End-users: The trigger to shape the European Energy System

Towards a Societal Appropriation journey

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How can end-users in the energy system be empowered? This Hot Energy Topic sheds light on the issue, assuming that the end-user will be key to a successful European Energy Transition. We shortly review the context, describe the process that we coin the Societal Appropriation of energy, a four step process that leads to end-users steering this transformation of the energy system. We then identify some barriers that currently prevent end-users from being empowered and follow with further elaboration on the overall process to employ short-term and long-term measures in order to increase end-users' awareness and understanding of how to fully participate in the transformation of the Energy System. Societal Appropriation of energy is the process and end-result arising from "the appropriation of behaviour that can lead to change in the overall energy system."

Consumers as the drivers of energy system transformation

The Societal Appropriation of energy will favour the emergence of innovative business models and technical solutions. There seems to be an increasing move to engage end-users more in the European energy transition[1]. In the electricity market for instance, the ongoing liberalisation process, together with the development of smart grids and the corresponding demand-side management potential, is leading to the emergence of new types of players, such as aggregators or virtual power plants, despite regulation being a barrier in some Member States[2]. We can also observe the future potential for electric vehicles, connecting mobility and (domestic) electricity consumption via battery storage. However, electricity and transportation systems are certainly not the only parts of the energy system concerned by this transformation. Heating and cooling might also be mentioned here, and more generally, the "energy hub" concept,[3] which illustrates the trend from thinking based upon energy carriers towards thinking based on energy services. Thus, we are possibly at the start of a profound transformation of how end-users view the energy system, and their relationship to it. The energy value chain is evolving, and new links in this chain are about to emerge, centred on the end-user's needs and concerns.

From the policy perspective, the SET-Plan of the EU emphasises the need to take care of active consumers, and the first stated challenge is to place the "Active consumer at the centre of the energy system" [4]. In addition, the European Commission

[1] "We have to empower consumers through providing them with information, choice and through creating flexibility to manage demand as well as supply." c.f. European Commission, Energy Union Communication, 25 February 2015, p. 2

[2] Smart Energy Demand Coalition (SEDC), *Mapping Demand Response in Europe Today*, 2015

[3] Geidl, Martin, Gaudenz Koeppel, Patrick Favre-Perrod, Bernd Klockl, Goran Andersson, and Klaus Frohlich. "Energy hubs for the future." *IEEE Power and Energy Magazine* 5, no. 1 (2007): 24.

[4] "Towards an Integrated Roadmap: Research & Innovation Challenges and Needs of the EU Energy System" December 2014

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communication about the Energy Union[5] states that "smart technologies will help consumers and energy service companies working for them to reap the opportunities available on the energy market by taking control of their energy consumption (and possible self-production). This will deliver more flexibility in the market and potentially reduce consumer bills". However, as the DG ENER of the European Commission stated during the EU Sustainable Energy Week in 2015 via its Head of Unit Internal Market, "being a consumer should not be a full-time job".

From an industry perspective, this transformation of the European energy system may be accelerated by the current energy use trend in the EU, characterised by a shrinking demand of both primary energy demand and electricity demand over the last years (Figure 1[6] and Figure 2). This could indeed be seen by incumbents or newcomers as a promising environment to shift or develop their strategy to focus on energy services and higher value added activities[7].

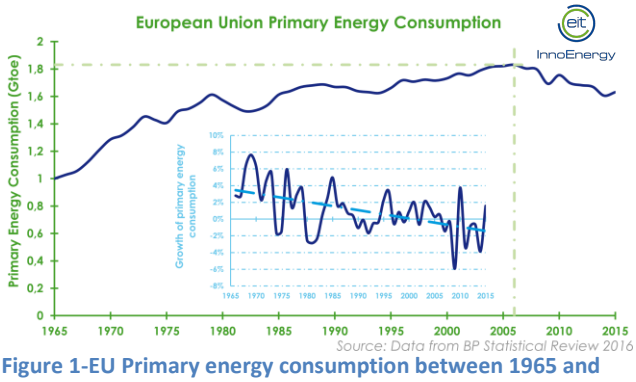

Figure 1-EU Primary energy consumption between 1965 and 2015, and corresponding y-o-y growth rate

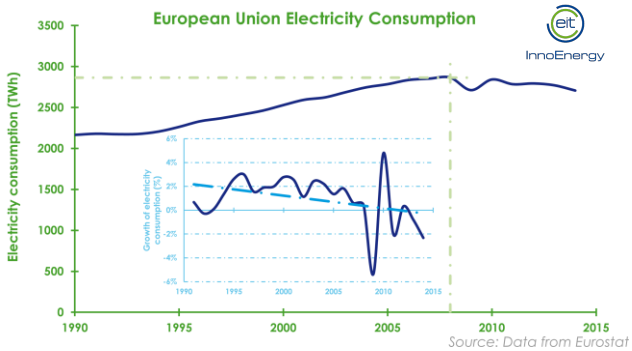

Figure 2-EU electricity consumption between 1990 and 2014, and corresponding y-o-y growth rate

The digital industry[8] has the potential to be the favoured channel through which this transformation of the European energy system will take place. It has already shaken up various sectors, from hospitality with Airbnb to mobility with players like BlaBlaCar or Uber, and the same phenomenon is emerging in the energy industry with newcomers such as Bidgely, Tendril or Opower. While the digital transformation[9] can be viewed as disruptive and, therefore, as a threat if not anticipated, it provides new opportunities for both incumbents and newcomers. For instance, it could allow for the emergence of new business models using digital capabilities, in which data, effectively exploited, could lead to competitive advantage. In this regard, some EU players have started to reorient their strategy towards the end-user and digitalisation[10-11]. For instance, in the new

[5] February 2015

[6] The BP Statistical Review data has been used because the time series are longer than the Eurostat's ones.

[7] See for instance Centrica, which potrays itself as "an energy and services company […] focused on satisfying the changing needs of [their] customers" in their strategy.

[8] The digital industry here refers to all the types of players involved in the digital transformation, while the Information and Communications Technologies (ICTs) are only the technological layer of this transformation.

[9] The digital transformation is not only the integration of ICTs into the various processes of an organisation, it is also the development of a culture in accordance with these tools (e.g flexibility, speed, dynamics, autonomy). Besides, digital transformation is also about involving these tools in the outward interactions (with current and potential customers, suppliers and other stakeholders). See for instance World Economic Forum, *Digital Transformation of Industries: In collaboration with Accenture*, January 2016 or Bain & Company, *Adapt and adopt: Digital transformation for utilities*, 2015.

[10] Digitalisation and digitisation are often used interchangeably. However, digitalisation goes beyond digitisation. See for instance Cindy De Armond, *Digitization versus digitalization: The stakes for insurers*, February 27th 2015.

[11] Isabelle Kocher, CEO of Engie, said on May 25th that something completely different has to be invented, and she believes that

strategy of Vattenfall, one of the three focus areas is "Strong customer focus and new customer-centric business models"[12], while "customer-focused solutions" is one of the four strategic areas for innovation management at Electricidade De Portugal[13]. Energy management, aggregation, decentralised generation and energy storage appear as prioritised topics identified by Engie. Another example is the first line of Alliander's strategy which is "Given current trends and developments, we expect fundamental changes in the energy supply of the future, with greater emphasis on sustainability, flexibility and active participation of our customers"[14]. Finally, Endesa wrote in its annual sustainability report of 2014 that energy models will need to adapt to the demands and behavioural changes of society.[15]

Towards the Societal Appropriation of energy

The reorientation of policy and industry efforts often have a focus on digital transformation processes. However, there is not only a technological dimension, but also, and most critical, a societal and behavioural dimension, which has to be explored and addressed. We therefore suggest the consideration of Societal Appropriation of energy, a process illustrated in Figure 3.

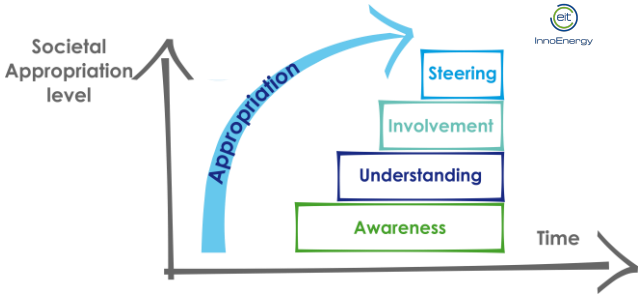

Figure 3-The process of Societal Appropriation of Energy

The Societal Appropriation of energy can be split into four levels, namely the awareness, the understanding, the involvement and finally the steering of the transformation of the European Energy System by the end-user (see Figure 3). The process therefore describes the increasing empowerment of end-users to contribute to the European energy transition. The first two levels are consistent with the general interest and might be promoted by public authorities, whereas the 'involvement' and 'steering' levels require solutions from the private sector, and an appropriate policy framework.

The empowerment of end-users can be achieved by increased technology automating energy service provision, or by behavioural change, or (most probably) by a mix of the two. Complete automation is probably neither desirable nor realistic; therefore successful solutions to empower the consumer will require an individual and collective commitment through societal changes.

Societal Appropriation should also be thought of as the process by which the citizen learns to consider energy as an essential part of everyday life, reflected in the integration of energy matters into daily decisions and resulting behaviours. That is, to establish energy as a new distinctive dimension of the (social and personal) identity as the result of the described process (see Figure 3)[16]. From this perspective, the objective of consumers understanding the role of energy in their daily life (in relation with their activities such as cooking or cleaning) is that they experience how they consume energy not only understand what it represents (to answer simple questions like "How much energy I consume a day?" As we already do for food with "How much calories do I need?")

"inventing this "something completely different" revolves around "two inextricably linked driving forces": "energy and digital.""

[12] Vattenfall Strategic Direction 2014

[13] EDP Annual Report 2015 (p.86)

[14] Alliander Annual Report 2014 (p.13)

[15] Endesa Annual Report 2014

[16] "Personal identity is the individuated self – those characteristics that differentiate one individual from others within a given social context. […] Social identity entails "a shift towards the perception of self as an interchangeable exemplar of some social category and away from the perception of self as a unique person"." Brewer, M.B., (1991), *The social self – On being the same and different at the same time*, Personality and Social Psychology Bulletin, 17(5), p. 476.

One might compare the process of the Societal Appropriation of energy with the process of appropriating time or money, which are two concepts acquired in childhood through daily management of them and recurring experiments with them. In this regard, the Societal Appropriation of energy should not be limited to digital devices and be also promoted through traditional pedagogical tools (in schools for instance).

One positive effect of Societal Appropriation, in particular the 'involvement' and 'steering' levels, is that it allows the transformation of the NIMBY effect[17] into a PIMBY effect[18]. One possible option for increased involvement is to allow for the financial investment of citizens concerned/affected by an energy project through crowdfunding[19]. Thus, citizens have a direct (and financial) interest in these projects.

There are many dimensions of the empowerment of end-users. We elaborate these further by using a concrete example of the electricity sector, an obvious case[20] for which the Societal Appropriation of energy by the end-user is key.

Empowerment of the end-user in the electricity system

From a technical point of view, an end-user is able to interact with the electricity system through the following four activities:

1) Long-term electrical load reduction (energy saving through increased energy efficiency or reduced energy services)
2) Load shifting as a short-term load reduction or increase (demand side integration (DSI)[21])
3) Generation (e.g., through photovoltaic (PV) panels or combined heat and power CHP system)
4) Storage.

The four activities can either be performed automatically with the help of ICT or require ongoing action by the end-user. This requires behavioural change, which can either be conscious (e.g., through informed appliance purchase) and habitual forms of behaviour.[22] The degree of empowerment with respect to the described four activities can be measured by several indicators. The need for appropriate indicators was already raised by the EC[23]; the selection in Table 1 meets this request with a focus on the Societal Appropriation levels of 'involvement' and 'steering'. The other levels of 'awareness' and 'understanding' would require a more qualitative assessment.

Table 1 : Indicators to describe end-user empowerment

Activity	Selection of indicator
Demand (shift or reduce load)	▪ % end-user involved in DSI ▪ # smart end-user solutions ▪ % end-users with smart meters installed
Generation (sell, store, self-consumption)	▪ % of end-user with generation capability ▪ % self-consumed electricity
Storage	▪ % of end-user with storage capability ▪ TWh of energy stored

The more activities an end-user is able to perform, the more empowered is an end-user. However, it should be noted that the indicators listed in Table 1 focus on technology-enabled empowerment. Yet, empowerment across all Societal Appropriation levels can also be reached by behavioural changes (e.g. better informed decisions). This is key because there are barriers to empowering some end-users through

[17] Not In My BackYard
[18] Please, In My BackYard
[19] Such as Lendosphere in France, Windecentrale in the Netherlands, Abundance in the UK, or Econeers in Germany.
[20] required balancing of demand and supply at every instant, combined with a growing penetration of variable renewable energy sources and with a plummeting cost of photovoltaic panels and of batteries.
[21] We use demand side integration synonymously to demand side management

[22] Valkering, Pieter; Laes, Erik; Kessels, Kris; Uyterlinde, Matthijs; Straver, Koen; Sarkadi, L. et al. (2014): How to engage end-users in smart energy behaviour? In EPJ Web of Conferences 79.
[23] European Commisssion Issues Paper No.3 /(version 17/12/2015) 3.1) Smart solutions for energy consumers

technology (e.g., limited income, living in a rental property).
Barriers to empowerment are described in the following section of this paper.

Barriers to end-user empowerment

Existing barriers which limit certain kinds of end-user empowerment can be categorised into the following types:

1) Informational
2) Technical
3) Structural
4) Economic
5) Acceptance

Informational barriers comprise both lack of and inappropriate information, e.g., no information on energy consumption and energy costs is provided to consumers or the information provided is too complex for consumers to understand. **Technical** barriers are related to the end-user technologies themselves. Examples include the spatial limitations for installing a CHP technology or static limitations in installing a PV panels on the roof. An example of a **structural** barrier is the owner-tenant-dilemma, in which only tenants benefit from an energy efficiency measure (e.g., lower energy costs) whereas the owner has to bear the investment costs (e.g., for a CHP or insulation). Another example of a structural barrier is the existence of multiple ownership, where decisions are more difficult to take and implement. **Economic** barriers consist of missing monetary incentives both on the profit side (e.g., premium for load shift) and the cost side (e.g., subsidies). **Acceptance** barriers lie in the aversion to adopt new technologies due to, for example, psychological ones. Acceptance barriers also include behavioural barriers such as the resistance to adapt the behaviour to new circumstances (e.g., start the washing machine depending on the current electricity price).

The strength of each barrier varies across different end-users. For example, low-income households will be less able to afford costly investments in more efficient or renewable technologies. Such households will need to be protected against costly mandatory measures to avoid the creation of winners and losers of smart solutions. However, they should also not be disadvantaged where, for example, a low-income rental is not upgraded. Therefore, different measures are necessary to engage differentiated consumer groups. According to IDAE[24], four types of measures can be distinguished: regulatory, economic, communicative and infrastructural. The following measures could address short-term and long-term requirements to overcome the mentioned barriers:

- training, communication, education, improved feedback on energy consumption
- enable contracting solutions
- change the market design to give incentives for earnings
- change the market design to reduce costs (e.g., financial aid for storage, generation, energy efficiency and DSI)

The term "smart solutions" implies benefits to the consumer. However, this is not necessarily the case for the energy transition, as it depends on how they are used. For example, smart homes primarily contribute to an increase in comfort and safety, but not necessarily to the functioning of the energy system. Furthermore, smart solutions are not by default beneficial for every end-user but rather this depends on the given circumstances (e.g., smart meter installations at end-users' premises with little energy consumption have a poor cost-benefit ratio). As a result, the widespread use of smart solutions should not be a goal itself, but rather be seen as a tool amongst many to raise awareness and understanding of energy consumption. The implementation or the design of the mix of measures should, therefore, reflect the system-optimal penetration of technologies in order to avoid, for example, excessive monetary incentives.

[24] Instituto para la Diversificación y Ahorro de la Energía (IDAE) : Changing Energy Behaviour, Madrid, 2009.

To this end, further research has to be conducted to identify a system-optimal degree of end-user empowerment (Table 1), which would detail the share of end-users, technologies, policies and measures necessary to ensure a smooth transition while highlighting the technological and economic limitations of achieving such objectives.

Conclusions

The Societal Appropriation of Energy is essential to reap the full benefits of the transformation of the European energy system.

A significant effort has to be made to integrate social sciences into energy, such as psychology, anthropology, sociology, consumer behaviour and political sciences. For instance, Public authorities who finance research projects in the fiel of energy could require applicants to assess the expected impacts and drivers of their project from the perspective of those social sciences.

Moreover, indicators could be defined to track the progress of the Societal Appropriation by measuring the degree of empowerment (both technically and non-technically enabled empowerment). Some first suggestions have been elaborated in this paper and listed in Table 1 for the electricity sector, for technically enabled empowerment. Through this development of indicators a deeper understanding of the role played by consumer empowerment can be gained.

To summarise, the road towards a truly end-user centric European Energy System is certainly long, as are the required research and investment needs, which have to be supported by all the stakeholders of the knowledge triangle (i.e., Business, Research & Technology, Higher Education).

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