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Are you thinking what I'm thinking? The role of professionals' imaginaries in the development of smart home technologies

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ABSTRACT

This article draws on a co-design workshop with professionals working in the field of smart energy in the UK, to explore their imaginaries of smart homes and how these are (in)formed by their everyday 'lay' experiences. Smart home technologies (SHTs) are fundamentally embedded in future visions of energy transitions as they are expected to support actions to tackle climate change. Nevertheless, literature and adoption rates reveal an apparent gap between householders' needs, expectations, and uses of SHTs, and how professional designers and developers view the same technology. Previous studies on SHTs imaginaries coming from industry and experts have focused on how users are represented in institutional visions, however, they routinely neglect the individual subjectivities of professionals producing such representations. The article presents three core results on the role of SHTs in digital energy futures: (1) it generates visual and textual conceptualizations of professionals' imaginaries around smart domestic environments; (2) it identifies empirical insights on the formative role of professionals' personal imaginaries for smart energy transitions; and (3) it calls for an alternative and more reflexive co-design practice to envision a fairer and more inclusive energy future.

1. Introduction

Smart homes are often associated with residences that, relying on specific hardware and software, are able to collect data on households' routines, interpret it, and perform tasks with apparent intelligence. Already present in the everyday lives of many, smart home technologies (SHTs) can be seen as a future-oriented group of technologies (Dourish & Bell, 2011). That is, they are routinely sold with the promise that they will bring about an ultra-convenient, automated, and often luxurious future, or what Strengers (2013) refers to as the 'smart utopia'. The list of features provided by SHTs ranges from security to entertainment, but their potential application for helping manage demand in variable renewable energy grids has gained particular attention, integrating digital energy futures into attempts to address energy crises and, more broadly, climate change.

Existing literature shows that the development of SHTs has been driven by industry's techno-economic optimism, with a focus on implementation challenges (Wilson et al., 2015; Gram-Hanssen & Darby, 2018). Such perspectives have been embedded in consumer devices, legitimizing an institutional narrative of smart energy futures that rarely, if ever, accounts for its social implications. In short, there is often a gap between how householders perceive and use SHTs, and how energy professionals view and develop the same technology (Strengers, 2013). Research shows that this divide could risks undermining SHTs' relevance in managing energy consumption, by increasing the energy-intensity of everyday practices (Cherry et al., 2017; Tirado Herrero et al., 2018). In response, there

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has been growing interest in user-centred and participatory approaches, pursued as a strategy to better include householders in the research and development of smart technologies. As Aagaard argues however, "the user perspective alone is insufficient for developing a full understanding of the meaning and implications of SHT" (Aagaard, 2021, p. 569).

The range of social values embedded into technologies during their design often becomes apparent when they are deployed or used (Winner, 2020) in ways that routinely serve to prioritise dominant framings of contemporary problems (and associated solutions) (Ballo, 2015, p. 18). One way to better understand which discourses are being privileged in this process is to analyse the expressions of different futures that drive technological development. "Such visions are inherently political, insofar as they promote specific futures from which particular values and concerns may be excluded" (Groves et al., 2021, p. 2).

Representations of SHTs and smart energy technologies have been disseminated by major stakeholders in government and industry, often serving as leading strategies within carbon reduction plans. Additionally, as highlighted by Ballo, some stakeholders have more power than others to insert their particular envisioned technological discourses into development processes (2015, p. 12). Considering that the ubiquitous adoption of SHTs would have multiple impacts in people's everyday lives, investigations into the role played by the visions of such technology in energy transitions has become a popular theme of inquiry within Science and Technology Studies (STS). Following the need to better understand the actors involved in the development of smart technologies and how they envision automated energy futures, previous studies of industry's SHTs imaginaries have tended to focus on how professionals imagine and represent users and their everyday practices. In so doing, however, they have often been neglected the professionals themselves, and how their professional practice is informed by their individual subjectivities, social practices, and backgrounds. Interestingly, there has been an oversimplification of the ways that the smart futures being envisioned today always and unavoidably stem from particular people and places (Suchman et al., 2008).

Here we understand professionals as individuals formally working on the development and implementation of SHTs, from within organizations that have "[…] privileged access to information and […] a high level of aggregated and specific knowledge that is otherwise difficult to access" (Furszyfer Del Rio et al., 2020, p. 4).

Cherry et al., demonstrate that professionals' visions and expectations play important roles in determining energy transition pathways (2017, p. 8). Consequently, we need a better understanding of the imaginaries guiding the development of smart technologies. This article explores professionals' imaginaries around SHTs. To do so, it investigates the following research questions: How can we characterize professionals' imaginaires of SHT?, and How are they shaped by both their professional and personal lives?

To answer these questions, we report on the initial phase of a co-design process involving smart energy industry professionals. The paper thus aims to contribute to an existing literature on the use of participatory methodologies for the development of SHTs (e.g., Fitton et al., 2018; Reisinger et al., 2019; Renström, 2019; Yao et al., 2019; Cockbill et al., 2020; Raju et al., 2021; Garg & Cui, 2022), by providing an exploration of professionals' imaginaries around smart domestic life, with a focus on the personal and subjective aspects of their lived experience with the technology, and its implications for just and sustainable energy futures.

Section 2 reviews existing work on exploring sociotechnical imaginaries relating to SHTs. This leads us to call, in Section 3, for an alternative approach to analyse professionals' visions and expectations of the technology based on the French concept of *imaginaire*, and we delineate the relevance of approaching such analysis through co-design (Section 4). Section 5 then summarises the methodologies employed in our co-design process. Section 6 highlights the key findings relating to professionals' definitions of SHTs, their understanding of how they should be used, while Section 7 discusses implications of their SHT imaginaries. Finally, Section 8 concludes the paper by calling for co-design processes that better recognise how professionals' imaginaries are shaped by their user experiences, and that therefore equalise power relations between user and professional.

2. Previous work: SHTs sociotechnical imaginaries

Research on industry or expert-generated imaginaries of SHTs has become a fairly popular topic in the past decade, part of the urge to understand the socio-technical futures envisioned by institutions designing or advising automated energy futures. For example, Aagaard identified a dominant industry imaginary wherein SHTs do not disrupt users' everyday lives, but, instead, provide them a convenient "hassle-free" experience (2021, p. 573). In the same study, 'interoperability' was identified as the prevalent strategy to provide such convenience, with all systems in the house seamlessly connected and automated "[…] without the need for people to continuously adjust or tinker […]" (Aagaard, 2021, p. 575). Rohde and Santarius found a similar imaginary in the German SHTs industry, with a "comfortable, safe, simple and effortless smart home" also generating a sense of "urgency" in automating the house to "enable control from everywhere at every time" (2023, p. 6). According to Strengers and Nicholls, industry has been legitimising their SHT imaginaries with the same "convenience" narrative. They argue, however, that instead of enabling residents to "do more with less", SHTs often serve instead to "[…] enrol householders in new forms of household labour" (2017, p. 92). In a recent publication, Strengers et al. explore industry's imaginaries of digital energy futures and highlight a late stage of the "convenience" narrative, wherein SHTs deliver everything from leisure to security to energy management without residents even needing to leave their homes (2022a, p. 6).

Based on expert reports and interviews, Cherry et al. identify smart home imaginaries as associated with "high-tech" solutions for future low carbon housing (2017, p. 41). Echoing the findings of a previous study (Ballo, 2015), this perspective indicates that dominant imaginaries of SHTs depict them as integrated into (and even remotely controlled by) a smart distribution grid based on variable renewable energy supply (Ballo, 2015, p. 16; Cherry et al., 2017, p. 41). The association of smart homes and energy systems is also part of Furszyfer Del Rio et al.'s list of SHTs' business potentials (2020). Supported by expert interviews, smart homes were framed as digitally connected houses, with enhanced levels of control and automation, promoting learning experiences for both householders and the technology (Furszyfer Del Rio et al., 2020, p. 5).

Analyses of industry imaginaries suggest that smart homes are usually portrayed as "modern and up-to-date" houses (Rohde & Santarius, 2023, p. 6). Whilst they can be designed for specific user needs and tastes, and may even have smart technologies integrated into their design from the outset, Hargreaves and Wilson (2013, p. 1775) argue that smart homes are predominantly portrayed as being gradually built-up by residents over time as they increase the smartness of their existing homes through modular and incremental technology acquisition and integration. In this way, SHTs are positioned as enhancing existing homes and appliances rather than substituting them.

Studies have also addressed how residents and users are represented by industry's SHT imaginaries. Shirani et al. elaborate on the impacts of industry's expectations over residents, and the possible reinforcement of inequitable social and gender roles within households (2022, p. 2; Strengers et al., 2022b). Users are also routinely positioned as 'passive' through the common use of "set-and-forget" approaches designed to provide convenience and automation (Aagaard, 2021; Hargreaves & Wilson, 2013; Strengers & Nicholls, 2017). Another recent study argues that the roles ascribed to residents within experts and professionals' imaginaries have important material dimensions and, as such, they not only imagine future user roles but actively enable and constrain particular types of future user engagement (Andersen et al., 2022, p. 5).

Most of these previous studies on industry's imaginaries of SHTs are grounded in the concept of 'sociotechnical imaginaries' (Aagaard, 2021; Ballo, 2015; Cherry et al., 2017; Rohde & Santarius, 2023; Strengers et al., 2022a). As initially described by Sheila Jasanoff and Sang-Hyun Kim, sociotechnical imaginaries are "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation specific scientific and/or technological projects" (2009, p. 120). More recently the concept has been expanded from 'nation state imaginaries' to imaginaries organized by any groups, corporations, social movements, or professional societies, accommodating "[…] the myriad ways in which scientific and technological visions enter into the assemblages of materiality, meaning, and morality that constitute robust forms of social life" (Jasanoff & Kim, 2015, p. 4). Still privileging a collective imaginary, in the updated conceptualization, sociotechnical imaginaries are "[…] collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff & Kim, 2015, p. 4). Such a concept seems appropriately employed within studies aiming to unveil the 'stabilized' narratives and visions of futures embedded in industry's official discourses about specific technologies. Jasanoff acknowledges that "[…] sociotechnical imaginaries can originate in the visions of single individuals or small collectives […]" (Jasanoff & Kim, 2015, p. 4), however, hierarchically differentiating 'visions' and 'sociotechnical imaginaries': "Only when the originator's 'vanguard vision' […] comes to be communally adopted, […] does it rise to the status of an imaginary" (2015, p. 4). A vision only acquires the status of a sociotechnical imaginary when "made durable" by powerful institutions (2015, p. 25).

As this brief review has shown, in trying to tackle the gap between industry and users, studies of SHTs imaginaries have predominantly sought to characterise the formal, institutionalised sociotechnical imaginaries that are guiding technological development or associated policy frameworks. Whilst this work is vitally important, Kuchler and Stigson (2024), p. 13) suggest that the focus on institutional imaginaries fails adequately to account for the individual imaginations of professionals directly working to inform and shape innovation in SHTs. To unfold understandings of professionals' imaginaries and how they may shape the development of SHTs, we suggest approaching it from the *imaginaire* perspective. Developed out of dialogues between structuralism, phenomenology, and hermeneutics in the context of the 20th century (Wunenburger, 2020) – alongside with other theories drawing attention to the importance of the self in the constitution of the collective –, the French concept *imaginaire* is helpful in unpacking and extending the analysis of the diverse dimensions in which images or metaphors of SHTs can be individually experienced, collectively held, and, in some cases, institutionally stabilized into durable narratives.

3. The french alternative: imaginaire

Jean-Jacques Wunenburger frames the *imaginaire* as a "[…] set of productions, either mentally or physically manifested, based on visual images (painting, drawing, photograph) and linguistic expressions (metaphor, symbol, story), forming coherent and dynamic sets […]", influencing the symbolic process of giving meanings to things and ideas (2020, p. 11). Such ontological and poietic scope were attributed to the *imaginaire* by Gaston Bachelard (Wunenburger, 2020, p. 18), who noticed a recursive relationship between the *imaginaire* subjectively held by individuals (Bachelard, 1971) and the external world — in which *imaginaires* can transform how one experiences the world whilst, at the same time, the world can transform one's *imaginaires*. Bachelard referred to an open aspect and a dynamic state of the *imaginaire*, based on the affective, individual experience.

Extending Bachelard's position and moving towards an anthropological analysis of the *imaginaire*, Gilbert Durand framed it as a phenomenon that is initiated at the neurobiological level (individual), but then extended to a cultural level (Wunenburger, 2020, p. 19). The *imaginaire*, whether coming from a single author, a social collective or cultural categories, would endure, locally and temporally, by the will of dominant social discourses contained within it (Durand, 2016). Such durable state of the *imaginaire* would be composed of aspects organised through productions (visual images and linguistic expressions). As Wunenburger argues, both dimensions (open-individual and organised-durable) are inseparable from and in constant interplay with one another (2020, p. 11), keeping the *imaginaire* coherent but dynamic (2020, p. 13).

Instead of a narrower representation of future visions informed by science and technology, *imaginaires* are part of how one perceives and constructs things and ideas while experiencing visual and metaphorical expressions in everyday life. As such, *imaginaires* are not part of a vertical hierarchy like a future vision elevated by powerful institutions to the status of sociotechnical imaginary (Jasanoff & Kim, 2015). Instead, as seen in Fig. 1, a possible diagrammatic metaphor for the structures of the *imaginaire* could be of an enduring constellation of contrasts, constants, prevalence, and absence.

As the concept of *imaginaire* is particularly interested in individual lived experiences, it appears to be compatible with our claim to access professionals' understandings of SHTs. As such, instead of comparing hierarchically different expressions of sociotechnical imaginaries (i.e., institutionally stabilized aspects vs individual's visions), the concept of the *imaginaire* removes the sense of hierarchy between the different visual and metaphorical productions experienced by individuals involved in participatory research, whether 'professionals' or 'users'.

Furthermore, the dynamism found within *imaginaires* grants it malleability (see Fig. 1), which can be intentionally applied in creative practices to set 'images-in-action' (imagination), transforming, re-creating and turning aspects of the *imaginaires* into intelligible representations (Wunenburger, 2020, p. 13). Making use of this plasticity, we propose here a co-design strategy as a way to access professionals' SHT *imaginaires*.

4. Co-design approach

The empirical work we present here is part of a larger research study exploring the application of co-design as a strategy to better include diverse actors in the development of SHTs for automated energy futures. This research study is composed of a series of connected workshops conducted in three phases. The first phase involved three separate design workshops to explore SHT *imaginaires* held with three different groups: i) professionals working on or advising the development of SHTs, ii) early-adopters of SHTs, and iii) late or non-adopters of SHTs. This article focuses solely on the workshop attended by professionals.

A key reason for seeking to understand how different actors perceive and characterize SHTs in this first phase of the co-design is to try and generate a common vocabulary that can be referred to in subsequent phases where the different groups of actors are brought together to discuss. As existing research suggests (e.g., Jasanoff & Kim, 2015; Wunenburger, 2020), comparison between imaginaries is helpful in revealing similarities and differences between representations, and, uncovering the presence and prevalence of some narratives as well as the absence of others among the different actors. However, while for sociotechnical imaginaries the comparison of policy documentation, reports, and regulations at a cross-national level are a crucial methodological strategy (Jasanoff, 2015; Jasanoff & Kim, 2013, 2009), for the theory of *imaginaire* "[…] no linguistic reconstruction can replace the singularity of visual ecstasy" (Wunenburger, 2020, p. 28) – acknowledging the potential of visual expression in giving form to the aspects present in the *imaginaire* (2020, p. 29).

Precisely because design relies on diverse modes of representation (e.g., visual, technical, sensory, etc.), it holds a valuable potential in helping to render intelligible the subjective, affective, and even unconscious expressions of individual's *imaginaires*. Design methods can thus be strategically employed to help enact "[…] the foundations, motivations, aims […]" (Wunenburger, 2020, p. 62) in a pursued project, providing dynamism, strength, and enthusiasm for individual or collective decision making, enabling comparisons

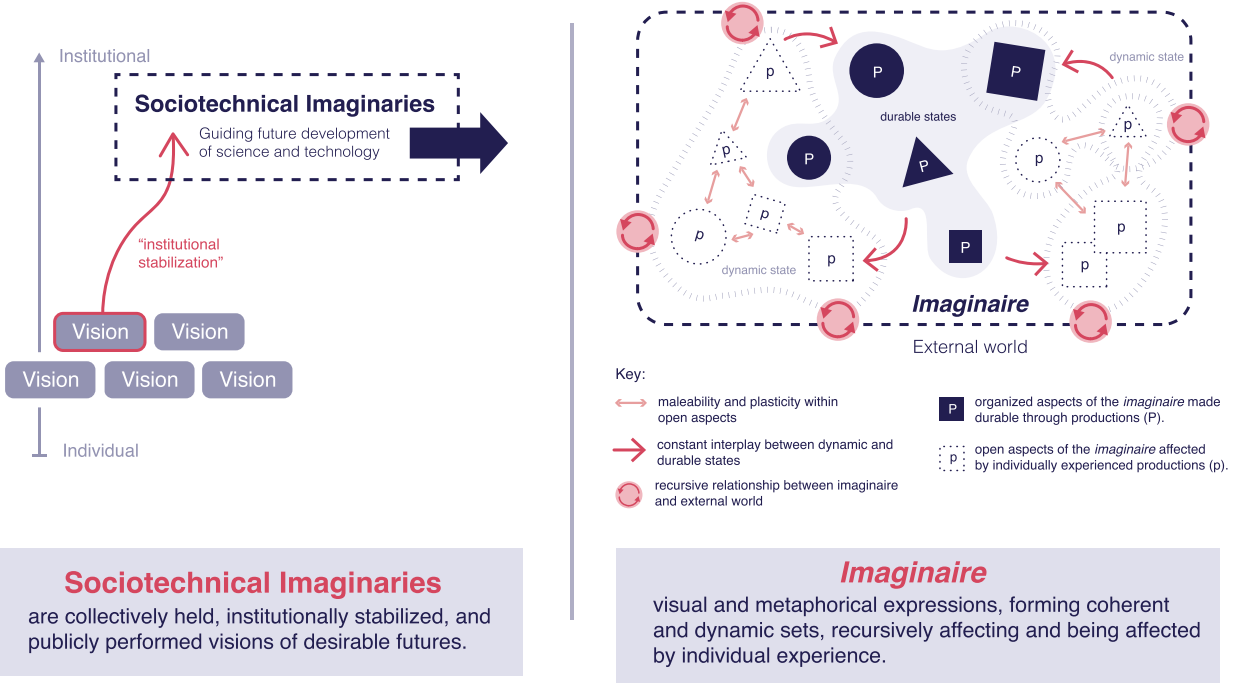

Fig. 1. Comparison between the concept of Sociotechnical Imaginaries and Imaginaire. On the left, a representation of visions being institutionalized into Sociotechnical Imaginaries, based on Jasanoff and Kim's definition (2015) and the institutional stabilization diagram presented by Rohde and Santarius' study (2023, p. 3). On the right, a tentative representation of the diverse states and aspects forming the imaginaire, according to Wunenburger (2020).

between non-institutionalized dimensions of the *imaginaire*.

In accordance with other Northern European scholars, we therefore define co-design as a collective design practice, positioned between the Scandinavian tradition of Participatory Design and the User-Centred approach coming from the United States (Bødker, 1996; Iversen et al., 2012; Sanders & Stappers, 2008; Simonsen & Robertson, 2012; Steen, 2013; van den Hoven et al., 2015; van der Velden & Mörtberg, 2021). A process that would infrastructure the emergence of participants' values, its elaboration and grounding into design ideas to be tested and reflected upon. It is a context-dependant practice that ought to be adapted according to the needs and preferences of people involved and their background. Thus, there is a diverse range of approaches following different schools of thought though sharing a core interest in forms of collective design for the empowerment of people affected by the things being developed.

Previous studies have applied co-design approaches to the development of SHTs (e.g., Bourazeri & Stumpf, 2018; Fitton et al., 2018; Reisinger et al., 2019; Renström, 2019; Yao et al., 2019; Cockbill et al., 2020; Raju et al., 2021; Garg & Cui, 2022) however, because these studies are usually led and orchestrated by professional designers and researchers who do not challenge or reflect on their positionality, they end up reinforcing the idea of users as 'research subjects', whilst the individual *imaginaire* of professionals' remains unquestioned, not surfaced, and is instead interpreted as the 'industry' view. We would argue however that, as co-authors in co-design processes, the individual *imaginaire* of both professionals and users should be probed and explored. The first phase of our co-design process thus sought to explore the *imaginaire* of professionals as a formative element of their expert practice. The next section details the precise steps taken in the initial exploratory workshop with professionals.

5. Methodology

The methodology was framed as a workshop where, using design methods, professionals were invited to explore and represent their SHT *imaginaires*.

5.1. Sample

The professionals taking part in the workshop had a diverse range of specialisms, including design, engineering, marketing, and user-research, and all worked at a UK advice and consultancy company focused on accelerating the energy transition through smart technologies. The relevance and novelty of the sample thus lies in their direct experience at the forefront of efforts to develop and trial innovative research methods like living labs and engagement workshops to generate just and inclusive as well as net zero energy transitions. Seven professionals attended the workshop, all were 20 years-old or older, predominantly white cis-gender females (n = 4) and males (n = 3), residing in the Birmingham area (West Midlands, UK), with a higher education degree or equivalent, and in a permanent work position. Recruitment was conducted through direct personal contact or via the internal company e-newsletter. £ 10 gift vouchers were offered for those who attended the workshop as both an incentive and a compensation for their time. The study received ethical clearance from [removed for peer review purposes]. To preserve anonymity, participants will be referred to as P1-P7. Key participant details are summarised in Table 1.

5.2. Data collection: exploratory workshop

The sequence of activities in the workshop sought to explore SHT *imaginaires*. Facilitated by the lead author, the session took place at the company's office and lasted for approximately two hours and 30 min. During the workshop, participants were presented with audio, visual, and tactile inputs as activators of their current perceptions and experiences of both smart technologies and domestic life so as to explore energy futures not only from within their professional training and specialisms but also, and crucially, from their personal histories and everyday experiences as home-dwellers and, in some cases, as early 'lay' adopters of smart home technologies. Participants were seated at the same table in one group. As summarised in Fig. 2, the workshop mixed individual activities with group activities.

An adaptation of Nikolai Ladovksky's experiments between design and psychology (Bokov, 2021) was used to open the workshop with the first task involving participants being blindfolded. Participants were handed everyday household objects (e.g., a plate, a pillow, a spoon, a toothbrush etc.) while listening to noises common to domestic life (i.e., kitchen sounds). After a while, the objects were collected back in, and participants were asked to recall a room from their own homes and describe it on a piece of paper. The descriptions were then collected and shuffled. As mentioned by Wunenburger, "[…] imagery finds its creative dynamic in the

Table 1
Details about professionals taking part at the exploratory workshop.

Participants		Gender	Field of Expertise
Participant 1	(P1)	Female	Engineering, Field Trial Operations Manager
Participant 2	(P2)	Male	Engineering, Software Support Technician
Participant 3	(P3)	Male	Engineering, Software Support Technician
Participant 4	(P4)	Female	Project Manager, Field Trial Operations Manager
Participant 5	(P5)	Female	HCI, Lead User Researcher
Participant 6	(P6)	Female	Psychology, Senior User Researcher
Participant 7	(P7)	Male	Mathematics, Modelling and Simulation Engineer

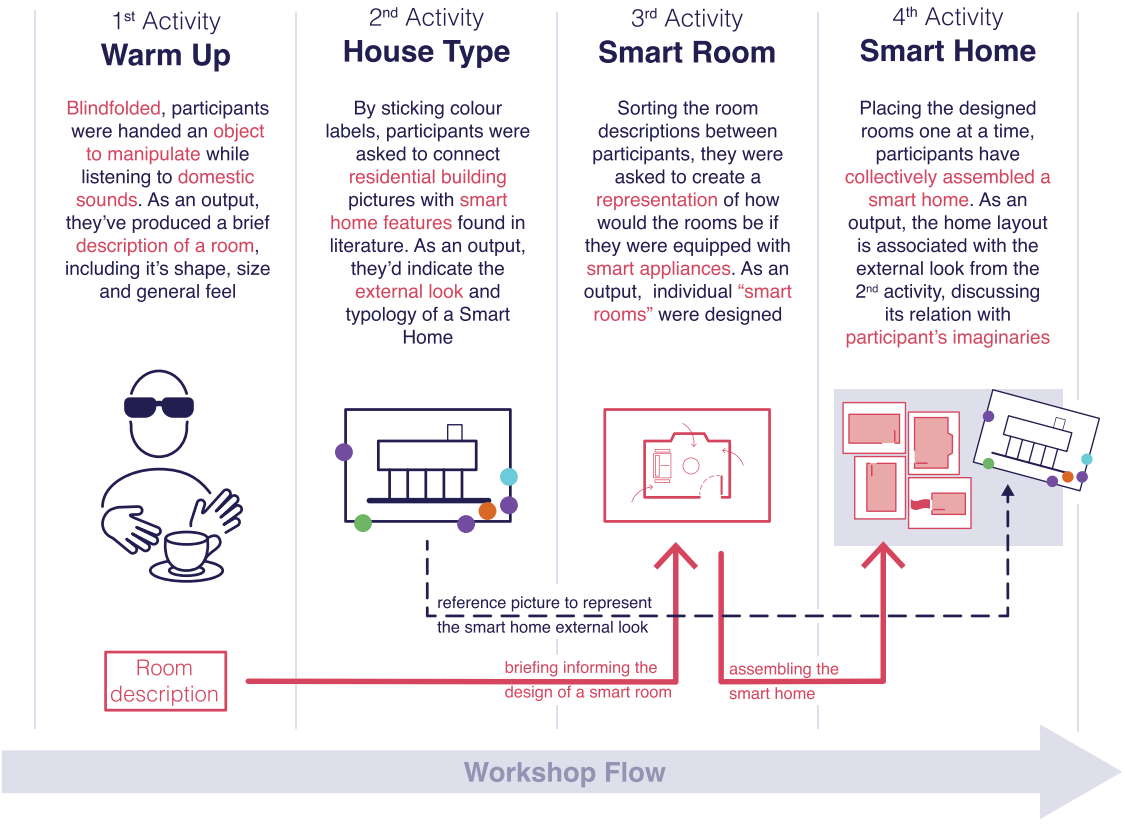

Fig. 2. Workshop flow diagram. The diagram shows the flow between the workshop's tasks and how their outputs are interconnected.

experience of the body […]" (2020, p. 19) hence this activity served not only as an engaging icebreaker but also to prepare participants to draw upon their personal experiences and memories, and to use their entire sensory system in the design activity.

The second exercise aimed to understand participants' first impressions of the external look of a smart home, and how particular features and functions described in literature may or may not be associated with the external look of the smart home. Prompted by a series of photos of potential 'smart homes' (see Fig. 3 in the following section) participants were asked to stick coloured labels on the image of a residential building they perceived as most closely related to a range of different features or functions of smart homes (e.g., safety, privacy, energy efficiency, convenience etc.). It was important for participants to responded using their first impressions, as in doing so they would activate the existing references and images present in their own *imaginaire*, associating them with each feature

Fig. 3. Series of pictures shown to participants during the second task, to test their reactions in combining different house typologies and styles and smart home's features.

alongside a corresponding building picture. This allowed us to better understand professionals' expectations of a smart home.

For the third task, the rooms described in the first activity were sorted between participants, and they were asked to suggest ways in which the room they were assigned might be converted into a 'smart' room. This involved them creating a representation of it using any technique they chose – e.g., drawing, collage, descriptive text etc. Participants were asked to draw on products already available in the consumer market instead of inventing new fictional devices.

The fourth and final exercise asked participants to arrange their individually produced representations of smart rooms on a large piece of blank paper, and thus to assemble a whole smart home, describing other structural elements of the house (i.e., doors, circulation, etc.). As well as producing a general representation of a smart home, the key purpose of this task was to prompt reflection and discussion between participants — as they would be contemplating aspects of their own SHT *imaginaires* in a visual and analysable representation.

The workshop was audio recorded, transcribed verbatim, and then coded using NVivo. Thematic analysis was used to identify common themes of discussion in the transcripts. In addition, the visual materials produced in the workshop were useful not only to raise discussion and reflection but also to inform contrasts and similarities between participants' individual *imaginaires*.

Participants were used to the proposed workshop setting as it is often part of their day-to-day work [see Table 1 for more details]. Nonetheless, the leading author-facilitator positionality as a Global South young cis-male and his experience as a designer, will have unavoidably influenced the creative and playful ways in which participants engaged with the proposed activities — and thus the visual productions they generated.

6. Results: professional's SHT imaginaires

This section describes professionals' representations or expressions of their SHT *imaginaires*. Section 6.1 outlines how professionals understood and defined the concept of a 'smart home'. Section 6.2 considers how professionals' conceive the different uses and purposes of SHTs. Finally, Section 6.3 explores how professional's *imaginaires* were informed and shaped by both their personal and professional backgrounds.

6.1. What is a smart home?

When asked to explain how they would define a smart home, participants offered very similar responses. For them, smart home is a term employed to define a dwelling where all electrical systems, "or at least most of them" (P1), are in "some way" connected to each other and to the Internet via Wi-Fi (P6). Systems like lighting and heating would be "working together" (P1) and be managed by "smart technologies" like a smartphone (P3). With connected or smart devices being controlled by "some kind of energy management" (P6), participants indicated that smart homes would be energy efficient (P5). This characterization resonates strongly with the extant literature around issues such as remote control, automation, and energy management (Furszyfer Del Rio et al., 2020; Shirani et al., 2022).

During the discussion, one of the participants highlighted the term 'smart' as not being clearly defined by industry, and that its pervasiveness in current consumer electronics is indicative of a marketing strategy rather than any actual "intelligence" in devices: "[…] it's a standard way of making something that was previously regarded as being 'dumb' or 'not intelligent', as having intelligence or having some kind of capability […]" (P2). For the same participant, real "smartness" was seen as deriving from "useful algorithmic control", which they exemplified by referring to thermostats able to autonomously control household heating systems. The technical knowledge behind this position, and the interest participants showed in delineating what 'smartness' means appeared to derive strongly from their professional expertise and training. In the workshop, however, it was possible to understand that these professional perspectives were not isolated from their everyday experiences.

During the second activity, participants characterised and represented the external aesthetic of a smart home, adding to their definitions of what counts as 'smart' technology. Participants were asked to reflect on a series of pictures of different residential buildings (see Fig. 3) and consider which residence they thought would have particular features (e.g., safety, privacy, energy efficiency etc.) and then which they thought looked most like a 'smart home' (see Table 2). Despite being instructed to place a coloured label silently and individually on what they saw as the most appropriate image, participants instead responded initially to indicate that: "It could be any of them!" (P2) or "all of them!" (P3), a position that resonates well with the standard industry vision that most buildings could be retrofitted with SHTs in an incremental and modular fashion and thus that smart homes would look broadly like any already-

Table 2
List of questions from the second task and the counting of associations made with each house typology in Fig. 3.

Smart Home Features According to Literature	A	B	C	D	E	F	G
Which one looks like the **safest**?		1	1	1	2	1	1
Which one would better protect your **privacy**?	1	1	2		2		1
Which one would **waste less energy**?				4			3
Which one looks the most **comfortable**?	1	4	1		1		
Which one would provide more **convenience** to an everyday life?	1	1	2	1		2	
Which one looks more **exciting and entertaining**?		1	5	1			
Which one would better support your **health and wellbeing**?		4	1	1			1
Which one is a **smart home**?			3	1		2	1

existing homes (Cherry et al., 2017, p. 5; Hargreaves & Wilson, 2013, p. 1775). A second prompting was necessary, reminding participants to place their labels based on their first impressions of the pictures. This time, they appeared to use less technically informed justifications, allowing themselves to nurture an interplay between the pictures and their *imaginaire* — a response based on their imagination. Three participants chose the picture of a luxurious detached unifamilial house in the international modernist style (see Fig. 3, picture C), described as the "cool one" with a "different design" (P2) even though this is at odds with institutionalised industry discourse that any home can be made smart. The same house was also seen as the most exciting and entertaining (see Table 2, column C). Two others selected a suburban semi-detached house because it looked "newly built" (see Fig. 3, picture F). The pictures of contemporary flats (D) and Victorian terraced houses (G) were chosen by one participant each. No participants selected the bungalow (A), the cottage (B), or the manor house (E) as being a smart home. In summary, despite their initial technically informed responses, participants appeared to generally imagine the smart home as a modern house, more or less isolated (detached or semi-detached), and 'looking new'.

In the last activity, after collectively arranging their individually designed smart rooms into a whole smart home as seen in Fig. 4, one of the participants reflected that, in their view a truly smart home needs to be designed as such at an 'infrastructural level':

> *"[…] what we've got on all these [rooms], my own included, are small individual, almost peripheral smart devices … small things. My definition of a smart home is a bit more fundamental, it's at an infrastructure level. It would have been built to be a smart home, by design, and it's the really sort of basic infrastructure of the home." (P2)*

This view is clearly at odds with the view of incremental and modular smart technology adoption and integration identified in previous work on industry's SHTs sociotechnical imaginaries (Hargreaves & Wilson, 2013). This "ground-up smart home" expectation (present in their *imaginaire*) also appeared to be informed by their expert knowledge in understanding that SHTs would provide a wider range of tangible benefits when fully interconnected within a purpose-built infrastructure. Another participant suggested that the smart home they all designed together, although not necessarily presenting integrated appliances, would be "much more like a home that we might live in, that's got smart additions", rather than a "custom-made smart home" (P6). Whether at a deep infrastructural or peripheral level, perhaps the core idea present in participants *imaginaires* to define the 'smartness' of a smart home was "interconnectivity" (something also found in previous literature like Aagaard, 2021). A fully interconnected and interoperable home was seen as the key to providing real benefits and thus being a "proper" smart home:

> *"[…] It has to be all built-in together. Like, having a smart room, and each room being its own separate thing is not the way forward. You have your whole house working together, every room, more or less the same system or centrally controlled." (P1)*

The smart home definition given by participants expresses dominant aspects of their *imaginaire* of SHTs, which are informed by both their expertise with technical production and individual subjective experiences. Some elements of the description echoed institutional visions found in previous research on sociotechnical imaginaires. Yet, as the theory of *imaginaire* can help elaborate, such organised and durable representations have been in constant interplay with participant's personal stories.

6.2. What is a smart home used for?

During the third workshop activity, participants were asked to create a representation of the rooms described in the first activity and use SHTs to make it "smart". As this was an individual task, each participant chose their own medium, materials, and colours to

Fig. 4. The collective smart home assembled by participants during the last task of the workshop.

produce the representation. The dominant techniques were drawing and collage, depicting a birds-eye, floorplan type view of the smart rooms (See Fig. 5).

Within the appliances mentioned, and probably echoing participants' field of expertise, there was a prevalence of technologies associated with energy and resource management, e.g., smart lights and switches, smart water tap, smart thermostats, underfloor heating, solar panels, and heat pumps. There was a secondary focus on technologies that helped to automate everyday tasks, e.g., occupancy sensors, smart windows, and smart blinds. In this context, participants highlighted kitchens as "the most interesting place" (P1) when it comes to smart technologies automating everyday life, exemplifying it with the energy efficiency of smart fridges:

> *"There's a lot of smart things that are of questionable usefulness, but the fridge is definitely one of the ones that have various special cues and use cases for this." (P1)*

> *"Smart fridge is one of the few appliances that does actually add value in a 'smart' sense." (P2)*

A third focus was on technologies designed to provide enhanced comfort and convenience, and this prompted participants to reflect further on SHTs "usefulness" or "added value" (P2). In the ensuing discussion, participants suggested that some SHTs "may be superfluous" (P5), including robot vacuum cleaners, wireless charging points, and smart mood lights:

> *"[…] it's very fashionable these days, to have like a smart kettle, where you can boil your cup of tea before you get out of bed and save yourself 30 s, which is ultimately meaningless in the grand scheme of your life […]" (P1)*

This discussion about utility complicated participants' technical knowledge about SHTs, as it necessarily involved them reflecting on their personal contexts and previous experiences. While reflecting on the usefulness of some technologies over others, participants offered several examples of their own experiences as SHT users suggesting that their adoption of a particular technology would be related to whether they perceived it as useful for their own everyday lives or not. Describing their house as a "small terraced", P3 argued that there's "nothing smart" in it. Because of the limited physical space, it "just doesn't need to be smart" (P3). Participants recognised that "people have different priorities in life" (P4) and that, as a result, "personal preference" influences the perception of utility in SHTs. For instance, whilst P1 expressed a personal dislike of digital voice assistants, stating that: "I'd much prefer just to have Google Home on a tablet and be able to just not have to talk to the thing, and then have it not understanding me and then saying it again" (P1). They later qualified this personal view by recognising from a more technical perspective that voice assistants "[…] would be great for someone with limited mobility or something like that […]" (P1).

Technologies focussed on entertainment and communication (e.g., smart TVs and smart speakers), were briefly mentioned in some of the smart room descriptions, however these did not receive much attention or discussion being generally treated as mainstream or "background" devices that were seen as having become somewhat standardised. Technologies focussed on security were not directly mentioned by participants in the workshop and, perhaps surprisingly, there was no discussion amongst the professional participants about privacy and surveillance.

In summary, the usefulness of SHTs have not been defined solely by participant's expert understanding of the potential benefits. In fact, their utility was considered in relation to their personal experiences as users of smart technologies and the social context as householders — which will be explored next, with the role of everyday lives in imagining smart homes.

6.3. How is a smart home imagined?

Although resonating with aspects found in the literature on industry's sociotechnical imaginaries of SHTs, the design approach employed in the current study allowed participants to step aside from their professional expertise, acknowledging their experience as SHT users, or early "lay" adopters. The dynamic between the institutional vision they follow at work and their everyday life perceptions was evident when participants described the design choices made during the creation of smart rooms. Even if expert knowledge sometimes nudged them to "check the most energy efficient" SHTs (P6), participants would frequently justify their choice

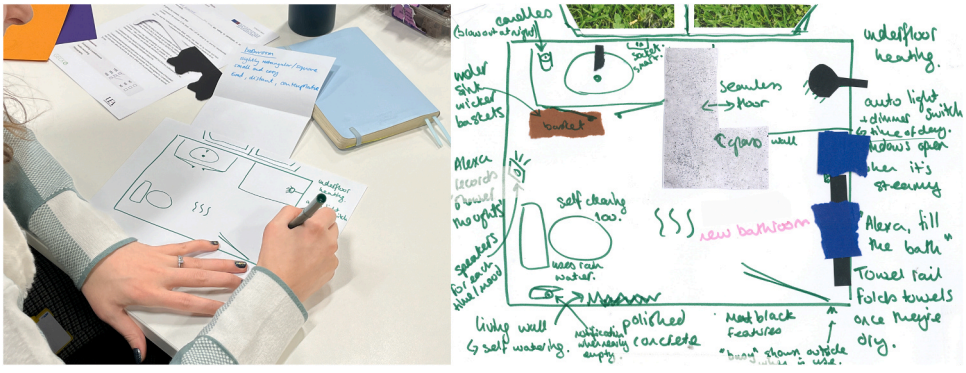

Fig. 5. On the left, one of the participants designing a smart bathroom based on a written description. On the right, the final diagrammatic design of the bathroom's floorplan, illustrating the general visual representations created by participants.

of technologies according to personal stories and experiences as smart home-dwellers:

> *"I've got a lot of home automation in my place, but I wouldn't say it's smart, and it's all proprietary. I've got the world's most complicated light switch, which you would not believe how much circuitry programming it's in a light switch […]" (P2)*

> *"I've got like smart doorbell, smart heating … What else?! … smart speaker … I talk to a smart speaker … what do you call it? Google … smart clock, like 'show me a recipe for this', 'play me some music', 'turn heating on'" (P4)*

As adopters, personal needs and subjectivities are at play when imagining when or how to use SHTs. Some identified alternative and non-official uses of smart technologies as "quite helpful" (P6) in achieving specific benefits or features for example, P6 described how they use presence sensors associated with smart lights in a hallway to check if their "[…] children are home or not" (P6). Another participant used smart timer plugs in an unoccupied family house to programme a time of the day when lamps and radio would go on "[…] so people have the impression someone is at home" (P5). Participants also included pets and a garden in the design of the smart home, expanding the technology's possible interactions with different types of inhabitants.

Participants not currently using SHTs (or who stated a lack of interest in using them), indicated the absence of previous interactions with technology as one of the elements preventing them from personally adopting it or prescribing it in the design of their smart rooms: "I didn't put a dishwasher because I don't have a dishwasher and … I've never had a dishwasher" (P1). For the same participant, growing up in a house without a centrally controlled heating system (e.g., thermostats) impacted how they imagined such technology as an adult:

> *"So, when I first moved in somewhere with a thermostat that worked and actually correctly set the heating temperature I wanted it to, it took me a very long time to get in the habit of using it. Because I've grown up from, you know, 15–20 years just thinking the heating is not worth the hassle […]" (P1)*

A diverse home environment and non-expected uses of SHTs found in participants' *imaginaire* during the workshop are aspects not well represented in institutionally stabilized sociotechnical imaginaries of the same technology (Strengers et al., 2022a, p. 10). Participants' technical and objective knowledge informed by science and technology were not the only expertise brought up during the design tasks. Instead, participants' everyday lives and user experiences were also shown been constitutive of their SHT *imaginaires*.

7. Discussion

The analysis of the workshop discussions provided insights on prevalent conceptualizations of smart homes that not only form professionals' *imaginaires*, but, consequently, influence the development of smart home futures. In this section we detail such concepts and propose an alternative reflexive co-design practice to better incorporate the potential of the *imaginaire* in fostering fairer smart energy futures.

7.1. SHT conceptualizations

From the workshop, it was possible to identify two prevalent conceptualizations of smart homes and its technologies in professionals' *imaginaires*: the first is the idea of a "ground-up" smart home, with smart technologies being part of the basic infrastructure of the house along with electrical systems, heating, water, and gas supplies. According to participants, a home designed to be smart would be able to better provide 'useful' benefits for its residents, like energy efficiency. Such framing of smart homes appears to be related to a techno-solutionism where complex problems (like energy transitions) can be solved through the pervasive use of a technological solution.

In contrast, a second concept entails a more incremental assembly of a smart home by peripheral smart technologies. This approach resonates with conceptualizations found in previous research on industry's SHT imaginaries and was also taken by participants as "much more like a home that we might live in" (P6), unveiling the idea of 'smart additions' as a better representation of the current consumer market of SHTs. Although still responding to a techno-solutionism, it appears to be less deterministic as it considers an 'interconnected' and 'building-blocks like' technology – holding the potential to cope with diverse household contexts and needs, like sensors being adapted by users to perform tasks not envisioned by developers.

What could look like a dichotomy between different ways of perceiving smart homes, actually emulates the *imaginaire's* dynamic interplay between an open-individual dimension and an organized-durable dimension, produced by both the participants' professional expertise and their personal everyday life. For instance, participants' professional experience and technical training informed them about the utility gains of having a ground-up house with an all-connected infrastructure. Even so, they themselves don't live in homes designed to be smart. When using SHTs or designing it into the smart rooms in the workshop, they opted for peripheral 'smart additions' that appear to better relate to their personal contexts and diverse needs.

7.2. Empirical insights

Such relationship between the open-individual and organised-durable dimensions of the *imaginaire* highlight the need to better incorporate professionals' experiences as "lay" early adopters in participatory design and research. The constellation of individually produced expressions of their *imaginaire* can reveal collectively held and pervasively experienced characteristics influencing professionals' decision making. Thus, it is important to acknowledge the multiple interactions that professionals may have with the

technology they are developing or advising on. For instance, as previously mentioned, their experience as adopters led participants to think about the usefulness of some SHTs according to their everyday life and social context, while their professional expertise led them to elaborate that not every smart technology presents intelligent behaviour, meaning that not every SHT would bring 'useful' benefits. The constant dialogue between both dimensions of their *imaginaire* was not plotted but rather illustrates the symbolic process of giving meaning to things and ideas described by Wunenburger (2020).

Current co-design practices are typically led and orchestrated by professional designers and researchers, restricting their contribution to the participatory dialogue with their institutional vision and structured knowledge. However, as we have seen in the workshop, their everyday experience is in constant contact with their professional expertise informing their *imaginaire* as experts. Instead of taking such phenomenon for granted and failing to challenge or reflect on the professional's positionality, the *imaginaire* could be intentionally and explicitly integrated into co-design approaches as a strategy to make subjective social cues intelligible for people involved, fostering more responsible and just co-design practices for energy futures.

7.3. Alternative co-design practices

These findings suggest a need to develop strategies that better include professionals' subjectivities in the research and co-design of SHTs, recognising their *imaginaire* as both experts and users of the technology. In doing so, future research can further explore co-design principles regarding participants' multiplicity, for example recognizing professional expertise and everyday life experiences as equally valuable contributions.

The concept of *imaginaire* can help unfold the fact that futures are produced by particular people in particular places (Suchman et al., 2008), which leads to important questions about whose *imaginaires* are shaping automated futures and whose are ignored. As we have argued, conventional approaches to co-design that maintain hierarchy between professionals and users, risk failing to challenge the techno-economic paradigm, treating stakeholders as unidimensional entities, and thus repeating tired narratives and strategies of techno-optimism. In contrast, we argue that redesigning co-design processes could allow them actively to set images and metaphors in-action, recognising the multi-faceted experiences of all participants and thus incorporating the dynamism and complexities of the imaginaire.

Thus, an exploration of professionals' *imaginaire* would enable more reflexivity in co-design. Even if momentarily, repositioning them(selves) from observers to (self)observed, could foster awareness over their professional inclinations informed by a privileged position as both experts and users. As demonstrated by the workshop, sensory and visual methods when applied to a co-design practice can surpass professional roles, supporting reflections on the full empirical experience constitutive of their *imaginaires*.

8. Concluding remarks

This article has explored SHT professionals' *imaginaires* of smart homes and how they are shaped by both their professional experience and personal lives. Through an exploratory workshop with participants working in the energy industry, we contribute to an existing literature on the use of co-design methodologies for more just and sustainable digital energy futures. Previous research on professionals or expert representations of SHTs has focused on institutionally stabilized sociotechnical imaginaries. We argue that such framings have overlooked how the individual subjectivities of professionals' imagination inform the design of automated energy futures. We suggest the use of the French concept *imaginaire* as a theoretical framework better able to grasp the complexity of how imaginaries are shaped.

We argue that acknowledging the multiplicity of professionals' *imaginaires* could foster a fairer participatory dialogue within co-design participants — i.e., a less hierarchical and fragmented process. As shown in our exploratory workshop, such *imaginaires* are not only informed by scientific and technical knowledge, but also impacted by professionals' personal experience, in a recursive interplay between two states: an open-individual and organised-durable. Thus, accessing professionals' subjective understandings and experiences of SHTs through their *imaginaire* would reveal and challenge the subjective positions informing technology development.

The theory of the *imaginaire* contributes to the field of social sciences, humanities, and design research on rethinking digital energy futures from a fairer and more inclusive approach. Its complex plasticity and dynamism hold the potential to be further explored within smart home technology research, being used to challenge positivist automation discourses and imagine alternative, counter-hegemonic futures.

CRediT authorship contribution statement

Tom Hargreaves: Funding acquisition, Supervision, Validation, Writing – review & editing. **Vinicius Juliani Pereira:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft.

Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

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