Towards a Social License To Automate in Demand Side Management: Challenges, Perspectives and Regional Aspects

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Abstract: Demand side management (DSM) requires automation in order to suitably address the fluctuating conditions within energy grids. One of the major challenges for introducing and maintaining automation solutions for DSM is to acquire a social license, that is, to ensure the acceptance and approval of the affected stakeholder communities. In this paper, we provide an overview of the current state of knowledge and remaining challenges to understand the relevant factors to acquire such a social license to automate. We also introduce a novel related international work group of the International Energy Agency Technology Collaboration Programme on User-Centered Energy Systems. The scope and planned activities of this work group are presented, which shall lead to a set of globally reaching and regionally contextualized guidelines for the successful set up and operation of DSM.

Keywords: Social License to Automate, Demand Side Management (DSM), Trust, Flexibility, Automation, User Interaction, Energy Practices

1 Motivation and Objectives

Without automation, demand side management (DSM) is unlikely to provide the electricity system with the fast-acting response needed to manage changing network and system requirements. A major challenge for introducing automation, however, is the deep distrust that energy users often exhibit towards corporate energy industry entities. At the household scale, we cannot always expect customers to explicitly agree to automation systems reaching behind the meter to access the customer's equipment to provide third party services. Customers who do not trust the electricity industry to act in their personal interest may not be the only party to hesitate to make the accommodations required for DSM to flourish; established participants such as distribution networks, retailers and regulators may as well be wary of the wholesale changes implied.

The notion of a ‘social license’ (cf. Boutilier & Thomson, 2011) describes the extent of an initiative’s acceptance and approval by a community of stakeholders. The social license refers to approval from affected communities and stakeholders towards an organisation‘s or industry‘s operation (aspect). It has evolved from concepts of ‘legitimacy’, ‘social corporate responsibility’ and ‘social acceptability’. It does not refer to a formal agreement but to a socially constructed perception of interactional, socio-political, economic and institutionalized legitimacy of the activities conducted by the responsible organisation or industry. The granting of a social license can be seen as based on the sequentially acquired perceptions of social legitimacy, credibility, and trust. A ‘social license to automate’ therefore represents trust in the legitimacy and approval by participants to apply (different levels of) automation within their homes and businesses in order to optimize DSM.

In this paper we provide an analysis of the current state of knowledge and remaining challenges towards securing a social license to automate DSM. The topic is being analysed by an international group of experts from different scientific disciplines, within the recently started User-Centered Energy Systems Technology Collaboration Programme (Users TCP) by the International Energy Agency (IEA, 2020). Its ‘Social License to Automate’ Annex aims to understand the non-technical obstacles to user engagement with automation technologies in DSM, and to identify what is required to build and maintain user understanding, acceptance and trust. The analysis in the following section is structured into the Annex’s five workstreams, which represent relevant challenges and related areas of expertise: (1) user interactions, (2) energy practices, (3) designing and aligning institutions, (4) the socio-technical making of automation and load flexibility, and 5) governing automation. The paper concludes with an outline of a methodology for providing guidance on approaching user-centered DSM automation on a global scale and with the awareness of regional differences and specificities.

2 The Current State of Knowledge and Open Issues

In the following, we provide a description of the current state of relevant fields of research and practice surrounding the social license to automate. We discuss the related state of knowledge with regard to the acceptance of different forms of DSM automation, and we show that research so far has been focused on specific research questions and studies with possibly restricted generalizability. To this end, inconsistencies, open issues and broader views that could be accommodated by the Social License to Automate Annex are derived.

2.1 User Interactions

A first topic cluster relates to the user's interactions with automation technologies and the establishment of interactional legitimacy. Novel demand site services must be communicated and introduced to the user through communication technology. The communication design must be tailored to the actual purpose of the service as well as to the (personal, social, environmental and technical) context of use, taking advantage of established guidelines and reflections in the area of Human-Computer Interaction and Environmental Psychology (e.g. Prost et al, 2015).

The first research question addressed within this stream of research is as follows: **Under which conditions are end-users willing to accept DSM automation?** To establish interactional legitimacy users need to feel informed, but also listened to. What do they want to hear, what do they want to be able to say? Which requirements are general and which ones need to be negotiated individually? Such requirements include a clear communication of purpose, records, and benefits of any actions taken, as well as invitations to influence, to agree or disagree, to give feedback and to question. Aspects known as central to acceptance of automation are therefore level of control, transparency, performance (usefulness), simplicity (ease of use), and assurance of privacy & security (e.g. Hoff & Bashir, 2015; Schaefer et al, 2016; Balta-Ozkan et al, 2013). Further, trust in the electricity supplier factors strongly into the acceptance of demand response (Fell et al, 2015) which underlines the importance of customer relationship building. There is a strong link between perceived fairness and trust which deserves special consideration in the context of privacy concerns and the provision of benefits tied to the collection and recording of personal data.

The second concern related to user interactions relates to **how end-users prefer to interact with DSM automation**. How do users want to be informed and how do they want to be listened to? General factors critical with regards to interaction preferences for smart grid applications are platform accessibility, speed of feedback, required cognitive effort, required interaction frequency, interruption quality (including need to react or to make a decision), and novelty of presented information (Buchanan, 2015; Hartzog, 2018; Hartmann & LeBlanc, 2014). Our time and cognitive capacities are limited and need to be used with consideration in order to communicate credibility and trustworthiness rather than be a nuisance or not reach us at all.

The third research issue looks at **how trust in DSM automation can be increased**. Trust indicates a willingness to enter a state of vulnerability under the expectation that another party will behave in a way that will safeguard one's own interests (Mayer, Davis, & Schoorman, 1995) and serves the role of helping people to accommodate uncertainty and complexity in the context of automation (Lee & See, 2004). The communication of fairness and reciprocity is therefore central to trust building and includes consequences for all involved parties depending on the fulfilment of promises made, as well as careful consumer relationship management (Lewicki & Wiethoff, 2000; Fell et al, 2015). Tightly tied into fairness are clear benefits and accountability, as well as questions of purpose communication, transparency and control (again). Appropriate trust in automation is further dependent on training regarding the capabilities, mechanisms and management of a system.

Across these three sets of questions, the energy users are assumed to be more or less rational human actors for whom communication by aggregators and others can be tailored according to their constraints. In this stream of work, a 'social license' arises through suitable interactions sensitive to issues of practice, context and culture.

2.2 Energy Practices

A body of scholarship applying social practice theory to the analysis of energy consumption offers an alternative to the behavioural economic and psychological approaches that have dominated how people are understood and governed to use energy (Strengers 2012). Instead of 'the undersocialized methodological individualism of the behavioural models' (Hargreaves, 2011), this research takes practices as the object of analysis, arguing that 'we do not consume electricity as such, but rather perform practices through which electricity is consumed' and that energy demand needs to be understood not as a function of individual choice but of practices (Christensen et al 2013). It 'investigate[s] the detailed dynamics of the activities and interactions taking place in (situated) domestic and local settings, while not losing sight of the broader context of systems of energy provision' (Naus et al 2014). It examines how energy infrastructures are implicated in everyday practices and asks how these practices emerge, are reproduced, and change – including whether and how specific strategies of DSM are effective in changing them (Strengers 2010). Viewing energy use from a social practice perspective highlights three groups of elements affecting energy practices in a home – images, skills and stuff (Shove et al., 2012). Image elements includes social structures, such as norms, laws and regulations. Skills contain people's skills and knowledge. Finally, stuff is a group of material elements, such as infrastructure and automation technology. Households and homes may be regarded as the intersection of these three dimensions or groups of elements.

Despite the extensive body of research on energy use in buildings, the literature on the home as a social context of energy use is surprisingly scarce. By understanding the concept of a home we may also learn about the nuances and the differences in how people use electricity and energy (Gram-Hanssen and Darby, 2018). Through a literature review, Gram-Hansen and Darby explored the concept of a home in relation to smart home technology: a place for security and control; for activity; for relationships and continuity; and for identity and values. These aspects are used to reflect on research on smart homes and the researchers note that technical and forward-looking research focuses on safety, security, governance and activity, while more evaluative research more often addresses relationships, identity and values.

The success of many DSM initiatives – including those that involve some degree of automation, such as direct load control and the programming of smart appliances – depends on the willingness of householders to reconsider and reconfigure energy consumption practices to achieve the flexibility necessary for load shifting and shaving (Verkade and Hoeffken 2017). The practice theoretical literature observes that there is significant variation in the quantity and forms of energy use that people consider essential or negotiable (Hargreaves et al 2010; 2013) and has investigated **which factors enable and constrain load shifting and shaving in particular residential settings**. Some households, such as those with children, are found to be particularly inflexible (Nicholls and Strengers 2015). The imperative to shift loads can make uneven demands on different members of households, given that practices in the home are often shaped at least in part by gender roles (Hargreaves et al. 2010; Ehrnberger et al. 2013). Load shifting also may be less possible in poorer households because they cannot afford or do not have the time and know-how to operate the supporting technologies. There are therefore 'equity issues' – including the potential to exacerbate energy poverty – with the assumption that all households are equally able to time shift (Tirado Herrero et al 2018).

This body of research also asks **which energy practices are or are not amenable to load shifting and why**, and it has shown that some practices are more malleable and available to rearrangement and rescheduling than others (Powells et al 2014). Some practices are considered more essential or more time-dependent than others; e.g. entertainment, lighting and cooking – of the evening meal in particular – are considered to be less flexible than laundry, household chores and dishwashing (Powells et al 2014; Goulden et al 2014; Smale et al 2017). Many studies report that at least some of the householders participating in existing DSM programmes have experienced the changes to their household practices associated with load shifting as inconvenient and disruptive (Pallesen & Jenle 2018; Christensen & Friis, 2016), and therefore may be unwilling to engage in such programmes in the future.

In considering **what would have to change to make some of these practices amenable to load shifting**, this literature finds that there may be scope for automation to facilitate load shifting where users are reluctant to rearrange their practices and sacrifice any comfort or convenience (Goulden et al, 2014). Automation may make load shifting more acceptable to users by 'tak[ing] over some of the planning otherwise left to the householder' (Verkade & Hoeffken 2017); for example, an EV charging trial in Denmark found that householders preferred automated to manual charging management as 'manual plug-in practice was generally experienced as […] something extra to do and remember' (Friis & Christensen 2016). Direct load control of smart appliances may further minimise disruption by making load shifting 'invisible' (Cass & Shove, 2018; Higginson et al, 2014). What is clear from the studies conducted to date is that users accept automation only in specific conditions, however, so further research is required to understand the potential for automation in DSM to achieve flexibility on the part of the user by reconfiguring their energy practices.

Across these sets of questions, human actors are less visible and amenable to intervention than the interactionist paradigm. How and where bundles of practices arise is at once a micro- and macro-question for social science to address: changing work patterns under post-industrial culture, personalities, household configurations and institutional factors all contribute to practices. Here 'social license' arises through a careful attention to these bundles of components, patterns and habits that constitute practice.

2.3 Designing and aligning institutions

Automated DSM has attracted huge interest recently in increasing the operational flexibility of modern power systems. As one of the new ways to increase system stability and flexibility, automated DSM can bring significant financial benefits to both transmission and distribution system operators (TSOs and DSOs), governments and customers. In future power systems, where most of the conventional generators are retired and disconnected, and with the increasing non-synchronous generators, automated DSM will play a much more important role in providing ancillary services to system operators as well as maximising local resources (wind, PV) and decreasing capital costs, network losses and so on. This is mostly because compared with conventional generators, DSM has higher ramp-up and ramp-down rates and can be more easily controlled due to the relatively small size of distributed energy resources. Most popular for automated DSM are the DLC programmes which are among the top DSM programmes in the USA. This is mostly done by the aggregator/operator.

Within the context of economic focus, **we first ask what role various actors (DSOs, aggregators) see automated DSM playing in electricity reform**. To begin with DSOs, as the entity who owns the current infrastructure to enable automated DSM with ripple control and long-wave radio control, the DSO sees the role of automated DSM as a tool to avoid low voltage loss reduction by flattening the load curve and reduce procurement costs by performing peak load management (Gerard et al, 2018). Regarding the transmission level, the wider interest regarding the role of automated DSM revolves around investment deferral and savings in the high voltage network (Crossbow, 2017). For example, generally less interconnection of new loads or generation may be needed which would offer reliability by freeing existing transmission assets to provide power, hence reducing the capital cost of transmission as well as the transmission losses from bringing power from more distant plants. Aggregators, with their business models based on the flexible portfolio of their own users, see the role of automated DSM as offering a more reliable source of demand flexibility by providing greater certainty over the amount, timing, and location of demand flexibility than solely depending on the households end user behaviour (Bhattacharyya 2011; Ericson 2009; Newsham & Bowker 2010).

Secondly, several studies show that automated DSM can create significant value for both the energy market and the grid. However, close inspection of the evidence in these studies shows limited evidence of overall electricity system benefits from automated DSM. Due to modelling complexity, energy value and market value are rarely discussed together (Klaassen et al. 2016). In considering **how have key direct load control and other automation projects (mis)aligned with industry, household, supplier and other interests, several studies showed that there could be a conflict between several entities and market**. For example, Veldman & Verzijlbergh (2015) and (Dallinger & Wietschel 2012) showed that using flexibility in residential areas to profit from low energy prices can create higher peaks in local distribution grids leading to misalignment between DSOs’ and aggregators' interests.

Thirdly, it is important to discuss **how the current ownership structures influence the forms of engagement of the promoters of automation projects.** The literature indicates that the two main obstacles for applying automated DSM programmes to medium and low voltage users by several actors are the lack of automatic control (i.e., static ripple control which can be changed only manually) and delay in rollout of the smart metering system. For the moment, it is the DSOs which have the infrastructure for DLC which excludes aggregators and TSOs promoting DLC. However, communication platforms are being developed and these can be used by the aggregators for more automation projects (Pau et al, 2018).

Across these questions, this stream of investigation demonstrates both the importance of incentives and inertia of electricity systems themselves. TSOs and DSOs are, after all, incredibly technically complex and the organisations that run them are not simply market actors but nationally significant actors whose effective governance is pivotal to the running of contemporary economies. The concept of ‘social license’ for automated DSM perhaps fits most naturally in this stream because the literature takes its point of departure in the development of new resources for extraction (Boutellier & Thomsen, 2011). Thus, this stream highlights the challenges policy-makers face in designing new institutions, such as markets, where powerful actors such as TSOs and DSOs are seeking to create new dispatchable resources.

2.4 Socio-technical making of automation and load flexibility

Another area of social scientific research views energy as a ‘socio-technical system’ that encompasses not only the technological elements that are the focus of the dominant approaches to the design and study of the smart grid, but also the social, political, and other dimensions that these approaches have typically excluded. It suggests that this exclusive focus has the potential to impede the development of the smart grid (Verbong et al, 2013) and proposes that it is ‘only via adopting a wider socio-technical framework that one can appreciate the interdependencies between social, organisational, commercial, regulatory, financial, legal and political factors as well as technical ones’ (Balta-Ozkan et al, 2014). Investigating the ‘social construction of technology’, scholars of Science and Technology Studies (STS) conceptualise smart energy technologies as emerging, like other technologies, in a ‘process of co-production where pre-existing local actor constellations shape technological development and choice, and where the entry of new technologies and new concepts shape the very same actor-constellations’ (Skjolsvold & Ryghaug 2015: 888).

This scholarship undertakes critical analysis of the **expectations of load flexibility and automation in DSM that underpin current initiatives, including how they differ among the various actors involved in DSM, including energy users, electricity retailers, network operators, and regulators.** Scholars of STS have examined how these expectations reflect ‘sociotechnical imaginaries’, which are ‘collective visions of desirable and feasible futures (Ballo 2015). These are embedded in social organisation and practices as well as in technologies themselves, which are inscribed, ‘like a film script [… with] a framework of action together with the actors and the space in which they are supposed to act’ (Akrich, 1992). For example, ‘in most versions of a distributed energy future, customers will effectively be enlisted as co-managers of the system, even if they are not conscious of it’ (Darby and McKenna 2013). Divergent, even conflicting, expectations among the various actors involved may pose obstacles to the automation of DSM, as has been experienced already in cases where users have resisted the roles set out for them that do not match how they see their relationship to the grid and their energy use (Goulden et al 2014; Throndsen & Ryghaug 2015).

This makes it crucial that users accept the proposed shifts in the way that energy demand is managed, and there is now a growing acknowledgement that the key to the success of a DSM programme is not the technology alone but also user engagement. Research has found that participants in the research to date have questioned the interests served by DSM – expressing a suspicion that energy companies, acting in their own interests, are the primary or sole beneficiaries (Throndsen & Ryghaug 2015; Fell et al 2014), for example – and conversely that they tend to accept it when they perceive benefits to themselves, their communities, and the electricity grid as a shared infrastructure. This suggests that users may reject DSM when they do not understand or accept its necessity, the use of automation technologies to achieve it, or the role of particular actors in managing it: ‘they need to know and respect the reasoning behind it’ (Darby & Pisica 2013). Thus a question to be investigated is: **How does the framing of the rationale for automated DSM shape public receptiveness to it?** Related to this is the question of **how other aspects of the socio-technical context, such as national cultures, shape user receptiveness to automated DSM**, and STS scholarship offers a means to analyse the significance of the specificities of this social context in different jurisdictions.

In summary, the questions in this stream offer an important perspective cutting across the domains of both institutional design and practice theory by highlighting the multiple scales at which automation can be imagined and governed. A socio-technical perspective highlights the ways organisations become dependent not only on particular solutions or products, but specific problem framings too. This can occur through forms of socio-technical lock-in which preclude alternative ways of understanding new technologies and hamper social engagement or acceptance.

2.5 Governing Automation

To design governing automation processes it is important to distinguish between implicit and explicit demand-side flexibility. The first one, often referred to as “price-based” demand-side flexibility, concerns the customer’s reaction to price signals by adjusting their behaviour aimed at saving on energy expenses. Here an energy service company can offer different services to customers, such as insight services or energy optimization services based on time-of-use tariffs. The second one, referred to as ‘incentive driven’ demand side flexibility, concerns actions of an aggregator who can trade on the different energy market (day-ahead, intraday or balancing). The role of the aggregator is to accumulate flexibility offered by active demand and supply and to sell it to a balancing responsible party or a supplier, a DSO or to the TSO. The Universal Smart Energy Framework (USEF) Foundation introduced the term ‘Flex Requesting Party’ as a market party interested in using flexibility for a specific service (2019). As concluded by Expert Group 3 of the European Smart Grid Task Force it is clear that a well-defined framework has to be in place for implicit and explicit demand response to work together in an optimal way (EG3, 2019). However, before such a framework can be defined there is a need to quantify the amount of flexibility to be delivered. In principle flexibility cannot be measured directly, but a quantification of the flexibility offered and ultimately provided should be made clear to the parties involved through a measurement, validation and settlement (MV&S) framework, in order to avoid e.g. double counting. An interesting research question is **how the requirements for measurement, validation and settlement of flexibility are defined to make a transfer of energy possible.** To answer this question a benchmarking study can be done aimed at defining best practices for flexibility definition which are simple, accurate and transparent.

Next to this, it is often not clear how the new General Data Protection Regulation will influence the usage of smart metering data needed for demand response. As we can learn from the Dutch case of smart meter introduction in 2010, where a legal dilemma caused by a breach of article 8 – the right to respect of the private realm and family life – due to frequent reading of a meter led to the adjustment of the smart meter legislation, clarity regarding customer consent is needed (AlAbulkarim, 2011). We therefore propose to **investigate international practices regarding the use of smart meter data without customer consent**.

Another point we would like to address is the lack of requirements regarding smart customer assets as smart washing machines and smart dryers owned by private owners. If they are connected en masse to the electricity grid without taking into account power quality management and system stability, a sudden frequency drop can occur. Therefore **network**

codes should be adjusted and assessed to ensure that large scale introduction of DSM is properly addressed.

3 Conclusions

Developing effective automation of DSM requires careful attention to a myriad of factors across individual, community, organisational, electricity system and national levels. The ‘social license’ concept provides a useful starting point for discussion about the potential beneficiaries of new DSM programmes by provoking a set of assumptions we have critically interrogated in the four streams above. These each take their points of departure with different organisational sites, conceptions of the human actor and its relative power in its engagements with electricity systems. The concept of a ‘social license’ for DSM is intended to provoke a wider discussion about how post-industrial societies can transition to a low-carbon future by effectively enrolling citizens in the management of electricity systems. A social license is not simply a regulatory stamp of approval but is inexorably social in the ways we have discussed across the streams above: embedded in interactors governed by liberal norms of consent; embedded in practices; a function of effective institutional design; and a matter of socio-technical framing and assembly. Thus a ‘social license’ to automate DSM requires more than ‘correct’ pricing’ but that operators are sensitive to wider changes in society: how trust and risk are distributed in society, and how patterns of life are changing.

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