

Building Pathways for Empowering User Toward Prosumer Behaviour

The Design for Experience with the Prosumer Empowerment Concentric Model

Marion Real, Quentin Tabart, Audrey Abi Akle

ESTIA

F-64210 Bidart, France

e-mail: m.real@estia.fr

Abstract— Acting as prosumers can help the transition toward low carbon and circular economies.

This paper discusses what can be defined as “prosumer behaviours” and proposes an innovative approach that fosters users in adopting daily virtuous experiences about energy production and consumption. Such experiences are based on smart interfaces as they emerge from complex socio-technical systems that combined ICT devices, smart grids and user-centred tools created to empower users and facilitate the emergence of a positive intelligence.

The Prosumer Empowerment Concentric (PEC) Model is presented here as an integrative vision to support the emergence of prosumer behaviours and perspectives are outlined via an interregional project that proposes to experiment the PEC model in households and citizen energy cooperatives.

Keywords - smart interface; smart grid; energy consumption; user-centred approach.

I. INTRODUCTION

At individual and community level, low carbon economies rely on decreasing the energy consumption of households and improving the local production of renewable energy. Empowering consumers and encouraging them to act and become prosumers remains a key challenge to provoke effective impacts on sustainability. The term “prosumer” has different meanings in academic works [1], [2] and recent reports from European Parliament [3], [4]. It is used here in line with Greenpeace [5] definition of active customer: “*a customer who performs any of the functions of generation, storage and/or supply of energy from renewable sources, or energy efficiency/demand-side management, either individually or through a community energy*”. Acting as a prosumer is adopting virtuous behaviours that create energy savings, reinforce the good understanding of energy bills and participate, in a direct or indirect way, in the production of local and renewable energy.

For designers, new systems, environments, experiences, products or/and solutions need to be imagined and

developed so as to facilitate the adoption of prosumer behaviours.

In a technological viewpoint, different types of solutions are developed:

- Information and communication technology (ICT) solutions are the most widespread, mainly composed by sensors and connected objects. Visualization interfaces and serious games are also created for improving the awareness on energy bills and encouraging energy savings.

- Small renewable energy like solar and wind turbines and home energy storage can be interfaced to the main grid through a local scale grid. The microgrid concept allows a local grid to operate independently from the national grid and thus enable a decentralized and cooperative energy distribution system.

Recent works underline new business models who involve changes in the relation between consumers and energy Service Company and communities [6]. In this line, citizen energy cooperatives are emerging models that participate to the production of renewable energy in territories through the involvement of consumers/citizens by financing new installations and diffusing awareness. Besides, small renewable producers and energy storage holders along with consumers can be aggregated using the Virtual Power Plants (VPP) framework [7]. It allows local producer/consumers to exchange their production (renewable energy, heat, etc.) locally and buy/sell from other VPPs. The European FENIX project [8] currently investigates the practical implementation of such concept.

However, there are some barriers and limits in the adoption of such solutions that prevent behavioural changes. Indeed, currently there are solutions that do not have long-term benefits. It is pointed out in [9] that the gamified solutions offer only a gain of 0.2% of long-term energy saving. Moreover, a key determinant of energy performance is the behaviour of occupants. Occupants use energy to perform various activities of daily life and most of the complex processes that occur in dwellings energy consumption result from human behaviour. The activities they undertake are stochastic in nature and difficult to predict [10].

We think that the new solutions have to be in line with the needs and habits of consumers while proposing feedbacks and stimulations that help them to pursue their

paths toward the adoption of new eco-efficient and sufficient behaviours.

This is why in our work, we propose a holistic human-centred approach that goes beyond classic product/service design, and give a particular focus on designing experiences for consumers, users and prosumers. User experience (UX) design consist in (i) exploring the real personal motivations, needs and representations of consumers [11], (ii) involving them in all stages of the design of future systems [12], (iii) monitoring the evolution of their environment through responsive interfaces [13], [14]. In our approach, UX tools and methodologies will be integrated in a systemic view combining both social, technical and user aspects.

Theoretical background on change and transition management is also investigated in this work to reach the design of coherent and adaptive experiences. Ethically, behavioural changes could not be managed externally without the consent and the intent of users. It exists a challenge for designers, and intermediary organisations, in persuading consumers through interfaces with the objective to inspire emergence of prosumers behaviours while reducing the diffusion of constraint feelings. Supports need to integrate the evolution of consumers and to guarantee solutions which will gradually influence the adoption of prosumer behaviours.

This paper proposes to describe a prosumer empowerment concentric model (PEC) that fit the necessity to build pathways toward prosumer behaviours (presented in Section 2) and explain how it will be used, integrated and experimented in households through a further European projects (see Section 3).

II. PROSUMER EMPOWERMENT CONCENTRIC MODEL

The model represents a set of user-experiences containing socio-technological solutions to move from standard consumer toward prosumer behaviour. Each individual can build his/her own paths to become a prosumer by releasing different actions which includes different types of solutions. Structures and institutions like cooperatives or change managers can also use the model as an interface to fit consumers' needs with solutions providers and stimulating changes.

A. Structures of the PEC model

The model is built through concentric layers representing levels of empowerment toward prosumer behaviours. Based on Carvallo and Cooper's work [15], four layers have been identified. They represent different levels in which consumers can move: from "standard consumer", "consumer awareness", "active consumer" to "prosumer" (see Figure 1).

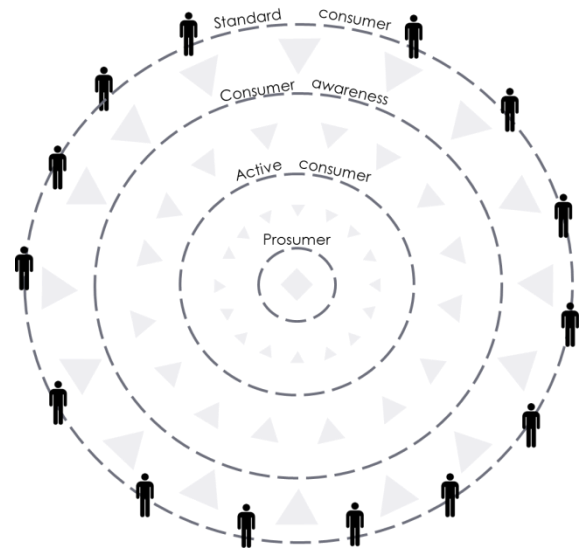


Figure 1. Concentric layers: going deeper in the engagement.

On each circle/layer of the model, we position "states" and in connection with these states we relate existing solutions (see Figure 2).

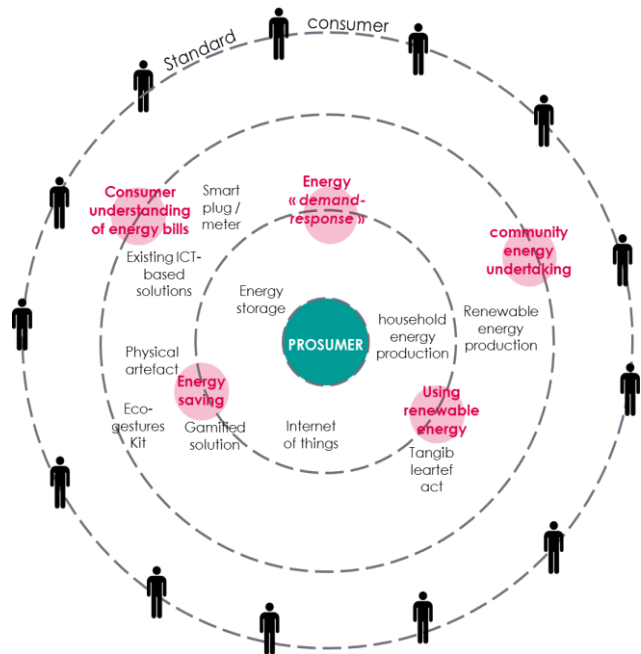


Figure 2. Model with statutes connected to existing solutions.

On the first circle so called "consumer awareness" there are two statutes possible: (i) "Consumer understanding of energy bills" where the objective is to facilitate understanding of energy bills and encourage the identification of equipment in the household that consumes a lot and possible energy losses within the home and (ii) "Community energy undertaking" which correspond to the

involvement of consumers in citizen organisations, like cooperative. They can participate in financing parts of renewable infrastructures.

On the second circle "active consumer", three states are possible: (i) "Energy saving", people will be encouraged to reduce their energy consumption within their homes; (ii) "Energy demand-response" where the objective is to encourage consumers to consume differently i.e. change / move consumption behaviours to avoid periods of significant demand in energy. One of the first actions (for example) is to inform consumers about energy cost and efficiency; and (iii) "Using renewable energy", here, we have the ambition to motivate people (according to their location) to consume only when their region / territory produces renewable energy. This state is close to the previous one but it is much more stochastic in the behaviour because directly related to the production of "green" energy. On the third circle, only "prosumer" status is possible, this is the last status available in this model. It consists in the production of energy directly produced by the consumer. It is encouraged on the one hand by all other states but also supported by existing solutions.

B. Pathways and evolution in the PEC Model

The model is built in order to adapt the path toward the consumer profile. Indeed, with this approach, the consumer chooses his/her own path towards "Prosumer" typology. In this way, the consumer chooses the «gateway» according to his/her profile (and his/her motivation) and defines step by step the objectives. In order to illustrate this adaptive pathway, the Figure 3, Figure 4 and Figure 5 present scenarios of various possible paths towards the status "prosumer".

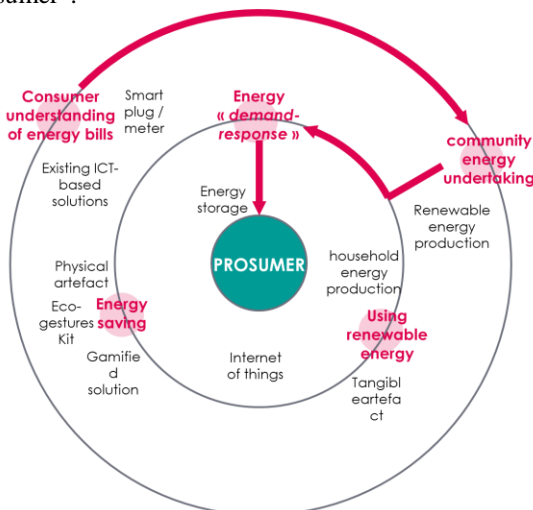


Figure 3. Example of path 1.

In the first scenario (Figure 3), the consumer initiates consciously his/her path toward prosumer typology by improving the awareness of his/her energy consumption. To do so, s/he starts to use an appropriate smart-meter and a visualisation tool to read its own energy bill and after one

month choose to become a member of an energy cooperative. After an important reduction of consumption, s/he decides to test new ICT devices which help him/her to better know when s/he has to consume (e.g. when to use a washing machine) to be in line with the energy production peaks. Finally, s/he decides to adopt renewable energy systems at home so as to gain in autonomy and participate in local electricity production. The scenario 2, depicted in Figure 4, insists on the role of energy communities as catalysers that motivate and advise consumers in adopting new habits and eco-efficient devices while the scenario 3 illustrates, in Figure 5, the case where people have already environmental awareness and start by actions that have a higher level of engagement (situated in both active consumer and prosumer).

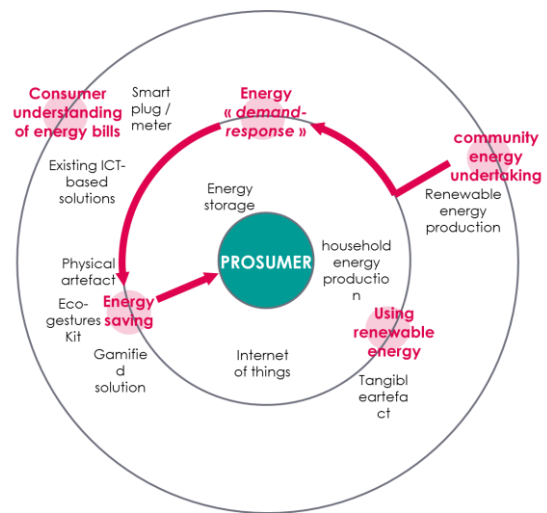


Figure 4. Example of path 2.

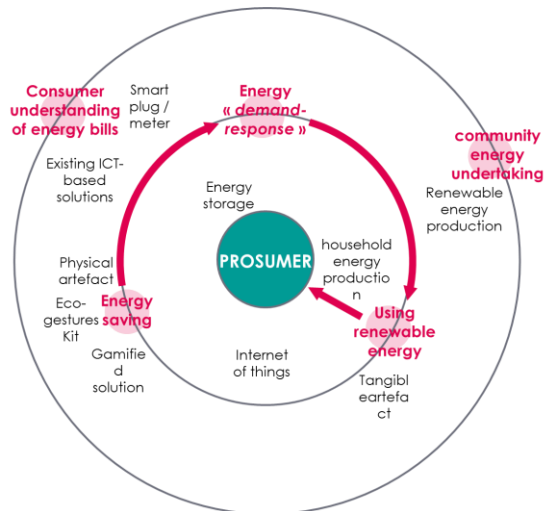


Figure 5. Example of path 3.

C. The PEC Model integrated in Smart Interface

"Smart and empowering interfaces" is coined as "the design and implementation of human-human interaction, human-

system and system-system that may foster the emergence of a positive intelligence for users". For several reasons, we are convinced that the PEC model is part of this area. First, it includes the study of behavioral changes and the interaction between solution kits and consumers in order to identify the potentials of deconsumption within each status (human-system interface). Then, it proposes the study of the interactions between the consumers within cooperatives to extract vectors of motivations towards a more virtuous behavior (human-human interface). Moreover, this work focuses on the exchange of energy between the VPPs (system-system interface). These interactions are also embedded in a systemic conceptual interface that connects different layers of environmental awareness within society.

III. CONCLUSION

The PEC model has already gained the confidence of two cooperatives (from Spain and France) and will be implemented and tested through a future European project, in three different regions of France, Spain and Portugal. In each region, cooperatives, energy service providers, intermediary organisations and households will be involved. The project will pursue the state-of-art of existing solutions helping in completing the PEC model. Then, the project will consist in defining the experiences offered to consumers whatever their profiles are. Each experience will be materialized by solution kits composed by a mix of ICT, renewable energy products, energy storage devices and pedagogical or gamified solutions. The first kit will be the installation box (i.e., the smart meters) and the other kits will be boxes sent monthly. The content of these boxes will obviously be adapted to the profiles and desires of consumers. A recruitment phase will select a panel of two types of consumers: members of cooperatives and aleatory households. A pre-analysis of consumers' needs and motivations will be realized. Once the solution kits and consumers will ready, the experimentation will begin. It will consist in four series of solution kits implemented in each household. The 4 phases of planned tests correspond to 3 states (on the "awareness" and "active consumer" layers) and a final test phase for the status "prosumer". For each series, different tasks will be reached: installation, learning stage, use phase with stimulations, feedbacks, behaviour changes and energy saving and production assessments. An approach to analyse human behaviour, behaviour change and their barriers will be deployed. The objective is to understand on the one hand the transition from one layer to the other (of the model) and on the other hand the transition from one status to another. Testing these experiences in real households will lead us to have direct feedbacks, to define new strategies of business models, especially for cooperatives and to draw conclusions for consumer empowerment. The experimentation will end by a capitalization and realization of a deep analysis on effective behavioural changes. Actions will also be engaged to transform citizen cooperatives in an interface organization

for energy behavioural changes supported by the PEC model: a practical tool will be developed to help them in supporting the involvement and engagement of their members toward pro-active behaviours.

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