbally and directly with their neighbours. Similarly, sharing data to the outsiders may not be a common practice for traditional communities as they are quite isolated, or choose to be one. Subsequently, they may feel discomfort to the "new" idea of data sharing in P2P energy trading and refuse to take part in the

respective design process.

With consideration towards misrecognition in mind, the deliberative team, or more precisely representatives of stakeholders in the electrical system must be able to capture and address those possible reactions that are rooted from socio-cultural identities of the communities in the design process of P2P energy trading. Forcing a system to be implemented in the communities without actually consulting how they are built, or what they perceive as important is then not recommended for the sake of justice as recognition. In fact, it can be harmful to the realisation of the P2P energy trading system itself. As what have been discussed, the communities may be culturally driven to refrain from the design process and resist the P2P energy trading system accordingly.

Adapting Jenkins et al. (2016)' principle, the socio-cultural identities of communities must be covered and taken into full consideration when deliberating how specific goods in P2P energy trading above should be distributed. Therefore, a norm that recognises the diversity in communities can be structured as follows:

> ***"Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading"***

The proposed norm addresses the diversity in the communities that is originated from their socio-cultural identities, which could be their (traditional) landscape, custom, or common practices. The norm also specifies that this diversity, which may trigger "unforeseen reactions", must be explored and captured within the design process of the P2P energy trading system.

5.4.2 Recognition of opinion

Another category for recognising the local communities in the P2P energy trading project is respecting the opinion of the locals. This category is based upon the act of disrespecting communities' opinion to disregard their existence of which Jenkins et al. (2016) refer to as the phenomenon of injustice. Therefore, listening and respecting the opinion of the communities can be a form to recognise their existence that, in contrast, draw the phenomenon of justice.

As indicated in section 5.3.2, the local communities must have a stake to submit their genuine opinion to make their participation in the design process more meaningful. In return, other deliberative team members must capture and take their opinion seriously for the sake of recognition justice. Accordingly, other stakeholders in the electrical system must listen carefully to the communities and capture how they want specific goods in the P2P energy trading system to be distributed.

McCauley et al. (2013) promote a principle to ensure that genuine opinion of communities can be impartially captured and respected. It suggests that people are entitled to their own opinion and for that, they must be free from physical threats. However, the physical threats may not be the only relevant threats in the P2P energy trading system. Rather, the communities must also be free from emotional and distorted financial threats.

There is a possibility that some of the rich state their objection to the technical arrangement of subsidy if it enforces the collection entirely from the rich. They might also object the technical arrangement of grid connection tariffs if it enforces the rich to bear all the additional costs from the reinforcement. Regardless of the final technical arrangement chosen for both specific goods, those people must not receive negative framing, such as being selfish or stingy, because of their opinion or objection that they brought forward during the deliberation. Similarly, traditional communities who state their uncomfortable feeling in any kind of data sharing must not be framed as uncivilised. This potential negative framing or labelling to their opinion can be seen as an emotional threat that must be avoided.

Communities must not also be deceived to pay a great amount of money when they disagree to a certain technical arrangement of specific goods. Traditional energy suppliers must not threaten the communities who disagree to share them the data from electricity trading with an exaggeratedly higher electricity bill. If there is indeed a consequence of higher electricity bill as a result of traditional energy suppliers do not have sufficient data to perform optimal energy-saving measures, they must tell it as it is without exaggeration. This exaggeration towards the bill to influence people's opinion can be seen as a financial threat that must be avoided as well.

Adapting McCauley et al. (2013)'s principles, a norm to capture and respect the genuine opinion of the communities in the design process of P2P energy trading can be formulated as follows:

> ***"Communities must be free from any physical, emotional, and distorted financial threats when they propose or reject technical arrangement to distribute specific goods in P2P energy trading"***

The norm above specifies that all stakeholders must be entitled to what they perceive as a correct or just technical arrangement to distribute specific goods in P2P energy trading. For that alone, they must be free from any form of threats, including physical, emotional, and financial.

5.5 Conclusion

This chapter strives to answer the following sub-question:

"What items in P2P energy trading system that can be relevant to the energy justice domain and what norms can be developed accordingly?"

To answer the half part of the sub-question above: *" What items in P2P energy trading system that can be relevant to the energy justice domain..."*, the developed criteria in Table 3.3, sub-section 3.1.2, can be used to highlight the items available in P2P energy trading that can be relevant to the energy justice domain. Those relevant items are promoted in the table below:

On-grid solar PV system			**Smart metering system**		**P2P platform**
Investment and ownership	Profitability	Local flexibility and grid balance	Data utilisation in communication network	Reliability of automatic smart meters	Transaction mechanism
The presence of investment costs to procure solar technologies and BoS	The presence of profit from compensation scheme (Feed-in tariffs)	The presence of cost for distribution grids' reinforcement which results in connection tariff adjustment	The presence of cost for communication network expansion	The need for information regarding reliability of the smart meters (e.g. accuracy of smart meters and which appliances/ devices can be connected)	The need for access to important features in P2P platform (i.e. purchasing and selling electricity)
The need for information to make recoverable investment	The presence of profit from supplying electricity/selling excess production	Batteries as a means to balance the grids but rather costly	Potential of emerging actors (e.g. aggregators) which indicates new job opportunities for communities	The need for communities' trust in the operation of smart meters	Designation of transaction mechanism/ principles highly depends on the platform owners
Private ownership which requires access to a private rooftop		Potential income for communities from offering local flexibility services via batteries	The need for access to the data from electricity trading for multiple stakeholders		Households become responsible for setting the electricity prices in the platform
Postcoderoosregeling ownership which requires access to people's property/rooftop		Potential of households to be balance responsible for their own electricity consumption/production	The need for access to the communication network as well as to the DSO's grids		
The need for area size setting of a postal code to support Postcoderoosregeling ownership		Potential of strategic behaviour which requires an agreement for the goals to be achieved and some incentives (subsidy/tax) as the mitigation	Potential of local database management/ organisation		
The need for information to support mobility/changing ownership					

Subsequently, a set of norms was formulated to govern the organisation of the items in the table above by adapting/adjusting principles that have been developed by other authors. Accordingly, four distributive norms, three procedural norms, and two recognition norms were promoted. Those norms are listed below.

- **Distributive norms**

  1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;
  2. Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;
  3. Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;
  4. Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.

- **Procedural norms**

  1. Representatives of communities must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;
  2. Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;
  3. Households and other stakeholders in electrical system must receive meaningful information that is necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading.

- **Recognition norms**

  1. Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;
  2. Communities must be free from any physical, emotional, and distorted financial threats when they propose or reject technical arrangement to distribute specific goods in P2P energy trading.

Chapter 6

Exploration of the conflicts for the implementation of justice norms for P2P energy trading in Bospolder-Tussendijken

After generating a set of conceptual norms for P2P energy trading, the relevancy of those norms will be evaluated and assessed against the specific setting of Bospolder-Tussendijken as the empirical work. Accordingly, this chapter aims to answer the third research sub-question, which is:

"What does the specific setting of Bospolder-Tussendijken imply to the developed conceptual justice norms for P2P energy trading?"

To approach the answer to the sub-question above, the potential conflicts that may arise when implementing the developed conceptual norms in the community of BoTu will be investigated. In doing so, the norms will be assessed by four interviewees who have a connection with the neighbourhood and then their input or recommendation will be interpreted.

This chapter starts with the description of the community of BoTu which entails their demographics, living, and social conditions, as well as their awareness of energy issues in section 6.1. Following that, the perceived-(energy)justice in energy projects of the interviewees will be explored in section 6.2. Subsequently, the expectation of those interviewees for the electricity trading and how they see the application of three technologies used in P2P energy trading in the respective community will be presented in section 6.3. Afterwards, the result of the norms assessment from four interviewees will be presented in section 6.4. Synthesising information in section 6.1 - 6.4, the potential conflicts within the developed conceptual norms will be explored in section 6.5.

6.1 Description of community of BoTu

Describing a community can be quite extensive work. For such a purpose, however, the demographics and social conditions of the community, and how they deal with energy on a daily basis receive more attention in this research. The reason is that they could give an immediate picture of how the community is built, which is particularly important for the tenet of justice as recognition, and for other tenets as well to some extent. In addition, those are the variables within the community that are relatively accessible online and that are conveniently discussed or known by the interviewees.

6.1.1 Demographics and social conditions

The demographics and social conditions of the community can be explained via social indicators. Those indicators that can be relevant to the conceptual norms developed in Chapter 5 are demonstrated below. In addition, the values of all the indicators presented here are relative to the aggregated neighbourhoods in the city of Rotterdam.

Composition of residents: ethnicity

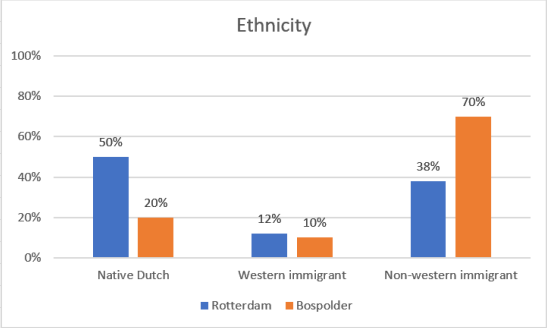


Figure 6.1: Ethnicity of the residents of BoTu

The residents of BoTu come from various cultural backgrounds. Only 20% of the people are native Dutch, while the other 10% are western immigrants who are those people whom one of the parents was born in one of the countries in the continents of Europe, North America and Oceania, or Indonesia, or Japan. The 4th interviewee confirmed that there is indeed a group of traditionally whites, higher educated, *left-leaning* people living there, in which he considered them as an important group of people. Meanwhile, the remaining 70% of the residents are non-western immigrants who are those people whom one of the parents was originally from one of the countries in the continents of Africa, Latin America, and Asia (excluding Indonesia and Japan), or Turkey. The 3rd interviewee further confirmed that, aside from Dutch descent and Surinamese, Cape Verdians, Moroccans, and Turks are three main groups living in the neighbourhood.

Household income

The income of the majority of people living in BoTu is considered low on the basis of national distribution. Only 24% of the population have medium range of income and not more than 6%

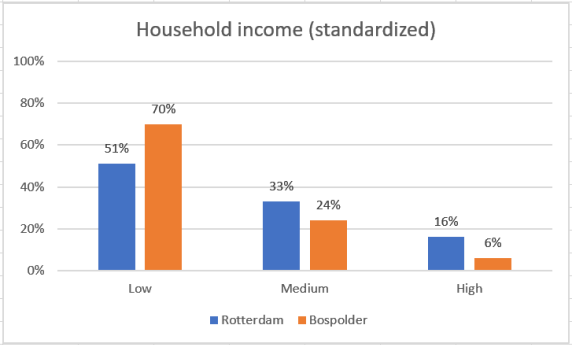


Figure 6.2: Household income

of the population have high level of income. The data is further confirmed by all the interviewees. They perceived BoTu as a poor neighbourhood in general. The 3rd interviewee added that part of the community works for the municipality and other groups of people usually more active in the day-to-day community services, such as bringing food to the elderly, driving people, etc.

The 1st interviewee further argued that most of the people there are less likely to be able to invest in solar PV, energy storage, or heat pumps by themselves due to their financial situation. However, the 2nd interviewee mentioned that the neighbourhood is now in the transformation phase. The municipality of Rotterdam is working hard to develop the community. A lot of attention and money is now being allocated to transform the community.

Lifestyle

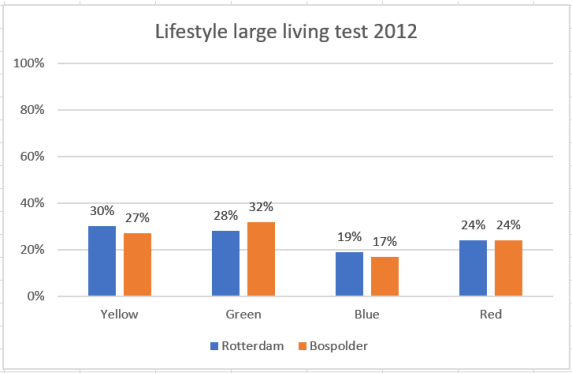


Figure 6.3: Lifestyle based on sociological and psychological elements

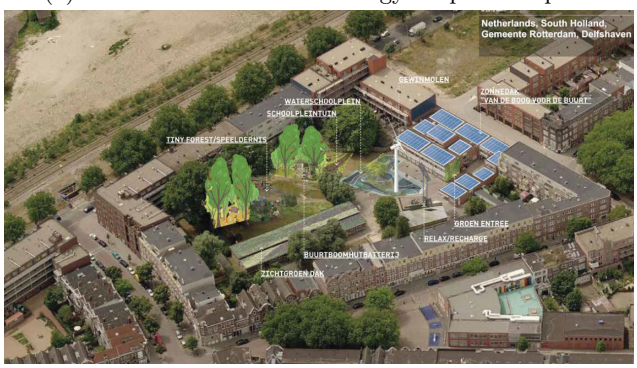
Combining both sociological and psychological element, the lifestyle of residents in BoTu can be distinguished into four types: yellow, green, blue, and red. Focusing only on the sociological element, the yellow and green represent residents who have strong group orientation, while the blue and red represent residents who have more individualistic orientation. Accordingly, around 59% of

the population in BoTu are perceived group-oriented, while the other 41% of the population are perceived ego-oriented.

The 3rd and 4th interviewee further confirmed that the community of BoTu has relatively high social participation or social capital. The 3rd interviewee mentioned that what sets BoTu apart from other neighbourhoods from the south of Rotterdam is that there are many collective initiatives. He also suggested that a lot of people in the neighbourhood have quite a lot of entrepreneurship. There are community gardens, local community centres, youth projects, some movements, and there is quite a do-it-yourself attitude within the community.

The 3rd interviewee further argued that they have organisational potential that, although still require some specific guidance to put them in the right direction, can be applicable to energy cooperatives. He later showed an example of energy cooperative plans in the neighbourhood. There is a school of which the board offered its roofs for the neighbourhood. The neighbourhood does not have to have any money for the roof, but it should benefit the parents of the children in that school through something like solar PV generation.

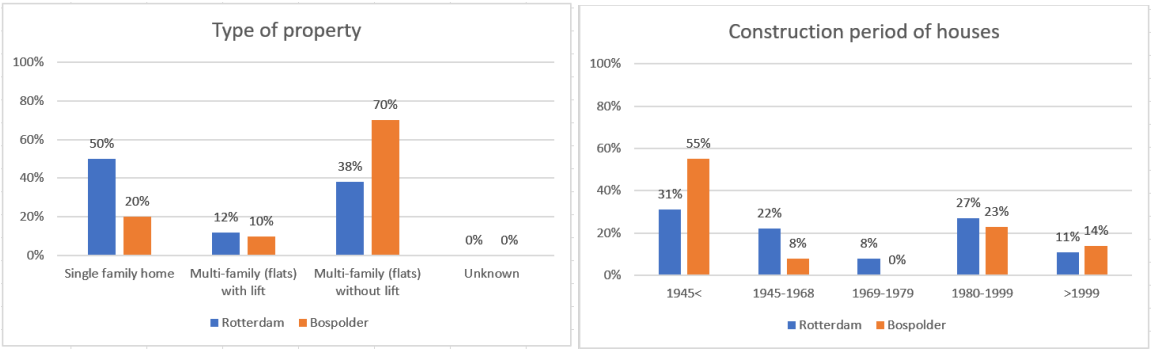
(a) The school area before energy cooperative plan



(b) The school area after energy cooperative plan

Figure 6.4: An energy cooperative plan in BoTu (Delfshaven, 2018)

Property situation



(a) Type of property

(b) Construction period of the houses

Figure 6.5: Profile of the property in BoTu

In BoTu, only 20% of the housings are categorised as a single-family home, which is a house on the ground floor that the entrance is unlocked through the entrance door, and without any other houses upon it. The remaining 80% of the housings are flat-type housing. The 1st interviewee also confirmed that most of the people there indeed live in the apartments.

Furthermore, most of the houses in the neighbourhood were constructed decades ago. 55% of the entire houses were constructed before 1945, and 31% of the houses were built between the period of 1945-1999. Only 14% of the houses were constructed from 1999 onwards. The 2nd interviewee further confirmed that they now have newly built houses that are more for the rich people

6.1.2 Perceived-energy awareness of the community

During the interview, all four of the interviewees were asked regarding the way the community of BoTu deal with energy on a daily basis. The 1st interviewee straightforwardly argued that energy is not the topic which is high on their priority list. He mentioned that energy is not on their daily worries and they do not really think about how they could get energy. He further imagined that energy poverty might be a problem in the community because of that. Similarly, the 4th interviewee also stipulated that the community cares relatively less about energy than the average neighbourhoods. A lot of people there are more concerned with meeting ends than with sustainability, energy transition, or other large overarching issues.

Quite contrary, the 3rd interviewee believed that the community knows very well what is happening with the energy. He proved that council of tenants, composed by 10-15 people on the lower social classes, had no problem in delivering their opinion and in formulating what is going on during their discussion of energy transition. He further mentioned that they also see the need to go off of fossil fuels. The 2nd interviewee also shared rather similar views to the 3rd interviewee. She said that some of the residents are indeed interested in energy development. However, she was not sure whether everyone in the neighbourhood has that kind of interest universally.

Even so, the 3rd interviewee still admitted that there is also resistance and fear of the energy innovations which potentially replace the use of gas in different areas within the neighbourhood. He mentioned that the fear comes from their habitual practices. People are worried that energy innovations could not support their activities, such as with *wok*-cooking. They were afraid that they could not *wok* on an induction stove. However, after he made a blind test where he let them *wok* on it, and see whether they could taste the difference from the regular stove, which they did not, they became interested in the innovation (induction stoves).

6.1.3 Summary

In short, community of BoTu is a community with various cultural backgrounds, and majority of the residents are adults at their productive age. Most of them statistically have low-income relative to the national distribution and live in flat-type housings. Despite the low income, they have high social capital/participation that can be an aid for initiating local energy projects/cooperative. However, the community also receives a bad reputation from some people with regards to energy awareness/utilisation.

6.2 Perceived-justice in the energy projects for the community of BoTu

During the interview, all four of the interviewees were asked regarding the way they value justice in local energy projects, especially for such neighbourhood (community of BoTu). Such information can be helpful to understand their frame of reference when they assess and make judgment for the developed conceptual norms. Furthermore, their narrative of what they perceive as justice in the energy projects will be contextually distinguished and localised into either one of the tenets of energy justice (distributive, procedural, recognition) as presented below.

6.2.1 Perceived-justice: Distributive

Access

The 1st interviewee mentioned that people who have money can invest in solar PV panel, and immediately experience the benefits of subsidies and tax advantages that come with it, while those who do not have the money cannot access those advantages. He judged such phenomenon as unfair. He believed that making sustainable energy accessible for poor neighbourhoods would mean more justice. Similarly, the 3rd interviewee also argued that people who do not have any money to invest in the energy projects should still be able to access or participate in the energy projects.

The 3rd interviewee demonstrated that energy projects, which include solar PV in particular, should have a scheme in which people can invest in different ways. People do not need to own and pay all the costs of solar PV, but they can just partially invest in it and get a return on the investment. He also added that those poor people can just have a subscription as an alternative for the investment to make those energy projects accessible for them.

Benefit/profit

The 4th interviewee further observed that people who participate in renewable energy, such as by installing PV panels, receive more financial benefits than if they put the money on the bank. Regarding this issue, the 3rd interviewee was convinced that everybody should be able to profit from sustainable (renewable) energy, whether he/she has money or not. Similarly, the 1st interviewee also believed that people who do not invest in energy innovation should also be benefited by it. He said that people without the money must be given access to the profitable side of energy transition as well. Accordingly, the 3rd interviewee proposed everybody to have a fair share. He illustrated that if the return on investment of an energy project is set between 3% - 4%, then there is still a room for people without money to profit from it as well.

Additionally, the 4th interviewee believed that energy projects must be able to foster social changes besides the financial benefits. The social benefits of energy projects must be evident. Similarly, the 2nd interviewee argued that energy projects for energy transition should be a support to help people to get a job. However, the 1st interviewee was rather unresolved that such local energy projects will bring a lot of markets for jobs for the locals. He was more convinced that the benefits of such local energy projects for the locals will be mainly financial benefits, more green supply, and taking part in the green energy system.

Cost

The 1st interviewee further substantiated that, from the past, the energy costs in the Netherlands are always socialised. People want to make energy as cheap as possible for everyone. Accordingly, the 2nd interviewee considered this cheaper or lower costs on (decentralised) energy system as more fair for people. However, the 4th interviewee warned that some local energy projects could end up with regular people have a rather worse financial situation. He illustrated that with a lot of investments thrown to houses for new heating system, it will require the housing corporations to increase the price of the houses. Consequently, all the tenants must pay higher rent even though some do not use a lot of energy in their home as they only heat one room when it is cold. Therefore, that energy project does not make people save much on their energy bill, but rather it makes people end up financially worse because of the resulting costs that they have to pay. He added that the costs minus benefits should not be negative to prevent people end up in financially worse situation.

Additionally, the 3rd interviewee rather believed that another type of bill is more problematic for people with not much income. Despite the potential unjust outcome discussed by the 4th interviewee, he preferred to include all the resulting costs of local energy projects within the rent so that those people do not need to be bothered with extra (new type of) costs. He suggested that the financial transactions to pay the costs of energy projects should still happen via housing corporations.

6.2.2 Perceived-justice: Procedural

Involvement/participation

The 3rd interviewee argued that local energy projects must always try to involve citizens. He mentioned that such projects which require community in the first place need people to come

together to make decisions. He and the 4th interviewee further added that energy is a market where people must be able to choose or decide between different options. The 4th interviewee continued that not having a voice (in the decision-making) in contrast is a social justice issue.

Similarly, the 2nd interviewee mentioned that the municipality is eager for residents to come in action and to participate in organising (local) energy transition projects. The reason is that the municipality sees these local energy projects as bottom-up movements of the energy transition where they must come from the citizen as well. She said that the municipality of Rotterdam is researching attentively the way to stimulate residents to participate in such projects, that it consults and exchanges knowledge with other municipalities such as Amsterdam, Utrecht, and The Hague.

Position

The 3rd interviewee further added that he could find justice in such energy cooperatives (local energy projects which involve the community in the design process) when everybody has one vote. People must not have more votes regardless they have more money or more panels. In light of that, the 4th interviewee warned that the voting process must be well organised. Otherwise, the decision could cause people who already have less money end up with a negative bottom line, in which he explicitly addressed it as a social justice issue.

Information/support

On a different note, the 2nd interviewee was convinced that the local community has all the potential and power to participate in organising local energy projects in spite of their circumstances. She argued that the municipality can be a support to motivate and help them to develop faster so that they can truly contribute to such organisation activities. In the same manner, the 3rd interviewee also saw the importance of the support or assistance for the local community. He mentioned that it is important to give people who do not have any interest in energy the information about how important energy is since energy is pervasive in human's life. He then saw this as intertwining between bottom-up approach and top-down approach as he believed both are inherently important.

6.2.3 Perceived-justice: Recognition

Diversity/identity

During the interview discussing justice in local energy projects, the 2nd interviewee at one point mentioned that the municipality has a department which deals with participation of citizens in particular. She acknowledged that the respective department has come up with different ways to approach people in different communities. She later argued that local energy project should really adjust on the communities and how they wish to be approached. The 4th interviewee even mentioned that there is a possibility that energy cooperatives adjust and fit with the specific social group where people find themselves to be part of it. He illustrated that it is an idea to set up Moroccan energy cooperative, or a Surinamese energy cooperative, or something others.

However, the 4th interviewee perceived this adjustment to the diversity as a potential barrier to the local energy projects because there are many social groups needed to tap into. He further said within those social groups, people might have different culture or attitudes to the risk or agreement

of what is considered fair. He also anticipated the need for a lot of translation for such approach to make those different groups understand of what the project is actually doing.

Opinion

Despite the support or assistance, the 2nd interviewee believed that the municipality should not be the one who takes control of everything and gives a list of this, this, and this-instructions for the locals. Rather, she continued, the locals should not be underestimated for the knowledge and experience that they have. They should be given room to say and come up with their own energy initiatives.

Similarly, the 3rd interviewee also believed that such local energy projects should listen to people and act according to what comes up from them. That way, energy projects can find out what the locals really need or want. The 4th interviewee further illustrated that people might prefer the ease of regular energy contracts, or want to haggle a bit more and find the cheapest energy contract out in the market, or do cooperative and profit from that a bit, etc. For every type of wish related to energy system, the 4th interviewee continued, people need to be respected that it should be voluntary for them to engage in (any kind of) it.

6.2.4 Summary

A summary of what each interviewee considered as justice in the (local) energy projects is presented below and their tendency to the tenets of energy justice (the tenet that they emphasised) is also interpreted.

1st interviewee	2nd interviewee	3rd interviewee	4th interviewee
Distributive justice	Procedural & Recognition justice	Distributive, Procedural, & Recognition justice	Distributive, Procedural, & Recognition justice
Emphasised on equal access to the system and allocation of benefits for all people including the poor.	Emphasised on assisting the locals to participate in organising local energy projects and trusting the competence of the locals: prohibit act of underestimation.	Emphasised on diversification of access (investment) to the system, fair share of costs and benefits for all, involvement of the locals to make decisions, endowment of information, listening to what communities want/need.	Emphasised on careful distribution of costs: avoid negative bottom-line, having a voice in decision-making process, and consideration towards the possibility and the hassle from mixing cultural identity of a social group and energy cooperation.

Table 6.1: Summary of perceived-justice in energy projects of each interviewee

6.3 Expectation of the interviewees for P2P energy trading and technologies evaluation

After being asked about their conception of justice in the local energy projects, all four of the interviewees were subsequently asked whether they think it would be feasible to establish electricity trading in BoTu that is aligned with their own conception of justice. Additionally, they were asked whether they could spot any obstacles in the application of either solar PV, smart meters, or digital platform to the community. Their answer to those questions can be helpful to understand where their judgement (in the norms assessment) comes from as their expectation for P2P energy trading to be implemented in BoTu can be observed accordingly.

6.3.1 Expectation of the interviewees

Challenges/concerns

All four of the interviewees immediately had a similar expectation that P2P energy trading to be implemented in BoTu will encounter *regulatory barriers/issues*. The 1st interviewee observed that current netting schemes and energy taxes in the Netherlands are leaning towards discouraging electricity trading. Unless people use it for themselves, the laws oblige people to pay the taxes for electricity that goes for someone else. The 3rd interviewee also mentioned the exact same issue that people start to pay taxes if they generate and share electricity behind the meter. Consequently, the benefits from the trading become insignificant that the 1st interviewee said people are better off with keeping the electricity for themselves.

The 1st interviewee also expected that the use of solar PV for electricity trading in BoTu will add to the administrative hassles of the entire system, especially when such *postcoderoosregeling* is also included. He even mentioned that when it goes to home level, the concern towards solar PV instalment supported by *postcoderoosregeling* is more about administration and not so much about privacy, as others might think. He believed that for new technology (system), people are likely able to organise it in such a way that privacy is respected.

Similarly, the 2nd interviewee expected that a lot of administration works need to be done to organise such electricity trading. From her experience, a lot of local energy initiatives have difficulty in completing administrative obligations as there are many, such as getting a license to put solar panels on roofs, she illustrated. Further, she mentioned that such administrative obligations come from different departments within the municipality. She demonstrated that when somebody needs a license to put up a solar panel on the roof, it is dealt with a totally different department from where she works. Some rules are even derived from the national government, she continued. Therefore, she was convinced that the peer-to-peer system will likely to find administrative barriers, similar to the other energy initiatives. However, she ensured that the municipality tries to help such energy initiatives (local energy projects) to come through the process of getting the license.

In light of regulatory issues, the 4th interviewee rather focused on the strict rules for the infrastructure of distribution grids. He was not sure whether it would be feasible for the community of BoTu to pay less for the grid reinforcement caused by P2P energy trading because the DSOs set the rules in all neighbourhoods equally and he thought that the DSOs prefer to have national

line in the end (so, not per-block). For the use of the grids, he continued, it is eventually up to the national governments, and within the current code (rules), all the infrastructure costs of a DSO are distributed equally between the connections.

The 4th interviewee further illustrated that although BoTu would have very little electric vehicles, solar panels, or any other thing that will lead to the intensive use of the grid, their (connection) price will still go up if, in the other neighbourhoods, people use the grid more intensively which results in the needs for grid investment. He reasoned that those investments will be paid by everybody in the service area (of DSO).

Possibilities/suggestions

Addressing his concern towards the taxes, the 1st interviewee expected the government to allow the households to share energy the same way they consume it themselves without taxes. He argued that it will be a big stimulation for local energy market and will let the community profit more from local energy trade and sustainability. Otherwise, he continued, the margin (profit) will be much lower, and (participation of) the people will only be driven by emotion and small gains in collectively buying energy from their neighbours.

Despite the potential administrative hassles in *postcoderoosregeling*, the 1 st interviewee also expected the authority to carefully configure the boundary for a community in a postcode, whether or not it chooses to keep the community limited. He further suggested that the setting of the community boundary should be connected to the system and social benefit. He gave illustrations that the authority can investigate whether a specific boundary setting will induce lower peak on the network, or it will give optimal income for the nation. For the former, he added that the DSOs may have some opportunity to define what boundaries of a community are.

He later expected a postcode to be filled by the mix of rich and poor. He argued that the best communities are those who have a mix of different types of households, different levels of income, different kinds of assets, and different possibilities to have solar panels on the roof. Accordingly, he argued that the municipalities can then link BoTu to other neighbourhoods where more money is available for the investment as the (new ideal) boundary. Additionally, he addressed a bit his comment with regards to the privacy concern in the electricity trading during the interview. In spite of his confidence for the designers/engineers, he expected that the data is well protected in the P2P energy trading system and people can have the choice if they share, to whom they share, and what they do not share.

The 2nd interviewee did not further address or suggest any possibility to her concern about regulatory issues for P2P energy trading aside from her confidence that the municipality certainly has a helpful attitude. The 3rd interviewee, on the other hand, had a quite solid description of P2P energy trading for BoTu that he has envisioned in mind. He expected electricity trading to be done in the way of circular work comprises community building, training/education, work (in the district), and energy cooperative. He argued that those elements are important to be embedded and put in place in this neighbourhood (BoTu).

He also expected that many people can be invited to participate in the energy trading in one way or another. He envisioned to invite the owners of the buildings nearby the school that vol-

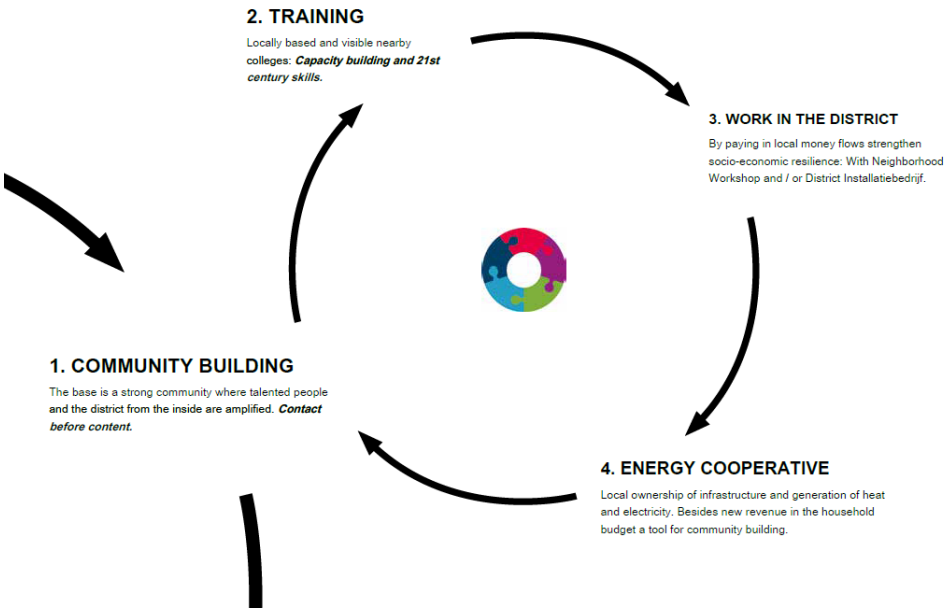


Figure 6.6: The concept of circular work discussed by the 3rd interviewee (Delfshaven, 2018)

untarily offer its roofs, and the nearby Moroccan initiative to also share their roofs and engage in the electricity trading accordingly. He subsequently listed some of the possible benefits that we (the electricity trading projects) could offer for their participation as stimulation. There can be paying less or discount on energy bill, access to education, access to work, or access to electric cars.

The 3rd interviewee also brought forward several technical possibilities that he envisioned for electricity trading in BoTu. He was keen to have as much energy as possible before the meter to steer the taxes. Therefore, he suggested having some sort of community storage installed in the neighbourhood. He further explicated his interest in a hybrid network which interconnects the main grid and community storage. He envisioned that some of the utilities can rather be supplied from the energy stored in the local neighbourhood battery, such as street lighting, or lighting of the housing corporation of the hallways. The community then will get the money in return, in which he considered that as a form of energy trading.

Meanwhile, the 4th interviewee could also sort out several possibilities to address the potential regulatory barriers for P2P energy trading related to the socialised infrastructure costs. He suggested requesting the Ministry of Economic Affairs to grant BoTu status as demonstration areas where the local authority can apply exclusive rules to, for instance, infrastructure costs. He further explained that, particularly for the grid costs/connection tariff, the DSOs must see whether there is a real demand for such a thing (electricity trading) before the status (exclusive connection tariff) can be granted. To prove the demand, he continued, there have to be more solar, storage, and potential of demand-side management in BoTu.

Additionally, the 4th interviewee expected a P2P energy trading project where people can easily join because then the project can also start experimenting with ways in which people can invest in batteries or solar panels, for instance. Had that already sketched as a fine model, he continued, Stedin and other companies may become interested in financing the project further.

6.3.2 Technologies evaluation

Evaluation, which entails challenges/concerns and/or possibilities/suggestions, of solar PV, smart meters, and P2P platforms, of all the interviewees are presented in Table 6.2 below.

	Solar PV	**Smart meters**	**Digital platforms/apps**
1st interviewee	• It has a risk of limited (private) space to install it • The roof of an industrial area outside BoTu can be used as an alternative	• They must not require people to invest their daily attention to work on the information about how much people trade electricity	• They must be plug-and-play apps (intuitive) • They will not work if they require people to have education to use them
2nd interviewee	• It has a risk of limited (private) space to install it • The roof of the public/utility buildings can be used as an alternative	• They have a risk that people are unfamiliar with smart meters • People who are unfamiliar with smart meters can be educated as an alternative • Those who are unfamiliar with smart meters can be provided with other options such as connecting them to the central system as another alternative	• They have a risk that people are unfamiliar with digital platforms/apps • Those who are unfamiliar with digital platforms can be provided with other options such as letting housing corporations to do the whole energy management kinds of stuff that are existed in the platforms
3rd interviewee	• It has a risk of disputable investment's sources driven by moral issues	• They must be easy to use, compatible with other technologies, and automatic (to support electricity trading)	-
4th interviewee	• It has a risk that people are unfamiliar with self-generation • Financial stimulus can be provided to make people interested in investing and using solar PV despite the familiarity	• They do not have significant obstacle for its own use but may be problematic when it is connected to the P2P energy trading system • It must be as easy as possible for people to use	• Community of BoTu may be willing to use the apps for electricity trading when they can also compare the prices of energy to find the cheapest

Table 6.2: Interviewees' evaluation of solar PV, smart meters, and digital platforms

6.3.3 Summary

A summary of the expectation of all interviewees for electricity trading is provided in Table 6.3 below.

1st interviewee	2nd interviewee
a. *Attitude:* Feasible (+)	a. *Attitude:* Hope to be feasible (+)
b. *Challenges/concerns:* • Current netting schemes and energy taxes discourage electricity trading: people pay taxes for sharing energy • Setting-up solar PV + *postcoderoosregeling* add the hassle of the administrative works of electricity trading	b. *Challenges/concerns:* • Installing solar PV on the roof for electricity trading requires fulfilling administrative obligations: get the license • P2P energy trading for BoTu may deal with multiple administrative works that come from different departments in the municipality of Rotterdam, or ones derived from the national government
c. *Possibilities/suggestions:* • Request the government to allow the households to share energy without taxes • Connect the configuration of the community boundary to the system and social benefit: include the DSOs to define the boundary • Mix the "the rich" and "the poor" in a postcode • Connect BoTu to other "rich" neighbourhood as the new boundary/postcode • Give people options to choose how they wish to organise/utilise their data	c. *Possibilities/suggestions:* -
3rd interviewee	**4th interviewee**
a. *Attitude:* Feasible: he had a clear conception in mind (+)	a. *Attitude:* Uncertain (0)
b. *Challenges/concerns:* • Current regulation makes people pay the taxes if they generate and share electricity behind the meter	b. *Challenges/concerns:* • The rules for the infrastructure of distribution grids are very strict: difficult to be adjusted to support electricity trading that ultimately favours the community of BoTu • BoTu holds the risk of bearing socialised costs of grid reinforcement (higher connection price) caused by projects in other neighbourhoods
c. *Possibilities/suggestions:* • Conduct electricity trading in circular work comprises community building, training/education, work, and energy cooperative • Invite as many and as diverse people as possible and provide as many alternatives to participate + profit as possible • Include community storage and use a hybrid network for the electricity trading	c. *Possibilities/suggestions:* • Request the Ministry of Economic Affairs a status of demonstration area to be able to adjust connection tariff that is exclusive for BoTu • Define an interesting model of electricity trading where people can easily join so that Stedin and other companies are willing to finance the project further

Table 6.3: Summary of all interviewees' expectation towards electricity trading

6.4 Assessment of conceptual norms

This section aims to identify whether the conceptual justice norms for the P2P energy trading have the potential to trigger any form of conflicts in BoTu through the help of interviewees' assessment. The result of the conceptual norms assessment from all the interviewees is presented in Table 6.4 below. Although all the interviewees were already asked to mark only one expression that is provided in Likert-scale, some of them still gave multiple marks with some conditions. To deal with such an event, their disagreement expression will still be prioritised, if there is any. It means that such a norm will still be considered as a multi-interpreted norm if it receives both agreement and disagreement expression altogether from one interviewee. Additionally, those multi-interpreted norms are yellow-highlighted.

Upon the application of the threshold that was defined for this research in section 3.2.1, 5 multi-interpreted norms are highlighted. They comprise 4 distributive norms and 1 recognition norm as depicted in Table 6.4. Recalling the threshold:

> **If there are one or more interviewees marked the expression of either *"neither agree nor disagree"*, *"somewhat disagree"*, or *"strongly disagree"* towards a particular norm, the respective norm will be highlighted as having the most potential to evoke conflicts or to have conflicting attributes for its implementation in BoTu.**

Accordingly, the comments of the 4th interviewee for the first distributive norm; of the 1st and 4th interviewee for the second distributive norm; of the 2nd interviewee for the third distributive norm; of the 1st interviewee for the fourth distributive norm; and of the 1st interviewee for the first recognition norm, with regards to their disagreement expression to the respective norm will be studied to explore the potential conflicts/conflicting attributes in the next section. Those comments are quoted in Table 6.5 below.

In addition, the 4th interviewee submitted 1 new distributive norm and 1 new procedural norm. They will also be regarded to explore the potential conflicts/conflicting attributes in the next section whenever possible. Those norms, in a respective manner, are provided below:

- ***"Non-participants should not bear public costs (i.e. from congestion) occurred by participants"***
- ***"Households must be able to decide on third party use of data"***

Conceptual norms	1st interviewee	2nd interviewee	3rd interviewee	4th interviewee
Distributive norms				
• Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;	Strongly agree	Strongly agree	Strongly agree	Strongly agree (for voluntary participation); Neither agree nor disagree (for regulatory)
• Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	Neither agree nor disagree	Somewhat agree	Somewhat agree	Neither agree nor disagree
• Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;	Strongly agree	Neither agree nor disagree	Strongly agree	Strongly agree
• Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.	Somewhat disagree	Somewhat agree	Strongly agree	Strongly agree
Procedural norms				
• Representatives of communities must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;	Somewhat agree	Somewhat agree	Strongly agree	Somewhat agree
• Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	Somewhat agree	Somewhat agree	Somewhat agree	Somewhat agree
• Households and other stakeholders in electrical system must receive meaningful information that are necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading.	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Recognition norms				
• Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;	Neither agree nor disagree	Strongly agree	Strongly agree	Strongly agree
• Communities must be free from any physical, emotional, and distorted financial threat when they propose or reject technical arrangement to distribute specific goods in P2P energy trading.	Somewhat agree	Strongly agree	Somewhat agree	Somewhat agree

Table 6.4: Assessment result

Multi-interpreted norms	Comments			
	1st interviewee	2nd interviewee	3rd interviewee	4th interviewee
Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;				"…So, first I said neither agree nor disagree, and then I said strongly agree, also depends a bit on what "must" mean: are people forced to join this peer-to-peer market, I do not think so. I strongly agree if it is voluntary but neither agree nor disagree if it is regulatory…"
Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	"I am not sure I agree to that. In some way I do agree but on the other hand I think it is dangerous. If someone gets tax benefits I agree, but if I buy solar panels and get less benefit, it does not give a good business mogul in normal economic activity… I put it in middle maybe because it is a little bit difficult to give such a distribution"			"So, we generate income, collectively as a peer group, and an individually. And I think it would be good and myself be willing that part of the money is spent on, preferably on something that is communal or joint. But perhaps also to somebody whose worse-off, so I think that is definitely an option, but it is for the participant to decide on how you distribute that"
Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;		"It depends on capacity of P2P system"		
Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.	"I think I disagree. I agree that if people like to do it, they are able to do it. But I think also we have to protect them in some way. So be very careful not to bring all responsibilities to that and maybe also not to allow that. I feel for customer protection, not allowing some responsibilities is not wrong. We need to distribute responsibilities as the advantage in a way it is not exposed to the risks. Therefore, I somewhat disagree, it has something to do with risk exposure and customer protection. "			
Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;	"I am in the middle. We acknowledge that they have their viewpoint, but you cannot always stop the process looking at everyone, if you look from a bigger picture"			

Table 6.5: Quotation of the comments of the interviewees who expressed their disagreement to particular norm with potential conflicts/conflicting attributes highlighted

6.5 Exploration of potential conflicts/conflicting attributes

After identifying a set of multi-interpreted norms, the potential conflicts/conflicting attributes from each of those norms will be explored in this section.

6.5.1 Multi-interpreted norm I: Distribution of costs

Visiting the comment from the 4th interviewee towards the norm for distribution of costs in Table 6.5, he demonstrated a concern or motive for a specific attribute of **freedom of choice (democracy)**. It seems that the first distributive norm has a consequence of the rich may involuntarily bear the costs of somebody else to make those affordable for them (the poor). Stepping back, the norm was formulated under a very optimistic attitude that people (engineers) can always resort to costs reduction to make thos affordable. However, in practice, the rich may indeed have to bear the extra part of the costs to make those affordable for the poor.

Furthermore, the norm believes that people would not feel burdened to pay the externality costs if they simply can afford those. However, people may still feel burdened if they pay those costs involuntarily or by force, even if they can afford those. Revisiting the 4th interviewee's perspective of justice, the norm may also disregard the issue of a negative bottom line. The costs may still be affordable within the range of the rich's financial capacity. However, it does mean that the rich can maintain their financial position had they must (involuntarily) bear part of the costs of the poor. Indeed, the rich can end up with a negative bottom line.

The judgment of the 4th interviewee can be interpreted as follows: it may still be alright for the rich to bear the extra costs to make those affordable, or to pay the externality costs for the poor, which could cause them to have the negative bottom line, if they themselves choose to do so. However, the issue here is then shifted to how many rich people are there in BoTu who are willing to "do the charity" for the poor? As indicated in sub-section 6.1.1, only 6% of the population are considered rich and it is still uncertain whether all of them want to do such charity, although the community, in general, has high social participation.

For such a limitation that there are not many rich people, let alone who want to voluntarily bear the extra costs, the expectation of the 1st interviewee to connect BoTu to other neighbourhoods may become prominent. Other neighbourhoods may have more rich people to increase the chance of "more donator" for poor people in BoTu. However, reflecting on the expectation of the 4th interviewee, it may be difficult to ask people on different neighbourhoods to pay more grid connection tariff for the sake of the community of BoTu. That is due to the current strict rules that prescribe the connection tariff to be distributed equally in all neighbourhoods.

Additionally, the authorities are challenged to reflect on themselves whether they are willing to sacrifice some part of the taxes before expecting the rich to voluntarily do such "philanthropist work". Recalling the expectation of the 1st and 3rd interviewee, the electricity trading faces such discouragement treatment by the imposed taxes. It could be a way of stimulating the rich to voluntarily pay the extra/externality costs for the poor by promising an additional profit from tax-free energy sharing.

Addressing the new norm suggested by the 1st interviewee, it can be a good addition to support a just distribution of costs in P2P energy trading. It does not seem to have any conflicting attribute apart from the fact that it could decrease the number of "donator", which makes the whole discussion above twice more complicated. It also requires a mechanism or change in the regulation to allow concentrating the externality costs within the participant. This new norm can, therefore, be of a challenge for the authorities to find such a mechanism for the sake of energy justice.

6.5.2 Multi-interpreted norm II: Distribution of benefits

Visiting the comment from the 1st interviewee towards the norm for distribution of benefits in Table 6.5, he demonstrated a concern or motive for a specific attribute of **feasibility** (of the project). It seems that the second distributive norm could rather be harmful to the funding of the project itself. Reflecting on the financial situation of the community of BoTu, it is less likely that the people could fund the projects, such as procuring the solar PV and storage, by themselves. Consequently, the external investors may be needed given such a situation.

Furthermore, the norm might immediately discourage those (external) investors as it explicitly favours the worse-off than them. It does not give interesting incentive nor any business mogul for those investors to fund the projects. They may get an idea that they will collect "just enough profit", which is not quite interesting, particularly for profit-driven investors. Learning the conception of justice of the 1st interviewee, he agreed that the poor must also be able to receive the benefits. However, he expressed it in a way that it must not violate the right of the rich to still be benefited by the project.

The 1st interviewee implicitly grounded his conception of justice in the principle of proportionality in which it allows both rich and poor to profit. Analogously, those external investors must also receive profits in return for their investment. The issue here now is rather, to what extent they should receive those profits. Accordingly, it is safe to say that the attribute of **feasibility** has shifted the attention from the worse-off into the better-off (the external investors).

The potential conflict above can also be linked to the expectation of the 4th interviewee for P2P energy trading. He was expecting an interesting model of P2P energy trading which can attract companies to finance the project. It seems that **feasibility** with regards to the funding is indeed important for the specific setting of BoTu. On the other hand, learning the conception of justice of the 3rd interviewee, he indicated that those investors must not also be greedy for the share of the return. Subsequently, "just enough profit" should not be the reason to decrease the feasibility of the project. Concluding all the information above, it is now up to the external investors whether they are on board to prosper community of BoTu by receiving "just enough profit" and allocating more to the worse-off as a response to the conflicting **energy justice** and **feasibility**.

Meanwhile, visiting the comment from the 4th interviewee towards the norm for distribution of benefits, he implied a rather similar judgment to his previous judgment towards cost distribution. Here, he also had the motive for the attribute of **freedom of choice (democracy)**. However, we need to be more careful to consider that the attribute of **democracy** are conflicting with energy justice in the distribution of benefits.

The 4th interviewee believed that allocating benefits to the worse-off is rather an option than

a prescription which must be pursued. However, it might be just he was mixing the concept between "a more technical arrangement" and "the pattern of distribution". In his comment, he mentioned that he would be willing to spend the money (allocate the benefits) on something communal. It will not be a problem if as a result of that communal activities, the worse-offs are the ones who are benefited the most. Here, those communal activities are just part of technical arrangement: in what form the (financial) benefits to be materialised/transformed, which people must deliberate.

Nevertheless, **democracy** will not be considered as the attribute that conflicts with the norm for distribution of benefits. It seems that **democracy** can work in harmony with energy justice referring to the 4th interviewee's case. It may be just he should have discussed his point in the procedural norms (the norm for involvement) instead of here.

6.5.3 Multi-interpreted norm III: Distribution of access

Visiting the comment from the 2nd interviewee towards the norm for distribution of access in Table 6.5, she demonstrated a concern or motive for a specific attribute of **physical capacity/availability**. However, it is quite difficult to interpret her motive as she gave very little information/comment. She did not emphasise the tenet of distributive in her conception of justice either. Similarly, her expectation for P2P energy trading is also not really helpful to reason her motive.

However, in her evaluation of solar PV, she brought forward the risk of limited private space to install solar PV. Recalling property situation in BoTu, the neighbourhood indeed has limited private space for solar PV as most of the housings there are flats. Her evaluation is then extrapolated as the last resort to reason her motive/judgment for the third distributive norm.

Looking back, the norm for distribution of access identified the roofs as, indeed, public/common services under *postcoderoosregeling*, which therefore must be accessible to perform/support electricity trading. However, such *postcoderoosregeling* scheme still cannot change the horrid fact that the number of roofs in BoTu is very limited. Even if the people are allowed to access the roofs easily by the regulation, they are still unable to do so as the roofs in the neighbourhood is very limited that they cannot help it. Consequently, this norm may not be effective to be applied in BoTu.

Furthermore, some could interpret the norm as forcing all the remaining capacity of public goods to be allocated for electricity trading when the practice gets more intense/common. The norm may disregard the fact that those (limited) roofs may also be used for any other purposes, such as for decoration. A similar premise may also apply to the distribution grids. The norm may disregard the fact that the grids can also be used by traditional suppliers to distribute electricity apart from electricity trading between households. Put differently, the norm simply disregards any other functions/purposes of the public goods and put electricity trading above everything. In contrast, the attribute of **physical capacity/availability** might require people to be restricted to perform energy trading so that there is still room for roofs or distribution grids to be used for other purpose. It is now safe to conclude from here that the attribute of **physical capacity/availability** may be conflicting with energy justice.

6.5.4 Multi-interpreted norm IV: Distribution of responsibility

Visiting the comment from the 1st interviewee towards the norm for distribution of responsibility in Table 6.5, he demonstrated a concern or motive for a specific attribute of **consumers protection/safety**. However, he did not mention a word about responsibility or anything related in his conception of justice (as a matter of fact, no interviewee mentioned explicitly about responsibility in their conception of justice). Fortunately, his comment was quite comprehensive that it could explain where his point came from.

His comment, combined with his evaluation of smart meters and digital platforms, give an indication that he preferred to distribute as little responsibility as possible to consumers (community of BoTu). It seems that the 1st interviewee is a pro-consumers person who thinks the consumers can be laid-back. It now makes that he really cares about consumers protection considering he highly prioritises the consumers and does not want to put them under the risks of the system failure. Additionally, he also had negative perception regarding community's awareness of energy-related issues. It might be frightening for him to let people who originally have low awareness of energy-related issue to execute crucial tasks in P2P energy trading because they may not undertake those tasks seriously or correctly and then fail the system.

Trying to cope with his concern and motive, the condition of aligning responsibility with the interest of stakeholders in the electrical system, especially the households, might become a backlash when they do not have an adequate qualification to support their interest. Looking back, the norm for distribution of responsibilities was also aware of such a risk to the point that the attribute of "(personal) capacity" was attached. It required the people to be qualified enough to execute certain tasks to maintain the functionality of the system.

Additionally, the norm was formulated with a rather optimistic attitude that it expected people to sacrifice their time to train and improve their capacity for something that they are interested in. The norm also believed that even households could execute any task or carry any responsibility held by other stakeholders as long as they are willing to train. In short, there was high confidence to combine the attribute of (personal) capacity and interest within the norm for distribution of responsibility.

It turns out that the capacity and the interest of the households may not be a perfect match, especially for the setting of BoTu. Consulting the perceived-energy awareness of the community of BoTu in section 6.1.2, the 1st interviewee mentioned that the people are not really aware or interested in the energy-related issue. Consequently, the norm might be ineffective to be put in place in BoTu. The community might eventually not carry any kind of responsibility in electricity trading because they have low interest in it, while the norm was rather expecting them (households) to carry several responsibilities. The 1st interviewee's preference to distribute as little responsibility as possible to consumers (community of BoTu) becomes even more plausible here.

Furthermore, the 4th interviewee argued that the reality is not as ideal as the optimism conceived by the norm which wants to merge capacity and interest. In his comment for the fourth distributive norm, which could be found in Appendix B.4, he indicated that there are several tasks which are currently impossible to be performed by the households individually no matter how eager

they want to do them due to technical or technology limitation.

However, adopting the attribute of "interest" to approach a just distribution of responsibility in P2P energy trading can not be taken for granted only because there is one or two "currently impossible tasks" or the community is currently not interested in the energy-related issue. It is difficult to give up on the premise that people are entitled to do the tasks that are available in P2P energy trading which they are interested in because the fact that people can be trained to do those held. People may also grow a new interest in energy later. Therefore, it is safe to conclude from here that the attribute of **consumer protection/safety** may be conflicting with the formulated norm as both can be equally important.

6.5.5 Multi-interpreted norm V: Recognition of diversity

Visiting the comment from the 1st interviewee towards the norm for recognition of diversity in Table 6.5, he demonstrated a concern or motive for a specific attribute of, again, **feasibility** (of the project). It seems that this norm could be risky for the completion (duration) of the project itself. The norm may indeed delay the project of electricity trading if it has to be stopped every time it wants to accommodate new social group or new ethnicity. Additionally, consulting composition of residents of BoTu in sub-section 6.1.1, there are many social groups to tap into. The conflict is, therefore, relevant to the specific setting of BoTu.

Although the 1st interviewee did not narrate anything related to justice as recognition in his conception of justice, his frame of reference could be followed from his expectation for P2P energy trading in BoTu. He was envisioning an electricity trading that connects BoTu with another nearby neighbourhood. As a consequence, there are even more social groups which must be acknowledged. The project then requires even longer time to be completed as a result of accommodating each and every identity of social group.

To understand the conflict better, we could imagine what will happen if there is no existing technology at the moment which could, for example, generate electricity that fits the identity of a particular social group in BoTu. It may then require another 5 years of research to come up with such fit solar PV or any other generation technologies. Accordingly, the question of whether it will be worth it to delay the project for that long for the sake of only one social group comes to the surface. From there, it is safe to conclude that the norm has the potential to conflict with the completion of P2P energy trading (**feasibility** of the project).

6.5.6 Additional: Procedure for position

Learning from the conflict in the distribution of benefits as a result of favouring the worse-off, it will be wise to review the norm for the procedure for position although it is not considered as multi-interpreted norms. Accordingly, the comment from the 1st interviewee for the second procedural norm in Appendix B.1 was checked. It was later proven that the condition of "... **maximising** the position of the worse-off" in this norm may be conflicting with the feasibility of the project with regards to the funding.

The situation in this norm is quite similar to the norm for distribution of benefits. The ex-

ternal investors may feel discouraged as a result of favouring the worse-offs, and it subsequently blocks the funding and eventually, the project itself. We may conclude from here that the second procedural norm has the potential to be conflicting with the attribute of **feasibility**. Additionally, the action of "maximising" could rather lead to the unbalanced situation which creates tension between stakeholders.

Regarding the new procedural norm suggested by the 4th interviewee, the first procedural norm may have addressed all the concern he expressed in it already. In sub-section 5.3.1, the norm explicitly suggested that the involvement of communities in arranging data sharing is important, and they can vocalise whether they want to share their data from electricity trading to particular parties or not. Therefore, his suggestion could be well covered by the first procedural norm already and it does not seem to have any form of conflict.

6.6 Conclusion

This chapter strives to answer the following sub-question:

"What does the specific setting of Bospolder-Tussendijken imply to the developed conceptual justice norms for P2P energy trading?"

To approach the answer to the respective question, four interviewees who know and have a connection with BoTu have been consulted. They were asked whether they would agree to have the developed conceptual norms for P2P energy trading be enforced under the specific setting of BoTu. It turned out that 5 out of 9 norms received disagreement expression from the interviewee(s). Those norms are considered as multi-interpreted norms, which means they have the most potential to evoke conflicts with other attributes. Subsequently, after further investigation of the interviewees' comments to the multi-interpreted norms, as well as of their perception of justice in the local energy projects, and their expectation for P2P energy trading to be implemented in BoTu, a conclusion can be made that:

"The specific setting of Bospolder-Tussendijken can cause the implementation of justice norms for P2P energy trading to be conflicting with several other attributes, which are: freedom of choice (democracy), feasibility, physical capacity/availability, and consumer protection/safety"

Further description of the potential conflicts/conflicting attributes that could appear when implementing justice norms for P2P energy trading in BoTu is provided in Table 6.6 below:

Multi-interpreted norms	Observed conflicting attribute	Observed indicator of the setting of BoTu that plays a role/motivates the conflict	Description
Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;	Freedom of choice (democracy)	Household income; Lifestyle	Forcing the norm to be applied in BoTu may force the rich to involuntarily bear the costs of the poor to make those affordable while at the same time, there are not many rich people in BoTu. They will be burdened as a result of such of force; Although the community, in general, has high social participation, it is still uncertain that those few rich people in BoTu will be fine to bear the extra costs of the rest who are poor.
Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	Feasibility (related to the project funding)	Household income	Community of BoTu is less likely able to fund the project of P2P energy trading by themselves, given their income. Forcing the norm to be applied in BoTu will discourage the external investors to provide the fund as it explicitly favours the worse-off than them.
Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;	Physical capacity/availability	Property situation	Specific to the technology of solar PV, community of BoTu has a very limited roof to install solar PV as most of the housings are flats. Forcing this norm to be applied in BoTu can be ineffective. It does not change the fact that they still have limited roofs which make them unable to access those even if the regulation allows the community to access the roofs easily; May norm could also be interpreted to force all the remaining roofs in BoTu to be installed by solar PV and disregard any other functions/purposes.
Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.	Consumers protection/safety	Perceived-energy awareness	Letting people who originally have low awareness of/interest in energy-related issue to execute some (crucial) tasks in P2P energy trading can be (perceived) risky and frightening for others (that those people would likely to fail the system); This norm may also ineffective to be applied in the community of BoTu: the community may as well not carry any kind of responsibility available in P2P energy trading as it has low awareness/interest in energy.
Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;	Feasibility (related to the completion of the project)	Composition of residents: ethnicity	Forcing the norm to be applied in BoTu may delay the completion of P2P energy trading as there are many/diverse social groups (ethnicities) in BoTu that need to tap into.
Additional: Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	Feasibility (related to the project funding)	Household income	The external investors may feel discouraged as a result of favouring/maximising the worse-offs. It subsequently blocks the funding and eventually the project itself as the community is less likely to fund the project by themselves, given their income

Table 6.6: Summary of the potential conflicts/conflicting attributes

Chapter 7

Discussion: Potential actions for the Municipality of Rotterdam to support the realisation of just P2P energy trading

After formulating a set of norms for a just P2P energy trading and identifying the potential conflicts for their implementation in Bospolder-Tussendijken, a set of practical actions to carry the respective norms will be proposed to the problem owner of this research: the Municipality of Rotterdam. Accordingly, this chapter aims to answer the last sub-question, that is:

"What can the Municipality of Rotterdam do to support the realisation of a just P2P energy trading in Bospolder-Tussendijken?"

This chapter is intended to be the discussion chapter of this research. Therefore, the answer to the sub-question above will rather be an open discussion of possible actions for the Municipality of Rotterdam to carry the conceptual norms developed in Chapter 5. Additionally, given the existence of the attributes that are in conflict with the justice norms for P2P energy trading, the implications of executing the recommended actions will be discussed and highlighted whenever possible.

7.1 Exploration of possible actions for the Municipality of Rotterdam: Distributive norms

From the tenet of distributive justice, four distributive norms for the P2P energy trading system were specified to govern the distribution of costs, benefits, access to public/common goods or services, and responsibilities.

Costs

To support the costs of solar PV and batteries to be affordable for the community of BoTu, the Municipality of Rotterdam can either opt between **cost-reduction** or **cross-subsidy**, or maybe

even do both. For the former action, the Municipality must be content to support the Research Development of the manufacture of both items. It may be important for the respective manufacturing companies to perform better cost-efficiency to lower the costs, which can be achieved through proper R&D. As a regulatory body, the Municipality can show the support by providing easy regulation for the operation of manufacturing companies which seriously make R&D to reduce the production costs of the items. The Municipality can also provide incentives such as tax benefits for such companies or even join to invest in R&D activities. The later means indicates that the municipality must be ready to lose some portion of the tax income.

With the second suggested action, on the other hand, the Municipality can retain the tax income, although its practice is rather controversial because cross-subsidy may require the rich (people with higher income) to pay extra to compensate the poor. The issue here will be more of a procedural issue, or more precisely, a conflict between the tenet of distributive and procedural. The Municipality can choose whether the source of subsidy withdrawn from the rich residents of BoTu will be **regulatory** or **voluntary**.

For the former, the success rate to make the costs of solar PV and batteries affordable for the poor is higher than the later (voluntary). However, as the rich will be as good as forced to pay more for the poor and do not have any voice, the tenet of procedural justice might be violated. Additionally, given the number of rich people in BoTu, collecting the source only from them might turn out to be ineffective to compensate the poor even if it strictly regulated. On the other hand, although the success rate to make the costs of solar PV and batteries affordable for the poor is intuitively lower than regulatory, having the rich to decide whether they want to be on board to compensate the poor also means honouring the tenet of procedural justice.

The high social participation of the community of BoTu gives a sheer indication that a lot of rich residents of BoTu might want to compensate the poor voluntarily. Therefore, the result might become fairly alike as with the regulatory, with an addition of avoiding the violation of procedural justice. In more general terms, regulatory leans towards the tenet of distributive and disregard the tenet of procedural, while voluntary leans towards the tenet of procedural and risk the tenet of distributive.

With regards to the cost for grids reinforcement, the action to make it affordable for the community of BoTu is even more difficult as the source of the problem is the regulation itself. Revolutionary changes to the way the costs are socialised are needed. Right now, the cost is impartially distributed across all people. As a result, BoTu even holds the risk of paying higher connection tariff when the electricity trading is turned out to be proceeded in other close-by neighbourhoods, and not in BoTu.

Coming up with a very concrete action to address the core of the problem is rather difficult. However, an action was suggested by the 4th interviewee in light of this issue. The Municipality can work together with the community of BoTu to appeal for status as demonstration areas. That way, the community of BoTu can have the exception for the regular connection tariff. The Municipality together with the DSOs, however, must find such tariff mechanisms where the poor can afford the tariff, and that is beyond the scope of this research.

Additionally, the respective action requires a committed work from the Municipality to convince the national government that the community of BoTu is indeed a prospective subject for such status. A

significant development must occur within the neighbourhood beforehand. The Municipality must work together with the community to install more solar PV, energy storage, as well as practising demand-side management as proof of the fitness.

Another alternative to approach a just distribution of grid cost is by regulating the cost of the grids reinforcement to be isolated within those who engage in the P2P energy trading system. Such an action can help to prevent non-participant from having a negative bottom-line. However, it can be technically challenging and it cannot guarantee that the costs will be affordable for every household in BoTu, especially for the poor.

Benefits

Through the instrument of taxes, the Municipality has significant power to control the distribution of financial benefits available in P2P energy trading. The Municipality can impose a higher tax for every kWh electricity traded by those people who have a relatively large capacity of solar PV or batteries. The proceeds may then be used for procuring solar PV or batteries for the poor, or for compensating the electricity price itself. Therefore, if there is an excess of financial benefits from trading the electricity, it will eventually go to the advantage of the worse-off via re-distribution. Likewise, the Municipality can regulate the maximum return on investment of the external investors. It could prevent the excess of financial benefits from being concentrated between them, while at the same time increase the possibility of the poor to experience (higher) percentage of the return/profits.

However, with such an action, there is a risk that the Municipality will encounter the problem in finding the investors who are willing to invest. It could even discourage the rich residents of BoTu to engage in the investment. Consequently, the Municipality will need to work harder to gather the funding, or need to spend more from the internal pocket (resources). Not to mention that under such an action which highly relies on regulatory power, it has a higher probability to violate the tenet of procedural justice.

Alternatively, the Municipality can re-distribute the financial benefits proportional to the costs that investors spend, while ensuring the benefits are still available for those who cannot make the investment. Such an action gives the impression that the investors also have a possibility to collect higher profit, depending on the costs/investments they spend, and they will not be disfavoured. It gives a more attractive offer to the investors, which consequently increases the feasibility of the project. Such an action, however, requires the Municipality to find the best weighting-factor for the proportionality. Additionally, it still does not solve the issue of highly regulated activity and cannot guarantee that the poor will receive the most from the excessive financial profit.

Access

The Municipality can support the accessibility of the roofs in BoTu for the solar PV instalment by optimising the *postcoderoosregeling* scheme. The Municipality can provide financial incentives or tax benefits to attract more building owners to offer their roofs for *postcoderoosregeling* scheme. However, unless the Municipality can parallelly increase the number of building or roof in BoTu, the suggested actions above will remain ineffective.

Even if the Municipality issued the regulation that can guarantee that people of BoTu can access the

roofs very easy, it is still no use if there is no roof available in BoTu. Alternatively, the Municipality can connect BoTu with the adjacent neighbourhoods where more roofs are available and integrate them as one postcode area for *postcoderoosregeling*. Such an action, on the other hand, causes the project to have longer duration to be completed to accommodate more diverse residents from other neighbourhoods.

Likewise, to support the accessibility of the roofs in BoTu for the solar PV instalment, the Municipality can impose a regulation where every unused buildings' roofs in BoTu can or should be installed by solar PV (of others). The suggested action, however, also has a consequence that the use of the roofs for other purposes will be disregarded (unprioritised). The fact that there is already limited capacity/availability of the roofs in BoTu requires the Municipality to make a stringent decision of how it should be used.

Alternatively, the Municipality can try to balance the use of the roof, in a sense that it will not be entirely used for the solar PV instalment to initiate P2P energy trading. Consequently, the Municipality does need to limit access to the roofs for the instalment of solar PV. Striving for the balance, the Municipality must come up with the best exclusion criteria to allow or not to allow access to the roofs for electricity trading purpose, which is beyond the scope of this research.

Furthermore, the Municipality should work together with the DSOs as the grid owner to ensure that the community of BoTu can access distribution grids for the purpose of electricity trading at any time. Similar to the roof, however, the capacity of the distribution grids in BoTu is considered limited, although Chapter 6 did not provide the exact measure. This situation puts the Municipality within the intersection either to disregard other functions of distribution grid for the sake of electricity trading or to make certain limitation to preserve room for other functions.

In light of access to data from electricity trading, the Municipality, as a regulator, should ensure and evaluate whether the request to access electricity trading data from any stakeholder in the electrical system is genuinely for supporting electricity trading. The Municipality must have the knowledge to distinguish the integrity of the stakeholder who makes such request. The Municipality, through a regulation, can also demand convincing proof (that the data will be used to perform or support electricity trading) before granting access right to data from electricity trading. However, determining in what form such a proof can be materialised is beyond the scope of this research.

With regards to access to important features of P2P platform, the Municipality can demand the P2P platform owners/developers demonstrate or report all the features that will be used by the community of BoTu before it can operate. Accordingly, the Municipality must have the knowledge regarding various possible business model in P2P platform so that it can distinguish whether the features embedded in the platform are already sufficient for the community of BoTu to both sell and purchase the electricity.

Responsibility

To support the community of BoTu to carry responsibility for managing/organising local database or setting the electricity prices in the platform independently, the Municipality can resort to conducting proper education or training. Such an action is aimed at increasing the capacity of the community

of BoTu to competently execute the related tasks. The Municipality can also make several energy campaigns to raise the awareness or interest of the community of BoTu of electricity trading.

However, such lenient decision to let the community of BoTu execute "new tasks" could become a backlash when it turns out that the people are incompetent to carry such responsibilities, even after all the training or campaigns that were given. Consequently, they may repeatedly cause system failures and put other stakeholders under the risk. As an alternative, the Municipality can assess the capacity and the interest of the community of BoTu before allowing the people to carry those responsibilities. As a consequence of the suggested action, the Municipality must resolve on the best criteria to measure such capacity and interest of the community, which is beyond the scope of this research.

Meanwhile, to enable the community of BoTu to be self-responsible for the balance of electricity production and consumption, the Municipality can support (fund) a particular research and development of an algorithm that can predict the individual use of electricity ahead. The Municipality could also support the R&D of the incentives that can make people of BoTu to register ahead before using the electricity. Such incentives or algorithm require another distinguished research.

On the other hand, the Municipality can do quite similar actions to ensure fair distribution of responsibility for the new emerging actors. The Municipality can let them assess their capacity and interest by themselves and trust them to carry the responsibilities they signed up for. However, it again could turn out to be a backlash when those new emerging actors could not assess themselves or overconfident about their own capacity, and then repeatedly incur system failure. Otherwise, the Municipality can assess their capacity and interest, with certain indicators, and decide whether they can carry such responsibilities for consumers protection.

7.2 Exploration of possible actions for the Municipality of Rotterdam: Procedural norms

From the tenet of procedural justice, a set of just deliberation procedure for P2P energy trading design process from three dimensions, namely involvement, position, and resource, was proposed.

Involvement

To support the involvement of the community of BoTu in the deliberation process (take part in the deliberative team), the Municipality can explicitly order the project initiators/investors to have a certain number of community of BoTu's representatives within the deliberative team through regulation. However, the Municipality also must monitor whether such regulation is complied by the initiators/investors of P2P energy trading project in BoTu. Additionally, the Municipality can provide the initiators/investors with easy administrative works or tax reduction (tax-free energy sharing, probably) if they can prove to involve the community of BoTu in the deliberative team. However, such an action can cause the Municipality to lose some portion of the tax income as a result of incentives or rewards provision.

On the other hand, the Municipality also deals with the community that is perceived to have low awareness of energy-related issue. As a result, the community might not be interested in

engaging in the design process. To deal with such an issue, the Municipality can conduct energy campaign in the neighbourhood to highlight the urgency of community participation in the design process of P2P energy trading and make them feel important. Additionally, the Municipality should ensure that the community can always decide between options and that their decision matter. Such an action could prevent the feeling of "with or without them, the result will remain the same", which could discourage the participation of the community in the design process.

Position

To ensure that the position of the worse-off is maximised during the deliberation process of P2P energy trading design, first and foremost, the Municipality should be able to distinguish who are actually the worse-offs in the community of BoTu and validate it. Subsequently, the Municipality should be sensitive towards what those worse-offs concern about and monitor whether their concerns and recommendation are taken into account or properly addressed in the design. Adhering to this suggestion, however, can discourage the participation of others and stimulate tension between the members of the deliberative team.

Alternatively, to alleviate the tension, the Municipality can endorse an even more democratic deliberation process by having all representatives equally hold single vote regardless of their circumstances. Therefore, no one will feel either disfavoured or prioritised and such a deliberation will become more attractive for external investors. Consequently, the feasibility related to the project funding is increased. However, such an action cannot guarantee that the worse-offs could be developed or empowered as optimal.

Moreover, the action might dissipate the safety-net that can prevent the decision to cause the worse-offs to acquire negative bottom-line since the decision will be very dependent on the majority now. Therefore, when the majority has decided on a certain technical arrangement, there is less likely the deliberative team can do more about it except to proceed, even when they know such a decision will put the worse-offs under the risk.

Resource (information)

The Municipality can support the community of BoTu in particular to have meaningful information to make a rational decision in several ways. The Municipality can oblige the project initiators to conduct a meeting with the community to explain all about the project detail, including the project investment. Furthermore, the Municipality can also require the initiators to conduct periodic meetings to present the progress of the project to ensure that the community is kept updated.

Addressing extensive administrative works involved in P2P energy trading, the Municipality can conduct a seminar or even several class meetings to educate the community about administrative obligations within the solar PV ownership via *postcoderoosregeling* scheme. Furthermore, addressing the mobility of the residents in *postcoderoosregeling* scheme, the Municipality can facilitate annual community meeting to update the situation in BoTu regarding who moved in or out the neighbourhood. The Municipality can also support the development of software/system that can automatically update the community when there is people moving in or out.

Similarly, the Municipality can order the project initiators, together with the DSOs, to conduct

a seminar in the neighbourhood to explain the reliability of the smart meters and the way it is connected to and used in the P2P energy trading system. For more transparency, the Municipality can ask the project initiator or the related engineers to make the algorithm of smart meters connection to P2P energy trading system as an open-source. Furthermore, the Municipality can order the platform owners/developers to make a seminar in the neighbourhoods to demonstrate all the features in the P2P platform and let the community try and experience them firsthand.

With such a lot of information to be disseminated and seminar to be conducted, the Municipality needs to anticipate the extra time required for the project to ensure the community to have meaningful information. The extra time needed will be dependent on how quick the community can absorb those information. In addition, the extra time and the effort to conduct seminars or broadcast the information can potentially escalate the project costs, which the Municipality also needs to consider.

7.3 Exploration of possible actions for the Municipality of Rotterdam: Recognition norms

From the tenet of recognition justice, two categories of which the local communities could or should be recognised in the P2P energy trading system were distinguished, namely by acknowledging their diversity of socio-cultural identities, and respecting opinion.

Diversity of socio-cultural identities

To support the acknowledgement of socio-cultural identities of the community of BoTu throughout the deliberation process, the Municipality can oblige the project initiators to conduct in-depth social research in BoTu (probably as part of their feasibility study), demonstrate the result in the report, and distribute it to the representatives of stakeholders in the electrical system. The research should address or investigate social groups in BoTu and the setting related to the landscape, custom, or common practices in the neighbourhood that are perceived important by each group and cannot be disturbed. Additionally, the Municipality can demand the project initiators to predict the reaction of each social group for every technical arrangement as part of the risks assessment.

The suggested actions above, however, require a longer time to complete the project and could also discourage the initiators or external investors as what the Municipality requests are rather troublesome. Therefore, the Municipality might need to provide incentives so that the initiators/external investors are willing to conduct the requested social research, such as by rewarding tax benefits to the initiators if they can prove that the P2P energy trading design successfully accommodate the concern of every social group of BoTu. It is also important for the Municipality to be able to advertise the community of BoTu to the initiators/external investors as a community that is easy to cooperate and has rich and unique knowledge on organising things as one of the incentives.

A more controversial alternative can be the Municipality demand the initiators to initiate P2P energy trading in BoTu per-ethnicity or social group. Such an action can guarantee the concern of each social group of BoTu to be accommodated. However, it also requires much time to finally have all social groups of BoTu perform P2P energy trading.

To make the completion of P2P energy trading more feasible, the Municipality can be lenient by letting the deliberative team not to decide the technical arrangement based on the socio-cultural identities of community, but still require the team to hear the concern of each social group. Although hearing and taking the concern of each social group into account also spend more time, the feasibility of the project to be executed is increased if the decision or the design is not obliged to fit the socio-cultural identities of the community entirely.

Respecting opinion

In more practical terms, the Municipality can support the community of BoTu to be free from any kind of threats for its opinion by ensuring that the community is always allowed to come up with alternatives and could opt-out at any time during the design process of P2P energy trading. Subsequently, there has to be strong law enforcement when such threats do materialise. The Municipality should facilitate the community of BoTu to report on the mistreatments or threats as a result of their opinion during the design process of P2P energy trading and accordingly impose sanction to those who exerted the threats. With the strong law enforcement and clear sanction, such threats can be prevented or at least minimised.

In addition, the Municipality can resort to a more delicate or persuasive approach. The Municipality can demand the deliberative team to get acquainted with the community of BoTu. Such an effort is aimed at harmonising the relationship between the community and other stakeholders in the electrical system. Although it requires more time, a harmonic relationship could discourage any stakeholders involved to exert threats and rather increase the tolerance for the opinion of others.

7.4 Conclusion

This discussion chapter strives to answer the following sub-question:

"What can the Municipality of Rotterdam do to support the realisation of a just P2P energy trading in Bospolder-Tussendijken?"

To answer the question above, several practical actions that the Municipality of Rotterdam can or should do to support each justice norm for P2P energy trading have been suggested and summed in Table 7.1 below. **In general, the Municipality as a regulatory body can exploit its regulatory power to cooperate with or regulate other actors who are involved in the (electrical) system, administrate or organise the items available in P2P energy trading, and advocate the community in particular, aggressively**. Additionally, the conflicting attributes found in Chapter 6 are incorporated in the table, and they are expected to affect several recommended actions. For those actions, alternatives of actions to address or compromise the respective conflicting attributes are provided. An attempt was also made to predict the consequences or the drawbacks of doing each recommended action. Those consequences/drawbacks could be found in Table 7.1 as well, which are **typically about dishonoring one of the tenets of energy justice, discouraging the external investors, and delaying the projects**. The observed conflicting attributes were the primary source in exploring those consequences/drawbacks. However, because some norms or some suggested actions are not explicitly exposed to the conflicting attributes, it becomes more difficult to foresee the consequences or drawbacks of such actions. Accordingly, they are left open with a hyphen mark ("-").

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Distributive justice	Households must be able to afford all the *costs* that are incurred to perform or support the practice of electricity trading;	1. The Municipality can aim for technology cost-reduction by: • Providing easy regulation for the operation of manufacturing companies which seriously make R&D to reduce the production costs of solar PV/batteries • Providing tax benefits for such companies above • Joining to invest in R&D activities	-	The Municipality might lose some portion of the tax income as a result of incentives/rewards provision	-	-
		2. The Municipality can facilitate cross-subsidy in which the source is regulatorily collected from the rich in BoTu	Freedom of choice (democracy)	The rich might be as good as forced to pay more for the poor, which technically violates procedural justice	The Municipality can facilitate cross-subsidy in which the source is voluntarily collected from the rich in BoTu	The success rate to make the costs of solar PV/batteries affordable for the poor is intuitively lower than regulatory
		3. With regards to the grids reinforcement cost, the Municipality can work together with the community of BoTu to appeal for status as demonstration areas to exclusively adjust the connection tariff	-	The Municipality, together with the DSOs, must find such tariff mechanisms where the poor can afford the tariff; The Municipality must work together with the community to install more solar PV, energy storage, as well as, practising demand-side management as proof of the fitness for the national government	-	-
		4. With regards to the grids reinforcement cost, the Municipality can isolate the cost to those who engage in P2P energy trading system	-	The action might be technically challenging and cannot guarantee that the cost will be affordable for every household in BoTu, especially the poor	-	-
	Households must receive the *benefits* from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	1. The Municipality can impose a higher tax for every kWh electricity traded by those people who have a relatively large capacity of solar PV/batteries. The proceeds are then used for procuring solar PV/batteries for the poor, or compensating the electricity price itself;	Feasibility (related to the project funding)	The Municipality might encounter the problem to find the (external) investors who are willing to invest for the neighbourhood	The Municipality can re-distribute the financial benefits proportional to the costs that the investors spend while ensuring the benefits are still available for those who cannot make the investment	The Municipality must find the best weighting factor for the proportionality; There is no guarantee that the poor will receive the most from the excessive financial profit
		2. The Municipality can regulate the maximum return on investment of the external investors to increase the possibility of the poor to experience a higher percentage of the return/profits				

Table 7.1: Practical actions that the Municipality of Rotterdam can or should do to support each justice norm for P2P energy trading

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Distributive justice	Households and other stakeholders in electrical system must be able to *access public goods or services* that are necessary to perform or support electricity trading;	1. The Municipality can provide financial incentives or tax benefits to attract more building owners to offer their roof for *postcoderoosregeling* scheme	Physical capacity/ availability	The actions might remain ineffective unless the Municipality can parallelly increase the number of building or roof in BoTu;	The Municipality can connect BoTu with the adjacent neighbourhoods where more roof are available and integrate them as one postcode area	The project might require even longer time to be completed to accommodate more diverse residents from the interconnection
		2. The Municipality can impose a regulation where every unused buildings' roof in BoTu can or should be installed by solar PV (of others)	Physical capacity/ availability	The use of the roof for other purposes will be disregarded (unprioritised)	The Municipality can try to balance the use of the roof, in a sense that it will not be entirely used for the solar PV instalment	The Municipality might need to limit access to the roof for the instalment of solar PV and need to come up with the best exclusion criteria
		3. The Municipality should work together with the DSOs, as the grid owner, to ensure that the community of BoTu can access distribution grids for the purpose of electricity trading at any time		The use of distribution grids for other purposes will be disregarded (unprioritised)	The Municipality and DSOs can try to balance the use of the distribution grids, in a sense that it will not be entirely used for the electricity trading	The Municipality and DSOs might need to limit the practice of electricity trading to preserve some capacity of distribution grids for other purposes
		4. In light of access to data from electricity trading, the Municipality should ensure and evaluate whether the request to electricity trading data from any stakeholder in the electrical system is genuinely for supporting electricity trading	-	The Municipality must have the knowledge to distinguish the integrity of the stakeholder who makes such request	-	-
		5. With regards to access to important features of P2P platform, the Municipality can demand the P2P platform owners/developers to demonstrate or report all the features that will be used by the community of BoTu before it can operate	-	The Municipality must have the knowledge regarding various possible business model in P2P platform so that it can distinguish whether the features embedded in the platform are already sufficient for the community of BoTu to both sell and purchase the electricity	-	-

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Distributive justice	Households and other stakeholders in electrical system must carry *responsibilities* to support the operation of electricity trading that are aligned with their capacity and interest.	1. The Municipality can resort to conducting proper education or training or energy campaign to support the community of BoTu to carry responsibility for managing/organising local database or setting the electricity prices in the platform independently;	Consumer protection/ safety	It could become a backlash when it turns out that the community is still incompetent to carry such responsibilities, even after all the education, training, or campaign that were given, and then repeatedly causes system failures	The Municipality can assess the capacity and the interest of the community of BoTu before allowing them to carry those responsibilities	The Municipality must resolve on the best criteria to measure such capacity and interest of the community
		2. To ensure fair distribution of responsibility for the new emerging actors, the Municipality can let them assess their capacity and interest by themselves and trust them to carry the responsibilities they signed up for		It could become a backlash when it turns out that those new emerging actors cannot assess themselves or overconfident about their own capacity, and then repeatedly incur system failures	The Municipality can assess the capacity and interest of those new emerging actors and decide whether they can carry such responsibilities	The Municipality must resolve on the best criteria/indicators to measure such capacity and interest of the new emerging actors
		3. To enable the community of BoTu to be self-responsible for the balance of electricity production and consumption, the Municipality can support (fund) a particular R&D of the algorithm that can predict ahead the individual use of electricity;	-	-	-	-
		4. To enable the community of BoTu to be self-responsible for the balance of electricity production and consumption, the Municipality can support (fund) a particular R&D of incentives that can make people in BoTu to register ahead before using the electricity	-	-	-	-

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Procedural justice	Representatives of communities must be *involved* to decide for technical arrangement to distribute specific goods in P2P energy trading;	1. The Municipality can explicitly order the project initiators/investors to have a certain number of community of BoTu's representatives within the deliberative team through regulation	-	The Municipality must work extra by monitoring whether such regulation is complied by the initiators /investors as the enforcement	-	-
		2. The Municipality can provide the initiators/investors with easy administrative works or tax reduction if they can prove to involve the community of BoTu in the deliberative team	-	The Municipality might lose some portion of the tax income as a result of incentives/rewards provision	-	-
		3. To deal with low awareness towards energy-related issues that could cause low participation in the design process, the Municipality can conduct energy campaign in the neighbourhood to highlight the urgency of community involvement and make them feel important	-	-	-	-
		4. The Municipality should ensure that the community can always decide between options	-	-	-	-
	Representatives of communities and other stakeholders in electrical system must maximise the *position* of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	1. The Municipality should be able to distinguish who are the worse-offs in the community, validate it, be sensitive towards what they need, and monitor whether their concerns are addressed in the design	Feasibility (related to the project funding)	Such action can discourage participation of external investors as they feel disfavoured (unprioritised)	The Municipality can endorse a deliberation process where all representatives equally hold single vote regardless of their circumstances	Such deliberation cannot guarantee that the worse-offs could be developed or empowered as optimal; There might be no safety-net for the worse-offs that can guarantee the decision will not cause them to have a negative bottom line

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Procedural justice	Households and other stakeholders in electrical system must receive meaningful *information* that are necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading.	1. The Municipality can oblige the project initiators to conduct a meeting with the community to explain the project investment and periodic meetings to present the progress of the project	-	With such a lot of information to be disseminated and seminar, the Municipality needs to anticipate the extra time required and the incurred costs.	-	-
		2. Addressing extensive administrative works involved in P2P energy trading, the Municipality can conduct several class meetings to educate the community about administrative obligations within the solar PV ownership via *postcoderoosregeling* scheme	-		-	-
		3. The Municipality can order the project initiators, together with DSOs, to conduct a seminar in the neighbourhood to explain the reliability of the smart meters and the way it is connected to and used in the P2P system.	-		-	-
		4. The Municipality can order the platform owners/developers to make a seminar in the neighbourhood to demonstrate all the features in P2P platform and let the community try and experience them firsthand	-		-	-
		5. Addressing the mobility of the residents in *postcoderoosregeling* scheme, the Municipality can facilitate annual community meeting to update the situation in BoTu or support the development of software/system that can automatically update the community when there is people moving in or out	-	-	-	-

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Justice as recognition	Representatives of stakeholders in electrical system must *acknowledge socio-cultural identities* of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;	1. The Municipality can oblige the project initiators to conduct in-depth social research in BoTu, demonstrate the result in the report, and distribute it to others	Feasibility (related to the completion of the project/ project duration)	Such actions might require a longer time to complete the project that may subsequently discourage the initiators from proceeding. Therefore, the Municipality must be able to advertise the community of BoTu to the initiators/external as a community that is easy to cooperate and has unique knowledge on organising things to the investors or reward them if they can prove that the design successfully accommodate the concern of every social group in BoTu	The Municipality can be lenient by letting the deliberative team not to decide the technical arrangement based on the socio-cultural identities of community, but still require the team to hear the concern of each social group	The probability that the technical arrangement will fit the socio-cultural identities of the community (social groups in BoTu) might be lower
		2. The Municipality can demand the project initiators to predict the reaction of each social group for every technical arrangement as part of the risk assessment				
		3. The Municipality can demand the initiators to initiate P2P energy trading in BoTu per-ethnicity or social group				
	Communities must be free from any physical, emotional, and distorted financial threat when they *propose or reject* technical arrangement to distribute specific goods in P2P energy trading.	1. The Municipality can support the community of BoTu to be free from any kind of threats for its opinion by ensuring that the community is always allowed to come up with alternatives and could opt-out at any time during the design process of P2P energy trading	-	-	-	-
		2. The Municipality should facilitate the community of BoTu to report on mistreatments or threats as a result of their opinion during the design process of P2P energy trading and impose the sanction accordingly	-	-	-	-
		3. The Municipality can demand the deliberative team to get acquainted with the community of BoTu to create a harmonic relationship	-	Building a good/harmonic relationship between diverse stakeholders may require a long time	-	-

Chapter 8

Conclusion

This chapter aims to integrate the answer to each sub-question that was discussed in a separate chapter to solve the following Main Research Question:

"What norms can be developed to approach a just P2P energy trading for the community of Bospolder-Tussendijken, and what do they imply to the Municipality of Rotterdam?"

The journey in gathering the answer to the question above was started with the identification of P2P energy trading system in Chapter 4. The respective chapter strived for defining the system from a socio-technical perspective. From resolving the sub-question in that chapter, the specific knowledge of the system could be acquired, which is the prerequisite for the next journey.

From rather broad socio-technical characteristics and definition of P2P energy trading system, an attempt was made to connect those and the energy justice value in Chapter 5. Accordingly, the information or items from Chapter 4 that can be relevant to the energy justice domain were distinguished and grouped. Those items were subsequently used as the context to specify the value of energy justice into a set of norms. Accordingly, from Chapter 4 and 5, a half part of the Main Research Question could be resolved, in which

"There are four distributive norms, three procedural norms, and two recognition norms that can be developed to approach a just P2P energy trading for communities in general"

Subsequently, the relevancy of those norms was assessed and evaluated against the specific setting of Bospolder-Tussendijken in Chapter 6. From the interview with four people who have a connection with the respective neighbourhood, a conclusion could be drawn that those norms could also be applied in Bospolder-Tussendijken. However, *the realisation is rather challenging and problematic as some of the norms are in conflict with several other attributes.*

Given the fact that the realisation of the justice norms for P2P energy trading in Bospolder-Tussendijken might face a challenge, a reflection on the roles of the selected problem owner of this research was made. It seems that *the actions from the Municipality of Rotterdam as a reg-*

ulatory body with extensive financial resources are needed to realise the norms in the respective neighbourhood. Subsequently, the actions that the Municipality of Rotterdam can or should do to support the realisation of those norms in Bospolder-Tussendijken were explored in Chapter 7. Acknowledging the conflicting attributes, *the typical consequences or drawbacks of those actions were also provided as the food for thought for the Municipality of Rotterdam to make a careful decision.*

Connecting partial information from Chapter 6 and 7 to the previous half part of the answer, the complete answer to the Main Research Question can now be presented. Recalling the MRQ:

"What norms can be developed to approach a just P2P energy trading for the community of Bospolder-Tussendijken, and what do they imply to the Municipality of Rotterdam?"

The grand answer to the respective question is then

"There are four distributive norms, three procedural norms, and two recognition norms that can be developed to approach a just P2P energy trading system for communities in general, including the community of Bospolder-Tussendijken. However, the realisation of those norms in the respective neighbourhood is rather challenging and problematic as some of the norms are clashing with several other attributes, given the neighbourhood's specific setting. Consequently, those norms require the Municipality of Rotterdam to perform several actions to support their realisation and to make a well-thought decision, considering there are typical consequences or drawbacks of their actions."

Additionally, the findings in each sub-question of this research will be restated below to clarify the detail of the statement above.

Sub-question 1:

"What is peer-to-peer energy trading system from socio-technical perspective?"

"By adhering to the principle of a socio-technical system which suggests that there are interactions between human behaviours and the technologies, P2P energy trading could be defined accordingly from its three different layers, namely physical, cyber, and business layer. Firstly, from the physical layer, P2P energy trading is a system which requires serious consideration of solar PV and energy storage investment. The investment costs could become a barrier to the succession of the entire system when they are soaring. On the other hand, it is also a system that potentially increases the financial wealth of the users. Additionally, it is a system which influences the organisation of distribution grids. Therefore, cooperation with the DSOs is as good as inevitable. Secondly, from the cyber layer, P2P energy trading is a system in which multiple stakeholders in the electrical system will demand access to the data from the trading to support their operation. It is also a system that opens the possibility for new emerging actors, such as aggregators, to take part. Thirdly, from the business layer, P2P energy trading is a system that requires digital platform as a medium for the

users to make the transaction. The way the users transact within the platform is highly dependent on the concept of the platform that is drawn by its owners/developers."

Sub-question 2:

"What items in P2P energy trading system that can be relevant to the energy justice domain and what norms can be developed accordingly?"

To answer the half part of the sub-question above, the items available in P2P energy trading that can be relevant to the energy justice domain are promoted in the table below. Those relevant items were highlighted under the guidance of the developed criteria in Table 3.3, sub-section 3.1.2.

On-grid solar PV system			**Smart metering system**		**P2P platform**
Investment and ownership	Profitability	Local flexibility and grid balance	Data utilisation in communication network	Reliability of automatic smart meters	Transaction mechanism
The presence of investment costs to procure solar technologies and BoS	The presence of profit from compensation scheme (Feed-in tariffs)	The presence of cost for distribution grids' reinforcement which results in connection tariff adjustment	The presence of cost for communication network expansion	The need for information regarding reliability of the smart meters (e.g. accuracy of smart meters and which appliances/ devices can be connected)	The need for access to important features in P2P platform (i.e. purchasing and selling electricity)
The need for information to make recoverable investment	The presence of profit from supplying electricity/selling excess production	Batteries as a means to balance the grids but rather costly	Potential of emerging actors (e.g. aggregators) which indicates new job opportunities for communities	The need for communities' trust in the operation of smart meters	Designation of transaction mechanism/ principles highly depends on the platform owners
Private ownership which requires access to a private rooftop		Potential income for communities from offering local flexibility services via batteries	The need for access to the data from electricity trading for multiple stakeholders		Households become responsible for setting the electricity prices in the platform
Postcoderoosregeling ownership which requires access to people's property/rooftop		Potential of households to be balance responsible for their own electricity consumption/production	The need for access to the communication network as well as to the DSO's grids		
The need for area size setting of a postal code to support Postcoderoosregeling ownership		Potential of strategic behaviour which requires an agreement for the goals to be achieved and some incentives (subsidy/tax) as the mitigation	Potential of local database management/ organisation		
The need for information to support mobility/changing ownership					

Subsequently, a set of norms was formulated to govern the organisation of the items in the table above by adapting/adjusting principles that have been developed by other authors. Accordingly,

four distributive norms, three procedural norms, and two recognition norms were promoted. Those norms are listed below.

- **Distributive norms**
  1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;
  2. Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;
  3. Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;
  4. Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.
- **Procedural norms**
  1. Representatives of communities must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;
  2. Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;
  3. Households and other stakeholders in electrical system must receive meaningful information that is necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading.
- **Recognition norms**
  1. Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;
  2. Communities must be free from any physical, emotional, and distorted financial threats when they propose or reject technical arrangement to distribute specific goods in P2P energy trading.

Sub-question 3:

"What does the specific setting of Bospolder-Tussendijken imply to the developed conceptual justice norms for P2P energy trading?"

5 out of 9 developed norms are considered as multi-interpreted norms as one or more interviewees who were asked to assess the norms had different opinions about those 5. Those norms are expected to have the most potential to evoke conflicts with other attributes. After further investigation, a conclusion can be made that:

"The specific setting of Bospolder-Tussendijken can cause the implementation of justice norms for P2P energy trading to be conflicting with several other attributes, which

are: freedom of choice (democracy), feasibility, physical capacity/availability, and consumer protection/safety"

Further description of the potential conflicts/conflicting attributes that could appear when implementing justice norms for P2P energy trading in BoTu is provided in the table below:

Multi-interpreted norms	Observed conflicting attribute	Observed indicator of the setting of BoTu that plays a role/motivates the conflict	Description
Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading;	**Freedom of choice (democracy)**	**Household income;** **Lifestyle**	**Forcing the norm to be applied in BoTu may force the rich to involuntarily bear the costs of the poor to make those affordable while at the same time, there are not many rich people in BoTu. They will be burdened as a result of such of force;** **Although the community, in general, has high social participation, it is still uncertain that those few rich people in BoTu will be fine to bear the extra costs of the rest who are poor.**
Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	**Feasibility (related to the project funding)**	**Household income**	**Community of BoTu is less likely able to fund the project of P2P energy trading by themselves, given their income. Forcing the norm to be applied in BoTu will discourage the external investors to provide the fund as it explicitly favours the worse-off than them.**
Households and other stakeholders in electrical system must be able to access public goods or services that are necessary to perform or support electricity trading;	**Physical capacity/availability**	**Property situation**	**Specific to the technology of solar PV, community of BoTu has a very limited roof to install solar PV as most of the housings are flats. Forcing this norm to be applied in BoTu can be ineffective. It does not change the fact that they still have limited roofs which make them unable to access those even if the regulation allows the community to access the roofs easily; May norm could also be interpreted to force all the remaining roofs in BoTu to be installed by solar PV and disregard any other functions/purposes.**
Households and other stakeholders in electrical system must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.	**Consumers protection/safety**	**Perceived-energy awareness**	**Letting people who originally have low awareness of/interest in energy-related issue to execute some (crucial) tasks in P2P energy trading can be (perceived) risky and frightening for others (that those people would likely to fail the system); This norm may also ineffective to be applied in the community of BoTu: the community may as well not carry any kind of responsibility available in P2P energy trading as it has low awareness/interest in energy.**
Representatives of stakeholders in electrical system must acknowledge socio-cultural identities of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;	**Feasibility (related to the completion of the project)**	**Composition of residents: ethnicity**	**Forcing the norm to be applied in BoTu may delay the completion of P2P energy trading as there are many/diverse social groups (ethnicities) in BoTu that need to tap into.**
Additional: **Representatives of communities and other stakeholders in electrical system must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;**	**Feasibility (related to the project funding)**	**Household income**	**The external investors may feel discouraged as a result of favouring/maximising the worse-offs. It subsequently blocks the funding and eventually the project itself as the community is less likely to fund the project by themselves, given their income**

Sub-question 4:

"What can the Municipality of Rotterdam do to support the realisation of a just P2P energy trading in Bospolder-Tussendijken?"

To answer the question above, several practical actions that the Municipality of Rotterdam can or should do to support each justice norm for P2P energy trading have been suggested and summed in the table below. **In general, the Municipality as a regulatory body can exploit its regulatory power to cooperate with or regulate other actors who are involved in the (electrical) system, administrate or organise the items available in P2P energy trading, and advocate the community in particular, aggressively**. Additionally, the conflicting attributes found in Chapter 6 are incorporated in the table, and they are expected to affect several recommended actions. For those actions, alternatives of actions to compromise the respective conflicting attributes are provided. An attempt was also made to predict the consequences or the drawbacks of doing each recommended action. Those consequences/drawbacks could be found in the table below as well, which are **typically about dishonouring one of the tenets of energy justice, discouraging the external investors, and delaying the projects**. The observed conflicting attributes were the primary source in exploring those consequences/drawbacks. However, because some norms or some suggested actions are not explicitly exposed to the conflicting attributes, it becomes more difficult to foresee the consequences or drawbacks of such actions. Accordingly, they are left open with a hyphen mark ("-").

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Distributive justice	Households must be able to afford all the *costs* that are incurred to perform or support the practice of electricity trading;	1. The Municipality can aim for technology cost-reduction by: • Providing easy regulation for the operation of manufacturing companies which seriously make R&D to reduce the production costs of solar PV/batteries • Providing tax benefits for such companies above • Joining to invest in R&D activities	-	The Municipality might lose some portion of the tax income as a result of incentives/rewards provision	-	-
		2. The Municipality can facilitate cross-subsidy in which the source is regulatorily collected from the rich in BoTu	Freedom of choice (democracy)	The rich might be as good as forced to pay more for the poor, which technically violates procedural justice	The Municipality can facilitate cross-subsidy in which the source is voluntarily collected from the rich in BoTu	The success rate to make the costs of solar PV/batteries affordable for the poor is intuitively lower than regulatory
		3. With regards to the grids reinforcement cost, the Municipality can work together with the community of BoTu to appeal for status as demonstration areas to exclusively adjust the connection tariff	-	The Municipality, together with the DSOs, must find such tariff mechanisms where the poor can afford the tariff; The Municipality must work together with the community to install more solar PV, energy storage, as well as, practising demand-side management as proof of the fitness for the national government	-	-
		4. With regards to the grids reinforcement cost, the Municipality can isolate the cost to those who engage in P2P energy trading system	-	The action might be technically challenging and cannot guarantee that the cost will be affordable for every household in BoTu, especially the poor	-	-
	Households must receive the *benefits* from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off;	1. The Municipality can impose a higher tax for every kWh electricity traded by those people who have a relatively large capacity of solar PV/batteries. The proceeds are then used for procuring solar PV/batteries for the poor, or compensating the electricity price itself; 2. The Municipality can regulate the maximum return on investment of the external investors to increase the possibility of the poor to experience a higher percentage of the return/profits	Feasibility (related to the project funding)	The Municipality might encounter the problem to find the (external) investors who are willing to invest for the neighbourhood	The Municipality can re-distribute the financial benefits proportional to the costs that the investors spend while ensuring the benefits are still available for those who cannot make the investment	The Municipality must find the best weighting factor for the proportionality; There is no guarantee that the poor will receive the most from the excessive financial profit

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Distributive justice	Households and other stakeholders in electrical system must be able to *access public goods or services* that are necessary to perform or support electricity trading;	1. The Municipality can provide financial incentives or tax benefits to attract more building owners to offer their roof for *postcoderoosregeling* scheme	Physical capacity/ availability	The actions might remain ineffective unless the Municipality can parallelly increase the number of building or roof in BoTu;	The Municipality can connect BoTu with the adjacent neighbourhoods where more roof are available and integrate them as one postcode area	The project might require even longer time to be completed to accommodate more diverse residents from the interconnection
		2. The Municipality can impose a regulation where every unused buildings' roof in BoTu can or should be installed by solar PV (of others)	Physical capacity/ availability	The use of the roof for other purposes will be disregarded (unprioritised)	The Municipality can try to balance the use of the roof, in a sense that it will not be entirely used for the solar PV instalment	The Municipality might need to limit access to the roof for the instalment of solar PV and need to come up with the best exclusion criteria
		3. The Municipality should work together with the DSOs, as the grid owner, to ensure that the community of BoTu can access distribution grids for the purpose of electricity trading at any time		The use of distribution grids for other purposes will be disregarded (unprioritised)	The Municipality and DSOs can try to balance the use of the distribution grids, in a sense that it will not be entirely used for the electricity trading	The Municipality and DSOs might need to limit the practice of electricity trading to preserve some capacity of distribution grids for other purposes
		4. In light of access to data from electricity trading, the Municipality should ensure and evaluate whether the request to electricity trading data from any stakeholder in the electrical system is genuinely for supporting electricity trading	-	The Municipality must have the knowledge to distinguish the integrity of the stakeholder who makes such request	-	-
		5. With regards to access to important features of P2P platform, the Municipality can demand the P2P platform owners/developers to demonstrate or report all the features that will be used by the community of BoTu before it can operate	-	The Municipality must have the knowledge regarding various possible business model in P2P platform so that it can distinguish whether the features embedded in the platform are already sufficient for the community of BoTu to both sell and purchase the electricity	-	-

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Distributive justice	Households and other stakeholders in electrical system must carry *responsibilities* to support the operation of electricity trading that are aligned with their capacity and interest.	1. The Municipality can resort to conducting proper education or training or energy campaign to support the community of BoTu to carry responsibility for managing/organising local database or setting the electricity prices in the platform independently;	Consumer protection/ safety	It could become a backlash when it turns out that the community is still incompetent to carry such responsibilities, even after all the education, training, or campaign that were given, and then repeatedly causes system failures	The Municipality can assess the capacity and the interest of the community of BoTu before allowing them to carry those responsibilities	The Municipality must resolve on the best criteria to measure such capacity and interest of the community
		2. To ensure fair distribution of responsibility for the new emerging actors, the Municipality can let them assess their capacity and interest by themselves and trust them to carry the responsibilities they signed up for		It could become a backlash when it turns out that those new emerging actors cannot assess themselves or overconfident about their own capacity, and then repeatedly incur system failures	The Municipality can assess the capacity and interest of those new emerging actors and decide whether they can carry such responsibilities	The Municipality must resolve on the best criteria/indicators to measure such capacity and interest of the new emerging actors
		3. To enable the community of BoTu to be self-responsible for the balance of electricity production and consumption, the Municipality can support (fund) a particular R&D of the algorithm that can predict ahead the individual use of electricity;	-	-	-	-
		4. To enable the community of BoTu to be self-responsible for the balance of electricity production and consumption, the Municipality can support (fund) a particular R&D of incentives that can make people in BoTu to register ahead before using the electricity	-	-	-	-

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Procedural justice	Representatives of communities must be *involved* to decide for technical arrangement to distribute specific goods in P2P energy trading;	1. The Municipality can explicitly order the project initiators/investors to have a certain number of community of BoTu's representatives within the deliberative team through regulation	-	The Municipality must work extra by monitoring whether such regulation is complied by the initiators /investors as the enforcement	-	-
		2. The Municipality can provide the initiators/investors with easy administrative works or tax reduction if they can prove to involve the community of BoTu in the deliberative team	-	The Municipality might lose some portion of the tax income as a result of incentives/rewards provision	-	-
		3. To deal with low awareness towards energy-related issues that could cause low participation in the design process, the Municipality can conduct energy campaign in the neighbourhood to highlight the urgency of community involvement and make them feel important	-	-	-	-
		4. The Municipality should ensure that the community can always decide between options	-	-	-	-
	Representatives of communities and other stakeholders in electrical system must maximise the *position* of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	1. The Municipality should be able to distinguish who are the worse-offs in the community, validate it, be sensitive towards what they need, and monitor whether their concerns are addressed in the design	Feasibility (related to the project funding)	Such action can discourage participation of external investors as they feel disfavoured (unprioritised)	The Municipality can endorse a deliberation process where all representatives equally hold single vote regardless of their circumstances	Such deliberation cannot guarantee that the worse-offs could be developed or empowered as optimal; There might be no safety-net for the worse-offs that can guarantee the decision will not cause them to have a negative bottom line

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Procedural justice	Households and other stakeholders in electrical system must receive meaningful *information* that are necessary for them to make rational decision for the technical arrangement to distribute specific goods in P2P energy trading.	1. The Municipality can oblige the project initiators to conduct a meeting with the community to explain the project investment and periodic meetings to present the progress of the project	-	With such a lot of information to be disseminated and seminar, the Municipality needs to anticipate the extra time required and the incurred costs.	-	-
		2. Addressing extensive administrative works involved in P2P energy trading, the Municipality can conduct several class meetings to educate the community about administrative obligations within the solar PV ownership via *postcoderoosregeling* scheme	-		-	-
		3. The Municipality can order the project initiators, together with DSOs, to conduct a seminar in the neighbourhood to explain the reliability of the smart meters and the way it is connected to and used in the P2P system.	-		-	-
		4. The Municipality can order the platform owners/developers to make a seminar in the neighbourhood to demonstrate all the features in P2P platform and let the community try and experience them firsthand	-		-	-
		5. Addressing the mobility of the residents in *postcoderoosregeling* scheme, the Municipality can facilitate annual community meeting to update the situation in BoTu or support the development of software/system that can automatically update the community when there is people moving in or out	-	-	-	-

Governing values	Derived norms	Suggested action	Observed conflicting attributes	Implication/consequence of action/ drawbacks	Alternatives to action (addressing conflicting attributes)	Implication/consequence of alternatives/ drawbacks
Justice as recognition	Representatives of stakeholders in electrical system must *acknowledge socio-cultural identities* of communities throughout the deliberation process for the distribution of specific goods in P2P energy trading;	1. The Municipality can oblige the project initiators to conduct in-depth social research in BoTu, demonstrate the result in the report, and distribute it to others	Feasibility (related to the completion of the project/ project duration)	Such actions might require a longer time to complete the project that may subsequently discourage the initiators from proceeding. Therefore, the Municipality must be able to advertise the community of BoTu to the initiators/external as a community that is easy to cooperate and has unique knowledge on organising things to the investors or reward them if they can prove that the design successfully accommodate the concern of every social group in BoTu	The Municipality can be lenient by letting the deliberative team not to decide the technical arrangement based on the socio-cultural identities of community, but still require the team to hear the concern of each social group	The probability that the technical arrangement will fit the socio-cultural identities of the community (social groups in BoTu) might be lower
		2. The Municipality can demand the project initiators to predict the reaction of each social group for every technical arrangement as part of the risk assessment				
		3. The Municipality can demand the initiators to initiate P2P energy trading in BoTu per-ethnicity or social group				
	Communities must be free from any physical, emotional, and distorted financial threat when they *propose or reject* technical arrangement to distribute specific goods in P2P energy trading.	1. The Municipality can support the community of BoTu to be free from any kind of threats for its opinion by ensuring that the community is always allowed to come up with alternatives and could opt-out at any time during the design process of P2P energy trading	-	-	-	-
		2. The Municipality should facilitate the community of BoTu to report on mistreatments or threats as a result of their opinion during the design process of P2P energy trading and impose the sanction accordingly	-	-	-	-
		3. The Municipality can demand the deliberative team to get acquainted with the community of BoTu to create a harmonic relationship	-	Building a good/harmonic relationship between diverse stakeholders may require a long time	-	-

Chapter 9

Reflection and recommendation

This chapter reflects the methodology that was applied in this research and the findings that have been promoted in each chapter. In the end, the recommendation for the Municipality of Rotterdam, as well as the recommendation for future research will be submitted.

9.1 Reflection 1: Literature review

For the conceptual work of this research, desk research was performed extensively as a lot of information from two fairly different topics, which are electricity trading and energy justice, must be gathered. With respect to the electricity trading, the observation addressed three layers and three technologies in which they are distinctive from each other. Similarly, specific information and principles of energy justice from three different tenets had to be gathered. I found that doing such an unsystematic review was exhaustive.

Instead of optimising the keywords and finding a few relevant papers, I used rather broad keywords and started reading one article and kept visiting the cited references iteratively. While such a technique could give the expected information quickly, I sometimes lost in too many articles. I also did not organise my paper properly, given the number of literature that was visited. Consequently, I found it difficult to recall which information in which paper sometimes. I should have coded all those papers properly by qualitative data analysis and research software such as *Atlas.ti* to prevent such a hassle.

9.2 Reflection 2: Stakeholders interview

The quality of the empirical work of this research seems to be highly determined by the data gathering via stakeholders interview. It was regrettable that I could not find more interviewees during the time span of this thesis and only ended up with four interviewees. Had I managed to interview more stakeholders, I could have improved Chapter 6 a lot better in a way that more conflicts/conflicting attributes might be discovered.

The conceptual work was very time-consuming. It took almost three months to investigate the

socio-technical characteristics of P2P energy trading, to connect those to the energy justice domain, and to generate a set of sensible justice norms. Before I knew it, it was already in the middle of June where people were already busy preparing summer break celebration or so and responded to the interview request slowly. Moreover, I did not manage my time well and refused to be pragmatic by insisting on completing the conceptual work first before making the first contact with the stakeholders.

In addition, I was unable to make a definite connection between the role of each interviewee and his/her answer to all my interview questions despite the diversity of their role. However, I believe that their role biased their answer to some extent, especially when they promoted conflicts/conflicting attributes during the norms assessment.

9.3 Reflection 3: Identification of socio-technical characteristics of P2P energy trading

The framework of multi-layered energy system was used to initiate the identification of socio-technical characteristics of P2P energy trading. The result of Chapter 4 indicates that the framework can be operationalised with technology-focused approach to characterise energy systems/innovations from a socio-technical perspective by assigning one technology driver to each available layer.

Nevertheless, the framework is lacking the information about how the technologies in each layer should be examined to arrive at comprehensive socio-technical characteristics of energy systems. For such a purpose, this research has proposed that those technologies could be discussed under several relevant topics/themes in which the selection is based on several designated criteria. Those criteria can be adjusted to the purposes of the research or what the researchers prioritise or strive for. Put differently, they are highly dependent on the researchers.

9.4 Reflection 4: Translation of energy justice into justice norms for P2P energy trading

One of the most challenging parts of this chapter was about making choices. In the beginning, I had to make a choice regarding which findings or items in P2P energy trading that are relevant to energy justice domain. I was not familiar with qualitative-ethical research to the point that I felt my work and the choice I made to connect those two topics were very intuitive. Later on, I realised that I unconsciously applied some rules/criteria to connect those two topics.

I tried to express those criteria more explicit by putting them in the table, and such practice was helpful. However, if people ask me how I could arrive at such a list of criteria, my best answer will be by my own interpretation. I could not justify myself further than that if it is about criteria or rules that I applied (also for any other criteria that I applied to make choices in other sections or sub-questions).

Formulating a set of sensible justice norms for P2P energy trading was equally challenging, if not more troublesome. Looking back, the whole conceptual work in Chapter 5 was grounded in the framework of value-hierarchy. Even though the framework does an excellent job in distinguishing

between values, norms, and design requirements, and how they can be connected to each other, it does not provide the systematic steps to construct a norm from a value. The result of Chapter 5 demonstrates that such systematic steps are necessary to formulate a set of norms from a specific value. Adapting the principles that have been promoted by other authors who made somewhat related research to the items that are discussed or aimed to be organised can be an alternative as well as a critical step to operationalise the framework. However, such an adaption technique requires extensive interpretation of the researchers, which may vary from one to another. Put differently, the result could become very subjective.

To acquire a more objective result, multiple stakeholders can be gathered to formulate the norms cooperatively. Such co-formulation of norms may do more justice as the resulting set of norms will not solely be based on an individual's interpretation.

9.5 Reflection 5: Exploration of the conflicts for the implementation of justice norms

One of the main activities in Chapter 6 was norms assessment. For such a purpose, a threshold was formulated to identify a set of norms that has the most potential to be in conflict with other attributes. Looking back, the threshold was adapted from the work of Miller and Friedman (2007) with respect to the concept of value dams. The result of Chapter 6 indicates that the respective threshold that was developed in this research may contribute to the fundamental concept of value dams, that people may oppose or have different opinions about the norms, besides the values. As such, a connection between value-hierarchy and value dams can be drawn. Moreover, the threshold that was developed from the conceptualisation of value dams could be applied in the Likert-scale for assessing not only the severity of harms but also the relevancy of norms in which they are quite distinctive from each other.

Additionally, some of the activities within the empirical work of this research were undertaken behind the desk. I resorted to characterising the community of BoTu by observing the web portal. However, it could be done differently by conducting an on-site observation in the neighbourhoods.

9.6 Reflection 6: Discussion

The discussion was highly grounded in my interpretation of stakeholders' suggestions and related literature. I also applied four hypothetical assumptions which could undermine the product of the discussion, which entails recommendation of actions for the Municipality of Rotterdam. However, such assumptions were applied partly because I have little knowledge about roles, responsibilities, and resources of the Municipality of Rotterdam. Chapter 7 can be presented better if I have better access to and communication with the Municipality.

9.7 Recommendation for the Municipality of Rotterdam

Chapter 7 has openly discussed in more detail the recommendation of actions for the Municipality of Rotterdam to support the realisation of justice norms for P2P energy trading in BoTu. The key-points of those recommendations will be pin-pointed below.

1. As a regulatory body, the Municipality of Rotterdam can exploit its regulatory power to organise the items available in P2P energy trading to optimise the tenet of distributive in particular. Such an organisation that is highly regulated seems to be effective for almost all types of goods in P2P energy trading that are relevant to the tenet of distributive. However, an overly-regulated organisation has a high potential to impair the tenet of procedural. The Municipality must decide whether the tenet of distributive will receive higher priority over procedural, or the other way around, or both tenets are better to be balanced.

2. For the sake of procedural justice, the Municipality of Rotterdam should issue the regulation, which entails rules and incentives, to ensure the involvement of the community of BoTu in the design process of P2P energy trading is safeguarded. However, the Municipality also needs to decide whether or not some of the people from the community who are considered as the worse-off will receive special treatment during the deliberation.

3. For the sake of justice as recognition, the Municipality of Rotterdam should issue the regulation that orders the project initiators of P2P energy trading to conduct in-depth social research addressing all social groups of BoTu as part of their feasibility study. Such social research can be partly for predicting the reaction of each social group to the realisation of P2P energy trading in its neighbourhood. However, the Municipality also needs to consider the extra time that is needed for doing such social research which could subsequently escalate the costs of the project and even discourage the initiators from advancing the project.

9.8 Recommendation for future research

As the final contribution, a set of potential future research as a continuation of this research has been listed below.

1. As indicated in Chapter 1, the findings of the conceptual norms can be specified further into more specific and concrete design requirements. It will be very challenging research to specify the items in P2P energy trading into a more technical level and to find validation criteria for the requirements.

2. The identification of P2P energy trading system can be further advanced by examining more technologies that could be used in the P2P energy trading system, such as by combining wind technologies and solar PV.

3. The empirical work of this research can be repeated with other stakeholders in the electrical system as the problem owner. Consequently, the actions to support the realisation of P2P energy trading should be addressed to those respective stakeholders. There might be conflicts of interest between actions of different stakeholders and it will be an interesting multi-actor-type of research.

References

Architecture, P. (n.d.). *BOTU NEXT: How to transform the deprived Bospolder-Tussendijken area in Rotterdam into a Next Generation and Zero-Energy Neighborhood?* https://www.personal-architecture.nl/botu.

Arráez-Cancelliere, O. A., Muñoz-Galeano, N., & Lopez-Lezama, J. M. (2017). Performance and economical comparison between micro-inverter and string inverter in a 5, 1 kWp residential PV-system in Colombia. *2017 3rd IEEE Workshop on Power Electronics and Power Quality Applications, PEPQA 2017 - Proceedings*, 5–9. doi: 10.1109/PEPQA.2017.7981678

Aslaksen, E. (2009). *Designing complex systems : foundations of design in the functional domain LK - https://tudelft.on.worldcat.org/oclc/839246614* (NV - 1 online resource (x, 164 p.) : illustrations. ed.). Boca Raton: CRC Press. Retrieved from http://search.ebscohost.com/login.aspx?direct=true{&}scope=site{&}db=nlebk{&}db=nlabk{&}AN=256974

Aubel, P. V., & Poll, E. (n.d.). Smart metering in the Netherlands : what , how , and why. , 1–8.

August, S. T. (2015). Data concentrators and the Smart Grid. , 1–6.

Bauer, J. M. (2014). Platforms, systems competition, and innovation: Reassessing the foundations of communications policy. *Telecommunications Policy*, *38*(8-9), 662–673. Retrieved from http://dx.doi.org/10.1016/j.telpol.2014.04.008 doi: 10.1016/j.telpol.2014.04.008

Bianchin, M., & Heylighen, A. (2018). Just design. *Design Studies*, *54*, 1–22. doi: 10.1016/j.destud.2017.10.001

Bompard, E. (2012). EMERGING ELECTRICAL SYSTEM AS INTERACTING DYNAMIC MULTILAYERS COMPLEX SYSTEMS. , 1–37.

Bouffard, F., & Kirschen, D. S. (2008). Centralised and distributed electricity systems. *Energy Policy*, *36*(12), 4504–4508. doi: 10.1016/j.enpol.2008.09.060

Boycom. (n.d.). *What Affects Speed ?* http://www.boycom.com/pdfs/WhatAffectsSpeed.pdf.

Bruch, M., & Müller, M. (2014). Calculation of the cost-effectiveness of a PV battery system. *Energy Procedia*, *46*, 262–270. doi: 10.1016/j.egypro.2014.01.181

Capodieci, N., Pagani, G. A., Cabri, G., & Aiello, M. (2011). Smart meter aware domestic energy trading agents. (January), 1–10. doi: 10.1145/1998640.1998641

Centraal Bureau voor de Statistiek. (2018). *More wind and solar electricity.* https://www.cbs.nl/en-gb/news/2018/09/more-wind-and-solar-electricity.

Cuppen, E. (2018). The value of social conflicts. Critiquing invited participation in energy projects. *Energy Research and Social Science*, *38*(January), 28–32. Retrieved from https://doi.org/10.1016/j.erss.2018.01.016 doi: 10.1016/j.erss.2018.01.016

Damme, E. (2005). Liberalizing the Dutch Electricity Market: 1998-2004. *The Energy Journal*, *26*, 155–180. doi: 10.2139/ssrn.869728

Davis, J., & Nathan, L. (2015). Value Sensitive Design: Applications, Adaptations, and Critiques.

Handbook of Ethics, Values, and Technological Design: Sources, Theory, Values and Application Domains, 11–40. doi: 10.1007/978-94-007-6970-0

De Vries, L., Correljé, A., & Knops, H. (2018). Sen1521 Electricity Market Design and Policy Choices.

Delfshaven. (2018). *Energiewijk BoTu (Energy District BoTu)* (Tech. Rep.).

Doorn, N. (2019). *Water Ethics: An Introduction*. Rowman & Littlefield.

eclareon GmbH. (2012). *Legal Sources on Renewable Energy; Netherlands: overall summary.* `http://www.res-legal.eu/search-by-country/netherlands/`.

Eekels, J., & Roozenburg, N. (1991). A methodological comparison of the structures of scientific research and engineering design. Their similarities and differences. In (pp. 197–203).

Ekanayake, J. B., Jenkins, N., Liyanage, K., Wu, J., & Yokoyama, A. (2012). *Smart Grid: Technology and Applications*. John Wiley & Sons.

Ellabban, O., Abu-Rub, H., & Blaabjerg, F. (2014). Renewable energy resources: Current status, future prospects and their enabling technology. *Renewable and Sustainable Energy Reviews*, *39*, 748–764. Retrieved from `http://dx.doi.org/10.1016/j.rser.2014.07.113` doi: 10.1016/j.rser.2014.07.113

ENA: Energy Network Association. (2015). Network Business Model Evolution.

Energieleveranciers.nl. (n.d.). *Overview of Electricity and Gas Network Operators in the Netherlands.* `https://www.energieleveranciers.nl/netbeheerders/overzicht-netbeheerders`.

Energy Networks Association. (2017). Open Networks Project. Workstream 3: DSO Transition. Product 1a). Retrieved from `http://www.energynetworks.org/assets/files/electricity/futures/Open{_}Networks/DSODefinitionandRR{_}v7.0.pdf`

Enexis Netbeheer. (2017). *Grid Flex Heeten.* `www.gridflex.nl`.

ENGIE. (n.d.). *Energy Communities in The Netherlands.* `https://innovation.engie.com/en/innovation-trophies-2018/energy-community/9781`.

Fahlquist, J. N., Doorn, N., & van de Poel, I. (2017). Design for the Value of Responsibility. , 1–15. Retrieved from `http://link.springer.com/10.1007/978-94-007-6994-6` doi: 10.1007/978-94-007-6994-6

Finley-Brook, M., & Holloman, E. L. (2016). Empowering energy justice. *International Journal of Environmental Research and Public Health*, *13*(9). doi: 10.3390/ijerph13090926

Frontier Economics. (2015). Scenarios for the Dutch electricity supply system. (September), 1–169. Retrieved from `http://www.frontier-economics.com/documents/2016/09/scenarios-dutch-electricity-supply-system.pdf`

González-eguino, M. (2015). Energy poverty : An overview. , *47*, 377–385. doi: 10.1016/j.rser.2015.03.013

Gramatikov, M., & Laxminarayan, M. (2008). *Weighting justice: Constructing an index of access to justice* (Vol. 010/2008). Tilburg Institute for Interdisciplinary Studies of Civil Law and Conflict Resolution Systems (TISCO).

Group, T. G. M. (n.d.). *Time to shine: Solar power is fastest-growing source of new energy — Environment — The Guardian.* `https://www.theguardian.com/environment/2017/oct/04/solar-power-renewables-international-energy-agency`.

Heffron, R. J., & McCauley, D. (2017). The concept of energy justice across the disciplines. *Energy Policy*, *105*(March), 658–667. doi: 10.1016/j.enpol.2017.03.018

International Energy Agency. (2010). Technology Roadmap: Solar Photovoltaic Energy. Retrieved from `https://www.oecd-ilibrary.org/energy/technology-roadmap-solar-photovoltaic-energy{_}9789264088047-en` doi: 10.1787/9789264088047-en

Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research and Social Science*, *11*, 174–182. Retrieved from http://dx.doi.org/10.1016/j.erss.2015.10.004 doi: 10.1016/j.erss.2015.10.004

Karimi, M., Mokhlis, H., Naidu, K., Uddin, S., & Bakar, A. H. (2016). Photovoltaic penetration issues and impacts in distribution network - A review. *Renewable and Sustainable Energy Reviews*, *53*, 594–605. Retrieved from http://dx.doi.org/10.1016/j.rser.2015.08.042 doi: 10.1016/j.rser.2015.08.042

Kellett, J. (2007). Community-based energy policy: A practical approach to carbon reduction. *Journal of Environmental Planning and Management*, *50*(3), 381–396. doi: 10.1080/09640560701261679

Koirala, B. P., Koliou, E., Friege, J., Hakvoort, R. A., & Herder, P. M. (2016). Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems. *Renewable and Sustainable Energy Reviews*, *56*, 722–744. Retrieved from http://dx.doi.org/10.1016/j.rser.2015.11.080 doi: 10.1016/j.rser.2015.11.080

Laan, M. V. D. (2018). GridFlex Heeten investigates feasibility of local energy market. Retrieved from https://ict.eu/wp-content/uploads/2018/10/ICT-GROUP{_}Casestudy-Energy-GFH{_}UK{_}Dig.pdf

Lakshminarayana, S., Quek, T. Q., & Poor, H. V. (2014). Cooperation and storage tradeoffs in power grids with renewable energy resources. *IEEE Journal on Selected Areas in Communications*, *32*(7), 1386–1397. doi: 10.1109/JSAC.2014.2332093

Liu, N., Yu, X., Wang, C., Li, C., Ma, L., & Lei, J. (2017). Energy-Sharing Model with Price-Based Demand Response for Microgrids of Peer-to-Peer Prosumers. *IEEE Transactions on Power Systems*, *32*(5), 3569–3583. doi: 10.1109/TPWRS.2017.2649558

Long, C., Wu, J., Zhou, Y., & Jenkins, N. (2018, sep). Peer-to-peer energy sharing through a two-stage aggregated battery control in a community Microgrid. *Applied Energy*, *226*, 261–276. Retrieved from https://linkinghub.elsevier.com/retrieve/pii/S0306261918308146 doi: 10.1016/j.apenergy.2018.05.097

Mathias Aarre Maehlum. (n.d.). *Solar Cell Comparison Chart – Mono-, Polycrystalline and Thin Film.* https://energyinformative.org/solar-cell-comparison-chart-mono-polycrystalline-thin-film/.

McCauley, D., Heffron, R. J., Stephan, H., Jenkins, K., Gillard, R., Snell, C., & Bevan, M. (2013). Advancing energy justice: the triumvirate of tenets and systems thinking. *International Energy Law Review*, *32*(3), 107–110. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85019450216{&}doi=10.1016{%}2Fj.erss.2017.05.012{&}partnerID=40{&}md5=d90270e8efc5f9dfd57fea1ff4d8b99e{%}0Ahttp://dx.doi.org/10.1016/j.erss.2017.05.012{%}0Ahttp://dspace.stir.ac.uk/handle/1893/18349 doi: 10.1016/j.erss.2017.05.012

Milchram, C., Hillerbrand, R., van de Kaa, G., Doorn, N., & Künneke, R. (2018). Energy Justice and Smart Grid Systems: Evidence from the Netherlands and the United Kingdom. *Applied Energy*, *229*(September 2017), 1244–1259. doi: 10.1016/j.apenergy.2018.08.053

Miller, J. K., & Friedman, B. (2007). Value Tensions in Design: The Value Sensitive Design. , 281–290.

Morstyn, T., Farrell, N., Darby, S. J., & McCulloch, M. D. (2018). Using peer-to-peer energy-trading platforms to incentivize prosumers to form federated power plants. *Nature Energy*, *3*(2), 94–101. doi: 10.1038/s41560-017-0075-y

Netbeheer Nederland. (2018). *Main Document: Dutch Smart Meter Requirements* (Tech. Rep.).

New England Clean Energy. (2017). *Different Types of Utility Meter for Solar — The Energy Miser.* https://newenglandcleanenergy.com/energymiser/2017/02/15/different-types-of-utility-meters-for-solar/.

Nieusma, D., & Riley, D. (2010). *Designs on development:Engineering, globalization, and social justice* (Vol. 2) (No. 1). doi: 10.1080/19378621003604748

Osseweijer, F. J., Van Den Hurk, L. B., Teunissen, E. J., & Van Sark, W. G. (2017). A Review of the Dutch Ecosystem for Building Integrated Photovoltaics. *Energy Procedia*, *111*(September 2016), 974–981. doi: 10.1016/j.egypro.2017.03.260

Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *American Economic Review*, *100*(3), 641–672. doi: 10.1257/aer.100.3.641

Paben, J. M. Z. (2018). Green Power & Environmental Justice - Does Green Discriminate? *Texas Tech Law Review*, *1069*(2012), 1–42.

Pekka, S., Diaz, L., Orchard, N., Vorisek, T., Rochas, C., Morch, A. Z., ... Togeby, M. (2008). Definition of Smart Metering and Applications and Identification of Benefits. *European Smart Metering Alliance*, *25*(May), 1–42.

Pesch, U., Correljé, A., Cuppen, E., & Taebi, B. (2017). Energy justice and controversies: Formal and informal assessment in energy projects. *Energy Policy*, *109*(November 2016), 825–834. Retrieved from http://dx.doi.org/10.1016/j.enpol.2017.06.040 doi: 10.1016/j.enpol.2017.06.040

Pols, A., & Spahn, A. (2015). Handbook of Ethics, Values, and Technological Design. *Handbook of Ethics, Values, and Technological Design*, 1–24. doi: 10.1007/978-94-007-6994-6

Pouttu, A., Haapola, J., Ahokangas, P., Xu, Y., Kopsakangas-Savolainen, M., Porras, E., ... Casado, S. (2017). P2P model for distributed energy trading, grid control and ICT for local smart grids. *EuCNC 2017 - European Conference on Networks and Communications*. doi: 10.1109/EuCNC.2017.7980652

Proka, A., Hisschemöller, M., & Loorbach, D. (2018). Transition without conflict? Renewable energy initiatives in the dutch energy transition. *Sustainability (Switzerland)*, *10*(6). doi: 10.3390/su10061721

Rawls, J. (1971). *A theory of justice.* Cambridge: Mass: Belknap Press of Harvard University Press.

Schleicher-Tappeser, R. (2012). How renewables will change electricity markets in the next five years. *Energy Policy*, *48*, 64–75. Retrieved from http://dx.doi.org/10.1016/j.enpol.2012.04.042 doi: 10.1016/j.enpol.2012.04.042

Schoen, T. J. (2002). Building-integrated PV installations in the Netherlands: Examples and operational experiences. *Solar Energy*, *70*(6), 467–477. doi: 10.1016/s0038-092x(00)00142-0

SIA Partners. (2018). *Peer-to-peer (P2P) energy : A threat or an opportunity for traditional suppliers ? — Energy Outlook.* http://energy.sia-partners.com/20180911/peer-peer-p2p-energy-threat-or-opportunity-traditional-suppliers.

Sidortsov, R., & Sovacool, B. (2015). Left out in the cold: energy justice and Arctic energy research. *Journal of Environmental Studies and Sciences*, *5*(3), 302–307. doi: 10.1007/s13412-015-0241-0

Sigl, C., Faschingbauer, A., Berl, A., Geyer, J., Vohnout, R., & Prokýšek, M. (2018). The role of smart meters in P2P energy trading in the low voltage grid. *CEUR Workshop Proceedings*, *2300*, 280–284.

Sijm, J., Gockel, P., van Hout, M., Özdemir, Ö., van Stralen, J., Smekens, K., ... Musterd, M. (n.d.). The supply of flexibility of the power system in the Netherlands, 2015-2050 - Report of phase 1 of the FLEXNET project. (November), 2015–

2050. https://www.tno.nl/media/12355/e17037-flexnet-the-demand-for-flexibility-of-the-power-system-in-the-netherlands-2015-2050-phase-1.pdf.

Smets, A., Jager, K., Isabella, O., van Swaaij, R., & Zeman, M. (2010). *Solar energy*. doi: 10.1201/b10163

Smith, E., & Klick, H. (2008). Explaining NIMBY opposition to wind power.

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435–444. Retrieved from http://dx.doi.org/10.1016/j.apenergy.2015.01.002 doi: 10.1016/j.apenergy.2015.01.002

Sovacool, B. K., Lipson, M. M., & Chard, R. (2019). Temporality, vulnerability, and energy justice in household low carbon innovations. *Energy Policy*, *128*(September 2018), 495–504. doi: 10.1016/j.enpol.2019.01.010

Stedin, & Energy21. (2018). Whitepaper: Layered Energy System - Inclusive enablement of local power. (November), 1–20.

Sytek. (n.d.). *Why Does My Internet Connection Appear to be Slow?* https://www.sytekcom.com/pdf/sytek-video-script.pdf.

TBM, I. (n.d.). *Electricity transmission grid.* http://infra.tbm.tudelft.nl/index.php/Electricity_transmission_grid.

TenneT. (n.d.). *Balance responsible parties.* https://www.tennet.eu/our-key-tasks/energy-industry/balance-responsible-parties/.

Times, N. (n.d.). *Dutch King pays unannounced visit to problem neighborhood in Rotterdam.* https://nltimes.nl/2019/02/20/dutch-king-pays-unannounced-visit-problem-neighborhood-rotterdam.

Tushar, W., Saha, T. K., Yuen, C., Liddell, P., Bean, R., & Poor, H. V. (2018). Peer-to-Peer Energy Trading with Sustainable User Participation: A Game Theoretic Approach. *IEEE Access*, *6*, 62932–62943. doi: 10.1109/ACCESS.2018.2875405

Van den Hoven, M. (2018). Co-designing Blockchain and Market in the Dutch Electricity Sector.

Van de Poel, I. (2013). Translating Values into Design Requirements. In D. P. Michelfelder, N. McCarthy, & D. E. Goldberg (Eds.), *Philosophy and engineering: Reflections on practice, principles and process* (pp. 253–266). Dordrecht: Springer Netherlands. Retrieved from https://doi.org/10.1007/978-94-007-7762-0{_}20 doi: 10.1007/978-94-007-7762-0_20

Van de Poel, I. (2014). Design for Values in Engineering. *Handbook of Ethics, Values, and Technological Design*, 1–20. doi: 10.1007/978-94-007-6994-6

van Hooft, S. (2006). *Understanding Virtue Ethics*. Acumen Publishing.

Vermaas, P. E., & Hekkert, P. (2014). Design Methods in Design for Values. *Handbook of Ethics, Values, and Technological Design*, 1–19. doi: 10.1007/978-94-007-6994-6

Versteeg, K. (2018). *Dutch Solar PV - Market Growth & Trends — The Solar Future NL '19.* https://thesolarfuture.nl/nieuws-source/2018/2/28/dutch-solar-pv-market-growth-trends.

Zhang, C. (2017). *Peer-to-Peer Energy Trading in Electrical Distribution Networks* (Doctoral dissertation). Retrieved from https://orca.cf.ac.uk/109074/1/2018ZhangCPhD.pdf

Zhang, C., Wu, J., Zhou, Y., Cheng, M., & Long, C. (2018). Peer-to-Peer energy trading in a Microgrid. *Applied Energy*, *220*(February), 1–12. doi: 10.1016/j.apenergy.2018.03.010

Zhu, T., Huang, Z., Sharma, A., Su, J., Irwin, D., & Mishra, A. (2013). Sharing Renewable Energy in Smart Microgrids.

Appendices

Appendix A

Components in the on-grid PV system

In this appendix, the functions of each component which form the on-grid PV system, as well as some technology options or configurations that are available in the market, will be presented.

A.1 PV modules

PV modules are component which responsible for converting the solar energy into electrical power. There are three options of solar modules commonly used in built environment, which are mono-crystalline, poly-crystalline, and thin-film. Those modules have different characteristics and the selection of which PV modules best to be used depends on the situation and the set of priorities. Comparison of the characteristics between the three PV modules is shown in Table A.1 below.

A.2 Inverters

Inverters are component needed to transform the DC power generated by PV modules to AC power so that they can be fed to the grid. Currently, there are three types of inverter architecture available on the market, namely central inverter, string inverter, and micro inverter. However, string inverter and micro inverter are the most preferred options for households use (Arráez-Cancelliere, Muñoz-Galeano, & Lopez-Lezama, 2017). The comparison between these two architectures is briefly described in Table A.2. Additionally, a lot of inverters has already been embedded with DC-DC converter to harmonise the fluctuating voltage of PV output as a result of changing weather (Smets et al., 2010).

A.3 Mounting structure

Mounting structure is important to fix and keep the modules immovable. This mounting structure depends on location where the modules are installed. In general, there are three ways to mount the modules, two most popular are roof-mounted and ground-mounted. As the name suggested,

roof-mounted puts the modules on top of the roof while ground-mounted sets the modules on the ground, such as backyard. Another, recently growing way to mount the modules in the Netherlands is building-integrated PV (Schoen, 2002). This method replaces some building parts, such as tiles or facades, with PV modules. However, this method is still on the early development stage (Osseweijer, Van Den Hurk, Teunissen, & Van Sark, 2017).

A.4 Cables

Cables are component used to connect all other components in the solar PV system as well as connecting the system to both distribution grid and all electric appliances (Smets et al., 2010). The cables have to be chosen in such a way that they can withstand the changing operational condition such as voltage, current, and environment.

Parameter	Thin-Film (Amorphous)	Mono-Crystalline	Poly-Crystalline
Typical module efficiency	6-8%	15-20%	13-16%
Area required for 1 KWp	13-20 m2	6-9 m2	8-9 m2
Lowest price/watt peak	0.69 $/W	0.75 $/W	0.62 $/W
Typical length of warranty	10-25 years	25 years	25 years
Relative production cost	Low	High	Low to medium
Temp resistance	Tolerate extreme heat	Performance drops 10-15% at high temperatures	Temperature resistant than monocrystalline
Relative energy yield	High	Medium to high	Medium to high

Table A.1: Comparison of characteristics between three common types of PV modules (Mathias Aarre Maehlum, n.d.)

Parameter	String inverter	Micro-inverter
Function	Set of PV modules in parallel are connected to the string inverter for DC-to-AC conversion; The entire string will get affected if one module is shaded.	One micro-inverter is assigned for every PV module to convert DC to AC; Shading affect modules individually.
Relative product price	Low	High
Performance in shading	Poor	High
Mismatch losses	Yes	No
Number of electronic components	Normal	High

Table A.2: Comparison between string and micro-inverter (Arráez-Cancelliere et al., 2017)

This page is intentionally left blank.

Appendix B

Transcripts interviews

B.1 Interview 1

Stedin's engineer
Date: 03-07-2019
Time: 11:00 - 12:00

Q: Can you tell me more about the community of BoTu? How would you characterize the people? Such as what kind of people reside there? How are their living conditions? How do they deal with energy on daily basis?

A: I do not know the people from there personally but the idea that is given from that neighbourhood is that it is a poor neighbourhood according to the Dutch standard. People living mostly in apartments, so not in houses. Energy is not the topic which is high on their priority list. For some, electricity might sometimes be a problem. So energy poverty might be a problem there I can imagine. My idea is that most of the people will not invest in PV, or storages, or heat pumps by themselves simply because they do not have the money for it to invest in front and also because it is not their daily worries. I think how they get energy is not something they very often think about. However, because the current Dutch energy system is quite cheap, I do not think they have energy shortage and I do not think they want to have it.

Q: How do you see and value justice for local energy projects, especially for such kind of neighbourhood or community?

A: Well, I see people who have money, they can invest in solar PV panels and install those on their roofs, and they can buy electric cars. When doing that, they can get profit from subsidies and tax advantages, which are available in the Netherlands. On contrary, the people who do not have the money cannot access those advantages. So, I guess, that is not really fair. Justice is not taking place there. I think by making sustainable energy accessible also for poorer neighbourhoods would mean more justice. But be careful because I think it will become more "interesting" for others to invest in sustainable energy which can be used by the poor neighbourhoods where not only people who invest in it can profit but also people who do not invest in it.

So then that is also a basic property behind *layered energy system*, that if you have a lot of local sustainable energy produced, you will also need households who do not make the investment to consume. So, they could get some balance and justice and we give people who do not have the money to invest access to profitable side of energy transition. I think people who do not invest in energy innovation should also be benefited. Basically, from the past, the energy costs are always socialised. We want to make it as cheap and accessible as possible for everyone. However, I also do not think that such energy project will bring a lot of jobs for many people. It will bring extra economic activities but in the end I doubt it will give many extra jobs where a neighbourhood like this can profit. I think the profit will be more in financial, more green supply, and taking part of the green energy system. Also of course, on the long term, I think it can help the neighbourhood to be more resilient. There will be grow of economic activities.

Q: Given the simple representation of electricity trading that I showed you, do you think it would be feasible to realise such electricity trading in this community that embrace your conception of your justice such as that you mentioned that the poor should be receiving money without investing to the project?

A: In theory it is feasible. However, with the current netting schemes and energy taxes, it is still quite difficult. So, the regulation and the laws at the moment are not really helping. But in theory, it should be possible to let community profit from local energy trade and sustainability. I think there is regulation barrier to share energy as an individual who owns solar panels on his roof. You can profit from netting scheme. But if I have solar panels on my roof I cannot say I utilise it collective as a group. I cannot say I produce electricity and I like my neighbour to use it. He still has to pay energy taxes. He does not really get low local price. If I keep the electricity for myself, I do not have to pay taxes, but if it goes for someone else, he has to pay taxes. That is quite a barrier which does not encourage local trade because you better off with keeping it for yourself. You can look for other ways to make it effective for local. It is not impossible, only the margin will be much lower.

If you trade locally, and you use the energy produced, it would be good for the government to allow you to see it as the same as the self-consumption. And that is quite different than it is now. It would be a big stimulation for local energy markets. Otherwise, the margin will be much lower, which is more about the emotion and about some small gains in collectively buying your energy. Those benefits are much lower than when you would be allowed to share your energy and pay taxes based on the community net load, instead of individual load. If that could change, that would really give a push. The benefit in feed in tariff need also be adjusted in a way that you get better feed-in tariff if you have community cooperation than when you do it alone. It does look a little bit similar with *postcoderoosregeling*. In general, the scheme uses more utility buildings than homes. And when it goes to homes, the concern is more about administration not privacy. Because for new technology, you can organise it in such a way that privacy is respected. Information stays local, or at individual level is anonymised before goes into shared place. We have to make sure the data is well protected and people have the choice if they share and who they share and what they do not share.

Also, the boundary for community in *postcoderoosregeling* is important to be taken into account, whether it chooses to keep the community limited. It is interesting to keep the trading local but

we would need to find more sophisticated way of setting the boundaries. With boundaries, my expectation is that the community will grow, and maybe some advantages only arise within a particular community. For example we as DSOs say, this part of grid is connected from a grid perspective, so that we see it as an interesting community where you can give the advantage. I would like the benefits from the boundaries setting to be connected system and social benefit. If you know what benefits can be there and how they are related to the size of a community, then you can develop sectoral postcode. If you say the benefit is lower peak on the network, then it is up to the DSOs. If you say the benefit is better balance in the system, then size of communities does not really matter. If you say social benefits, then you can say it should not exceed the size of a neighbourhood or a city. Maybe DSOs in the city could also decide on that. And maybe in the end the Dutch government will limit the size based on the financial part because energy taxes are important income.

There has to be balance. A postcode will be much more interesting if it mixes the rich and poor. The best communities are those which have a mix of different types of households, different levels of income, different kinds of assets, different sizes of houses, different possibilities to have solar panels on the roof. There might be a link to municipalities, because like in BoTu, I think the municipality has the interest to develop such neighbourhood and may be to connect it to other neighbourhoods where more money is available for investment. There you could say local municipalities in cooperation with, for example, DSOs might have some opportunity to define what boundaries of a community are. So you go from postcode to maybe a new set of rules. When you need something to deal with the Ministry of Finance you can say, it will not lower the tax income. It will give more fair division of taxes.

Q: How do you relate the characteristics or conditions of people in BoTu with the utilisation of the three technologies I evaluate? Do you find any barriers or concern for them to be used here?

A: If it is about technologies for electricity trading, I think it is not just about BoTu, for now their barriers are almost for everyone because it is not yet really plug and play. So, I think it needs to come to a level where you say, Okay, I download the community app, I enter my personal information, and I can give my wishes and my strategies. It needs to work on that level. Then it is going to be adopted by the mass and people in BoTu. However, it is not yet plug and play. I do not know enough from BoTu, but I guess BoTu is close to a more industrial area with a lot of roof area, so you could find combination with that. I think it should be possible. But you need to be creative because most of the apartment buildings there I think are five or six high and quite small roofs. It is a challenge but maybe you have to look a bit outside of the area to find a place where you can invest in solar energy.

If it comes to the apps level, when you need education to do energy trading, then it is not going to work. That is what we learn. People do not want to spend much time on energy apps. It is what we learn also from pilot projects in the past that people are not going to spend much time on it. So the way to work with smart meter information with the information on how much they got trade, it has to be really easy, user friendly, does not need your daily attention, because that is not going to work.

Assessment of norm for distribution of costs:

Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading. So, you say the costs must be so low that everyone can access the benefits or energy trading? If you talk about justice, this is important. It should not be a toy for the rich. I strongly agree. But for the socialised costs that are incurred, they should not be kind of cherry picking. You create local advantages and all people are paying for that, it is not the way it should go. So, it should also be fair in the way that, if, for example, a community of hundred households creates a lower peak on the network, and we say, okay, you are not using our network as the others do, so you get a lower tariff. So for example, the normal peak of 100 households is, if they have PV on their roof, maybe 100 times 4 kilowatt, so 400 kilowatt, on our network and that is normal, but because they cooperate, it is only 200 kilowatt so they give a peak reduction of 50%. For that, you can also have grid tariff with 50% of reduction.

It sounds fair but somewhere here in a house, I have no solar panel, I am an individual, I cannot take part in the community (project), and my individual peak is only 1 kilowatt, but I cannot profit from the advantage. I have to pay double that tariff although I use even less than the community and my peak is lower. So, it is not fair I think. So, in that way you have to find, if you give them an advantage, you have to be able to give the same advantage to someone else and the other way around. Otherwise you will get a system which is not balance anymore. And the socialised costs indeed lead to unacceptable differences and other people are going to pay for the advantages of the local community. Maybe that is acceptable for a number of years in a transition because you want to start it up, but on the long term, I think you need to find the balance where real socialisation takes place and there is a fair way of paying the causes you make.

Assessment of norm for distribution of benefits:

Yeah, I am not sure I agree to that. In some way I do agree, but on the other hand I think it is dangerous. If someone gets tax benefits I agree. However, if I buy solar panels and get less benefit, it does not give a good business mogul in normal economic activity. But if I get much profit because I do not have to pay taxes, then I fully agree. But there should be a limit on it. I put it in middle maybe because it is a little bit difficult to give such a distribution.

Assessment of norm for distribution of access:

Households or stakeholders must be able to access public goods or services that are necessary to perform or support electricity trading. Yeah, I agree to that. Looking at European law, I think we have to arrange that it is in the end possible for everyone to choose whether to join into a local community or not. Choices are also pretty much important. You also have to be able to say no.

Assessment of norm for distribution of responsibilities:

Households or stakeholders must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest. Yeah, I think I disagree. I agree that if people like to do it, they are able to do it. But I think we also have to protect them in some way. So be very careful not to bring all responsibilities to that and maybe also not to allow that. I feel for customer protection, not allowing some responsibilities is not wrong. We need to distribute

responsibilities as the advantage in a way they are not exposed to the risks. Therefore, I somewhat disagree, it has something to do with risk exposure and customer protection.

Assessment of norm for procedural justice involvement:

I think it will be good to have them involved. Maybe not to the full level, but somewhat agree. I do not know if you can, to what level you can make your principles general for the Netherlands entirely. Some can be adjusted on more local level, and some national, and there you can, I think, have to have the representatives. So, it could be an entity representing the community, maybe someone from municipality.

Assessment of norm for procedural justice position:

Representatives of households and stakeholders must maximize the position of was during the negotiation for the principles. I somewhat agree. Because if you use the word maximise, if you maximise too much and someone paying, I think it might block the development. It is difficult and give tension. You need fund from us and the people who are able to invest. On the other hand, we cannot neglect that there are people who are staying behind and maybe are paying the bill for the people who are able to invest. So there, I really agree. However, if you put it too much to the other side, things are not going to happen. For example, Germany started investing in solar panels, very, very large scale. Now they are paying the bill for it. But if that would not have happened, I think the world would have been behind one or two years in solar PV development. So, let it starts somewhere, and maybe it will not be the most fair system, but afterwards, we go for it. So it is about the balance between fairness for everyone and stimulating first step made by the people with the money.

Assessment of norm for procedural justice resource (information):

All of stakeholders must receive high quality information that is necessary for them to make rational decisions for the discussion. Yeah, I agree they must receive high quality information. But you have to be able to explain it, I do not think it would reach everyone.

Assessment of norm for recognition of diversity:

I am in the middle. We acknowledge that they have their viewpoint, but you cannot always stop the process looking at everyone, if you look from a bigger picture. For instance, from Dutch national point of view, I still do not say it is okay. I hear what you say, but I do not think I will do it anyway. Because what do you mean by acknowledge? You say you have to listen to people, respect everything, but it does not mean that you have to decide based on them. You need to listen to people and even take into account, but not agree decide on it. It is always a trade-off between individual against social arguments.

Assessment of norm for recognition opinion:

I agree everyone must be able to say what they want and think and even act. However, to the point where, if you make use of social infrastructure, that must be fair. So, I agree that you can

say I am not taking part in a local trading. But you cannot say I am not taking part but I still want the advantages.

"Within the context of P2P energy trading project, these norms are relevant/realistic for the community in Bo-Tu and should be pursued"

Distributive justice (fair distribution of goods/objects among stakeholders)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading	✓					
2. Households or stakeholders must receive the benefits from the electricity trading practice where relative differences with respect to excessive benefits generally allocated or given to the worse-off			✓			
3. Households or stakeholders must be able to access public goods or services that are necessary to perform or support electricity trading	✓					to say no or not use the public goods also must stay possible
4. Households or stakeholders must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest				✓		related to risk exposure and customer protection
5.						
6.						

Figure B.1: Assessment distributive norms

Procedural justice (Inclusion of stakeholders during the decision making process of an energy project under non-discriminatory principle)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	**Comments**
1. Representatives of households and other stakeholders must be involved to decide for technical principles to distribute specific goods in P2P energy trading;	○	☑	○	○	○	
2. Representatives of households and other stakeholders must maximise the position of the worse-off during negotiation for the principles to distribute specific goods in P2P energy trading	○	☑	○	○	○	balance between fairness for every one and stimulating first steps.
3. Households and other stakeholders must receive high-quality information that are necessary for them to make rational decision for the distribution of specific goods in P2Penergy trading	☑	○	○	○	○	
4.						
5.						

Figure B.2: Assessment procedural norms

Justice as recognition (Acknowledgement towards the existence of local communities with regards to their background diversity and opinion)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	**Comments**
1. Stakeholders must acknowledge socio-cultural background of others throughout deliberation process for the distribution of specific goods in P2P energy trading;	✓		✓			need to listen and take into account but not agree/decide on it.
2. Households and other stakeholders must be free from any physical, emotional, and distorted financial threat when they propose or reject principles for the distribution of specific goods in P2P energy trading		✓				
3.						
4.						

Figure B.3: Assessment recognition norms

B.2 Interview 2

Adviseur Duurzaamheid Gemeente Rotterdam
Date: 19-07-2019
Time: 11:00 - 12:00

Q: Can you tell me more about the community of BoTu? How would you characterize the people? Such as what kind of people reside there? How are their living conditions? How do they deal with energy on daily basis?

A: I am not particularly working on BoTu. I do not really work for BoTu. But I know like, in general case, they are a lower income neighbourhood. But they are now in a really transformation phase, because they are developing and there is a lot of attention going to BoTu. So, there is like a policy, they wrote a really big documents on the neighbourhoods, which they are going to work on really much. So, they put a lot of money now in the neighbourhood to transform it and to make it a better neighbourhood. And you also see that, because of the housing situation that the housing prices are very high, there is a lot of people now decide to go live there. They are attracting more and more high-income people now. For example, they have now also newly built houses, which are more for the rich people. So now the mix more becoming like rich and poor. And together, they are like really in transforming neighbourhood.

About the energy situation, I am not sure but I think they want to do the district heating system there in that neighbourhood. I am not sure about that. But you can look it up on the on the website of Rotterdam. And I think, for the future, they want to put a central district heating system in that neighbourhood. But I also know like there are some counter movements from some people living there. They want to do like a more decentralised energy system. So, there is a balance, or maybe a struggle between, do we want a central heating system, or decentralised energy system. That is what I know about BoTu. I do not really know the community there. Some people there are interested in energy development, but others I do not know. I think the municipality really sees the area of BoTu as a chance to lift the neighbourhood up and also take the energy transition as a means to let neighbourhood become more developed, richer. Also, have more people have jobs that come from the energy transition. So, I think that is their goal for the neighbourhood.

Q: How do you see and value justice for local energy projects, especially for such poor community?

A: So, now we are making a policy or a way to act on how we can stimulate these energy initiatives. So, with energy initiative organizations that are, for example, building solar panels on schools, and then people can buy a part of the solar PV for their own electricity generation at home. Because maybe they do not have a roof, that they live in a flat or apartment. So, these kind of organisations, the municipality really wants to stimulate them and motivates more people to organize this. But you can see, on the other hand, there are more poor people, or maybe less educated people. They do not really start up this initiative. So, we have to find a way as a municipality to also motivate these kinds of people to come in action and to also participate in the whole energy transition. So, we are doing now at this moment research on how to motivate them more to contribute to the energy transition. But it is so difficult. There is no like “for how to do this”. So, we should work with the

city, the citizens, we are working with several organisations together to get their knowledge about this kind of people and how we can stimulate and contribute.

However, we do not really stimulate private parties, rather it is more like NGOs, not for profit organisations. We stimulate non-profit organisations by subsidies, but also by, we are thinking about maybe setting up a program for them. However, we are just now in the research phase, where we are thinking about how we should act with them, what we should give them and what not. So, we are now in the progress of the research to look out, what is the best way to stimulate these NGO parties that want to live up the neighbourhood by doing energy transition things. However, maybe we should also consider the private party, but we did not consider it yet because we see it as like the bottom up movements of the energy transition, something that comes from the citizen. So, when you have a company, or private party, it is more of companies and it is not really from the citizens. So, that is maybe now the reason, but I think we should also look into the private sector as well to see how they could contribute to the neighbourhoods.

Also, I think the community has the power as well. I think the municipality can be a support, so we should not take it from them and say, like, you are powerless without us, no! I think we can just help them to develop faster and maybe make them bigger. So yeah, this is what I think. Some communities are really easy to be motivated to participate in energy movements. There is a neighbourhood with a whole bunch of people around them that is really enthusiastic. And you have that in a lot of neighbourhoods in Rotterdam. But in other neighbourhoods, we do not have any contact. There is no enthusiasm about energy transition. So, it is different between communities, between people. With such difficult neighbourhoods, we do not know yet how to deal or motivate them. So, together with other municipalities like Amsterdam, Utrecht, and the Hague, we are trying to exchange knowledge and experiences about this kind of approaches. And then we try to learn from each other. Because in Amsterdam, they are a bit further with this whole policy on energy initiatives and energy transition. So, we try to learn from them and see how they do it, then we can also do that, but now we are in the phase of like, learning, researching, experiencing, and then we want to come up with an action plan, like how can we support these neighbourhoods who are less enthusiastic, but we, of course, want to reduce the energy injustice. So how can we do that, is really a question for us.

We also have another department which is more about participation of citizens. So, the issue is not only in the energy transition but also all other areas. That specific department has come up with different ways on how to approach people in different communities. So yeah, I think you should really adjust yourself on the community and how they how they wish to be approached. In general, I see the justice in energy transition in a way that it can be of a support to help them to get a job, or may be have a low electricity bill, so it can be a support. However, I do not think these people lean on the government to come out of their poor situation, that is not what I meant. I think the energy transition can be of a help and we need something like a peer to peer system or other technologies or initiatives to come up with it. But then the question is like, how do we? Because we do not want our municipality to say, okay, we are gonna do a peer to peer system, there, there, and there. Because it is a top-down. So yeah, it is really a search for how to stimulate the bottom-up movement actually.

Also, it is more fair to have more power over your own energy system. So, that is why I re-

ally support the Bottom-Up movement of the energy system, energy justice issue. And I really like the decentralization of the whole energy system and this kind of peer-to-peer system. So, I think, it is more fair for people because they have, maybe, lower costs, and they have more power of their own energy use. I think, that will be more fair. However, I do not know about how the people who do not know, or who cannot understand this kind of systems, how they can connect to them. And I also think we should not underestimate communities because a lot of less educated people also know how to do things. May be they are less educated, but they have knowledge, and they have experiences. We need to have a bit faith in them. They can have the intelligence to also come up with energy initiatives. But they maybe need a bit more support, or a bit like examples. Also, a lot of my colleagues are a bit careful with energy initiatives and that peer-to-peer system, because for other people, the costs may become higher, and that is a problem.

Q: Given the simple representation of electricity trading that I showed you, do you think it would be feasible to realise such electricity trading in this community that embrace your conception of your justice?

A: I wish it would be feasible. It sounds really good. However, we heard from a lot of energy initiatives, other one, Blijstroom, there is a very successful energy initiative in Rotterdam, I hear from a lot of this kind of initiatives that they have troubles with the administrative burden of organising this. So, it is a lot of administration, and they need to get licenses to put solar panels on roofs, for example. They need all kinds of laws and regulations in order to come up or to start this initiative. So, I think also with a peer to peer system, that could be a big barrier. So, the administration and the licenses, organisation, that kind of things. With regards to administration, well, there are lots of different departments within the municipality. So, like, for example, when somebody needs a license to put up a solar panel on the roof, it is a totally different department than where I work. So, we try to help these initiatives to come through the process of getting the license. But it is going to be hard because of the rules and regulations. And some rules are even from the national government, so we cannot really help it. So, yeah, that is a struggle.

Q: How do you relate the characteristics or conditions of people in BoTu with the utilisation of the three technologies I evaluate? Do you find any barriers or concern for them to be used here?

A: Well I do not know, not in particular for poor neighbourhoods. I do not think so. Because I think you can educate these people. So, no, I do not know or I do not think so. For solar PV, even for neighbourhoods which do not have enough roofs, we know some initiatives that use the roofs of schools, or roofs from other municipal buildings, so that is a possibility. However, you need to do all the administration stuffs. But yeah, it is possible. For the smart meters and digital platform, I do not know if they are then the best option for this neighbourhood if they could not use it. I think that needs more research because I cannot move after front doors to see if people can read a digital system or not.

And maybe, you should look for something else if that is the case. So, I think we should look at every neighbourhood to see what is the best option for them probably. But I know that [*name], the contact I gave you, he was talking about the housing corporations. They are renting houses to people with a lower income. And they are like a social agencies also like an NGO kind of type of organisation, for renting houses to people with lower incomes. And he said, maybe we can use these housing corporations to do the whole energy system management stuff. And the people with lower

income who live there, they can benefit from it without having to do all the administration kind of things. Maybe that is an option for people who do not want these smart meters and digital platform. But we also have to look at the other options, like if they do not connect to this kind of peer to peer systems or bottom up initiatives, then there are other options to become part of the central system, such as that central district heating system, which is way easier. So, there is also an option, I think. But I am not sure actually about how this is going to be regulated in the future, like if there is going to be options or not. But it could be nice, maybe. I think the whole integration of the bottom-up systems and top-down systems is now in a transformation phase, and now really complex. So, we should see how the time goes and how it turns out with and how we can put them together.

Assessment of norm for distribution of costs:

Yes, of course, everyone should be able to afford the electricity, but I think it is also really political question about justice. So, politician should make decision about this I think. Like me, as a civil servant, I am not the one who chooses about this. Because you have different parties, like the right wing, which is the ruling party now in the Netherlands. They would say no for the rich to pay more costs for the poor. But then you also have party on the left wing, maybe they would say, yes it is fair that the rich people pay more for the poor people. So, we have different parties with different views on this kind of issues. And I think, in the end, there should be a decision from all the governments about this. I would vote somewhere in the middle. I would say it is no good for the rich people to pay everything for the poor, but maybe they should pay a bit more something. Yeah. And I think, the most important thing is the sustainability issue, and we should become a more sustainable energy system. So maybe, it costs a bit more money. For me, that does not matter. But that is because I am more like sustainable minded person. So, for me, the whole sustainability is really important. And about the cost, that is also, of course, important, but I do not know how to handle it.

Assessment of norm for distribution of benefits:

Analogue to the income tax, I think in the Netherlands, people have cultural mindset and we are adjusted to the tax system where higher income people are given higher tax. However, it is also when you put out the taxes, you do not earn the same as the poor people after put a bigger part of your wages to the taxes. But, in the end, if you compare the money which you get in the bank, you get still more money if you are rich than if you are poor. Maybe with the benefits from electricity trading, that can also be a way of the system.

Assessment of norm for distribution of access:

It depends on capacity of P2P system.

Assessment of norm for distribution of responsibilities:

About responsibility, I think this is also still a question. Because on the session when I met [*name], there was also some grid operators. We talked about this as well. They said like, somebody should be responsible for safety of the nets and for like to always have energy and not only when the sun is shining. Somebody should be responsible for this. And who is going to be that? I do not know yet. Still a question. And I think maybe the grid operators could be of help here, like so the

grid operators do not only do the whole big systems, but also can maybe do the small systems like peer-to-peer system. But then there you also have a kind of intermediary. But I do not think you can say to citizens, so you are responsible for your own safety. It is a bit difficult maybe. In terms of safety, I think we should have some rules or something to also help them with it. Also, I think we should have more knowledge as the municipality to sort out the questions about distribution of responsibility especially for the new emerging actors.

Assessment of norm for procedural justice involvement:

I think community participation will be good but only if they want it themselves. So, we should only invite people who want to participate, and not the people who are not interested. We should invite them not only to listen, but really to participate. So, like to share their views. I think when people taking efforts to come to the decision-making process from the municipality, they have some knowledge, or at least they have something to say. Maybe they are really struggling with something, and there is something that you can listen to. As a municipality, you listen to them and try to help them or try to incorporate their views in the whole decision-making process. So, even if you see or think they do not have the knowledge, maybe they have because they live in that neighbourhood. Maybe they see different things than we do. So, I think it is really important to take their views into account.

Assessment of norm for procedural justice position:

-

Assessment of norm for procedural justice resource (information):

I think we should provide them with knowledge.

Assessment of norm for recognition of diversity:

Rotterdam is a really multi-cultural city. So, when you want people to participate, you should take into account their background, their way of thinking. I do not know if it can help, but maybe they have different views on how we can organise things. Maybe, you can see it as an opportunity because they have different views on the challenges. I would say, to get the right people for this whole participation process, so the right people who are open for all different cultures, and who can listen very well to people. And then we can take it as the opportunity and not as the obstacle.

Assessment of norm for recognition opinion:

I think the energy is one of the basic needs of people, so, we should not get that needs in the threat. It is probably the first thing to think about.

"Within the context of P2P energy trading project, these norms are relevant/realistic for the community in Bo-Tu and should be pursued"

Distributive justice (fair distribution of goods/objects among stakeholders)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading	☒	☐	☐	☐	☐	
2. Households or stakeholders must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off	☐	☒	☐	☐	☐	
3. Households or stakeholders must be able to access public goods or services that are necessary to perform or support electricity trading	☐	☐	☒	☐	☐	Depends on capacity of P2P system, maybe with batteries not necessary?
4. Households or stakeholders must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.	☐	☒	☐	☐	☐	
5.						
6.						

1

Figure B.4: Assessment distributive norms

Procedural justice (Inclusion of stakeholders during the decision making process of an energy project under non-discriminatory principle)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	**Comments**
1. Representatives of households and other stakeholders must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;	○	☒	○	○	○	
2. Representatives of households and other stakeholders must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	○	☒	○	○	○	
3. Households and other stakeholders must receive meaningful information that are necessary for them to make rational decision for the technical principle to distribute specific goods in P2P energy trading	☒	○	○	○	○	
4.						
5.						

2

Figure B.5: Assessment procedural norms

Justice as recognition (Acknowledgement towards the existence of local communities with regards to their background diversity and opinion)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	**Comments**
1. Stakeholders must acknowledge socio-cultural identities of others throughout deliberation process for the distribution of specific goods in P2P energy trading	☒	☐	☐	☐	☐	
2. Households and other stakeholders must be free from any physical, emotional, and distorted financial threat when they propose or reject technical arrangement to distribute specific goods in P2P energy trading	☒	☐	☐	☐	☐	
3.						
4.						

3

Figure B.6: Assessment recognition norms

B.3 Interview 3

Resident and local energy initiator in BoTu
Date: 23-07-2019
Time: 10:00 - 11:00

Q: Can you tell me more about the community of BoTu? How would you characterise the people? Such as what kind of people reside there? How are their living condition? How do they deal with energy in daily basis?

A: Here we have Surinamese, Cape Verdians, Moroccans, Turks, people from Dutch descent. I think these are the five main groups. A lot of people have quite a lot of entrepreneurship in this neighbourhood. So, what sets this neighbourhood apart from neighbors from the south of Rotterdam is that there is much more collective, an individual initiative. So, a lot of citizens initiatives, for instance, community gardens, local community centers, youth projects. Also, there is quite, some movements, and do-it-yourself attitude. For instance, this is a former school building, which is bought by people from Moroccan descent, to have as a sort of mosque or educational center. They bought this thing themselves and now they are renovating it with youth which are sidelined on the job market, and also with youth who have been in prison and want to reintegrate into society. So, this is what they do themselves. Also, the school board of a school here said that the roof is for the neighbourhood. The neighbourhood does not have to have any money for the roof, but it should benefit the parents of the children at our school. So, they have an organizational level, which could also be applicable an energy cooperative. So yeah, there is potential in the neighbourhood. However, I would say, it takes some specific guidance, information, and knowledge, to put it in the right direction.

People here also know very well what is happening in energy. So, I had a talk with the Council of the Housing Corporation, Council of tenants, which is like 10-15 people on the lower social classes. The theme was energy transition, and they were very much able to formulate what is going on, what their opinion is. So, in their own way, people have an idea of what is going on. So, from my experience, they also see the need to go off of fossil fuels. But there is resistance, also fear of what it will do in different areas. So, if we go off gas, why not do the Russian gas? And what is the problem with Russia? Or, how can I cook, because I do wok cooking. This is not possible on the induction. So, what we did as an energy cooperative, one of the first things we did is we made a wok challenge. So, we bought an induction wok, and a gas wok, and we let people taste and see if they could taste the difference. So, this was very interesting, because people could not taste the difference but they could also see, well, this wok is much cooler if you stand behind it than this one because the heat is sort of dissipating. And here, the heat is really within this thing. So, with this, you have like interesting conversation with regular people who say: Well, this is nice. So, what does it cost? Oh, it is not that cheap but not so expensive. And also, as some people who are really, in the beginning say: Well, no, no, I just only wok on gas. And then after they saw it, they say: Well, maybe this is also interesting for me.

I would say Bospolder-Tussendijken is not a really rich neighbourhood. I think here there is a mix between people who are willing to participate and invest in energy cooperative and people who are not really able to invest in which sustainable energy is further from their frame of reference.

Q: How do you see and value justice for local energy projects, especially for such kind of neighbourhood

or community?

A: I think we should invest in mainly social entrepreneurship, things that benefit the social infrastructure in the neighbourhood, so on welfare, on energy, on green, on different kinds of things, in which you always try to involve local citizens who are connected, who are sort of involved, but also take some personal background and knowledge experience.

For energy projects with solar PV, there should be a scheme in which people can invest. This is for the *postcoderoosregeling*; So, people can buy solar PV, they can invest in it. They do not own the panel but they can invest, and they get a return on investment. And also people who do not have any money to invest, they can also participate if they live in this *postcoderoos* area with a loan which also has some benefits to them. So that, it can either be financial, so they have a lower energy bill, or they can have access to the mobility, or other sorts of forms of benefits, like education.

People who do not have any money to invest in the energy projects should still be able to participate. People pay their energy bill, so they can keep on paying the energy bill. But if we can take their energy bill and then have them profit from sustainable energy, then it will be also possible for them to join. Also, with a loan from the Bank Nederlandsche Gemeenten, we can finance them as well. Those [poor] people can just have a subscription. So, they just pay what they pay now. Only, it is, or part of it, is then sustainable energy. However, how we do that is still up for debate. Because for people with not much income, another bill is complicated. So, we should try to see can we sort of combining with the Housing Corporation, so can we do the financial transactions via the Housing Corporation? Because then you do not need to bother people with extra costs.

In the energy projects or cooperation, we need to find out what people want. So, one of the things is to see what is the mobility need of the people. So, what do they need? What do they lack? What do they pay now? Because they are the one who will benefit from it. Also, in the energy projects, we need to research and calculate different options and then show them to the people and say: What do you think? What is your preference?

It is also important to give people who do not have interest in energy information about how important energy is. Although you have a bottom-up approach, which is needed, you also have a top-down approach, which is also needed because we need to go off of fossil fuels. So, this is one of the big reconstructions of the neighbourhood, or of the whole city, or of the world. So, at one point in the conversation, you have to have a talk about energy. And because it is so pervasive that it has consequences for how you cook, how you heat, how you isolate your home, how you drive, even what clothes you wear, what food you buy. So, it is so pervasive that it also has in itself the opportunity to foster social changes. So, this is the theory about resilience. Can you sort of take this crisis, and not just do heat net in the ground, and solar panels on the roof, and then that's it. What are the social benefits of this energy transition? Because, if you leave the rest the same, then there is no added bonus. So, by looking at what you can do extra, with this energy transition, you can foster social changes.

I also think that for local energy projects you need community first, where people can develop trust, to be able to share information from that position of trust. So, I would say there are some needs, but also possibilities, for people to come together. And an energy cooperative, if you take part in

sustainable energy, is something to meet about, something for interaction, for exchanging ideas, knowledge, network. Also, we listen to people, put people together, and see what comes up. And with what comes up, you start to grow and make projects.

We have to find a balance in the investment in local energy projects. So, I think everybody should be able to get a return on their investments, and to not only be beholden to people who have money. So, if you have money or not, you should be able to profit from sustainable energy. I think the justice in such scheme is that the legal framework is a cooperative, where everybody has one vote. And you do not have more votes if you have more money, or more panels. And I would say it is about everybody having a fair share. So, if you see the return on the investments of private equity firms, or stuff like that, is in double digits, like if you make 11-12% return on investment, then it is likely costing someone. So, if people have a return on investment of 3-4%, then there is also a room for other people to profit from it. So, it is about not getting the maximum, but it is about sharing the return. If you have money or not, everybody should equally be able to share the profits of sustainable energy.

There should be different kind of investments. So, people can invest individually, or banks can invest with a low interest rate loan, and you share the burdens between rich and poor people. It is about balance. And also with the balance, you need to locally see what people need. And then you can see, does energy transition do something, or can climate adaptation mean something? So, it is about how you sort of shaping the transitions which we are in, and how we use that to benefit communities, make them stronger, make them more resilient.

Q: Given the simple representation of electricity trading that I showed you, do you think it would be feasible to realise such electricity trading in this community that embrace your conception of your justice? How would you like it to work?

A: I think we have to do it in a way of community building. And I want to sort of making circular work with it. So, from community building, if you have a program, you train people in community building. The second step could be education, and afterwards could be work. So, there is now a local installation company founded. It is owned by local people who are doing the work in the energy transition. It does the isolation, and also placing solar panels. And the fourth thing is an energy cooperative, which we just found it like, a month ago, in which we want to bring it together because if you have an energy cooperation, you have something with people together. So, it is also contributing to community building. So, community building, education, work, energy cooperation, these are the four things we have to put in place in this neighbourhood.

I also think, we should do integral projects with this energy cooperative, in which, for example, we refurbish the school, work on the outside and inside climate, also on educational programs, and at the same time, make it to be a green cool space. And what we want to do is to put solar panels on the school, and see if the owners of nearby building also want to join in, also with this Moroccan initiative. And see if we can couple it to electric mobility, an electric bus, which can drive up and down to where people work, via sort of a smart micro grids. So, we want to have as much energy as possible before the meter because if it is behind the meter, you start to pay taxes. Also, what we would like to do is to see if we can multiply the value of the energy which you raise, because you gain more energy during the daytime and you need it at the night time, so you need

some sort of storage. So, we sort of looking at a block level and we think how can we sort of smartly keep as much energy and as long as possible in this block.

We also need to have some possibilities to participate in such a system. You can either, pay less on your energy bill, or you can have access to education, or you can have access to work. So, if you can help installing the solar panels, you might be able to get a discount on your energy bill, or get energy for free, even. Or, you can have access to a car, electric car.

I am also interested in a sort of a hybrid network. So, there you have solar panels, cars, maybe a bakery, or supermarkets, maybe also a small factory, in which you make a sort of local smart grids for them. And then you have sort of an access point to the main grid. So, there is the interchange, and there is the microgrid. So, can we electrify the school directly by the solar panels? Can we do the streetlighting, or the lighting of the housing corporation of the hallways? Can we do that directly by the solar panels? In that way, you maybe also need a storage, local neighbourhood battery. So, I think the storage facility is quite interesting because then you can do peak shaping, and also you can sort of dealing with the network. It is also a form of energy trading where you can make money for this cooperative. You can also have the storage to charge cars and to have benefit. Because cars are often charged at night, so you need some temporary solution to store energy. Also, we should work from the bottom-up and see where the connections are with the top-down initiatives.

Q: How do you relate the characteristics or conditions of people in BoTu with the utilisation of the three technologies I evaluate? Do you find any barriers or concern for them to be used here?

A: I think I rather see the promise and the prospects of sustainable energy. It gives people the opportunity to own the energy infrastructure themselves, and makes them less dependent on companies, as a consumer. They can also become more empowered. However, with the smart meter, I would like to buy smart microgrid starter kit at IKEA that has an aggregator in it and software installed which I can just plug and play, and I have the solar panels, some wires [to the meter], some storage, and I can hook it up to the net, and I put it on, and then it starts a trade automatically. And with solar PV, there is an issue with the source of investment. Investment can come from oil company. And they can make the investment mainly for greenwashing. However, their business model is finite. So, if they want to survive, they have to divest in alternative energy solutions. For them, it is also needed. So, if we can help them by doing a good project, and showing them how they can get off of oil faster, or smarter, then we do also something back for the world, for the money we received.

Assessment of norm for distribution of costs:

-

Assessment of norm for distribution of benefits:

I think, to start that, there is no such thing as the poor. So, it is not the poor and the rich. It is everything in between. So, it is a grayscale which is there. But yeah, I would say that people who need it the most should also benefit from it. But what you ask is also a political question. Do you use the energy transition, or more to the point this energy cooperative, to bridge the gap

between the poor and the rich, do you do redistribution? If you look at the capitalist neoliberal world, in which the differences between poor and rich are getting bigger, there are less poor people, but the rich are getting faster and richer and the poor are getting less poor. You could argue that, yes, you could do that. But I can have an opinion on that. So, I would say yes. People who need it more, should be able to have more benefits. However, I would say it is also maybe in the mix of things you offer. I can imagine it, someone who has not much, a poor person, is too soon to have the benefits of education, or work, or car, which he does not have before, than a rich person, which already has a car. So, for them, it is not needed. And for other people, it can be of life importance, because if they want to go to work, then they need transportation. So, in the end, I would say it is up to the group. So, it is about being a diverse group of people together and have them decide on it.

Assessment of norm for distribution of access:

For instance, the algorithm that is used in the system (smart meters) should be open source.

Assessment of norm for distribution of responsibilities:

(I raise an issue about households will need to set the electricity price)

You need aggregates, so aggregators that can trade in supply and demand of energy. So, I think this is an algorithm that helps you to do that. The algorithm should say: Well, if the energy price is this high, we sell it to the DSOs, if it is below certain point, we store it in our facility. And, so, it needs to cascade and with some different parameters.

Assessment of norm for procedural justice involvement:

Considering and involving all people can be a risk to the realisation of energy cooperative. But I think an energy cooperative is also a way of reinventing democracy, because it is a way of dealing with difference and with sharing common interests, and you have to talk about that. You also have to have political leadership to do that. So, if people from their experience, from their bottom-up experience to say: I do not want an electric car. But if you, from your knowledge, can say or see, this is where it is heading, this is what could benefit people, and now you do not see the benefits but I have seen studies there or examples here and here, and there are also people started to see the benefits after two or three years, then you also need the political leadership from the Board of these energy cooperatives, to say, well, we are still going to do this. So, it is again a delicate balance, also within an energy cooperative, but I suggest you to have board, you have the members, and you have the board of advice, which is optional. So, the board has once a year a member meeting in which decisions are made.

So, the board prepares decisions and the members can vote on it, whether they want to do it or not. But if you have a board of advice, they can also ask, well, the board is proposing this, this, and this, what is your advice on that? The locals will be the members, and so the board is being chosen by the members. So, if from the members, people want to be in the board then they can apply. And this should also be an explicit goal, because if you have people coming forward and saying, well, I want to be on the board, then it is a capacity building for them, because then they develop skills in communication, management, in economics, finance. Also, to do board member work, people need to

be able to work in projects, and you need to be able to understand finance scheme. There are different positions in this board. So, you do not have to be able to do everything. So, a person can be good at community management, at communication, at finance, at the technical side of it, or at the administration side of it, at the relations with outside parties. So, I think these are sort of six qualifications which you need as a board in total. And you have to pick the right people to represent all those needs.

Assessment of norm for procedural justice position:

I have the case that I made a proposal about solar panels for people and I made it for the city government of Rotterdam. And they found a financer, and it wants to invest 100,000 euros in something with energy for disadvantaged, disenfranchised people. If we talk to a school or a housing corporation, they are sort of scared. They say: Well, if we have solar PV on our roof, it is PR risk for us because the financer does not have a great track record on human rights. So, should you accept this money to invest in energy solutions, in which poor people also have access to? So, this is, I think, a moral dilemma which we have, but which we also should debate within the people or the cooperative. So, in one hand, some people could say, well, we do not want it. However, I can also imagine that, this is also something I say to the housing corporation, you might have the moral luxury to say: Well, I do not accept this money. But does climate have this moral luxury? And does the people who do not have any money, do they also have this moral luxury? I say, it is not maximising, but balancing, where the scale tips are in favor of the worse-off.

Assessment of norm for procedural justice resource (information):

I would like to be transparent about it. I think there is a risk that the locals will refuse the energy project if they know too much about what is behind it, but I think the bigger risk is media. Because, if the newspaper in an article makes a headline, which is reductive, I think the real danger is in that. So, if the media somehow simplifies the problem, and not shows its nuance, then I would say, I think that is the risk. Because you will always have people pro and con, but media is a big way of influencing people's mind.

Also, we can provide information to the community by showing. Just showing things as they are. Show people solar roof array, smart micro grids, show how it can work and the added benefits. So, if you can show what the added benefits are, if you can show that you can be independent from foreign governments, if you can show that energy can also contribute something to community, I would say then you have a way of showing people. So, we are not just into making this kind of leaflets and just doing it in the post box, and then let people decide for themselves. I mean, there you can only reach maybe 2-3% of the neighbourhood. So, you have to show it. So, this is what we want to do, just making the prototypes.

However, for the information, people do not need to understand everything to have justice. You do not need to understand everything to have justice, there are experts, who could have a role and play. I mean, this is the leadership of the scientific community to be transparent about. So, in the scientific community you have a responsibility to be transparent about what mechanisms you use.

Assessment of norm for recognition of diversity:

You have to be culturally sensitive, because energy means different things in different cultures. You have to be sensitive on it, but at the same time, everybody needs energy. So, it is also the theory of bonding and bridging in heterogeneous communities, people that ordo of the same kind is bonding, and bridging is between different communities of different kinds. So, provide an opportunity for bridging the communities, bridging the networks. And in that sense, it also can contribute to the society as a whole. And when there is rejection because of their culture, we should talk about it, why it does not match with their culture, what is the reason that it does not match, and can we address it in a different way.

Assessment of norm for recognition opinion:

Yes, you should be free from physical, emotional and distorted financial threats. In an ideal world, yes, but in reality, for some people, it is often different.

"Within the context of P2P energy trading project, these norms are relevant/realistic for the community in Bo-Tu and should be pursued"

Distributive justice (fair distribution of goods/objects among stakeholders)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading	☑	☐	☐	☐	☐	
2. Households or stakeholders must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off	☐	☑	☐	☐	☐	
3. Households or stakeholders must be able to access public goods or services that are necessary to perform or support electricity trading	☑	☐	☐	☐	☐	
4. Households or stakeholders must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.	☑	☐	☐	☐	☐	
5.						
6.						

1

Figure B.7: Assessment distributive norms

Procedural justice (Inclusion of stakeholders during the decision making process of an energy project under non-discriminatory principle)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	**Comments**
1. Representatives of households and other stakeholders must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;	●	○	○	○	○	
2. Representatives of households and other stakeholders must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	○	●	○	○	○	not maximize, balance where the scale tips in favor of the 'worse-off'
3. Households and other stakeholders must receive meaningful information that are necessary for them to make rational decision for the technical principle to distribute specific goods in P2P energy trading	●	○	○	○	○	
4.						
5.						

2

Figure B.8: Assessment procedural norms

Justice as recognition (Acknowledgement towards the existence of local communities with regards to their background diversity and opinion)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	**Comments**
1. Stakeholders must acknowledge socio-cultural identities of others throughout deliberation process for the distribution of specific goods in P2P energy trading	✓	○	○	○	○	
2. Households and other stakeholders must be free from any physical, emotional, and distorted financial threat when they propose or reject technical arrangement to distribute specific goods in P2P energy trading	○	✓	○	○	○	In an ideal world yes. But in reality for some people it the case.
3.						
4.						

3

Figure B.9: Assessment recognition norms

B.4 Interview 4

Smart grid expert-Wolfpack's engineer
Date: 29-07-2019
Time: 13:00 - 14:00

Q: Can you tell me more about the community of BoTu? How would you characterise the people? Such as what kind of people reside there? How are their living condition? How they deal with energy in daily basis?

A: I think that people are culturally very diverse. Socially, economically, usually in the bottom brackets. As with pretty much any of the older neighbourhoods in Dutch cities, there is also a group of traditionally whites, higher educated, left-leaning people living there, and they are important. Part of the community work, as far as it goes to the municipality, setting it up, etc, etc. Whereas other groups of people are usually more active in the day to day community services, bringing food to the elderly, or driving people.

And apparently, it is traditionally a neighbourhood that, although low income, has a quite high social participation. So, relatively high social capital. Those two things are pretty much the reason why we are working in BoTu on a peer-to-peer energy trading and stuffs like that. You see the economic needs, also the economic challenges, as it is different from neighbourhoods where energy cooperatives traditionally thrived more. But it is also possible, because we feel there are a lot of networks, and people can reach different communities to work from.

(I asked whether there is correlation between low income and social participation)

There is not really a correlation. For instance, you have neighbourhood with a low income with a lot of people moving in and out of the neighbourhood at high speed. So, people start living in the neighbourhood, because that is where they can find affordable housing. And as soon as they earning more, they leave. So, in those [new] neighbourhoods you have somewhat less participation. It is also a historical thing, I guess. But I think they care less about energy than average, but that might be just my personal, social bubble thing. So, a lot of people are more concerned with meeting ends, than with a sustainability, transition, or other large overarching issues.

(I asked whether there is correlation between their low income and their education)

Yea, there is. But I am not really sure whether it matters for setting up peer-to-peer energy trading. I think a higher education helps understanding how these taxes, and subsidies, and information flows, etc work. But of course, I really want to create something that is easy and intuitive for everybody to understand.

Q: How do you see and value justice for local energy projects, especially for such kind of neighbourhood or community?

A: Well, so currently a lot of the economical benefits go to people who participate in renewable energy, such as in installing PV panels, to which they get more revenues than if they will put

the money on the bank or something like that. As a neighbourhood, we will shift to a heat grid, and all the regulations of that heat grid are decided by the municipality and a couple of large companies. It might be that because they are not well organised to get a vote in those processes, they end up with, at least financially, in a worse position than they are now. For example if it will happen, it will require big investments in their homes. Corporation is going to make these investments, and the people will end up paying more rent. But generally they do not use a lot of energy in their home. So, if it is cold, they only heat one room, or they make it less hot than needed, or things like that. So, they will end up paying more rent, and not saving as much on their energy bill. Or, they end up paying as much for their heating as I do right now but then they will have to pay more for their cooking equipment. So, there is a risk that they will end up financially worse than they are now, and that is a social justice issue, I think. And not having a voice is also social justice issue.

(I asked whether paying more for the additional/new benefit received would be fair in that case)

I think you should look at the bottom line. So, the costs minus the benefits. And if the bottom line is negative for them, and they already have less money, that will be a social justice then. And personally, I think energy is a market where people can choose the provider which best fits their needs. And I think there will be people who will prefer the ease of regular energy contracts, or want to haggle a bit more and find the cheapest energy contract out in the market there is. And that there is also a group of people who think it is important to do something together and profit from that just a bit, and are willing to invest in the additional time to install new things, go to meetings, etc. So, it should be voluntary for people to join.

(I asked the relation between people diversity and energy project)

I think the diversity will be a barrier because there more social groups you need to tap into. Within those social groups, people might have a different culture or attitude to risk or agreement of what is fair, or even different understanding about what it is actually that we are doing together. Those take a lot of translation. One of the best ideas about the neighbourhood from the colleague of mine is that we might want to set up Moroccan energy cooperative and a Surinamese energy cooperative or something. So that you have a cooperative that really fits with the social groups. And for other reasons, that might be undesirable. However, it would be easier, I guess, for people to understand and feel that energy cooperative is something shared. I think we should separate between energy and culture not just because people think differently about energy, but if somebody from the mass would say this is a good idea to join, then they can have a better or different reach than if we would stand in the streets and hand out flyers to everybody passed by.

Q: Given the simple representation of electricity trading that I showed you, do you think it would be feasible to realise such electricity trading in this community that embrace your conception of your justice, that the community can use the distribution grid as the infrastructure without paying more for the reinforcement, for instance? Do you think it would be feasible?

A: I am not quite sure how that would work out. I think the grid operators want to choose a national line in the end. Since they, together with the energy companies, and authorities, set the rules in all neighbourhoods, the local initiatives are still in the process of finding out how that eventual model will be. So, I do not think that in Bospolder-Tussendijken something different will

happen in terms of using the grids than in any other part. For the use of the grid, eventually, it is up to the national government. In the current code, all the infrastructure costs of a DSO are distributed equally between the connections. So, for example, in Bospolder-Tussendijken, if there would be very little electric vehicles, and solar panels, and other things that will lead to using the grid more intensive, their price will still go up because in other neighbourhoods, people will use the grid more intensively and that might result in the needs to invest in the grid, and those investments will be paid by everybody in the service area of this case study.

(I asked whether it is possible for the community to rather pay less instead of equal)

So, not in the current system. But it might be good if there will be demonstration areas where you can apply to change rules like infrastructure costs or something like that in a particular area, and Ministry of Economic Affairs can grant you that right. And then you can try out new stuff. But especially for this, the grid operators want to see whether there is a real demand for such a thing. So, it is not just an idea, but it is actually a very good place to experiment with the current regulations. And to prove that demand, we need to have more solar, storage, show the potential of demand side management etc in that neighbourhood. As an energy cooperation, so, first we want to find ways in which it is easier for people to join in PV projects, etc. And once we have that in place, we want to start experimenting with ways in which people can invest in batteries or solar, for example, in time or educational credits. That is pretty much a project place. And if this ends up in a model where Stedin, and other companies think is interesting and applicable to other neighbourhoods, then they might go finance this project. So, this is all project based and only for those who participate in the project. So, that might be 1% of the neighbourhood, might be 10% of the neighbourhood, might be 30% of the neighbourhood. And for it to be something that is really structural and applicable to majority of the neighbourhood, we first need to demonstrate what kind of potential there is for mitigating infrastructure costs, and then we sit down with Stedin for a different conversation. I think energy transition is not a major concern for people, making ends meet is. It is a concern for some of the people living there. Those are the people we are reaching out first.

Q: How do you relate the characteristics or conditions of people in BoTu with the utilisation of the three technologies I evaluate? Do you find any barriers or concern for them to be used here?

A: For smart meters, not really, because they are already implemented. For connecting these smart meters to peer-to-peer energy trading system, I think there will be quite a few barriers. And we have to make it as easy as possible and I do not really know how that would work out because we have not tested any new model or how an interface work or something. So, when we were asking around in the neighbourhood, we did find, for example, that some people had a different apps on their telephone to find out the place where milk, or eggs, or something was the cheapest. So, they were actively comparing supermarkets. And, to me, that signals that people might also do this with energy. But that at the same time, these women who had these apps were not particularly interested in sharing economy, or climate change.

(I again asked whether the community are familiar with self-generation with solar PV)

Not a lot is familiar with self-generation, but if you talk to people and say: So, you can invest in these solar panels, and that will generate money, and we will make it easy for you to join,

etc, people will be interested. I think for the motives to join, if you give me a list of options I could choose from, I think a lower energy bill by the end of the month is a number one or two or three. I think climate change or becoming more independent is relatively less important. I think doing things together with the people living in your street and the school nearby, I think that could be important as well.

Assessment of norm for distribution of costs:

I think a distributed issue as in, say, I am a bit wealthier than most of the people in the neighbourhood, if I have the choice of spending a couple of thousand euros on a PV, but I have to pay twice as much because I am paying for the PV of somebody else, I do not find that fair as well. And how this distribution should occur is something we have to decide together. So, first I said neither agree nor disagree, and then I said strongly agree, also depends a bit on what "must" mean: are people forced to join this peer-to-peer market? I strongly agree if it is voluntary but neither agree nor disagree if it is regulatory. Preventing barriers to access also depends on who is paying for that [bear the costs].

Assessment of norm for distribution of benefits:

So, we generate income, collectively as a peer group, and individually. And I think it would be good if that part of the money is spent on, preferably on something that is communal or joint. But perhaps also to somebody whose worse-off, so I think that is definitely an option, but it is for the participant to decide on how you distribute that.

Assessment of norm for distribution of access:

I think it is very good to have as low as possible barriers to access. I agree, public goods should have the lowest possible barriers for everybody to join, for all the public, so they should be open.

Assessment of norm for distribution of responsibilities:

I think it is also good that people do have some kind of responsibility. I do not know what the responsibility mean, might change in circumstances.

(I raise the issue about households being responsible for their own production and consumption)

We are thinking about that actually also with the platform that we are now building. The problem with a balance responsible thing is that it is a lot better to distribute that across all the members of this local peer-to-peer market. Because there is no algorithm or anything that will precisely predict what I am going to do, if I am going to start cooking at six o'clock, or at 6:30. Also, I do not think I will log every time, like hours ahead of time, when I am going to start cooking. So, there will always be some mismatch between what I expect to use and produce and what I actually produce. But over a couple hundred of people, you can fairly predict what time the majority of them start cooking. So, it is a statistical thing as well. So, I think you should bear the balance responsibility with all the members, but also include some incentives for people not to do something harmful.

So, I had that in a strongly agree and with a responsibility to prevent free riding.

New distributive norms:

I think what is important for distributive justice is that between people who join this system and people who do not join this system. So, it is not only distribution within this peer to peer markets, but also with other people. For example now, if you buy a heat pump to get a well insulated house, that is one of the cheaper options you have. But a large part of the cost, the cost that will result from that, are grid costs, which are shared by everybody. So, my neighbour who does not buy heat pump ends up paying my costs. So, I think it is important that non-participants should not bear any public costs, like grid costs that are occurred by the participants, and vice versa. So that if my peers and I in this market are really flexible, and averaging things out nicely, but the 40% who does not join this market, all decide to charge their cars, their electric cars at eight o'clock in the morning, so the whole grid will be replaced, I do not think that we should bear those costs. And vice versa, we have all this PV capacity, and at peak times we cannot use it in our batteries or in our homes. And, so we overload the grid. I do not think the other people should bear those costs. And in general, I think that the distribution between the people who participate in this peer-to-peer energy trading is as important as distribution in between those who do not participate and those who participate in this marketplace.

Assessment of norm for procedural justice involvement:

I think it is important to be involved in deciding for technical arrangements. But I also know that if it gets slightly more technical, it will be very difficult conversation to do with all the members or the representatives. So there, I said, somewhat agree, because I see a lot of practical bottlenecks.

Assessment of norm for procedural justice position:

I also said somewhat agree, I think it is fair that not all the risks are put on the people who got the benefit the least from this. But that it might also be that there will be all kind of practicalities in which we should decide. For example, if people end up paying a lot more for this peer-to-peer platform, I do not know why but it could be, that it is important to try to see this way ahead of time, and notify people that this might happen. It is also important to make it easy for people to opt out by what circumstances, that they can also leave the platform.

Assessment of norm for procedural justice resource (information):

Yes, a meaningful information for them to make a good decision very important. That will be something of challenge.

(I asked about whether people need to know everything)

I think that it should be possible for them to get all the information as there is. So, it is all as transparent as possible. But I myself do not understand what happen when you do power purchase agreements with solar provider which sets the price for a long period of time, and then who actually gets to trade in the day-ahead markets. There are tons of things I do not understand about this whole thing. And for me, it is part of my daily job. So, making it as easy as possible on

the most important gains and risks for people to assess them is very important. And once you go under that and you have to have this conversation with 10s of people, things which supposedly work out quickly, might end up to be not working.

New norm for procedural:

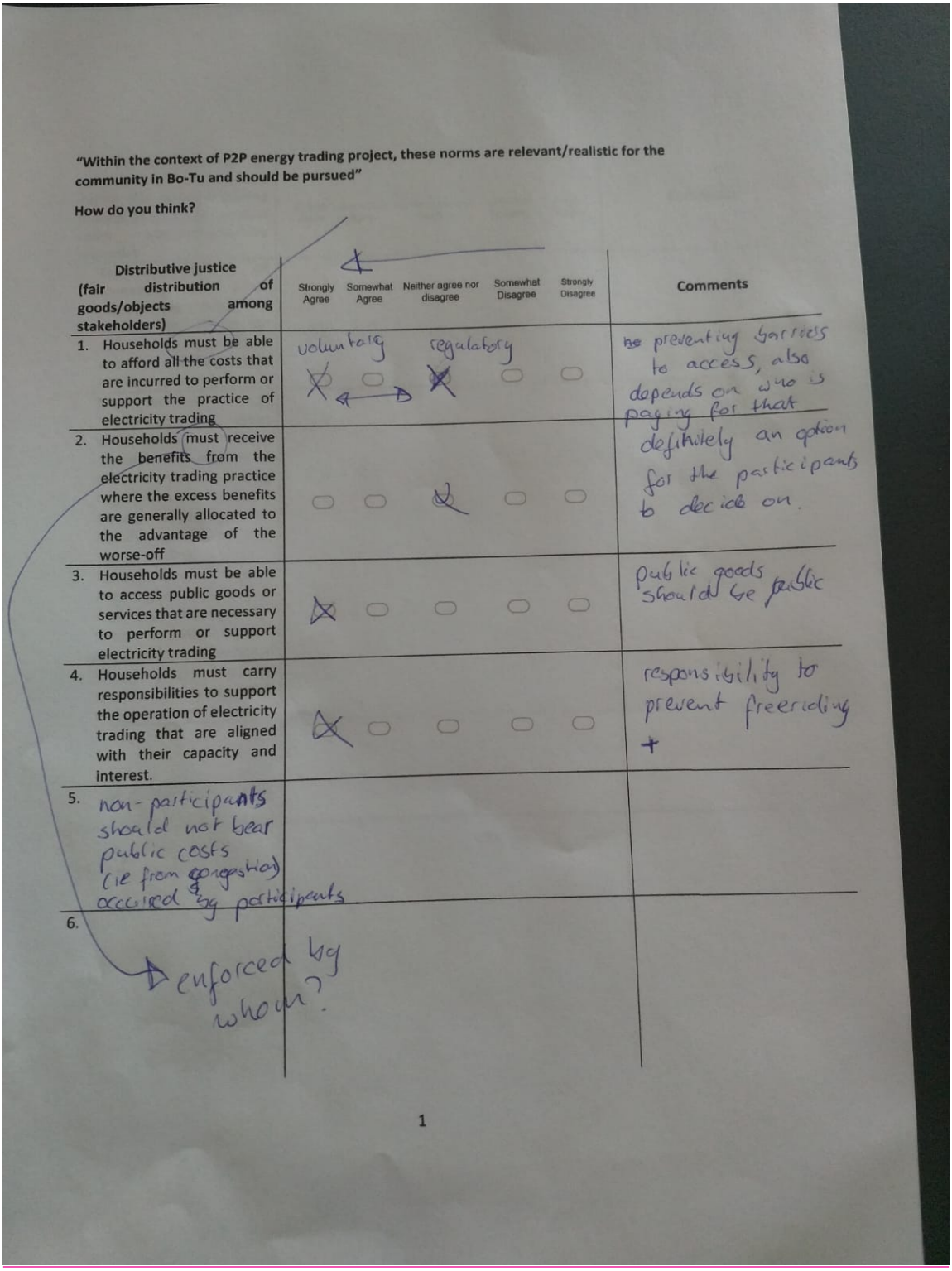
Another issue that might play a role is third party use of platform like this. For example, do you want a construction party to buy the data so that they could knock on your door and say: Well, we got your energy use and trading data. I think we could insulate your house best by this and that way. I think that is something that should be decided by the members in the platform. So, any kind of these third party use of the data or third party like an aggregator who uses the information to trade on the balance market. I think it is a matter of procedural justice that the platform should be cooperative. So, you decide together on, things like that. Everybody should be included in organising the data. So, decide on can everybody look into this data? Or, can you buy or sell it to others, and under what circumstances?

Assessment of norm for recognition of diversity:

So, I think it is important in general, and very important in this particular neighbourhood as we kind of assume that people are less likely to think the same about this subject, or trust each other to join this project than in any other projects.

Assessment of norm for recognition opinion:

Of course, people must be free from any physical, emotional, and distorted financial threat. And I think, in a more practical term, it should result in the right to opt out fairly easy so that there is no or as little as possible barriers to exit this energy market. For example that it is easy to sell your shares in PV panels, or things like that. The second, should be, it is more government related, so the right to come up with alternatives, that there is room and time for people to come up with different ways of doing the investments, or sharing the benefits, working together, trading time for money.



"Within the context of P2P energy trading project, these norms are relevant/realistic for the community in Bo-Tu and should be pursued"

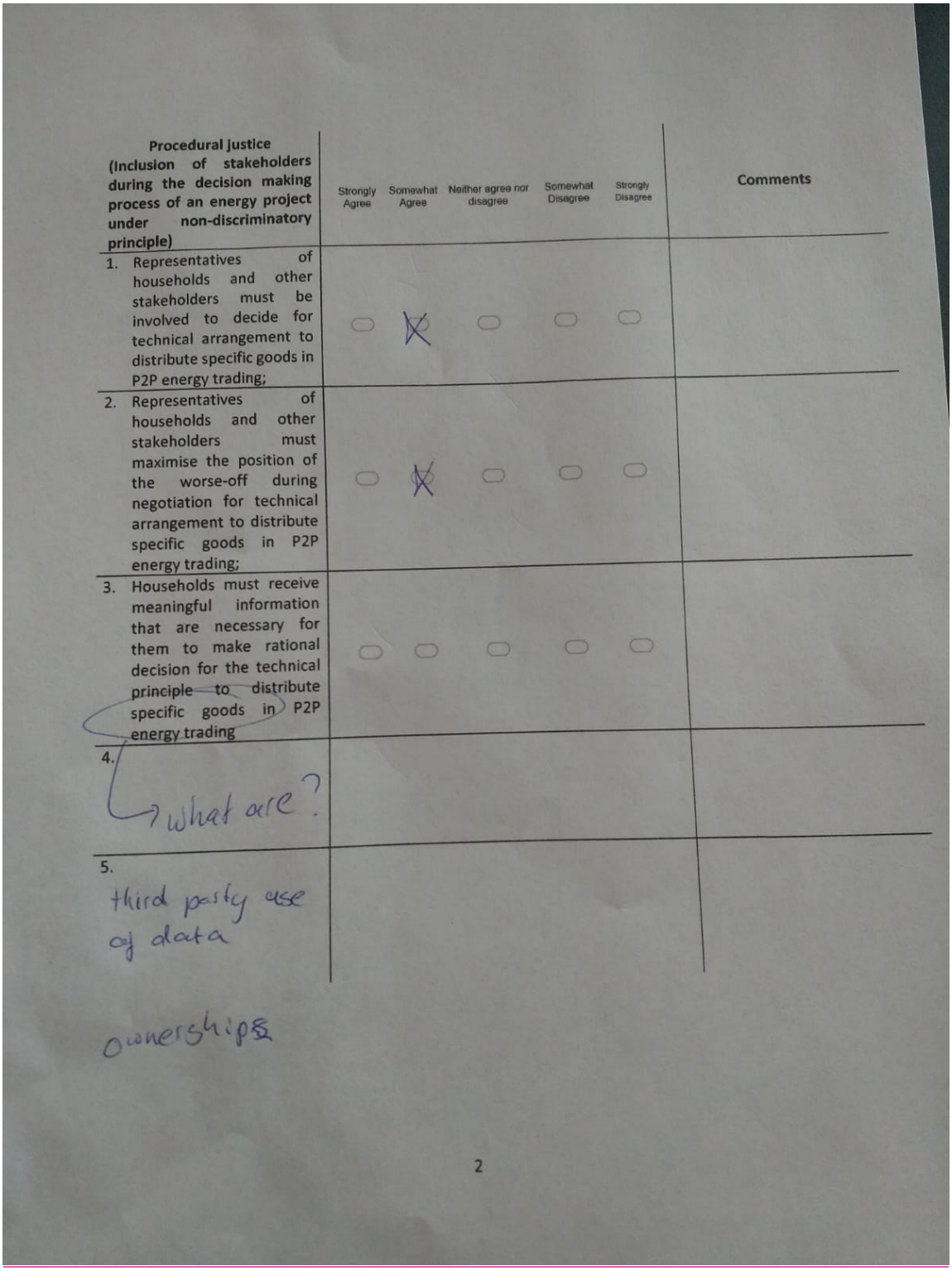
How do you think?

Distributive justice (fair distribution of goods/objects among stakeholders)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. Households must be able to afford all the costs that are incurred to perform or support the practice of electricity trading		voluntary	regulatory			no preventing barriers to access, also depends on who is paying for that
2. Households must receive the benefits from the electricity trading practice where the excess benefits are generally allocated to the advantage of the worse-off						definitely an option for the participants to decide on.
3. Households must be able to access public goods or services that are necessary to perform or support electricity trading						public goods should be public
4. Households must carry responsibilities to support the operation of electricity trading that are aligned with their capacity and interest.						responsibility to prevent freeriding +
5. non-participants should not bear public costs (ie from congestion) caused by participants						
6.						

enforced by whom?

1

Figure B.10: Assessment distributive norms

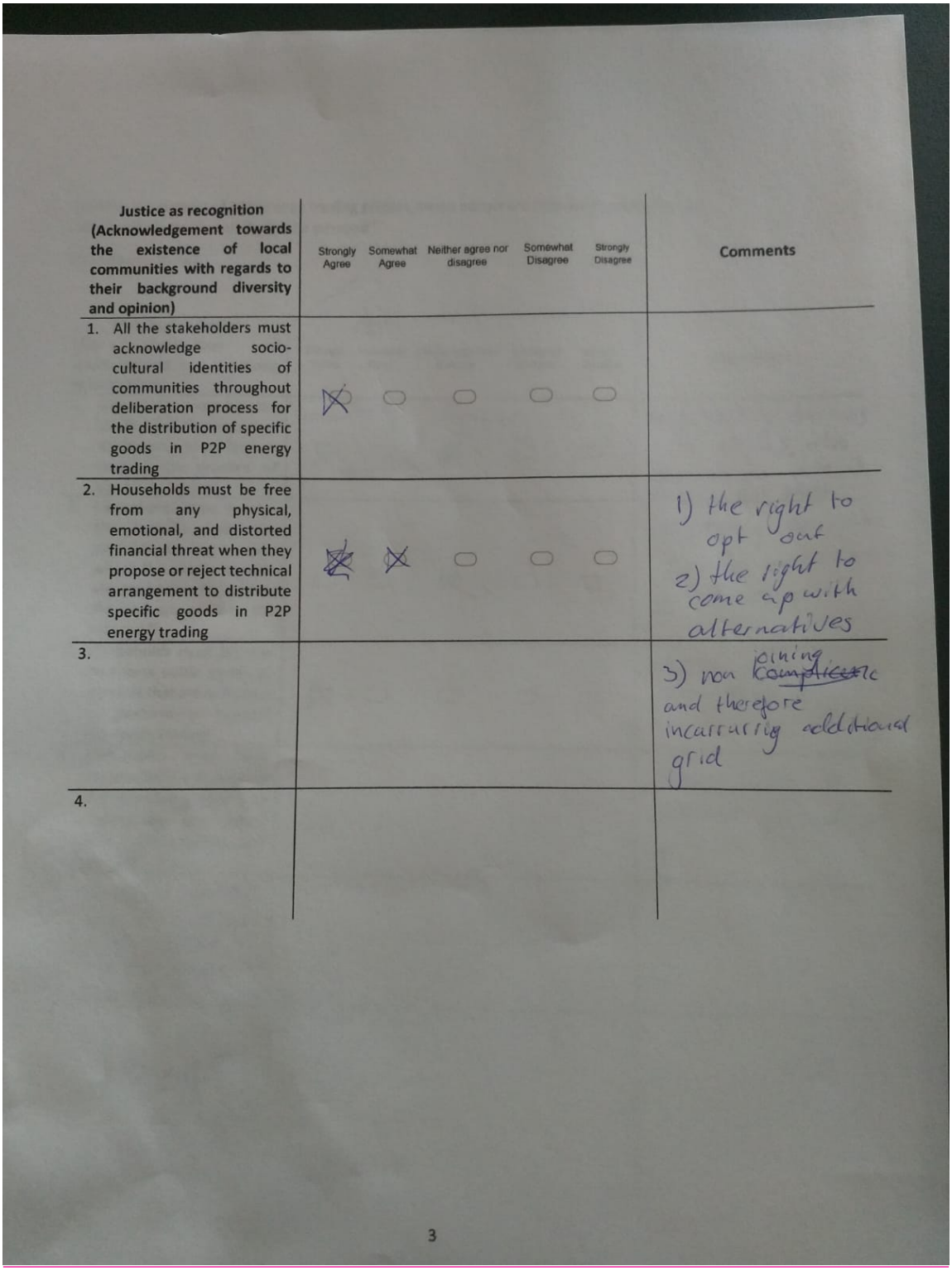


Procedural justice (Inclusion of stakeholders during the decision making process of an energy project under non-discriminatory principle)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. Representatives of households and other stakeholders must be involved to decide for technical arrangement to distribute specific goods in P2P energy trading;	○	X	○	○	○	
2. Representatives of households and other stakeholders must maximise the position of the worse-off during negotiation for technical arrangement to distribute specific goods in P2P energy trading;	○	X	○	○	○	
3. Households must receive meaningful information that are necessary for them to make rational decision for the technical principle to distribute specific goods in P2P energy trading	○	○	○	○	○	
4. → what are?						
5. third party use of data						

ownerships

2

Figure B.11: Assessment procedural norms



Justice as recognition (Acknowledgement towards the existence of local communities with regards to their background diversity and opinion)	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree	Comments
1. All the stakeholders must acknowledge socio-cultural identities of communities throughout deliberation process for the distribution of specific goods in P2P energy trading	X					
2. Households must be free from any physical, emotional, and distorted financial threat when they propose or reject technical arrangement to distribute specific goods in P2P energy trading	X	X				1) the right to opt out 2) the right to come up with alternatives
3.						3) non joining and therefore incurring additional grid
4.						

3

Figure B.12: Assessment recognition norms