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Smart energy systems beyond the age of COVID-19: Towards a new order of monitoring, disciplining and sanctioning energy behavior?

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ABSTRACT

The Corona pandemic has led to the increased use of online tools throughout society, whether in business, education, or daily life. This shift to an online society has led social scientists to question the extent to which increased forms of control, surveillance and enforced conformity to ways of thinking, attitudes and behaviors can be promoted through online activities. This question arises overtly amidst a pandemic, but it also lurks behind the widespread diffusion of smart energy systems throughout the world and the increased use of smart meters in those systems. The extent to which forms of monitoring, disciplining and sanctioning of energy behavior and practices could come to reality is thus an important question to consider. This article does so using the ideas of Michel Foucault, together with research on smart energy systems and current trends in energy policy. The article closes with a discussion of energy democracy and democratic legitimacy in the context of possible effects of smart technologies on community energy systems.

1. The Corona crisis and its impact on the energy sector

The Corona pandemic has prompted social lockdowns throughout the world, and the rippling effects have implications for the future of smart energy systems. Smart devices have been discussed in the context of the energy transition for years, but they have not yet become established in private households, businesses, or the public sector. The so-called "smart city" remains a utopia [1,2], but the pandemic makes us ask whether the Corona crisis might change that. Covid-19 has pushed societies online, and the rapid expansion of digital tools for communication and organization could set a course for the future digitalization of energy systems and the widespread diffusion of smart energy technologies. But that prospect also calls for deeper thought about that smart energy future.

Smart energy systems existed before the pandemic, but Covid-19 has given a new impetus to digitalized work and life. Here we distinguish "digitize" – to convert information into digital format – from "digitalize" – to convert life and work processes to use digital technologies. The pandemic has driven education, business, and government to *digitalize* day-to-day operations, and in working with these new forms, people have learned new ways of living and interacting. New attitudes and values as well as behaviors and routines have developed, and these will not be discarded when the virus threat abates. These new attitudes and values could ease the way to a broader diffusion of smart energy systems, one that entails profound changes in all "ongoing social practices, innovations and sustainability transitions" [3].

We see three pandemic-related developments as promoting this broader smart energy system diffusion. First, a new awareness of digital tools and digitalized workflows has emerged among the public, and with it a restructuring of everyday life through digital technologies. Second, individuals and communities have learned about and tapped into these new digital tools, acquiring essential skills (aka. literacies) that will be necessary for the extensive use of smart energy technologies. Third, new smart tools have proliferated, notably in the context of smart homes, smart mobility, and smart energy.

Undoubtedly, many processes had been digitalized prior to the pandemic. But the essential question in the context of applied technology was and still is to what extent new technologies meet with acceptance. This depends on how compatible the innovations are with existing social, economic and technological conditions. In other words, new technologies must fit into everyday life. In that respect, the Corona pandemic has acted as a paradigm shifter. It has moved us from digitized information as the norm for documents and media to digitalized processes as the norm for life and work flows.

This shift provides further impetus to the smart energy transition in that, first, individuals have become more accepting of digital technologies by becoming more familiar with them and acquiring competencies in their use. Second, the tools themselves have developed in the areas

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mentioned above. Both developments fuel the trend toward a fully digital and electrified age [4]. However, in doing so, they increase the demand for electrical energy, putting new pressure on an industry already making a begrudging transition to sustainable sources. Yet the more we turn to electricity as the power source of preference in the future, the greater the urgency to move to sustainable electricity production. This further amplifies the call for smart energy systems.

While the smart technology to digitalize a wide-area energy system is not available to all countries, the greatest emitters are pursuing smart energy systems vigorously. In Europe, the European Union, through the Green New Deal and the Clean Energy Package of the EU Commission, seeks to completely convert the electricity production of its member states to renewable energies by the middle of the century and to achieve optimized energy efficiencies through smart systems deployment. The same push exists in the US, where an infrastructure modernization package is being negotiated that will deploy digitalized energy and mobility systems to bring smart energy, smart homes, and smart mobility together in the form of a digital ecosystem that supports diverse energy communities and interactions.

Such a digital future may seem utopian to some, but the pandemic has also shown us how divisive social issues have become. It is hardly news that the clash in Europe and the US between civil society and state restrictions has prompted angry protests. But even voluntary self-regulation to minimize the contagion – a practice directly in the interest of the individual – has met with strong resistance in some communities.

What these events imply for the future of the energy transition is not hard to extrapolate. They cast doubt on the viability of sustainability strategies based on the voluntary pursuit of efficiency and sufficiency practices, or on self-regulation internalized as socially desirable [5]. Other strategies, such as green nudging [6,7], that focus on intrinsic motivation, aim to change behavior through positive experiences such as self-efficacy or through collective benefits that have been internalized as personally relevant [8-10].

This focus on intrinsic motivation, however, becomes problematic when attempts are made to engineer it from the outside. For the pandemic has also made us ask after the logic of those who refuse to wear masks or get vaccinated – apparently dismissing the value of good health. But it would be one-sided to judge these individuals solely from that perspective. They can be seen as using a different calculus: namely, one where a greater value is gained from defying coercive state power than from accepting public health dictates. It would be naïve to believe these calculations do not affect, or will not affect in the future, the ongoing energy transition.

In this context, we find it worthwhile to consider the social implications of smart energy and the energy transition. To this end, we find insight in the theories of Michel Foucault about the relationship between power and knowledge. We are intrigued by how a self-controlling and self-disciplining energy regime might emerge, one that obviates overt state control yet still constrains individuals to act in certain ways through the influence of round-the-clock mutual observation. At its most benign, such an energy regime could underpin a sustainable future; but its influences are not necessarily benign, as considerations of the interplay of power and knowledge make clear. We first establish the groundwork for our approach, then discuss influences that we see shaping the future of smart energy in the post-pandemic period. We then put forward a systematic framework of social perspectives on smart energy system diffusion. This framework summarizes the different modes of power constellations on their multiple levels. Finally, we conclude with critical theses that need in-depth debate together with research directions for the future design of energy, Internet and privacy policies.

2. Introducing a Foucauldian perspective

In his book *Discipline and Punish: The Birth of the Prison (1977)*, Foucault outlines a state-imposed all-encompassing, totalitarian quarantine that takes the form of a decree to control the plague at the end of the 17th century; he cites this as an exemplary exercise of disciplinary power [11]. Today, the example reads like a blueprint for the quarantine measures of numerous governments in the Corona crisis. The strongly restrictive and even punitive measures to protect against the virus set the stage for the playing out of the power dynamics Foucault sees in society. We contend these dynamics, brought to light as it were in the pandemic, will also influence the future of smart energy.

Foucault saw the development of modern societies in the 18th and 19th centuries as essentially an expansion of disciplinary power, where its overt exercise by government agency commands public attention, but with increasing development of the social order, the rules become the individual's own and govern self-regulation and immediate choices in the local environment. The individual takes on the task of self-discipline, and overt disciplinary power becomes superfluous.

We can use this process framework to better understand both the pandemic and the energy transition. Three key ideas of Foucault prove useful. The first is that of *pastoral power*, so named to compare a guardian state to a shepherd watching over its flock [12]. To Foucault, power is not a noun, but a verb, an influence that exists throughout society. When exercised by the state, it takes two forms, the first being the disciplinary, or political, power embodied in governmental bodies and laws. These establish acceptable and unacceptable behaviors. But a second power, pastoral power ("governance of the soul") also exists that establishes acceptable and unacceptable thoughts and feelings [13]. This is the so-called winning of hearts and minds that is so critical to the energy transition.

The second key idea we take from Foucault is his adaptation of Jeremy Bentham's *panopticon* to serve as a metaphor for the control exercised through internalized surveillance and made possible through mutual observation [11]. Bentham (1791) developed the *pan-* (all) *opticon* (seeing) concept as an idea for prison design and management. It was designed to instill in inmates a feeling of always being watched, and with it the sense that any infraction of the rules would surely be punished.

The third key idea of Foucault is that of *technologies of the self* to describe the emerging processes of self-regulation and governance. Here, "technology" is used more in the sense of its Greek root, *tekhnē* "an art, a system or method of making or doing." It is the art of constructing the self undertaken by an individual to make a life. In a control sense, it refers to regulations conceived and applied by individuals themselves [14].

At first, one may wonder how these philosophical concepts are related to smart energy applications. It would be simple to consider the use of these apps to be no more than a lifestyle choice. But that would grossly underestimate what the emerging network of interconnected smart energy apps in fact represents. From a Foucauldian perspective there emerges a prime example of individualized-subjectivized bio-politics and the unfolding of micro-power structures [15].

Two complex synchronous movements are at work. The state exercises pastoral power by enacting formal energy policies, but in the shadow of this power, informal power relationships unfold between individuals who are digitally networked. State agencies serve as overt shepherds. Within the smart energy regime, however, the shepherd is now longer seen but hides completely within the flock; the shepherd's guidance emerges through the distributed actions of the regime's members. In Foucault's language, the transferred directives have become internalized.

Today has witnessed a step further in the process. When no explicit shepherd exists to give instructions, a power vacuum ensues. The vacuum is ideally filled by the "technologies of the self" [14], the third key idea from Foucault, where individuals exercise internal governance over themselves. From this perspective, these forms of central control and self-regulation are not contradictory; they can complement each other as the state withdraws its control and an independent individualized subregime takes over responsibilities.

This development will, however, create two effects. First, the individual will be subjected to more pressure than in the pastoral power regime, not only because of the shaming power behind the force to conform to the lifestyles of the other individuals in the system, but also because this influence has the omnipresence of a cellphone. Second, it will become increasingly difficult to create regulated structures for data protection and privacy, because the possibilities for protective intervention are limited. For instance, Internet service providers can only delete or to block persons, comments or activities, hardly an adequate solution. As Foucault emphasized, self governance does not mean withdrawal from the tasks of social governance and its power structures.

3. Foucault and the malaise of the energy transition

For years, climate change skepticism has challenged scientific knowledge, ignored effects on coastal communities around the world, and mocked the policies adopted and measurements taken to pursue climate protection goals [16–18]. These feverish denials of climate change find fuel for their fire in the dark musings of conspiracy theorists. These form driving ideas in discourse around gated communities and, above all, in virtual communities, forums and other digital exchanges. It is not hard to predict the reaction of conspiracy-minded individuals to the suggestion that we compromise a measure of data privacy to optimize energy efficiency in local- and wide-area energy networks.

When considering the interaction of individual agency and smart energy technologies from a Foucauldian perspective, questions of knowledge, power, and governmentality come to the fore. [19]. Foucault's concepts about knowledge and space, together with those about control and power [20], can be applied when we recognize knowledge as a basic prerequisite to understand, apply, and assess smart energy systems and applications concerning surrounding environments. Foucault, most importantly, sees knowledge as inseparably related to power [21]. Power is also, above all, constituted through spaces [22]. In our context, this means technological "spaces", and we note that a smart energy system is based on knowledge and has entry requirements in the form of knowledge. Hence, conditions exist for power relations to develop [23].

To Foucault, knowledge is a process that allows the subject to change while constituting an object [24]. He emphasizes the totality of elements (e.g., objects, types of formulations, concepts, theoretical decisions) formed in the field of unified discourse ("The Order of Things": see [25]). The key question becomes: How is something defined, i.e. how and by whom is definitional power exercised? The question addresses how objects, concepts, modalities of expression, and strategies are embedded in a technical institution, narrative, or practice [26]. The pandemic has reminded us how control of the narrative is a principal means for the exercise of power, and for the resistance to that exercise by counter-narratives.

The relationship between knowledge and the unfolding of power in discourse is to be understood as reciprocal: "There is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute at the same time, power relations." [27]. Discourse serves certain interests, which use established knowledge to generate norms of verification and coherence. A prime example is seen in the peer review process. Knowledgeable peers represent the dominant discourse in a field and allow certain voices to enter the conversation while excluding others [24]. Consequently, pressure develops to align with the dominant discourse, generally regarded as following the principles of good science.

However, a social analog of Newton's third law seems to prevail when the context is climate change or public health. Social actions intended to achieve one outcome provoke opposite reactions. The field of action in this case is society, and the forces are the influences that move people. Reactions take the form of counter-discourses that emerge against mainstream knowledge. This "revolt of knowledge" is not directed against content, methods or concepts, but against the power effects of a discourse considered to be singularly authoritative.

We can better understand these dynamics when we recognize with Foucault that knowledge societies are also control societies; they serve as producers of norming and standardization and use disciplinary technologies for this purpose. Foucault used the panopticon as his prime example of the constellation of power and knowledge [28]. Other examples include industrial, cultural and social agencies that define standards and norms. Their power to set standards is granted them by their standing in their respective knowledge society.

Foucault distinguishes five functions of a knowledge society [24], each of which can be found in the smart energy movement:

- First, computation and statistics: Mass data collection follows the calculus of mass distribution, oriented toward the ideal of averages, limits, and normal spectra. Example: Determination of average energy consumption through smart energy tools.

- Second, regulating power: Governmental power is exercised, following the logic of subjectification, so only a loose form of control is exercised, which has a subjectifying effect. Example: Motivating people to save energy through smart energy tools.

- Third, the idea of flexible normalization: This means flexible-normalistic phenomena shaped by the forms and effects of governmentality and self-care ("control of activity"). Example: Customizing individual activities and behavior based on feedback from smart energy tools.

- Fourth, statistical transparency: Control functions (both externally and internally) as a form of discipline. The goal is to achieve the normal spectrum toward maximum expansion and flexibilization of normalizing technologies. Example: Transparency through permanent real-time transfer and display of energy data and notifications through smart energy tools.

- Finally, fifth, a control function: A means bringing under control the interconnections between individuals, networks and processes. Example: recording data from smart energy tools, transmitting it to energy service providers who collect and analyze it, and modify the tools permanently, aka. mining "Big Data".

In reality, the functions of the knowledge and control society are contained in various strategies of normalization, which can be applied flexibly in every case. Foucault describes these strategies in terms of governmentality. Governmentality means different forms of action and fields of practice that aim at steering and directing individuals and collectives in various ways he calls the "microphysics of power" [24,29–31]. This includes a specific relation between power and subjectivity. This occurs, first, through the linking of techniques of governance with practices of the self (e.g., self-adjusting energy behavior) and, second, through forms of political governance linked to techniques of self-governance (e.g., activating self-motivation) [32].

By exercising both political and pastoral power, governmentality keeps the individual permanently monitored and supervised. This would seem to exclude individual freedom, but under liberalism the freedom of the individual is considered indispensable for governmentality [29]. But liberalism organizes the conditions under which individuals can be free. Above all, this follows a security principle, since it is always in question whether and to what extent the free pursuit of interests can be a danger to the general interest. Translated to smart energy regimes, this means: The tools promise users the freedom to control everything, but this reaches limits where non-rational behavior occurs, where it violates a norm (e.g., deviation from the average), or where the freedom of others (e.g., influencing others through critical questioning) is restricted.

4. Foucault and the smart city

Other researchers have also found relevance in Foucault's theories of control, surveillance and discipline to the context of digitalization and the establishment of new technologies [33,34]. In particular, surveillance studies and the idea of a post-panoptic society have become active topics [35,36]. The extent to which "technologies of normalization and self" [37] and a "management of knowledge" can be identified is debated [38].

Issues of surveillance and control play a more prominent role in the context of networked and integrated technologies in smart cities (based on big data analytics, Internet of Things, real-time processes) [39-41]. For where data are all-encompassing and permanently collected and "spatialized intelligence" is created through sensing, recognition services, artificial intelligence, and automated processing [42,43], there are "politics of urban data" at play [44]. Understanding these requires analyzing the complex processes and systems in the smart city unfolded, as described by the metaphor of an "unplugged" smart city in the literature [45-47]. Existing studies mostly include a critical understanding of these Big Data phenomena and surveillance trends usually very critical [48-51]. An important role is played by the question of what individual right citizens have in the smart city (as it conceptually follows a logic of 'citizen-focused' city) and what role equity, participation, and democratic principles play [52-56].

Smart city studies based on a Foucauldian perspective fundamentally assume "production of techno-centric rhetoric and narrative where urban and societal problems are rendered docile and amenable subjects to technology solutions" [57, p. 4378]. Three main theoretical starting points and concepts have been transferred and made fruitful for concrete analyses:

- First, a re-invention of the panopticon: smart technologies can generate surveillance according to this model, since no guardian, i.e., no controlling authority, is necessary to induce individuals to comply with rules or adapt their behavior; possible sanctioning is already actively anticipated [58].

- Second, an unfolding of pastoral power through a scripted design of public space, which is inscribed, for example, in the architecture of security; through this, individuals are led to adapted behaviors solely through the spatially digitized contextual conditions (e.g., via sensors, tracking, camera surveillance) without having to exercise direct guidance through controlling or sanctioning modes of action [59].

- Third, the unfolding of power dynamics inherent in governing through codes of behavior, based on the concept of automated and anticipatory governmentality and concerned with the central question of how "smart information technologies intervene in the governing of everyday life" [60, p. 869]. The internal logics and dynamics of smart energy systems can be investigated using the distinction made by Foucault between apparatuses of discipline and apparatuses of security by evaluating codes across three rubrics: referentiality, normativity, and spatiality.

Referentiality asks to what extent the code relates to referent objects. Relevant questions address how the governed reality is approached and conceived, how power relates to the uncertainty that is inherent in the governing of multiplicities. Normativity looks at the process by which norms emerge out of discipline and security concerns. Questions address the setting of norms and their influence in the society. Spatiality addresses questions related to the use of space in the exercise of power: "What forms of spatial organization do discipline and security produce, and, in turn, how does spatial organization mediate the exercise of power in the two models?" [60, p. 873].

At the center of interest of power-related social science research into smart energy are social control mechanisms related to the unfolding of governmentality in socio-technical environments such as digital platforms, which follow the trend of individuation. These are inscribed, for example, in any mobile energy application [61-67]. In particular, disciplinary strategies [68], oligoptic surveillance [69-71], anticipatory logics [72], decision-making methods [73], new regimes of spatial data [74], and profiles of users and non-users [75] are all found in practice.

Examples of concrete analytical starting points that have been taken include infrastructural control [76], aerial mobility (drones) [77], automating surveillance [78], platform urbanism (e.g., Airbnb) [79], algorithmic governance using the Internet of Things [80,81], or smart grids [82]. Almost without exception, these are critical data studies, problematizing data- and future-driven urban practices [83-85], from which strongly negative attitudes towards the smart city concept have also emerged [86,87], but suggestions as well for a broader interdisciplinary research agenda [88-90]. On the other hand, positive potentials [91] specifically regarding socially beneficial implications [92] and digital innovations for urban sustainability are also considered [46,93].

5. Smart energy systems and the upcoming energy revolution

The feeling of impotence in the face of dominant state power comes to the immediate fore when, for example, federal authority dictates wind turbines be installed in a community over local objections. This feeling plays a prominent role in the anti-Corona movements, possibly exacerbated by or transformed into fear of a surveillance society, one created not in the Orwellian sense of *1984*, but rather out of the 24/7 monitoring technologies increasingly embedded in modern society to measure, count, and track elements of state interest.

This phenomenon is abetted by the *sensoric revolution*, i.e. the proliferation of embedded sensors in millions upon millions of "smart" devices that together build out the *Internet of Things, Industry 4.0.* Combined with mobile applications, real-time processes, modern algorithms, robotics, autonomous systems, augmented or virtual reality, and artificial intelligence, there emerges ever more clearly the contours of a *Smart Machine Age* [94-97].

This dynamic is in part driven by the second energy revolution. The first focused on the replacement of fossil fuels with renewable sources; the second focuses on the digital transformation of energy systems and the rise of a modern digitalization regime [98,99]. Modern digitalization makes the energy practices of public entities more transparent and open to optimization. The same applies to one's own energy practices, the awareness of which can spur choices to support the climate and conserve energy [100]. Intelligent, smart energy applications can connect and synchronize various small-scale, decentralized energy generation, consumption and storage systems. With the help of applications developed for managing big data, the energy systems can be optimized for efficiency [101,102].

The newer trend of embedding diverse sensors in smart devices has created the possibility of comprehensively monitoring energy processes across sectors, giving rise to the idea of a "smart utopia" [1]. Modern smart energy applications can calculate exactly how much energy is currently being consumed, where savings potentials can be realized, or new sources of supply created, or connections made between devices that could contribute to greater efficiencies. The idea is that end-users can make smart energy choices with the aid of direct dynamic feedback [103-105].

In this way, the ideal of sustainability becomes normative and ascribes, at least implicitly, the principle of benefit and value to certain practices and ways of thinking. Those who save energy are seen to act in an exemplary manner oriented towards the common good; their commitment to sustainable practices signals their readiness to share in the socio-ecological responsibilities for the future. At the same time, unsustainable practices are overtly threatened with sanctions, offering ripe fodder for representatives of conservative and right-wing populist movements to use to stoke public resentment and anger, and so gain popularity and win votes.

Framed in Foucault's way of thinking, smart energy logic rests on a system of individualized-subjectivized disciplinary power that works like Bentham's panopticon. Round-the-clock energy transparency means constant mutual control; the central supervisory authority becomes superfluous, since the architecture of the system itself ensures that individuals constantly observe each other and adapt, normalize and sanction their behavior accordingly. The anticipation of possible consequences and reactions exercises a decisive influence on individual modes of action, which in this sense are "brought into line" as a mainstream forms itself without a recognizable leading figure, narrative, framing or ideal to drive it.

Certainly, smart energy systems can help curb rising energy costs by delivering savings through increased efficiencies, synchronization or cost-reduction incentive programs. However, these savings exact a privacy cost, namely they require access to personal data and information. This creates a fundamental dilemma between reducing energy costs and protecting personal data.

In the European Union, the decision was made in 2006 to introduce smart meter infrastructures. So far, however, implementation has proceeded at a snail's pace in the member states, making for weak diffusion of the technology [106-108]. Scandinavian countries are working to push the transformation to a digitalized energy system forward; indeed, starting in 2020, all newly installed electricity meters in Germany must be smart meters.

The smart meter may appear benign, but it can be used to influence energy consumption in novel ways. Consider the idea advanced of a new "energy community." Here, energy infrastructures with embedded digital applications are connected to, for example, electric vehicles and other electric appliances; these are all networked in the neighborhood with usage statistics updated in real time and shared across a wide-area national or international network of applications. In this picture of a new "energy community," members exchange individual profiles, practices, and activities, just as they do in communities built around leisure activities. A social energy network then arises, forming in effect the online network of a smart city, but one in which control is effected through round-the-clock engagement in monitoring, comparison, and evaluation [66].

6. Cultural differences: lessons learned from frontrunner countries

Cultural differences play a certain role in smart energy behaviors, particularly in the digitalization of life and work routines. We might then look at practices in Scandinavian countries, where a high degree of daily life has been digitalized with a corresponding increase in usage transparency, to forecast the future of smart energy systems. A systematic review of access to big data in energy systems in Scandinavian cultures has identified various practices of surveillance capitalism, with some examining privacy protection, but "only few examine the fundamental ethical questions that discuss how big data practices may change societies and increase their vulnerability.“ [111, p.1] Overall, it is assumed that "even in highly trusting societies, like the ones found in Scandinavian countries, trust can be undermined and weakened" [109].

Norway is considered a vanguard country in implementing smart energy technologies. Yet among smart energy prosumers in Norway, serious divergences have been found between imagined and real experiences, such that ultimately more work is created for participants [110]. The future imaginaries of smart meters and grids are conceived of almost exclusively in closed networks of actors in Norway; in contrast, in Germany, cooperation and commitment across actor groups and sectors are assumed [111]. Even there, though, these relationships are thought of solely in technological and economic terms; thinking lacks the openness toward and the inclusion of multiple perspectives and ways of knowing [112]. In Norway, markedly different ways of dealing with smart technology (aka. "situated technology") are found; the focus there is on "greening", grid optimization, and user flexibility. Nonetheless, even in this green-friendly culture, organizational and disciplinary conflicts have lead prosumers to recoil from the smart energy concept [113].

In Finland, researchers have demonstrated an even weaker diffusion of smart energy, one that should be understood less as lagging adoption and more as active resistance arising out of disinterest, disenchantment, and displacement, with disinterest and disenchantment predominating [114].

In Denmark, the Danish National Smart Grid Strategy imagines a "flexible electricity consumer," who makes green-friendly decisions out of a techno-centric understanding. Yet the Smart Grid Network has met with criticism [115]. During a smart grid trial, negotiations between the residents and those responsible for the project went awry as users and project owners were unable to reconcile questions of control [116]. The smart systems, in their algorithmically-driven operations, tend to induce a passive consumer attitude and to discourage active prosumer behavior. Participants lose interest in delivering energy to the system, which undermines the ideals of smart energy systems.

These difficulties have led to more flexible tools being proposed [117]; but then the scope and complexity of infrastructure becomes more and more confusing [118]. Plans to define technological qualities and purposes meet with skepticism from lead actors [119]. In the Netherlands, for example, it was found that only project leaders actively pursue project goals [120]. Where new forms of cooperation between households (horizontal) and between households and service providers (vertical) are emerging, and decentralized system in particular are promoting householder participation, issues of autonomy and concerns about privacy still tend to impede participation [121]. It is also claimed that if householder engagement with sustainability goals are not safeguarded from flexibility instruments, engagement will derive solely from financial benefits [122]. However, it is still unclear how energy communities can benefit from smart energy solutions; there is no 'fit and transform' strategy that is also geared towards the long term [123].

Thus if we compare the experiences with smart energy systems across the Scandinavian countries, the Netherlands, and Germany [124], we can draw two conclusions. First, just introducing smart energy technologies, no matter the state power behind it, does not mean they will meet with acceptance and adoption by the population. Second, and behind the first, the technologies are not well adapted to the diverse needs of specific communities.

7. Smart energy systems in households: techno-economic benefits vs. negative attitudes

Smart energy systems are predominantly considered from a techno-economic perspective, one that highlights the many benefits for individuals but often overlooks social aspects and human values [125]. In private households, smart energy devices are selected not only for the energy savings, efficient energy management, and consequent financial benefits. They are also chosen for other reasons, such as comfort, healthcare, individual control, security, safety, and quality of life [126]. Comfort and convenience count more positively than do risks negatively. Factors that most strongly influence acceptance of the technologies in a household include age, openness to experience, a positive attitude toward smart homes, and the perceived benefits of demand flexibility [127].

When we examine how attitudes develop from knowledge through persuasion and finally to decision-making, acceptance again depends heavily on individual starting conditions; broadly speaking, knowledge drives persuasion and adoption [128]. But attitudes differ depending on whether the context is the workplace, a policy abstraction, or the home. In residential contexts, people are more conservative and show less impulsivity and shared responsibility [129]. People mistrust the pre-set schedules of the technologies and find it difficult to understand the broader objectives [130]. Deeply rooted objections – I cannot live without air conditioning! – as well as personal values, identity percepts, and situational factors all impact acceptance [131].

Advocates of smart energy systems in private households claim they collect "occupants' preferences and using those preferences deliver improved occupant comfort, lower operating costs, reduced environmental impact, and more significant demand response" [132]. However, economic incentives influence the energy-consuming practices of households much less than this line of thinking anticipates [133]. The systems offer flexibility options, but the householders' capability of being flexible is unevenly distributed [134], which is ignored by systems and providers. Rather, the social acceptance of smart meters is mainly driven by social psychological factors such as familiarity and climate change risk perception as well as social structural conditions (age and income) [135].

Acceptance of eco-friendly smart home services has been found to depend on attitude, perceived behavioral control, data disclosure, environmental consciousness, and compatibility. Perceived risk is the main barrier, while subjective norms do not play a decisive role [136]. It has also been found that perceived technology attributes, especially usefulness and risk to privacy, have direct effects on support for smart meters [137]. The factor with the highest explanatory power for adoption is perceived behavioral control [138]; that is, access to control features has the greatest influence on energy-saving behaviors [139]. Previous individual experiences also play a role, in particular people's perceptions and experiences with privacy violations [140]. However, the resource-saving use of the technologies is less dependent on them but is primarily influenced by strong environmental attitudes, and pro-environmental behaviors are based on social needs, social capital, social norms, and environmental concern [141].

The effects of feedback on consumption behavior and behavioral change are therefore limited [142]. Attempts have been made to respond to this through data visualization, better recommendation systems, micro-moment behavior observers [143], energy control systems [144] or more user-friendly technologies [145]. A "structural winningness" to save money without changing energy-use behaviors has been named [146] to counter heterogeneity in households. The main reasons for technology rejection include "distrust and resistance, limited perception of smart home, concerns of financial issues, privacy and security concerns, technology anxiety and negative social influences "[126].

In some cases, education can influence energy behavior [147]. There are learning effects, for example on environmental issues [148,149], but "knowledge of and exposure to smart meters does not necessarily lead to acceptance; knowledge, and exposure, is associated with increased concerns about negative impacts of these technologies "[150]. Many people surveyed were largely disinterested and voiced a considerable lack of trust in energy companies [151]. It must therefore be recognized in principle that "a smart user who is actively engaged with energy is critical of much of what is proposed by demand side management" [152].

Finally, even smart systems can lead to household conflicts (parents vs. children, hosts vs. guests, roommates vs. each other, landlords vs. tenants, and couples vs. each other), whereby the parties differ in their energy desires [153]. The well-known substitute phenomenon of social conflicts can arise in the event of conflicts, as "preferences become a proxy for something else, and emit strong feelings about how household members view another person as lazy, careless or wasteful" [154]. Furthermore, it has been proven that these systems are capable of "enrolling people into new techniques of surveillance, new forms of automation and new markets of data" [155].

In summary, privacy, social norms, and attitudes towards technology (e.g., discomfort or excitement) explain attitudes towards smart energy technology [152]. In principle, the assumptions of the value-belief-norm theory and the value-identity-personal norm model can explain behavior [156]. Typical motivations to adopt sustainable innovations are effective here [157], whereby in addition to instrumental attributes (evaluations of the utility) and environmental attributes, symbolic attributes [158] play a prominent role: "people are more likely to adopt a sustainable innovation the more they evaluate the attributes of these sustainable innovations favorably and the more they think significant others would consider adoption" [154].

8. Gender roles, age and smart energy neighborhoods

Other factors strongly influence attitudes and behaviors toward smart energy systems, the first of these being the crucial role of gender [159]. Gendered dynamics in smart home technology preferences in the United Kingdom were investigated, and strongly differing gendered perceptions were found. These relate not only to attitudes towards technology [160] but to knowledge and awareness. Differences prevail regarding attitudes to sustainability, trust, risk tolerance, and comfort [161]. Differences in perception regarding novel benefits are also present, but gendered models are not considered by technology so far [162].

Alone the systems are gendered because women and men have different economic, social, and cultural capital, which is why it is important policies "be designed to promote new practices that are attractive for a more diverse group a more sustainable and equitable low-carbon energy system" [163, p.1]. This is also emphasized elsewhere by considering diverse roles for people in smart energy systems, "some wishing to be guided, while others wanted to think for themselves", from which three purposes follow: "give information, enable control, and change the preconditions for energy use" [164, p.1].

Finally, the potential for gender economic inclusion, especially in the global south [165], is also to be considered, as this increasingly plays a role in smart farming, for example [166]. Questions of discrimination also play a non-negligible role in connection with data privacy; for example, if the exclusion is the consequence [167]. In the United States, it has been shown that households of color experience energy insecurity at higher rates than white households [168].

Second, the age of participants should not be neglected. Because young generations grow up with social media, they exhibit other routines and norms regarding a digital society ("digital natives") [169,170]. This factor has been little researched so far. First, the literature suggests that there is a difference in how smart home risks are assessed: old adults versus youth (age), wealthy versus poor (income), and homeowners versus those in social housing (tenancy) [171]. Low-income groups are more likely to see the technologies as a luxury and disruption of daily routines, younger ones are also more likely to see them as a disruption of daily routines and making household members lazy [171]. At the same time, older people suspect that an increased dependency on outside experts arises and results in a lack of control [171]. However, there is no difference between younger and older people in the assessment of smart home risks; they are perceived as equally empowering, but for older people, there may be a greater interest especially related to monitoring health issues [174, p.15].

The biggest differences are found between homeowners and those in social housing. In particular, homeowners suspect much more strongly that an increased dependency on outside experts will result in a lack of control; moreover, they suspect that the technologies reveal sensitive data [171]. These differences are easily explained by the fact that homeowners feel much more in charge of the technologies.

Surprisingly, younger individuals do not seem to rate technologies as particularly positive, but rather critically. Another study from rural Scotland found that the elderly population differs from the majority since they have lower incomes and face the risk of fuel poverty. Accordingly, their willingness and capacity to change time-use behaviors and reduce consumption is comparatively not as high [172]. To better unite generations and strengthen the sense of community, the concept of smart energy neighborhoods has been developed in terms of local energy system sharing, where the "same local energy infrastructure" is shared, a "network of social relationships and group-focused concerns" is built, and "smart adaptive mechanisms enabling participation, coordination and cooperation" are deployed [173]. Through smart neighborhood management, the social capital of residents is increased [174].

This corresponds to the community model of smart energy communities, which are also intended to serve the harnessing of social relationships by connecting people living in the same community to improve cooperation towards shared objectives [175]. However, this has not yet been translated into practice, as community energy approaches are still underdeveloped in this respect, and the chances for such a development are not currently good.

9. Community energy and the hope for smart communities of the future

For some time now, hopes for a more participatory, fair, and democratic transformation have been pinned on community energy systems and their enabling role in the so-called *just transition* [176-178]. The European Union strongly promotes community energy approaches and has created a passage in the new version of the renewable energy directive that is intended to provide financial support for this operating model. In particular, support is to be given to people who have fewer resources and who suffer from high electricity costs in some parts of Europe.

The idea behind smart energy systems is to tap into the digital dynamic. Yet even with smart meters, it will probably not be possible to make one's individual energy profile public and share it. But that is precisely the end envisioned by collaborative approaches that use co-produced, shared and collective energy operating systems and infrastructures. These approaches, as evident with smart mobility systems, drive publication of energy data and thus adaptation to the norm. So, with a view to climate protection, these collective dynamics seem to pursue desirable ends, but from the perspective of the protection of privacy, personal rights and the self-determined individual, the means appear questionable.

The essential objective of smart energy architectures is to shape energy norms, but this is only possible if there is a deeper change in individual attitudes, value systems and behaviors, because "energy consumption is shaped in and by social communities, which construct consciousness of the energy implications of lifestyle choices" [179]. It is precisely in respect of these "social communities" that a core dilemma arises when the changes in lifestyles and behaviors for a secure energy future can seemingly only be achieved through state intervention or direct impositions on personal privacy and autonomy.

The ideals motivating the community energy approach could be better realized and implemented more precisely through technical and social modes of exchange, wide-ranging portfolios and forms of utilization beyond simply the operation of a renewable energy plant. This way, reciprocal exchange relationships that yield greater benefits for the entire community could be activated [180]. Hopes lie in the idea of networked virtual power plants [181] and community energy storage [182-184]. Game-theoretic approaches suggest balancing could be attained through such networks [185].

Smart Energy Communities would be part of larger smart city networks [186,187]. The logic of a complete transformation to renewable energies implies that in the end, only integrative solutions that include all sectors and all parts of the population can be successful. In order to move from individual smart energy communities to smart energy municipalities and further to nationwide or even broader systems, some form of comprehensive control is required, since it is the only way "to satisfy all energy requirements" [188]. This gives rise to the classical "centrality dilemma," as for logical reasons of efficiency all competencies would come under one controlling umbrella, yet such centralization would at the same time create extreme dependencies and an enormous potential for abuse of control and power.

Furthermore, it remains an open and decisive question as to whether smart technologies in the smart city would tend to promote or dissolve the sense of community, as technologies would lead to less physical contact and exchange and thus could split communities rather than bringing individuals together [189]. There is certainly untapped potential for wider diffusion of community energy and for people to find benefit in it [190,191], and the same holds in relation to smart energy products [192].

However, it cannot be assumed that all people will be equally willing to accept smart energy technologies [193]. Vulnerable consumers in particular are likely to react critically or even reject the use of these technologies [194]. Results from a representative UK survey show that trust in the organizations delivering smart energy applications is low, as is willingness to share location data with an energy utility, as the vast majority sense they would have no control over how such data would be used [195].

While these cybersecurity concerns may influence individual willingness to connect energy data to a broader network, they hardly restrict the willingness to participate in smart energy systems [196]. Rather, comparative studies have shown that the smart home applications rely on techno-centric approaches, and the design and construction of the tools is not user-friendly, with a noticeable absence of holistic approaches or applied principles of human–computer interaction (HCI) as found in participatory and collaborative, open-data-based design approaches [197]. In addition, gender considerations matter in smart energy home solutions, as gender disparities are still the predominant realities of domestic labor [198]. If in the future, feminized AI assistants orchestrate IoT appliances to create comfort and capture value, Johnson [198] states that "women unable to afford a surrogate AI wife may find themselves becoming a 'flexibility woman' or otherwise excluded from accessing the cheaper, greener electricity of the future."

Apart from network approaches, the greatest expectations are closely linked with machine learning effects that could be achieved, for example, with the help of artificial intelligence in smart energy community management [199] and the use of blockchain technologies [200,201]. However, the expanded need for individual use of technology interfaces amplifies the role played by personalized competencies, engagement, and devices, which means that lower competency levels could adversely affect the individual benefits of technology outputs [202].

Contrary to the assumption that all people are ruled by the system defaults in smart energy environments, which then exert a paralyzing effect on innovative capacities, competitive energy trading models are being tested in neighborhood area networks [203] and individual smart applications already account for various roles for people and their uncertain behaviors [204,205].

However, a smart energy world is still a dream of the future, and it remains difficult to estimate what will prevail and what effects will be generated. A leap from separated individual communities to smart energy municipalities is being considered [188], but not all the prerequisites for the implementation of smart districts have been met to date [206] and the necessary smart grid is not yet available – apart from pilot projects [207].

Thus, there is still an immense gap between vision and practice [208]. Common business models, which are widely used, are still not combined with smart energy systems [209]. Milchram [210] already point out a basic problem, namely that smart grid systems do not necessarily lead to more energy justice: On the one hand, they allow for transparent and reliable billing through small-scale electricity generation; on the other hand, they generate conflicts of privacy and cyber security risks that encroach upon users' sense of well-being.

10. Discussion: smart advantages vs. self-monitoring drawbacks

We have seen how the diffusion of smart energy systems will make individual attitude and behavioral changes even more significant. The behavioral change process embedded in the smart energy transition rests on mutual observation and monitoring, so individual pressures to adapt will grow and mechanisms of control, discipline and power will come into effect. As a consequence, personal choices will gain visibility, since smart energy systems make individual behavior, practices and lifestyles public. Hence, individualization and subjectivation will play increasingly important roles in the future energy regime, evidence of which we can already see in today's orchestrated sustainable lifestyles. Conceivably, there may emerge new smart energy communities, sustainable energy networks, in which membership entails individual behavior being subject to greater collective or systemic control than that found outside the community.

The question now arises, if the traditional control system of pastoral power transforms more and more into the mutually controlling technologies of self in a complex system of panopticons, self-monitoring smart energy systems, does a new "AI power" emerge? Will the pastor become a bot?

Let us recognize it is not artificial intelligence that is assuming power, as is often believed. Rather, in the spirit of Foucault, we see the manifest, visible and concrete power relations dissolving into the fluid dynamics of interpersonal digital interactions. There will still be a field of power, but it has become both more widespread and less tangible with the entry of smart devices into every area of life. In former days, it was possible to go off the grid, to separate from a central power system. This will hardly be possible in an energy future where everything is networked and digitally connected.

Does this mean the individual will have lost control and that not even the state will be able to serve as guardian? To a certain extent, this is probably the case, but individuals remain the gatekeepers and can shape the systems and manage them to desired outcomes. As an example: Digitalization could create new opportunities for disadvantaged rural areas, as distances are bridged and new collaborative forms of living and working arise. Smart community energy systems could foster a spirit of community and create resources to mobilize engagement.

Let us recognize that policies in liberal democracies have not succeeded in creating a balance between the economic value of data and the democratic value of privacy. The balance is especially pertinent in the deployment of intuitive, individually adaptable digital applications. While smart energy systems offer great advantages in terms of energy-efficient climate protection, the danger of invisible control not only by suppliers, but also by collective mutual observation cannot be ignored. Thus, in addition to the proactive design of smart systems, higher-state-level regulation is still required in the end, and so the role of the pastor seems to remain indispensable.

What has changed during the COVID-19 pandemic? While it energy use and home energy management did not change much, technology anxiety, cybersecurity, and trust in utilities showed fewer negative influences on behaviors [211]. However, the phenomenon of "smart" quarantine has also been observed, which may lead to increased use of and receptiveness to smart technologies through the upgrading of housing [212,213]. More and more activities from home play a role, which includes engagement and volunteering [214]. Thus, the notion of home as a "private space, and digital technology and surveillance in the home" [215] is gaining scope, especially in its implications for privacy [216].

The smart and at the same time monitored home ("brave new home" of [217]) is thus no longer an utopian dream [218], as numerous indications of misuse exist such as Pegasus spyware [219]. However, development should not be thought of in linear terms because users evolve practices and strategies that either render surveillance pointless or render desired adjustments to behaviors futile. The systems are treated as a game to be played, and the desired practice is simply simulated to beat the monitoring system is at its own game. We see this expressing the spirit of counter-movements to intended social effects as described by Foucault.

The initial smart strategies focusing on energy feedback, dynamic pricing, home automation, and micro-generation [1] are now poised to become more comprehensive and holistic due to artificial intelligence, the Internet of Things, and automation. This will drive the price of privacy control higher and higher, as more surveillance and novel panopticon systems are deployed, for example in connection with vehicle automation [220-224].

The first core problem here is that the systems develop nested logics [225] and energy policy cannot respond to this directly because it is entangled in the model developments themselves [226]. The technical systems lead to new object-oriented materialism [227] due to their penetration of all areas of life. Because these systems grow further and further beyond 'local' contexts, because stakeholders frame projects around non-local goals, a pragmatism is emerging through which 'local' boundaries are drawn creatively to align with project objectives [228].

A second problem lies in the contradiction between complexity and simplicity. Services are marketed as a way to simplify and enhance everyday life, but in practice, they lead to complication and overload [229], while doing little to improve resource efficiency or waste reduction [230]. This is significant because energy access is increasingly a foundation of pandemic-resilient livelihoods [231].

This leads to the third problem in implementing smart energy technologies if they are understood as contributing to climate change mitigation and faster decarbonization [232-234]. However, few ideas exist for how the serious problems of smart energy technologies might be addressed, such as a roadmap for the moral programming of smart technology [235]. As Véliz and Grunewald [236] noted, protecting data privacy is key to a smart energy future; innovation is, therefore, all the more urgently needed during the Covid-19 [237]. Complete transparency [238] must be effectively avoided, on the one hand, if for instance privacy is understood as an aggregate public good [239]; on the other hand, trust must be built [240-242].

The fourth and final problem introduced by the future aspirations for smart energy deployment concerns energy justice. Concerns about energy poverty will become increasingly important in the post-COVID world as further technological innovations are introduced [177,243].

11. A framework introducing social questions of power in smart energy systems

Although smart energy technologies have been the subject of various studies, including those that probe the social effects of digitalization, there is as yet no comprehensive perspective from which the social dimensions of smart energy diffusion can be differentiated. We offer here a framework that can serve as such a perspective. It recognizes three interrelated levels – micro, meso and macro – each of which embeds four dimensions of smart energy diffusion. From left to right in Table 1, we see at each level in the first column the widespread smart technologies; in the second, the various modes of acting, behavior, interaction, and power interplay between individuals, communities, providers, and technologies; in the third column, the types of power constellations, system-power logics, drivers and motivations related to individuals, communities, and actors themselves and between them; and finally, in the last column, example approaches for community solutions.

The micro level represents the perspective of the individual. Smart technologies include the entire range of smart energy/home/mobility solutions, such as apps, smart meters, or smart storage devices. The modes of acting, behavior, interaction and power interplay associated with the technologies can be characterized primarily as mutual surveillance and monitoring, self-disciplining, and anticipation of behavior. To this is added conformity, since permanent comparisons of values can be made, which can be competitive ("challenge") and generally tend to make deviating from the norm more difficult. Behavior is under observation (systemic or caused by other users), generating overarching conformity in user behavior and attitudes from the emerging pressure to adapt.

Major forms of interaction with the technical systems arise from the three basic forms of smart energy, i.e. energy feedback, home automation, and micro-generation applications, which can be given by textual input, haptic, audio-based, or visual, with options constantly expanding through the Internet of the Things, artificial intelligence and sensor systems. Derived from this, the dominant type of power constellations is characterized as self-regulation in the sense of technologies of the self, i.e., an individualized-subjectivized form of disciplinary power. As essential formative system-power logics, drivers, and motivations, data comparison, resulting mechanisms of self-efficiency and self-optimization, effects of incentives via benefits (e.g. financial, credits, savings), affordances of the technologies (e.g. simplicity, intuitive handling, usefulness), and the effects of meta values (e.g. climate protection, economizing, pioneering) can be described. Finally, community

Table 1
Smart Energy Systems and Social Aspects on Micro, Meso and Macro Level.

Level	Smart Technologies	Modes of Acting, Behavior, Interaction, Power Interplay	Types of Power Constellations	System-Power Logics, Drivers, Motivations	Community Solutions
Micro	Smart-Energy/Home/Mobility-Technologies, e.g. Apps, Smart Meter, Smart Storage	Mutual surveillance and monitoring, self-disciplining, anticipation of behavior, conformity Interaction: energy feedback, home automation, micro-generation applications	Technologies of the self (self-regulation): individualized-subjectivized disciplinary power	Data Comparison Self-efficiency, Self-optimization Incentives via Benefits IT Affordances Meta Values	Smart Micro Networks, Social Apps/Media, Crowd Solutions
Meso	Smart District Management, Smart Micro Grids, Urban or Rural Smart Mobility Systems	Specific System Monitoring and Control Interaction: Feedback Micro Level, System Adaptions, Optimization, Feedback Control, Customer Care	Self Governance,Logics of Coordination und Configuration, Internal iterated and volatile IT-processes	Connectivity, Availability, DevelopmentSector Coupling Efficiency, Optimization User Acceptance Complexity Reduction Technological path dependencies	Community Energy Systems: Smart Energy Neighborhoods, Community Grids, Community Mobility Systems
Macro	Key System Control of Energy, Mobility and Living Devices by Federal State Administration or E-Commerce-/IT-Companies or Energy Providers	Creation of System Design (based on big data analysis) Interaction: Feedback Micro/Meso Level, Reception of Information, Adaption System Design, Top-down Rule-making Overall System Monitoring and Control	Pastoral Power, Central Control, Incentive Regimes, Harnessing User Control Logic and Affordances	Standardization, Rationalization System Efficiency, System Effectiveness Efforts, Rebound Effects Costs, Benefits Technological path dependencies	Hybrid Joint Venture Project Solutions (collaboration of private companies, public enterprises, civil society associations)

solutions can be found on this level, for example, smart micro-networks (e.g. multiple party systems), social apps or media as well as various crowd solutions.

The second, meso, level captures the perspective of urban or regional districts, where energy systems in the form of smart district energy management, smart micro-grids, or mobility systems are operated and organized in medium-sized spatial units such as villages, small towns, or urban districts or neighborhoods. Here, the modes of acting, behavior, interaction, and power interplay consist of a specific system monitoring and control (of the associated system such as smart grid, building, and facility energy or storage management systems or e-mobility services) and interaction via feedback from the micro-level (the user) and, based on this, system adaptations, (system) optimization, feedback control and customer care.

These modes give rise to types of power constellations where self-governance occurs in the sense of immediate self-adaptation of the systems (often in real-time) based on the logic of coordination and configuration and internally iterated through dynamic IT processes. Essential system-power logics, drivers, and motivations consist of the required connectivity and availability of the systems and a cross-system development of sector coupling (connection of energy production and distribution, heating, mobility, etc.) as well as the typical guiding principles of efficiency, optimization, user acceptance, complexity reduction, and the system-inherent technological path dependencies. Examples of community solutions include all forms of community energy systems (energy production, distribution, heating, etc.) like smart energy neighborhoods, community grids, or community mobility systems.

Finally the third, macro, level represents the control of energy, mobility, and living devices by the combined actions of federal and state regulatory bodies, public and private energy companies, e-commerce businesses, IT firms, network operators and energy companies. The predominant modes of acting, behavior, interaction, and power interplay at this level are the creation and definition of system designs (typically based on big data analysis), which inevitably leads to specifications for the lower levels, which are obliged to follow.

The interaction with other levels is characterized by feedback from the micro and meso levels being combined with the reception, collection, and evaluation of related data, from which an adaptive system response follows. Top-down rule-making and overall system monitoring and control also exist, since the institutions exercise complete authority over the systems and infrastructures. As types of power constellations, this results in pastoral power, the exercise of central control, and the establishment of incentive regimes, where user control logic and affordances are harnessed to achieve the desired goals of the companies or the systems, such as stability, maximization, expansion, or profit generation. The corresponding system power logics, drivers, and motivations are system efficiency and system effectiveness as well as possible efforts and rebound effects, costs and benefits, and again technological path dependencies of the systems. Community solutions can also be found at this level, for example in hybrid joint venture project solutions, i.e. the collaboration of private companies, public enterprises, and civil society associations.

12. Conclusion: In search of the rare chameleon

Some decisive questions regarding privacy and the benefits of technological approaches to the energy transition must be addressed more strongly in public dialog. This holds especially true for core questions raised by smart energy systems. While the energy efficiencies such systems can deliver are promising, the systems introduce vulnerabilities into society that can then easily be exploited. One need only think of social networks and the political and social chaos wrought by their misuse.

Smart energy systems promise efficiency advantages delivered by usage transparency and comprehensive control over energy flows. These come at the cost of the potential for data abuse, manipulation and the formation of monopolistic cartels. Providers can argue that they are increasing the degree of freedom, control and self-determination in people's lives. Yet, we should not ignore the other side of the smart energy system coin, the dark side that casts an oppressive shadow on those very same democratic ideals.

The approaches of co-design between citizens, stakeholders and users, e.g. to develop interface design proposals [244], can certainly be seen as positive starting points to develop bottom-up solutions that are more friendly to citizens and users. But there remains the crucial question of who is participating. From research on political and social participation, we know that it is usually the more affluent and privileged who are engaged in the energy transition [245].

In the sense of just transitions and energy democracy, the only way out of this situation is to implement more inclusive decision-making processes [246]. If all sections of the population not are engaged, the widespread implementation of smart energy systems will worsen existing inequalities, increase resistance, breed mistrust, and spawn more social movements based on science denial and conspiracy theories.

Widespread engagement, however, requires as a first step that policies be subjected to more argumentation and dispute. Smart energy policies should not be dictated by committee from the top down. To be effective, they have to leave room for negotiation and discourse with individuals and communities not included in formal policy making [247]. If the interests, preferences, emotions, and concerns of these individuals and communities remain subordinated, or even ignored, in the policy process, then defiant reactions against the state will likely follow [248]. Citizen perspectives need to be incorporated more strongly into legislative and executive processes through enhanced participation channels, such as citizens' councils.

Evaluating and assessing the diverse trade-offs, contradictions and washback effects of smart energy systems calls for more innovative models of action, and this calls for research that can provide starting points for better coordinated and adapted networks and integrated systems. But just as critical is a soft, user-centered approach to the design of technologies to be integrated into human society and daily life [249]. The future of a world of prosperous smart cities and energy systems should not be left to chance, and while groundbreaking and pioneering solutions may be lacking, innovative digital solutions based on the creative commons approach show great promise when access points of the energy providers are opened to the public.

We see in this new challenges emerging for post-pandemic energy social research [197,250]. Ways of re-imagining surveillance power [251] and gender aspects [252,253] have begun to be explored. To explore social aspects of smart energy in more detail, energy social research may rely on established approaches and methods such as social actor discourse analysis [254], focus groups [255], role play [256], ethnography [257], or situational analysis [258]. That said, recognize that serious methodological challenges arise in studying energy companies, those that play a central role in the smart energy regime [259]. Certainly, transdisciplinary approaches are necessary [260,261]; there will also need to be more emphasis on social psychological approaches to exploring emotions and norms [262]. In any case, bold and novel approaches are needed that creatively explore social dynamics more in broader comparative work [263,264].

Building on the nuanced framework presented in this contribution, further research can gain valuable insights into power relations in social networks across levels. We have shown that, first come diverse experiences with smart energy that make blanket assessments difficult; smart energy needs to be described and analyzed in a very nuanced way. Second, power in smart energy systems is level dependent, but driven from the top down, as described in the framework. And third, the nexus structures, the interfaces between levels, systems, and actors is where power exists; understanding these is crucial: how does individual knowledge reach higher levels, what does that evoke, and, conversely, how do top-down structures unfold? What shapes these processes? Who are gatekeepers here, how can the eye of the needle be controlled by policies, and how are privacy concerns protected?

Although digital processes are fundamentally much more seamless and comprehensive than those involving human beings, and thus tend to be more totalitarian, the paradox of complexity, chaos, and data overload still exists. It remains to be seen how, for example, artificial intelligence can cope with this and what this, in turn, would mean for a new possible pastoral power instance that is just emerging. More research is needed here in the future, with exciting results expected.

The times call for a broader and deeper debate about smart energy systems, debate between technology developers, policy makers, civil society, science and future users that results in genuine collaborative exchange. If an integrative process could be set in motion so that smart energy systems were better adapted to user preferences and concerns about data protection and privacy, then the benefits of energy-efficient climate protection could be achieved without trade-offs between individual freedom and state-imposed control. It seems to be the search for a rare chameleon.

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