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Platforms in Power: Householder Perspectives on the Social, Environmental and Economic Challenges of Energy Platforms

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Abstract: New business models and digital infrastructures, in the form of ‘energy platforms’, are emerging as part of a transition towards decarbonised, decentralised, and digitised energy systems. These energy platforms offer new ways for householders to trade or exchange energy with other households or with energy system actors, but also bring along challenges. This paper examines how householders engage with potential environmental, social, and economic opportunities and risks of energy platforms. We convened two serious-game style workshops in which Dutch frontrunner householders assumed the role of platform members and were challenged to deliberate about different scenarios and issues. The workshop results, while explorative in nature, are indicative of a willingness to pursue energy system integration rather than autarky or grid defection. The idea of energy platforms as vehicles for energy justice appealed less to the householders, although the participants were moderately interested in sharing surplus renewable energy. Finally, environmental motivations were of key importance in householders’ evaluation of different platform types. This shows that in the role of energy platform members, householders can engage with both the community and the grid in new and different ways, leading to a diversity of possible outcomes for householder engagement.

Keywords: energy platform; decentralised energy transition; energy exchange; households; energy storage; participation; public engagement

1. Introduction

With the emergence of new renewable energy technologies at a household level, such as solar panels, smart meters, and home batteries, householders have taken on new roles in the energy system. As prosumers, they have installed solar panels and started producing their own green energy, thereby taking responsibility for the decarbonisation of the electricity system. Households can also engage in energy generation collectively, for example in local energy initiatives [1]. With the roll-out of smart meters and the introduction of smart grids, households have started to monitor their household energy consumption and production, and responding to this information by shifting their energy use in time, or taking energy-saving measures. Their involvement in so-called demand response programs makes them co-managers of the grid [2]. Recently, the term ‘prosumager’ [3,4] has been coined to refer to grid-connected households who have, next to solar panels, also installed residential batteries.

In addition to these renewable technologies at a household level, at a more general level, new business models and digital infrastructures in the form of ‘energy platforms’ are emerging as part of a transition towards decarbonised, decentralised, and digitised energy systems. In this paper we define energy platforms as digital technology-based, decentralised platforms in which (groups of) householders manage the generation, consumption, storage and exchange renewable electricity

between their members and the wider electricity grid. Energy platforms can perform a variety of functions within energy systems: aggregating distributed energy resources and integrating them into the wider grid, providing grid balancing flexibility, boosting self-consumption of renewable energy, facilitating peer-to-peer and local energy exchange, and organizing trading of energy on markets [5].

There are a myriad of positive expectations about the benefits energy platforms can bring to both energy systems and householders, ranging from reducing overall costs and CO₂ emissions by better integrating and coordinating distributed energy resources [6], democratising access to renewable energy [7], to eliminating reliance on established energy actors or central intermediaries [8]. At the same time, there are concerns that 'platformisation' produces uncertainties and privatises energy provisioning, which may hinder the transition towards sustainable energy systems [7]. These concerns echo the now widespread critiques of what has been called the 'platform society' [9] and 'platform capitalism' [10]. These critiques revolve around platform accessibility and exclusion, exploitation of participants, and the potentially surreptitious role of algorithms, among others. Moreover, the deployment and operation of renewable energy assets in energy platforms is characterised by trade-offs and different (environmental and economic) outcomes. For instance, McKenna et al. [11] highlight a tension between economic gains and environmental gains with respect to energy storage technology, a key component of (real and imagined) energy platforms: "the scenarios in which storage is operated for economic gains increase emissions, whereas those that decrease emissions are unlikely to be economically favourable" (p. 601).

The opportunities and risks posed by energy platform development warrants a closer look at what participation in energy platforms can mean for the roles and energy practices of householders in the (future) energy system. Still, while householders will play a crucial role in realizing climate and energy goals in future energy systems [12], studies about how households would want to be engaged in and with platforms, and how they view the different possibilities and risks of energy provisioning via these emerging energy technologies are largely absent.

The aim of this paper is to provide a householder perspective on the emergence of energy platforms. Our main research question is: how do householders view the social, environmental and economic opportunities and challenges of energy platforms, and how do they respond to the new roles and responsibilities for householders that energy platforms could bring along? Since energy platforms can take many forms, from boosting self-consumption of green energy, to energy trading and providing grid balancing services, our goal was to understand how householders view different alternatives. To do this, we draw on our findings from two serious game-style workshops in which we confronted householders with different future scenarios of 'platformised' energy provisioning.

In the next section, we place the rise of energy platforms in the broader context of the emergence of new roles and responsibilities for households in low-carbon energy systems. In the methodology section, we provide a typology of energy platforms and describe how we conducted the workshops. Section 4 presents the results of the workshops. Finally, we reflect on what the new role of prosumers as platform members might imply for energy justice and citizenship in decentralised energy systems.

2. Energy Platforms: New Roles and Responsibilities for Prosumer Households

The role of households in the energy transition, and in particular, their engagement with renewable energy technologies in or close to their homes, has received a lot of attention in the energy social sciences. The introduction of solar panels, smart meters, and home batteries has led scholars to analyse how householders have taken on new roles as prosumers: individually, or as energy collectives and cooperatives (community energy), and more recently as co-managers of energy in so-called smart grids. As the number of prosumers increases, the electric utility sector is expected to undergo significant changes, offering new possibilities for the greening of the system as well as many unknowns and risks that need to be identified and managed [13].

2.1. Prosumers as Energy Community Members

Prosumers can pool resources and start a local energy initiative [1]. In the literature, such grassroots innovations are seen to be challenging the existing governance of the energy system. Community energy has broadly been characterised as civil society activity ‘tackling a wide range of sustainable energy and related issues’ [14]. Community energy initiatives can be understood as “diverse–explicit and implicit, more or less conscious–forms of political engagement” [15]. Jenkins et al. [16] describe how energy communities engage with different dimensions of energy justice, such as distributional energy justice (referring to divisions of costs and benefits) and procedural justice (power dynamics in decision-making). Community energy is viewed as a key component of ‘energy democracy’, a vision and movement which advocates redistributing power to the people through renewable transformation, for example by establishing community ownership of renewable energy assets and “locally-focused decision making reflecting local priorities” [17]. Research has shown that a mix of gain and normative considerations, and, to a lesser extent, hedonistic motivations (such as having fun and community cohesion), play a role in householders deciding to engage with community energy [18].

Scholars have also identified various risks associated with the proliferation of community energy. There are concerns, for example, that affluent communities who pursue renewable energy self-sufficiency and autonomy may not contribute equitably to the societal costs of energy grid maintenance (sometimes referred to as ‘islanding’, or less neutrally, as ‘utility death spiral’ [7]). Moreover, energy communities tend to be socio-economically homogenous, not reaching those at risk of energy poverty, in this and other ways, community energy has “the potential to reproduce, or even exacerbate, existing socio-economic and spatial inequalities” [19] (p. 149). More generally, the emphasis on self-reliant communities and a diminished role for the state (as observed in UK discourse on community energy) reveals a politics of localism which neglects social justice considerations [20].

2.2. Prosumers as Co-Managers of Energy

Studies on households and smart grids have examined how with the introduction of smart grids, households are imagined to get a more active role in the energy system through monitoring their household energy consumption and production, and responding to this information by shifting their energy use in time, or taking energy-saving measures [2]. Home energy management by prosumers (who then become ‘prosumer-managers’ or “prosumagers” [3,4]), in the forms of both everyday behavioural adjustments and automated digital energy technologies (such as storage devices and smart heating systems), is considered crucial to the success of smart grids [12,21].

However, a growing number of practice-theory informed studies on smart grid pilot projects has shown that in such projects, the images of householders as rational decision-makers held by designers and providers often do not fit with the ways in which people use energy as part of everyday domestic practices [22,23]. This literature has also pointed out that despite the rhetoric of ‘active users’, many smart grid projects are steered by a provider-driven logic, with users experiencing a lack of control [21,24]. There are concerns that smart energy technologies “may reinforce unsustainable energy consumption patterns in the residential sector, are not easily accessible by vulnerable consumers, and do little to help the ‘energy poor’ secure adequate and affordable access to energy at home” [25]. Moreover, the assumption that prosumers will be motivated to act as co-managers out of financial considerations is problematic, as rewards are likely to be very small [26]. A stronger motivator for ongoing engagement with energy management appears to be optimally using self-generated renewable energy (for example by shifting energy use) [2].

2.3. Prosumers as Energy Platform Members

With the rise of energy platforms, a novel role for householders in energy systems is emerging. The energy platform member is both connected to a community and to energy systems, and, hence, combines aspects of the community prosumer and the grid-connected prosumer roles. Energy platforms

are thought to represent a profound break from previous generations socio-technical configurations of energy systems [7]. They vary greatly in terms of their socio-technical characteristics and range from commercial networks of electricity-trading prosumers spread across the country, to local initiatives where residents collaborate with energy utilities and/or market actors to better manage the generation, distribution, and consumption of locally generated renewable energy in order to achieve costs and emissions reductions. Typically, an intermediary party acts as “supervisory third-party in charge of interfacing with the market and system operator and of guaranteeing the collective common agreements” [27]. The intermediary role can be played by established energy sector actors, for example, utilities such as distribution system operators (DSOs) or energy companies, as well as new entrants such as aggregators. Energy platforms referred to by Koirala et al. [6] as ‘integrated community energy systems’, “are emerging as a modern development to re-organise local energy systems allowing simultaneous integration of distributed energy resources and engagement of local communities” (p. 981). However, much remains unknown about the potential value that these systems can provide to local communities and to the wider energy system [6].

We propose, as the main theoretical argument of this paper, that energy platforms establish and significantly reconfigure three key relationships: (1) prosumers’ relations with the wider energy system, (2) relations between platform members, and (3) relations with non-members. Similar to the energy co-manager and the community member models of householder participation, this reconfiguration opens up a range of (social, environmental, and economic) opportunities as well as risks for householders and communities. With respect to prosumer relations with the wider grid, energy platforms can be aimed at grid integration or local self-sufficiency. The first version works towards a deepening entwinement of households with national energy markets, the latter can potentially result in grid defection. Similarly, relations between platform members may be characterised by individual or by collective approaches to goal-setting, decision-making, monitoring and sharing of data, and the provisioning of (financial) incentives. Moreover, energy platforms can be organised as geographically dispersed peer-to-peer networks of more or less anonymous prosumers, but can also be rooted in local frontrunner networks or communities. Social cohesion between platform members, feelings of responsibility towards non-members (and associated with that, opportunities for enhancing energy justice or alleviating energy poverty) are likely to differ greatly between community, (commercial) grid-integration and peer-to-peer models of energy platforms. To conclude, energy platforms as socio-technical innovation appear to be highly open-ended and flexible entities which deserve closer analysis with respect to the opportunities and risks for householders and communities.

3. Methodology

To investigate the main research question, we conducted two iterations of a serious game-style workshop with householders involved in energy platform projects. Below we provide an outline of the workshop, including the typology of three energy platforms upon which the workshop is based, and a description of the two participant groups. We selected a participatory workshop methodology because it can achieve a dual purpose [28]: fulfilling participants’ expectations that they might learn or achieve something related to their own interests on the one hand, and on the other, fulfilling a research purpose through the production of reliable data. By using this approach, the emerging diversity of energy platforms, with their different environmental, economic, and social characteristics, can be made understandable for (non-expert) householders. The use of visualisations and an interactive format, designed to convey complexities and consequences in bits (mini-assignments), contributes to this. The method employed in this paper was designed to stimulate deliberation amongst householders while they navigate different energy platform scenarios involving a series of questions and challenges. In attempting to construct an immersive context for learning, deliberation and decision-making, this methodology is inspired by the emerging use of serious games in energy social science research [29].

3.1. Three Platform Types

While at first sight energy platforms seem to contribute to the energy transition, they may, in fact, do so in widely different ways. For the workshop, we drew up three distinctive platform types, each of which performs a different function in relation to the wider grid: commercial platforms, balancing platforms and climate platforms.

Commercial Platform:

In commercial platforms, platform members engage in energy trading on (national) energy markets. Renewable electricity generated by the platform members is stored in in-home batteries and sold to the grid at optimal times. The sustainability objective is to increase the overall share of renewable energy on the grid. Commercial platforms generate a flow of (financial) benefits to platform members. Platform members can choose to distribute those benefits in different ways. Individual returns may be coupled, for example, with some form of benefits sharing, to alleviate energy poverty or to support local facilities, like sports clubs. In this way, platform members are challenged to weigh individual economic returns against (collective) environmental and social objectives.

Balancing Platform:

In balancing platforms, platform members provide grid balancing services to the wider grid. Householders are engaged and financially rewarded as co-managers of energy systems. The sustainability objective is to increase the resilience and flexibility of the grid infrastructure. By aligning with energy system needs, households become further integrated into energy systems (instead of becoming more autonomous/autarkic). In this way, platform members are provided with new opportunities to take responsibility for the wider energy infrastructure. On the other hand, balancing platforms may also create new dependencies where platform members become reliant on the intermediary actors which organise the grid balancing services.

Climate Platform:

In climate platforms, platform members engage in self-consumption of (locally or self-generated) renewable energy and/or in local energy exchange. The sustainability objective is to achieve CO₂-reductions through local renewable energy generation, energy-saving, and self-sufficiency. The climate platform provides members with the opportunity to achieve 'climate neutrality' at the individual household level or at a more collective (platform) level, through individual engagement or collective action to reduce the CO₂-footprint. In addition, the focus on CO₂ reduction challenges platform members to consider to what extent non-energy related practices (such as food consumption and everyday mobility) should be included in the platform.

Each of the three platform types thus enables householders to become involved in new energy practices: energy trading, providing grid balancing services, self-consumption and local energy exchange. In addition, each platform type has embedded in its workings particular economic, social, and environmental opportunities and challenges (see Table 1). For example, the balancing platform can contribute to the resilience and sustainability of public electricity infrastructure, whereas commercial platforms can increase pressure on (local) electricity grids. Moreover, within one platform type, tensions can emerge between social, economic, and environmental objectives. In the workshop, householders were confronted with the three platform types, the new roles and practices these platforms would afford them, and the key opportunities and challenges of the platform types.

Table 1. Overview of key features of three socio-technical configurations of energy platforms.

	<i>Energy Practice</i>	<i>Key Opportunities and Challenges</i>
A: Commercial platform	Energy trading on (national) energy markets	<ul style="list-style-type: none"> • relative importance of quick economic returns vs. environmental/(social) objectives • optimal economic returns for individual households versus benefits sharing • individual householder engagement or local community engagement
B: Balancing platform	Providing grid balancing services	<ul style="list-style-type: none"> • integration into and responsibility for wider infrastructure (vs. autarky) • reliance on intermediary actors
C: Climate platform	Enabling self-consumption and/or local energy exchange	<ul style="list-style-type: none"> • individual householder engagement or collective action to reduce CO₂-footprint • energy-focus versus broadened platform to target CO₂-reduction in non-energy related practices

3.2. Outline of the Workshop

The workshop consists of two phases, each 45 min long. The objective of the first phase was to enable discussion among householders about social, environmental, and economic aspects of energy platforms. Dual statements were developed to structure the discussion, each statement reflecting different values with respect to social, environmental, and economic aspects of energy platforms. To illustrate, one set of dual statements concerned the distribution of economic gains: (1) “It is more than reasonable to aim for a quick return on my investment” (reflecting individualist/economistic values), and (2), “I want to use my assets to achieve broader sustainability or community benefits” (reflecting ‘green’ or community values). After discussing the statements, the participants were asked to declare their preferred statement, first individually and then as a group. The series of dual statements took the shape of a decision-tree, physically depicted on the floor in which the workshop was conducted. After a series of three to five group choices, this leads the participants to their preferred energy platform (platform type A, B, or C) depicted on a large poster (Figure 1). As an example, if participants consistently picked ‘economic’ statements over socially or environmentally motivated ones, they would arrive at the commercial platform and be confronted with the (environmental, social, and economic) qualities of that platform type. The small sample size and frontrunner characteristics of the participants did not allow for a representative assessment of the relative popularity of different platform types, and therefore participants’ preferences for the platform types are not presented quantitatively in the Results section. Instead, the participants’ deliberations generated by the workshops constitute the primary research data.

The goal of the second phase of the workshop was for householders to develop a more in-depth familiarity with different platform scenario’s, and to engage them in the discussion about potential issues as members of future energy platforms. This part of the workshop was structured around an introductory text and a visual depiction of a dilemma or ‘challenge’ for the participants to debate and solve, as members of the platform in question. Three challenges were developed, each tied to the commercial platform, the balancing platform, and climate platform, respectively. The first concerned the distribution of benefits in energy platforms in relation to socio-economic justice and equity. The second revolved around the trust relationship between platform members and potential intermediary partners. Finally, the third challenge concerned operationalising the climate objective, specifically with

respect to the in- or exclusion of non-energy domains (food, everyday mobility, air travel) and the selection of instruments (information provision, gamification, financial incentives).

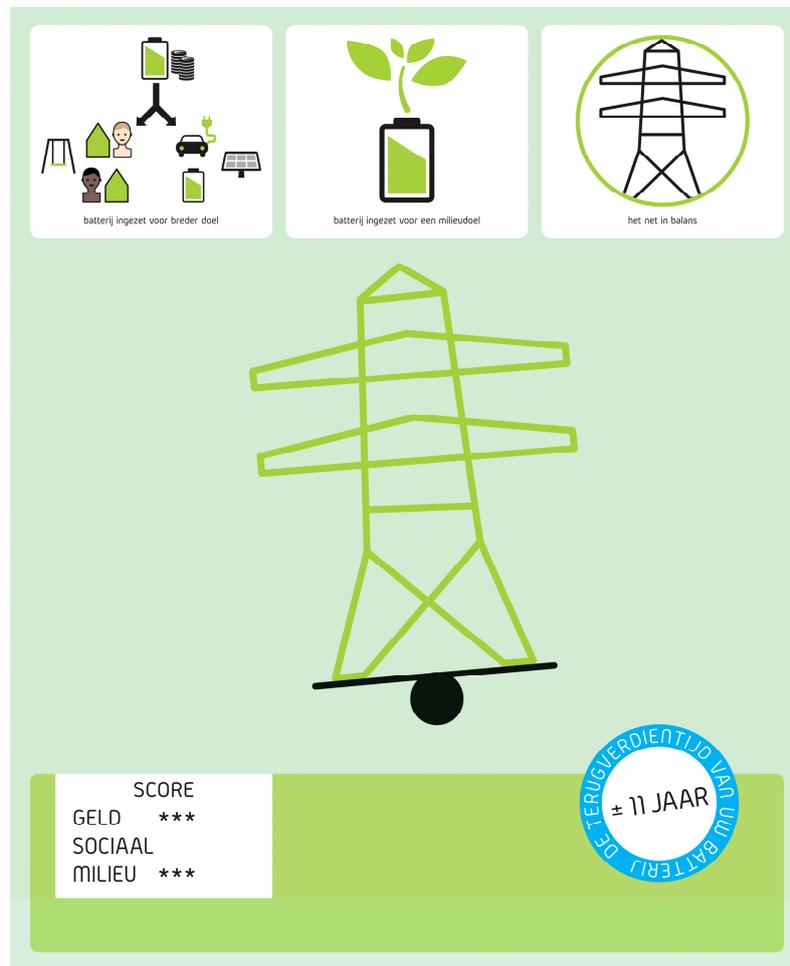


Figure 1. Example of a poster used during the workshop, depicting a grid-balancing platform. Translation of the workshop materials is provided in the Supplementary Materials.

The role of the researchers during the workshop was to: (1) explain the assignments during the workshop, (2) to moderate and record the discussions, requesting input from all participants and when necessary providing extra context or explanation, and (3) to keep track of the time and, if necessary, nudging participants on to the next question or issue. The recordings of the workshops were transcribed and anonymised. The workshop transcriptions were colour-coded per theme (environmental, social, economic) and subsequently analysed for reference to previously identified tensions (Table 2). References to and discussions about these tensions were then grouped per platform type, enabling the integration of results into the narrative-style format which is presented in the Results section. Pseudonyms have been used section to protect participants' anonymity.

Table 2. Analytical framework used to analyze the workshop transcriptions.

<i>Theme</i>	<i>Tensions</i>	<i>Indicative Keywords</i>
Environmental	<ul style="list-style-type: none"> • Energy self-sufficiency vs. system-efficiency • Indicators of sustainability (at different scales) • Narrow vs. broad approach to CO₂-reduction • Climate objectives vs. household needs 	Climate change, self-reliance, autarky, Paris accords, comfort, grey & green electricity, CO ₂ -neutral, grid balance, flexibility, responsibility
Social	<ul style="list-style-type: none"> • Individual vs. collective approaches • Householder empowerment vs. intermediaries and algorithms • Trust and intermediaries • Social cohesion 	Engagement, participation, fun, decision-making, power relations, democratic, community, peer-to-peer
Economic	<ul style="list-style-type: none"> • Inclusion and exclusion • Responsibility for societal costs • Distributional effects 	Costs, benefits, fairness, inequity, members and non-members, solidarity, sharing, trading, business model, incentives

3.3. Description of the Participant Groups

Two participant groups were selected for the workshops. The two groups were selected based on their involvement in two energy platform demonstration projects, both of which featured battery storage and some degree of householder engagement (i.e., not a purely technical pilot). Both groups consisted of frontrunner householders with experience with renewable energy generation (all participants owned solar panels) as well as some familiarity with energy platforms. In this way, the participants would be able to rely on their knowledge and past experience to reflect critically on different energy platforms and their issues. The two, small-scale demonstration projects out of which the participants were recruited were primarily technical in nature and made no particular attempts at demographic representativeness. As a result, the participant groups' characteristics mirrored those generally attributed to 'energy frontrunners', with an overrepresentation of older, male, affluent, well-educated householders. Detailed demographic data on the participants was not collected or used in analysis due to the limited representativeness of this participant group and the explorative nature of the study.

Workshop 1 involved 35 participants in the 'CityZen VPP', a demonstration project of a Virtual Power Plant (VPP) in a neighbourhood in Amsterdam. In this VPP project, the householders' renewable energy resources (solar panels and batteries) were pooled and used to test out different functions, including providing grid balancing services and trading energy on energy markets. The workshop was conducted at the end of the pilot phase of the VPP. Therefore, the participants had first-hand experience with home batteries and smart energy services prior to the workshop. The general attitude in the participant group at the time of the workshop was that the innovation is laudable but information provision about battery functionalities, the broader objectives and results of the pilot, and the value for the participants could be improved.

Workshop 2 was conducted with 24 participants of the project 'cVPP Loenen'. Relative to the urban and dispersed CityZen participant group, these householders formed a more tightly-knit community, situated in a semi-urban village. As members of a local renewable energy cooperative, they declared their interest in establishing a community-based virtual power plant (cVPP). The idea was to develop the cVPP together with the community, with the householders co-determining the objectives and practices of the platform. Adding to this participatory approach, the workshop presented in this paper was organised at the start of the householders' involvement in the initiative. As such, these

householders did not yet have the first-hand experience with home batteries, energy platforms or smart energy services.

4. Results: Discussion with Householders in Two Workshops

This section reports on the general themes which emerged in householders' discussions during workshops, in which the participants were confronted with three diverse socio-technical configurations of energy platforms: commercial, balancing, and climate platforms.

4.1. 'Commercial' Energy Platform

The commercial platform scenario confronted participants with the concept of individual households acting as traders on (national) energy markets to sell their renewable energy, to generate income for themselves or the community. By presenting participants with different forms of benefits-sharing, the scenario challenged householders to discuss their economic self-interest (operationalised as the 'pay-back time' on the home battery) in relation to environmental and social objectives. This triggered debate about what constitutes fair and just social and economic relationships among energy platform members, and between members and non-members (the local community and beyond it).

During the discussions, the participants articulated their (moral) engagement with their 'green energy'. Many were critical of profit-based energy trading and instead were enthusiastic about self-sufficiency or sharing green energy with others.

Mr. Visser: 'For me, part of the returns should go to cover the costs of exploitation, to expand and reinvest in renewable energy assets, or even to provide my neighbours with power in the future.'

When confronted with the notion that charging batteries with fossil fuel-based 'grey' electricity at night (when electricity demand and thus prices are low) may be profitable or contribute to grid balance, the participants were equally critical:

Mrs. Smit: 'I didn't quite understand when you said that batteries might be charged with grey electricity at night, wind turbines produce electricity at night, right?'

Mr. Martel, in response: 'Yea, it should be possible to choose to only allow your battery to be charged with green energy at night...'

Mr. Hendriks: 'I would want to be able to check if the electricity being purchased [by the intermediary] is green and self-generated.'

The participants generally did not evaluate the economic performance of different energy platform configurations purely as rational economic decision-makers. Instead, they drew frequently upon a range of moral frames, such as responsibility towards future generations. Some householders explicitly adopted a long term, (environmental) ethics/morally motivated perspective with respect to their investment in renewable energy technologies, even when confronted with slower returns on investment:

Mrs. Jacobs: 'I have read the Club of Rome report, I know what is coming towards us... If I know [our community] as well as I think I do, we are in it not for our own profits but for the common good.'

Mr. Visser: 'That dot on the horizon, for my children and the children of my children, that is why I decided to place solar panels on my roof.'

Other householders, on the other hand, emphasised that a sound economic model would be crucial for recruiting a critical mass of participants to kick-off energy platforms and ensure their longevity.

Mrs. Van Beek: *'Emphasizing economic returns is not greedy behaviour—a return on investment is the only way to get a project like this off the ground.'*

Next, the participants reflected on how platform benefits and costs should be distributed. The participants discussed and expressed a preference for different ways of reinvesting (part of) the profits generated by the energy platform. These included: (1) paying out all the financial gains to the members, in accordance with their relative contribution, (2) collectively re-investing in additional renewable energy resources, (3) redistributing platform benefits to (certain) members and/or non-members, (4) investing in exclusive (e.g., a shared 'energy platform e-bike') or non-exclusive neighbourhood facilities (e.g., a playground), or (5) a mix of these options.

Confronted with this task, participants argued option 1 (paying out to members) was the most motivating and fair to the platform members. They tended not to view energy platforms as vehicles for social or energy justice. The participants drew boundaries between platform members and non-members when they were debating how to distribute and reinvest profits. Instead of assuming broad socio-economic responsibility, the participants identified a number of 'thematic' (energy-related) opportunities for benefits-sharing or synergies with the wider community. Householders who are not able to invest in, for example, solar panels, due to lack of suitable roof space or insufficient capital, could benefit from roof sharing projects or 'revolving' renewable energy investment funds.

Mr. De Jonge: *'We can also consider 'lease' constructions, for people who do not have a roof and those who have many panels, saying: 'I have 15 panels, you can lease 3'. Then you do end up with a form of collectivity.'*

Some participants also suggested that benefits for the wider community could be achieved through support for local associations and facilities, such as a swimming pool, sports club, or community farm, for example by co-financing rooftop solar PV, by sharing expertise, or by offering energy contracts at a reduced fee.

The discussions in both workshops revealed a critical attitude towards assuming socio-economic responsibilities within an imagined community energy platform. Wholesale redistribution of benefits was seen as unfair and unmotivating. Instead, participants expressed enthusiasm for concrete, 'thematic' energy-related projects and schemes through which to engage and share benefits with the wider community (ranging from non-member residents to local clubs and facilities).

4.2. 'Balancing' Energy Platform

The 'grid-balancing' energy platform scenario confronted participants with possible consequences of decentralised renewable energy generation for the electricity grid (imbalance, curtailment, societal costs of infrastructure reinforcement), challenging the participants to reconsider their households' and the platform's relationship to the wider energy system and to intermediary actors. In the discussions which followed, several participants stated that solely pursuing self-sufficiency or autonomy, as a platform, a community, or as individual households, would likely introduce "inefficiencies". Moreover, they considered a resilient energy grid as a "boundary condition" for any energy platform's success:

Mrs. Veenstra: *'You need the grid. Your goal can be to reduce CO₂ as much as possible, but you cannot simply make that step without ensuring a stable energy grid. That is a precondition.'*

Mr. Scholten: *'So you say that you also carry responsibility for the grid, to keep it into account?'*

Mr. Bosch, in response: *'Yes, I think so. Otherwise, you start introducing inefficiencies. That would be a shame.'*

Many participants stated being keenly aware of the different kinds of resources required to establish and run an energy platform (including knowledge, capital, access to energy markets, and technology), as well as of their own lack of insight into the overall energy system needs. This led several participants to wonder if a 'hybrid energy platform' would be possible:

Mrs. Hermans: *'[We need] a type of hybrid. You cannot go off the grid anyway, so you have to take it into account. We don't have to start trading, but we can see how we can all reduce and how we can relieve the grid.'*

In such a 'hybrid' platform, householders would team up with electricity distribution system operators (DSOs) or other energy sector actors to form an energy platform which combines grid balancing functions with other sustainability objectives, such as renewable self-sufficiency. In these discussions, there was a willingness to think along with the wider energy system. Participants were keen to debate energy platforms which prevent grid problems rather than exacerbate them. Notably, one participant felt more empowered to contribute to grid balance than to tackle fossil-fuel dependence:

Mr. Sanders: *'Look, we ourselves do not control getting rid of our dependence on fossil fuels, that is much more with companies. Large companies, that is where the problem lies. I believe we are much better off if we, together, ensure that there is a stable energy grid.'*

However, some participants were sceptical about contributing to grid balance, with some arguing that this type of entwinement with the energy system would lead to new dependencies:

Mr. Verbeek, in response: *'I believe balancing the grid is not something we should do. It is not an option for me, because then before you know it we are once again in bed with the big energy companies who will be involved in that.'*

Moreover, simply providing grid balancing services for a financial return did not match the idealistic motivations of many participants. To them, a precondition for engaging with the needs of the wider grid was that measures taken by the platform should contribute to its own central objective: to become energy neutral and accelerate the sustainable energy transition. Next, the researchers asked the participants which type of actor they would consider trustworthy, why, and under which conditions, to collaborate with a platform in order to provide balancing services to the grid. The participants discussed a number of aspects (desired qualities of the intermediary, preconditions for the contract) which would contribute to the trust relationship:

Mr. Timmermans: *'I would take as a precondition that there is no commercial interest involved, that it won't be about making a profit or something like that as in the case with energy companies. I think that when it comes to knowledge and structure, they [grid operators] are most suited to deal with the power fluctuations. If you can combine that with a progressive and innovative start-up, then that would be excellent indeed. But the grid operator is my first choice.'*

Some householders argued that established actors in the energy sector (energy companies, grid operators) should be preferred because of their capabilities (knowledge, experience, capital, etc.). Overall, the participants were sceptical of commercial interests and emphasised the importance of control (checks and balances), transparency, and participation in decision-making. Moreover, they emphasised the importance of the trust-building role of authentic local 'advocates' and contact persons towards (potential) members:

Mrs. Vink: *'I think that the added value of active community involvement is simply that you earn the trust of the people in the village who joined. It would be best if as cooperative you form a trustworthy point of contact towards the community. From there, you outsource to another party. I don't think that we should have a company from 'outside' tell our story.'*

4.3. 'Climate' Energy Platform

The 'climate' energy platform scenario challenged participants to consider different ways in which energy platforms may achieve climate objectives (operationalised as CO₂-emissions reduction). Participants were triggered to discuss their preferences for individual or collective approaches to goal-setting, monitoring, and providing incentives (financial rewards, gamification), as well as to

consider if and under which circumstances the energy platform could achieve climate benefits in non-energy lifestyle domains (food consumption, daily mobility, and vacationing).

With respect to an individual or collective approach to the ‘climate’ energy platform, the participants generally agreed amongst each other that a collective strategy was undesirable. Collective approaches to monitoring and providing incentives were viewed particularly unfavourably. The participants’ main arguments for this were the possibility of ‘invasive social control’ and the risk of making unfair comparisons between incomparable households—especially if such comparisons would be attached to financial consequences or if they would lead to naming and shaming.

Mr. Dijkstra: *‘This [a collective approach to monitoring] gives me the image of ‘big brother is watching you’. But, big brother is sitting right next to me! And as much as I find him a nice guy, the idea that he knows what is up or where I might be, that is not for me.’*

Participants were generally more positive about collective goal-setting. Still, several participants argued that those collective objectives should be made meaningful and actionable in the context of the individual households which make up the platform:

Mrs. Vermeulen: *‘A collective objective can only be articulated individually. Otherwise, nothing will happen’.*

Mr. De Bruin: *‘In the end, you yourself inhabit the home in which energy is used. So if the VPP helps me to reduce my energy bill, to use energy more sustainably, then perhaps it will automatically trigger the interest of those around me.’*

Some participants strongly preferred an “own energy affairs in order first” approach:

Mrs. Postma: *‘[I think] all have the same ideology, which is that “I want to do something, I want to do something primarily for my own house”. And secondly, whatever [resources] might be left is saved and tagged for later investments’.*

With respect to expanding the ‘mandate’ of a climate-energy platform into non-energy domains, participants were generally sceptical. The main argument for retaining a renewable energy focus was the likely ineffectiveness and unpopularity of any attempts to set objects for, monitor, or reward non-energy lifestyle aspects in a platform initiated by householders who “came together on the topic of renewable energy”. Moreover, the participants in both workshops considered sustainable vacationing (flying less) an individual responsibility and not a lifestyle change a climate-energy platform should set targets for, monitor or reward. However, the energy community participants, in particular, did see some potential for an energy platform committed to climate objectives to facilitate and stimulate more sustainable daily mobility and food consumption, especially if multiple problems experienced by the community could be addressed in conjunction. For example, this group concluded, the platform could play a role in helping senior residents remain mobile by sponsoring a locally operated electric mini-van, or by collaborating with community-oriented farms (e.g., local organic produce offered at a discount to platform members). While the participants identified a few such specific, positive ways in which the platform could ‘move into’ domains other than energy, the ultimate consensus in both workshop groups was that an energy platform is not an appropriate vehicle for “broad” climate change action unrelated to the theme of energy.

5. Discussion and Conclusions

The main argument presented of this paper is that energy platforms reconfigure several key relations: householder relations with energy systems (infrastructure and intermediary actors), relations between platform members, and relations with non-members. How householders come to relate to energy systems, to fellow platform members, and to non-member as energy platforms, has important social, environmental, and economic implications. Therefore, the aim of this paper was to explore and

analyse how householders deliberate about social, environmental and economic opportunities and challenges in the context of different socio-technical configurations of energy platforms. To achieve this objective, two workshops were held in which frontrunner (prosumer) householders were challenged to think, discuss and make choices as platform members. This methodology yielded a number of insights.

The first concerns platform members' relations with other members and with non-members. Energy platforms enable new forms of trading and sharing of energy. As such, energy platforms present opportunities to enhance energy justice, as well as risks of exacerbating energy poverty due in part to the capital- and knowledge-intensive barrier to entry. In the two workshops, participants acknowledged these opportunities and risks and were moderately interested in for example sharing surplus renewable energy. However, they generally argued that energy platforms were not appropriate for vehicles of social justice. Participants were moreover wary of scenario's in which neighbour platform members would be able to monitor and compare each other's performance ('Big Neighbour'). Furthermore, the (potentially) limited socio-economic diversity of platform members was considered natural and unavoidable, indicating that the participants were not strongly triggered by distributive or recognition justice issues in the context of energy platforms [16].

Secondly, with respect to householder relations to energy systems, the two workshops showed that the prospective platform members were to some extent aware of and cared about the effects of their platform on the grid. The extent to which participants would be willing to actively take responsibility for these effects differed, with some participants referring to negative perceptions of intermediary actors or pointing to the perceived (in)commensurability of grid-integration and autonomy objectives. The nuanced positions most participations took with respect to pursuing either energy independence or system integration necessitates distinguishing between autarky and autonomy ambitions. Autarky can be defined as independence from energy supply, whereas autonomy refers to the ability to self-determine one's energy provision. Both individual autarky and autonomy have been shown to be strong motivators for the adoption of energy storage technology [30]. The workshop discussions centred not around platform autarky, but on different ways, energy platforms can interact with the wider grid for mutual benefit, and how in that interaction the platform members can set terms and conditions (fairness in decision-making, or procedural energy justice [16]). The question became how energy platforms can operate as autonomous actors vis-a-vis or in collaboration with established energy sector parties to determine platform relations and ambitions, as well as how environmental, social, and economic tensions and dilemma's should be addressed.

Householders in their (imagined) role as platform member thus appeared to be open to engaging with the energy system. While other studies have shown that energy storage technology in individual households can facilitate autarky and disengagement of householders with energy management [21], our workshop findings indicate that storage in the context of energy platforms can also serve as a building block for public participation and engagement in wider energy systems. This is also important because grid-connected energy platforms which optimise self-consumption of renewable energy in coordination with the wider grid have been shown to outperform grid-defected platforms cost-wise. Moreover, such grid-connected platforms are considered as 'beneficial to the alternative of solely being supplied from the grid both in terms of total energy costs and CO₂ emissions' [6]. Importantly, the willingness of both participant groups to engage with the wider energy system rather than pursue self-sufficiency must be understood in the context of their participation in demonstration projects, which were designed specifically to experiment with householder collaboration and integration in smart energy systems, in the process of which householders learned about energy system needs.

Thirdly, for most participants, sustainability was the primary motivator in making choices and discussing alternative scenarios. Even when the participants chose the scenario of energy trading on energy markets to optimise economic returns, they strongly preferred not to trade in non-renewable energy. At the same time, they expressed themselves negatively about incorporating substantive connections to other lifestyle consumption domains in energy platforms, such as food or mobility. This broadening of energy platforms to become 'sustainability platforms' is in principle made possible by

ongoing platformisation (various recent technological applications enable cross-domain valuation and exchange). It will be interesting to monitor if such integration will yet occur overtime.

A final, general observation concerns how the particular backgrounds of the participating householders shaped their deliberations and preferences with respect to energy platforms. They frequently referred to and applied their past experiences and motivations for engaging with sustainable energy as well as with their local community during the discussions. In the two workshops analysed in this paper, this meant that one participation group responded more positively to energy platforms catered towards individual households, whereas the participant group with an energy community background expressed preference for additional ‘green’ investments in the neighbourhood and for platforms structured as cooperatives (rather than, for example, commercial- or utility-led platforms). Moreover, one participant group was at the start and the other was at the end of their involvement in a VPP project: this difference in an experience enabled the latter group to formulate more precise desires and priorities, surrounding, for instance, transparency of battery operation. This implies that yet other groups of participants will likely yield different outcomes of the deliberation.

In conclusion, the workshop showed that—with facilitation—prosumers are very well able to articulate their concerns, motivations and values with respect to different ways of organising and operating energy platforms. With households and their renewable energy resources representing the crucial ‘nodes’ of emerging platform networks, prosumer householders are an (if not the most) important factor in energy platforms. There is a clear need for householders to be involved in discussions about how platforms should work and what their role in platforms could be. Such discussions need to cover issues such as responsibility for public energy infrastructure, climate change, the (re)distribution of costs and benefits, decision-making, and inclusion and exclusion. These are all issues which connect individual households and their everyday energy consumption, generation and management to general public issues [31]. The new role of energy platform member presents prosumer householders with opportunities and risks ones associated with both energy co-manager and community modes of participation in energy systems, leading to a diversity of possible outcomes for householder engagement. How energy platforms members intend to employ their renewable energy to achieve which energy and climate goals, and what type of relationships they wish to form with fellow platform members and non-members, and with actors in the wider grid, has important implications for the transition towards decarbonised, decentralised, and digitised energy systems.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/2/692/s1>, Table S1: Example of a ‘play-through’ of the decision-tree assignment. Bolded text means that statement was chosen over the other; in this fictional case, the outcome is platform A1.

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