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Pursuing Pleasance:
interrogating energy-intensive visions for the smart home

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Abstract

In recent years, household sustainability has received increasing attention in the field of Human-Computer Interaction. This has largely been driven by the argument that through interaction design, we can create 'smart homes' that enable households to be more responsible with precious resources, such as food, water and energy. However, the assumption that home automation technologies lead to improved sustainability may not hold. As a contribution to this discussion, this paper demonstrates how home automation devices promote a lifestyle vision which may undermine intended energy savings. Drawing on a qualitative content analysis of smart home articles, we identify and interrogate the industry vision of 'pleasance'. We highlight seven qualities that underpin this vision: aesthetic experience, fun and cool, customisation and control, convenience and simplicity, peace of mind, extension and expansion, and effortless energy-saving. We analyze how energy-intensive pleasance is embedded within two commercially available types of devices: smart thermostats and networked lighting. We show how these devices and the pleasance vision that they mobilize may encourage householders to use more energy. The paper concludes with design suggestions on how HCI community can re-envision pleasance through the examples of thermostats and networked lighting to achieve energy reductions and sustainability outcomes.

Keywords: Sustainability, Smart Home, Energy Consumption, Home Automation, Lighting, Thermostats.

1. Introduction

Sustainability in households has received increasing attention in recent years in the field of Human-Computer Interaction. The key contention behind this has been the proposition that through careful interaction design for smart home devices, such as eco-feedback portals, or app-controlled and automated appliances, we can enable households to act more environmentally responsibly in their use of resources, such as food, water and energy. Based on this argument, many prototype systems have been designed and deployed, showing promising results in terms of immediate and longer-term sustainability outcomes. These have been reported through highly respected outlets, such as CHI, UbiComp, TOCHI, ICT4S and IJHCS (e.g. Bourazeri and Pitt, 2018, Costanza et al., 2014, Pierce et al., 2013, Costanza et al., 2012; Froehlich et al., 2010). More widely, commercially available smart home products have become popular, with many promoted for their potential to help households save energy and be more sustainable. As an example, the following passage from an online article delivers a familiar message from those advocating the energy benefits of home automation:

> *"Home automation does the work for you. Life is busy. People forget. We forget things like leaving the lights on upstairs, because we were coming right back. Oops. We forget that the kids were watching television downstairs before they went outside to play. It's okay. Motion sensors have your back. They can turn off that light or television when the room is empty and prevent wasting energy (and money)"* (Little, 2015)[1].

As this quote illustrates, the energy-saving benefits of automated devices come from the removal of unnecessary 'waste', responding to occupants' existing routines, or bypassing lazy and forgetful human behaviors. In this way automation is thought to operate "in the background" and deliver "set and forget" (Harper-Slaboszewicz et al., 2012) energy demand response "without compromising modern lifestyle" (Ausgrid, 2012).

These aims are also tied up in government ambitions to reduce greenhouse gas emissions and peak electricity demand with the help of information and communication technologies (ICTs), including smart home technologies (Climate Group, 2008; IEA, 2011). A growing number of studies are devoted to measuring the energy savings possible by using technologies in line with this vision. While there is no agreed amount of energy that can be reduced by home automation, one online article estimates that householders can *"easily lower … [their] utility bills by 10% to 25%",* noting that automation provides *"a good solution to help preserve … natural resources"* (Fritz, 2015).

However, as we and other researchers have previously argued, the assumption that home automation technologies lead to improved sustainability outcomes needs further interrogation, and may in fact not hold true (Hargreaves & Wilson, 2017; Herrero et al., 2018; Hazas & Strengers, 2019; Jensen et al.. 2018). This is because other value propositions for smart home technologies put

[1] Quotes drawn from our content analysis articles, like this one, are italicized throughout this paper and marked with an asterisk (*) in the reference list. Other quotes drawn from literature are not italicized. We explain more about our content analysis in Section 3.

forward by the industry may promote lifestyles that lead to *increased* energy use (Darby, 2017; Strengers & Nicholls, 2017; Hazas & Strengers, 2019). More specifically, automated and connected devices are often primarily marketed as a way to deliver a range of home improvements, with energy reduction being a secondary consideration or side-benefit (Strengers et al., 2016). This is reflected in definitions of the smart home which emphasize the role devices play in enhancing everyday experiences by "anticipat[ing] and respond[ing] to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond" (Aldrich, 2003: p17). Such benefits are intended to "improve [peoples'] … lives in meaningful ways" (Harper-Slaboszewicz et al., 2012: p375].

As previously argued by Shove, improvements in comfort, cleanliness and convenience (the three Cs) constitute the "environmental hot spots of consumption" (Shove, 2003: p3). Historical analyses also demonstrate how past household technologies and infrastructures have contributed to transformations in everyday life and, in doing so, increased resource use (Forty, 1986; Schwartz Cowan, 1989). Given the rapid growth in smart home technologies, it is timely to ask more questions about how the lifestyle expectations promoted by smart home advocates are orienting household desires and practices in ways that may increase energy demand. From an HCI perspective, how might interaction designers working with the challenge of supporting sustainable homes and lifestyles best respond?

The disciplines of ubiquitous computing and HCI design have played key roles in articulating and critiquing technological visions (Dourish & Bell, 2011), and proposing methods to imagine alternatives (Dunne & Raby, 2013; Raptis et al., 2017). HCI research on the smart home has focused on delivering measurable sustainability benefits through devices, such as efficiency improvements, increased environmental awareness or energy demand response. However, the lifestyles promoted by smart homes have received less attention from HCI scholars (Jensen et al., 2018a, 2018b).

In this paper, we investigate and illustrate the concept of 'pleasance', which was originally coined by home automation company Lutron to describe an ambient and electrically enabled lifestyle that brings "comfort, romance and peace of mind" into the home (Lutron, 2015: p3). Our specific contribution and focus is on how technology industry and other public commentators imagine and promote an energy-intensive vision for pleasance enabled by smart home devices.

The paper proceeds as follows. We begin by providing background on how related work in HCI and ubiquitous computing has approached the smart home. We introduce our study, which involved qualitatively analyzing the text and images of 270 international online and magazine articles written about smart homes and home automation published from 2000-2016. We outline the overarching vision of pleasance and its key qualities in the smart home, before turning our attention to two types of smart home technologies (smart thermostats and automated lighting). We analyze the qualities of pleasance promoted through these devices along with their energy implications. We conclude by discussing how HCI designers can imagine and manifest lower-energy lifestyle visions for the smart home.

2. Related work: HCI and the smart home

Related work on smart homes is substantial and growing. In a systematic review of smart home literature it was found that most is based in the engineering and technical sciences where "users are assumed to have a stable set of service demands and expectations based around comfort, security, safety and cost that [involve] … essentially regular and fixed patterns of behaviour" (Hargreaves & Wilson, 2013: p1770). While there are notable exceptions in HCI, particularly in regards to thermal comfort studies (Clear et al., 2014; 2013), most smart home literature assumes that lifestyle expectations emerge from households themselves, and must either be 1) made more efficient through automation, or 2) supported through interaction design for better user experience. Below we briefly review the literature concerning these two approaches.

2.1. Automated interventions in energy

In HCI, a significant number of papers have provided valuable insights regarding the control and automation of specific functions or application scenarios within the home: for example, heating, lighting, or laundry. These have often engaged with energy as part of their motivation, design, and/or evaluation.

Typically consuming 40% or more of home energy, heating and cooling systems have been a common target for automation. For example, Scott et al. (2011) found that per-room radiator control and occupancy prediction aimed to keep rooms heated when they were inhabited, which in some homes yielded energy savings of 2-18%; however, in other homes this raised consumption by 1-5%. Koehler et al.'s (2013) study showed that automatic algorithms can use GPS data from mobile phones to control heating systems more accurately to achieve energy savings, particularly where inhabitants are driving to and from home.

The Nest Learning Thermostat (discussed below in our analysis) is a commercial product making use of some of these concepts: the Nest aims to sense occupancy and predict when the home should be heated or cooled. Yang et al.'s (2014) study investigated households' use of this device over the course of a year, using interviews, diary entries and participant-captured screenshots. Participants had high engagement with the Nest at first, but less so after several months. This is particularly crucial since ongoing engagement with the system is important for achieving energy reductions – the Nest's algorithms may identify spurious events (such as unusual midday occupancy) and enshrine these permanently in the heating schedule as daily or weekly requirements.

Another set of work anticipates increased availability of renewable, off-peak or cheaper energy, which is often related to variable pricing schemes for electricity. Automation is used in these situations to reduce the carbon intensity or cost of energy, by time-shifting consumption or directly controlling the load of specific appliances (known as Direct Load Control in engineering (Hesser & Succar, 2012)). For example, the HeatDial interface allows inhabitants to specify an acceptable range of temperatures and realize cost savings by the system automatically shifting the actuation of an electric heat pump (Jensen et al., 2016). This short-term flexibility is enabled because well-insulated homes retain heat, and low-energy heat pumps are slow acting.

Automating the machine-washing of laundry is another area where researchers have demonstrated potential to shift consumption earlier or later in response to pricing signals or energy availability. This is because laundry is

commonly considered a 'flexible' routine (Higginson et al., 2013; Pierce et al., 2010). For example, Costanza et al. developed a laundry booking system, and deployed it in a study with household participants who committed to running the laundry machine at particular automated times when it was assumed that electricity would be less expensive (Costanza et al., 2014).

This body of research is concerned with achieving energy demand response associated with existing expectations, perceived levels of service, and 'normal' routines. Important exceptions include the acknowledgement that a laundry booking system might impose a new rationalization in everyday life that was not there before (Costanza et al., 2014: p820); and that a range of temperatures might be acceptable, rather than a single standardized 'setpoint' (Jensen et al., 2016). But broadly these studies assume that life-as-usual should be upheld – or at least that it is not the role of designers to intervene in it.

This literature also reflects the energy policy vision for home automation technologies, where these devices are intended to reduce peak electricity demand, better synchronize energy demand with available supply, and make existing demand more efficient without compromising modern lifestyles, as noted in the introduction. Critical work in the past two years has also pointed out home automation's often unstated reliance on Internet connectivity, remote storage and processing in data centers worldwide, all of which require more consumption of energy, albeit outside the home (Hazas et al., 2016).

2.2. Improving user experience through interaction design

Recently, smart home research has also focused on improving the user experience of systems and devices through interaction design, attempting to understand and remove barriers for broader adoption (Brush et al., 2011). For example, Mennicken et al. (2014) surveyed the ACM literature with an explicit focus on inhabitant experiences, in order to draw implications for improving the design of smart home use experiences and technologies. These researchers identified the need for supporting "high-level goals" and values, and pointed out that many studies don't explore these with participants. Mennicken et al. (2014) also identified the need to share new ideas and configurations, to help support the great diversity encountered across homes, within homes, and over time—a point previously made by Davidoff et al. (2006). Both of these studies argue that systems need to expose the underlying reasoning for automated actions, and have interfaces which "allow for the organic evolution of routines and plans" Davidoff et al., 2006: p.28). Smart home technology features here as something which can support and enhance existing routines.

Much of the valuable work on smart homes in HCI and UbiComp has focused on these sorts of issues. For example, Ur et al.'s (2014) study showed that improvements to "if this then that" (IFTTT) rule building and sharing has the potential to make smart homes accessible to the less experienced. In another study by Woo and Lim (2015), eight Korean households with varied programming experience were able to set rules for a small number of smart home devices, to fit in with or support home life. Mennicken et al.'s (2016a) study sought to make smart home sensor data more accessible to all inhabitants, and more relevant to everyday routines, by displaying visualizations of sensor data alongside family calendars. The researchers also explored possible futures for smart homes to have personality traits (e.g. proactive or passive), by having

participants work through typical scenarios in a lab-based mock up (Mennicken et al., 2016b). These included getting ready for work, arriving home at the end of the day, and going to bed.

This research supports the premise that a smart home's role is to be helpful, supportive, comfortable and pleasant, by adapting to the inhabitants and being easy to configure. However, while automated devices feature as a key enabler of these qualities, these studies rarely focus on energy demand reduction or load shifting. It is also important to bring these two bodies of work together, by considering the energy implications underpinning smart home improvements, experiences and lifestyle expectations, as we do in this paper.

3. Study

Our focus is on how the smart home is being discussed in consumer, news or trade articles (e.g. published in *PCMag*, *The Guardian* or *TIME Magazine*), written primarily by technology industry and other public commentators who are mostly enthusiastic about these devices. Following Hargreaves and Wilson (2013), we contend that the ideas promoted in these articles play a significant role in shaping emergent smart home systems (and their resulting energy demand). Following Shove (2003), we also argue that these ideas play a role in shaping our expectations for normal everyday life.

There is a rich history of scholarship demonstrating the ways in which marketing and media materials have and continue to shape social practices and conventions – not always in the ways advertisers intend or promote. Schwartz Cowan (1989), for example, provides a seminal analysis of how the industrial revolution of the home (involving the promotion of new labour-saving domestic technologies) promised to free up women's time but also created heightened expectations of cleanliness that resulted in "more work for mother". Likewise, Forty's (1986) historical analysis of the promotion of electricity and other appliances shows how lifestyle narratives normalize and legitimize the role of infrastructures and technologies everyday life.

In this study, we conducted a qualitative content analysis of a total of 270 retrieved consumer articles to understand the lifestyle expectations promoted by these texts and images. Our process for this analysis was divided into four major steps involving 1) sourcing and searching for articles, 2) reading and coding the retrieved articles, 3) developing an analytical framework, and 4) theme analysis and identification. We sourced articles published in the period 2000-16, aiming to capture expectations for the '21st Century smart home' (e.g. since the turn of the century until 2016).

3.1. Sourcing and Searching

Articles were sourced in 2016 by searching online and academic databases for the terms 'home automation' and 'smart home', including variations and derivatives (e.g. 'networked home' or 'connected home'). While we were not aiming for a representative sample of articles, years or outlets, we did seek to analyze a wide range until we reached saturation, where no new themes arose. During the sourcing, we assessed each article on whether it explicitly discussed the use of smart and automated devices inside the home. We only included articles that mentioned the smart/ automated home, and we excluded articles

that focused narrowly on a specific device and brand (such as reviews of one product, which are more likely to represent advertising or product-sponsored content). This is because we weren't primarily interested in specific devices themselves, but rather broader visions for the smart home. This approach also excluded some of the most obvious promotional articles, but given that financial arrangements between article authors and industry are rarely declared, many articles are likely to have been written under advertising deals, despite presenting to readers as independent commentaries.

The majority of articles identified were published in the United States and United Kingdom. Our selection of articles reflects the current trend towards who is writing about the smart home (technology enthusiasts and specialist magazines), and where English-language content is mainly published (UK and US). Most of the articles were published in 2014-16, which reflects their more ready online availability and the increasing interest in smart home technologies. Table 1 provides an overview of the articles analyzed.

<Table 1 appears here>

The articles were sourced from a range of outlets with different objectives and agendas. Articles in some news outlets such as *The Guardian,* for example, were more critical or 'balanced' in tone and content. In contrast, articles from smart home trade magazines (e.g. *Electronic House* and *Connected Home*) or 'tech' outlets (e.g. *PCMag*), more commonly emphasized positive benefits for these devices. We did not specifically search individual news or online outlets for smart home content, but relied on search engines and online databases to find relevant articles. We did not deem this to be an issue with our sampling method, given that we weren't interested in understanding the differences between content across different outlets, or in seeking to provide a representative analysis of online materials about the smart home. Instead, our aim was to thematically analyze a corpus of materials written about the smart home.

These differences in the outlets, presentation and levels of enthusiasm expressed for smart home devices are both a limitation and strength of this paper. They are a limitation in the sense that we have bundled together a range of articles from disparate sources with different agendas and biases. However, this is also a strength because, as we go on to demonstrate, despite the different types of outlets we sourced these articles from, we found a consistent lifestyle vision across the sample.

3.2. Reading and Coding

All 270 retrieved articles were read by two authors, who also identified feature images in 166 articles. Coding was divided between authors using a structure derived by reviewing a sample and modifying this as necessary when new themes emerged. The coding team discussed and crosschecked themes as they emerged, grouped them together, and undertook some joint coding to ensure consistency and address irregularities.

While our sample size was large, consistent with qualitative methods, we did not seek to count or quantify the recurrence of themes as might be expected in a quantitative analysis with a sample of this size.

The article texts (270) were coded thematically using qualitative inductive coding methods (Schreier, 2012). An 'in vivo' coding technique from grounded theory was used where possible, which aims to identify recurring key terms emerging from the text (Richards, 2015). The purpose of the analysis was to identify concepts central to the smart home, rather than categorize or quantify products on the market, or measure the frequency of terms and phrases. This reflects a similar process to how qualitative data is coded iteratively and thematically.

The article feature images (166) were coded using frequency coding against data-driven categories about what and whom they depicted, and the type of image (photograph, computer model, cartoon etc.) (Rose, 2016; Schreier, 2012). In addition, interpretative methods (Richards, 2015) were used to develop memos on image themes, which identified lifestyle expectations such as evidence of domestic activity (e.g. housework), or depictions of luxury and grandeur.

Article coding stopped once a substantial corpus of diverse material (across different sources, type and year) and data saturation was achieved, in line with qualitative research techniques (Boddy, 2016). The coding was conducted using NVivo qualitative analysis software.

3.3. Analytical Framework

Our analysis is framed through the sociology of normality (Shove, 2003), which explores how expectations for everyday life come into being in relation to technological innovations and design. In her book, *Comfort, Cleanliness and Convenience* (the 3Cs), Shove explores the making and remaking of normal expectations through the 3Cs framework. She demonstrates how technological innovation, product marketing, and changing meanings and competencies associated with practices like heating and laundering, have come to change expectations of normality. Importantly, this is not a one-way or linear process, through which any one thing (such as advertising) determines how people think or what they do. Following Shove's understanding of normality and other related concepts from Science and Technology Studies such as 'scripting' (Akrich, 1992), our analytical framework allows us to explore how marketing and political ideas infuse the design of devices and intentions for their use, which are then interpreted by people as part of their everyday routines and practices.

In this paper, we approach pleasance as a form of promoted normality put forward by smart home proponents and scripted into the design of devices. We first came across the concept of pleasance when pursuing smart home promotional websites. As already mentioned, pleasance is a term used by Lutron home automation to describe how their technologies provide "comfort, romance and peace-of-mind" (Lutron, 2015). We approached our analysis as a way of both identifying different instantiations of pleasance, and thematically defining and understanding its qualities as described and visually represented within online and magazine articles. Our selection of the pleasance term also reflects our intention to draw on industry language and terminology wherever possible, as per the in vivo coding method described above.

We therefore adopt the concept of pleasance as our starting point to identify and interrogate the core qualities underpinning this 'normal' vision for everyday life through our thematic analysis, and discuss how these qualities harness technological innovation and product marketing in their attempts to transform

everyday practices in the home, such as those concerning thermal comfort and lighting.

3.4 Theme Identification

Our analysis generated seven themes or 'qualities' that underpin the overall vision or meta-theme of pleasance, and were frequently reflected in the evocative language used in the articles we coded.

Our qualitative approach means that we are unable to generalize our findings to all media and online outlets writing about the smart home. Nonetheless, the consistency of themes occurring across our sample indicates that the findings are likely to have wider relevance for representations and visions of the smart home. Providing insights of this kind is consistent with the analysis of other qualitative materials (e.g. interviews).

We approach our findings below by briefly outlining the key qualities of pleasance. In doing so we focus on the benefits or enhancements discussed in smart home articles, and therefore minimize discussion of the less positive commentary. For example, some authors raised potential security and privacy concerns, 'glitches' preventing some technologies from working as intended, or unnecessary or undesirable complexity. These problems were generally expected to be resolved as smart home technologies matured and households embraced their anticipated benefits. Our paper should therefore be read with the understanding that it presents a positive bias of the smart home as represented in the popular articles we analyzed.

After identifying the qualities of pleasance, we delve into the ways this vision is manifested through the promotion of two smart home devices: automated thermostats and networked lighting. In each example we focus on different lifestyle expectations for pleasance, namely improved comfort (smart thermostats) and relaxation or entertainment (networked lighting). Our selection of these devices is exemplary of the broader expression of pleasance found across the content analysis. These specific product categories were selected because they are commercially available devices with fast growing markets and some available user studies already conducted on their energy-saving outcomes.

4. Key findings

Our analysis found that, on the whole, consumer and trade articles espouse a lifestyle vision that promotes an enhanced quality of life. More specifically, the articles we analyzed conveyed ideas about how their users' lives will be improved through the superior quality of their experiences, mirroring (or consistent with) the Lutron website's use of the term 'pleasance'. While smart home articles also discussed practical user applications, these were often secondary to the ways in which these devices were expected to embellish households' lifestyles and enhance the home environment.

In the following discussion we elaborate on our findings in two ways. First, we briefly define the overarching vision of 'pleasance'. Second, we unfold the concept of pleasance into seven qualities.

4.1. Pursuing pleasance

The images analyzed through our study served to complement the text and stimulate the reader's imagination by depicting evocative scenes and lifestyles. Most images featured a room inside someone's house (50 images), a device or technology (44), or a demonstration house (26). The images mainly depicted spacious and open-plan rooms inside large detached dwellings. In addition, wealth, luxury and grandeur were depicted in extra-large 'showcase' smart homes with landscaped or mood-lit gardens, pools and spas, and/or outdoor and indoor cinema rooms. With people largely absent in the images (present in less than one sixth) – and rooms, homes and technologies foregrounded – readers were invited to imagine themselves inside this future decadent lifestyle. Such imagination was also supported through article text:

> *"Imagine flipping on your home's lights via a remote control on your car visor, never more arriving to a dark home at night. Picture a beautiful canvas hung above your fireplace, which rolls up to reveal a TV Envision – a home theater system in which your cataloged DVDs could be searched by title, actor, director and/or genre. Conceive of a 'vacation mode' button on your light switch that records your light usage for two weeks prior to take-off and then plays the pattern back while you are away"* (Jaffe 2008).

The stylistic trope of inviting readers to 'imagine' living in a smart home was a common feature of the articles we analyzed, as illustrated by the article quote above. Other articles encouraged readers to *"imagine having a house chock-full of smart devices"* (Betters, 2015), *"imagine walking into a home theatre and having the window shades automatically begin to lower when you close the entryway door"* (Sienkiewicz, 2013), or *"imagine one person being on holidays anywhere in the world and being able to check on his/her home from the laptop"* (Anon., 2006).

As these examples illustrate, smart home articles invited readers to place themselves inside an imaginary future where everyday life is simplified, personalized, secure and more pleasurable. This is distinct from the historical promotion of appliances and homes, which has tended to emphasize freeing up occupants' time for *leisure* (Forty, 1986; Schwartz Cowan, 1989), rather than enhancing activities in the pursuit of *pleasure*.

This reflects Lutron home automation company's definition of pleasance, which they describe as "a fundamental feeling that is hard to define but that people desire to experience" (Lutron, 2015: p3). Heckman (2008) has previously alluded to the importance of this vision, although he uses a different term to describe it. He argues that the smart home is oriented towards "the Perfect Day … [a] technologically enhanced mode of daily living … [which] cultivat[es] the terrain between impulse and gratification … [by] offering up customized solutions and experiences" (Heckman, 2008: p15). Pleasance builds on Heckman's vision for the smart home, and in particular the modes of pleasure delivered through 'impulse and gratification'.

Articles that ask readers to imagine themselves inside the smart home are also similar to past technological utopian visions such as ubiquitous computing, which have been concerned with what Dourish and Bell (2011: p20) call a "proximate future", or a future that is just around the corner. Pleasance is unique

in orienting everyday life towards a version of contemporary hedonism or technological utopianism featuring networked and automated devices pervading all facets of the home. It is *"the pursuit of lavish entertaining, convenience and comfort"* (Rushing, 2015) that promises to deliver accessible pleasures to the whole household.

4.2. Qualities of pleasance

Within the broad vision of pleasance, our study revealed seven main qualities of pleasance: 1) aesthetic experience, 2) fun and cool, 3) customization and control, 4) convenience and simplicity, 5) peace of mind, 6) extension and expansion, and 7) effortless energy-saving. These are summarized in Table 2, alongside their typical devices and functionalities. We discuss each quality in more detail below.

This is not an exhaustive list, but rather an exemplary set of principles that underpin the pursuit of pleasance in the smart home. The qualities are not mutually exclusive, as most articles emphasized several or all of them, rather than separating them out as we do here for analysis.

<Table 2 appears here>

4.2.1. Aesthetic experience and atmosphere

Pleasance is primarily concerned with generating an **aesthetic experience,** which best reflects what Pink (2012: p119] describes as "the sensory, affective and satisfying dimensions of everyday life". Articles emphasizing this attribute typically focused on the appearance, comfort, ambience, or 'feel' of the home which residents can expect to experience. As Berry et al. (2007: p240) observe, this pursuit typically involves some technologies receding into the background, "blending seamlessly with walls, ceilings and doors, furniture, decorative features and outdoor spaces", while other features are foregrounded to revitalize the ambiance of the home. These aspirations of 'blending' and 'receding' were also reflected in our analysis, with articles frequently promoting the idea of "*hiding gear* [in order] *to preserve the serene aesthetic throughout your home"* (Rushing, 2014).

Aesthetic experiences were typically discussed in relation to lighting, comfort or audio-visual enhancements that focus on generating a particular mood, or appealing to the senses. For example, one article discussed how *"a home's lighting and entertainment systems* [should be] *designed to reflect the changing needs and moods of its occupants"* (Anon., 2010). The following excerpt is a typical example of the kind of new aesthetic experiences offered:

> *"During a holiday gathering, you might activate a zone to call attention to a family portrait above the mantel; at a cocktail party a different zone of lights could be activated to bring out the color and texture of cozy furnishings in the sitting area"* (EH Staff, 2014b).

Other articles referred to the smart home's aesthetic qualities as *"a plethora of styles, colors and finishes"* (EH Staff, 2014a) designed to add "*sophistication and elegance to a home's appearance"* (EH Staff, 2014d) through the integration of smart technology. As these examples illustrate, the emphasis is on the 'look' and 'feel' of the home, and its ability to help cultivate and curate moods or 'scenes'.

4.2.2. Fun and cool

As well as enhancing the mood, smart homes were discussed as being full of *"cool stuff"* (Shapiro, 2013) and *"something the whole family can enjoy*" (Iozzio, 2015). Pleasance is therefore also about creating a **fun and cool** home environment. As one article put it, *"a family that plays together, stays together".* This article went on to suggest that home automation is *"a lot of fun for the entire family"* and can *"bring the family closer together as everyone learns about the technology's capabilities together"* (Iozzio, 2015). In this way, smart home technology is positioned as a source of pleasure for households, adding a bit of "*frills (or fun) to our lives"* (Iozzio, 2015). Specific sources of this fun include "*apps that can turn your lights into a disco party, flash when your team scores a touchdown or turn your living room into the colors of the Amazon rain forest"* (Tuohy, 2015a). The living or family room was identified as a common 'playground', and described by one article as "*definitely the most fun space to outfit with a host of digital gadgets"* (Colon, 2015).

Articles involving interviews with smart home entrepreneurs or company representatives also noted how much their customers "*love*" the technology, how their clients are "*thrilled*" with the result, or how *"we get to make people happy"* (EH Staff, 2015a). Similarly, one smart home customer quoted in an article described it as *"a joy and a pleasure to have one remote or one keypad for use to operate all the audio, temp controls, shades, and window treatments"* (Rushing, 2015). Other sources of potential fun included the opportunity to create a *"party atmosphere"* (Rushing, 2015), an *"automation playground"* (Montgomery, 2014), or to *"amp up the entertainment factor"* (Anon., 2014).

This speaks to a further source of fun and 'coolness' identified in the articles: namely the ability to 'showcase' or 'show off' a property's features, thereby allowing home owners and smart tech users to capitalize on their *"bragging rights"* (Cericola, 2015). Other devices were *"uber cool"* in their own right, such as motorization, which one article described as being able to make "*jaws drop and eyebrows lift … in a James Bond kind of way*" (EH Staff, 2014c). Articles played on the novel technological nature of smart home devices as providing an intrinsic source of pleasure.

4.2.3. Customization and control

A third quality of pleasance was **customization and control.** Every household was presented as unique, with its own needs and preferences. Articles typically discussed this quality by emphasizing the ability of devices to provide *"a tailored response"* (Perkins, 2015) or *"optimal individualized control"* (Anon., 2008) that can be customized room-by-room or device-by-device. A familiar piece of advice went something like this:

> *"Automation is only beneficial and practical if it fits your lifestyle. Since everyone's lifestyle is different, the manufacturer should provide its dealers with the tools to customize the system to your specific needs"* (Montgomery, 2015a).

Pleasance is therefore not presented as a 'one size fits all solution' (in contrast to a related device such as smart metering); indeed, part of its appeal involves promising the aspiring smart home owner ever greater choice and control over their own home.

Personalization of the smart home was often discussed in relation to the creation of scenes (rule-based automation) that allow users to control multiple devices or functions simultaneously through, for example, a *"custom-labelled button on a lighting control keypad*" (EH Staff, 2014a) (enabled through a smart phone or tablet application). These could include personalized 'Welcome Home' and 'Goodbye' scenes tailored towards the preferences of each household.

4.1.4. Convenience and simplicity

A focus on custom scenes that combine multiple functionalities together was also connected to the quality of **convenience and simplicity.** This was commonly reflected in phrases such as *"one touch button"* (Montgomery, 2015a) or *"all-in-one solutions"* (Green, 2016) where the goal is to create improved convenience through connectivity, integration and scalability.

In contrast to historical analyses of home appliances, which have emphasized their labour- and time-saving benefits, smart home convenience was commonly discussed as a way to "*make it easier to complete daily tasks"* (Pickett, 2015). While some articles espoused the ultimate goal as allowing occupants to *"just sit back and let your house do the work"* (Anon., 2000), convenience was more commonly expressed in relation to combining multiple functionalities together (through scenes as discussed above), or simplifying complex tasks through smart control and automation. One article summed this up as *"an amazing list of magical things* [that] *can be programmed to happen automatically based on changes in particular aspects of the home's environment"* (Sienkiewicz, 2013).

As such, greater convenience was identified as delivering pleasance by reassuring and soothing householders through mundane tasks and chores. As one article put it:

> *"Having your living room lights turn on as you arrive home, the stereo playing your favourite song and the door opening as you approach with a bagful of groceries is perhaps the ultimate luxury of the smart home"* (Tuohy, 2015a).

4.2.5. Peace of mind

Pleasance can also be realised by providing householders with **peace of mind.** Memory lapses, trips away, stay-at-home pets and troublesome teenagers or neighbors were reportedly addressed through security features and monitoring equipment that removed any potential cause for anxiety. Articles suggested that smart home sensors *"have your back"* (Little, 2015), and that "*electronic door locks and security notifications provide greater peace of mind"* (EH Staff, 2015c). In this way, home automation and security systems were promoted as performing the twin functions of a *"watchdog and personal assistant, providing a Web feed of your front-door cam or sending you a text message when the kids get home"* (Wardell, 2004). Another article claimed that home occupants can:

> *"…never again worry about your home while you're away. Using home video cameras and an Internet connection, you can check on the status of your home or kids from anywhere in the world using a PC or web-enabled phone"* (Anon., 2015)

Similarly, some articles promoted scheduling lighting systems on randomized scripts *"to simulate a person moving around the house to different rooms, turning*

lights and appliances on and off" (DeMaria, 2002).

Smart home devices were also identified as being able to remember to do things when people forget, and 'take care' of the home when occupants are away or absent. As one article put it, *"you'll finally be able to relax, knowing that your house has the know-how to ward off intruders on its own"* (Anon., 2000). Privacy and security were thus positioned as delivering peace of mind – and through this, relaxation and enhanced pleasure – enabled by live-stream cameras, monitoring equipment and remote property access. Put simply, *"high security is part of high living"* (Anon., 2000).

4.2.6. Extension and expansion

Delivering 'peace of mind' also allows for and requires new forms of **extension and expansion,** in which pleasance permeates all areas of life. This was described in articles as inherently spatial, involving being *"anywhere in the world"* (Anon., 2006) whilst still being in touch with, and in control of, the home.

Expanding outwards from the house, articles promoted pleasance's extension into gardens and outdoor entertaining areas, creating a *"whole-of-property experience"* (Castle, 2015a). This was commonly discussed as a way to expand a property's living areas, by "*bring[ing] the comforts of indoor living—audio, video, security, and reliable Wi-Fi and cellphone service—to the entire property"* (EH Staff, 2015a). Additionally, smart home technology could bring the outdoor environment inside the home. For example, one article emphasized how a property's 29 security cameras *"capture images of wildlife around the property—and provide security"*. More specifically:

> *"When an animal passes by a camera, its built-in motion sensor signals the home's Savant automation system to activate every TV in the residence (eight total). The TVs tune automatically to a preset 'wildlife station,' giving the owner a close-up view of the many deer, birds, squirrels, and other creatures that stop by for a visit. If the owners happen to be already watching TV, the camera footage pops up in a picture-in-picture window"* (Montgomery, 2015b).

In these ways the property owners were able to enjoy an expanded appreciation of their property and the other creatures that inhabited it.

Similarly, another article recommended home automation to *"illuminate outside pathways; showcase outdoor artwork; and create mood by turning the pool blue or purple with fiber optics while the negative edge creates a soothing sound"* (Anon., 2005). These kinds of enhancements were intended to allow homeowners and residents to fully appreciate their entire property.

4.2.7. Effortless energy-saving

In addition to these pleasure-enhancement qualities of the smart home, articles also promised that technologies would deliver **effortless energy-saving.** This quality was typically discussed in relation to devices being efficient or switching off when not being used. Energy savings were positioned as easy for households to achieve by avoiding unnecessary 'wastage' but without compromising improved lifestyle features delivered through the other qualities of pleasance.

For example, some articles emphasized that home automation can help householders *"save money on utilities"* and be *"good for the environment"* (Fritz,

2015). Specific devices, such as smart thermostats and smart lights were commonly promoted as ways "*to cut electricity costs and have more control over energy use*" (Perkins, 2015). Some articles promoted other sustainability benefits of smart home technologies, such as automated water sprinklers that can set a schedule based on the weather and geography, or solar panels that can be coordinated with automated appliances.

Energy monitoring devices, similar to those which provide eco-feedback, were also put forward as an energy saving feature in some articles, as were remote control functionalities for appliances. However, these features could be simultaneously promoted as ways to further *consume* energy:

> *"An example: if you want the aircon roaring before you come home, buy one of these energy monitors, plug it in to the plug you connect your aircon to, add it to the app, and use the app to turn it on before you get home"* (Jayne, 2015).

Most energy-saving features were discussed in tandem with the other qualities of pleasance, as the following evocative excerpt illustrates:

> *"Rick presses a button on a control panel, and the lights that the children left on downstairs are shut off, the alarm system is armed, and the heat is lowered. The house even prepares for the morning. After Rick wakes up, he'll hear the soft strains of Brazilian jazz as he steps onto the recently heated bathroom floor. When he gets out of the shower, his towel will be waiting on a warming rack"* (Kirschner, 2000).

Importantly, the everyday luxuries Rick is enjoying in this quote (such as surround sound, heated floors and warmed towels) involve new forms of consumption for most households. Home automation thus promises to reduce energy waste by lowering the thermostat and turning off unused lights, whilst also delivering other qualities of pleasance that may result in *more* energy demand. We elaborate on this finding below.

5. The pleasance of two types of smart home devices

In this section we discuss how the qualities of pleasance identified above inform the design of two specific smart home device categories: 1) smart thermostats and 2) networked lighting. Drawing on our study of smart home articles and related literature, we're interested in the pleasance expectations promoted in relation to these devices, and the possible energy implications associated with them. We focus on smart thermostats and automated lighting as exemplars of emerging smart home technologies – neither were readily available or accessible even ten years ago.

5.1. Smart thermostats

Smart thermostats pursue pleasance by enhancing the **aesthetic experience and atmosphere** of the home (in the form of comfort) whilst promising **effortless energy-saving**. These aspirations were reflected in smart home

articles we reviewed which claim that *"all smart thermostats share a common goal: save money while staying comfortable"* (Iozzio, 2015).

Energy savings from smart, automated or connected thermostats, such as the Nest Learning Thermostat, are typically claimed to be in the 20-30% range (Smarttherm Ultimate Devices Reviews, 2016). However, York et al.'s review of studies found that averages of 10-12% savings on heating and 15% savings on cooling are more realistic (York et al., 2015). Nest's own surveys indicate that, compared to programmable timer thermostats, the heating savings are about 7%, and cooling savings are just a few percent (Nest Labs, 2015: 11).

Smart thermostats aim to overcome householders' previous failure to use programmable thermostats as designers anticipated (York et al., 2015). Savings come from the smart thermostat learning when to adjust the setpoint when people aren't home or are sleeping, thus maintaining comfort and effortlessly saving energy. Some thermostats, such as the Nest, do this by learning householders' routines and eventually *"tak[ing] over, so when you wake up or arrive home, the house will already be at your ideal climate"* (Iozzio, 2015). Similarly, the Honeywell Lyric Thermostat tracks householders' whereabouts, and can be set to turn on or off when householders pass a pre-set distance from the house. Smart thermostats thus embody other qualities of pleasance, promising **peace of mind** and **convenience and simplicity** in the delivery of customized comfort. Additionally, they are also sometimes discussed as **fun and cool** ways to optimize the temperature of the home, and save energy. As one author writes:

> *"Imagine the money you can save—by touching one button on a smartphone as you leave the house, you can have the lights switch off, the motorized shades close, and the thermostats set back. Energy savings is finally in vogue and – dare we say – cool"* (Castle, 2015b).

Other smart thermostats *"allow the simple touch of a button to tell your heating and cooling system that you are 'coming home' or 'leaving home,' getting your home to the ideal temperature, no matter what your schedule brings"* (Little, 2015). Here the pleasance quality of **extension and expansion** provides new opportunities for households to save *and use* energy in the pursuit of comfort, such as turning thermostats on or off remotely. Importantly, these devices assume that householders want (or need) thermostatically-controlled comfort at all times when they are at home. However, many households in diverse regions of the world either don't regularly use air conditioning, or only turn it on when they really 'need' it, resulting in sporadic and intermittent usage (Chappells & Shove, 2005; Strengers, 2010; Winter, 2013).

Another interesting finding from our article analysis is that even though automated windows and blinds are commercially available and can assist with improving thermal comfort by blocking out, letting in and containing radiated heat or cool breezes, articles discussing their benefits focused on the qualities of aesthetics, convenience and peace of mind, rather than their energy-saving potential. For example, one article advised that:

> *"The effectiveness of your intended ambiance will often be at the mercy of sunlight. For this reason, it's wise to complement your smart lighting*

> *products and systems with motorized window treatments. … The window coverings can adjust to allow sunlight to contribute to the look and feel of the interior and to weave the outdoor scenery into the room environment"* (EH Staff, 2014d)

Likewise, reference to energy-efficient passive or adaptive comfort standards (Clear et al., 2013) were largely absent in the articles. Instead, text and imagery of smart thermostats and automated climate control systems presented the thermostat as the sole method of achieving comfort in the home (see Figure 1).

<Figure 1 appears here>

What these findings suggest is that as well as responding to and learning householders' existing *"wants and needs"* (Vella, 2014), smart thermostats implicitly recommend new ones. In particular, they promote interactions which may *increase* energy use and encourage further homogenization and convergence towards thermostatically-controlled indoor comfort standards. User evaluation studies of smart thermostats often overlook these potential implications, as others have described (Yang et al., 2014; Alan et al., 2016).

In summary, we see that our seven qualities of pleasance infuse the design and promotion of smart thermostats in articles written about them. Additionally, the focus on the thermostat comes at the potential exclusion of other ways of providing comfort, such as making use of shading, breezeways, draught proofing or other adaptive comfort principles.

5.2. Networked lighting

Networked, automated and remotely controlled lights, such as Philips Hue and Belkin WeMo products, are accessible and affordable components of the smart home (Strengers et al., 2016). A Deloitte Consumer Review on the connected home suggests that smart lighting devices are a likely area of growth, with two fifths of UK consumers expected to replace their lighting with connected devices once they 'need to' (Deloitte, 2016). Available as 'off-the-shelf' or 'plug-and-play' devices, starter bulb kits can be purchased from most major electronics, homewares and hardware retailers. They typically involve two or more networked light bulbs which are controlled or automated via a smartphone app. Networked lights can also be controlled and automated through voice-activation (e.g. via Google Home or Amazon Alexa), programmed switches mounted to walls, or centralized control panels.

While lighting has long been associated with the creation of atmosphere, wellbeing, comfort and coziness (Bille, 2015), automated lighting affords new **aesthetic experiences** intended to realize pleasance, as found in our content analysis. One designer interviewed for a *Connected Home* article described this as another form of **extension and expansion**, whereby ordinary objects and experiences are taken 'beyond' their functionality to extend their affective potential. They explained this as follows: *"Light can do wonderful things for your body, so we looked to develop something that could help you relax, concentrate or re-energise"* (in Skelton, 2015).

In this way, our analysis found that automated lighting was increasingly enrolled in generating **customizable and controllable** scenes and moods with

names such as *"Relax, Deep Sea, Energise, Cherry Blossom, Cozy Flame and Fairy Woods"* (O'Boyle, 2015) involving different combinations of color and the placement of lighting (e.g. as backlit colored strip lighting behind benches on under tables and beds).

This simple act of *"setting the perfect mood in your home with the touch of a button"* (Tuohy, 2015b) was discussed as a way to involve lighting in the curation and enhancement of both mundane and luxurious activities (such as eating dinner, vacuuming the floor, watching television, taking a bath or entertaining friends). These enhanced affordances of lighting were also emphasized in the imagery we analyzed, and were depicted through multiple colors, mood-lit alcoves, and extensive property (outdoor) lighting (see Figure 2).

<Figure 2 appears here>

Smart lighting was also discussed as a way of making ordinary lighting **convenient and simple,** while simultaneously being personalized through pre-set schedules such as 'Good Night' mode, which can automatically shut down a range of different appliances and devices in the home, including lighting. While this has clear **effortless energy-saving** benefits, it can also provide new opportunities to consume energy. For example, some smart lighting systems were discussed as being able to provide *"Away"* or "*Vacation"* modes, where *"a control system can evoke a lived-in look by randomly turning lights on/off and raising/lowering shades*" (EH Staff, 2014d). This involves turning more lights on to deter potential intruders and provide **peace-of-mind** – a task traditionally delegated to neighbors, friends or a smaller number of lamps with electronic timers, as mentioned earlier.

Additionally, lighting was commonly discussed as a source of **fun and coolness**, particularly for families. As well as enhancing parties and entertainment (see above), lighting scenes were described as playful and creative. For example, one author described how smart lighting could provide *"all sorts of exciting functions that make it much more fun than your standard light bulb"* (O'Boyle, 2015). While these lighting ideas are not necessarily new, home automation makes them more accessible and widespread throughout the home and property.

The energy implications from our analysis of smart lighting are unclear. While smart bulbs typically use LEDs which are more efficient than other forms of lighting, the networked standby energy consumption for smart lighting can exceed that for producing light itself (IEA, 2016). However, a bigger concern identified here is that, like smart thermostats, smart lighting may also promote new energy consuming expectations in the smart home. As discussed above, these new 'needs' include securing the property while occupants are away, providing aesthetic experiences across the whole property, decorating and drawing neighbor and passerby attention to the home and garden, helping to moderate moods for sleep and other activities, and providing a source of fun and entertainment.

In summary, our seven qualities of pleasance underpin the discussion of automated lighting in the smart home articles we analyzed. While effortless

energy-saving is part of automated lighting and could be one outcome, the opposite outcome could also eventuate.

6. Discussion: implications for work on sustainability in HCI

Based on our study of smart home articles in popular consumer and trade outlets, and our analysis of two types of smart home devices, we now discuss possible implications for work on sustainability in HCI.

Design has always played a critical role in imagining a 'better life'. Pleasance is a possible new iteration; a contemporary sociotechnical imaginary (Jasanoff & Kim, 2015) designed to inspire and unite us towards a common goal. While utopian visions rarely work out as planned, they are productive in orienting our gaze towards a desired state (Dourish & Bell, 2011). This makes pleasance a particularly influential vision that deserves further critical attention from HCI scholars and practitioners.

Our analysis demonstrates where the qualities of pleasance may serve to undermine one another in the pursuit of energy-saving outcomes in the smart home. Furthermore, in better understanding these qualities and how they circulate through narratives present in smart home articles, we are able to consider the potential impact and outcome of reframing pleasance to better pursue sustainability goals. We therefore contend that HCI scholars and practitioners who wish to pursue sustainability objectives have an important opportunity – and even an *obligation* – to consider the resource intensity embedded into the visions of everyday life they assume and circulate through research and design.

The opportunities for re-envisioning pleasance are endless, and could involve or exclude smart home technologies. One method is to imagine and design desirable ways of life into devices that use less energy, as we have begun to do elsewhere with colleagues (Jensen et al. 2018a, 2018b). HCI and related disciplines provide much inspiration for this. Examples include designing for 'slow time' (Odom et al., 2014), 'downtime' (Leshed & Sengers, 2011) or low-energy aesthetic experiences which are restful, rejuvenating and positive for family interaction, such as prioritizing 'simplicity' (Vannini & Taggart, 2015). Reimagining pleasance could also seek to extend Chapman's (2005) ideas of emotionally durable design into devices, associating pleasance with an aesthetic of care, familiarity and cherishing, rather than ongoing consumption. The important point is to focus on the qualities of the experiences that pleasance seeks to generate through different smart home devices, rather than only attempting to make those devices more efficient or less 'wasteful' in their consumption of *existing* energy demand.

Another opportunity might involve working with research participants to reimagine low-energy pleasance by focusing on their own visions of 'the good life' through cultural probes and other participatory methodologies. This could take inspiration from studies of happiness and liveability, which are often critical of consumerism and its impact on wellbeing. (For a summary see Szejnwald & Vergragt, 2016). Instead, this research might lead to a renewed emphasis on the importance of social and family connections, access to green and open spaces, and leisure activities beyond the home (Glaeser, 2011).

Additionally, design fiction, speculative design (Dunne & Raby, 2013) and provocative design (Raptis et al. 2017) provide HCI practitioners with further opportunities for imagining different kinds of futures, or intervening in possible futures, through which what is valued or desired might change. Such research could start with questions about how people might want to live in resource constrained scenarios, or in societies that place a renewed emphasis on values that are more likely to deliver sustainability outcomes. Design fiction scenarios might also contemplate how HCI design might itself intervene in different modes of living, working or mobility to improve sustainability. Alternatively, provocative design methods could be used to challenge and disrupt the dominant narrative of pleasance, or provide alternative perspectives that suggest pleasance may have a sinister or less desirable side (by being overly helpful, or 'creepy', for example (Pierce 2019)).

Recognizing that many HCI designers work with specific devices, rather than the broader visions encompassing sites of new technologies such as the smart home, we will below consider how this re-envisioning could be approached on the scale of the two types of devices, smart thermostats and automated lighting, discussed in this paper. This discussion is summarized in Table 3.

<Table 3 appears here>

6.1. Smart thermostats: lower energy comfort

One way the HCI community could assist in lowering the energy demand associated with smart thermostats is to stop focusing on them as a design solution. The emphasis on the thermostat, rather than other designs for thermal comfort or "thermal delight" (Heschong, 1979), dramatically limit design possibilities by assuming the need for mechanical (thermostatically-controlled) heating or cooling. Designing for lower energy comfort, as other HCI researchers have considered (Kuijer & De Jong, 2012), diversifies the options available.

Examples include an early study by Intille (2002), which investigated the potential of automated alerts, combined with temperature and wind sensors, that notified occupants when it was a good time to open a window. Other disciplines also provide insight. For example, 'high-tech' solutions are emerging from the health sector involving the use of cooling and warming suits, vests, mats and underwear designed to regulate the body's temperature for outdoor workers in extreme weather conditions (Furtado et al., 2007), or for pets who are at home during the day (Strengers et al. 2019). In architecture and engineering a large body of work continues on how to design for passive and adaptive thermal environments which prioritize the active involvement of householders in maintaining comfort (Winter, 2016). Additionally, public cooling centers and community water splash parks are gaining popularity as a community, health and climate change adaptation response to heat stress (Farbotko & Waitt, 2011). These approaches provide alternatives to whole-of-house, thermostatically controlled heating and cooling, promoted through the smart home articles we analyzed and upheld by the vision of pleasance.

Another way to think about lowering the energy demand of smart thermostats is to consider how to vary the comfort expectations embedded into their design, by prioritizing lower energy standards. International comfort studies have shown that householders commonly turn heating and cooling on 'when they

need it'. They also rely heavily on other methods and materials to maintain comfort, such as opening or closing windows, doors and blinds; adjusting clothing; eating different foods and drinks; taking hot or cold showers; or adjusting their activity (Chappells & Shove, 2005; de Vet, 2014; Hitchings, 2011; Moore et al., 2016; Strengers & Maller, 2011). Other research has challenged the very idea that people desire to be comfortable all the time; instead demonstrating that they may prefer to experience a range of thermal conditions which put them in touch with the natural environment and seasonal variations (Heschong, 1979; Vannini et al., 2012; Winter, 2016). Research which indicates that temperature variation may be good for health also presents an interesting new avenue to link energy saving with a healthy lifestyle (Lichtenbelt et al., 2017).

One HCI study by Clear et al. (2014) took up some of these ideas by investigating the potential to 'drift' indoor temperatures lower in winter and higher in summer, allowing for very localized adjustment of heating and cooling, whilst prioritizing other ways of keeping warm and cool (e.g. adjusting clothing, consuming hot and cold drinks). Thermostats could also be designed to switch heating and cooling off entirely during mild periods of weather giving occupants the opportunity to adjust to a wider range of indoor temperatures, as is already the case in many homes (Huebner et al., 2013), or provide an opportunity to manually reactivate the system if thermal comfort is not practical via other means.

6.2. Automated lighting: lower energy aesthetic experiences

Aesthetics are often considered a matter of 'taste', but they are also a matter of design, underpinned by ideas and aspirations about how we want to live, as demonstrated by this study. The different lighting options discussed in the articles we analyzed promise a particular articulation of aesthetic taste, in which networked lights become integral to modulating mood and achieving both routine and more luxurious activities such as going to sleep, staying comfortable, providing home security, or showing off a property's features to others. In identifying or developing alternative visions to pleasance, it is important to recognize that this aesthetic interpretation contrasts with many other visions for desirable ways of life.

Perhaps the most striking potential design alternative to pleasance lighting comes from visions that emphasize minimal or absent light and technology, such as in communities pursuing voluntary simplicity or off-grid living (Vannini & Taggart, 2015). In mainstream culture, another low-energy vision popular in Australia, the UK and US is the Danish concept of *hygge* (pronounced hoo-ga). *Hygge* loosely translates to cosiness, comfort or pleasure, but it also refers to a way of life which emphasizes intimacy, warmth and togetherness (Wiking, 2016).

This Scandinavian vision emphasizes the ways in which warm lighting shapes atmosphere, emotional experiences and human connection (Bille, 2015). Unlike pleasance, *hygge* advocates candles and low-lit rooms or natural light to achieve a *different* type of pleasance – one which focuses on simple, cosy living and togetherness. Comfort is also a priority in *hygge* designs, by making the most of the natural environment and single-room wood heating, supplemented by hot drinks, home-cooked meals and blankets. While *hygge* also implicitly requires

energy demand, it does not rely heavily on technology. In a related study conducted with some of the authors of this paper, *hygge* provides inspiration for HCI scholars interested in reframing what the desirable and low-energy smart home might look like, through the example of lighting (Jensen et al., 2018b).

Alternatively, new visions might emerge through innovative methods such as sensory ethnography (Pink, 2009; 2012). Following the 'feelings', movements and sensory transformations associated with light (and other practices or the flows between them) could provide ways to design for different low-energy aesthetic expressions as Pink and her colleagues are exploring (Pink, 2012; Pink & Mackley, 2014; Pink & Sumartojo, 2017). An interesting design question raised by this line of enquiry might be about how different forms of light could excite or please the senses to deliver the qualities of pleasance, but without additional energy consumption.

For example, architectural or non-smart designs, such as coloured glass hanging in windows, stained-glass windows, or recycled and colored glass drink bottles built into walls, could create mood lighting at different times of the day in line with the orientation of the sun and the seasons. Likewise, automated blinds, windows, mirrors (that reflect or angle light) and louvres could be used to let in or block out light in order to aid the everyday activities that pleasance seeks to infuse, albeit with less energy consumption than current forms of smart lighting.

Finally, one other way to think about re-envisioning lighting is to focus on the opportunities potentially afforded by simple 'manual' lighting, such as reducing the amount of 'screen time' children are exposed to (by removing the need to control lights on a smartphone), and teaching children practical energy-saving skills (such as turning lights off when not in use) (Nicholls et al. 2017). These kinds of practical strategies may be highly valued by families who are seeking to instil sustainability values in their children, and encourage less time on screens. It is also an approach that resonates with other trends that return to non-smart forms of 'fun and cool' pleasance, such as playing board and card games.

Combined with the speculative methods mentioned earlier, these experiments and enquiries provide fruitful ground for thinking about how to embed low-energy lighting into everyday practices whilst still pursuing a variation of pleasance.

7. Conclusions

In this paper we have interrogated the possible energy and sustainability outcomes of a vision for pleasance circulating in popular news, media and trade articles about the smart home, and provided inspiration for how to re-imagine it. Our study provides additional depth and insights that add to past qualitative studies that have also questioned the energy-savings potential of smart home devices (Hargreaves et al., 2017; Nicholls et al., 2017).

Our analysis suggests that the advocated qualities of pleasance may lead to increased energy demand if more automated and smart devices take hold in households. However, there isn't data available to draw broad conclusions about the energy implications of smart domestic environments. This is partly because of the invisibility of promoted household expectations in products and studies attempting to achieve energy demand reductions – an oversight we have sought to rectify here. Smart thermostats, for example, can achieve direct energy savings

while simultaneously promoting energy-intensive comfort. However, only direct energy savings are currently being measured, and often in high energy use homes (e.g. Nest Labs, 2015, pp. 5-9) or large detached dwellings. There is little to tell us the energy outcome of smart thermostats in homes which are more conservative in heating and cooling consumption, or in other typical dwellings such as two-bedroom terraced houses or apartments.

Making smart home advocates' expectations for the smart home transparent has also provided us with a unique platform to consider alternative design visions for pleasance. This is directly relevant for the HCI community, which has been active in the area of home automation for some time (Brush et al., 2011). As Desjardins et al. (2015) have identified, "smart homes and home automation" is one of the seven genres of domestic technology research in HCI. We have argued that researchers and designers interested in pursuing energy demand reductions and sustainability improvements are in a unique position to disrupt dominant smart home visions, given their extensive contributions towards imagining, designing and provoking alternative futures (Dourish & Bell, 2011; Dunne & Raby, 2013).

Our findings and conclusions are limited by several issues posed by the materials selected for analysis and our analytical approach, as outlined in Section 3. First, the diverse article sources pose a limitation, given their different motivations, agendas and writing styles. However, the unified vision for pleasance found across them also demonstrates its prevalence in relation to the smart home.

A second limitation is that our study has foregrounded the positive qualities of pleasance (as opposed to its potential pitfalls and problems). Further considering the risks of smart home technologies, as other studies have done (e.g. Maalsen & Sadowski, 2019; Pierce, 2019; Wilson et al., 2017) would provide a more nuanced understanding of other potential outcomes, and provide additional insights into how smart home devices are being adopted, rejected and incorporated into the home.

Relatedly, further research could consider how different visions for and interpretations of the smart home coalesce or depart from one another. For example, it would be interesting to compare the vision for pleasance analyzed here with smart home themes from academic literature (Wilson et al., 2014).

From our study and analysis, we draw several conclusions and contributions for the HCI design community to take these findings forward. First, when considering the direct and indirect energy demand of home automation devices, the energy increase has the potential to be most significant in applications which involve heating, cooling, audio and visual media playback, and lighting. These also happen to be the most intensive categories of domestic energy consumption (DECC, 2015). For HCI practitioners and researchers wanting to reduce energy consumption and carbon emissions, these are the most impactful areas.

However, even for applications which should be less intensive, such as remote control or home security, smart devices can be insidious in their aggregate energy consumption: they are typically on all the time, and rely upon networked infrastructures. Wi-Fi routers, for example, can consume more energy than laptops, monitors, and printers (Terry & Palmer, 2016), despite being relatively low power. Thus, HCI practitioners working with any smart home technology

should be mindful of the energy requirements – especially networked standby power – of the hardware and software they intend to deploy.

Second, our study shows that advocates of home automation devices are prioritizing a vision of everyday life which is more energy-intensive than most households currently experience. We conclude that devices explicitly designed to 'save energy' are likely to have limited impact if expectations continue to ratchet upwards in their resource intensity. Therefore, it is crucial that HCI designers consider sustainability objects in combination with the other promoted benefits, visions and uses for smart home devices.

Finally, a key contribution of this paper has been to provide some suggestions for re-imagining pleasance, drawing ideas from within and outside the HCI community. Re-imagining pleasance could involve investigating how the qualities of this vision manifest in specific devices, such as smart thermostats or networked lighting (as we have done here), or it could involve homing in on one or more qualities of this vision, such as aesthetic experience, to imagine low-energy alternatives for its realization. Importantly, this work needs to be pursued in conjunction with households who are already incorporating or wish to incorporate smart home devices into their homes, to understand how the design vision for pleasance translates into people's everyday practices.

More broadly, our focus on visions addresses a gap in HCI research on the "Big Questions" (Beck & Stolterman, 2017). In sustainable HCI, where much of the home automation research is situated, these questions involve extending beyond the "remarkable heterogeneity of methods, orientations, and approaches, which have contributed to the rubric of sustainable HCI" (DiSalvo et al., 2010). In this paper, we have contributed to this pursuit by analyzing the big question of how expectations embedded in devices prioritize certain forms of consumption, and how this state of affairs can be addressed.

We find that the sustainable HCI community is well-placed to continue this re-envisioning work. However, we do not wish to suggest that it is all down to HCI researchers and designers to curb or reverse the ratcheting trend of household expectations. Indeed, the smart home industry, and DIY communities and householders, also play an important role in changing expectations and imagining alternative futures.

As we have argued, there is now an important opportunity for the HCI community to focus on manifesting desirable low-energy ways of life in and for the smart home.

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Source of articles	Type	Years published
124 different sources*	Magazine articles (134)	2000 (5)
	Web articles (136)	2001 (2)
5 most common sources:		2002 (1)
- Electronic House (EH Network) (58)		2003 (2)
- Connected World (15)		2004 (6)
- PC Mag (12)		2005 (4)
- TIME Magazine (9)		2006 (4)
- The Guardian (7)		2007 (1)
		2008 (5)
		2009 (4)
* Additional source information and article titles provided in supplementary document.		2010 (8)
		2011 (2)
		2012 (4)
		2013 (12)
		2014 (79)
		2015 (99)
		2016 (28)

Table 1. Overview of the 270 articles analysed: source, type, and year of publication

Qualities	Typical ideas	Exemplary devices or functionalities
Aesthetic experience and atmosphere	Sensory experiences and thermal comfort help to moderate mood and create opportunities for pleasure, relaxation, romance or entertainment.	Smart thermostats, mood lighting, automated water fountains, surround sound systems, entertainment.
Fun and cool	Devices that allow people to 'play' with technology. Things that people come to 'love' or 'showoff' to others.	Lighting scenes, learning how to use automation, scheduling and controlling different functionalities, voice control.
Customization and control	Each smart home and suite of devices can be uniquely tailored to suit the individual needs of the occupants and household.	Customisable scenes and scenarios for music, lighting, entertainment systems, heating, cooling and other household settings.
Convenience and simplicity	Everything in the smart home is achieved, monitored and managed with less effort and involvement from human occupants.	'One touch' systems, scenes and scenarios, homes and devices that 'take care of themselves'. Child monitors, smart lighting, robotic and automated appliances, self-tracking devices (e.g. fridges that monitor supplies).
Peace of mind	The smart home has 'got your back' with in-built monitoring and security features.	Security systems, automated lighting for security, baby/ children/ pet monitors, health monitors.
Extension and expansion	The home can be accessed from anywhere in the world via smartphone apps; pleasance creates 'whole-of-property' experiences.	Smartphone security apps, outdoor automated features (e.g. water fountains, garden and pool lighting).
Effortless energy-saving	Devices are 'smarter' at turning off, bypassing human laziness, and operating at maximum efficiency.	Efficient devices, smart thermostats, blinds and windows, 'Good night' and 'Away' modes that turn off appliances/ devices, automated energy-saving features.

Table 2. Qualities of pleasance and exemplary smart home devices or functionalities

	Smart thermostats	Networked lighting
Dominant approach and assumptions	The home has predictable routines and setpoints to maintain. Prioritizes mechanical space heating and cooling whenever occupants are at home.	Artificial lighting indicates important and meaningful times of the day. Lighting scenes and automated lighting help balance moods and provide security.
Energy scope and pitfalls	Doesn't account for thermal variation in and between households. Downplays or ignores other expectations and ways of staying comfortable. Can lead to unneeded energy consumption.	After the novelty period, automated lighting programmes may carry on, even if not meaningful or useful. Artificial lighting can undermine opportunities for natural lighting. Standby consumption for network-connected smart lights can be higher than the energy for lighting itself.
Alternative approaches, potentially leading to lower energy use	Automated systems could default to lower temperatures in winter and higher in summer, or switch systems off rather than 'down' when the home is unoccupied or occupants are sleeping. Other designs, such as cooling and warming suits, vests, mats and underwear, could provide alternative ways of staying comfortable. Automated passive design features could provide for new forms of 'thermal delight' and adaptive comfort. Public cooling centers and community water splash parks provide alternatives to home-based automated and mechanical forms of comfort. Digital interaction could facilitate reflection, problem solving, and suggest different ways of keeping comfortable.	Smart homes could prioritize and promote natural lighting (e.g. automated skylights and blinds) or low levels of lighting for relaxation activities through concepts such as *hygge* (Danish coziness). Mood lighting could be reserved for special occasions (just as how 'fairy lights' are brought out for certain holidays), or used in one room. Mood lighting could be created using non-electric designs and natural lighting, such as with recycled, reused or stained colored glass. Based on light sensor data, systems could point out when natural lighting (and minimal or no lighting) could be used to support diurnal patterns and household health. Automated blinds, windows, mirrors (that reflect light) and louvres could provide opportunities for natural lighting to support different activities. Manual lighting provides opportunities to lower children's screen time and promote sustainability values.

Table 3. Two smart home device categories, energy issues, and options to promote lower energy use

Figure 1 Typical smart thermostat image

Figure 2 Seamless design with mood lighting