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Participatory Design For Community Energy

Designing the Renewable Energy Commons

Andrea Capaccioli

Advisor:

Prof. Vincenzo D'Andrea

Università degli Studi di Trento

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Statement of Contribution

This thesis reports research principally done by the author, as a part of his doctoral research.

This thesis consists of the following publications:

1. Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2016. Exploring alternative participatory budgeting approaches as means for citizens engagement: The case of energy. In Smart Cities Conference (ISC2), 2016 IEEE International, 1–4. Retrieved March 14, 2017 from http://ieeexplore.ieee.org/abstract/document/7580816/ —> Chapter 1
2. Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2016. Participatory infrastructuring of community energy. 9–12. https://doi.org/10.1145/2948076.2948089 —> Chapter 2
3. Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2017. Exploring participatory energy budgeting as a policy instrument to foster energy justice. Energy Policy. https://doi.org/10.1016/j.enpol.2017.03.055 —> Chapter 3
4. Giacomo Poderi, Mela Bettega, Andrea Capaccioli, and Vincenzo D'Andrea. 2017. Disentangling participation through time and interaction spaces–the case of IT design for energy demand management. CoDesign 0, 0: 1–15. https://doi.org/10.1080/15710882.2017.1416145 —> Chapter 4

Additional published articles arising from this research:

1. Matteo Bonifacio, Andrea Capaccioli, Giacomo Poderi, Maurizio Marchese, and Vincenzo D'Andrea. 2014. Communities of Practice and Renewable Distributed Energy: The CIVIS Experience. Volume One: 148.
2. Giacomo Poderi, Matteo Bonifacio, Andrea Capaccioli, Vincenzo D'Andrea, and Maurizio Marchese. 2014. Smart Meters as boundary objects in the energy paradigm change: the CIVIS experience. In A Matter of Design. Making Society through Science and Technology.

Abstract

The energy sector is facing a major paradigm shift from centralised production and management to distributed energy generation and management. Digital technologies play a crucial role in enabling such scenario; emphasis and attention has been given to Smart Grids and new energy management systems both for final users and companies. Energy, its consumption, and its production are at the centre of our everyday lives and are connected to everyday practices and habits. However, while this scenario can be seen as mundane, new spaces can be created for citizens and communities to participate and be empowered. This thesis presents the work done by the author within a three-years European Project used as his main research field. The focal points were: (i) the participatory design process of a community energy digital platform; and (ii) the advantages and disadvantages of a commons based approach to renewable energy management on the development and empowerment of local communities. First will be presented how a participatory design process opens a new space for citizen participation to design as an alternative energy management model. Then will be presented the energy budgeting framework designed within this process, discussing how social acceptance of technology affected the design and how energy has been translated to a new kind of value within this framework. Afterwards, it will be discussed how the participatory process and the framework contributed to the construction-in-practice of energy justice, and how this process reconfigured the relationships among civil society, the energy sector, and politics. Finally, the whole three years project experience will be analysed retrospectively using the interaction spaces framework, highlighting how participatory configurations evolved over time and how cross-participation is crucial for the boundary-spanning of design issues. Therefore, concluding reflections will be drawn based on this content, they will consider lessons learned, limitations of the experience and possible future work to continue explore the relationship between energy, digital technologies and participatory design.

”We are called to be architects of the future, not its victims.”

(Buckminster Fuller)

Flashback

On the 28th of September 2003, I was seventeen, living with my parents in our old apartment, the one where I grew up. My grandad was at the hospital and we were supposed to go there and check on him. The house was strangely silent. I tried to turn on the TV: nothing. There was no electricity in our apartment. No electricity in the whole 4 apartments building. No electricity in the whole street. Later on, we found that the power went off in the whole town, and there was no electricity in the whole Italy. The biggest blackout in the history of Italy just took place that night: for hours, all the country (aside from Sardinia and some other islands which had their own independent electricity network) was powerless, and I felt myself likewise powerless. I vividly remember the empty roads, my father silently driving to the hospital and the radio talking about the issues related to the blackout; in Rome, a big event was happening, with hundreds of thousands of people in the street at the moment of the blackout. When we arrived at the hospital, I had a strange feeling. The lights were off, with just the emergency system on: all so quiet, it was like a total different sensation than the everyday experience.

Introduction

The blackout of 2003 and the feelings I had at the time came into my mind while starting to reflect about the outline of this thesis. It was a moment of discovery and materialisation of the energy infrastructure. This infrastructure is usually transparent and even unrecognised in our everyday life: we "naturally" think that the light bulb will light up if we switch it on, that the TV will show us our favourite channel if we plug it to the wall or that our internet connection will be always available.

The interconnection of energy, telecommunication and social infrastructure became evident that day: the blackout made visible how the lack of electric led to a telecommunication breakdown, which recursively brought new electric blackouts in a cascade of failures (Buldyrev et al., 2010). At the same time, this made clearly visible the dependence upon energy and telecommunication networks that we have in our everyday life practices.

Tertzakian and Hollihan (2009) in their book start from recognising how for thousands of years now the development of societies has always been coupled with increasing consumption of energy, creating what they calls the *"energy obesity"* paradigm. They analyse how this paradigm is approached, and shows that, in order to break it, technology is necessary as much as social and policy changes. However, to break this paradigm, we must start working to design alternative new paradigms. A possible first step is that of analysing and discussing *"what energy is for"* by putting at the centre the recognition of energy as an important factor of practice. Shove and Walker (2014) highlighted how this approach then conducts to consider society as emerging and defined by our social practice, also in relation to energy usage. Hence, as noted by Shove and Walker (2014) the dynamics of social practice and its changes must be considered by whoever want to address and break the *"energy obesity"* paradigm.

Energy transition to a low carbon society is one of the objectives that international organisations and governments declared has to be achieved in the near future: from the COP 23 - Paris Conference to the European Commission with its

"Roadmap for moving to a low carbon economy in 2050" (2011b). Goals in CO_2 emission reduction and transition toward sustainable energy and technologies are recognised as key factors to tackle the ecological crisis we are facing.

Still, the European roadmap and all the initiatives undertaken are within the same old paradigm, where the problem is seen is just as a matter of shifting from fossil energy sources to renewable ones, without taking into consideration the possibility of putting under discussion how to exit and how to find another path to follow. An example of this is the creation of market mechanisms for the commodification of gas emissions, also opening up for financial speculation, with all the risks that markets carry with them (Frame, 2011).

It is a period of *"great transition"* as Manzini defined it (Manzini, 2015), in which we are now experiencing and exploring how to live with the reality that our planet has limits in terms of resources; with our extreme exploitation, we as the humanity in the last centuries created the conditions for catastrophic changes in the planet we all live in. Therefore, there is the need for new economic models, new production systems and new ideas of wellbeing. New opportunities arise at the intersection of green technology, networks and diffuse creativity: for example, a scenario of Small, Local, Open, Connected (SLOC) initiatives (Manzini, 2010). Small and Local original possibilities and cultures can be now be scaled up to become Open and Connected globally, in what can be called a *"cosmopolitan localism"* (Manzini, 2010). However, there still are open questions about how SLOC initiative can grow and increase in impact. Manzini describes two possible strategies: (i) *replicating*, that implies the implementation in a new local context, and therefore the design of a new solution for the local initiative; and (ii) *connecting* local initiatives to scale up vertically by inserting them in the context of a larger programme, or scale out helping the propagation of the initiatives in other contexts (Manzini, 2015).

The societal impacts and the ethical implications linked to the transformation and the transition of energy systems still remain to be fully grasped from a philosophical point of view. Before embarking on the redesign of our energy system

we should, for example, have a clue about current consumption, if is a result of the energy supply structure or of the fulfilment of human needs and wants. These figures should also be contextualized in the possible daily and seasonal rhythms of renewable energy that will induce different energy consumption practices (Geerts et al., 2014). The pivotal role of energy in our society implies that the redesign of our energy system, to cope with the energy transition to new sources, should be addressed in a more integrated way: energy technologies, ICTs, policies, practices, and at the end all the aspects of our lives must be considered as a whole. Design has a powerful role in this: design researchers and practitioners have the potential to inspire people towards a change in practices and a shift in culture to face a future scenario where humanity may enter a period of "collapse" (Tomlinson et al., 2008).

Using the vocabulary of Fry (2008), up until now we are continuing *"de-futuring"*: our past, present and also future actions will negate our future. For Fry (2008) our practices are oriented toward de-futuring: to sustain our short-term perspective we collectively destroy resources that all other beings depend upon, negating for us human and for other the future. It thus becomes central shifting radically the way we, as humans, make our world: design can be a powerful actor of this change, if we start design for *"futuring"* (Fry, 2008). For Fry futuring defines "a disposition (understood as an inscribed way of being of both human beings and of non-human beings and things), a mission and the organising of principles of practices", which means "giving the self a future". Thus, futuring is about the design practices that we need to pursue in order to design our future. This future for Fry must consider two main pillars: taking care of the self and taking care of the conditions of the environment where the self is in being. This second pillar implies the role of the community as an agent of change for the future. The community will then become an even more important factor for sustainability, and its nurturing and sustainment is essential to cope with the adaptive change needed (Fry, 2008) by climate change, economic and environmental crisis.

The energy transition process becomes a moment in which as a society we can take advantage of the new opportunities and challenges that emerge from this

perspective by putting participation and the creation of an alternative at the centre. Energy can be considered as a commons (Ostrom, 1990), and the energy transition as a process toward different energy sources and to a different socio-technical paradigm (Byrne et al., 2009). Exit from the energy obesity paradigm and design futuring energy system imply change the status of energy and think about energy, and renewables energies in particular, as a common good. From this perspective Wolsink (2012) started defining a research agenda on how this could be achieved: change the paradigm imply also shift the focus from the design of technology itself toward focusing on the practices and institution that should sustain the new paradigm. As it will also be discussed in the next paragraphs and chapters, the Participatory Design (PD) community has much to offer in this direction, in terms of design artefacts, but also in terms of looking at design as a future and futuring perspective.

This thesis wants to explore the possibility for building such a sustainable future, highlighting the challenges and opportunities of a community-based (DiSalvo et al., 2012) participatory design process of a community energy platform, and the advantages and disadvantages on local communities of a commons-based approach to renewable energy through the specific case of the construction in practice of energy-justice as the result of the commoning process. The work presented – based upon four papers already published in which the author contributed significantly – was done in the context of the three years EU-FP7 CIVIS project aimed to reduce energy use and carbon emissions to address the so called "societal challenge" of efficient energy and used an Action Research based approach to engage the actors and stakeholders involved in the research part, but also to design and deploy an effective set of tools to be used by participants and stakeholders. In the next paragraphs of this introduction first will be presented the context of research, then the research questions and the methodological approach, finally the related work, before leaving space to the four main chapters.

Context of research

The research discussed in this thesis has been carried out within the CIVIS[1] project, a three years EU-FP7 research project started in October 2013 and ended officially in November 2016. CIVIS aimed to reduce energy use and carbon emissions to address the so called "societal challenge" of efficient energy, by an increasing integration of ICTs to promote new relationships between the actors of the energy value chain for the domestic sector (producers, distributors, intermediaries and households). In the vision of CIVIS ICTs represents an enabler of the new decentralised paradigm of energy, where new ways of production and consumption of energy play a role in transforming the role of citizens to become active player in the energy field. The overall idea of the project is that the human being is not just an *"homo oeconomicus"*, but that the complexity of social dynamics and human interaction are guided by a multi-dimensional value system. Taking from one side the example of the Web and Internet as a form of decentralised infrastructure empowering people, and from the other the role of ICTs in smart grid for measuring, forecasting and optimising consumption and production, CIVIS worked in combining together those aspects promoting an integrated approach to energy efficiency taking into account the preferences and social dynamics of individual and communities to understand the reshaping of how energy is generated and used to achieve an environmental goal. So, the whole project was based in the design, prototyping and real-life testing of *"ICT solutions able to reduce energy use and carbon emissions by leveraging on the potential of social networks and communities"*.

The project worked through three main dimensions: Energy, ICTs and Social. The three dimensions are connected together: the new ICTs tools, which were deployed to the users participating in the project, were designed together with new policy process in order to move toward a more "systemic" approach, where the economic and environmental goals are framed with a social and community dimension.

[1] http://www.civisproject.eu

CIVIS activities took part in 5 pilot sites: 3 in Italy and 2 in Sweden. I worked on CIVIS both as part of the coordinators team of the project, which was leaded by the University of Trento, and for the engagement of the three Italian pilot sites local communities and actors in the participatory process through all the duration of the project. I had the chance to be in contact with the participants and the local context through all the duration of the project:

- By working at the communities engagement;
- At the organization and coordination of activities with participants (focus groups, workshops);
- By supporting the participants for technical support (in relation to the Participatory Energy Budget (PEB), the smart sensors installed, and the YouPower app) and clarification with doubts about the project goals.

In total, in the three Italian pilot sites 325 participants from 105 families participated in the project activities and experimentation. The Italian experimentation consisted in the developing and testing of YouPower application, in connection with the development of a prediction model able to generate a Time-of-Use (ToU) signal provided to the participants in order to change their consumption behaviour according to local load balancing capacity of the grid, meaning helping people consuming the locally produced energy.

YouPower

YouPower main feature are: i) a time-of-use signal; ii) a set of energy data visualization tools and iii) tips for energy-reduction actions. The latter is the only feature that was developed for both the Italian and Swedish pilot sites, while the first two (time-of-use signal and energy visualization tools) were developed and deployed only for the Italian pilot sites. The visualization tools helped the participants to check their real-time and their historical consumption data, and/or production if they had Photovoltaic (PV) panels installed at home. The project provided also two smart-plugs

to participants and data from the selected appliances were shown in the energy consumption section of YouPower.

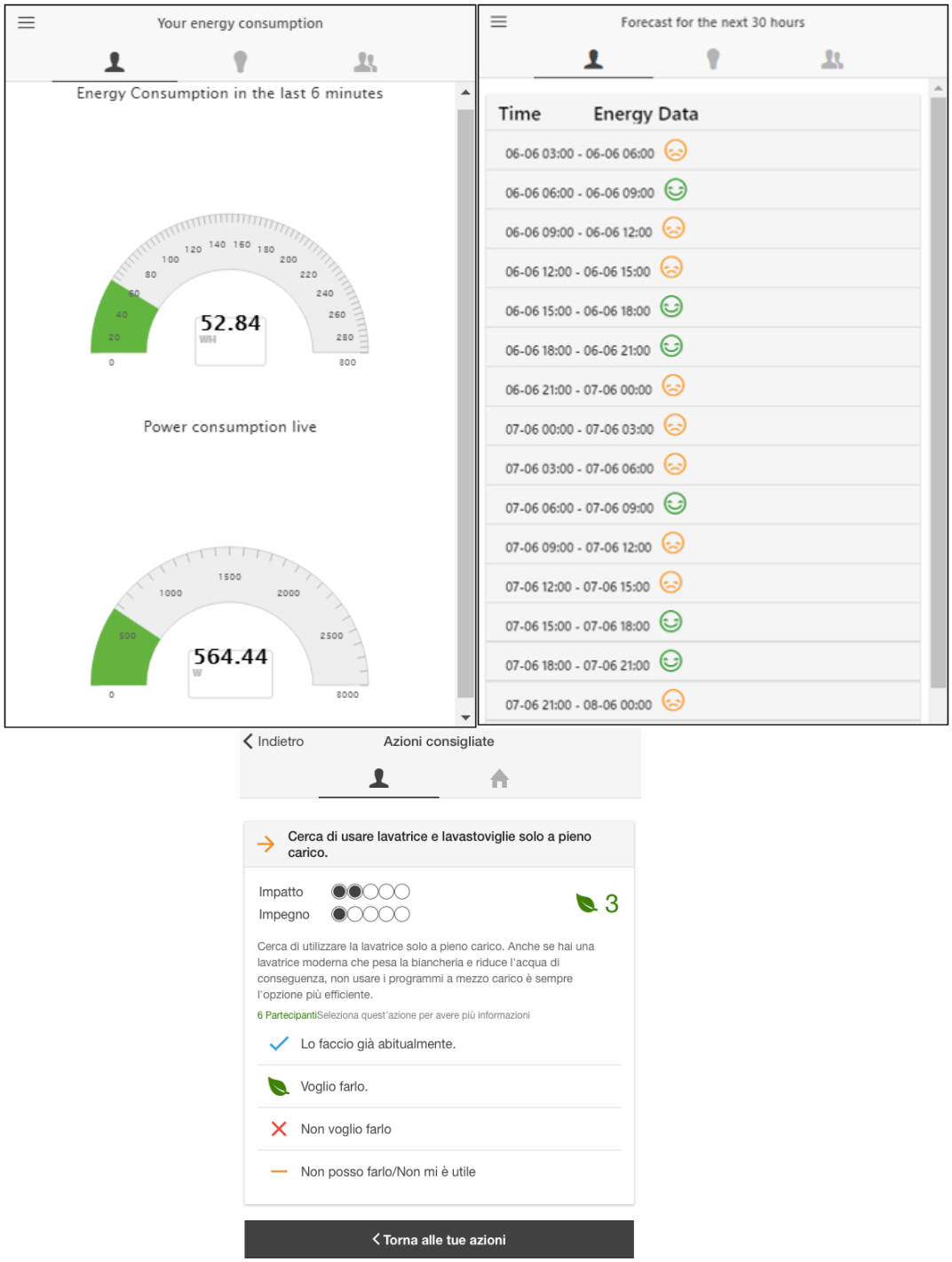

Figure 1 YouPower application: real-time energy consumption, Time-of-use signal and energy tips features

The time-of-use signal provided participants a 30 hours forecast period showing when it is the best time to consume energy to maximize the use of local renewable energy and contribute to the PEB. For an easy reading the signal is represented by a green happy smile for the best timeslot to shift consumption and a yellow sad smile for the ones where to save consumption (*Figure 1*). The tips function provided participants with useful actions to save energy and a function to track the actions they did. The actions provided had a different level of difficulty and impact (e.g. "Fill up your fridge but don't cram it too full" or "defrost your freezer regularly"). For a wider perspective on the different YouPower features developed for the Italian and Swedish pilot-sites, the paper by Huang et al. (2017) presents them.

Among the proposed functionalities the ToU signal was the main feature provided in the YouPower platform for the enabling of the PEB process, but the whole process encompassed other different technological, social and policy arrangements that will be discussed later in Chapter 1 section 1.8 and following.

Participants to the project engaged in the co-design phase of YouPower providing insights and proposals for features and functionalities. Originally the project had a stronger emphasis on social networking functionalities, but this were discarded by the participants during the co-design process, instead they focused more on the visualization data. As a part of the local coordination team responsible for the activities with the participants, I coordinated with the project developers in order to share with them the results of the participatory process. The YouPower platform was released in March 2016 and it was used until March 2017, while the PEB process lasted until June 2016.

Local stakeholders

The main local stakeholders for the Italian side of the project were two electric consortia producing distributing and selling electricity in the three municipalities were the project took place: CEIS and CEdiS. They both produce renewable energy to distribute to their members and customers by managing hydroelectric and solar power plants. They also promoted, during the last years, the installation of photovoltaic

panels for the members; this has brought a significant diffusion of such technologies in the territory.

Both of the consortia are electric cooperatives born at the beginning of the 20th century, and are historical enterprises focused on the mutual cooperation. Their roots are deeply embedded within the local territory, where the consortia have strong social and economical relationships. Their cooperative form implies that members participate in the governance of the companies and that the profits are re-invested in the companies or used to lower the price of energy to members.

Storo

Storo is a municipality situated in the Province of Trento, part of the Giudicarie Community valley. It is 70 km away from Trento and 50 km from San Lorenzo in Banale (the other site of the project), with an approximate population of 2,800 inhabitants. The municipality is located at 400 m above the sea level and it covers an area of 63 km2. For the production and distribution of electricity, Storo is served by the Consorzio Elettrico di Storo (CEdiS). CEdiS is a cooperative founded in 1904, with the aim to produce and distribute electricity in the municipalities of Storo, Ledro and Bondone. The cooperative produces electricity using renewable energy sources, it is the owner of 3 hydropower plants and 3 centralized photovoltaic plants. The energy is sold to the cooperative's members and the local families and companies with a discount of roughly 20% compared to the market price. During the last years CEdiS also promoted, from the technical and the bureaucratic aspects, the installation of photovoltaic panels within the local territory. 34 families living in the municipality participated in the CIVIS experimentation.

Figure 2 Photovoltaic installation in Storo

San Lorenzo in Banale

San Lorenzo in Banale is also part of the Giudicarie Community Valley local government, in the Province of Trento. The municipality has an approximate population of 1100 inhabitants. San Lorenzo is 37 km apart from Trento and 50 km from Storo. The municipality is located at 800m above the sea level and it covers an area of 62 km2. San Lorenzo in Banale is served by the Consorzio Elettrico Industriale di Stenico (CEIS), a local-based cooperative institution founded in 1905, with the aim to support the local territory in managing energy services, and in particular the production, distribution and management of electrical energy. CEIS serves the territory of six municipalities: Bleggio Superiore, Comano Terme, Dorsino, Fiavè, San Lorenzo in Banale and Stenico. Thanks to the ownership of electrical production plants, transport and distribution grid, CEIS can ensure to its members a discount from 20% to 30% of the energy price compared to the market price. The production comes entirely from renewable energies: CEIS has the ownership of 1 hydropower plant, 5 centralized photovoltaic plants and 2 biogas power plants. CEIS promoted also the diffusion of households' photovoltaic installation during the last years. 68 families living in the municipality participated in the experimentation.

Research question and contribution

The main inquiry of this thesis is to make sense of: **the challenges and opportunities of a community-based (DiSalvo et al., 2012) participatory design process of a community energy platform, and the advantages and disadvantages on local communities of a commons-based approach to renewable energy management.**

Due to the complexity of the topic it is worthwhile to break up the topic in sub-questions addressing specific matters, including a reflection about methodological aspects. Each of the following questions is addressed in one of the main chapter of this thesis.

RQ1. How can a commons-based approach to renewable energy management be designed and enabled?

The main contribution of this thesis is the development of a "Participatory Energy Budgeting" (PEB) framework that together with a smart-grid infrastructure allows communities to generate and manage value to use for social and collective goals. The answer to this question is informed in Chapter 1 that examines how a space for citizen participation can be created in a continuous design process and by defining the framework and its rationale.

RQ2. What are the advantages and disadvantages of a commons-based approach to renewable energy management on local communities in terms of social and energy justice?

The implementation of such framework becomes a powerful policy instrument that can strive to reconfigure the relationship among civil society, energy sector and politics to achieve a more just and equal energy distribution and management. The question is addressed in Chapter 2.

RQ3. How can we as researchers and designers look at a complex participatory design process and acknowledge for the multiple perspectives

and political agendas of the different actors in order to support future decisions?

To inform RQ3 is fundamental key to go back to RQ1 and RQ2 in order to analyse in full the participation of all the actors involved during the whole duration of the project and to look at how participatory configurations evolved over time and how cross-participation is crucial for the boundary-spanning of design issues (Chapter 3). This last question also contributes to a methodological reflection for designers and practitioners involved in complex participatory projects.

Related work

The work presented in this thesis starts from the increasing interest in understanding and investigating how we can shape a different future in relation to the increasing pervasiveness of digital technologies in our society and more specifically the impact of energy transition on society.

As already mentioned in the previous section, the work of this thesis lies within the community-based participatory design domain. From there it focuses on analysing the challenges and opportunities of a community-based PD process of a community energy platform, which used a commons-based approach to renewable energy management. Therefore, the following paragraphs discuss the related works around the main areas I explored during my work: the community-based participatory design field, the commons theory and the energy commons, the energy justice framework, and the technological part related to the smart-grids. The presented works are at the basis of the next three chapters, which are formed by four different papers already published, so most of the concepts presented here can be found in the related works section of each paper. Here I convey all the theoretical corpus together leaving readers the chance to have a broader view before going deep into my work.

Community-Based Participatory Design

Community-based PD, as an area of research and practice, has growth in the last years due to the increasing impact of digital technologies together with the increasing prominence of neo-liberal market forces (DiSalvo et al., 2012). As noted by DiSalvo et al. (2012) in their contribution to the Routledge International Handbook of Participatory Design, the growth of community-based PD is connected to the exit from the original PD roots in the workplaces toward the outside of the classic organisational workplace. In their analysis of community-based PD, Di Salvo et al. (2012) identified three main *"topics"* shaping the future of the research field for them: i) new form of politics, ii) publics and iii) infrastructuring. The three are inherently intertwined and build on each other. Therefore, one opportunity for PD is to create the condition for a constructive manifestation of democratic pluralism and contestation. As noted by Di Salvo et al. (2012) this range of political actions in community-based PD intersect with the other two topics of publics and

infrastructuring: publics is a notion to define groups of people identified with an issue, and with the willingness to take action and pursue a change, and they can be sustained by infrastructures and/or publics can emerge around issues related to infrastructures. Those three elements are central also in the context of the experience presented in this thesis they are all present and interrelated (see Chapter 1).

Thus, community-based PD faces a challenge similar to the original PD purpose: provide for alternative perspectives on participation and democratization and actively engage in organize and foster democratic settings for innovation to take place (Björgvinsson et al., 2010). Shifting the centre of the design intervention toward *community* then means to have new emergent and situated design practices and research (Verran and Christie, 2007). Thus each design intervention takes place in a unique context in which negotiate participation and where the different viewpoints, agenda and role of participants shape the whole process (Winschiers-Theophilus et al., 2010). This means that communities and designers must co-create tools, techniques, and methods that best fit the situation where they are participating (Sabiescu et al., 2014).

Viewing PD processes as contingent and situated implies that practitioners, designers and researchers are confronted with a higher degree of reflexivity about their participatory practices, instead of focusing on methods replicability (Light and Akama, 2012). For Akama (2015) then designing is situated in "between-ness", emerging from a relational sensitivity through a *"becoming together"* approach among all kind of actors, places and *"atmospheres"*. Thus, the role of PD is about bringing people into the design of the yet invisible structures around them (Light and Akama, 2014). The original political agenda of PD is reinforced and brought back by this perspective: participation is essential to ensure that the voices of communities and marginalized groups are heard in policy-making processes in order to design the futures we all wish to live (Simonsen and Robertson, 2012). And if this is what we want to pursue as PD practitioners then it becomes essential starting working against neglecting us the future (*"de-futuring"*) and leading instead the reflection with

"futuring" starting setting design practices that consider decisions for the future, a future which is well beyond our finite-time as human beings (Fry, 2008).

Acknowledge this, and recognize that we cannot consider our time and our future as something business as usual then implies that we start designing for the common good. Light et al. (2017) then argue that this means that there is not a one end-state of design, but instead it is more a process of awareness and of supporting the evolutions in state. Communities need tools to support them in care and fulfillment, and wonder, but what this means and how to make it possible it is a task to be done in each community, and with every design decision (Light et al. (2017).

To achieve such a challenging ambition the PD community must start grasp and reflect about the whole different political issues and agendas that are embroiled in the contexts – techno, social, political, societal – where PD is brought (Karasti, 2010). Furthermore, the practical work of community-based PD practitioners, which usually takes place with citizens and communities, it is connected and interrelated with different level of institutions (from regulatory institutions to funding bodies) and even if the work unfolds at the micro-level of, it can generate effects and changes also at the meso and macro level (Huybrechts et al., 2017). Huybrechts and colleagues (2017) observe that neglecting these relations, for example by hiding this complication to citizens and participants, has been a major issue toward the depoliticisation of PD processes. Thus, they focused on *"institutioning"*, highlighting the role of institutions in shaping and being shaped by PD processes, and therefore underling how PD processes are political practices.

The politics of design and the design of politics then become central also for Dourish (2010) in relation to HCI and design for environmental sustainability. In his view potential important areas of design investigation are hidden by considering the market and his mechanisms as natural, and by putting the focus on individual competition rather than cooperation. In the next section I will introduce the relevant literature of commons as a possible alternative, also in light of the growing interest for this topic in the PD community.

Common(s) and Energy

A Common Pool Resource (CPR) has been defined as: "a natural or man-made resource in which it is difficult to exclude or limit users once a resource is provided, and one person's consumption of the resource units makes those units unavailable to others" (Ostrom, 1990). Classic examples of CPR are forests, fish stocks, water, basins, irrigation systems. After the analysis of over 80 case studies of local natural resource commons, either successful or unsuccessful, Ostrom argued that many successful CPR management are mixed, holding together individual property and common property (e.g. the case of farmers in the Swiss Alps described in Ostrom book: the farmers individually owned plots for the growing of vegetables, and an association at the village level manage summer meadows, the irrigation systems and the roads). In other words, in a commons management the choices of the single individuals affect all the community, and all together the individuals influence each other decisions. One of the main point from the Ostrom perspective is that the management of the commons is a matter of a collective-action dilemma (Ostrom, 1990). For Ostrom this dilemma could be modelled as prisoner's dilemma (Ostrom et al., 1994), where the cooperation among the *"prisoners"* could led to a benefit for the whole community, but with a sub-optimal results for the single individual, thus the risk is to pursue the individual benefit instead of collaborating. Hardin in his paper about the *"tragedy of the commons"* (Hardin, 1968) argued that the possible solutions to not solving this dilemma are only or a top down management by the state or the government or at the opposite the establishing of propriety right over the common resource and the privatisation. This second solution has become dominant in the public discourse following the rising of the neo-liberal politics over the last thirty years, leading to solution like the commodification of carbon emissions (Frame, 2011) and the idea that a free-market system could be first step to "fix" climate change, which had a strong support from politics and the technocratic establishment but with contrasting and debatable results (Lohmann, 2005). For Ostrom et al. (1994) instead is complex and rather difficult to use market solutions to manage commons resources due to the effect of externalities affecting all the excluded by the use of a commons. Since there is not a general solution to commons management issue, studying successful and

unsuccessful examples of commons management Ostrom tried to understand the principles characterising a commons. Such principles guide how rules and institutions emerge with the very final goal of constraining the behaviour of single individuals in order to solve the collective-action dilemma. Ostrom (1990) described eight *"design principles"*; they are essential elements helping to account for the success of the commons in sustaining and gaining the intergenerational compliance.

Those eight principles are: 1) Clearly defined boundaries; 2) Congruence between appropriation and provision rules and local conditions; 3) Collective-choice arrangements; 4) Monitoring; 5) Graduated sanctions; 6) Conflict resolution mechanism; 7) Minimal recognition of rights to organize 8) Nested enterprises.

The label *"design principles"* is misleading, Ostrom has later clarified that she thought at the design principles as general successful rules in terms of producing sustainable outcomes for the management of a natural resource, and not as practical principles to be used in design work (Ostrom et al., 2012), but they still remain useful for learning from them. Wilson et al. (2013) discussed how the design principles can be generalized: they come from the evolutionary dynamics of cooperation in all species and that they have a wide range of application, becoming relevant also in other context where groups of people must cooperate to achieve common goals. For these reasons, Wilson et al. (2013) suggest that the principles, which require a local tailoring implementation, are a practical guide to increase the efficacy of groups.

Dietz et al. (2003) described five conditions to achieve a successful governance of a Common Pool Resource: 1. The resources and the use of the resources can be monitored. The information from the monitoring can be verified and understood at relatively low cost. 2. Rates of change in resources, resource-user populations, technology and economic and social conditions are moderate. 3. Communities maintain frequent face-to-face communication and dense social networks that increase the potential for trust, allow people to express and see emotional reactions to distrust, and lower the cost of monitoring behaviour and inducing rule compliance. 4. Outsiders can be excluded at relatively low cost from using the resource 5. Users support effective monitoring and rule enforcement. The challenge for Dietz et al.

(2003) is to devise institutional arrangements to help set such conditions or tackle challenges related to the governance where the ideal conditions are not present.

In the last years varieties of *"new commons"* have been mapped (e.g. Digital Commons, Cultural Commons), both evolving from the development of new technologies that enabled the possibility to define commons previous non-definable goods (from the Internet to the electromagnetic spectrum) or from reconceptualising resources publicly shared (e.g. playgrounds, urban gardens, sidewalks) (Hess, 2008). One category of the defined new commons is the *"Infrastructure Commons"*; Künneke and Finger (2009) define infrastructures, also the energy infrastructure, within the definition of CPR, therefore they can be perceived and managed as commons. While analysing the resolution of CPR problems in infrastructures, Künneke and Finger recognise how in the traditional studies of CPR the integration and evolution of technology and institutional arrangement is not recognised. They point out how ICTs allow for more decentralised infrastructures and at the same time for new possible systems of governance. This is one level to understand energy as a commons, another one is to conceive a commons not the infrastructures but the energy itself, with this perspective energy could be positioned within the *"Social Commons"* (Byrne et al., 2009). Within this perspective, the emergence and the design of a new governance of energy, over the liberal and technocratic one, is also the condition that Byrne et al. (2009) discuss as a way to challenge the energy obesity paradigm. They define and discuss the model of a *"sustainable energy utility"* as a possible tool to empower the creation of a *"commonwealth"* model, where energy decisions are taken by the community considering the *"common"* benefit.

The *"common"* without the s, has been defined by Hardt and Negri (2009) as the "common wealth of the material world", meaning natural resources available to humanity, and also more significantly according to their view as *"those results of social production that are necessary for social interaction and further production, such as knowledges, languages, codes, information, affects, and so forth"*.

For Vercellone and colleagues (2017) the main difference between the "commons" and the "common" is that the second, using a materialist approach, always is a social and political construct and it is not ascribable to some intrinsic characteristics of goods, in contrast with the neo-classical theory ascribing intrinsic features to goods to determine their different status. Thus, the central points are the forms of governance and cooperation ensuring the production, reproduction and distribution. Their approach to the common as a mode of production is, therefore, a social construction based on the spread of knowledge and on the self-government of production. The new approach, affirmed Vercellone et al., could lay the foundations to a new social and economic order, with a completely different relation between the public, the private and the common.

With a slightly less optimistic vision, Hardt and Negri (2009) recognised how the common can be nourished but also can be appropriated and exploited, which is the phenomenon taking place in the current form of capitalism, where also knowledge, social practices and social relationships are dispossessed by capital to create a surplus value. In their book Hardt and Negri highlighted how the shift from the present "republic of property", which they saw in the modern society strong focus on the right of private property and in the exclusion of those without property, to an alternative social relations pass from making common. In their view intellectuals and academics must work for new practices in a co-creation process of these, without vanguards. Through this vision I will present in the next section the specific case addressed in this thesis, which is related to the commons-based approach for energy-justice. I will then first describe the energy-justice framework and its relation with the common(s).

Energy Justice

This section is about energy justice as a specific case to evaluate the effectiveness of a commons-based approach to energy, which will be discussed in relation to the PEB in Chapter 2. Energy justice is recognised as the pursuit of an *"energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial decision-making"* (Sovacool and Dworkin, 2015). Energy justice derives from the environmental justice movement started in the USA during

the '70s; it pursued a public debate and possible solution to inequalities in the distribution of environmental ills that mostly affect marginalised and poor segments of population (Walker, 2012).

Energy justice wants to focus the attention on problem such energy poverty, energy efficiency, emissions reduction and all the spectrum of possible inequalities toward energy, but more from a technical perspective without considering the broad societal aspects and implications (Heffron et al., 2015), even if one of the goal of energy justice is to discuss the ethical, philosophical and moral aspects posed by today energy challenges Sovacool and Dworkin (2014). In literature three are the main tenets defined for energy justice: distributional justice, procedural justice and justice as recognition (Heffron and McCauley, 2014; Heffron et al., 2015; Jenkins et al., 2016). *Distributional justice*: relates to the physical and spatial dimension of energy and is concerned with the unequal distribution of resources, risks, and responsibilities. *Procedural justice*: calls for transparent, inclusive, non-discriminatory decision-making processes around energy. It stakes a claim for all stakeholders involved or affected by energy decision making to be able to participate in the process and to be effectively listened to. *Justice as recognition*: concerns the acknowledgement of inequalities and their fair accounting when devising energy infrastructures or policies.

Jenkins et al. (2016) claimed the need to address a new direction for the energy justice development applying a "systems" thinking. To address injustice the authors propose the following three steps using the three main tenets defined earlier: i) first to identify the concern (distributional justice), ii) to identify who is affected by the issue (Justice as recognition) and iii) identify strategies for remediation (procedural justice). In terms of remediation in form of procedural justice, they discussed three main points to apply all over the energy system: i) mobilize local knowledge to achieve outcomes, ii) greater information disclosure and iii) better institutional representation, which are also three important points in relation to the commons-based approach and to the possible role of PD in enabling it discussed in the previous paragraphs. Moreover, according to Sovacool and Dworkin (2015) energy justice can be

a tool to supports analysis and decision-making related to energy, the proposed energy justice decision-making framework is based on eight principles[2]: 1) availability, 2) affordability, 3) due process, 4) good governance, 5) sustainability, 6) intergenerational equity, 7) intergenerational equity, and 8) responsibility. If not tackled the issue of energy justice can drive to energy systems that depletes assets available for future generations at benefit of the present ones, or that separate the negative externalities related to the production of energy to the positive attributes of energy consumption (Sovacool et al., 2016). The overall idea presented by Sovacool and Dworkin (2015) with their energy justice framework is that it is not only a matter of building new infrastructures, new technologies or improving energy security, if first energy justice is not assessed, if first we do not look at what energy is for, who benefit, and what values should guide us. Indeed, there are already evidences of the use of energy justice framework: Bartiaux et al. (2016) did a comparative study between Portugal and Belgium and highlighted how energy policies must account for differences among social classes to be more effective. Heffron and McCauley (2014) looking at the Denmark discussed how energy justice frame at the national energy policy level is an enabler for growth of new energy supply chain. The acceptance of new energy infrastructures could be increase by having a fair and transparent decision-making process, as discussed by Gross in relation to Australia wind installation (Gross, 2007).

More recently Energy Policy journal published a special issue with the title *"Exploring the Energy Justice Nexus"* where the published papers encompassed a whole subjects addressing the energy justice issue from a broad perspective and focusing on the practical application of the framework in different contexts, with a close look to policy implications: new challenges emerge for researchers and practitioners that want to mitigate the impact of energy in a more ethical and socially just way (Jenkins et al., 2017). Jenkins (2018) recognised that there are a stream of research with a novel practice-oriented approaches to energy-justice that wants to have a set of tools to exit

[2] It is funny to note the recurrence of some numbers across different areas: the eight principles, the three dimensions. Even if it is totally random, I found enlightening how all of the different areas fit together also with the numbers.

from the academic discourse to have a practical action of change within society. Among this novel approach one of the possible tool is the Participatory Energy Budgeting discussed and presented in the next chapters of this thesis. Also considering that the energy systems are embedded with political and deliberative challenges, and interventions over them are about technology as much as about political power, social cohesion and ethical and moral concern over equity (Sovacool et al., 2016), for this reason the design of alternatives to the actual energy obesity paradigm must take into account the design of alternatives socio-economic relations based upon the nourishing of the common. To do so it is necessary to confront with the technological and institutional scenario that is nowadays at the centre of the discourse for the future of energy, the one related to the development of "smart grids", which I will present in the next section.

Smart grids

The electrical power industry already entered a period of rapid change, a series of events from international political instability to climate change work as drivers for the future transformations: the energy sector is moving towards an inevitable transformation of the actual grids into smart energy grids (Farhangi, 2010). This transformation is part of a fundamental shift of the energy paradigm: smart grids are characterized by a pervasive use of ICT, enabling the ongoing shift from a centralized energy system, with large suppliers and one-way communication, to a distributed one, where the energy flow becomes bidirectional and the production is shared through a series of actors, from traditional operators to users and new emerging organizations. The actual topography of the electric grids is a result of years of human activity, both the institutional energy infrastructure and the actual physical infrastructure of cables, wires and power plants have been in place for decades and highly embedded in our lives, but still from the beginning having a central-station supply was one of the goal of Edison (Hughes, 1993), but today after more than a century we are at a changing time.

European Commission defined smart-grid as *"an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient,*

sustainable power system with low losses and high levels of quality and security of supply and safety" (2010). Evidence has shown that the spreading of smart-grid technologies needs supportive and integrated policies from the States to foster also the interoperability of the deployed technologies (Brown and Zhou, 2013). The European Commission identifies smart grids as a key factor for a future low-carbon electricity system and to increase the shares of renewables and distributed generation (European Commission, 2011a). The European Commission strategy for smart grids deployment considers the development of smart grids in a competitive retail market a crucial precondition for a successful transition, which should also encourage consumers to change behaviour, and become more active and adaptive to new energy consumption patterns. The core of the new model should be an efficient demand response, which requires real time or almost real time interaction between consumers and utilities, with the need of time-differentiated electricity prices to allow that consumers to have a genuine incentive to adapt their consumption patterns. The practical implementation of a smart grid varies among the cases, but the use of sensor and communications technologies, which provide improved reliability and enable consumer access to a wider range of services, are standard among all the cases (Potter et al., 2009). Smart metering and smart monitoring should be the basic technologies for effective smart grids and one of the means to enable direct two-way communication with the customers and the energy suppliers (EU Commission Task Force for Smart Grids, 2010).

The smart grid concept can also been considered as a larger grid, integrating together smaller microgrids. A distributed generation microgrid *"is formed by integrating loads, distributed generators (DG) and energy storage devices. Microgrids can operate in parallel with the grid, as an autonomous power island or in transition between grid-connected mode and islanded mode of operation"* (Lidula and Rajapakse, 2011). Still, energy storage is not yet a technology with a mass spreading and at the same time renewable energy sources and their variability over time poses new problem to the management of the grid: digital technologies and new information system are central to maintain the energy system reliable (Potter et al., 2009). The core of the new model is expected to be an efficient and dynamic demand response,

which requires real time interaction between consumers and utilities (Farhangi, 2010). This is essential in order to provide services that can foster strategies such as Demand Side Management (DSM) to optimize users consumption through economic incentives (Karnouskos, 2011) or through demand side community action (Burchell et al., 2014).

Obviously this new possible energy landscape of smaller autonomous microgrids open new challenges and issues also from policy and institutional level, differences among smart grids and the actual centralized system are enormous and we can see how, in such a new scenario, all the actors in production and consumption would play completely different roles, and new actors would emerge. Nowadays, most actors who support the actual highly centralized energy system (e.g. energy companies, authorities and regulations) do not fit into this possible future community energy scenario, where generation is distributed through smaller renewable energy plants and where the energy network is becoming highly decentralized and locally controlled. Communities may interact and collaborate, in a dynamic ecosystem, where new third party service providers or new institutions could emerge to assist them. The presence of distributed generation renewable energy within the microgrids transforms the energy prosumers and consumers into new actors that can be empowered to act collectively. Karnouskos (2011) argued that shifting the focus from individual to communities of prosumers will gave the critical mass for realizing the energy transition depicted by the smart grid era. The major challenge would then become how such system would be socially constructed and embedded (Wolsink, 2012). Therefore experimentation of new modes of governance are needed, even if limited and restricted design of experiments is not beneficial, and a wider perspective and coordination among Europe could help in avoid clashing modes of governance (Lammers and Diestelmeier, 2017). The rethinking of the current technocratic and technology driven governance is also at the centre of Wolsink (2012) research agenda about renewable energies as Common Pool Resources. The agenda describes the need not only of an enabling technology to be imposed, but the pushing of a socio-technical approach that takes into account the communities and the users, in order to re-design the current institutions, which were originally designed to support the centralised

energy system and thus do not fit with the new paradigm in a microgrids and smart-grid energy system. Giotitsas et al. (2015) build on the peer-production as the mode of production utilised in the domain of information commons to explore the potential of a commons-based peer-production model for the energy sector from a theoretical perspective. Similarly to what has been discussed by Wolsink (2012) the authors define their model as a network of microgrids connected as in a peer-to-peer network, but while information can be reproduced with a marginal cost near zero this is not the case for energy, therefore in their model, going back to the first Ostrom principle, only who produce the energy could consider it as a commons. They draw conclusions about the fact that technology cannot solve the energy problem by itself, but the application on a larger scale of this approach must encompass a change in the whole socio-economic context. Indeed, looking at a more practical level, Melville et al. (2017) investigated on how local communities participating in a demand-response trial perceived the idea of a commons-based energy management. The findings from this inquiry are interesting because they match in a large part with the findings discussed in this thesis later on in chapter 1, regarding both the level of community participation, the role of technology and the concern over privacy, but at the same time the authors saw the benefits of pursuing the research agenda toward a commons-based governance of energy.

Participatory Design, common(s) and energy

The last part of this chapter is meant to understand how the combination of PD, commons and energy contribute to the community-based PD approach. A design reflection about how to enable the commons-based scenario must start from the understanding that the process should be open-ended and co-designed, where the role for experts is to trigger and support these processes (Manzini, 2015), a first step should start from comprehending how the commons framework could be integrated with PD. Also, from a mere design perspective must be stressed the importance of using the open-ended approach, as highlighted by Walker (Walker, 2008) analysing a community-energy project, one of the main barrier to the success of the community-energy initiatives is the long-term capacity of the community to maintain and operate the systems (e.g. installation of renewables, new ICTs infrastructures) after their

installation. ICTs and energy technologies are just two of the actors mobilised in the design of the new energy paradigm, from a PD perspective Marttila et al. (2014) discussed how the commons framework could be linked to the PD endeavours and broadening the scale, not just the technology development, but knowledge production, sustainability and resilience. This perspective opens up challenges related to the complexity of processes distributed in space and time and with more complex socio-material assemblies, new challenges are posed in relation to the design of self-governance processes and fairness, sustainability and inclusiveness of rules and practices for cooperation (Marttila et al., 2014). By binding together the commons framework with infrastructuring, PD is trying to move back to its original democratic ideals (Karasti, 2014). Teli (2015) suggested to PD practitioners to supplement the commons framework with the theory coming from the work of Hardt and Negri (2009), broadening the perspective to the *"common"* without the "s". Within this framework Teli (2015) proposed a *"renewed utopia"* for PD: increasing awareness of the current capitalistic mode of production and orientating PD practices toward the common. PD can become a force of progress that can strength social practices and social groups to nourish the common, if it is able to find new social allies in the marginalised and precarious communities of citizens and workers. Furthermore, Teli and colleagues (2017) argue that PD is a *"commoning practice"* (Marttila et al., 2014) and that PD can nourish and sustain the common.

Therefore, looking at the energy sector, the possible transition to a new paradigm for energy based on commons can be supported and encouraged by the PD community by enabling and fostering *commoning practices,* also considering the impact that energy has in our lives and considering the potential impact that changes in energy production and distribution could have on social relations and on social structures. The common could so emerge in a non-commodified space and with a higher degree of participation of community at a local level, participation both in the production of energy and in the collective effort of the community toward shared goals (Giotitsas et al., 2015). Indeed, looking at the experience of already existing community-energy projects has been discussed how the participations to such project

is motivated by the perceived benefits for all, rather than for personal benefits, and an important role in participating is given to the connection with a physical place (Hoffman and High-Pippert, 2010). The role of communities is recognised as central in the ongoing energy transition, becoming active players of transformation (Schoor et al., 2016). However, to foster the role of communities citizens must be engaged in a system of public participation that need proper institutional arrangement to ensure participation and self-government (Hoffman and High-Pippert, 2010). Institutioning (Huybrechts et al., 2017) then becomes a central component to consider during PD processes, and for the project discussed in this thesis we can see how the micro-level of intervention and participation, with citizens and communities, was dependent by different institutions at different level, but at the same it had the force and the possibility to generate effects also on meso and macro-level institutional frames, following what was discussed by Huybrechts et al. (2017). The shifting toward a community governance and toward the pursuing of collective goals to enable a commons-based governance allows the establishing of new values above the ones imposed by the energy obesity paradigm: speed, infinite growth and extra-large capacity are overtaken by energy sustainability and energy justice as the outcomes from the new energy-ecology-society relations (Byrne et al., 2009).

Methodological approach

To understand better the work done for my thesis in this section I will present the methodological approach used and the activities carried out during my PhD.

I actively worked within the CIVIS project during the whole duration of my PhD, my involvement has been deep and I worked together with the local communities, stakeholders and project partners both to the coordination and management of the project and to the activities in the pilot sites in Trentino region. Therefore, having defined the central role of the local communities, it becomes clear the need to fully engage them also into the design process that will have a twofold purpose: the concrete design and implementation of the platform, and enable the community participation to trigger and foster the social energy mechanism. The design process needs to take place as a process: for, with and by communities (DiSalvo et al., 2012). The whole PEB process has been negotiated and designed collaboratively with the involvement of project participants and the main stakeholders during the whole life of CIVIS.

The main challenge for my work so has been to positively involve all the actors (local stakeholders, communities and project researchers) in a fruitful relationship and to accomplish two objectives: as researcher my aim is to contribute to develop new knowledge, but I also feel committed to address practical problems related to energy and social issues of the local context where the research takes place.

This lead to the choice of an Action Research (AR) based methods. Action Research as a method go back to the end of the II World War and the work of the Tavistock Institute to deal with the veterans social and psychological disorder after the return from the battlefields, but it is only at the end of the '70s and during the '80s that AR entered the information systems research field to study the information systems, their use and the subsequently organisational changes in practical contexts (Baskerville and Wood-Harper, 1996). It has its roots in the post-positivism tradition of research, the key aspect is its interventionist approach: AR is a method that merges research, by investigating a phenomenon, and praxis, by intervening in a situated context to solve a problem, working together in a cyclical process with the people

having the interest in solving the problem and producing knowledge from the overall experience (Baskerville and Wood-Harper, 1996). As defined by Baskerville and Wood-Harper (1996) the three main distinctive characteristics of AR are: i) the researcher is actively involved, ii) the knowledge obtained can be immediately applied, iii) the research is a cyclical process that links theory and practice. While the original application of AR look at interventions in organisations and companies, the focus has been widened also to communities using the Participatory Action Research (PAR) method. PAR is a form of AR where professional researchers work as full collaborators with the members of organisations and communities that want to operate a change in their contexts (Whyte, 1991). Greenwood et al. showed how PAR is an emergent process where the local contexts and conditions play a relevant role in guiding the process (Greenwood et al., 1993). MacDonald (2012) in a paper discussing her choice toward PAR highlighted how PAR can also be traced back to the work of Paulo Freire about the empowerment of poor and marginalised sectors of society for positive changes in their conditions. The vision of PAR, as a method and a process that people can use to determine their own development and to be able to address injustices (MacDonald, 2012) is matching the goals of my research: the empowerment and development of communities, the tackle of injustices in the form of improving energy justice toward the development of a commons-based energy management, while also producing new knowledge.

For these reasons I chose to use a PAR-based approach, but also due to the context of my research, which was carried out within a research project which has also design specific goal. . Participatory Action Design Research (PADR) approach (Bilandzic and Venable, 2011) methodology combines both Action Research (AR) and Design Science Research (DSR). DSR has been defined as a research activity that invents or builds new, innovative artefacts for solving problems or achieving improvements, but without assuming a collaboration between researchers and the clients/practitioners involved, focusing only on the design part (Iivari and Venable, 2009). PADR it is mostly a PAR version with the improvement of a design phase, and in my case a PD phase, during the whole process, but in particular in the taking action stage. It is not a

mainstream approach to AR but it has been defined among the community-informatics community and it was thought for urban informatics project.

PADR has five phases, which can be repeated through a cycle process: diagnosing, action planning, action taking design interventions, impact evaluation, and learning and creation of actionable knowledge for the participants. During each stage as discussed below, different activities are carried out using, with the possibility to use different approaches and methodologies. In my case mostly using ethnographic methods and PD methodologies, each chapter discusses the methods used during the different stages and timing of the project.

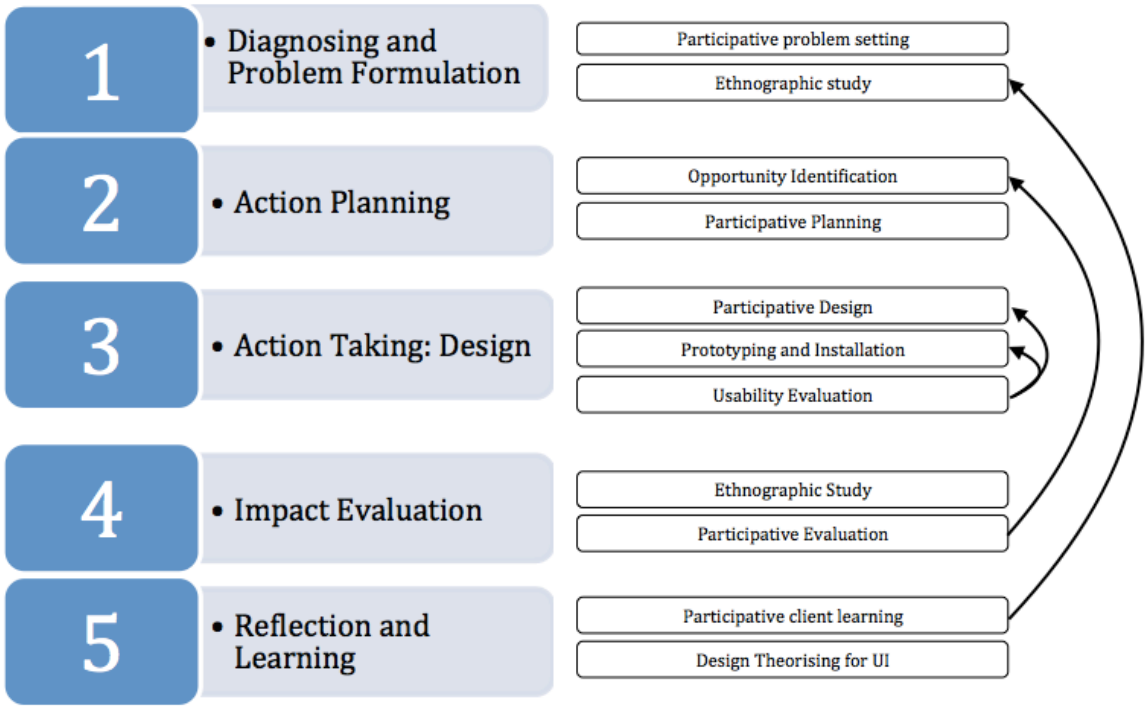

Figure 3 Participatory Action Design Research cycle: adapted from Bilandzic and Venable (2011)

The 5 stages are borrowed from AR even if different versions of AR exist; most of them follow the same stages in the large part of the versions, from the Canonical Action Research (Davison et al., 2004) to Participatory Action Research (Whyte, 1991). Among versions there are differences in how *"clients"* and practitioners are involved into the process: from a more active and intensive involvement in the Participatory Action Research to a mostly deliberative involvement for the Canonical Action

Research. The PADR cycle, as modelled in theory, is represented in Figure 3, while in the following paragraphs is described a more detailed description of the activities done during the different stages, making clear the differences in the practical and contextual application of the PADR. While during the whole duration of CIVIS it has been accomplished just a complete iteration of the PADR cycle, it must be noted how the different stages

I had an active role in organizing, designing, moderating all of the activities except in the case marked with an asterisk in the table (in brackets the actual number of activities in which I had an active role).

1 - **Diagnosing and Problem Formulation**: in the first stage the goals are identifying the stakeholders, analysing problems and arrive to a common understanding about the specific problem to be solved. During the initial part of the project this has been done through the involvement of both stakeholders and participants into the process of participative problems setting, engaging them as co-researchers. Stakeholders and project partners were initially engaged in order to define the problem setting and the main points.

Type of activity	**#**	**Description**
Focus Groups	2	Exploration of local communities to understand: i) sense of belonging to the community; ii) collective awareness about energy and environmental issues; iii) role of ICTs in energy interventions
Meetings/Roundtables	5	Exploration and negotiation with stakeholders and local partners (consortia representatives, municipalities) about the possible interest and their needs

Table 1 Activities done during "Diagnosing and problem formulation" stage

During the first year of CIVIS seven meetings and roundtable has been done together with the representative of stakeholders and project partners both to discuss their engagement and the planning of the project activities and to understand the local context. Then, as also discussed in Chapter 1 citizens and participants to the project participated in activities such as focus-groups and workshop to inquiry their actual practices of consumption and their attitude toward renewable energy. Also in this stage it has been possible for participants and communities to start a first critical reflection on their consumption practices, which comes along with the identification of problems and criticalities.

2 - **Action Planning**: this stage is needed to derive from stage 1 an idea to be developed and the implications for designing the effective technology able to solve the identified problems. It is the prelude to the designing phase; participants and communities continue the participatory process. Techniques such user stories, scenarios and personas help to explore how possible futures can be enacted from design choices (Brandt et al., 2102). Four user stories were produced and used to plan the intervention and the engage both local stakeholders and participants in this stage. The use of this tools helped in define the main issues around which reflect, making visible the main Matters of Concern (Latour, 2004) emerged during the project.

Type of activity	**#**	**Description**
Workshops	2	Participatory workshops to make participants reflect about: i) their consumption and their daily habits; ii) possible changes and possible motivation to change; iii) reflection about future scenarios
Meetings/Roundtables	2	Discussion a with local stakeholders about user stories and scenarios based on the previous analysis of the context and on the interaction with project partners

Table 2 Activities done during "Action Planning" stage

3 - **Action Taking**: the central stage of the PADR is aimed at the design and development of the identified solution. Participatory Design is a fruitful approach for this stage of the process. Prototyping is the main activity for this stage, starting from low-level paper prototypes and going through cyclical processes of evaluation and refinement of the prototype. Also it is necessary to evaluate the prototype to validate if it is mature enough to reach the defined goals.

Figure 4 Ideas generation activity during the workshop for the design of possible project to be funded with the PEB - April 2016, Storo.

Type of activity	**#**	**Description**
Workshops	8	- 2 co-design workshops related to the design of YouPower frontend, with the design of wireframes and prototypes - 2 workshops for the definition of the PEB mechanism - 2 workshops for idea generation of possible project proposal for the PEB with participants and local associations - 2 workshops for a collective qualitative evaluation of the proposed projects before the online voting

Table 3 Activities done during "Action Taking" stage

During this stage local stakeholders and participants actively participated both in the prototyping of the online platform, and in the designing of the PEB process; also the call for proposals of the PEB has been co-designed with participants (see chapter 1 and 2) and they were involved in the ideas generation process for possible project to be funded (Figure 4).

4 - **Impact evaluation**: the diagnosing phase described the problem, in order to change it and solve it. Thus, after the action taking stage, it is necessary to evaluate the changes occurred. If judged as unsatisfactory, for the emerging of new problems or because the starting goals are not met, it is possible to restart from the first stage and go through another cycle of PADR.

Type of activity	**#**	**Description**
Focus Groups	5 *(4)	- 3 focus groups in March 2016 to evaluate with participants the use of YouPower and an early evaluation of the PEB process so far - 2 focus groups in June 2016 to evaluate the final results of PEB and the experience of participants and local associations involved, with the whole process.
Meetings/Roundtables	2	Presentation and evaluation of the results with the two consortia, feedback about their experience and the possible future collaboration and exploitation of the project results. Reflection about their possible future goals and interests according to what has been the outcomes of the project.

Table 4 Activities done during "Impact evaluation" and "Reflection and Learning"

Ethnographic methods can be very useful in this stage (Bilandzic and Venable, 2011), since the impacts may vary across the participants and the stakeholders, and the new technology can create whole new practices and ecology. The evaluation of the PEB process has been done in terms of the analysis of the process effects for the energy justice. How the designed and implemented process and technologies affected

the construction-in-practice of energy justice in the involved communities (see chapter 2).

5 - **Reflection and Learning**: following the Action Research process, after the end of development it is necessary for all the participants to reflect on what happened during all the stages of the process, making explicit what has been learned. The communities of participants will focus on the practical outcomes, while researchers will be interested in creating new knowledge. Reflecting about the project itself and about the participatory configuration helped mapping the configurations of participation within the different interactions spaces in order define a scaffolding tool for analysing and reflecting on the multiple participatory configurations emerging during time (see chapter 3). While reflection and learning moments has been done with the local stakeholders during the evaluation stage (see table 4), due to the timing of the project one of the methodological limits of this work has been the missing of a reflection and learning moment with participants. In part this has been done during the last two evaluation focus groups (see table 4), but still remain a limited experience.

Thesis outline

The thesis consists of these introductory chapters, 3 main chapters, and a final conclusion chapter:

Chapter 1 introduces how a participatory design process open a new space for citizens' participation to design an alternative an energy management model. Moreover it discusses about the energy budgeting framework designed within the participatory process, highlighting how social acceptance of technology affected the design and how energy has been translated to embed different values than the economical one, becoming a sort of currency within the PEB framework.

Chapter 2 discusses how the participatory process and the framework contributed to the construction-in-practice of energy justice, and how this process reconfigured the relationships among civil society, energy sector, and politics. It highlights how energy justice in a local community might be closely linked to issues such as the form of energy governance, the accountability of the process, policies and technological limitations.

Chapter 3 analyses retrospectively the whole three years experience of CIVIS project using the interaction spaces framework, highlighting how participatory configurations evolved over time and how cross-participation is crucial for the boundary-spanning of design issues. It is a more theoretical contribution about the participatory process and the relations between researchers, stakeholders and users.

Conclusion: key contributions of this thesis, limitations and future direction of research.

1 Participatory Infrastructuring of a Commons-based approach to energy

1.1 Preamble

This chapter is formed by two publications, which together inform RQ1. The question and the subsequent reflections emerged together with the writing of these papers. Therefore, the answer to RQ1 stems from the main elements enclosed in the following publications and later discussed in the conclusion chapter of this thesis

The first part, comprising of a paper presented at the PDC conference of 2016, discusses how, by connecting the concept of commons and infrastructuring, PD can go back to its original democratic and political ideas (Karasti, 2014), becoming a force that drives the nourishment of the common (Teli, 2015). The paper explores the infrastructuring of collective actions related to the energy system, clarifying how PD can support the "commoning practices", looking ahead of the technology development itself toward knowledge production, sustainability and resilience (Marttila et al., 2014). As mentioned in the conclusion of this paper, PD can contribute to creating a sustainable alternative and form different relationships between the actors involved, opening a space for citizens' participation in a continuous process of design for energy management. One of the main questions that emerged was how to make this space sustainable in the future. This issue, which became apparent in the earlier stage of the project, will be discussed and clarified in the subsequent chapters.

The second part of the chapter discusses a paper presented during the IEEE Smart-Cities Conference of 2016 and introduces the Participatory Energy Budgeting framework (PEB), contextualising it within the smart-grid and smart-cities discourse. It clarifies how the ICTs tools supported the collaborative implementation of the PEB process and how the social acceptance of new technologies could be a barrier to participation and engagement. The paper approaches the technological implementation of the PEB as a process that wants to foster a bottom-up and collaborative process around the energy management, the design of an alternative system and the implementation of new sustainable practices. It draws from the critical

perspectives of the mainstream ideology about smart-cities, as a top-down technocratic agenda (Söderström et al., 2014; Greenfield, 2013). It presents in a clear way that the three dimensions of ICTs, Energy and Social are intertwined and how they interact with each other.

This paper informs RQ1 by presenting the vision of the use of energy as a value embedding not only an economical dimension related to the price, but also as a meaning to reflect about environmental and social impact. A further discussion on this last point is at the centre of the reflection on energy justice elaborated in Chapter 2.

Paper 1: Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2016. Participatory Infrastructuring of Community Energy. In Proceedings of the 14th Participatory Design Conference: Short Papers, Interactive Exhibitions, Workshops - Volume 2 (PDC '16), 9–12. https://doi.org/10.1145/2948076.2948089

1.2 Abstract

Thanks to renewable energies the decentralized energy system model is becoming more relevant in the production and distribution of energy. The scenario is important in order to achieve a successful energy transition. This paper presents a reflection on the ongoing experience of infrastructuring a socio-technical system in which local communities can manage renewable energies as a Common Pool Resources. We explore how to create a space for citizens' participation in a continuous process of design for energy management. Objectives of the paper are: i) to clarify how Participatory Design could support the sustainability and the effectiveness of an alternative, ii) to present an experimentation with renewable energy as CPR as an alternative model to the actual vision of the energy system. Preliminary results reported in this paper suggest that a Participatory Design process can be valuable for communities in order to establish new energy management models.

Paper 2: Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2016. Exploring alternative participatory budgeting approaches as means for citizens engagement: The case of energy. In Smart Cities Conference (ISC2), 2016 IEEE International, 1–4. http://ieeexplore.ieee.org/abstract/document/7580816/

1.3 Abstract

This exploratory paper presents a reflection about the activities from an European research project aiming at engaging citizens in a novel governance of local renewable energy sources, while reducing and optimizing energy consumption. This exploratory vision is explored and inquired through the use of ICTs tools and a new deliberative process built upon the participatory budgeting model. We provide two main points of discussion regarding social acceptance of technology and the shifting from a monetary budget to an energy one.

1.4 Participatory Infrastructuring - Introduction

The COP21 Paris Conference brought to a wider audience the issues of climate change, global warming, energy consumption, CO_2 emissions and the goals that we need to achieve in order to avoid a "catastrophic" future for humanity. These issues are nowadays at the centre of political debate and they will need answers in the near future by countries and institutions, as much as by citizens and communities. European institutions have already declared and recognized the energy transition to a low carbon society as a goal to achieve in the near future (European Commission, 2011b). These declarations are contradicted however through interventions such as the commodification of energy and greenhouse gases through the creation of new markets, opening the possibility for a financial speculation (Frame, 2011). In our perspective, within this vision of the energy transition, the central rhetoric discourse in Europe around energy and emissions issues, involves just a shift from one source of energy to another one. The status quo is mainly preserved with only small changes for the social and economic actors involved in the energy value chain. However, this process could be the opportunity to rethink and redesign the electric production and distribution network and to enable new practices for a greener, more sustainable and

socially accepted use of energy. An alternative approach which takes advantage of the above mentioned opportunity, can be to consider energy as a commons and the energy transition as a transition not only toward a different source of energy, but to a different socio-technical paradigm (Byrne et al., 2009). Shifting from a paradigm of "energy obesity" (Tertzakian and Hollihan, 2009) toward the creation of a new sustainable paradigm. While on one side there is a need for better and greener technologies, on the other side it is necessary to conciliate them with the life, the practices and the cultures of people and communities. A different approach can help such people and communities to increase awareness and to participate actively and successfully in infrastructuring an alternative to the way energy is conceived, managed and used. The Participatory Design (PD) community has much to offer in this direction, in terms of design artefacts, but also in terms of looking at design as a future perspective, using the concept of PD as a form of infrastructuring that supports the creation of a fertile ground for a community of participants (LeDantec and DiSalvo, 2013). Effort has already been spent in using PD approaches for different kinds of interventions in the energy domain, such as enabling sustainable energy consumption (Dick et al., 2012; Prost et al., 2015), for supporting networking among local energy initiatives (Nieusma, 2000) or for simulating micro-grid design (Abdullah and Kennedy, 2015). In this paper we explore the infrastructuring of collective actions related to the energy network, which is a suitable example of broadening the view from technology development to knowledge production, sustainability and resilience (Marttila et al., 2014). PD is moving in this direction through binding together the concepts of commons and infrastructuring, as a way to go back to the original democratic ideals of PD (Karasti, 2014). Furthermore PD can be a force strengthening social practices nourishing the common (Teli, 2015). The paper is structured as follows. Firstly, we present the theoretical framework behind the research. Secondly, we analyse the experience and the preliminary outcomes of an ongoing Participatory Design experience aiming to design an ICT platform for community energy management. Finally, we conclude by discussing the implications and highlighting points of attention for future work.

1.5 Participatory Infrastructuring - Infrastructuring Energy As A "Common"

With the ongoing energy paradigm shift toward smart grids, we can also conceive energy, and renewable energies in particular, as a common good managed as Common Pool Resources (CPR) (Ostrom, 1990). The challenge according to Dietz et al. (2003) is to design institutional arrangements to help set the required conditions or tackle the challenges related to governance where the ideal conditions are not present: this is still the case of enabling the management of renewable energies as CPRs. Thus, within this scenario there is the need not only for an enabling technology to be imposed (such as in the dominant technology-driven view toward energy transition), but a socio-technical approach that takes into account the communities and the users to foster the creation of social acceptance of this new system (Wolsink, 2012). Nowadays, most actors who support the actual highly centralized energy system (e.g. energy companies, authorities and regulations) do not fit into this possible future community energy scenario, where generation is distributed through smaller renewable energy plants and where the energy network is becoming highly decentralized and locally controlled. Both the institutional energy infrastructure and the physical one have been in place for decades and highly embedded in our lives. Smart-grid opens up the possibility of challenging the present condition in order to create an alternative by integrating the existing energy network with ICTs, generating new information. The electric grid becomes an information infrastructure (Neumann and Star, 1996). The design and the implementation of such a thing define the power relations among the actors: citizens with a more decentralized network can have the possibility of sharing more control in terms of managing the energy source. That is why the involvement of communities plays a central role in the concrete design of the needed technologies to foster new sustainable practices. The focus on the community level of management is also seen as a way to increase the possibilities of reaching the critical mass that would have an impact on the energy transition goals (Karnouskos, 2011). The transition toward a community based energy paradigm, where distributed renewable energies are managed as CPRs, can be supported and encouraged by the PD community by enabling and fostering the "commoning practices"(Marttila et al., 2014).

It becomes central to the role of the design process that needs to take place at a community-based level, as a process: for, with and by communities themselves (DiSalvo et al., 2012).

1.6 Participatory Infrastructuring - Making Visible The Invisible: Infrastructuring New Energy Relations

The research presented in this paper is related to the ongoing experience of an EU/FP7 Project. It is an interdisciplinary project looking at the innovation of the energy system through the lens of a smart-grid. The project wants to integrate a new ICT platform to help local communities manage their local energy system. The focus is on the social and collective dimension of renewable energies. ICTs and their design shall serve as an empowering tool for the communities, helping them to reflect and to change their energy practices for the sake of the improvement of the community and to achieve collective self-defined goals. The Project has two pilot site areas, this paper focuses on the Italian area that comprises two rural municipalities in a northeastern Italian region: GreenVillage A, GreenVillage B. By September 2015 293 people from 93 households were involved as participants in the pilot site area, all the participants are volunteers. The main feature of the Italian sites is the presence of two energy consortia that produce, distribute and sell electricity in the area of the three municipalities. The consortia are electric cooperatives born at the beginning of the 20th century; they are membership-based focused on mutual cooperation. Their roots are deeply embedded within the local territory, where the consortia have strong social and economic relationships. Due to their nature as cooperatives, members can participate in the governance of the companies. Both produce and distribute energy to their members by managing hydroelectric power plants and photovoltaic power plants. Most of the energy that the users of the involved municipalities consume is directly produced by the consortia or by the members through their photovoltaic panels. In case of a peak of consumption exceeding the available energy produced by the consortia, the needed energy is bought from the national grid at a higher cost and without a control over the sources. We involved the participants in an ongoing PD process, with the aim of creating and establishing a community energy management,

which go beyond the individual household level. This process is supported by the development of an ICT platform; participants are engaged in the definition of the features and the design of the interface. For this paper, we used the outcomes from 2 focus groups and 2 workshops carried out between January and June 2015, during the second year of the project. The outcomes from a second cycle of workshops, regarding the design of the platform interface, are not yet implemented and we are waiting for the release of the platform. While, from January to June 2016 we are currently carrying out a third cycle of workshops regarding the design and the implementation of the process for the allocation of the savings generated through the use of the ICT tools, with which participants will finance initiatives proposed for the sake of local communities.

1.6.1 Renewables energies and community sense of belonging

We conducted two focus groups, one in GreenVillage A and one in GreenVillage B to gather preliminary understandings of the local communities. The focus groups involved 10 and 9 participants respectively and lasted around two hours each. Three main points were discussed: i) sense of belonging to the community; ii) collective awareness about energy and environmental issues; iii) role of ICTs in energy interventions. A strong sense of identity and belonging to the community emerged from both focus groups. A heterogeneous and lively substrate of associations is presented in both municipalities; data from an explorative questionnaire, administered at enrollment, show that 76% of the respondents are members of at least one local association. At the beginning of 2015 the municipality of GreenVillage A completed a merging process with a nearby village. During the focus group participants discussed their community, highlighting how this process had been socially accepted and how the two municipalities already had administrative services in common. What was missing according to the participants was a more common sense of being a single community, instead of two separate communities. This has an influence on the willingness to put in common and share resources, such as energy. The two Consortia play a central role in the communities, as historical actors within the municipalities. During both the focus groups participants expressed a sense of pride for what the Consortia do. In GreenVillage B focus group participants told us the

story of the first light bulbs installed more than a century ago, and what that meant for such a rural and isolated village. Furthermore, due to the membership and consortium-based way in which electric energy is managed in GreenVillage A and GreenVillage B, participants highlighted a high level of energy awareness. There is a good knowledge about energy market dynamics and about the impact of renewable energies. One of the key issues, which emerged in both focus groups is the lack of understandable and reliable information regarding the effectiveness of behaviour perceived as virtuous. In both focus groups the idea of receiving concrete and verified suggestions, about how to improve practices for energy efficiency was discussed. Also, they reported a lack of information regarding the amount of energy consumed and produced by the community as a whole. They expressed the desire to do more for energy savings, while the two energy cooperatives could do more to spread information and create awareness.

During the focus groups we asked about the possible use of saved energy for collective purposes. Participants reported more than one concern, such as: "how to correctly measure the energy saved?", "how to transfer the savings?" and "how to predict the possible savings in order to plan how to use them?" The major concern expressed was about the need for accountability of the whole process. In a certain way, the participants were expressing the need to see the first of the five conditions described by Dietz et al implemented (2003): the monitoring of the energy and its use. From the ICTs point of view, they expressed concern at dealing with an "enslaving" technology, which forces them to constantly monitor, such as for the use of already existing Apps and services like social networks. A technology that requires small efforts and no duty of a constant monitoring would be best accepted.

1.6.2 Co-Designing tools for collective management of energy

In May 2015 we carried out one workshop in GreenVillage A (17 participants) and one in GreenVillage B (9 participants). The initial part of the workshop was meant to prime the participants (Sanders et al., 2010) in order to bring out the deep relationships that we have with energy, and how its use is spread across our day. We inquired about this dimension asking the participants to complete a calendar board

with their actions related to household electricity use during the previous week (see Figure 5).

Figure 5 Participants to a workshop expliciting their weekly energy practices, May 2015

Then, while looking at their filled in board, we asked them to reflect on the reasons that led their electricity consumption habits and on the possible drivers to change them in order to improve their consumption habits. The second part of the workshop was intended to work on a plausible future scenario that reflected the energy situation of the two municipalities and the use case scenario we developed in collaboration with the consortia and project partners. This was meant to set the users in a future situation in order to generate design concepts (Sanders et al., 2010) helping the realization of such a scenario. The story of a fictitious village improving the collective energy consumption by adopting an ICT platform and a new kind of dynamic price scheme for the optimization of locally produced energy. The story highlights the idea of considering energy as a common good. Starting from the given scenario we asked the participants to reflect on two points: problems and difficulties they could experience in such a scenario and possible solutions to these problems. The final activity of the workshop was to combine the initial reflection of their

consumption habits with the difficulties and the solution of the futuristic scenario. Divided into groups, participants came up with possible stories of families, developed through the use of the different things they thought about during the previous activities. For the participants finding the possible connections between the reality and the scenario was a challenging activity, and they came up with stories leading to different goals: energy savings for the families, increased environmental awareness, overcoming difficulties in changing energy practices due to day to day commitments.

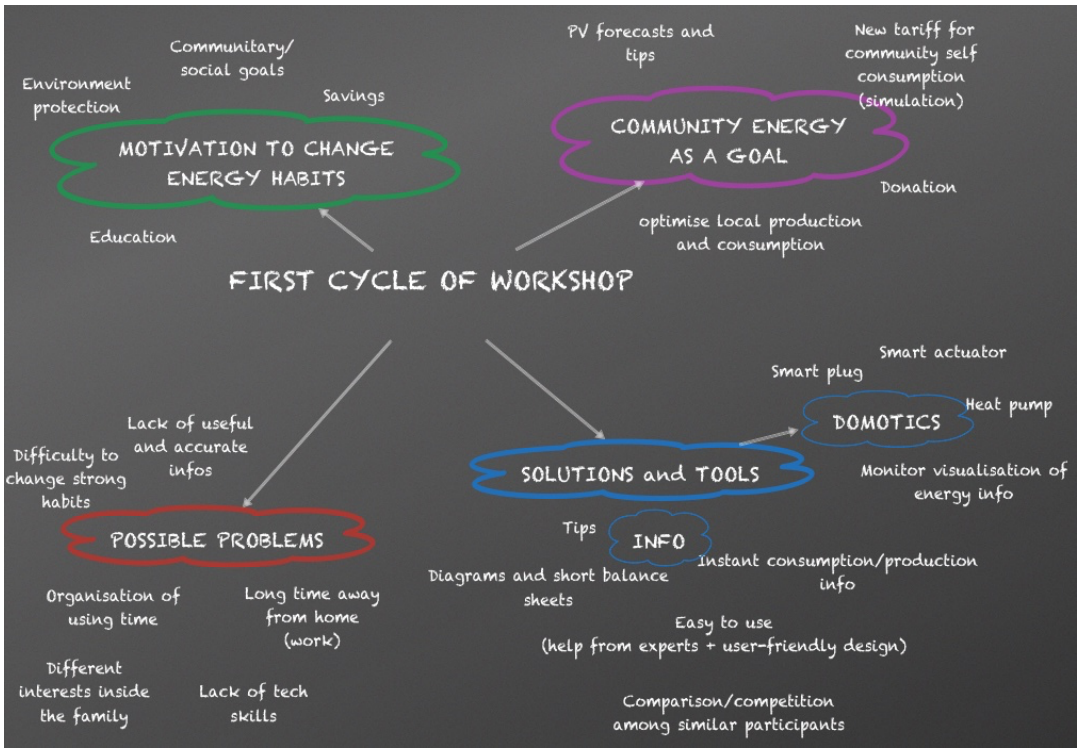

Figure 6 Diagram of the outcomes from the workshops

The results of the workshop are summarized in a diagram (see Figure 6). As possible problems they recognized technical aspects such as the lack of accurate information, but the main problems are mostly related to everyday practices. The participants considered routines, habits and different interests inside the family as major concerns about a successful implementation of the proposed scenario. The underlying motivations to overcome the possible problems are related to achieving community and environmental goals, with the focus also on possible savings. So, while the identified problems are at the household or at the individual level, the motivations to change reside to a community and society level. This duality emerged during the workshops, where participants expressed also, as possible solutions, two categories of

technology: domotics and automation solutions, and information tools. The implementation of ICTs is also combined with the creation of new social practices to reach the community energy goal: to implement an energy donation mechanism it is necessary to find a common agreement within the community on how to manage the process and which kind of organization is needed to have a clear accountability. Indeed, this first part of the project opened the possibility for creating the conditions for the participation to energy management at the community level. Such goal is related with the design of an effective ICT platform, embedding both the household and the collective level.

1.7 Participatory Infrastructuring - Conclusions

Energy is a key factor for societies, and its abundance in the last centuries is one of the factors that led to the impressive development of our society since the industrial revolution, but it is also a factor for all the major environmental downsides that we are now facing (Tertzakian and Hollihan, 2009). The infrastructuring of collective actions for energy management, as explored and presented by experiences described in this paper, has provided an example for imagining an alternative future going "beyond capital" (Hakken et al., 2015). The communities participating are fully aware of the impact of climate change and they want to take a stand with concrete actions. They are helped by the cooperative values, which are embedded in the history of the consortia and widely spread among the members and their communities. They can base their participation in the community energy management upon an existing socio-technical context already based on different values rather than only an economic one. The existent electric infrastructure, which is already in place and hardly modifiable without hard intervention, can be modelled and adapted to the local social context by the means of ICTs, opening new possibilities. The PD community can help experiences like these to design a sustainable alternative, creating new relationships among the actors involved. This creates a space for citizens' participation in a continuous process of design for energy management. An important question that emerged from the activities described in the paper was how to make this space sustainable in the future for citizens and communities who want to control their energy. The deployment phase

and the evaluation of the process at the end of the project could bring more insights about the issues of sustainability and appropriation of energy as CPR. So, the answers will arrive from the citizens participating in imagining their own possible future.

1.8 Energy Budgeting - Introduction

Several critics pointed out the rhetoric driving smart-cities implementation as something derived from a top-down approach (Greenfield, 2013) or related to corporate interests (Söderström et al., 2014). However, smart-cities require citizens to be at the centre of such approach, not merely as informed consumers, but rather as individual who are driven by motivations and expectations that go beyond optimization and reduction of resource consumptions (Giovannella and Baraniello, 2012). In this process, ICTs can play a central role, "real" smart-cities must use ICTs to enhance democratic debates about city development and citizenship (Hollands, 2008). So, smart-cities are smart for their use of technology to foster participation and engagement of citizens, allowing all groups to contribute in tackling societal challenges, among which the energy and environmental issue. This issue is becoming central also for political institution: the European Commission recognized the need to pursue an energy transition to a low carbon society in the near future and the deployment of smart-grids a means to achieve this purpose (European Commission, 2011b). Renewable energy sources, with their variability, poses new problem for the managing of the grid, more information and more technology is needed in order to maintain the reliability of the system (Potter et al., 2009). The core of the new model should be an efficient and dynamic demand response, which requires real time interaction between consumers and utilities (European Commission, 2011a). This is essential in order to provide services that can foster strategies such as Demand Side Management (DSM) to optimize users consumption through economic incentives (Karnouskos, 2011) or through demand side community action (Burchell et al., 2014). In smart-cities ICTs services are considered to have a great potential of reducing energy use, but it is difficult to make a reliable appraisal. In this paper we present an experience from an ongoing European research and development project on smart-cities and smart-energy system, which hold together technical implementation of ICTs

and social intervention to enable an innovative energy management approach aiming at promote Demand Response (DR), while achieving meaningful social goals for local communities. The project use the participatory budgeting (PB) approach in order to engage and motivate the participation of communities to a collective effort for generating value from the load shifting and to allocate this value for social goals.

In the following paragraphs we first define the participatory energy budgeting framework, then we present an ongoing experience of use of such framework. We then discuss some emerged issues: the relation between online and offline participation in connection with ICTs acceptance and the use of energy for counting the budget instead of money. We conclude drawing some reflections upon possible future works related to the sustainability and the analysis of other contexts.

1.9 Energy Budgeting - Participatory Budgeting Framework

PB is a process introduced by many public administrations, starting from the municipality of Porto Alegre at the end of the '80s. The process aims at promoting participation and decision making for the allocation of part of a public budget. Originally PB was seen as a form of democratization from above, which is supported by direct participation of citizens and based on a transparent process, orientating the relationship between politics and civil society (Ganuza and Baiocchi, 2012). Since then, several models for PB emerged to match the specific contexts where it was adopted: from model inspired to the original Porto Alegre experience to model where funds to be allocated are given by enterprises or are directly controlled by communities, with a limited involvement of public administrations. In the "Community funds" model participants decide the rule of the community fund and in this model the promotion of socially disadvantaged group is central. Furthermore the participants are in charge of the realization of the proposed projects (Sintomer et al., 2008). In connection with the growth of ICTs, also PB projects are interested in using digital tools to improve information sharing and to make citizens engagement more effective along the process (Stortone and De Cindio, 2014). At the same time ICTs are recognized as having an impact promoting processes of change and empowerment of smart-

communities in urban environment to achieve energy and social efficiency (Gargiulo et al., 2015). In our vision, energy could also be placed at the centre of these two processes. We propose to use PB to empower and engage citizens and local communities: i) in energy efficiency efforts; and ii) for tackling societal challenges through the generated energy savings. Thus, a feedback loop is created: citizens generate a value (the energy savings) and they decide collectively on how to use it. At the same time, the funded activities will support community awareness for energy savings and optimization. Therefore, empowering citizens and communities to obtain a better use of energy can have a twofold effect: it is a goal to improve consumption reduction and it is a means for extracting values to devise to tackle important social issues. In the next paragraph we then describe how such vision is implemented in an ongoing research project.

1.10 Energy Budgeting - A Process For Participatory Energy Budgeting

CommunityEnergyProject is an ongoing European research project that aim at prototyping and validating an ICT platform within the local energy grids in order to empower local communities to optimize demand and response of locally produced renewable energy. This system serve as an empowerment tool helping citizens to reflect and to change their energy practices in order to achieve collective self- defined goals. CommunityEnergyProject has a socio-technical approach, which merges together three main dimensions: energy grid, ICTs and the social dimension (see Figure 7).

People are considered as part of a broader social system, having heterogeneous social needs and participating in different form of social aggregations and communities. The project pilot site area, which is used to investigate and validate technical developments, as well with changes in social dynamics, knowledge and practices, includes three small Italian municipalities in a northeastern region. By October 2015 325 people from 102 households were involved as participants.

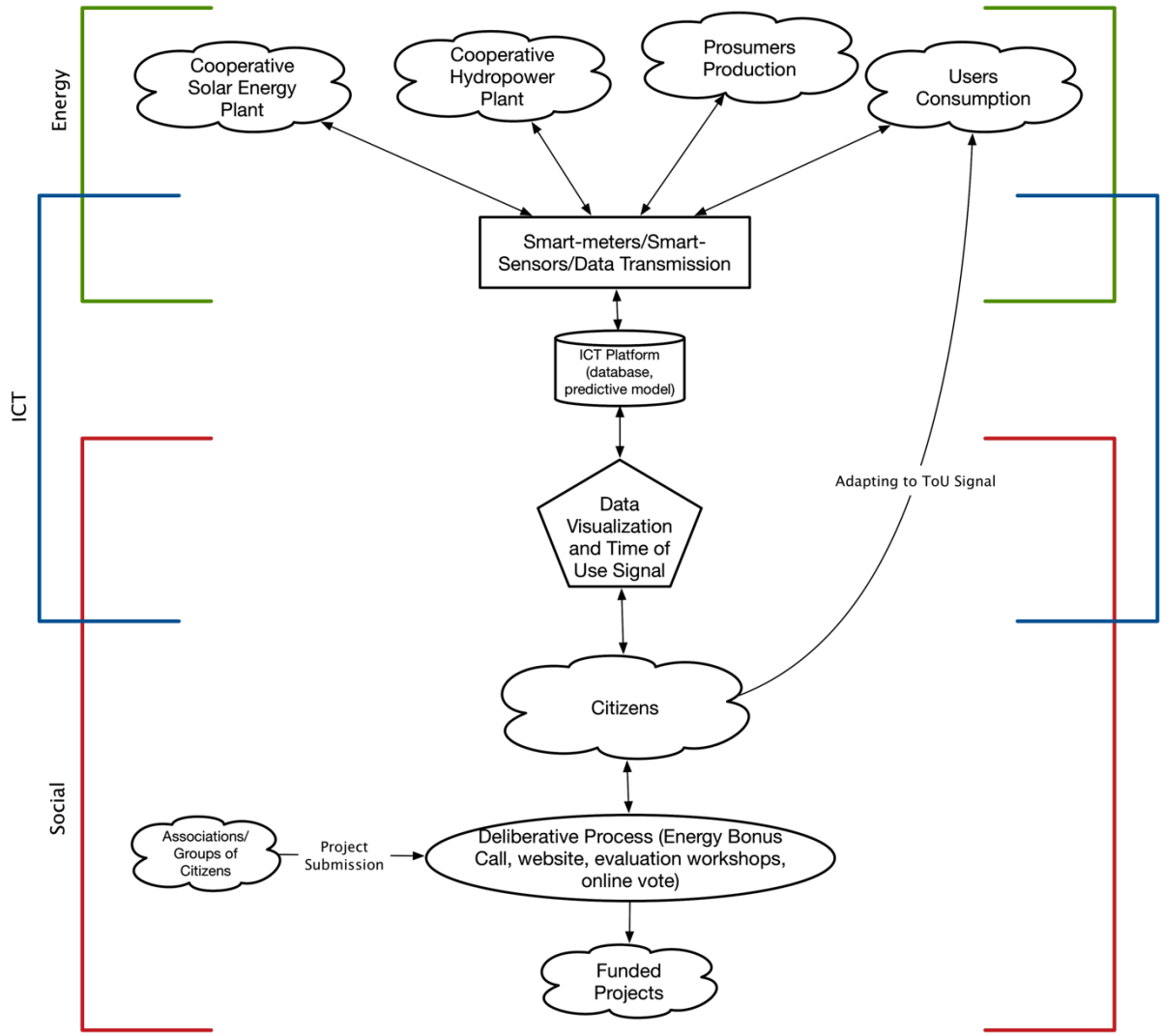

Figure 7 Participatory Energy Budgeting infrastructure scheme

From our perspective, the main characteristic of these municipalities is the presence of local energy cooperatives that produce, distribute and sell electricity within the area. As these cooperatives are born at the beginning of 20th century, they are key actors among the local communities. They are membership based and rooted in the local territory, with strong social and economic relationships. The cooperative form implies the pursuit of social goals and the strength of community relationships. The cooperatives production is based completely on renewable sources through, hydroelectric and photovoltaic power plants. The cooperatives also promoted, during the last years, the installation of photovoltaic panels for the members that has brought to a significant diffusion of such technology. The local grid is connected to the national one, while mostly the local consumed energy is produced by the cooperatives. However, during times of consumption peaks there may be the need of acquiring

energy from the national grid, with higher costs for the cooperatives and thus for the members. On the contrary, during off-peak times the surplus of locally produced energy is distributed to the national grid for cheaper prices. Indeed, achieving a better demand response, by shifting consumption during off-peak period, is a goal valuable for the cooperatives and for the local communities. This generates savings that could be invested to reach valuable social goals for the communities. Below, we first introduce the ICTs platform deployed in the pilot sites area, and then we describe how through the use of this tool a new PB processes is activated within the involved local communities.

1.10.1 ICTs tools

The ICTs platform is the main tool for users to have real-time feedback. It is a web application that has four main features:

1) A predictive model: it provides a graphical signal to the users in order to label every moment of the day as "good" or "bad" to consume energy. It is the core part to enable the PB process, because the energy budget is created and made available by the cooperatives, through the savings generated shifting the consumption.

2) Visualization tools providing the users with individual and collective consumption and production data, both real-time and historical.

3) A support system providing verified energy tips to reduce energy consumption.

4) A blogging website in order to manage the submissions and the reviews of the proposed projects for the PB process.[3]

1.10.2 Collaborative implementation of a participatory energy budgeting process

We introduced our participants to the idea of a collective management of the project gains, from the very beginning. Feedbacks about this issue have been collected in January 2015 during two focus groups whose aim was learn more about the local communities and in May 2015 during two workshops for the co-design of the platform.

[3] This feature is implemented as external from the web application. It will be implemented as a feature of the platform in the next future.

A good disposition towards the collective destination of the project gains emerged particularly during the co-design events. Our participants were keen to label the idea of donation to a collective project as a "motivations for change their habits/objective" rather than as "difficult/critical conditions". Nevertheless, the strongest need expressed by participants was to have a fully accountable process. As this scenario was coming to light, an expert in participatory budgeting has been consulted to better understand if this kind of tools and methodology could fit the situation. This helped to sketch a detailed plan, which was then scaled on the timing and kind of situation we were dealing with: small communities, with already strong social tights and a preference about relying more on face-to-face rather than ICT mediated interaction. We choose to engage people mixing both of them. During the whole participatory budgeting process, participants have been invited to interact through the use of the project web application and a common CMS based website as well as through several face-to-face meetings. Due to the request for a transparent management of the resources, we have chosen to allocate the "energy bonus" through a call.

The first draft of the call was presented to the participants in January 2016 during a public presentation of the whole participatory budgeting process. In this first version, some key aspects of the call were deliberately left incomplete. This decision was made to further empower the participants, that during the evening attended a workshop designed to collect feedbacks about the issues that have been left open to consultation (i.e. advertisement of the call, who is entitled to submit proposals, who decides who the winners will be, what kind of decision- making process will be used). A second version of the call was then written mediating between the different opinions and ideas emerged during the workshops. This version was published on the blogging platform, inviting all the participants to give us any other feedback. This passage has been added to include those who did not attended the presentation meeting, reinforcing the participation. The final version of the call defines the needed steps and requirements for the project proposal.

The main are:

1) Any kind of proposal is welcome, as long as having a relapse on the local communities (beneficiaries cannot be single persons/families).

2) Any social formation located within the area served by the consortia can send its proposal, even if they are not project participants.

3) The proposals will be published on the project website in order to allow citizens to send comments and suggestion. The project leaders could rely on to modify their proposal.

4) The selection will be made by project participants and will take place in two phases: a public meeting and an online vote. People who will participate to public meeting will judge the quality of the single proposals using an evaluation grid and consulting mentors. A graphic summary of strength and weakness of every project proposal will be provided as an outcome. Any of these graphic evaluations will be uploaded to the related proposal page on the website.

5) All participants will be invited to vote online, by ranking the proposals (and they will chose if taking into consideration the graphic evaluations or not).

6) The "energy bonus" will be paid by the cooperatives as a discount on the electricity bill; as the bonus is generated by the project participants' energy shifting, the exact amount will be unknown until the end of the project. For this reason every proposal is presented demanding an amount of Kw/h that are required to proceed. The projects will be financed until there are resources available, following the online vote ranking.

The final version of the call has then been posted on the project website, and the whole process has been circulated within the local communities by various media (i.e. emails, letters to local associations, official emails from consortia, posts on local websites). We decide also to engage more the actors not yet directly participating to the project by organizing two idea-generation workshops especially focused for local associations. The workshops had been held in April 2016 and were attended by some participants as well as by some representatives of local associations. At the moment of this writing (April 2016) the call is still open, but six proposals were already submitted both by project participants and non- participants.

1.11 Energy Budgeting - Discussion

Beyond this straightforward and streamlined description of the process, there are a series of aspects worth discussing about its design and (ongoing) implementation. These concern both technology development and community engagement. We discuss them further hereby.

1.11.1 Technology and social acceptance

We explore an approach trying to reinforce engagement and community feelings using a PB style process. In this context ICTs provide information and services that participants otherwise wouldn't have access to. ICTs give the opportunity to unblock resources to share among the community, providing new motivations to reflect about energy consumptions. However, using ICTs for increasing engagement and empowerment does not necessarily imply that all social interactions happen only through digital services. Indeed, for our participants face-to-face interactions and meetings remained the most important way to participate, even if ICTs also opened the possibility for online participation. This is also due to the context: in small towns offline activities are more feasible, even if an interplay between online and offline activities is still necessary for PB processes (Stortone and De Cindio, 2014). We can state that ICTs and face-to-face interactions had a complementary role inside our process: ICTs provided new information unblocking resources while PB engaged and motivated participants through non-monetary goals. Face to face approach *"served"* ICTs providing participants with the motivation to use technologies that most of them are not comfortable with. In some cases they simply don't know how to use ICTs (e.g.: they don't know how to use smartphone or PC, even if they own them). In other cases we dealt with the wary that a lot of participant had toward *"technology"*, or a certain vision of it. A concern about ICTs has been expressed during focus groups: they do not want to deal with an "enslaving" technology, which require them to monitor constantly, such as for the use of social networks. At the same time, during co- design workshops they pointed out the need for more information and, in a future, for maintain control over automated services such us smart-appliances implementing DR approaches. This aspect is important if we consider future smart-grid scenarios where automation plays a central role in DSM (Brena et al., 2015). They want to be able to

decide over their energy consumption behaviours and not delegate totally to the technology.

To become implementable the Energy Participatory Budgeting process needs, in addition to the technological tools, a set of institutional and social requirements, also at the moment due to policy regulations. In our case, thanks to well establish and recognized institutions such as the energy cooperatives, it simplified the building of a community around the project. Participation in community energy projects starts from early enthusiasts and should later be extended to other less initially enthusiasts (Hoffman and High-Pippert, 2010). The cooperative form differs from the standard company also for the values they promote: going beyond the profit maximization to include social principles, social responsibility and democracy, acting for protecting and developing communities and not to exploit them (Vieta and Lionais, 2015).

1.11.2 Energy: beyond monetary value

The approach to participatory budgeting that we explored emphasized the fact that values are community-generated. We chose to allocate an energy budget instead of a monetary budget in order to separate the intrinsic meaning of money in our society. The energy budget seemed the best option as thinking about energy can lead to a monetary evaluation as well as to lead to wider reflections. Being *"forced"* to think in terms of energy eases the acquisition of knowledge about emissions, consumption as well as the reflection upon daily practices. Doing this as a community and not as mere individuals open up the possibility to connect experiences and knowledge. One of the most meaningful observation about this process occurred during the idea generation workshops. During these meetings, participants discussed about how to allocate the energy budget. A large majority of project participants proposed ideas concerning educational activities for children and young people about the topic of energy savings. They framed this experience as a support for the communities to understand the complexity of energy consumption. People who attended the idea generation workshops without being part of the project was more focused about different kind of ideas instead. These proposed actions, goes back to the cycle of

creation and management by the community of the energy value, reinforcing and working also on the sustainability for the future.

1.12 Energy Budgeting - Conclusion And Future Work

As already mentioned, the research project is still ongoing. We will follow the final stage covering the evaluation of the submitted proposals and we will monitor the implementation of the winning ones. A crucial stage will be the end of the project, because cooperatives, participants and associations already expressed the willingness to continue using this approach. So, sustainability after the end of the project is a key issue we will need to address in the upcoming months. Also, future works must focus on comparing the Participatory Energy Budgeting with other PB experiences. An important aspect would be to understand how, in a smart-city context, other processes could implement the same approach that is using PB in order to engage and motivate citizens to participate by means of ICTs tools.

In this paper, we first describe a novel vision for participatory budgeting to engage citizens in a smart-grid context, using energy as the value to be allocated by communities. We then present an ongoing implementation of such vision, describing both technologies and social aspects involved. We discuss how the presented experience tackle issues such as social acceptance of technology and why go beyond a monetary budget to use an energy one for the Participatory Energy Budgeting process.

2 Participatory Energy Budgeting: a policy tool for Energy Justice

2.1 Preamble

The paper discusses how effectively the implemented PEB framework and its participatory process has been able to create new dynamics within the local communities, making clear how the PEB as a tool can contribute to the construction-in-practice of energy justice. Energy justice tries to frame the nexus between energy systems and social justice by highlighting its distributive, procedural, and recognitional aspects. In short, it is defined as the pursuit of an "energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial decision-making" (Sovacool and Dworkin, 2015). The three aspects of energy justice (distributive, procedural, and recognitional) are discussed in the paper in connection with the practical implementation of PEB.

The paper contributes to the Impact Evaluation stage, and adopts an analytical approach inspired by the grounded theory (Glaser and Strauss, 1967), which was used to analyse the data from seven focus-groups along with field notes. The interpretation of the data allowed to identify the emerging categories and clusters of relations among them and to discuss their connection to the energy justice framework. The results and discussion of this paper contribute to addressing RQ2.

Paper 3: Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2017. Exploring participatory energy budgeting as a policy instrument to foster energy justice. Energy Policy. https://doi.org/10.1016/j.enpol.2017.03.055

2.2 Abstract

The ethical and sustainable production and consumption of energy are becoming increasingly important with the ongoing transformation and decentralization of the energy system. For other kinds of goods and commodities ethical consumption have direct implications for, and the participation of, informed citizens. Due to its intangibility, energy lacks the same levels of reflection and intervention by citizens

and those aspects are yet to be fully explored in practice. This paper contributes to the understanding of how energy justice might be approached. We reflect on an empirical experience of participatory energy budgeting, a process aimed at determining how to redistribute a share of energy linked to collective virtuous consumption behaviours. We analyse through a qualitative thematic analysis how participants make sense of the participatory energy budgeting process and the emerged dynamics within the local communities and how this process can strive to reconfigure the relationship among civil society, the energy sector and politics, in order to remediate injustices. We highlight how the construction-in-practice of energy justice in a local community might be closely linked to issues such as the form of energy governance that allows for the participation of citizens and the accountability of the process, policies and technological limitations.

2.3 Energy Justice - Introduction

Recently, great attention has been given towards the societal impacts and the ethical implications linked to the transformation and decentralization of energy systems, the understanding of which requires the exploration and clarification of the space where the energy transition is taking place (Geerts et al., 2014). In this scenario new challenges emerge for researchers and practitioners that want to mitigate the impact of energy in a more ethical and socially just way (Jenkins et al., 2017). This article contributes to the debate around energy justice by exploring a transparent, participatory and democratic process for the collective management of energy in the case of community energy (Walker and Devine-Wright, 2008). The connections between sustainable energy transition and social justice are consolidating as a relevant nexus to be studied and understood. Initially rooted within the field of energy policy and tailored to address energy systems at a macro level, energy justice tries to frame such a nexus by highlighting its distributive, procedural, and recognitional aspects. In short, it is understood as the pursuit of an "energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial decision-making" (Sovacool and Dworkin, 2015).

In this paper, we explore the application of participatory energy budgeting (PEB) for the management and allocation of an energy bonus, which is collected through a collective effort to shift demand toward peak generation hours. Concrete contexts of this case are two rural areas where electric energy is produced and distributed by membership-based electric cooperatives, which fully rely on renewable energy sources. The experience took place within the context of CIVIS, an EU/FP7 project aimed at enhancing energy awareness and to improve energy behaviours via ICTs.

We reflect on the implications of the PEB process within local contexts, and on the dynamics, expectations and attitudes that thereby emerged: how the PEB process can strive to reconfigure the relationship among civil society, energy sector and politics in order to remediate injustices. We highlight how the construction-in-practice of energy justice in a local community might be closely linked to issues of energy governance such as openness to citizen participation, and the accountability of the process, policies and technological limitations In the next section, we provide an overview of energy justice, we then address the frame of participatory budgeting and how this is articulated in the context of a community energy project. Following that, we describe the concrete experience that took place and the overall methodology we used to analyse the collected data. In the analysis and discussion sections, we discuss the four main clusters that emerged and we interpret them in connection with energy justice. Finally, we close by pointing out the interrelated policy implications.

2.4 Energy Justice - Participatory Energy Budgeting as a means to implement energy justice

2.4.1 Energy Justice

As far back as the 1970s the debate on environmental justice had begun in the USA in connection to the unequal distribution of environmental ills (e.g. pollution, waste treatment facilities), which were often situated closer to marginalized parts of the populations and poorest areas of the town or region (Walker, 2012). The ambitions of environmental justice were led by principles of empowerment, social justice and public health (Davies, 2006). Since then, the concept has widened in scope to

encompass both global and local perspectives, and also became of interest in studies on climate change (Dawson, 2010; Schlosberg, 2013).

Energy justice recently emerged as an attempt to focus the attention around the ethical, philosophical and moral aspects of contemporary energy challenges (Sovacool and Dworkin, 2014). Indeed, issues such as energy poverty, energy efficiency, and CO_2 emission reduction have been tackled mainly in technical terms - economic, political, infrastructural and technological (Heffron et al., 2015) – with little considerations for their broader, societal aspects and implications. Initially, energy justice focused on distributional aspects or procedural ones separately. However, the current approach rests on three tenets that are considered as an intertwined whole: distributional justice, procedural justice and justice as recognition (Heffron and McCauley, 2014) (Heffron et al., 2015; Jenkins et al., 2016). Distributional justice relates to the physical and spatial dimension of energy and is concerned with the unequal distribution of resources, risks, and responsibilities. Procedural justice calls for transparent, inclusive, non-discriminatory decision-making processes around energy. It stakes a claim for all stakeholders involved or affected by energy decision making to be able to participate in the process and to be effectively listened to. Finally, energy justice is also a matter of explicit recognition. Therefore, it concerns the acknowledgement of inequalities and their fair accounting when devising energy infrastructures or policies. Conceptually, the lenses of energy justice can support researchers and practitioners in framing contemporary energy challenges. PEB aligns with the views of Jenkins et al. (2016), who, when presenting their research agenda on energy justice, claimed the need for more pronounced "systems" thinking in order to apply their three-pronged approach across the whole energy system: i) mobilize local knowledge to achieve outcomes, ii) greater information disclosure and iii) better institutional representation.

Moreover, according to Sovacool and Dworkin (2015) it also supports analysis and decision-making. Indeed, evidences of the importance of an energy justice frame have already been reported in literature. For instance, through a comparative study between Portugal and Belgium, Bartiaux and colleagues (2016) showed that designing

energy policies could be more effective in terms of social diffusion when done by accounting for differences among social classes. Similarly, the perception and recognition of fair and transparent decision making processes greatly increase the acceptance of new energy infrastructures, as was the case for wind farms in Australia (Gross, 2007). Furthermore, Heffron and McCauley (2014) argued that an energy justice frame at the level of national energy policy can enable the growth of new energy supply chains, as transpired in Denmark in connection to the recent diffusion of wind energy power. From an individual consumer point of view energy poses challenges to the possibility of an ethical consumption, also due to its intangible and invisible form (e.g. the lack of accessible information about where the energy comes from do not allow citizens to make informed choices). As proposed by Hall (2013) reflecting about those aspects open the possibility to move the focus of energy justice from a national and international scale of consumption to other consumption practices and the ethical and moral motivations surrounding consumption.

2.4.2 Participatory Budgeting: between policy instrument and device

Participatory Budgeting (PB) aims to promote participation of non-elected citizens in the allocation of a part of the public finances (Sintomer et al., 2008). Five criteria characterize it: "(1) the financial and/or budgetary dimension must be discussed; participatory budgeting involves dealing with the problem of limited resources; (2) the city level has to be involved, or a (decentralized) district with an elected body and some power over administration (the neighborhood level is not enough); (3) it has to be a repeated process (one meeting or one referendum on financial issues does not constitute an example of participatory budgeting); (4) the process must include some form of public deliberation within the framework of specific meetings/forums (the opening of administrative meetings or classical representative instances to 'normal' citizens is not participatory budgeting); (5) some accountability on the output is required" (Sintomer et al., 2008).

PB was first experimented in the municipality of Porto Alegre at the end of the 1980s. It was a political answer to the rise of social movements protesting against the inequalities within Brazilian society in the late 1970s. After these early experiences, PB

was adopted by more than 1500 cities around the world during the last three decades (Baiocchi and Ganuza, 2014; Ganuza and Baiocchi, 2012; Novy and Leubolt, 2005). Several models emerged from its diffusion: some of them are rather similar to the Porto Alegre experience, others diverge considerably; the elements that vary are: who can participate, on the basis of what resources and upon how such resources are deliberated. Ganuza and Baiocchi (2012) provided some examples: in the "Participation of organized interests" model there are associations, NGOs, interest groups participating in the process and they mostly deliberate on political guidelines, rather than on concrete project ideas. Other models ("Proximity participation" and "Consultation on public finances") diverge considerably from the original and turn PB into a consultation process. Here, participation is carried out via open councils, but participants do not have decision-making capacity and are only able to contribute to the debate.

Finally, a trend that has recently emerged in Europe levers on a 'fund for investments' which is only loosely linked to the municipal budget and which is devoted to projects in social, environmental and cultural areas. Therefore, the municipality does not have the last word on the use of the fund. In one model ("Public/private negotiation table"), private enterprises raise or put money towards the fund. In the "Community funds at local and city level" model the funds might be provided by specific policy programs or jointly contributed to by private and public bodies. Furthermore, the participants are in charge of the realization of the projects that are proposed for the use of the fund.

Regardless of the specific model, recently there was a transformation that accompanied the evolution of PB (Ganuza and Baiocchi, 2012). Initially and until the late 1990s, it was approached as a policy instrument, a form of democratization from above situated in an existing political strategy, aimed at orientating the relationship between politics, civil society and the state. Later, PB turned more and more into a device, often used in isolation. This latter version implied technical (e.g. calculations, procedures, rules) and social components (e.g. representation, symbols) mixed together to achieve a given objective, without anything to say about changing the

relationship between politics, civil society and the state. In this phase, the attention around social justice faded as the tight connection between direct participation and redistribution of resources became less relevant (Ganuza and Baiocchi, 2012). However, the emergence of the community funds model appears able to bring back such a connection and it is particularly relevant for our case.

2.4.3 An energy policy instrument for community energy

The ongoing transformation of the energy system to a decentralized renewable energy based one opens up new challenges and possibilities for local communities to be active players in this local transformation (Schoor et al., 2016). Participation in community energy initiatives not only means considering citizens more than economic actors, but it means engaging them in a system of direct public participation where proper institutions are created in order to ensure civic participation and self-government (Hoffman and High-Pippert, 2010). However, Walker (Walker, 2008) highlighted how the long-term capacity of the community to maintain and operate the systems (e.g. installation of renewables or new ICT infrastructures for energy management) after their installation could be a barrier to the success of community energy initiatives. As discussed by Walker and Devine-Wright (Walker and Devine-Wright, 2008) higher participation contributes to greater acceptance of community energy initiatives and increases the support for renewables. However, if the benefits of the projects are not shared among local people there is the risk of the project creating division and controversy in local communities. Therefore, support measures and instruments to community energy projects should serve: i) from a process side, to open the participation to a high degree of involvement of local people, and ii) from an outcome dimension, to share the benefits towards the communities.

Within this frame a PEB, specifically built upon the community funds model, becomes a powerful energy policy instrument. This instrument allows the empowerment and engagement of citizens in order to achieve energy efficiency, to tackle societal challenges, and to account for a more ethical consumption and production of energy. Drawing on this, in the next section we present our context of PEB.

2.5 Energy Justice - The case of PEB in two rural areas

Our experience took place in San Lorenzo Dorsino and Storo, two Italian villages of respectively 1600 and 4700 inhabitants. In the context of CIVIS, 68 and 34 families took part in PEB voluntarily for a total of 325 participants. In these two areas, electric energy is provided respectively by CEIS and CEdiS: two electricity consortia that produce, distribute and sell energy to their associate members (*Table* 5). Historically, the presence of the consortia is associated with the local hydropower plants (together the two consortia have four hydropower plants with an installed capacity of 8500kW), the first two of which were built more than one hundred years ago and as a result there is an important economic and social role within the communities involved. The production is entirely based on renewables and both consortia have both hydropower and solar plants. Solar production is also diffused at household level through rooftops PV panels: 40 of the families out of 102 involved have them installed.

Consortium name	Municipalities served by consortium	Number of associated members served by the consortium	kWh devolved to local proposals
CEIS	**San Lorenzo Dorsino** + 4 more	3500 members	6000
CEdiS	**Storo** + 4 more	**3310 members**	4000

Table 5 Information about consortium members and served municipalities

Both municipalities are small-sized rural contexts where community feelings are still relevant to their inhabitants; according to participant narratives, relations among inhabitants seem to be quite strong and constructive, although during our work there we noticed some tendencies to avoid other people's judgment and to refer to possible "envies" among people or institutions. Nevertheless, a dense network of associations (e.g. cultural, recreational and sports associations) is present in both villages, as well as a strong religious participation and local food tradition, which also drive the agricultural sector. The main difference between the two is the presence of a larger industrial sector in Storo, which has suffered the most with recent economic crises.

By means of action research (Whyte, 1991; Greenwood et al., 1993), and by creating a space for citizens' participation in a continuous design process (Capaccioli et al., 2016a), an intervention for demand side management was put in place through the creation of two specific tools: YouPower, a web application that delivers variable Time-Of-Use (ToU) signal; and a PEB process that relied on a collective energy fund hoarded cumulatively in relation to participants' performances.

To make participants reflect upon energy and to ease the acquisition of knowledge about consumption and energy practices, we deliberately avoided to express the fund – the energy budget - in a monetary value and instead used an energy value (kWh) (Capaccioli et al., 2016b). The whole PEB process has been negotiated and designed collaboratively with the involvement of project participants and the consortia. It had the twofold goal of subsidizing participants' efforts while letting them decide collectively on the final destination of this energy fund (Figure 8).

The Energy Bonus has been allocated through a competition announcement, the call for proposals has been co-designed with participants. They have been involved in workshops dedicated to discussing who would be entitled to submit proposals, who would be entitled to decide the winners and what kind of decision-making process would be used.

The final version of the call was then posted on the project website, it can be summarized as follows:

1) Any kind of proposal having an impact on the local communities is welcome;

2) Any local social formation can participate;

3) The submitted proposals are to be published publicly on the project website;

4) Citizens of San Lorenzo Dorsino and Storo have the possibility of writing comments and suggestions about the proposal. Delegates for the proposals can use these comments to improve their proposals;

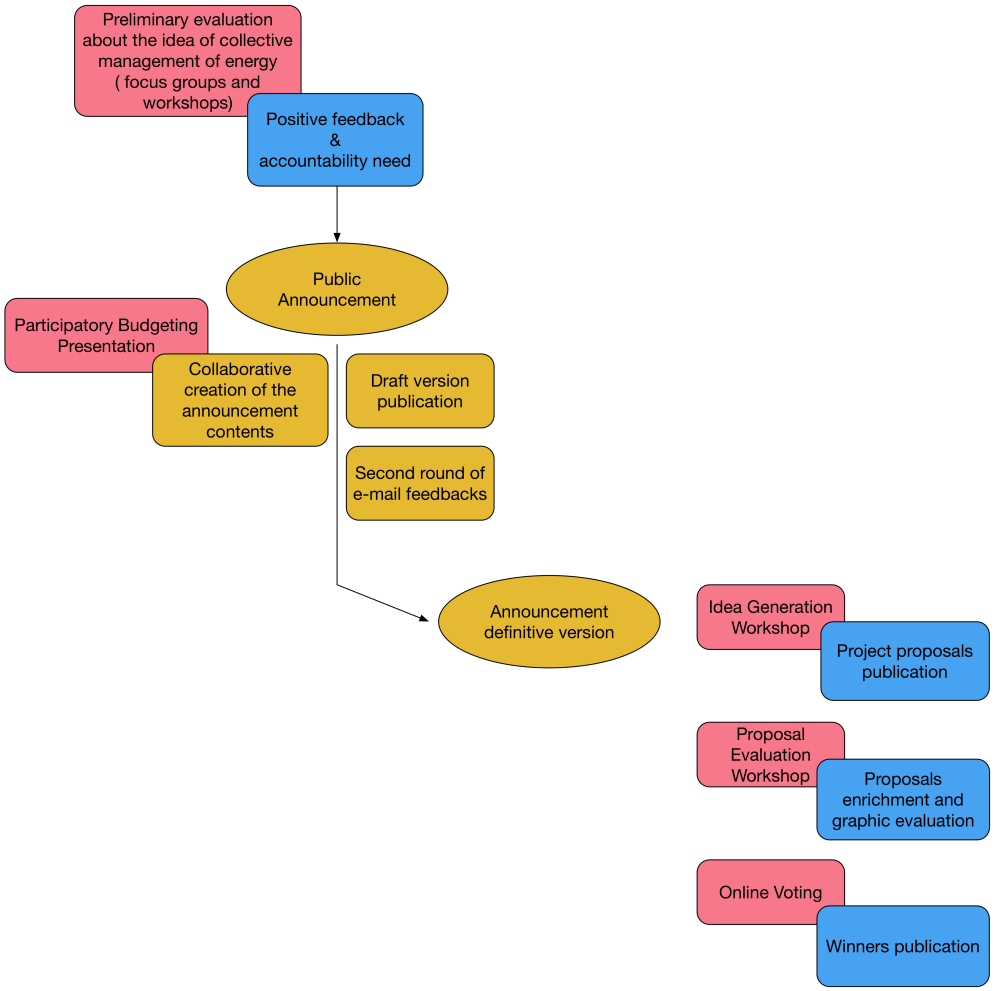

Figure 8 Creation of PEB in the context of CIVIS. Red: main meetings with project participants; blue: main meeting's outcomes; yellow: steps and outcomes strongly related to public announcement

Project participants made the final selection of winning proposals in two steps: first an assembly for preliminary evaluation and, following that, a final vote based on Condorcet method (Young, 1988). During the evaluation meeting the association representatives presented their proposals and then improved them according to CIVIS participants' feedback. Then, CIVIS participants evaluated the updated proposals, generating a graphic summary of the strengths and weaknesses of each proposal, which had the function of supporting participants' decision during online voting. We held two idea-generation workshops open to the entire community, and we invited local associations to participate. This engagement process was done to prevent a possible lack of participation, to avoid not having enough proposals, and also to

generate interest about the PEB. We collected eight proposals, coming both from CIVIS participants and local associations initially not involved with the project. The highest ranking proposal was funded through a discount on forthcoming electricity bills, up to the depletion of the resources. For CEIS area it funded the purchase of new books for the kindergarten library (6000 kWh), and for CEdiS it funded the installation of rehabilitation tools in a local health care structure (4000 kWh).

2.5.1 Methodology and analysis

In this paper, we adopt an analytical approach that is greatly inspired by grounded theory (Glaser and Strauss, 1967; Charmaz, 2006): an interpretive and analytic methodology that is widely used in social sciences to work mainly with qualitative data. This methodology evolves through the iterative coding of the empirical data in order to derive sets of labels (or codes) and relationships that can be interpreted at different levels of abstraction.

	Where	Date	N. of Participants
1st series of focus groups (Exploration of local communities)	San Lorenzo Dorsino	January 2015	10
	Storo	March 2015	9
2nd series of focus groups (Early assessment of APPNAME and of PEB process)	San Lorenzo Dorsino	March 2016	5
	San Lorenzo Dorsino	March 2016	4
	Storo	March 2016	4
3rd series of focus groups (Final evaluation)	San Lorenzo Dorsino	July 2016	5
	Storo	July 2016	3

Table 6 List of the focus groups series

The analysis presented in this paper rests on the seven focus-groups (Table 6) that we conducted among participants during the entire lifespan of the PEB in both areas. Furthermore, our direct engagement in the local settings and the field notes produced along the process eased the interpretation of findings (Charmaz and Mitchell, 2001).

A first series of two focus groups, one for each site, was conducted at the beginning of the project in January and March of 2015. The aim of this first series was to collect feedback and learn more about the local community dynamics, and to better understand participants' knowledge about ICTs and their disposition toward community managed energy. Three focus groups were conducted in March 2016, at the beginning of the PEB process and after the deployment of the project ICT platform. We investigated participants' feelings about the use of the recently deployed app and about the ongoing PEB process. A final series of two focus groups took place after the conclusion of the PEB process in July 2016. Those focus groups were specifically targeted to evaluate the PEB experience in its entirety and its capability to shape the sense of community; moreover we wanted to get information about feelings regarding the collective management of energy.

The analysis has been done working on the focus-groups transcripts. We coded data using Atlas.ti and we did a thematic analysis (Braun and Clarke, 2006) in two full iterations of coding: firstly, through an open coding we identified 360 labels, which we grouped in eight categories; secondly, we networked all labels with relations and we identified the core clusters to focus on thanks to the relational density involved in the categories. Finally we discuss these clusters in connection to the energy justice frame.

2.6 Energy Justice - Results and discussion

Here, we provide the analysis of data and discuss the empirical results in relation to the three Energy Justice dimensions.

2.6.1 Overview of coding outcomes: emerged categories

From the coding and the subsequent analysis eight categories emerged which cover a wide range of aspects as described in Table 7.

We further analysed the categories that emerged through a network analysis of the relationship among codes. Then we selected the nodes of the network with a higher relational density, and, by looking at the labels repetition within the categories, we defined the main clusters.

Emerged Categories	Description
App Design and Use	Discussion over the technological use of the ICT platform we deployed and possible design improvement
Awareness	Participants' awareness (or the lack of awareness), about different topics, in particular energy and technology
Community	Due to the main inherent goal of the project, discussion about community, the sense of, the role of associations and collectives emerged as one of the most discussed themes.
Energy Bonus	Mostly during the second series of focus groups, but the energy bonus related to the Participatory Energy Budgeting process has been raised up as a theme.
Energy Practice	The most discussed theme during the three series of focus groups, it regards the practical use of energy
Knowledge	Participants expressed and discussed about energy and technological knowledge, how to share it and the lack of.
Motivation	Various motivations to put effort and interest in energy use improvement had been discussed, from environment to community and economic reasons.
Project	All the discussion about the experience and outcomes from the participation to the project activities.

Table 7 The eight categories that emerged and their description

2.6.2 Main clusters: dimensions of Participatory Energy Budgeting

We found four main clusters:

1) **Sense of Community and the Values of Cooperation**: relationships between the expressed sense of community and the social, ethical and re-distributional values attached to cooperative forms of organization;

2) **Education**: labels related to educational needs of young generations;

3) **Distribution of housework and ToU Signal**: labels in relation to the division of housework among family members and how this is affected by the ToU signal;

4) **Practical actions to save energy**: labels associated with the actions put in practice by participants and their families in order to achieve energy savings.

2.6.2.1 Sense of Community and the Values of Cooperation

Figure 9 shows the first cluster, which is about the sense of community and the cooperative values embedded within the consortium as an important local institution. The two main labels of the cluster, "sense of community" and "cooperatives value" are directly associated, but they are also connected through the label "consortium role in helping local associations". This connection helps to highlight how the cooperatives values, which operate around the consortium, strengthen the sense of community. Firstly, it is important to remember that the project took place in two rural areas and the participants sometimes mentioned the distance from the nearest cities as an element that strengthens their sense of community. Namely, they felt the distance from the city was a barrier to opportunity in terms of education, work and entertainment (mostly for young people). They also associated this isolation with a sense of pride relating to the high number of local associations and the proposed activities and events, which made them feel the implications of such distance were more bearable:

> *"The new Priest arrived and told us that he never saw anything like that in terms of volunteering initiatives and associations. We have lots of volunteering, lots of people creating initiatives. He wanted to know more in order to contact them and he found a lot! It seems impossible, they look like just names on paper, instead they are people doing 2 or 3 activities, but we are a lively village thanks to those realities"*[4]

[4] All the quotes, which are cited in brackets and italic, are translations from focus groups.

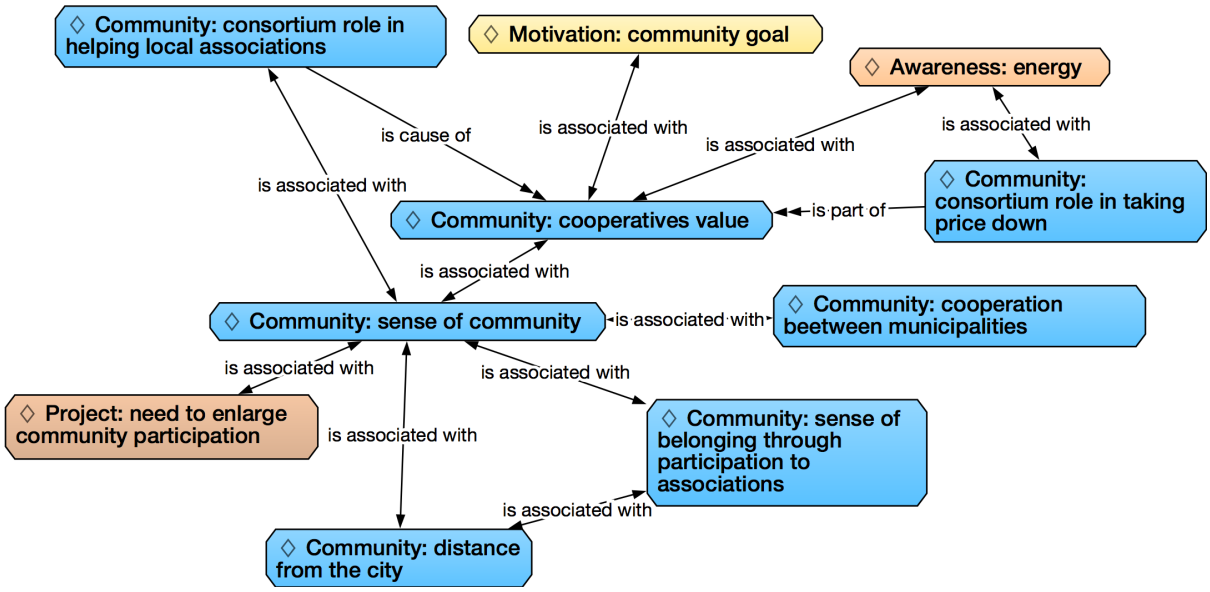

Figure 9 Sense of Community and the Values of Cooperation network

The social role of the two energy consortia is highly valuable among the local communities partially due to their efforts in the promotion of local initiatives. This is in connection with the organizational structure of the consortia, which are cooperatives, and their founding values that include social principles and responsibility, and democracy (Vieta and Lionais, 2015). Furthermore, the cooperative values are connected to the role of the consortia in providing renewable affordable energy at a lowest price in comparison with other companies. The concerns that some participants expressed about the possibility of negative outcomes of a high degree of competition among local associations is another hint of how inhabitants take care of the sense of community, being aware that it rests on a delicate balance. In particular, they were concerned that resentment and jealousy around the final ranking could have undermined the overall intent of the participatory energy budgeting process that was to support cooperation among local initiatives. Setting aside these kinds of concerns, participants are generally confident about the potentialities of this project in boosting the sense of community.

CIVIS participants also highlight the important role of the consortia in sustaining renewable energy culture, helping private households with installation procedures and operating to widen collective plants:

"the three or four hundred installations [of PV panels] here in the valley, we don't see elsewhere around the region… even all over Italy. And that's happened thanks to an association a little bigger [than the other local ones], more than one hundred years old [the consortium], which connected all the municipalities in the valley and spread the example and helped in doing this"

At the end of the project, the fact that only a limited number of households have been involved was identified as an issue. To make the process and its outcomes really relevant and worthwhile, participants felt we should have extended the experimentation to the entire community. Discussions about how to scale up the project and regarding the importance of having the entire community on-board in order to achieve a greater result emerged during the focus groups: "We need this project to expand to a consistent majority because we are few – too few – and because of that we do only the little we can do, if we expand more then we may all find benefit".

2.6.2.2 Education

Another cluster, which emerged in our analysis in connection with the sense of community, concerns education. In Figure 10 we can see how education is at the centre of a constellation of labels concerning the energy practices and awareness. From the very beginning of the project, education has been one of the central topics arising from participants. To educate youngsters on responsible energy behaviour, environmental issues and new technologies is considered important in order to raise generations that will be aware about the upcoming environmental and societal challenges that will need facing in the future:

"So that's why people need to be sensitized about those problems, because I say that is the drop which makes the sea. If all get information about these things, how to use appliances, how to use clean energy…it goes to benefit all […]."

This commitment to future generations has been expressed several times during the project in associations with a pessimistic expectation about the future. However, the pessimistic expectation has been translated in an urgency to act with concrete

actions, like more fair energy consumption behaviour and requests for new policies to promote energy savings.

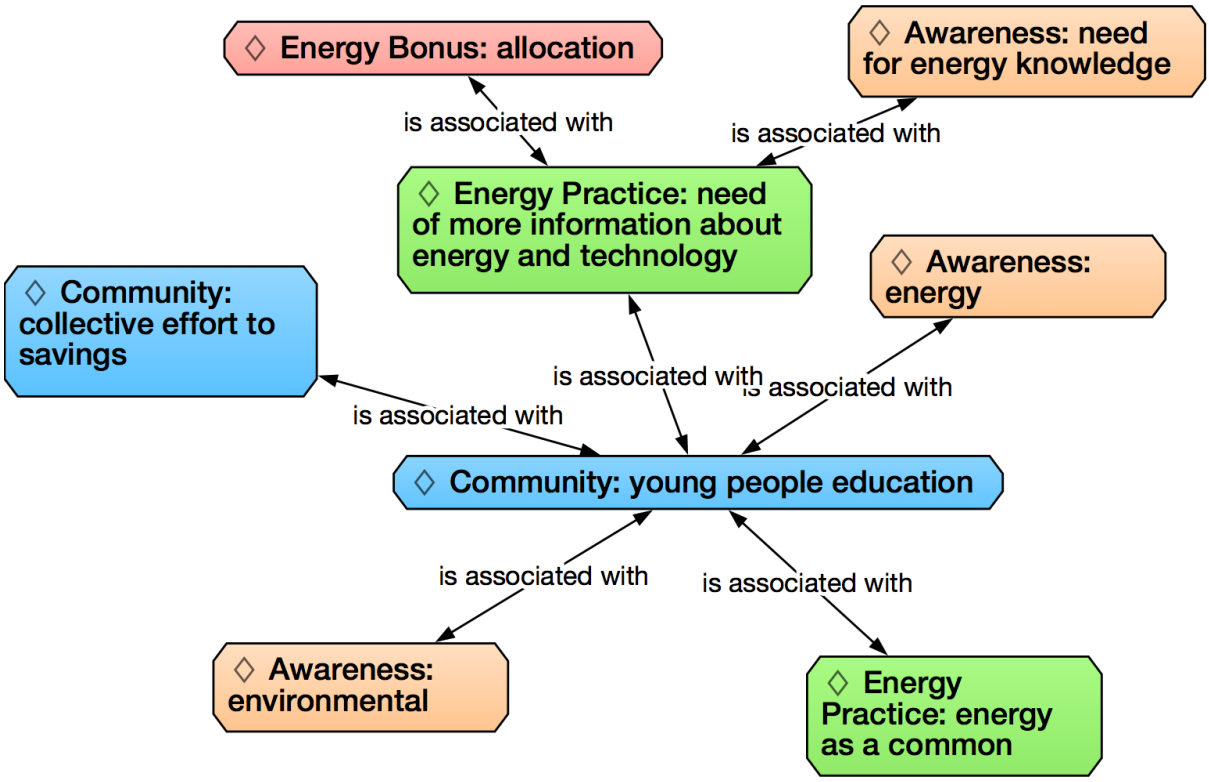

Figure 10 Education network

Education is also connected with the emerging need for more information about energy and technology, which is both connected with the perceived need for more energy knowledge, but also with the PEB process, in relation to the energy bonus allocation (Figure 10). The energy bonus allocation process opens up the possibility for a new dimension of energy savings. Participants recognized this new dimension as a collective one, which entitles the whole community to participate and be involved in the allocation process of the savings collectively achieved, generating a system where the energy is considered as a common good:

> *"I always talk to my daughters, we need to infuse in my grandsons, when they can understand it, that the energy is a common good, it is not infinite, we need to be aware of the future, maybe we should use candles again".*

2.6.2.3 Distribution of housework and Time-of-Use Signal

The third identified cluster put together the division of work within the family and the adaptation of daily routines to new energy practices. As shown in Figure 11,

labels regarding the app use (use of the ToU signal and family involvement in the use of the app) are associated with the label about division of chores within the families, also the label about the use of ToU is connected to the one describing the changes in energy practices drove by the project intervention.

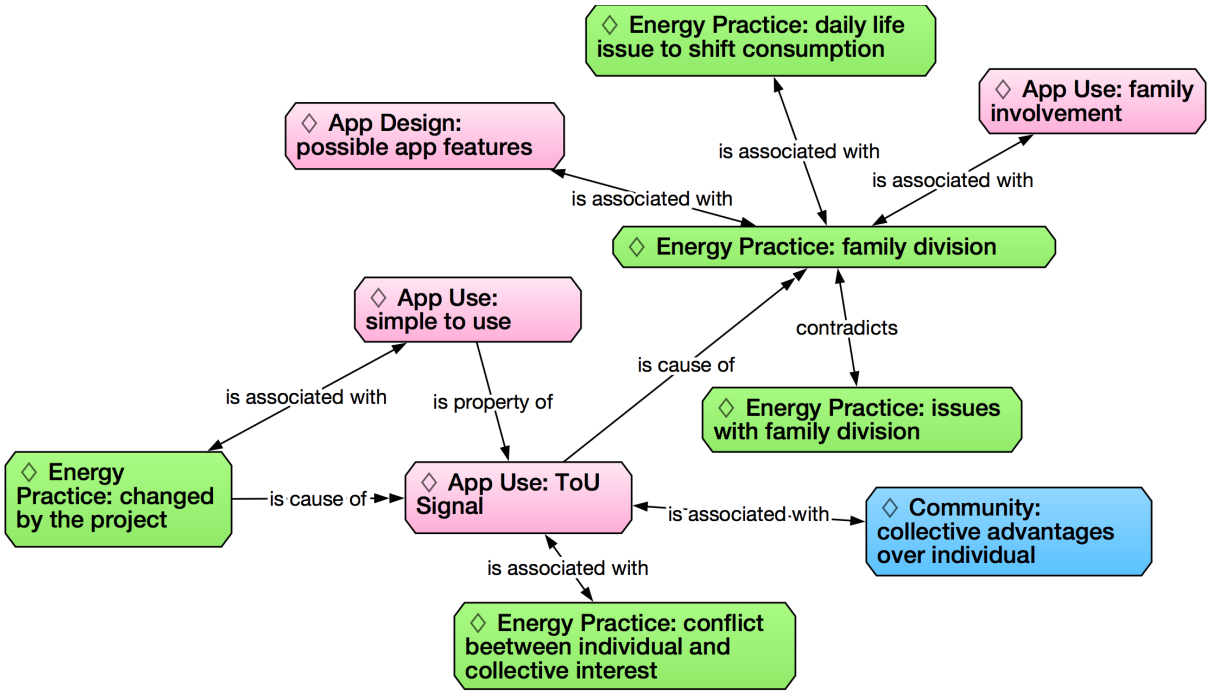

Figure 11 Distribution of housework and ToU signal network

These connections make visible how the ToU influenced the families. At the same time, these changes also raised issues among family members as also visible with the connection with the label issues with family division. Saving energy and shifting consumption require the help and the collaboration of all family members. However, the classic situation described by our participants was characterized by a strong gender disparity, where women, as "house keeper", are the ones deciding about the usage of appliances like dishwashers, washing machines and ovens:

> *"I1: [...] to be honest I am at home rarely, so I don't participate that much, we split our duties, if I need to fix the washing machine I fix it. But for me it's hard even to start it, however the dishwasher is more familiar to me.*
>
> *I2: We always discussed who does things or not, but I am rarely home. It's always the wife that does it: whether to start the washing machine or not, the dishwasher, she does everything, she's the manager of the house".*

The need to be flexible in order to follow the Time-of-Use signal suggestions, required a coordination improvement among the family members: *"it was Saturday and I told her [the wife]"tomorrow if you need to use the washing machine do it at that time"*. At the same time, receiving feedback and information about the time-of-use could be perceived as stressful, and generates a sense of information overload:

> "*Maybe for a young person it's ok to be more dynamic, but I can't become crazy to "start in five minutes", "stop using it in ten minutes", "then in fifteen minutes", in my opinion life is already chaotic, I think we should start thinking about something able to be organized, not related to stress, we already have enough".*

2.6.2.4 Practical actions to save energy

The fourth cluster we identified regards the actions to save energy, which were practiced by participants. As shown in Figure 12 this cluster is formed by two main parts, connected together by the two main labels: actions to save energy and adaptation to renewable energy. While the first concerns all the participants, the second reflects the actions of households with installed photovoltaic panels. This also makes visible the emerged differences of motivation expressed by participants with installed photovoltaic panels. Nevertheless, the reflections about actions to save energy mark an important act of consciousness among participants, about the way in which they can contribute to make a better use of, and to take into account the importance of consuming, their own energy. This opened up the possibility of discussing collective effort for savings and possible new community practices, which can be discussed with the municipality:

> *"We should start talking about the economics of the community, at municipal, provincial level… let's talk about public illumination in our villages… I look here, there are streets lighted for hundreds of meters with no one during the winter they could turn off the light after 10pm, it's a waste, an exaggeration!"*

A collaboration and an interest from the local administrators are needed in order to understand how such proposed energy saving policies are adoptable and to evaluate the possible impact.

Participants with installed photovoltaic panels described how adaptation to the discontinuous production happened over the time, and how they used to draw

information by observing the inverter display or just checking outside the window to look at the sky. Those participants were already adapting to a continuous time-of-use signal, their expressed goal is to maximize the consumption of the energy produced by their PV panels in order to write off the investment they made.

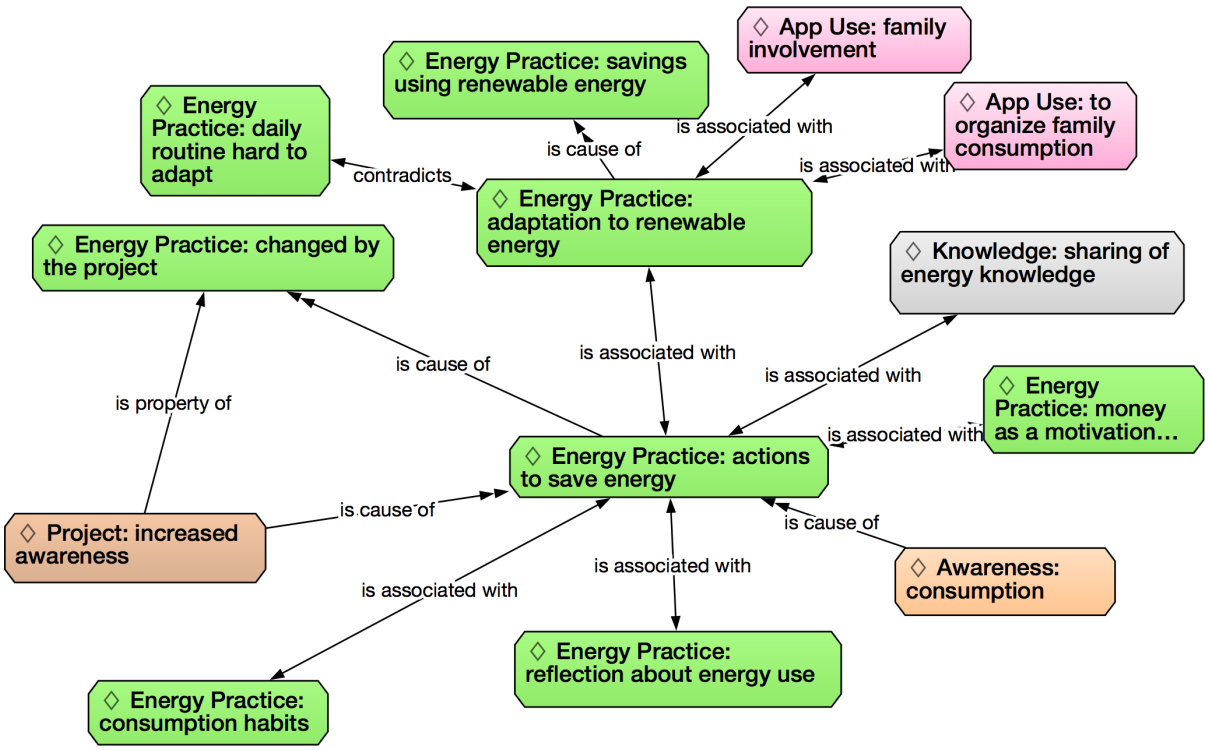

Figure 12 Actions to save energy network

There may be a sub-optimal scenario for the participatory energy budgeting: it is possible that at the same time the collective signal says not to consume, while in that moment the PV panels in some households are producing sufficient energy to run the house. Also, the collective goal of the participatory energy budgeting could conflict with the individual goal of PV panel owners:

> *"we produce... Our PV panels produce, right? For my own interest I need to try to consume this energy as much as I can. Because selling it to the grid is not as interesting as consuming it, because I don't need to buy it!"*

2.7 Energy Justice - Energy Justice in Participatory Energy Budgeting

Following the approach proposed by Jenkins et al. (Jenkins et al., 2016) we discuss if and how PEB could promote energy injustice by identifying the concern (distribution), whom it affects (recognition) and then the strategy for remediation (procedure).

2.7.1 Distributional Justice

The role played by the consortia in strengthening the sense of community, as already discussed in section 2.6.2.1. During the focus groups participants told stories about the past with pride: about the building of the plants and how these were drivers for local economic development; and stories about the installation of the first light bulbs in the villages and how these changed the everyday life of the inhabitants. The redistributional actions taken by the consortia during their lifetime can be considered as a form of distributional justice. This same role is also played nowadays: recently both the consortia provided successfully incentives for renewable energy installations, and now with the PEB experience. This deep root element of the local culture nourished the sense of distributional justice, experienced also through a high social acceptance of renewable energy among citizens. This position has also been expressed during the project, with attention given to using the saved energy bonus to grant incentives for new energy saving appliances or for providing electric vehicles to the community:

> *"it's ok whatever association, but I would like if there was something that could improve more from an energy point of view, an electric car, a transportation for the kids. With your money the kids go to the kindergarten with an electric bus".*

From the actions to save energy cluster emerged a connection between the increase of awareness achieved by the project and a change in energy practices while during focus groups participants stated that the use of the app helped to achieve energy savings. So, YouPower use helped the adoption of new energy savings practices among participants and through the ToU signal pushed for a more fair distribution of the benefits coming from the renewable energy installations owned by the consortia. We think this element can be an indicator of distributional justice pursued by our

intervention within the two local communities. However, it is important to recognize that at the same time we created a differentiation between the communities participating in the project and other nearby communities not participating, but with tight connections related to some services (e.g. school and after-school activities, sports activities, events, etc.) provided to citizens of San Lorenzo Dorsino and Storo. This aspect was discussed, but not implemented, during the co-design phase of the open call, where some participants expressed the willingness to also allow for the submission of proposals coming from associations from other municipalities.

2.7.2 Justice as recognition

The second dimension of energy justice refers to the recognition of inequalities and accounting for them fairly when devising new energy infrastructure and policy. This dimension is present in both the distribution of housework and the practical actions clusters. The conflicts between collective and individual interest, which emerged in connection with the effective implementation of the energy bonus, are elements that we can report as an inequality in recognition, privileging possible individual economic goals over environmental and collective ones. This is clearly visible in the contrast between households with PV panels and households without, as also discussed in section 2.6.2.4. They could have divergent goals in relation to the energy bonus, and so act according to their different strategies, such as not looking at the ToU and not putting in effort towards following it, and so losing interest in the whole PEB process. At the same time the privileged group of people with PV panels has developed knowledge about energy consumption and how to change behaviour in order to adapt to the PV production. This knowledge could be mobilized and made explicit to help the people without PV panels to adapt their consumption to the ToU. Thus, once the inequalities between the two groups are recognized, a collaboration can be initiated to maximize the possible PEB outcomes, while at the same time tackling injustices in recognition.

From another point of view, inequalities emerge in relation to gender differences, with the lack of recognition of the role of women and workload imbalances at home. Women are, more often than men, carrying out the work related

to energy consumption practices at home. Men participated more to the project initiatives and reported themselves as the ones using the application, but their relationship within the family seems more directive than collaborative (as previously discussed in section 2.6.2.3). The lack of a more explicit reflection and intervention about the gender imbalance could be a criticality for the sustainability of the initiative in the long term, leaving the burden of adapting consumption to the women and the honour of the results to the men participating to the PEB related initiatives. Proper strategies must be developed to tackle such misrecognition; therefore careful attention shall be paid to the topic of gender balance in PEB practices at home.

2.7.3 Procedural Justice

The last dimension of energy justice links with the transparent, inclusive, non-discriminatory decision-making processes around energy. Jenkins et al. (2016) made explicit three mechanisms of inclusion for achieving just outcomes and remediation: mobilizing local knowledge, disclosing information, and representation in institutions. In our experience of PEB those mechanisms emerged in relation to the public announcement co-design and to the accountability of the whole process. The importance of the allocation process emerges from the education cluster (discussed in section 2.6.2.2), where it is associated with the need for more information about energy and technology to use in practical actions. In the cluster (Figure 12) we can see the relationship between the labels “sharing of energy knowledge” and “actions to save energy” – this connection makes clear how the mobilization of local knowledge could affect the practices of consumption. The PEB is thus also a process to improve and facilitate this sharing of knowledge and increase in awareness. Information disclosure of collective consumption information is a focal point of the whole PEB process, such data are the base through which to calculate the energy bonus. The relationship between the need for more information and the energy bonus allocation process also highlights possible critical points. If the allocation process is not clear enough this could affect citizens’ participation and create controversies among communities. It could also raise issues related to privacy. That is also why we found the accountability and the transparency issues particularly relevant during the design phase of the call,

also in accordance with what emerged from the first series of focus groups, quoting one participant of the first focus group in San Lorenzo Dorsino:

> *"one thing must be connected to all these ideas, and this must be the transparency of the initiative, because nowadays in Italy, but also in other parts of the world, a lot of good initiatives start but you don't have the required transparency to motivate the actors and the participants. I mean, I'm proud to give a small contribution, and for me this is a necessary link to motivate".*

Representation in institutions in our case means allowing the participation and the representation of all local groups and people in the deliberative process. Criticalities during the implementation of PEB emerged in connection with the digital divide: not all the participants had an Internet connection or the proper ICT tools (e.g. smartphone, tablet, PC) and/or the knowledge to use them properly.

2.8 Energy Justice - Conclusions and Policy Implications

In this paper we described how participatory energy budgeting could attempt to support energy interventions that are inspired by the principles of energy justice in the context of community energy. As a contribution to the energy justice agenda we focused on how the implementation of PEB shaped a construction-in-practice experience of energy justice in two local communities and how such an experience was tightly connected to the form of energy governance and the (collaborative) construction of PEB itself. Jenkins et al. (2017), when introducing this special issue, claimed that as researchers our work is not only to pursue socio-technical changes but, to do so in "an ethically defensible, socially just way". What we did in our intervention and discussed here pursues this path. We want to reflect upon the methodologies for energy justice highlighted by Jenkins et al. (2017), trying to understand how the energy justice framework has been incorporated within the PEB experience. As we showed, community energy initiatives and the original PB ideals (i.e. citizens and community empowerment, and fight to inequalities) can be linked together through the pursuit of energy justice by the means of PEB as a new policy instrument. Limitations to this instrument emerged: one of the key issues we encountered is the accountability of the process. Policy instruments and

organizational forms that could support the adoption of PEB on larger scales do exist: the growing number of community energy initiatives and energy cooperatives (Schreuer, 2010), ethical consumption groups, or innovative companies with a pronounced sense of social responsibility and ethical market approach. They already constitute an important substrate of the European energy scenario and policies already take them into account (e.g. feed-in tariff schemes, tax incentives, funds to help start-up initiatives, etc.). However, they still need more adequate supporting tools in terms of policies and technologies. For instance, these initiatives could be allowed to use the incentive schemes that already exist for renewables to feed the creation of the energy bonus in connection to improvements of energy consumption. This could be realized by considering the consumption from collective owned renewable energy installations as collective self-consumption and thus to permit receiving the provided incentives, like in the case of the two consortia presented in this paper. In conclusion, if the original PB experiences aimed at orientating the relationship between politics, civil society and the state, the PEB process can strive to reconfigure the relationship among civil society, the energy sector and politics in order to remediate injustices. That is why its adoption in other contexts must immediately take into account the concern of the local contexts, whom it affects and then the possible remediation strategies to be pursued via the PEB, through the system approach proposed by Jenkins et al. (2016). The risk is the same as that which occurred during the PB experiences: to become simply a device without anything to say about changing these relationships.

3 Disentangling participation: interaction spaces and participatory configurations over time

3.1 Preamble

Finally, the following publication reflects retrospectively on the participation of all the actors involved during the whole duration of the project as well as on the evolution of the participatory configurations over time and on cross-participation. The idea is that, as PD enlarges its scope, going beyond the classical context of work settings and IT design, it needs a more developed critical form of reflexivity in order to account for the complexity of participation where there are multiple and heterogeneous actors. As has emerged from the previous chapters, participation in the project spanned different levels over time: from the more formal project level to the more informal and uncontrolled participation within the PEB or the more specific PD level. This is the reason for a more methodological reflection on this experience. In the paper, the interaction spaces have been used as a tool to discuss in retrospection and to account for the different levels of interaction. The main focus is on how the design, development and testing of the ICTs platform let the networks of actors emerge, who engaged in different activities through the different participatory configurations. The use of this kind of reflection is a tool that could help future initiatives to grow. In addition, the use of the proposed framework could also be a tool that can be used during the process to foster participation or to have a better understanding of the possible issues. This paper addresses RQ3 and the contribution resides within the reflection and learning stage of Participatory Action Design Research (PADR) as described in the methodological section of this thesis.

***Paper 4*:** Giacomo Poderi, Mela Bettega, Andrea Capaccioli, and Vincenzo D'Andrea. 2017. Disentangling participation through time and interaction spaces–the case of IT design for energy demand management. CoDesign 0, 0: 1–15. https://doi.org/10.1080/15710882.2017.1416145

3.2 Abstract

Participatory Design has recently seen growing interest in developing critical forms of reflexivity able to disentangle the complexity of participatory ensembles. This article makes a methodological contribution to this endeavour. Drawing on socio-cognitive analyses of collaborative design, it proposes the frame of 'interaction spaces' as a scaffolding tool for conducting retrospective analyses of participatory design processes. The paper uses the 'interaction spaces' frame to analyse the three years of collaborative activities of the CIVIS Project. Through a longitudinal and multi-dimensional account of participatory dynamics involved in the designing, prototyping and testing of an IT platform for home energy management, the frame evidences how participatory configurations evolve over time; it makes clearer the characteristics of participation as partial and overtaken; and it identities moments of cross-participation as potential basis for the boundary-spanning of design issues.

3.3 Disentangling Participation – Introduction

Recently, the field of Participatory Design (PD), which has traditionally concerned itself with the involvement of end-users and stakeholders in the co-construction of such systems, has started to reflect critically on the proliferation of meanings, interpretations, and practices connected with participation in the design of contemporary IT (Saad-Sulonen et al., 2015; Vines et al., 2015). As PD has enlarged its scope beyond IT for organisational and work settings (Clement and Van den Besselaar, 1993) by embracing wider domains such as the nurturing of digital infrastructures for urban planning, the promotion of social innovation and commons (Botero and Saad-Sulonen, 2010; Seravalli, 2011; Teli et al., 2015), it has recognised the need to develop critical forms of reflexivity able to account for the complexity and multiplicity of voices which subtend collaborative ensembles in PD processes. Inspired by the analytical framework of socio-cognitive analyses of collaborative design (Sack et al., 2006a), this paper makes a methodological contribution to this area of interest in PD. It provides a scaffolding tool with which to analyse and reflect retrospectively on the multiple participatory configurations that emerge in and characterise participatory ensembles in their attempts to 'draw things together' (Storni et al., 2015; Ehn, 2008)

over time. We focus on the CIVIS project as a case exemplifying the design, development and testing of an IT platform for home energy management over a period of three years, and in which we authors were closely involved. The article is organised as follows. In the next section, we lay out our research questions and frame them within the recent PD literature concerning the meaning of participation and the need to tackle multiplicity in the field. Afterwards, we address the epistemological foundations of the interaction spaces frame, by building on Mol's political ontology (Mol, 2002, 1999) and on the framework for socio-cognitive analyses of collaborative design (Sack et al., 2006a). Section 3.6 explains how we adapted in practice the original framework for the case of the CIVIS Project and shows the resulting interaction spaces. It follows a streamlined narrative of the three-year process from the perspective of the collaborative work performed by the participatory configurations in each interaction space. In Section 3.8 we reflect on the implications of using the interaction space frame in connection to the theoretical and epistemological foundations. In the closing section, we summarise the findings and point out directions for future research.

3.4 Disentangling Participation - Participation and multiplicity in PD processes

According to recent framings in PD, participation relates to the creation of *products*, which are always coupled with their *politics*; *people are involved* in the design process, that is performed in diverse contexts through the use of specific methods (Halskov and Hansen, 2015). However, despite the various methods, techniques and conceptual frames developed to tackle participation in PD (Bødker et al., 2004; Schuler and Namioka, 1993; Simonsen and Robertson, 2012), there is no consensus on what it means concretely. Andersen and colleagues (2015) suggested that participation, rather than being a well-defined matter of fact, is a matter of concern, in the Latourian sense (Latour, 2004): an issue a group of people is preoccupied about and whose boundaries or core aspects are constantly discussed and interpreted. In line with Latour, they characterise participation as overtaken in action and partial in its existence (Latour, 2005). Meaning that, firstly, the agency of participation is not

possessed or performed by individuals. Instead, it derives from interfering or overlapping sources. Secondly, different forms of participation take place in different contexts, which are not always bounded to the designers' methods or intentions. Therefore, participation becomes "first and foremost a relational and heterogeneous network achievement running through specific design processes and projects" (Andersen et al., 2015). We draw three general implications from Andersen's analysis: (i) participants are not stand-alone actors but act in participatory configurations; (ii) participation does not happen only in specific design sessions, but extends beyond them through artefacts or intermediaries; and (iii) there is no a priori standard for evaluating participation, which can only be accounted for during and after the process.

These implications align with another area of interest in PD, where a call has been issued for a critical form of reflexivity. Interest in the heterogeneity of participants and stakes at play within participatory ensembles is reviving, along with attempts to conceptualize such complexity. For instance, 'Design Things' highlights the convergence and alignment work involved in efforts to draw things together through PD interventions (Storni, 2010). Similarly, the ideas of adversarial (DiSalvo, 2012) or agonistic design (Björgvinsson et al., 2012) highlight forms of design and design processes, which do not strive to resolve conflicting interests, but rather to enable their coexistence. However, PD researchers still face the challenge of making the multiplicity of participants' perspectives transparent at a practical level. For instance, ethnography and qualitative based studies, which often accompany PD, demand that the richness of knowledge that they generate be preserved and conveyed (Blomberg and Karasti, 2012; Mörtberg et al., 2010). Similarly, accountability in PD is often treated as a one-dimensional phenomenon even when relating to collectivities, complex ensembles and projects, resulting in an oversimplification of the political and ethical dimensions in PD interventions (Bratteteig and Wagner, 2012). For instance, scholars rarely address their own roles and academic needs in connection to the 'higher goals' of PD processes (Bratteteig and Wagner, 2016). Similarly, the various

'higher politics' that frame PD processes, such as the influence of research agendas or funding agencies, are often neglected (Balka, 2010; Kyng, 2010).

If, as suggested by Kaiying and Lindtner (2016), PD should become sensitive to an ethics of multiplicity, then we need to be able to describe such multiplicities in order to reflect on them. By taking stock of current framings of participation in PD and the need for a critical form of reflexivity for PD processes, in this paper we engage with the following questions: *how can we make the partial and overtaken nature of participation more evident? How can we support a retrospective analysis of participatory design processes so that the multiple agendas, needs and politics, which characterize them, can be acknowledged?* In the next section, we clarify the epistemological foundations for our frame, whence it derived, and how we adapted it for the case of CIVIS to answer these questions.

3.5 Disentangling Participation - Foundations of the framework for retrospective analyses of participation

When we started reflecting on the CIVIS Project, we were faced with the challenge of understanding whose interests we were mediating, whom we were empowering and how, due to our twofold role of project coordinator and leader of the Italian pilot site. For instance, we recognised that to define and to pursue the objectives of the project with local stakeholders' participation bore very different dynamics, techniques and implications for the intervention itself than when done with the broad participation of all CIVIS stakeholders (i.e. project partners, local energy actors, and recruited households). Therefore, we sought a way to reflect on CIVIS developments in a way that would preserve and convey the multiple ways in which an IT design intervention is simultaneously and differently constructed over time. Basically, we assumed an ontology whereby participatory configurations are multiple.

As a digression to clarify our position, we refer to Mol's pivotal study on medical practices connected to atherosclerosis (Mol, 2002). In her work, Mol shows how atherosclerosis is interpreted, performed and reified as a completely different thing in

the various departments of the hospital: in the pathology unit, atherosclerosis is a set of lab procedures performed on tissue samples by technicians, while in the outpatient clinic it is a set of information and caring procedures performed by doctors, patients and nurses. Accordingly, she argues for the importance of treating reality as multiple and going beyond 'perspectivalism' - i.e. the assumption of a specific perspective which, however rich it may be in details and nuances, reduces the multiple complexity of reality, or better realities, to one (Mol, 1999). The framework for socio-cognitive analyses of collaborative design (Sack et al., 2006b) provided valuable support for our purposes by showing the political ontology inherent to PD processes.

Barcellini and colleagues' framework (2009) focuses on the socio-technical infrastructure of collaborative design projects to highlight: (i) how connections among participants evolve over time and across different areas of the infrastructure; (ii) how participation is influenced by the localised instances of governance that characterise the infrastructure; and (iii) how design-use issues are mediated by participants within and across different areas.

This framework is inspired by actor-network theory (ANT), which frames the elements of socio-technical ensembles as 'actors', 'actants', and the relationships between them. Through a combination of computer-assisted ethnography, text-mining and social network analysis, the framework analyses the emergent structure of design issues as they are characterised in different information spaces by the interactions among participants and artefacts (e.g. mail threads, forum messages, code submissions). It also allows analysis at content level by looking for signs of coherence related to a given design issue as they emerge within the single information spaces or travel among them. At a concrete level, such information spaces refer to areas of the project infrastructures and the main practices thereby enabled (e.g. the concurrent versioning system for the implementation space; the online forum for the discussion space) (Barcellini et al., 2009; Sack et al., 2006b). At a conceptual level they represent small 'socio-technical worlds' that allow design issues to be multiple: to be interpreted, performed and reified in different ways. In the next section, we present

the CIVIS Project and explain how, inspired by this frame, we analysed the project artefacts to reconstruct the various participatory configurations that emerged therefrom and evolved in time.

3.6 Disentangling Participation - Mapping participatory configurations and interactions spaces in the Smart Energy Project

The CIVIS Project was a three-year, EU-funded project. It pursued the design, development and testing of an IT platform to support improvements of energy behaviours by levering on social innovation. Formally, CIVIS involved a consortium of twelve project partners with a diversified set of disciplines and interests in connection to eight work packages that covered the three main project areas: energy, ICT, and social innovation. Overall, CIVIS activities were roughly divided into three broad phases that loosely overlapped with the three project years: (i) exploring and aligning the CIVIS' overarching objectives with the needs and interests of local contexts in the pilots; (ii) designing and developing the IT platform, from the infrastructuring of data monitoring devices to the front-end applications; (iii) deploying the platform front-end in the pilots for usage and assessment. Two countries, Sweden and Italy, hosted two piloting areas. The main vantage point that we present here relates to the Italian pilot, which involved two rural municipalities of a northeastern region: Storo and San Lorenzo Dorsino. Both were broadly identified as suitable for the CIVIS' purpose, because electric energy is produced, distributed and sold by cooperative and membership-based entities, which fully rely on renewable energy sources (hydroelectric and photovoltaic). Two municipalities, two local associations, and 93 recruited households (approx. 300 people) were also part of the Italian pilot.

YouPower[5], the CIVIS platform application deployed in Italy, supported demand-side management (DSM): shifting household consumption loads to match peaks in locally produced energy. YouPower included three main feature categories: a time-of-use signal; a set of energy data visualization tools, and tips for energy-reduction

[5] For a technical overview of the platform architecture and platform design see Huang et al. (2017)

actions. This was the outcome of lengthy and complex exploration, negotiation and alignment work that we authors pursued as project and Italian pilot coordinators. We facilitated moments of discussion and collaboration in order to pursue the CIVIS' goals on a consensual basis with the relevant, interested stakeholders. On one hand, the platform deployed in Italy should have satisfied the expectations of the project partners and the funding agency. On the other hand, we wanted it to be in line with the needs and expectations emerging from the local contexts.

Inspired by the analytical framework, we took YouPower as the key object of analysis and reconstructed the structure of the participatory process and the related participatory configurations. We reviewed all CIVIS meeting agendas, minutes and artefacts, selecting those involving more than two stakeholders. Out of these, we identified 55 that had a direct connection with YouPower. They included: 13 round table meetings, 6 sessions in project plenary meetings, 13 telcos, 10 workshops, 6 focus groups, and 7 public events. For each of these, we mapped the form of interaction, the date, and the stakeholders involved into a spreadsheet.

Thereafter, we clustered them to highlight consistency of participatory configurations over time. This enabled us to identify three interaction spaces (Project; Local pilot; End-users), as we named them: conceptual arenas that framed relatively stable participatory configurations harnessing the design and development of YouPower through a specific mode of collaboration and at a specific level of IT design. Figure 1 provides a graphical representation of the temporal and 'spatial' distribution of the collaborative activities that defined YouPower in CIVIS. They are clustered within their respective interaction space, which we briefly explain here.

Project - This frames the participatory configuration that pursues the implementation of the YouPower from the vantage point of the CIVIS work plan. It includes the 12 international partners (authors included) with rare presences of core local stakeholders (Italian and Swedish pilot areas). It is primarily oriented to fulfilment of the CIVIS work plan (e.g. meeting intermediate formal objectives and deadlines).

Local pilot - This frames the participatory configuration that ensured legitimacy to act and proper understanding of the local context in the Italian pilot (e.g. exploring local needs; engaging household participants; accessing data infrastructures; defining local intervention objectives). Together with two additional CIVIS project partners, the two electricity cooperatives and two municipalities, we acted as core participants and stakeholders in this space.

End-users - This space frames the participatory configuration that worked to identify end-users' needs and define the YouPower front-end functionalities. We and sub-groups of the 93 recruited households acted as the main participants. Electricity cooperatives participated only on a few occasions.

It is worth clarifying that our choice to focus on YouPower as 'object of the analysis' in CIVIS has a direct implication on the activities we selected, the resulting interaction spaces and participatory configurations. These would be quite different had we picked another object of analysis in CIVIS. The collaborative moments whose exact placement within one of the interaction spaces was difficult (shaded in dark grey in Figure 13) deserve attention as well. Referring back to the original terminology of the frame, these moments were clearly characterised by 'cross-participation': they included participation by stakeholders who also acted in another interaction space. In the end, we opted for a clear placement within a specific space by following a rule of thumb, based on our actual involvement in the project, more than an 'objective' criterion. We believe that these moments are particularly relevant to PD processes, as we will argue below, and that they warrant particular attention in future research. In the next section, we provide a streamlined, high-level narrative of the process with a focus on the participatory configurations and their role in the project. We intend to clarify the kind of work performed in each interaction space and at what level of IT design each of the related participatory configuration interacted with YouPower. Furthermore, we intend to provide more context about the moments of cross-participation, marked in dark grey in Figure 13. To structure this narrative, we use CIVIS' three main phases and, for each, we touch upon all interaction spaces.

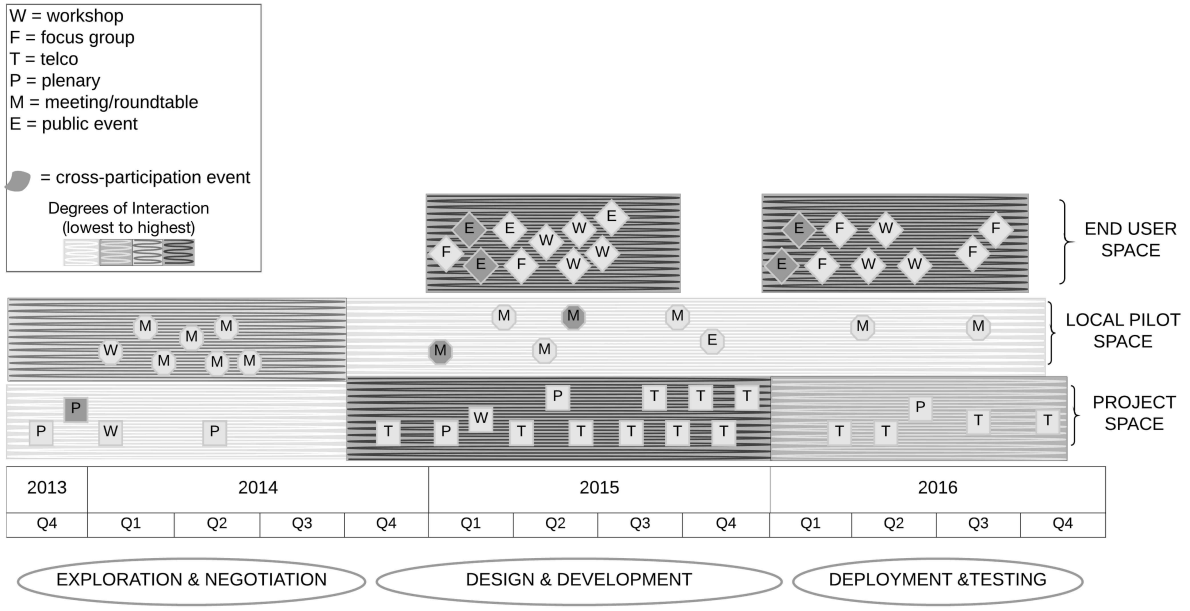

Figure 13 Temporal and spatial distribution across interaction spaces of 55 activities in which more than two stakeholders participated in relation to the design, development and testing of YouPower. Note: Activities with cross-participation of stakeholders from different interaction spaces are shaded in darker grey.

3.7 Disentangling Participation - Participatory configurations evolving over time

3.7.1 Exploration and negotiation

One of the first concerns in the CIVIS Project was to identify and legitimise those energy interventions and IT tools that would be meaningful for the local contexts without neglecting issues of feasibility and novelty. The bases for intervening at the level of DSM and for legitimising the core purpose of YouPower were laid during the first year. As shown in Figure 13, this took place through the involvement of two participatory configurations: the one in the project space, and the one in the local pilot space (without any interaction in the end-users space). In the former, project partners defined how to collaborate among themselves and with the local contexts of the pilots. Furthermore, they collaborated to synthesise and assess the inputs yielded by the Italian and Swedish pilots compatibly with the formalities of CIVIS (e.g. translating interventions into formal use cases). At the same time, in the latter configuration, other actors collaborated to define the specificities of CIVIS

intervention (e.g. mapping existing IT infrastructure and identifying concrete objectives).

Figure 14 Local stakeholders and project partners at a plenary meeting (2013, Q4), while listening to a presentation by the CEO of one of the Italian electricity cooperatives. Note: Project Space.

The two configurations largely acted independently from each other, except for an important meeting at the very beginning of CIVIS. Right after the initial kick-off, local stakeholders of both countries were invited to an additional plenary meeting (2013, Q4) to present and to state their expectations as to how CIVIS would be of support to them (Figure 14). The Italian electricity cooperatives presented two main issues. Firstly, they wanted to know how to optimise the ratio between local production and consumption, therefore reducing their need to buy energy from the national market at a higher price. Secondly, they sought means to engage their members more actively in the collective management of energy.

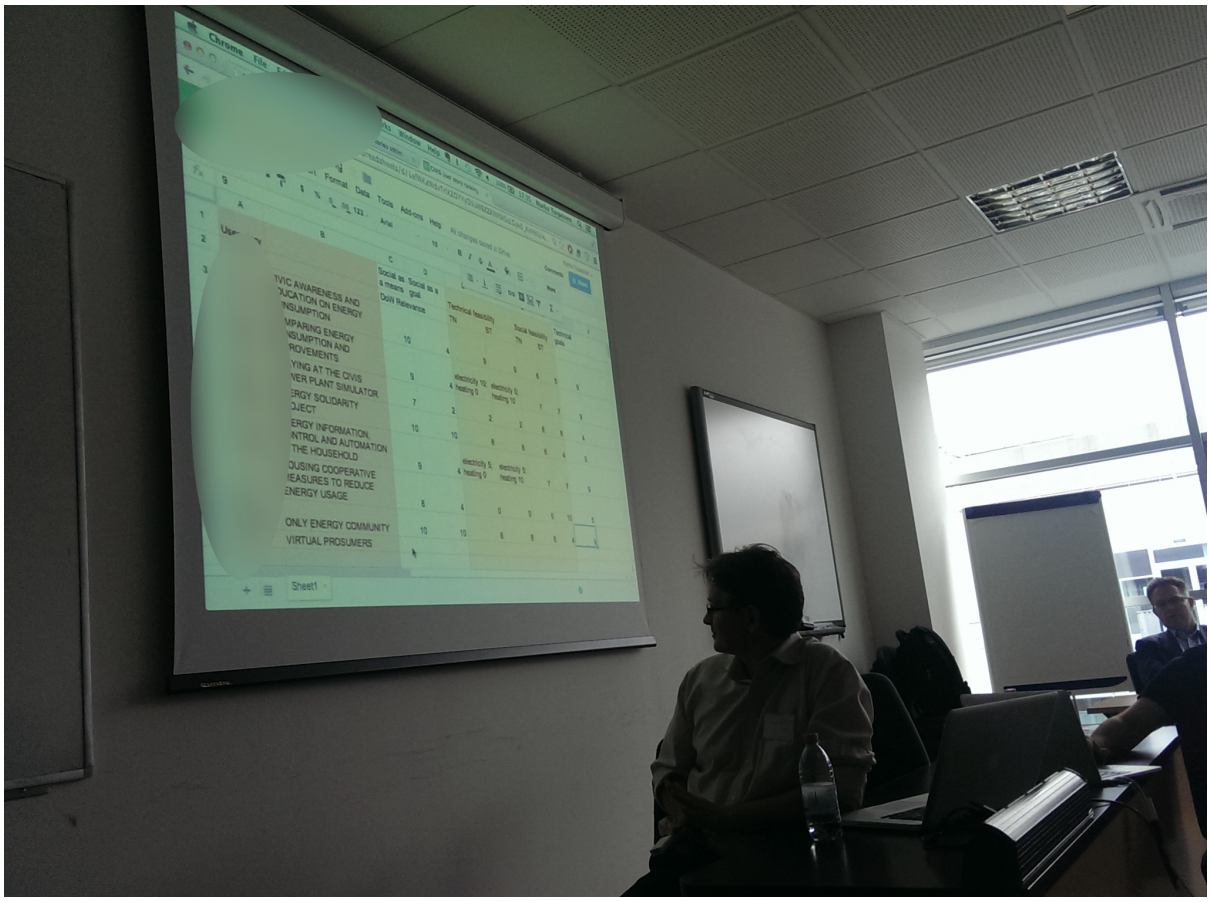

Figure 15 Work session by the CIVIS project partners during a plenary meeting (2014, Q2) to assess and rank the feasibility and innovative value of the various interventions proposed until then. Note: Project Space.

This event was a milestone for two reasons: (1) it gave local stakeholders from Italy and Sweden the chance to meet CIVIS partners and make the case for their interests; (2) it introduced all participants to the tool of user story and scenario development, which became the core methodology employed in CIVIS to facilitate alignment and collaboration for subsequent activities. Out of the possible ways to support DSM through IT that emerged from the local pilot space, CIVIS project partners settled for developing a time-of-use signal and subsidising engagement through the availability of a collectively managed 'energy budget' for the benefit of the local communities. This decision was taken during another plenary meeting (2014, Q2) in the project space when the innovative values and feasibility of the possible interventions were assessed (Figure 15).

3.7.2 Design and development

During this phase, the overall collaborative work in CIVIS became hectic as the heterogeneous ensemble interacting with the platform in multiple ways was augmented by a new participatory configuration: that of the recruited household members as the future end-users of YouPower.

Figure 16 First workshop held on identification of 'user needs' (2015, Q2). The collage session focused on the identification of appliances usage patterns. Note: End User Space

This also introduced a wider range of ways to engage with stakeholders in CIVIS. Indeed, they participated in public engagement events, focus groups, and workshop sessions (2015, Q1-Q3). During these events they provided feedback on the scope of CIVIS and the intervention scenario on DSM. Furthermore, they provided information on the local energy culture, their expectations and needs (Figure 16) with regard to YouPower (Capaccioli et al., 2016a). These interactions also furnished insights on how to shape the platform front-end.

For instance, contrary to the initial intentions and assumptions that emerged in the project space during the first year, the integration of social networking features was abandoned, the focus on real-time and historical data was strengthened, and the feature for performance comparisons was drastically simplified. The artefacts produced in the end-users space – focus group reports, map of needs, wireframe – were circulated within the project and in the local pilot spaces.

Figure 17 A meeting (2015, Q2) between local stakeholders and technical project partners, focusing on the rationale and the modeling aspects of the algorithm for the ToU signal. Note: Local Pilot Space

The involvement of the other participatory configurations was characterised by round table meetings in the local pilot space, and by plenary and, mainly, telcos in the project space (2015, Q2-Q4). In the former, Italian local stakeholders supported the detailing of the specific aspects of demand-side management. They helped to identify the time-slots for the time-of-use signal and how to value them in connection to the 'energy budget'. Technically challenging, these aspects required iterated project partners meetings to focus on the platform's general architecture and its front-ends to make them suitable for the different actions in the Italian and Swedish piloting areas. Similarly to the previous year, interactions took place in the various spaces mainly with the participation of the related core stakeholders. However, on a few occasions,

the participation of a specific stakeholder from one interaction space to another proved important. In one case, Italian cooperatives took part in the public presentations of the project's objectives. This gave legitimacy to the households engagement process and the project intervention itself. In two other cases, project partners with technical expertise intervened in meetings with the Italian local stakeholders to resolve some pending issues: finalising the selection of monitoring devices compatible with the existing energy infrastructure; and determining the proper configuration of the algorithm for the time-of-use signal (Figure 17).

3.7.3 Deployment and testing

In this last phase, CIVIS platform was basically ready to be released in the piloting areas. The attention was centred on the testing phase with the recruited households. Therefore, the general interactions of the participatory configurations in the interaction spaces changed. Indeed, the overall work of CIVIS was on the right track with regard to its presence in the local context: it was justified and legitimised, and the major controversial issues emerging from the Italian pilot had been resolved. The work meetings with Italian stakeholders in the local pilot space became sporadic. Their participation was primarily oriented to receiving updates and providing minor feedback about the maintenance of the project infrastructure, the households' engagement with YouPower, and the assessment of energy impact. However, local stakeholders did take part in the two public events, in the end-users space (2016, Q1), for the launch of YouPower and the discussion on the participatory energy budgeting process. These meetings were planned as public events. Their presence and active participation in answering questions and providing warranties was valued by the recruited household members that attended. Similarly, interactions that affected YouPower also diminished in the project space. A few telcos and a session in the last plenary meeting were still necessary among project partners (2016, Q2-Q4) to ensure maintenance and minor upgrades to EnergyApp and its infrastructure. In the end-users space, the collaborative effort of this participatory configuration continued with the same intensity and same type of meetings as in the previous year. Household members engaged with participatory energy budgeting activities (Capaccioli et al., 2017) by taking part in the public launch events (2016, Q1), the workshops for tailoring

the governance mechanisms of the process (2016, Q2), and the focus groups for the intermediate and final evaluations (2016, Q1 and Q3). During this phase, household members shaped core details of the participatory energy budgeting, such as the criteria for beneficiaries' eligibility, the mechanisms for the evaluation process, as well as the allocation procedures for the energy budget.

3.8 Disentangling Participation - Implications of framing the multiplicity of participatory configurations

Having presented how the frame can be used to reveal the participatory configurations that emerged in CIVIS' interaction spaces, and how their interactions and evolution characterised the project, we now briefly highlight its main conceptual implications.

3.8.1 Participatory configurations evolving over time

Recent concerns on the proliferation of meanings, interpretations and practices connected with participation in the design of contemporary IT (Halskov and Hansen, 2015; Vines et al., 2015) have directed attention to the lack of a temporal dimension (Saad-Sulonen et al., 2015) in the study of participatory processes. Adopting the interaction spaces frame for a longitudinal study of an IT project like CIVIS proved useful in starting to tackle this gap. From a methodological point of view, it shows how how artefacts produced during the process can be used with hindsight to reconstruct the process itself. More substantially, the frame reveals how IT design can be defined by participatory configurations whose forms of collaboration, internally and among themselves, change in the different phases of the project. As CIVIS case shows, the overall arrangement of participatory configurations changes considerably from phase to phase - exploration and negotiation; design and development; deployment and testing. For instance, the pattern of collaboration on YouPower in the project and in the end-users spaces varied much more than it did in the pilot space. At a broader level, there was also variance in the political ontology of which group of stakeholders, or participatory configuration, harnessed which aspect of YouPower in which phase - e.g. the intervention's objectives were defined among project partners and local stakeholders without household members' participation. The frame basically

reveals the structure of the participatory process as an evolving pattern of multiple participatory configurations.

3.8.2 Participation as partial and overtaken

If we accept Andersen and colleagues' position on participation (Andersen et al., 2015), we may consider it an achievement to be accounted for in retrospect. We may also understand it as partially existent and overtaken in action. Using the interaction spaces frame for an IT project like CIVIS highlighted the structure of the resulting collaborative process upon which a partial and overtaken stakeholders participation took place. It becomes clear that each moment of collaboration with a stakeholder (or group of stakeholders) stops being a stand-alone event with a clearly identifiable agency or impact for the project's developments. Instead, it appears as a moment of participation whose meaning is relational to others, at temporal and ontological levels: inside the interaction space, it is preceded and followed by other moments of participation; relatively to the other interaction spaces, it further pursues the construction of a specific and unique reality for the project's design and development. For instance, the frame evidences that the series of meetings, which allowed the identification of needs and the production of the wireframe for YouPower in the end-users space, happened at the same time as local stakeholders and project partners were negotiating and working on the mechanisms to support DSM through YouPower, in their respective spaces.

3.8.3 Cross-participation as a basis for boundary spanning

Framing participatory configurations within interaction spaces also requires PD researchers to maintain a reflexive and critical attitude. This is evident in connection to those collaborative moments characterised by cross-participation (i.e. marked with darker grey in Figure 13), whose placement within a specific interaction space is more challenging than for the other ones. Therefore, at the practical level of using the frame, PD researchers are urged to reflect on the particular meaning of those moments in the 'political economy' of the process development (e.g. why did cross-participation happen there? Who promoted it?). For instance, having to decide the placement for the stakeholder plenary meeting (Figure 14), it helped us in reflecting and understanding how important and functional that meeting had been for the

project objectives. It was supported, encouraged and deemed necessary by all project partners much more than it was by the local stakeholders. Albeit enthusiast and intrigued by the opportunity, they were certainly in a less favourable position for formulating concrete and effective requests or expressing well-formed expectations, given their unfamiliarity with the project. At the level of the outcome of the analysis, being able to identify these moments is also a first step in understanding negotiation, alignment or mutual learning among stakeholders. Indeed, to refer to the original construct of Sack and colleagues' analytical framework (Barcellini et al., 2007; Barcellini et al., 2008), cross-participation can be conceived as a fundamental pillar for boundary spanning to happen: understood as the positive resolution of a design issue which emerged from different contexts, interaction spaces, in our case. Although our work did not focus on the content level of the design process and could not address boundary spanning directly, it was able to identify those underlying moments of cross-participation which could potentially realise it. For instance, the joint plenary meeting in which all project partners and key local stakeholders of the Italian and Swedish pilots worked to find common objectives and means to collaborate was certainly a pivotal moment for the overall process.

3.9 Disentangling Participation - Discussions and conclusion

In our analysis we engaged with the issues of how to make the partial and overtaken nature of participation evident, and how to support retrospective analyses that would allow multiple agendas, needs and politics to be acknowledged. Inspired by Mol's work on political ontology (Mol, 1999; Mol, 2002), the first step was to acknowledge the nature of participatory processes as multiple. Our second step was to search for an analytical frame that could address such multiplicity. We found an adequate tool in the framework of socio-cognitive analyses of collaborative design. By building on this framework, we transferred its fundamentals to the less technologically mediated context of PD and applied them in a more interpretive way. We pursued the network(s) of actors that emerged in relation to the design, development and testing of YouPower, in the CIVIS Project. We focused on the structural aspects of the process

and, by reviewing the project artefacts that directly connected to YouPower, we identified three different interaction spaces and tracked the activities of their respective participatory configurations. Some directions for future research spring from our work. At the methodological level, the question arises as to whether and how this frame can be useful for PD practitioners during their work, rather than only in retrospective and analytical terms. More substantially, another open issue pushes us to develop the frame further so as to tackle design and participation at the content level, rather than just at a structural one. Finally, we shall explore clearer and richer ways to report, represent and discuss the results emerging from the use of the frame. In conclusion, we argue that thinking in terms of interaction spaces - as conceptual arenas that frame relatively stable participatory configurations, each of which contributing to IT design through a specific mode of collaboration and at a specific level of design - is a valuable scaffolding tool to look back at PD interventions. This makes it possible to disentangle participation without smoothing the complex political ontology of the process or assuming 'perspectivalist' positions (Mol, 1999). To return to our research questions, the frame of interaction spaces can reveal the multiple reality of participation and make its partial and overtaken nature (Andersen et al., 2015) more transparent over the lifetime of complex IT projects. This can serve as a basis for furthering our understanding of design politics in complex IT settings and opening opportunities to be explored so that an ethics of multiplicity can be concretely embraced (Kaiying and Lindtner, 2016). Furthermore, the interaction spaces frame is a viable means to identify cross-participation and therefore gain better understanding of boundary spanning (Barcellini et al., 2008). More and more frequently, participatory designers engage with contexts where the heterogeneity and the multiplicity of participants make it difficult or even undesirable to work towards an objective that can synthesise such diversity of voices, needs and expectations (DiSalvo, 2012; Björgvinsson et al., 2012). To better comprehend PD processes in these contexts, it is not surprising that designers and researchers matured a desire for critical forms of reflexivity that are able, for instance, to return the richness of knowledge generated by the processes themselves (Blomberg and Karasti, 2012; Mörtberg et al., 2010) or to discuss about multiple accountabilities (Bratteteig and Wagner, 2016). We consider our work a valuable contribution to this area of PD.

4 Conclusion

I opened the thesis with a flashback, a personal glimpse of a moment in which energy became visible and relevant for my life, and I guess for the lives of the other people which were blocked somewhere that day. I tried to understand how the current energy paradigm is inherently related to our socio-economic development model and how the "obesity" of energy consumption that we have fed is the very reproduction of our economic relations and inequalities. Those same inequalities, in turn, led to all the environmental and social injustices and issues, which are nowadays rampant. The design of an alternative solution starts by working against *"de-futuring"*, leading instead the reflection with *"futuring"* (Fry, 2008). The community as an actor for sustainability is, in this reflection, put at the very centre through the main focus toward community-based PD as the approach to address the energy justice practical case over which build the new common based approach to renewable energy.

This thesis discussed a first step toward a possible future. Here, the current energy transition process is recontextualized as a moment in which we can take advantage of new opportunities. These emerge as consequences of putting participation and the creation of a full-fledged alternative model at the centre. This alternative is to consider energy as a commons to find an exit from the energy obesity paradigm and to enable a commoning process to sustain and maintain the production, reproduction and distribution of the energy common. To do so, I proposed a participatory approach to engage communities, using the concept of PD as a form of infrastructuring that supports the creation of a fertile ground for a community of participants (LeDantec and DiSalvo, 2013).

In this last section I first present the contributions to research; then I discuss the limitations of this research highlighting future directions; finally, I conclude with some remarks about my experience in the context of what this thesis has achieved.

4.1 Thesis overall contributions

This thesis contributed to community-based PD by showing how to use a participatory approach to enable and nourish a commoning process, and support communities. The adopted means, within the community-based PD, contributed to the emergence of a new way to consider energy as a commons. Three main interrelated elements were central: i) visualization: YouPower with his visualization features made possible to make energy public as a "thing" (Schoffelen et al., 2015); ii) participatory workshops: these were used for the design of YouPower features, but also as a way to let participants reflect about energy consumption practices, and about energy as a commons; iii) PEB: provided a formal framework for the implementation of the commoning process, making PEB a tool for energy justice. These three elements cannot be separated, and they could inspire other uses in other contexts, to let the common grow and thrive.

To achieve such a challenging perspective, designers and practitioners must start asking how to design better infrastructures and frameworks to enable and sustain the commoning practices (Marttila et al., 2014); therefore within this view PEB is a first step toward a broader agenda looking at how to design a more sustainable and equal future. PEB framework has been the result of a situated participatory design process, a "becoming together" (Akama, 2015) approach where people, both the participants, the stakeholders and the partners, were brought into the co-designing of the yet invisible structures around them (Light and Akama, 2014). The commons-based approach that pursued community governance was meant to infrastructure new relations among energy-ecology-society, with the energy justice as a product of the commoning practice.

In the next section it will be discussed how the PEB design relates to the original design principles from Ostrom work, in order to understand how PEB can become the tool to nourish the common, considered as in the vision of Vercellone et al. (2017) as a mode of production based on the self-government. Therefore, PEB is a practical experience, stemmed from a community-based participatory process, of a form of

governance and cooperation to ensure the production, reproduction and distribution of the common, with the possibilities to pose the foundations of a different relation between public, private and common. It was not an easy process, it aligned and mobilized a number of different actors from the micro-level to the macro-level: municipalities and mayors, energy utilities, design practitioners and technology experts, lawyers and policy makers, are just some of them. Therefore, institutioning (Huybrechts et al., 2017) has been a central practice throughout all the work, contributing to the design of the PEB framework.

However, in order to better discuss the key contributions it is worth it to go back to the three research questions presented in the introduction chapter:

4.1.1 RQ1. How can a commons-based approach to renewable energy management be designed and enabled?

As presented in Chapter 1, the main contribution of this thesis is the design of the Participatory Energy Budgeting (PEB) framework. This, together with a smart grid infrastructure, allows communities to generate and manage value stemming from sustainable use of renewable energy for social and collective goals. The PEB has been used in the context of the CIVIS project and has been an integral part of the project activities, contributing to the overall goals. A first step toward the design of the PEB framework that also informed this question is the understanding of how a space for citizen participation can be created in a continuous design process, as discussed in Chapter 1.

The PEB framework could be seen as a first enabling tool to empower communities toward adopting a common-based approach to renewable energy management. Indeed, if we look at the eight original design principles proposed by Ostrom (1990), the mapping of those principles on the actual implementation of the PEB is clear: 1) clearly defined boundaries are defined as part both of PEB features that define who can participate. Also, 2) appropriation and provision rules are part of the designed framework that includes the 3) collective-choice arrangements about how the decision making-process allows for the participation of citizens, both virtually and in real life. The PEB is intrinsically connected to the need of 4) monitoring and

accountability, which has been one of the main issues recognised during the design process by participants. This is also imposed through the use of the YouPower feature and through institutional arrangements. The 5) graduated sanctions were not directly discussed and defined during the PD process, probably because the testing happened in a short period and we were, as researchers, recognised as "experts" and advisors, being part of the CIVIS project. For that reason, even the 6) conflict resolution mechanism passed through our expertise. PEB allows for the 7) minimal recognition of rights to organise, where the organisations and the decisions are managed through the designed participatory process. The last principle 8) about nested enterprises regards only larger systems, which for the moment it is not the case of the implemented PEB.

Further improvements geared toward constructing a more integrated system are required to achieve a full and complete shift to a commons-based energy. However, the role of PEB could be an entry point to empower communities and to enable them in a more actual and practical way. The PEB is a first-step for a possible new socio-economic model, following what Bonifacio (2014) defined as the "systemic change approach" of social innovation. PEB is inscribed at the intersection of green technology, networks and diffuse creativity as in the idea of Small, Local, Open Connected (SLOC) initiatives defined by Manzini (2010). PEB is intrinsically a framework to be adapted for Small and Local communities. The framework however also has all the features to let the communities become Open and Connected globally, in a *"cosmopolitan localism"* (Manzini, 2010) way. From a scalability perspective, looking at the strategies described by Manzini, PEB could be both replicated in a new local context, with a tailored implementation; and connected with other local initiatives to scale up vertically in the context of a new larger programme, for example by following the model of the peer-to-peer approach (Giotitsas et al., 2015) of interconnected micro-grids as peers. Also, the PEB emphasises the fact that the value through which the process should be measured is not monetary, but it is the energy itself. Here, energy is detached from the purely economic value, but it integrates also other elements such as environmental and social value. During the implementation process this helped the acquisition of knowledge and the reflection from participants in terms of emissions, consumption and their daily practices. This, in turn, led to the

discussions during the workshops about intergenerational activities such as events and experiences for children and young people to foster energy savings, with the overall goal of achieving a sustainable future.

These proposed actions go back to the cycle of creation and management by the community of the energy value, reinforcing and working on future sustainability.

4.1.2 RQ2. *What are the advantages and disadvantages of a commons-based approach to renewable energy management on local communities in terms of social and energy justice?*

As discussed in Chapter 2, the PEB can be used a powerful policy instrument within the energy transition process. The framework can help to reconfigure the relationship among civil society, politics and energy sector to have a more just and equal energy distribution and management. In this sense, Jenkins et al. (Jenkins et al., 2017) claimed that as researchers our work is not only to pursue socio-technical changes but, to do so in "an ethically defensible, socially just way". In Chapter 2 therefore it is discussed how community energy initiatives and the original ideals of participatory budgeting (i.e. citizens and community empowerment, and fight to inequalities) can be linked together through the pursuit of energy justice by the means of the new PEB tool.

Indeed, what emerged from the analysis of the gathered data, as discussed in Chapter 2, is a contribution of the PEB to the three dimensions of energy justice:

i) Distributional Justice: this dimension is more related to the local context, and to how the energy system is locally shaped. However, the implementation of the PEB, in connection also with the deployment of the IT platform, helped the adoption of new energy practices more related to a fair distribution of the benefits coming from the renewable energy installations present in the territory.

ii) Justice as recognition: conflicts between collective and individual interest emerged in the effective implementation of the energy bonus; they are

elements of inequality in recognition. A clear aspect of this is the contrast that could emerge between people with installed photovoltaic panels and people without; the two groups could pursue two different strategies to adapt the consumption according to the PEB process. For the first group more oriented toward individual goals, while for the second group there could be difficulties in adapting their consumption. Thus, once the inequalities between the two groups are visible and recognized, it could be possible to develop collaboration between them.

iii) Procedural Justice: PEB contributes to the three mechanisms of remediation defined by Jenkins et al. (Jenkins et al., 2016): mobilizing local knowledge, disclosing information, and representation in institutions. The first one is the mobilisation of local knowledge, PEB has a connection with the creation and transfer of energy knowledge related to actions to save energy, as discussed in Chapter 2. One of the PEB focal point is related to the disclosure of information connected with the collective consumption, and the accountability and privacy issues related to this part has been relevant during the design phases. The representation in institutions in the case of PEB is related to the representation of all local groups and people in the deliberative process. However, critical points emerged during the process in relation to the digital divide affecting participants not equipped with Internet connection or proper devices.

To conclude, we can look back at Byrne et al. (2009), which discussed their concept of a sustainable energy utility referring to the work of Ellul (1964) in their conclusion. Here, they refer to justice as "a slogan" in modern society and that without a compass for finding justice, society would risk the disaster of climate change. In this sense, they are aware that their proposal cannot solve all the issues, but could be a step toward finding a compass. I am aware too that PEB has limitations and that cannot solve the whole problem, but it is a tool to empower communities and a step toward finding a compass toward justice, both in an energy and social sense.

4.1.3 *RQ3. How can we as researchers and designers look at a complex participatory design process and acknowledge for the multiple perspectives and political agendas of the different actors in order to support future decisions?*

The context of my research as part of the CIVIS project had a significant role in shaping my activities and interactions. A complex network of actors took part during the whole project: this meant working for the alignment and satisfaction of different needs related to the different goals of the involved actors. This became visible in Chapter 3, also looking at Figure 13. Being able to visualise the different interaction spaces has been a powerful insight to reflect about the heterogeneous network (Andersen et al., 2015) that unfolds over different design processes and contexts not necessary bounded to the designers intentions. It is interesting to notice how Chapters 1 and 2 discussed, from different perspectives, activities deployed (with some overlap) in the three main stages used in Chapter 3: i) exploration and negotiation, ii) design and development, iii) deployment and testing. The participatory configurations related to PEB has been discussed in Chapter 3 within the more general context of the CIVIS project, and helped to explain the relationship between the different interaction spaces. While in the beginning stage, the PEB was more connected to the overall exploration and negotiation phase of CIVIS, involving the project space and the local pilot space, with their respective participatory configurations of actors. The focus shifted later to more specific interactions related to PEB on the local pilot space and on the end-users space in the design and development phase, but even more for the end-users space during the practical deployment and testing stage. It is worth to notice, how the overall configuration of the project, which was more driven by our side as researcher in close connection and negotiation with the local stakeholders, left the participation of the end-users more peripheral until a more mature stage of the project. I suppose that mapping the interaction spaces and the participatory configurations in a context of a more active participation from the end-users side would have ended in a different kind of process and outcome. In that case I would expect a more strong focus on the "political" agenda of the end-users, rather than the one of the stakeholders.

As noted in Chapter 3, accountability in PD is an issue that risks oversimplifying the political and ethical dimensions in PD interventions (Bratteteig and Wagner, 2012). Therefore, one of the key issues to be addressed is that of deeply exploring the participatory component, being aware, rather than avoiding, of the complex political ontology brought by the participatory configuration. The risk here is to neglect the different positions and to slip toward perspectivalist positions (Mol, 1999). As discussed in Chapter 4 then, the use of interaction spaces framework as a scaffolding tool is a valuable solution to look at complex PD interventions. This is a particularly delicate issue where there are difficulties at arriving at an objective of synthesis between the different voices and agendas from the different actors (DiSalvo, 2012; Björgvinsson et al., 2012) while fostering critical reflexivity from the designers' and researchers' side in order to discuss the multiple accountabilities (Bratteteig and Wagner, 2016).

4.2 Limitations

The limitations of this thesis are related: i) to the very narrow context of testing; and ii) to methodological approach.

i) For the first point: the work done was carried out in two small and closed communities in a rural and isolated area of a mountainous region. Even if the context was already receptive toward the issues explored by the CIVIS project (with well-established local energy cooperatives, an high spread of renewable energy installation and a positive attitude toward pro-environmental actions) engaging the communities within the project and within the activities related to my research has been one of the most difficult stage of the work. Also, limitations in terms of data availability and timing of the interventions have been a significant challenge. Moreover, as discussed in Chapter 3, another limitation is posed by the regulatory context. Even if policy instruments and new organisational forms that could implement and test the PEB exists, such as the community energy initiatives and energy cooperatives (Schreuer, 2010), there is a

lack of adequate supporting tools both in terms of technologies and policies. Some suggestions to address this limitation have been discussed in Chapter 2.

ii) In terms of methodological approach, it has been pointed out how AR is bounded to the context, and not context-free (Baskerville and Wood-Harper, 1996). In practice, this means that produced knowledge risks being difficult to replicate elsewhere. Indeed the work presented here refers to only one context: the CIVIS project. It can be stated that the generated outcomes such as the designed PEB process are generalised and potentially applicable also in other contexts. This, however, requires further testing and triangulation with results from other contexts in order to provide a stronger case. The PEB has been tested only in two communities with similar contexts, but the testing has been limited in time and also has been driven by the more general context of the CIVIS project. A longer prolonged testing would be necessary to have a better understanding and results, also in terms of sustainability. In this sense, PEB and the shift to a commons-based management of energy are thought to be a sustainable form of organisation over time. Finally, in terms of methodological limitations, my reliance on mostly qualitative data is a limitation, even if data are differentiated in their forms: from focus-groups to workshops and field notes. A stronger evaluation of the effectiveness of PEB would need to address these methodological concerns. This is also connected with what has been discussed before about the timing of the intervention and the need for a more prolonged testing.

4.3 Future Work

The contributions presented in this thesis provide also scope for future work in a number of directions. Due to the interdisciplinary approach I applied to my work, it is possible to discuss future directions in different possible fields of study. In the next paragraph I discuss two possible perspectives to look at future development of my work, being inspired by Manzini (2015) I defined the two perspectives: horizontal and vertical.

4.3.1 A horizontal perspective

A horizontal perspective means to consider replicating and adapting in different contexts small initiatives, therefore continuing in having new experiences of PEB. Obviously, as it has already been discussed, there is the need to continue the experimentation in different contexts of the PEB to refine and have a better validation. However, future implementation could also be related to urban contexts and virtual communities, connecting the energy and ICT sectors to work on the so-called virtual power plant (Pudjianto et al., 2007). This will also allow to understand how communities based on interests could organise themselves following a peer-to-peer based approach (Giotitsas et al., 2015). There is also the need, as discussed in the previous paragraphs, to have a more stable and long-term perspective. In order to achieve this, it could make sense to work from a "push" perspective rather than a "pull" as happened with the CIVIS project. Another horizontal perspective could be a continued focus on just a better integration of the PEB between the ICT and energy dimensions. Along with this, a stronger vertical focus could be helpful, maintaining the interest in the implementation of the energy-justice framework, which is gaining traction in the last years with dedicated publications and sessions in relevant conferences.

4.3.2 A vertical perspective

What I think it is more interesting than the horizontal perspective is to approach the possible future work form a vertical perspective. Manzini (2015) defined the concept of "vertical scaling" as the integration of several small initiatives in larger framework context, connecting similar projects but also integrating them with other kinds of organization. By this view PEB could become one of this framework under which integrate several other initiatives. As discussed before, while energy is an important factor for our society, at the same time there is an increasing interest toward design for sustainability and for futuring (Fry, 2008). This means, in my view, the possibility to look at both different kinds of resources where an approach similar to PEB could be tested. More interesting, however, is the possibility to connect the energy PEB with the current development in terms of emerging of new collaborative economic models, like the *"commonfare"* (Fumagalli and Lucarelli, 2015; Botto and

Teli, 2017), as a new form of welfare provision based on the more extended definition of common (Hardt and Negri, 2009).

In a time of platform economy and financial capitalism with a massive exploitation of resources (both natural and human), an alternative should be able to integrate the different aspects of our life toward a new form of living together. Energy is one of the core elements of our lives, thus it should be taken into consideration in the design of possible alternative to the current socio-economic paradigm. Therefore, an interesting perspective for a future work is the one taking into consideration the possible application in a more extended and generalised way of PEB-like approaches as a possible value creation process for the commonfare.

4.4 Final Remarks

It has been a long journey for me, and I enjoyed it, even considering the struggles I encountered through the entire journey, which helped my a lot in terms of learning experience. I learned how to participate as a member of a complex project as part of the coordination team, but also as a person who worked in the pilot sites with the participants and in contact with stakeholders and partners, each with different needs, goals, and expectations. Learning how to take all together and keep the project and my research going was for sure the most difficult part and the one that I think it is the most valuable for me and for my future. I enjoyed seeing how trust and a relationship with the participants was built and I found really valuable the time spent in the local communities of Storo and San Lorenzo Dorsino, entering the houses of participants or being recognised at the local cafe. I found interesting to learn the local practices and customs, to know how energy in such an isolated areas is an important matter from a long time.

Personally, as a future direction, I would like to work on understanding how the intricate relationships between energy, policies and technologies could be re-shaped by an emerging process of re-appropriation and creation of experiences and communities around the topic. In the very next future we will need to face incredible

challenges posed by the over-consumption and over-exploitation of resources and energy. This is why I personally believe the design of an alternative should pass from one of the most important matters, one that is mostly invisible in our everyday practices: energy.

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