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Stocktaking of social innovation for energy sufficiency

Deliverable 5.3

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Content

Given the past 40 years of experience with super-efficient technologies that are never quite what they seem, why is there so much effort still devoted to trying to prove to yet another new audience that energy efficiency works? One definition of 'insanity' is doing the same the over and over and expecting different results.

(K. Janda & Topouzi, 2015)

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0. Methodological notes

This deliverable provides the floor for broader and more informed debates on the potentials sufficiency considerations can contribute to the overall reduction of energy consumption of private households. It is based on intensive literature review among others in consumer/consumption journals.

A rather general scan took place in 56 journals, with more detailed search in the following

1. Advance in Consumer Research
2. Consumption, Markets and Culture
3. Ecological Economics
4. Energy Research and Social Science
5. Environmental Policy and Governance
6. History of Retailing and Consumption
7. International Journal of Consumer Studies
8. International Journal of Innovation and Sustainable Development
9. International Journal of Sustainable Development
10. Journal of Cleaner Production
11. Journal of Consumer and Consumption Research
12. Luxury: History, Culture, Consumption
13. Sustainable Development
14. Sustainability: Science, Policy and Practice
15. Sustainable Production and Consumption
16. The Forum for Family and Consumer Issues
17. Working Papers of the Institute for Future Energy Consumer Needs and Behavior

While in the majority of journals sufficiency does not appear at all the few others concentrate on self-sufficiency in a sense of voluntary simplicity. This however, is not what this deliverable intends to communicate. Instead it develops sufficiency in a broader, not at least political context and therefore searches out for framing conditions which support sufficiency thinking and behavior beyond individual sacrifice.

Sufficiency considerations in such a sense were found in more hidden ways in various researches recognizing the limits of efficiency approaches – mainly in energy, environment and housing related journals. The most concrete and developed ideas, however, still seem to be in a project phase and have not made its way to peer reviewed academic journals. Therefore in broad parts the deliverable is based on exemplary projects, mainly found in a German, Swedish and Swiss context. The selection of the final collection of ideas and instrument presented here were steered through exchange and interviews with scholars and practitioners working in the field of e.g. energy efficiency, energy consultancy and 'beyond GDP' research and initiatives.

As the deliverable is exploring new ground the results presented here mainly provide a first food of though and input into an emerging debate. They will be further developed not at least in the workshop 'Beyond Energy Efficiency – How to develop the potentials of energy sufficiency' (Deliverable 5.4) before we can present an 'Identification of promising instruments and instrument mixes to promote energy sufficiency' (Deliverable 5.5) as a final result in the context of this project.

1. The importance of sufficiency to achieve energy targets

The intention of the deliverable is to open up the discussion on energy-sufficiency, explaining the objective necessity, and providing a conceptual basis for the interpretation of available empirical data. So far, while lots of sufficiency initiatives are on their way, the issue itself is not yet fully recognised and the initiatives not adequately valued in their overall contribution to meet climate (and resource) targets.

1.1. The shortcomings of efficiency

In the last four decades, energy efficiency increased significantly in OECD countries. However, only recently, total energy consumption started to decrease a little, and much more slowly than energy efficiency potentials would suggest. The Paris agreement has set a long-term goal of keeping the increase in global average temperature to well below 2 °C above pre-industrial levels and the aim to limit the increase to 1.5 °C, which requires an almost carbon-free economic system by 2050 (80-95% less carbon emissions) in the affluent countries, and a complete global phase out of fossil fuel use by the end of the century. Whereas the latter is an objective energy efficiency can obviously not deliver (as the target is a complete, not a partial replacement), proponents of increasing energy efficiency consider it a key mitigation instrument and capable of reaching the former objective. They continuously highlight that efficiency improvements provide reductions in energy use without corresponding inconvenience or loss of amenity. In this perception, efficiency might best be thought of as a measure of *relative* consumption. Bigger, more powerful, more functional products get to use proportionally more energy or power but can still be labelled as efficient or earn rebates, as long as they use less energy than other equally big, powerful, functional products (Calwell, 2010). Furthermore, efficiency is usually measured for a specific technical system, and not for broader human behavioural patterns: cars become more efficient every year, but also larger and heavier, which about compensates the efficiency gains. Smartphones offer more communication and information options with relatively low energy consumption, but as long as they complement landlines, TV and CD players, their technical efficiency does not decrease overall energy consumption. In the household, fridges get more efficient but as well bigger, heating cost per square meter may decline but the size of living space continues to go up, etc. Finally, the measurement is flawed: improvement estimates are made comparing the status quo to a situation with a prognosted percentage of economic growth without technological improvement, so that any technological progress, but also GDP growth rates lower than expected will testify for efficiency – a highly misguiding measurement approach.

As a result there relative improvements dominate the debate, while the distance to target – the issue of concern to environmental policy – is not the decisive criterion in technology development, marketing and labelling. There is a discrepancy between what is considered optimal from an efficiency point of view (doing things better, with least energy consumption, not doing better things) and what is taken to be needed to reach environmental and social goals such as those defined in the UN Agenda 2030 and the Sustainable Development Goals (Hagbert, 2016).

In fact, efficiency improvements can often be achieved by using efficient technical artefacts and introducing incremental modifications of current unsustainable consumption patterns, without challenging orientations and consumption levels. In order to not only reduce energy consumption as compared to hypothetical scenarios, but to drive it down enough to meet the EU 2030 target and the even more massive reductions in absolute terms implied by the Paris agreement, efficiency is indispensable, but it is not enough.

This is no new insight, however, but and old and inconvenient one. Already in 1997, five years after the famous UNCED Rio Summit, the German Environment Agency (Umweltbundesamt) published a feasibility assessment for the transition to a sustainable society and economy, concluding that the instruments at hand for politics, business and science were in a number of important fields such as energy consumption not sufficient to bring about the changes necessary to reach the goals of sustainable development. It recommended involving societal groups to stimulate changes of individual (consumption) behaviour (UBA Umweltbundesamt, 1997). 14 years later, in the run-up for the UNCSD Rio+20 Summit, the United Nations came to similar conclusions: the UN World Economic and Social Survey 2011, taking a closer look at technology potentials (including renewable energies and organic agriculture, concludes that technology is not enough and must be accompanied by behavioural and consumption change, and that strong governments, able and willing to act, setting up a politically defined framework forcing business sector investment and innovation in a direction towards sustainable development are indispensable (United Nations, 2011).

Efficiency tends to reap the low hanging fruits, but less of them than frequently expected due to rebound effects on the micro- and the macro-level. On the micro level they arise when energy users use the monetary savings resulting from an efficiency improvement for additional energy consumption, reducing the effectiveness of efficiency. On the macro level, increased efficiency in using one input to the production process reduces the consumption and thus the cost (given a constant production volume); the efficiently provided input factor becomes relatively to other inputs cheaper – which is an incentive to use more of it, and the total consumption increases. This effect is known to economists since the 19th century, when higher efficiency stimulated the use of additional coal, as Jevons' paradox (Jevons, 1865). The magnitude of rebound effects, particularly at the whole economy level, is however controversial (Wallenborn, 2015)

Thus essentially it is long known that efficiency is not enough and sufficiency, also referred to as enoughness or strong sustainable consumption (section 1.2) must accompany it and the just as indispensable policy initiatives: neither neglecting consumer involvement, nor delegating responsibility to them offers solutions for the sustainability challenges. This is as true for domestic energy consumption as it is for any other consumption domain (Lorek 2010; Lorek, Spangenberg 2014). Consequently, Europe and (all) other countries also need to look beyond efficiency improvements towards how we can reduce absolute energy consumption, and to seriously discuss and understand what drives consumption (see section 1.3). Thus in addition to lowering energy intensity, increasing productivity and optimizing resource use, energy sufficiency has gained new attention as a way to limit and reduce total energy consumption of a household or a country: we need a profound discussion on sufficiency and limits.

1.2. The need for sufficiency

Figge at al. (2014) argue that the concept of sufficiency is primarily concerned with the reduction of consumption and 'living well on less'. So, in essence where eco-efficiency is concerned with production based on using fewer resources, eco-sufficiency follows the premise that we should limit what is produced or consumed in absolute terms. Sufficiency thus essentially implies being satisfied

with less material goods than usually consumed today, and being satisfied means the no loss of quality of life is implied: needs are to be satisfied in a different way, and conspicuous consumption is to be avoided (Figge, Young, & Barkemeyer, 2014). For instance, taking resource constrains seriously, including the available time, deceleration is considered an important element of sufficiency, offering a different and thrilling way of enjoying things. Sufficiency protagonists welcome the well-established slow food movement, and they support extending the concept to more domains, promoting e.g. a slow travel movement. This includes the re-discovery of places and public urban spaces as sources for recreation and communication supported by an urban planning that prioritises pedestrians and bikers, offering commerce-free zones without consumption obligations and without advertising (Schneidewind, 2013; Schneidewind & Zahrnt, 2014).

Both efficiency and sufficiency require a readiness for behavioural change. However, whereas efficiency can thrive on incremental changes (intentions stay the same, routines are gradually modified), sufficiency not replacing but complementing it tends to be more of a challenge (Pfäffli, 2012). Deliberately choosing alternative behaviour, not necessarily but frequently requiring substantial changes of consumption patterns and reductions in the level of material consumption, can prove disruptive, for own routines and habits as well as for the acceptance of peer groups. The latter is the case when certain consumption patterns are linked to real or claimed group memberships, due to their distinction function. Sufficiency as a mind-set - enoughness as contentedness rather than voluntary simplicity – is a challenging thought in a society of consumption-driven individuals taught to equate materialistic accomplishments with status as well as with identity. To upgrade the value of sufficiency in the affluent society brings about potential for a reorientation towards sustainability (Callmer, 2016).

Thus sufficiency often includes changes requiring the willingness to enter social disputes or even conflicts, which in turn presupposes a significant level of motivation. This can be a high hurdle to be overcome even before real change starts, if not similar reorientations occur simultaneously in significant parts of the singe consumer's peer groups. For instance, the Swiss initiative for a 2000 Watt society has visualized how seriously the shrinking from the actual situation has to be (see Figure 1), illustrating the challenge. This concept, developed by ETH Zürich, aims for a sustained power consumption of 2000 Watt per person (compared to 5400 Watt in 2013) and an output of 1 t CO2eq per person and year (compared to 7,2t in 2013)(2000 Watt Society, 2017)

For behavioural change to happen, opportunity (also called, more technically, feasibility) and desirability must coincide.[1] Opportunities can be legal as well as technical, economic or organisational. Whereas the feasibility of sustainable consumption options is usually pretty well known as far as technical aspects are concerned, its socio-cultural aspects are disputed (on key theoretical differences in interpreting consumer behaviour see below). Desirability (also described, more subjectively, as affordability) has both, subjective and social components. For instance, reducing the energy consumption of households, and in particular the consumption of fossil fuels is generally considered desirable on the macro level, however the impacts on micro level (individuals) and meso-level (households) well-being resulting from such transitions have to be desirable as well, beyond merely economic benefits, to generate stabile motivations and a lasting change. The motivations are influenced by intrinsic and extrinsic drivers: the '*extrinsic factors like disposable income have a significant influence on the availability of consumption options, intrinsic factors shape the choice between the alternatives available. One key factor determining such decisions is the individual assessment if existing alternatives are affordable in terms of purchasing power, time use*

[1] The joint vanishing point of desirability and feasibility has been called a Leitbild (Dierkes, Hoffmann, & Marz, 1992), roughly translated as joint vision. On the role of Leitbilder guiding consumer behaviour and political decision making see e.g. (Lorek, 2010).

preferences, resource endowment, social status and acceptability, legal and ethical constraints, etc. These factors need to play a key role when deriving policies to reduce the resource consumption of households.' (Joachim H. Spangenberg & Lorek, 2002)p. 236). In particular time availability is a determinant of consumer behaviour often neglected in sustainable consumption research (not so in marketing), but increasingly important as time becomes a more and more scarce resource (Cogoy, 1995, 1999). Similar criteria (including the function of goods to maintain or improve self-esteem) apply to goods not traded on markets, but exchanged with or without equivalent compensation, like all services from unpaid work such as caring and supply, housekeeping and education, voluntary and community activities, and so on (Joachim H Spangenberg, 2004).

On the positive side, sufficiency implies a new level of consumer freedom: not having to buy what is fashionable, not to have to keep up with the Jones' (or in other countries with the Wangs or the Müllers) allows focussing on own preferences (except for those groups which have almost no discretionary spending as all their resources are consumed covering daily necessities: sufficiency tries to overcome poverty, not to glorify it). From this perspective, sufficiency means perceiving energy saving behaviour as question of not buying the wrong products instead of buying the right ones (right meaning relatively low consumption, an efficiency perspective). Above the poverty line, this way of rethinking consumption is a promising avenue to the overarching sufficiency objective of being satisfied with less material goods. But how such a reorientation can emerge and be stimulated is still disputed, based on different theories of consumer behaviour.

1.3. Understanding Consumer Behaviour

Two theoretical approaches dominate the current debate: the Theory of Planned Behaviour TPB and its derivates with modified rationality definitions, and Social Practice Theory SPT (Keller, Halkier, & Wilska, 2016). We are analysing the strength of both concepts while being aware of the risk of oversimplification of our social and environmental reality, and the risk of getting lost in complexity.

1.3.1. Individuals and the Theory of Planned Behaviour

Usually, pro-environmental behaviour is defined as '*behavior that consciously seeks to minimize the negative impact of one's actions on the natural and built world*' (Kollmuss & Agyeman, 2002): 240). Consequently, empirical studies on the transformation of consumption practices have often concentrated on the home and domestic everyday life, including eating, cleaning, heating, cooling, washing, showering, lighting, and cooking. Regarding the underlying drivers, analyses of consumption routines have mostly focused on individual determinants, such as environmental attitudes, beliefs, motivation, sociodemographic characteristics or environmental awareness. The contexts in which people act are viewed as external to them and can be both favourable and impeding. The latter are conceptualized as barriers, and intervention programmes often focus on removing such obstacles (Keller et al., 2016). Sustainable consumption policies have then focussed on approaches seeking to effect social change through inducing individuals to make 'better choices', considering individuals and their (mostly isolated) behaviours to be the basic units to be targeted with interventions. The conceptual basis this approach refers to the Theory of Planned Behaviour (Ajzen & Fishbein, 1980; Fishbein & Cappella, 2006), for short TPB, and its diverse derivates like the 'social marketing' approach (Lefebvre, 2013).

The TPB intends to capture an individual's intention to perform a pre-established behaviour (Ceglia, de Oliveira Lima, & Leocádio, 2015). Intention is influenced by the attitude towards a behaviour, subjective norms and perceived behavioural control which can influence behaviour directly as well and is defined as the ability to perform an intention, if the individual has resources and opportunities to perform the action (Ajzen & Fishbein, 1980).

The mainstream policy paradigm interpreted it as postulating a linear relation between knowledge, attitudes, intention and behaviour as well as an underlying rationality of human action, resulting in a number of 'myths' (Mont, Heiskanen, Power, & Kuusi, 2013). They include claims such as 'More information leads to sustainable behaviour', 'Green consumption is the solution', or 'Consumers should lead the shift to sustainability'. Consumer policies based on such myths assumed a rather linear chain from consumer information leading to knowledge and increased awareness, which in turn would stimulate pro-environmental attitudes resulting in changed consumer behaviour. In this simplified view shaping policies, the individual can behave either in a rational and self-interested manner (homo economicus) or as a rule-following social being (homo socialis)(Reckwitz, 2002) and the more or less reflective and rational individuals can be persuaded (often with communicative means) to adopt desired behaviours, to make a calculated choice in the desired direction. That such a simplified version could become hegemonial in policy circles is no pure coincidence: politicians and public administrators are familiar with public awareness raising campaigns as widely used and handy way of attempting to effect behaviour change (from voting to purchasing behaviour). Also, linear models of behaviour change present themselves as simple and sufficiently workable. They seem to be plausible because of their deep entrenchment in individualist thinking, a foundational pillar of the policy dominating economic discourse, and they help avoiding conflicts by appealing to consumers instead of reregulating producers (nudging goes a step further to that direction, see below). Starting from the assumption of rational behaviour, an information deficit is the only possible explanation for the observed unsustainable consumption patterns: the basic assumption necessitates the conclusion that consumers and citizens are in need of adequate or correct knowledge, and that providing this knowledge would be sufficient to cause behavioural change (by the way, this is the same assumption scientists make when being confident that better familiarising decision makers in business and politics with data on climate change or biodiversity loss will automatically lead to different policies)

Subjective factors often neglected in the simplified policy discourse, but included by Ajzen (1991) in his foundational conceptualisation of the Theory of Planned Behaviour, include intention and perceived behaviour control. According to him, the intention needed to practice a certain behaviour is in turn influenced by attitudes and subjective norms. While attitudes as a personal evaluative construct have been shown to be a poor predictor of sustainable consumption (see e.g. (Chandon, Morwitz, & Reinartz, 2005), other research has highlighted its ability to shape overt behaviours (Ajzen & Fishbein, 1980). Thus attitudes may be understood as a necessary but not sufficient factor to shape intentions which then can influence behaviour; their relevance is probably influenced by the subjective assessment of the influence of a decision on certain positive or negative outcome (Ceglia et al., 2015). The other factor influencing behavioural intentions, for instance towards the consumption of sustainable goods, is a normative construct, namely subjective norms (Robinson & Smith, 2002) which are influenced by the perceived likelihood that the social group may accept said behaviour. Thus neither attitudes nor norms are objectively given; they emerge, are shaped and change in exchange with the social environment. For instance, if the values system of a society includes both egoistic and altruistic values, recognising that a certain unsustainable behaviour would lead to adverse consequences for valued objects and for other people (the main objects valued by altruists) can lead to adopting a pro-environmental behavioural intention. Manifest behavioural change can then be expected if the perceived ability to reduce that threat (i.e. the perceived behavioural control) makes the behavioural change appear as an effective means to this end. In this understanding of the TPB, the approach is no longer exclusively individualistic or atomistic, but embedded in social context: sustainable consumption requires that individuals share their knowledge, and engage in collaboration with the different sectors of society (Lozano, 2014).

Individualistic approaches such as the simplified perception of the Theory of Planned Behaviour are still the basis of governance decisions and policy developments, although economic rationality (incl. bounded rationality and incomplete information) has long been proven to be an insufficient

description of humans and their behaviour – it is undercomplex. The concept fails by underestimating the resilience of coupled behavioural routines and thus the difficulties arising from the need for their simultaneous change.

A relatively new derivate of planned behaviour theory, the so-called 'nudging' or 'choice architecture' approach, builds upon cognitive science (decision psychology) and behavioural economics. Unlike in TPB, individuals are characterised as led by 'bounded rationality', oriented towards finding at 'satisficing' rather than optimal results (Gsottbauer & van den Bergh, 2011), guiding them in most habitual situations, where they do not engage in lengthy reflections but rather resort to shortcuts. Choice architecture strategies are derived from experimental research showing that pre-set default options can in some cases have a strong influence on consumers' propensity to make desirable choices, such as choosing green electricity and promotes institutional frameworks in which the desirable options are given as defaults (Keller et al., 2016).

Although 'choice editing' has raised considerable criticism as undermining consumer sovereignty, it is no more doing so than car emission standards or housing energy standards such as those enshrined in the EU Directives; criticism than nudging is anti-democratic seem to be overblown results of a libertarian paradigm set as absolute. Mont et al. argue that '*Policy is never neutral: it shapes social norms and values in society. Policy-makers need to create the 'politics of possibility' towards sustainability by using the plethora of existing and new strategies and tools synergistically*'(Mont et al., 2013): 108). We consider it a useful complement to TPB approaches and a bridge to Social Practice Theory SPT as it tackles the issue of routinized behaviour at least to some extent.

1.3.2. Collectives and the Social Practice Theory

According to sociological studies, environmentally relevant behaviour is part of numerous basic daily routines, such as preparing and having meals, showering, combining the way to work with shopping or organising a home office. These routines are rarely reflected upon and deeply embedded in institutional and infrastructural contexts, which makes them very resistant to change (Darnton, Verplanken, White, & Whitmarsh, 2011; Jackson, 2005; Schäfer, Jaeger-Erben, & Bamberg, 2012). Yet, up until now, the consideration of habitual processes and their embeddedness has mostly been neglected, not only in the analysis of current behavioural patterns but also in terms of its practical implications for the development of appropriate strategies and interventions that can foster pro-environmental behaviour or sustainable consumption practices.

This is the issue Social Practice Theory STP deals with, analysing the characteristics of habitualised everyday behaviour and – at to for some of the researchers – drawing conclusions on how consumption practices could be changed.

Unlike most behavioural approaches in the literature based on assumption of rational (fully or bounded) and planned behaviour as described in section 1.3.1, SPT takes into account that individual behaviour is deeply embedded in social and institutional contexts and is often carried out in a habitualised manner. This way SPT changes the focus of investigation, from analysing the role of individuals and single environmental behaviours to exploring '*social practices ordered across space and time*' (Giddens 1984: 2). From this perspective, understanding change in consumption practices requires not only focusing on specific and located practices (e.g. heating) but also considering the connections between practices across space and time (e.g. household working, socialising, caring etc.). At a closer look, every practice – such as cooking, showering, cleaning, gardening, or taking care of oneself or of others – consists of three interconnected elements (E Shove, Pantzar, & Watson, 2012):

i. materials: objects, infrastructure, tools, hardware and the body itself;

ii. practical knowledge: shared understandings of good and appropriate performance (e.g. rules, norms) as well as skills required to perform; and
iii. meaning: mental activities, emotion and motivational knowledge.

Consequently, SPT concepts suggest that a systematic for greening consumer choices requires providing supportive material conditions, practical knowledge as well as meaning for the performance of sustainable consumption practices. We suggest that this also applies to strategies for greening household energy consumption.

Taking practices consisting of these three elements as the central unit of analysis provides a different view on consumption choices: consumption is then a by-product of practice, of what people 'do' every day and what is meaningful to them; it is not an end in itself. As knowledge is exchanged between agents (and changes with experience), and meaning is a social construct emerging in discourses, individual households cannot be analysed in isolation. It is crucial to understand how people coordinate themselves to jointly develop and perform particular practices.

A consumption practice consists of a multitude of single and often unique actions reproducing the practice, such as getting a hot water boiler or using an energy consumption signalling app (Reckwitz, 2002). For instance, a simple monitoring tool giving real-time visible feedback regarding heating energy consumption can be altering the perception and potentially the meaning of heating and airing (Jensen, Holtz, Baedeker, & Chappin, 2016). Using it to monitor airing and optimise it can improve the perceived in-room air quality, and as far as the 'traffic light' stimulates behavioural modifications over a longer period of time, it contributes to their permanence as the 'new normal'. The example also illustrates that practices exist as performance: it is through performance, through the immediacy of doing, that the pattern provided by the practice-as-entity is continuously reproduced (E Shove et al., 2012). From this perspective, individuals are the 'carriers' of consumption practices. This is a radical departure from more conventional approaches in which understandings, know-how, meanings and purposes are taken to be personal attributes.

Although practices appear to be stable entities in themselves, opportunities for changing them can arise when its elements become disconnected from each other. This can happen under various circumstances:

First, practices can change when a 'population of carriers' – people who perform a practice – changes, through recruitment to or deflection and migration from the practice as well as through variation and redistribution of commitment across participants (Southerton, Olsen, Warde, & Cheng, 2012). Recruitment to practices can occur through social networks but also through law, material networks and cultural norms (such as daily showering). Interventions could, therefore, aim at shaping social relations and networks which hold undesirable practices in place or through which practices propagate (Shove et al. 2012).

Second, practices can change when some of their elements disappear or interconnections between elements are broken (Shove et al. 2012). People create combinations between new and existing elements, such as with newly acquired competences or new technology or equipment (e.g. disappearance of the coal oven for heating and emergence of the wood pellet oven; (Gram-Hanssen, 2008, 2010). In these processes, elements shape each other (e.g. maintenance of a coal oven requires different competences than a wood pellet oven). Interestingly, many studies reveal that new practices tend to emerge whenever people connect old behaviours to new meanings e.g. (Schäfer et al., 2012; Elizabeth Shove & Pantzar, 2005).

Third, practices can also change when relationships between them – so-called practice bundles – shift. Bundles are defined as '*loose-knit patterns based on the co-location and co- existence of practices*' (E Shove et al., 2012): 81). Gram-Hanssen, for example, explores how practices

related to household energy consumption – including indoor climate regulation, standby consumption and computer use – are interlinked. Changing unsustainable practices can be fostered through creating conditions under which desirable bundles of practices can be developed and disseminated (Gram-Hanssen, 2011).

Fourth, not only consumption practices, but the whole system of practices should be included in the analysis. For example, providing the possibility of using home offices might encourage people to work more at home and travel less (Spurling & McMeekin, 2015), with impacts on both transport and home heating energy consumption.

By focusing on daily routines, an SPT approach allows an integrated view of behavioural patterns. However, since practices have 'emergent and uncontrollable trajectories' (Elizabeth Shove & Walker, 2010): 474), it is not possible to precisely steer consumption practices in specific directions. External interventions (single measures or long-term campaigns) can only be one part of this process; it is also crucial to include legal rules, social norms and cultural meanings to change the way 'things are normally done' within the household. Other SPT-informed studies (Hargreaves, 2011; Strengers, Moloney, Maller, & Horne, 2015) confirm the significance of social exchange for the emergence and diffusion of sustainable consumption practices. However, exchange based behavioural modifications are not one-off events: the measures taken should be long lasting, regular or only vary within a small range. Only then can a stabilisation of practices be expected, as it requires '*ongoing accomplishments in which similar elements are repeatedly linked together in similar ways*' (E Shove et al., 2012): 24) which can only be attained over an extended period of time. Furthermore, there should be room for experimenting with newly introduced practices (e.g. airing patterns) or re-examining existing practices (e.g. hot water generation) providing enabling settings for domestic energy consumption reductions. Such enabling settings comprise three central dimensions – opportunity, experimentation and stabilisation.

1.3.3. Combining levels – towards an integrated view

Both the Theory of Planned Behaviour and its derivates, and Social Practice Theory have their strengths and shortcomings. While the prevailing approach to consumer motivation can be considered failed, the TPB theory has more to offer than an exclusive focus on (autistic) individuals. It highlights the role of values held and of motivations, i.e. the factors we described as intrinsic motivations in section 1.2., and the role of communication processes for sharing information, knowledge and experience. Individuals are rightfully perceived as driven by personal, but not necessarily egoistic motivations as intrinsic factors; desired group membership, for instance, is also a personal motivation influencing consumption behaviour. Social habits, everyday routines, and social practices are deeply interwoven with societal norms and shared ideas about what are 'normal practices' which citizens (not only consumers) repeat routinely without specific reflection (Kumar & Kumar, 2008). This social environment restricts individual decision, rendering isolated information and mobilisation campaigns almost necessarily unsuccessful: single elements of complex systems cannot be changed in isolation.

Individualism based theories fail as far as the role of habitual behaviour determinants is concerned, and tend to turn a blind eye to the mutual stabilisation of different behaviours constituting broader practices. On the other hand, Social Practice Theory does not address individuals, their motivations and preferences, considering them as carriers of specific practices. It focusses on behavioural patterns, of individuals or groups (in this sense like behavioural therapy as compared to psychoanalysis). Changing such complex interacting patterns is inherently difficult if at all possible – some prominent authors like Elisabeth Shove praise its analytical strength but consider it unsuitable as a basis for policy interventions (Keller et al., 2016). The habitual behaviour challenge is addressed by choice architecture processes which intend to make the environmentally benign option the

default one, a clearly policy oriented approach. This resonates well with proposals for socio-environmental fiscal reforms (i.e. dismantling of unsustainable subsidies plus ecological taxation, as for instance foreseen in the UN Agenda 2030 and the SDGs, UNGA 2015) which aim at making the environmentally desirable also the economically rational choice.

Given these different strength and weaknesses, we suggest a complementary use of theories and tools, with elements from the world of TRB varieties usable to cover the individual in its role as agent with intrinsic motivation, but constrained by its social, material, economic and institutional context. SPT is indispensable to understand humans as social creatures, the role of extrinsic motivations, the necessities of complex approaches, and to identify suitable intervention points and strategies. Budging provides examples how such extrinsic motivations could operate in business and politics.

Although both TPB and SPT mention the institutional conditions of behavioural change, they do not immerse themselves too deep into this issue, and the fourth of the conditions we explained in section 1.2., the economic affordability seems to play no major role in the concepts.[2]

Coming back to our earlier description of consumption behaviour as determined by the complex interaction of (mostly unreflected) routines and habits, subjective motivations shaped by intrinsic and extrinsic drivers, and social as well as institutional framing from strict restraints to gentle nudging (on the different kinds of institutions for sustainability see Spangenberg et al. 2002). Behavioural change then depends on its perceived social, economic, institutional and subjective affordability; we define these four dimensions of influences as defining the sustainable consumption policy space. In this view, any effective sustainable consumption strategy must address prevailing deficits in all four dimensions (following rather Liebig's law of the minimum than considering unsustainable behaviour as an information failure as some TPB scholars do):

Subjective motivation and affordability, dependent on values held, the subjective perception of the efforts of changing behaviour (the transaction cost are non-negligible, as the example of 'quitting smoking' illustrates), including the perceived fit of the suggested new behaviour with self-perception, self-esteem, existing habits and ambitions. On this level the TPB can provide helpful insights;

Social perception and affordability, including most informal institutions of society, like the supportive or sceptical reaction of relevant peer groups, conflicts of interest between changed and unchanged elements of the same broader habit, the efforts to justify and maintain a change over time for it to become routine, the fit with the overall orientations of society including the ideas of good life, progress, citizen behaviour norms etc. Here the SPT is indispensable to understand the functioning of habits, routines and broader behavioural developments;

Institutional affordability and necessity, referring to the formal institutions of society. Institutions are the rules of decision making, from laws and administrative decisions to the constitutions and bylaws of relevant organisations. Behavioural innovations deviating from the past can be violating such rules resulting in more or less serious punishment, but they can also reward it. On the other hand, institutions are social structures in which social learning takes place, also on issues like sustainable consumption, and they can be the extrinsic motivator for behavioural changes. Political science may be able to clarify how formal institutional conditions can be shaped to make them supportive to experimentation and stabilisation;

Economic affordability seems to be the elephant in the living room. As long as environmentally benign consumption decisions are perceived by consumers as being more expensive (which is

[2] Possibly there is a middle class bias of researchers and research objects, a legacy of the starting point of the research tradition, which is overconsumption and environmental unsustainability, and the continuous benign neglect of underconsumption and social unsustainability.

not necessarily always the reality today), the subjective assessment of the individual or household carrying capacity will become decisive in the step from intentions to realisation. In times of polarising income structures, different preferences may compete for limited resources, not always ending up in a preference for sustainable household consumption.

1.4. Sufficiency Policy Instruments and Strategies

Drawing on the conceptual insights presented, what does this imply for sustainable consumption politics and for household energy consumption policies in particular? Since the condition of change is the coincidence of desirability and opportunity, sustainable consumption politics have to address both components simultaneously, with respect to the four categories of affordability derived in section 1.3.

The subjective motivation campaigns still make sense if they address the values held, and if they raise awareness on the real, often overestimated cost of behavioural change: if it is recognised as easy and beneficial, the chance of it being adopted increases. Campaigns can also be image changer, breaking up the links of different elements in habitualised behaviours, like the media coverage of the SUVs of suburban commuters in London as 'Chelsea tractors', which led to a significant reduction of trips with such cars. The suggested social innovation should also be portrayed as an honourable act, as something to be proud of (e.g. to have the lowest household energy consumption at a good quality of domestic life) and as being a legitimate source of enhanced self-esteem. Thus public information campaigns do not lose their usefulness, but they might be refocussed and need to be combined with other elements.

The second element familiar to decision makers in politics, business and civil society is rule setting, i.e. modifications of the institutional affordability. Politics interferes with household energy consumption for instance by setting energy standards (as the EU Directives do for new buildings). Working place experience with energy saving can spill over into domestic behaviour, in particular if the possibility is a matter of communication amongst colleagues. Housing associations can showcase energetically optimised 'demonstration flats' and/or offer training courses for resident groups (both allowing for experimentation, and the latter creating a communication network supportive to stabilisation). They can offer simple monitoring tools giving real-time visible feedback regarding heating energy consumption to support the stabilisation process. Mandatory energy passes for flats are obligations to house owners, but rather a nudging effort to households intending to move. The same holds true for the energy efficiency labelling of household equipment (maybe combined with extended guaranteed repair and take-back rules to make the purchase of long living equipment the new normal). However, labelling is often based on the information deficit hypothesis: if consumers only knew about cost/impacts/efforts, they would act more conscious in their consumption behaviour – an approach which failed too often to be a convincing option. The responsibility for sustainable household consumption should not be delegated by politics and business exclusively to the consumers in the name of a misinterpreted 'consumer sovereignty' (nobody uses this argument to call for a ban on advertising). Instead a combination of choice editing, choice architecture design, motivation support and stimulation of collective learning processes should be pursued. Concretely, products and behaviours which pose an acute risk to human and environmental health can and should be addressed through the choice editing of formal institutions, e.g. by bans or restricted licencing (in case they can be used by skilled users for positive purposes), while products which are not dangerous one by one, but in sum pose such a health risk (like high energy consuming household appliances) could be pushed back by nudging, including taxation, communication (image change), and by creating opportunities (a supply side policy component). For instance, the legislation on construction has a significant influence not only on the immediate resource consumption, but also

on the maintenance and operating resource demand which are far from overcome today (Darko & Chan, 2016). Household energy sufficiency policy must be aware of the necessity to offer solutions which are desirable on both the macro and the micro/meso level, and the importance of the social sustainability dimension in this respect. In some cases, learning from old solutions, the cultural heritage, may provide enlightening ideas, although usually no blueprints to copy (Zarghami, Fatourehchi, & Karamloo, 2017b).

Investing for the future is a means of shaping the opportunities for sufficiency in consumer behaviour. The production-consumption systems that meet essential social needs such as food, energy, housing and mobility rely on costly and long-lasting infrastructure, meaning that investment choices have long-term implications. This makes it essential to avoid investments that lock society into existing technologies, and thereby limit innovation options or hinder investments in substitutes (EEA, 2015). This is particularly true for the housing stock; flexibility of use options has not been a primary design criterion despite the technical possibility and more than 30 years of discussion about houses with movable walls and flat sizes which can be adapted to changing demands for area and comfort, and rent budgets varying over the residents' life time. For instance, while limiting the average dwelling floor area per person might be a strong institutional setting, flexibility could be introduced by having flats which can shrink to the size needed once the size of the family has been shrinking, making it easier to maintain and finance a suitable living space in the (partly long-) used location and neighbourhood. Offering subsidies for flat splitting could be a policy measure attractive to house owners and beneficial for residents.

The social affordability is the issue of SPT, and has so far not played a major role in energy consumption strategies and it does not lend itself easily to external interventions given the complexity of habits, social interaction and coupled consumption bundles. In any case, it requires opportunity for experimentation and collective learning, regular exchange and communication about experiences and attitudes, and extended periods of stabilisation to make behavioural innovations a new normal – conditions which are rarely given per se but can be improved by sustainable consumption policies.

The significance of social exchange for the emergence and diffusion of sustainable consumption practices cannot be overestimated. However, exchange based behavioural modifications are not one-off events: the measures taken should be long lasting, and regular. External interventions (single measures or long-term campaigns) can only be one part of this process; it is also crucial to include social norms (including positive role models) and cultural meanings to address daily routines and change the way 'things are normally done' within the household. Changing the composition of groups of people performing a practice is a normal process, but slow ('old habits die hard' is a public wisdom); policy intervention cannot enforce but potentially accelerate it. Mixed settlement structures instead of isolated peer communities are one element, the campaigns mentioned (also using social media) in combination with legal provisions may motivate individuals to deflect from the practice if better options are available, and networks which hold undesirable practices in place or through which practices propagate could be stigmatised through civil society engagement. Breaking connections between elements of practices and thus practice change is supported by new elements emerging which can be integrated into a practice while changing it – from technical artefacts to societal norms and new meanings emerging from the semiotic system of society. Practices can also change due to spill-over effects within bundles of practices. For instance, reducing the energy consumption of household appliances by getting rid of superfluous stand-by modes can break the ground for changing other household energy consumption related practices such as indoor climate regulation. However, the communication is not easy: presenting all options of a bundle simultaneously can be overwhelming, while singling out one practice may fail due to their interconnectedness. Changing unsustainable practices can be fostered through creating conditions

under which desirable bundles of practices can be developed and disseminated. In the analysis, the frame should not only be on the household's in-house energy consumption; for instance, using home offices might encourage people to work more at home and travel less, with a moderately increasing in-house energy consumption significantly overcompensated by saving of transport energy.

Furthermore, there should be room for experimenting with newly introduced practices (e.g. airing patterns) or re-examining existing practices (e.g. hot water generation) providing enabling settings for domestic energy consumption reductions. However, the three central dimensions of such enabling settings (opportunity, experimentation and stabilization) face particular difficulties in the housing sector as they can only to a very limited degree be initiated externally, from outside the social groups and communication networks of the household members: practices can only be changed while being performed. Examples of environmentally superior routines performed by others are not immediately visible in the household, depriving them of an important innovation motive as changing of routines most of the time happens in the course of emulating and imitating the behaviour of peers. Opportunities can be created by making use of social networks (face-to-face or online) if network members visit each other, permitting to exchange views and experiences inside the home. Housing associations, civil society groups and similar informal institutions can be instrumental in bringing superior routines into the household and stimulating experimentation.

Finally, the economic affordability or desirability is a critical point in a market economy, but rarely discussed in a sustainable consumption context and again, opportunity and desirability aspects should be addressed. Opportunities can be enhanced by offering a kind of basic income to everyone so that decent housing is available to all citizens (national housing policies increasing the number of available flats or condominiums can help, as can legal caps of housing prices to restrict speculation). Regarding energy consumption and taking social aspects into account, a free basic supply as physical component of the basic income would provide decent living conditions to all consumers, and combined with progressive cost structures it would be nudging consumers to thrifty energy use, even the upper market consumers due to the price progression. Like energy taxation, this would an element of choice architecture design aiming at making the environmentally desirable also the economically attractive, and thus the default option.

Additional options apply to owner-residents of single or terraced houses. Here energy efficiency standards are hard to enforce as the may conflict with basic property rights as long as the houses are owner occupied, but again nudging by offering advice and credit could be combined with image campaigns making low housing energy consumption a matter of good reputation (as opposed to ruthless squandering resources at the expense of children and grandchildren). Such social factors are decisive in particular for older owner-residents as many can calculate that the investment in energy saving will not reach its break-even point within their expected life time and thus no economic incentive prevails. Behavioural training for energy saving could be provided by local doctors, as part of a long-lasting or even better permanent 'healthy home' initiative.

Finally, easy credit at attractive conditions can be an important lubricant as households are reluctant to invest their savings in energy saving as they are uncertain about the payback time and reliability. Although counterproductive from an economic point of view, the inclination to save and an increased liquidity preference are plausible reactions to the current state of economic uncertainty and the enforced saving caused by privatising pension systems and by the collapse of private sector pension plans first in the aftermath of the Great Recession and then due to the quantitative easing policy of the European Central Bank driving the returns on financial assets down to almost zero, or even lower. Thus overcoming uncertainty and a more equitable income distribution would be important contributions to making household energy sufficiency strategies workable.

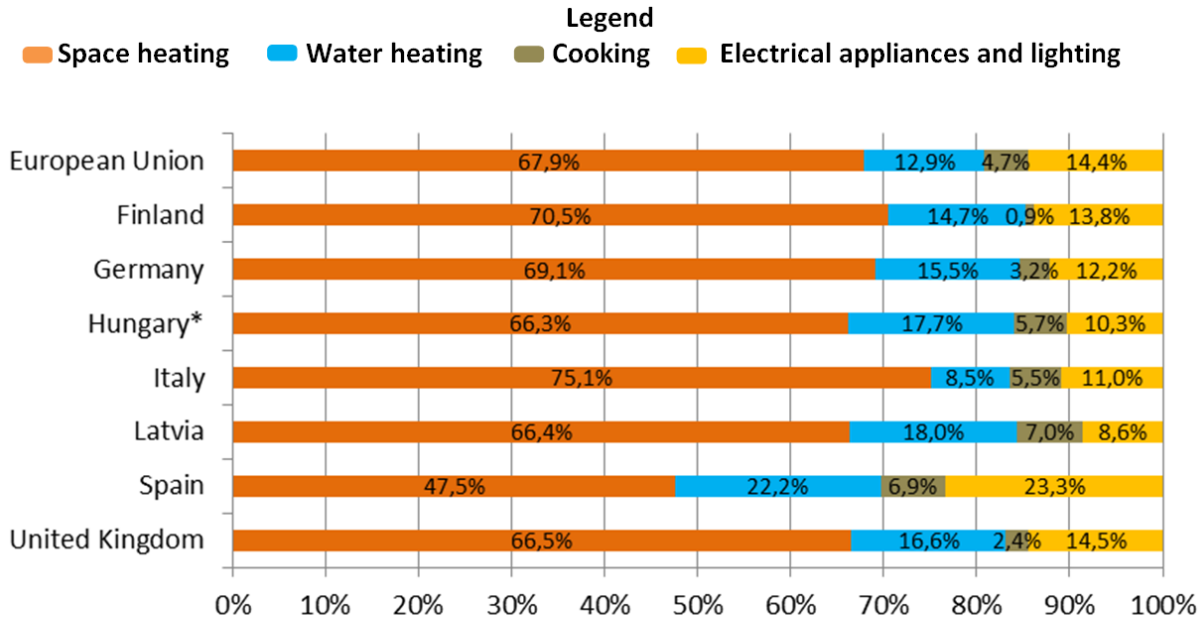
One of the burning questions of sustainable energy consumption strategies in households is how policy might support market actors in using energy sufficiency options. As for energy efficiency policy, it starts with the gathering of potential sufficiency actions and the analysis of the relevant barriers market actors and citizens face, to derive recommendations regarding which policy instruments should be combined to provide an effective policy package, and which other pre-conditions have to be met. Some instruments of the energy sufficiency policy package may look familiar – they are the same as for energy efficiency. However, besides that sufficiency also requires new approaches, particularly to mitigate the drivers of non-sufficiency, from the promotion of completely different services for food and clothes cleaning, to instruments for limiting average dwelling floor area per person, or to a cap-and-trade system for the total electricity sales of a supplier to its customers. Politics is in need of experimentation as much as consumers are; in fact, Social Practice Theory is as well applicable to the need of changing policy routines and habits. Open discourses, joint reflection, craving out spaces for policy experiments and testing means supporting their stabilisation are urgent tasks for the classe politique; may voters can nudge them towards tackling it.

2. Energy Sufficiency at homes

How can the insights developed above best be utilized to achieve a significant reduction in the energy use of households? For new housing throughout Europe, the EU directives set rather ambitious standards, requiring 'near zero emission' construction. Although there is still some room for improvements regarding the technical standards and the enforcement for new buildings, the potential achievements however are small compared to what can be achieved by addressing the stock of existing housing. In these buildings room heating is the most important cause of energy consumption (see figure 2), and reducing it requires both technical efficiency measures (in particular isolating the building plus efficient heating systems) and sufficiency change (the social innovation of modifying routines, practices and other forms of standardised behaviour). Bierwirth and Thomas argue that especially in homes sufficiency could be best friend with efficiency and tackle wealth, rebound, and other effects that counter-act efficiency progress (Bierwirth & Thomas, 2015). Even in efficient buildings running on renewable energy and equipped with best class appliances a moderate sufficient lifestyle can result in an additional reduction of 45% of greenhouse gas emissions. Thus sufficiency concepts may become the wild card to ensure that climate targets can still be reached.

As laid out in a previous phase of the project space heating represents the highest share of residential energy use in the European Union. Consequently also the considerations about sufficiency elaborated upon in this report concentrates more on the aspect of housing and living in general than on the fine-tuning of lighting habits or the correct use of electrical and IT appliances.

Figure 1 Final residential energy consumption by end-use 2013 (%)



* Data for Hungary and Romania are of 2010 and 2011 respectively.
** The energy end-use "air cooling" is not represented in the figure because it is not significant.

Source: (Trotta & Lorek, 2016)

One of the main factors influencing energy requirements in housing is the size of living area. Energy efficient renovation might be a pre-condition for achieving energy targets. However, sufficiency criteria have to be applied to put a hold on the constant increase of m² per person – in various countries the trend even needs to be reversed.

A Swiss study commissioned for the City of Zürich, highlights three main measures of successful sufficiency gains: reducing the per capita living area (calculation basis from 60m² to 40m²) a moderate change in user behaviour in the use phase of household electric and electronics and a change in the mobility modal split (Pfäffli, 2012; Steffen & Fuchs, 2015).

The results indicate that in reducing the living area primary energy could be reduced even in already efficient existing building blocks as well as in new buildings. So it presents a relevant contribution on top of efficiency gains. Section 3.4 provides more detailed information gained from that research.

2.1. The tragedy of the counter effects to energy efficiency

Despite all efforts of the efficiency strategy to exploit the potential for energy savings in buildings it is still applied rather slowly in most countries. Improvements were found to have unintended consequences associated with technological home energy, both beneficial and detrimental, including improved comfort levels in retrofitted dwellings and reduction in energy use but also an increased likelihood of overheating following the improvements, potential under-performance of low-carbon systems due to lack of understanding and inadequate installation and commissioning, along with adaptive energy behaviours leading to increased energy use and a widening gap between predicted and actual savings (Soetanto, Gupta, & Barnfield, 2014).

In addition, energy savings are partly compensated particularly by income growth but also rebound effects, the 'empty nest' (persistence of elderly people and couples in family homes), divorce rates, widows, more generally: increase of single person households and cohort effects (e.g. vintages of people or buildings). As mentioned before, the existing trend in housing is a continuously growing floor space per capita. Over the last decades it expanded e.g. from about 20 m² in 1960 to currently 45 m² per person in the UK or 15m² in post war Germany to 45m² in 2015. Forecasts expect a further increase to more than 50 m² per person in the coming decades. Obviously, more floor space needs more energy for space heating and cooling, ventilation, and lighting, but it also allows the household to operate more and or bigger appliances, all of which increase energy consumption. Whether this is an indication of peoples willingness to consume (Røpke, 1999) or if they are locked in (Sanne, 2002) is an ongoing debate. In any case, instruments for limiting average dwelling floor area per person will be an important part of the energy sufficiency policy package as they address one important driver of energy consumption and non-sufficiency (Thomas, Brischke, Thema, & Kopatz, 2015).

2.2. Sharping the lenses for the surplus of the sufficiency perspective

Considering sufficiency in a consequent way is a demand side response for low-tech options to meet essential needs if conventional high-tech options and the energy intensive lifestyle they depend upon become unavailable or unaffordable (Alexander & Yacoumis). To help doing this in a transparent and democratic way the UK research on minimum income standards (MIS) developed a participatory and consensual process to find evidence of shared social understandings about energy needs in different household types. It is an ongoing project where in a biannually repeated process deliberative workshops are carried out to ascertain the goods and services that members of the public consider to be the basic necessities that everyone in the UK should be able to afford and have present in their everyday lives.

Walker and colleagues analysed the data gathered through the MIS research to gain insights regarding energy consumption (Walker, Simcock, & Day, 2016). Basic intention of the project was to identify the lower limits of energy needs to overcome energy poverty. However, where exactly are

the boundaries between ‘necessities’ and ‘wants’ and on what basis might these change? Four areas were identified creating need for energy.

Table 1 Aspects of a good life and their related products or services with energy requirements

Health and well-being	heating, cooker, fridge to keep ingredients fresh, lighting
Social participation and interaction	phone and computer, vacuum cleaner to keep the home tidy, hot water, washing machine, iron to keep the person tidy
Development and opportunity	access to transport
Living life in a practical way	electric kettles and microwave

own table based on (Walker et al., 2016)

Interesting might be here what was not considered as necessity: dishwashers and tumble dryers and cars respectively the latter ones only entered the list of necessities in 2012 and 2014. It was also observed over the years that the items declared as necessities increased respectively got upgraded, e.g. regarding computer equipment and TV size or hair styling tools.

Overall in the project, energy necessities in the UK society appeared as diverse and plural, producing access to multiple valued energy services—heat, mobility, refrigeration, light, communication and others. The profile of necessary energy uses shifts over time and is to some degree differentiated across different demographic groups.

However, the question of minimum energy need is tricky to handle from the fuel poverty perspective alone. And it gets even more complicated under the framing conditions of climate change. The list of items on the MIS might well be seen as entirely indicative of a ‘western’ pattern of unsustainable over-consumption. If so, to support this profile of energy uses as ‘necessities’ that all citizens should have access to, could appear ethically problematic. Is a 32 inch TV screen or a hair straightener an essential need or a fashion?

This empirical evidence from public deliberation plays into tensions between different forms and scales of energy justice. On the one hand it can be taken as a legitimate grounding for defining minimum standards and therefore the scope of state policy for supporting access to affordable energy and ‘doing justice’ in terms of fuel poverty. On the other, it can be interpreted as showing the ongoing escalation of these standards and of norms of energy dependency and consumption in a society already in an energy and carbon intensive condition. Doing justice in terms of global climate change therefore arguably entails challenging embedded norms rather than following them. A way out could be focusing not on energy consumption (in kWh), but instead on enabling access to energy services, inequalities can be reduced by investment in improving technical energy efficiency (of homes, heating systems, lighting, fridges and so on) and maximising the use of natural energy flows. It is energy services that should be the unit to which rights claims refer, not a particular level of energy consumption per se. It could be observed for example, that the number of public libraries had direct implications on how participants reasoned about the necessity of having a car and using a computer at home (Walker et al., 2016).

A helpful perspective to overcome the tension between upscaling norms and factual needs and to recognise the surplus of the sufficiency approach regarding domestic energy consumption is offered by Ellsworth-Krebs and colleagues (Ellsworth-Krebs, Reid, & Hunter, 2015). They recommend looking from a perspective of home and not purely the house. Research on the home opens up a huge potential for a greater understanding of what drives energy demand.

A house is the physical building where people live (including flats/apartments in this sense). In traditional housing research, underpinned by quantitative measures, householders are perceived as

passive just to use the house as intended or designed to be used. This leads to rebound because expected energy savings to not necessarily materialize.

The dominance of a house approach in domestic energy scholarship and policy is based on a traditional development prioritising positivist science, engineering, technology and mathematic backgrounds and techno-economic thinking (e.g. rational choice theory or relying on modelling), which has remained based on the core theoretical assumptions of engineering and economics since the 1970s. Studies of the house (e.g. improvements in efficiency and design) are an important part of delivering high quality, affordable, and sustainable homes but this approach is not sufficient on its own. Rather than focusing on improving the house the real challenge is to pursue understandings of domestic energy which combine both physical and social factors.

Looking from a house perspective there is a dominant focus on thermal comfort and temperature in particular; with comfort becoming commonly defined which suggested that 21◦C is the optimal temperature for thermal comfort based on a study carried out in the late 1960s (Fanger, 1970). While Fanger clearly understood comfort as the result of complex interaction between multiple criteria, his work nevertheless has lead to the perception and acceptance of comfort as a definable condition and establishment of universal standards for the indoor environment. So the aim now is seen to design indoor environments that deliver it.

However, comfort is still socially constructed. Expectations of indoor climate co-evolve with changes to the material features of our homes. Other regions face other problems regarding a 'right' temperature and started to overcome them through different measures than purely technological. For instance, the Japanese government reduced energy by not cooling office buildings below 28◦C in the summer, in response employees were able to remain comfortable and productive by adapting and wearing lighter-weight business attire. This example is not about a change in technology or the indoor environment alone but is also accompanied (and dependent on) social changes that made working in warmer conditions more accepted or tolerable.

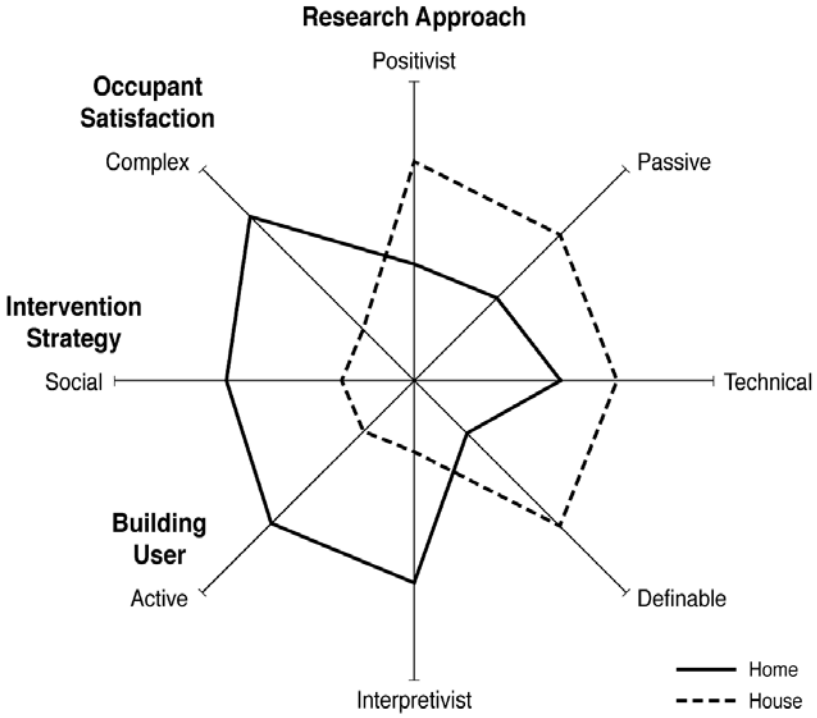
As counterpart to the physically focused house approach Ellsworth-Krebs and colleagues point towards the home approach instead which looks beyond the physical/material object. Home is connected to emotions and relationships as well as social and cultural expectations. Such a change in perspective may be of help to challenge the dominance of the mainstream techno-economic approach which focuses on improving design, technologies, or other physical aspects of domestic buildings. To systematically point out the difference between house and home and the significant social aspects of home (e.g. comfort, identity, security, and privacy) can help to anchor sufficiency in domestic energy research and practice. Family members, and especially house-holders, are integral to the management of their home. It is their routines and expectations which shape and create demand. Everyday activities are not simply structured in order to uses appliances or building features as they are designed. How the home is managed is the result of complex social conventions. In research on the home householders are viewed as actively reproducing and transforming the norms of how the building and technologies in the home are used.

The concept of home does not take occupant satisfaction or comfort to be universally definable or measurable but as a complex and contested concept. This allows quite alternative discourse than only those of thermal standards.

Common amongst domestic energy scholarship – whether on the house or on the home – is a recognition that a major gap exists between modelled or designed building performance and the actual energy demand from a home. Those thinking in terms of the house mainly perceived building users as passive. Questions of accessibility, rebound or details of consumption are regarded by building scientists and engineers as some other disciplines problem. They tend to treat the phenomenon as a failure in design. A focus on the house has skewed debates away from bringing

questions of demand into view. Since there is no such thing as an unlimited energy supply, more fundamental questions need to be asked about how much energy is enough and what establishing ways of living which require much less energy than we use today may really mean.

Figure 2 Comparing different emphasis of 'house' and 'home' approaches in domestic energy research



(Ellsworth-Krebs et al., 2015)

Figure 2 illustrates how shifting from a house to a home perspective helps to shift attention about energy problems and potential solutions. The home perspective regards the users of a building more as active decision makers (of an average temperature for example) than passive acceptors which in worst case counteract technologically set energy adjustments. The consideration about the occupant satisfaction mirrors the considerations made above on justice and energy minimum standards. The home perspective recognises that comfort is constructed and cannot be narrowly defined. The intervention strategy therefore lies more towards the social end of the socio-technical axe. To adequately consider all this the home approach consequently can be found more on the interpretivist side of methodological approaches, based on research on social phenomena, human experience, and social action.

2.3. Sufficiency beyond the privacy of one's home: sufficient living

In addition to the elaborations above, the home approach delivers its potential for a proper design of sufficiency measures even more when we consider aspects beyond the house. Energy effects on housing/living include more than just the four walls building the own flat. It also has to consider the conditions in the social and physical surrounding: the neighbourhood (Knüsel, 2013). They reach from the fulfilment of further basic needs:

- Is the provisioning of daily needs nearby possible?
- Do people have easy access to (public) mobility options?

- Is recreation possible nearby?

to social needs:

- Are their places to meet people?
- Can I receive guests? etc.

Thus concepts for sustainable living necessarily consider the location of the homes. Interestingly most projects striving for sufficient living conditions are found in urban areas not on the country side as false assumption about sufficiency communities might suggest. They are often located in inner cities where the reduction of transport plays a crucial role. Energy use is avoided when grocery shops are at reach either by foot or bicycle, when public transport is reachable within 500 m from the house and/or car sharing facilities are offered in similar distance.

Looking from the social perspective the situation often appears to be different. In projects for alternative forms of living beyond the typical family approach, e.g. the more generation houses, sufficiency aspects are not the main, often even not an explicit goal. They appear more as a side effect of fulfilling social needs. However, through reducing per capita floor area they contribute to sufficiency (Fuhrhop, 2014).

2.4. Social innovation as a tool for energy sufficiency

To achieve sufficiency in homes need a broad variety of different considerations and will need engagement of a many different stakeholders. Their potential roles are further elaborated upon in chapter 6. What ties the bits and pieces together, however, is the aspect of social innovation.

As sufficiency is not the counterpart to efficiency, social innovation is not the antithesis to technical innovation. At the bottom of both is the idea of novelty which develops to a new normal through an evolutionary process – the acceptance by people (John, Rückert-John, & Jaeger-Erben, forthcoming). To recognise social innovation and call them as such is just the more recent concept. Developed in academics towards the end of the 1980s (Zapf, 1989) it reached the European policy agenda in the context of the economic turmoil in 2008 latest and became subject of political endorsement (Hubert, 2010). Social innovations are innovative activities and services motivated by the goal of meeting a social need and often – but not exclusively – developed and diffused through social organisations (Mulgan, Tucker, Ali, & Sanders, 2007). Their intention however is, to be in a public interest and to contribute to solve public problems (Howaldt, Kopp, & Schwarz, 2015).

As a driver for equitable socio-ecological change social innovations also found their way into environmental policy. Collaborative consumption might be the first aspect that comes in mind in this context. Food cooperatives, urban gardening, transition towns and the already mentioned car sharing initiatives are parts of this picture. As will be laid out, sharing is also one of the possible elements of social innovation in sufficiency home(s) concepts. But also other aspects are to consider. Table 2 briefly outlines some of them.

Table 2 Examples fostering social innovations to achieve/support sufficiency

urban planning	Intentionally develop habitats providing short way to daily provisioning, schools, medical care, and recreation (parks and similar areas für sports and leisure)
	Foresee bicycle facilities for biking, parking and maintaining
	Enable car sharing
Design	Develop flexible room management to enable reduced individual space need
	Foresee possibilities to change the function of rooms
	Upgradable design in case of new technological development

Social change	Install participative approaches to ensure sufficiency solutions are user friendly
	Ensure availability and maintenance of shared facilities
	Provide space for communication

derived from (Steffen & Fuchs, 2015)

The following chapters elaborate on core elements for sufficient homes in more detail. Chapter 3 asks which kind of messages and stories might be needed to reach behind the pseudo-linear tales of the eco-efficiency new technologies are promising to provide. Chapter 4 considers the possibilities and obstacles smart home solutions and how to improve such approaches. Chapter 5 deals with the monetary aspect of sufficiency mainly the possible financial incentives to make consciously sufficiency decisions. In chapter 6 finally we expand on the manifold possibilities the various stakeholders have to steer towards substantial reduction in home energy use.

3. Developing narratives for sufficiency

Quite some work on energy consumption in housing emphasis, that individual behaviour can result in a factor 2 differences even in identical flats. This is partly for sad reasons: in most households, attempts to understand energy use can still be compared to shopping at a grocery store without any prices on individual items and receiving a bill at the end of a month's worth of the purchases. With energy bills the situation is even worse as normally it comes once a year only. In the absence of specific information, residents asked to reduce their consumption have a hard time estimating the costs and benefits of their actions. And the ongoing messages to switch off the light when leaving the room or to better not to use stand-by functions add to the confusion of people assuming that they do their share while they in fact only do some peanuts (Bilharz & Schmitt, 2011).

Research conducted in different contexts over the past 25 years shows that providing feedback on energy use can in some way help bridging this information gap and reduce consumption. Savings have been shown of about 5–15% for direct feedback and 0–10% for indirect feedback - a small and surely not a sufficient range. The limited step from knowledge to action is because saving energy is far from being the only, in fact not even the main, criterion for consumption decisions. There is little indication that energy feedback on a plasma screen a, aquarium or a water bed tank will results in changed behaviour. There is not too much reason to expect that more information about energy consumption and energy classes of appliances will necessarily deliver either greater understanding or better behaviour (K. B. Janda, 2011).

On a general basis we, of course, agree that behaviour matter, however, this deliverable does not intend to simply echo or duplicate research findings in this respect. This is because we do not share the 'if only…' assumptions housing research tend to dedicate to the better provision of the right information. Instead in this section we like to draw a broader picture: the development of new narratives for low energy homes.

3.1. Engaging households in learning stories

As every policy, energy policy is made of language and this language carries both: facts and values. Values and worldviews are always communicated despite assumption that e.g. smart metering data are mainly neutral accurate information. There are underlying messages resulting from the way information are selected and presented. They e.g. also carry the assumption that the user of the smart meter data is a rational being taking highest utility from optimising the energy flow in the house or apartment. To illustrate this Janda & Topouzi researched how messages to save energy are constructed. Paying attention to and utilising the elements of the classical hero story, the horror story and the fable can help to frame public understanding for a necessary reduction in energy use (K. Janda & Topouzi, 2015).

The story told most in the energy field is the hero story. It is inspiring and positive: clever technologies are developed to save the planet. The hero in an energy hero story is the actual technologies, for the time being renewable energies, energy storages, internet based information and steering tools, and so on. In these kinds of stories, there is not too much need for people to change because the technology will make the necessary changes for them. What is missing in the energy hero stories, however, is a proper foe. While in other environmental issues citizens may have to fight against e.g. large corporations' the problems energy consumption is causing sets people against themselves and their own ways of life. So people do not like to get engaged in this part of the story but prefer close their eyes, lean back and rely on the promises made by the hero-technologies.

A second effect encourage telling the hero stories. Stakeholders of all kinds enjoy achievement-oriented hero stories. Policymakers and research councils e.g. are tightened to the kind of certainty that the hero story provides. Researchers are encouraged to be policy relevant, and their livelihood often depends on winning future funding from research councils. And, of course, many researchers believe in their work and want their predictions to be true. So they interpret the facts optimistically, and tell a story that looks as heroic as possible. Deviations from predictions may be ignored, minimized or suggested as topics for future research as if these deviations could be corrected that way. Janda and Topouzi uncover this reinforcing mechanism in an analysis of building projects all over the world. This way their stories help technology-heros to generate attention in media and beyond and to get rewarded by policymakers, funders, and the public.

A final reason why the hero story is so appealing is because the only recognised alternative is the horror story. The predictions of climate change often appear in the way of horror stories up to the level of movies like *The Day After Tomorrow*. Typical elements of the horror story line are a fear which does not seem to be rational and the evil invisible to the naked eye. The horror component reveals itself over time and there are many disbelievers. The horror story in the energy field would be less sophisticated. It would be simply the story of failure. But still it is hardly be told because *'the fear is not in the central character: the fear is in the teller' (K. Janda & Topouzi, 2015)p. 520*. It is the fear of not delivering, of project requirements unsatisfied, of recognising that climate does not read declarations but react to physical facts only.

An underexplored and interesting way out of the hero-horror dichotomy is to inspire change in the spirit of a fable. Fables are short stories designed to teach specific life lessons. They occur in overly fictitious settings with stylized characters – often animals. But those are often representing real human weaknesses. Fables are learning story which anticipates that all people involved in a setting (respectively the animal characters representing them) have to play a part in the solution of the challenge ahead. Learning stories in both their original form and their adaption to tell energy (saving) messages occur in all the detailed variety of the real world. Learning stories derived from a fable do not form universal patterns that can be mapped. There are no heroes and no villains. In a learning story, protagonists are normal people who need to respond to a challenge. Normal people are not saved by fictitious heroes; therefore they must rely on their own actions. The learning story can be difficult and contentious. It is less soothing than the hero story, as it asks for participation, reflection and does not try to provide a linear, single truth.

Given that stories will be told anyway in the development of energy consumption, is there something to be learned from thinking consciously about storytelling, rather than unconsciously telling a story? Or, to put it differently: how to apply the fable metaphor and make energy users a main character of the energy story? By adding more learning stories to the energy toolkit, it is possible to move beyond binary hero/horror or success/failure frames. Consider, for example, the often implicit objective of getting people to care about energy and the environment as a basis for moderating their behaviour. If the assumption that caring actually makes a difference is true, then this has to be better induced.

Learning stories reveal more about how the socio-technical system of the built environment actually behaves, whereas hero stories describe how building physicists and energy analysts wish it would work. This brings us back to the house vs. home thinking laid out in chapter 2.2. In the absence of a policy regime that formally recognizes the socio-technical nature of energy consumption, the concept of a 'caring story' could help create the social potential to move in this direction (K. Janda & Topouzi, 2015).

In the telling of such stories users could play the critical role in the built environment which actually is still so poorly understood and often overlooked. In the face of climate change, architects for

example could develop their professional expertise beyond improve buildings towards ways of integrating user involvement in building performance and could claim a leadership role in this area (see 6.1.) The understanding could be improved through an environmental educational programme that includes literacy on building performance. Building professionals – particularly architects – could accept greater responsibility for teaching this kind of understanding to the public (K. B. Janda, 2011).

In most countries, the building performance regulatory regime depends more on building physics than on the skill of people using them. Messages about operations and social responsibility are more muted. Applying the learning story to this context: What if people were required to take lessons and pass tests about how they would drive a building in the same way that they must demonstrate their ability to drive a car? This kind of a shift would recognize that the built environment (like transportation) is a socio-technical system, rather than a just a technical one. This process could, for example, make transparent the current assumptions about 'proper' use which are already embedded in predictive models (K. Janda & Topouzi, 2015). Starting from school curricula to passing some tests before signing a rental or buying contract for a new home could be possible points for intervention.

3.2. Adding the space component to the picture

A more holistic approach, also tackling the value system, appears from questioning ownership as the only desirable form using products, including room(s). The element of sharing entered modern lifestyles quite some years ago – as neighbourhood exchange as well as a business model. Also initiatives towards more sufficient lifestyles in housing often go hand in hand with argumentation for a sharing society. A reinvention and revival of sharing in our cities is expected to enhance equity, rebuild community and dramatically cut resource use. With modern technologies the intersection of urban space and cyber-space provides a platform for a more inclusive and environmentally efficient sharing economy. Especially co-housing is a relevant aspect here. The greater Copenhagen area is seen as the origin of co-housing, a housing movement which began in the 1970s and has now spread internationally. Co-housing communities consist of several families living separately with extensive communal space, in a neighbourhood designed specifically for social interaction (Agyeman, McLaren, & Saefer-Borrego, 2013). This includes new and flexible housing concepts with for example shared guest rooms or party facilities available for rent (Schneidewind, 2013). Stories of such forms of living are engaging – not for all perhaps but for many. With the erosion of the traditional multi generation family young parents as well as elderly are often in search of sharing their burdens and would like to get inspiration through wisely told 'fables' how to come together.

3.3. Sufficiency consulting to open up perspectives

A way to spread a new energy narrative, but also contribute to it, would be to systematically establish sufficiency consultancy (Steffen, 2014). Whether such institutions would be set up explicitly or sufficiency aspect become interwoven into regular energy efficiency consultancy is debated at the moment and might depend on concrete situations. Sufficiency consultants could act as trainers how to best run an efficient home (and thus contribute to the learning story) but would not be limited to this. At the far end it could be imagined, that (building) projects have to pass a mandatory check whether space could be reduced ore used more wisely.

Some messages to be spread in consultancy on sufficiency are obvious however already now:

3.3.1. Different messages for different types of buildings

The factual influence of user behaviour clearly depends on the energy status of the building. Efficiency of building and appliances assumed the main sphere of influence for the user shifts from reducing room temperature to electricity consumption especially hot water – an important information which not necessarily has reached the users so far. Different from old buildings the contribution of behavioral effect is less influential in energy efficient buildings with a high share of renewable energy. Here the building phase increase in importance and perceived from the tenants overall energy balance mobility decisions have to get into the focus (Pfäffli, 2012).

3.3.2. Reconsidering target groups

Confirming the learning story, households mainly react on intensive consultancy providing customized consumption feedback on energy use. This is not only but especially the case for low income households (Podgornik, Sucic, & Blazic, 2016). Recognition grows however, that low income groups are hardly the main problem of accelerated energy use and thus not the most important target group for energy sufficiency anyway. One may consider whether it is efficient to invest in consultancy capacities here above the average.

Strategies to reduce resource use and CO_2 emissions therefore might better focus on those where energy consumption and saving potentials are much higher. As in most areas energy use correlates with income strategically relevant target groups are those of higher income. As they also tend to have a higher education level, are more open to information and declare more positive attitude to the environment sufficiency messages are expected to fall on fruitful ground. The main problem with this population segment, however, is that they tend to underestimate their energy consumption. While they claim to 'doing what they can' this is in comparison with their own peers only and does not count in high above average levels of living and traveling. (Kleinhückelkotten, Neitzke, & Moser, 2016).

3.3.3. Switching from relative to absolute figures

In this context a switch to absolute figures helps to uncover real consumption. This indicates shifting from m² to per capita messages in energy consultancy. Comparable low energy consumption per m² can easily sum up to a high energy use in total. To stay in the picture of grocery shopping products (see 3) there also show the final price while the price per unit is side information only. Therefore the more useful relation in a sufficiency context is energy consumption/person (Brischke & Spengler, 2011; Hagbert, 2016).

Practical social innovations as well as academic literature provide a rich variety of instruments and instrument mixes how a shift towards more sufficient patterns of living can be supported. Before we go into the details of such instruments and the related stakeholders we like to provide here two examples of different but coherent stories for sufficiency and how it can contribute to reduce energy consumption and the related emissions.

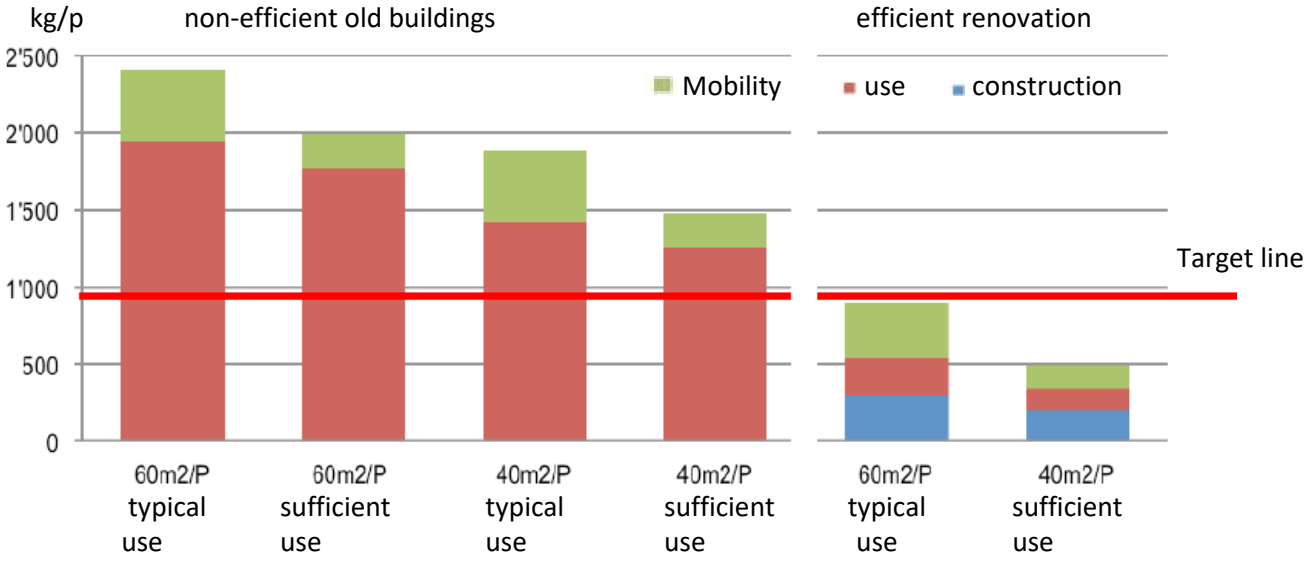
3.4. Story One - How sufficiency can help to arrive in a 2000 Society

Switzerland - and especially the city of Zürich - follows the explicit and democratically agreed goal to achieve a stage of a constant flow of 2000 W per inhabitant by 2050. This number is based on the calculation of average energy consumption of the global population end of the 1990s. To meet climate targets these 2000 W shall be achieved through a high share of renewable energy, a broad variety of efficiency as well as sufficiency measures.

A study conducted by the city of Zürich present clear figures, that neither efficiency (including renewable) nor sufficiency steps alone will be able to develop the necessary potential.

Figure 3 shows the differences between typical and sufficient behaviour patterns on the Co2 emissions per person in non-efficient old buildings and efficient refurbished ones. As target line 930 kg/person is assumed.

Figure 3 CO2 emission per person in renovated and not renovated buildings considering living area and behaviour effects

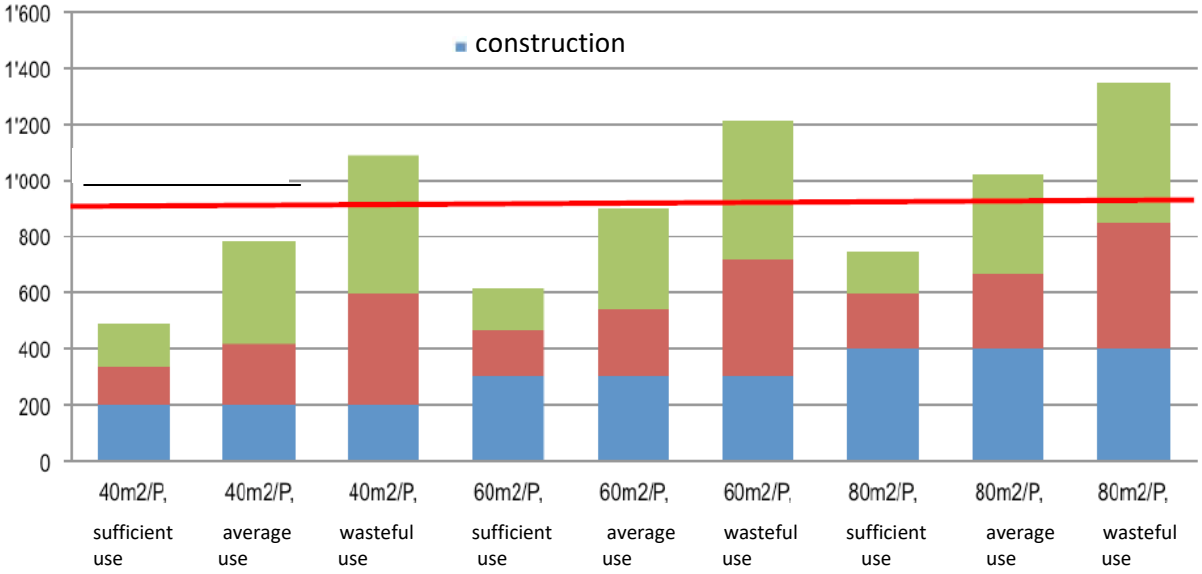


Source (Pfäffli, 2012) p. 50 (own translation)

In turn, it also does not help to only care for efficiency as wasteful users may still cause missing the target as can be seen from Figure 4 and Figure 5. The study from Zürich indicate that renovation of buildings tend to better support sufficiency in respect to living area as the older building stock tends to have smaller room/flat size than new buildings. As a result refurbishment better and less costly helps to achieve the target figures towards the 2000 society than new buildings. Nevertheless, a 40²/person flat can achieve the target in both kinds of buildings. Living on 60m²/person already exceed the target in new buildings but still meets them in old buildings – an otherwise sufficient lifestyle assumed. With 80m² even an otherwise sufficient lifestyle results in higher energy consumption than the target, slightly higher in refurbished buildings, remarkably higher in new ones (Pfäffli, 2012)

Figure 4 CO2 emissions per person in an efficient renovated building depending on living area, use patterns

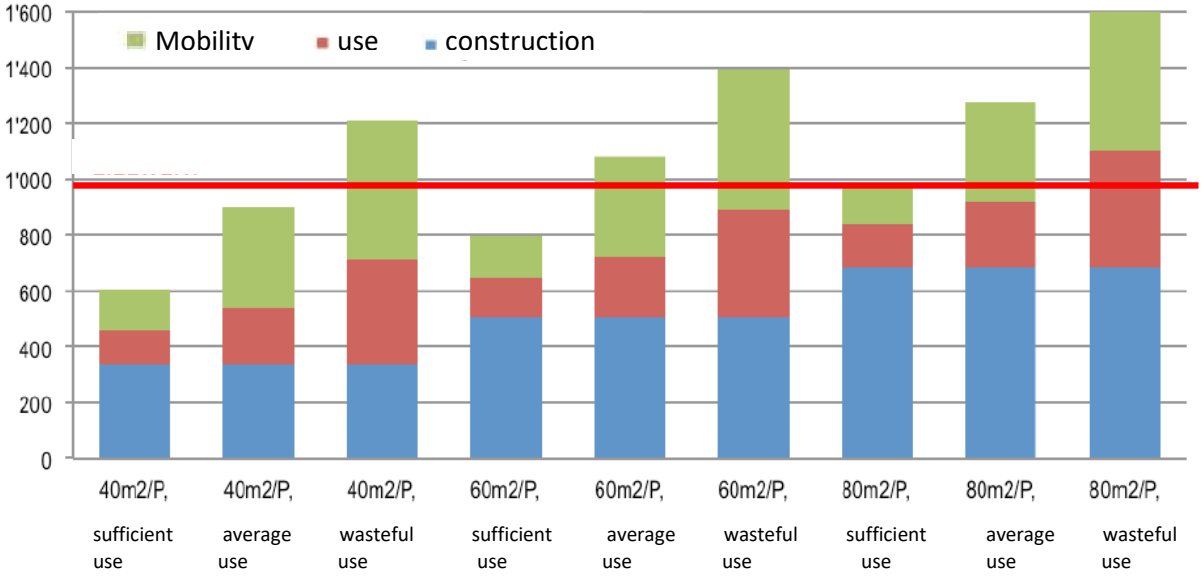
kg/person



Source (Pfäffli, 2012) p. 47 (own translation)

Figure 5 CO2 emissions per person in an efficient new building depending on living area, use patterns

kg/person



Source (Pfäffli, 2012) p. 46 (own translation)

These results are based on research of a block of flats in an inner city well connected to the public transport. The building is typical for Switzerland in a way that it has a typical size and compact form. Construction, refurbishment and heating demand fulfill the criteria of the Swiss Minergie standard. The equipment of the flats meet the average standard, all lighting and appliances show the best energy efficiency class. The results show, that energetic refurbishment leads to less emissions than constructing new houses, even most (Minergie) efficient ones.

The sufficiency activities respectively decisions assumed reflect what the study calls ‘moderate sufficiency’. Households respectively person called sufficient live in an attractive urban apartment

with some less living space but equipped with all appliances perceived as normal according to the Swiss standard. However, according to their motto 'less is more' they also easily resign things they don't really need. The lifestyles calculated for the sufficient and wasteful scenarios are no utopia but Swiss realities already now.

According to the study, sufficiency appears to be necessary second leg to achieve a 2000 society. The absolute reductions of nearly one tonne of CO2 per year and person from moderate sufficiency might be a key factor towards the realisation of the 2000 W Society. The reduction of living area/person in m² is in not efficient buildings the most effective sufficiency measure. Support from policy and housing companies to explore this potential may help at least to win time for efficient modernisation but also to reduce likeliness for rebound effects.

Pfäffli, K. (2012). *Grundlagen zu einem Suffizienzpfad Energie - Das Beispiel Wohnen*. Stadt Zürich - Amt für Hochbauten.

3.5. Story Two - Strategic development for a sufficient refurbishment of a quarter

The sufficiency scenario developed by Anja Bierwirth (Bierwirth, 2015) takes a different approach. She reports from a fictional future in 2035 about the success story a local housing cooperation has taken to achieve climate targets through consequently fostering sufficiency measures. We summarise here the story line.

The (fictive) project was kicked off when the company recognised that energetic refurbishment and switch to renewable energies in a required way would have led to a drastic increase in rents to a level more than 30% of the original tenants wouldn't have been able to afford. The task approaching from there was to reduce the costs for renting and search for different ways of financing.

Build in the late 1950s the quarter to be renovated hosted mainly elderly, poor and migrant families in 2015 and had developed towards a social hot spot over the decades.

The planning phase

In parallel to technical and economic concepts the company started a participatory process to inform as well as to include the inhabitants into the planning.

Common financing

A broad variety of possible financial instruments were explored: Public/national funding (see 5.2), public credits (KfW) (see 5.2), energy contracting with the local energy provider.

The citizen cooperated in financing local solar projects. This not only ensured a (small) financial contribution. It mainly created ownership for the overall project. Finally the city contributed money saved as they did not had to invest into infrastructure for new quarters.

Contributing through avoiding costs

As various inhabitants offered do-it-yourself contribution, some local crafts enterprises joint the experiment to instruct the tenants to do the energetic renovation themselves. This on one hand reduced the costs but on the other still ensured that work was done properly. The tenants in turn could benefit from reduced or even postponed rise of the rent, while they already enjoyed the reduced energy bills.

Others agreed in a restructuring of the buildings leading to smaller individual flats compensated with common shared guests and other rooms. Reason for this also was to keep the rent affordable.

For a third group finally, living on social welfare, the housing company successfully negotiated with the public authority to pay higher dwelling allowance for energetically refurbished flats because the higher costs there are overcompensated by the reduced costs for energy bills (see 5.2)

The construction phase

The intensive exchange during the planning phase paid out. No interested tenant had to leave the quarter for financial reasons and due to the grown identification with the project the inhabitants did not cause any delaying problems. For the times of renovation there were interims accommodations for all in need. Floor plans were changed as agreed, inner space gained through stairways on the outside of the buildings etc. For the social benefit small shops for the daily provision as well as an ambulant nursing service moved into the quarter.

Streets and mainly previous parking slots were changed to green areas and playgrounds. The inhabitants can still drive in for loading or unloading but have to park at the end of the streets. These parking areas also provide space for car sharing.

Bierwirth, A. (2015). Strategische Entwicklung eines zukunftsfähigen Wohnraumangebots – ein Suffizienz-Szenario. *uwf UmweltWirtschaftsForum, 23*(1-2), 49-58.

4. Setting examples through smart home solutions

Despite the difference between home and house elaborated upon in chapter 2, of course the design of the house sets framing conditions for the possibilities of more or less sufficiency options. Many of them are based on private initiatives. This section provide some examples of such projects, motivated by diverse reasons, all however, with sufficiency gains as one results. It starts with the *One Tonne Life* project to implement aspects like sustainable materials and energy efficiency rather than downsizing the dwellings in sustainable housing projects and calculated how this supports a family on their way to a low carbon emission lifestyle. However, inspiring solutions for sustainable living projects also emerge offering optimised living spaces. They range from *Vertical Villages* which re-combine the elements of working and living with the infrastructure to support daily needs over micro-compact student homes to individual tiny houses which even can follow their owners if they have to move.

4.1. Market leaders experimenting on technology-behaviour interface

The Swedish companies Vattenfall, Volvo, the house manufacturer A-Hus, the supermarket chain ICA, and other partners initiated in 2014 the *One Tonne Life* project. The aim was to see if a family can reduce their carbon emissions from the Swedish average of 7.3 tonnes each per year to one tonne. The objective was to demonstrate that if one family can make a difference, many families can drastically reduce their climate impact. For 20 weeks, a typical family of parents with two teenagers lived in a 155 m² house built with the latest technology using energy efficient technology (incl. solar cells) and an electrical vehicle. The family's emissions from private consumption before the project started corresponded to 6,6 ton CO_2-equivalents per person per year, indicating them as well below the Swedish average already. By letting the family move in to the house with the solar cells and use other energy efficient technology they reduced their emissions to 3 ton per person per year. For the mid time period the largest reductions were made within transportation and accommodation. During this period the family to the largest extent used the electrical vehicle and public transportation and lived an energy efficient life in the house. During the 20 weeks the family stayed in the house they gradually changed their habits and consumption patterns to reduce their environmental impact. Towards the end of this time the family had reduced their carbon emissions down to 1.6 tonnes each. This means that their carbon footprint decreased by 75 per cent. The largest reduction was achieved in transport (95 per cent) followed by food (80 per cent) though switching to a nearly vegan diet and 60 per cent from accommodation (Björk, 2011; "One Tonne Life - Final Report," 2011).

Vattenfall, as one of the project partners, draw a rather positive message from the results in various ways, among others about the demonstrative character of the initiative. The project reached more than one-third of the Swedish population, half of then said that *One Tonne Life* inspired them to take action in their own lives. Much of the technology and solutions used by the test family is already available to the general public. Many households can reduce their energy costs substantially by actively monitoring their electricity consumption, using more energy efficient appliances and improving insulation. Vattenfall uses the lessons learned from *One Tonne Life* to spur further development (Vattenfall, 2014b).

Three years after the end of One Tonne Life, another family, with father, mother and one son took a second round in the experiment. They managed to half the emissions compared to an average Swedish family (Vattenfall, 2014a).

4.2. Vertical villages

A commercial form of the co-housing described in chapter 2 actually is developing worldwide under the catchword of *vertical villages*. In urban central areas predominantly old buildings are restructured to combine living and working with the elements of shopping and service provision. A prominent example of a newly build vertical village is *The Interlace* in Singapore, awarded World Building of the Year (Blair, 2015).

Similar projects under construction in various cities Germany for example combine small, partly furniture compact apartments with office space, hotel, shopping facilities, restaurants, hotels and even child care under one roof (Gröner Forschungen und Entwicklungen GmbH, 2017). The aim is to combine the advantages of neighbourhood in villages with modern possibilities of provisioning. Sharing of dining rooms and guest apartments, co-working space, and up to date technologies are part of complex lifestyle packages. Target group to become vertical villagers are free lancers as well as companies interested to provide accommodation for middle management in case of new place of action.

4.3. Students as experimental ground for mini houses

Student housing is suitable for downsizing due to its nature of a temporary accommodation. In Kämnärsrätten, Lund, Sweden the student housing concept *BoKompakt* was developed and carried out to meet accommodation problems during term. Low rent, sustainable building and reduced use of resources in both the construction and management phases were the aims of the project. Explicit ambition was to achieve the smallest possible floor space without compromising the functions that purpose-built student apartments most include. To realise the project it took three years of negotiations with courts, architect's offices, student collaboration, and construction companies. Basis was a specific regulation in the building laws allowing that individual dwellings for students or young people with a residential area of not larger than 35 square meters, the room for everyday social contact, the room for sleep and rest, or the room with fittings and equipment for cooking do not need to be separable. If dwellings for students have separable parts of rooms for cooking, the separable parts do not need to have windows facing the open (Mårtensson, 2016).

By reducing the size of the WC, and by minimising and combining other spaces and housing functions, it was possible to design apartments with 10 m² of space allocated to each resident. In 2014 finally 31 students move in to the 22 apartments. Energy use at *Bokompakt* is only about 500 kWh per resident and year not at least through well designed technique for heating and hot water provision (AF Bostäder, 2014; Kullving, 2014).

BoKompakt is not the only example for compact student accommodation. The city of Munich already build up the O2 settlement of *micro compact homes (m-ch)* in 2005. A professor for architecture in collabotation with his students had designed cubes of 3m edge length equipped with all necessary areas for sleeping, working, cooking and sanitary needs. The micro compact homes can be grouped in horizontal or vertical arrangements as 'family clusters', or form larger villages. Meanwhile micro compact homes are realised in various European countries (Horden, 2007; Horden & Masip-Font, 2017) however mainly as additional rooms, accommodation for guests or even hotels.

4.4. Small and Tiny House Movement – idealism meets financial constrains

Different from the student homes tiny houses are meant to be permanent solutions for different styles of living. Originated in the US the idea to move to tiny homes has made its way to Europe.

People are joining this movement for many reasons. The most popular include environmental concerns, financial concerns, and the desire for more time and freedom. Tiny houses are fully equipped with kitchen bath and toilette just size and design allow an extremely reduced floor space. What counts as a tiny house is not precisely defined but 45m² is surely seen as a maximum. And they may well go down to 12m² for those homes build on trailers or at least moveable in theory. Despite voluntary commitment to reduced space and the higher flexibility in case of moving an additional criterion to decide for a tiny house is the much lower price compared to a traditional building. (Bosler, 2017; The Tiny Life, 2016)

4.5. Learning from the extremes

4.5.1. Limits of Smart Homes lacking smart thinking

Despite the positive evaluation Vattenfall e.g. gave to their experiment of the *One Tonne Life* the results show, that the target was not reached. As part of the problem the rather large size of the experimental house can be assumed. This at least suggests why the second family consisting of one person less arrived much further away from the target than the four-person family.

However, even beyond consideration of space, research found some more hindrances why smart home solutions may perform far from assumed. In one of the world's highest profile examples of Sustainable City Development (Stockholm's Hammarby Sjøstad) Pargman and Raghavan studied the practicability of smart home solutions. They discovered that elements of smart infrastructure was found in only 5% of the flats that had been built. Unfortunately, a closer look on those examples even showed further obstacles:

Some of the designed smartness became already outdated. Smart home technologies with short life spans were integrated into the buildings' walls that have a very much longer service life, without due consideration on how to dismantle the former. If a building is to stand for at least 100 years, how many times should the ICT infrastructure (built into the very walls) be replaced and what are the implications from a sustainability point of view? Maintenance, development and education (of building managers) the researchers concluded is needed for smart infrastructure to stay smart.

Pargman and Raghavan summarised: '*the most broad and common source of unsustainability in sustainable human-computer-interaction (HCI) is a lack of holistic thinking*'. Easy questions may help to articulate when, how, and why a technological intervention appropriate. A crucial is: could the technology be replaced by an equally viable low-tech or non-technological approach to the situation? In the smart home example above, alternatives could for example be to build (high-tech) advanced passive houses or (low-tech) clay or cob houses. An energy-saving solution that would always be appropriate is to do with less, i.e. to build smaller houses and apartments. By widening the system boundaries and by adopting a more holistic perspective, radically different solutions might become conceivable or even apparent. (Pargman & Raghavan, 2015)

4.5.2. Induce societal debate

So far living in smaller homes is not especially widespread, not even among sustainable housing projects. But if the prerequisites are getting more supportive, it could hopefully spread more (Mårtensson, 2016). What becomes clearer more and more is to construct a giant apartment and call it energy-efficient is not especially sustainable. Reducing the size of individual living space, in combination with shared facilities and user-friendly smart technologies make both environmental and economic sense. The driving force is indeed often economical because land prices are high and people want to live in cities. Quite some examples are under development or carried out already

that downsizing is gaining popularity. A further motivation for such project is to learn more about the consequences of building smaller and if it is possible to obtain sufficient quality of accommodation on such small areas. The attention such project receive contribute to raise awareness for the underlying intention of sufficiency.

5. Setting financial incentives

The individual decision to live on less space than the average or less than used to before is not necessarily driven by sustainable reasons. More often than an explicit decision it is due to external constraints, such as financial or social restrictions that limit living space, e.g. in case of income losses (Bierwirth & Thomas, 2015). We are fully aware of this fact and despite the ecological benefits of such living conditions by this individuals or families it is not what we have in mind when talking about sufficiency. On one hand because this does not mirror the positive emotions and attitude linked to a sufficient lifestyle and on the other hand – perhaps even more important – those people may like to switch to lager apartments or houses as soon as they can afford.

From the societal perspective there are good reasons to better promote sufficiency solutions. Efficiency measures go hand in hand with high investment costs and sometimes get under pressure in times of economic crisis. Sufficiency strategies in turn can be realized without investment costs and thus are not only a tool to approach environmental goals but an effective ways to save money; and it can help to win time for the challenging effort to refurbish the existing building stock within the next decades (Pfäffli, 2012).

Unfortunately, the focus on supporting efficiency measures tends to leaves out adequate considerations how also sufficiency solutions could be supported financially. Still some can be discovered.

5.1. Alternative concepts of financing more sufficient homes

5.1.1. Investing into social housing projects

Models of ownership for housing can strongly influence flexibility for the concept of homes. Compared to classical ownership cooperative houses are an interesting model which often allow easier change of flat size and structure and thus can be adopted to developing demands, might it be the increase or shrinking of space (Steffen, 2014). One approach to enable sufficient, community enhancing living is the solidarity-based economy is crowd funding. The *Mietshäuser Syndikat (apartment-house syndicate)* can serve as one example here. It provides advice to self-organized housing projects. It invests in the houses for such projects so that they can be taken off the real estate market (Miethäuser Syndikat, 2016). Another possibility are local investment funds restricted to citizens of the municipality (Kaltenbrunner, 2014). Especially the flexible use of shared space and facilities for further respectively additional rent offer an interesting potential to reduce concerns of investors into sufficiency motivated houses. And so do the reversible structure which allow necessary corrections with small effort (Steffen & Fuchs, 2015).

5.1.2. Location Efficient Mortgages

Location Efficient Mortages take another approach to support a more sufficient living. The total living and transportation costs of a household are largely independent of the distance to the regional centre. Lower living costs for households located in peripheral areas are often offset by additional transportation costs. In turn that means that living in the cities normally means less transport costs and such the possibility to allow a higher level of amortisation home owners can pay to their banks. This has led to calculation better conditions to those urban settlers strengthen the wider goals of saving land, lowering traffic loads, strengthening urban centres and avoiding follow-on costs for the public purse. Initial discussions are underway regarding the possibility of introducing recognised practices from the USA into Germany (Schiller, Gutsche, Siedentop, & Deilmann, 2009).

A further way to support more sufficient living is to give incentives to tenants who like to move to smaller flats. The *Potsdamer Wohnungsgesellschaft Gewoba* for example offers a living space bonus. Tenants who like to get smaller are offered a rent 10% below the normal level *(Fuhrhop, 2014).*

5.2. Public incentives

While housing companies or cooperation's mainly target tenants house owners may mainly need support through public instruments.

The importance of switching from m² perception of energy consumption to per person calculation was highlighted in 3.3.3 already. Such a shift would gain importance when also supports with public loans were not based on the objects per se but on the number of users. Even more, next to public credits for energy efficiency renovation (in Germany KfW financing) a similar stream of funding could be offered when sufficiency criteria are met (Steffen, 2013). This would increase the incentives for compact dwelling and thus not only reduce energy consumption but reduce the need for further soil sealing.

To make moving more appealing for people living in flats or houses too large for their actual needs a full or partly reduction of real estate transfer tax could be applied in cases where the new flat/house is at least a defined percentage smaller than the old home (Kopatz, 2014; Thomas et al., 2015). In general sufficiency aspects would benefit from a switch in the system of real estate and/or land tax (Kaltenbrunner, 2014; Löhr, 2008). For example, land located in central urban areas has the disadvantage, in comparison with peripheral areas that owners are much more hesitant to sell. As property tax currently provides almost no stimulation to the market, there are strong financial arguments (as well as environmental considerations) to reform the system of property tax with the aim of reducing costs (Schiller et al., 2009). In countries that don't raise acquisition taxes but higher property taxes, the latter could be waived for some time. Bonus payments to older couples who sell their houses in favour of bigger families might be possible as well. Similar incentives for rented dwellings need some further consideration as well (Thomas et al., 2015).

Financial support could also be gained through increasing flexibility on the local level when setting limits for dwelling allowances. For people living on social welfare public authority might justify paying higher dwelling allowance for energetically refurbished flats because they will benefit – or even be overcompensated – by the reduced costs for energy bills.

5.3. Various

A final example may be given here how sufficiency thinking can be rooted in social innovations motivated in completely different settings: In Germany various cities offer room for students not for money but for hours spend on helping the elderly landlord. As a rule of thumb the 'rent' in such arrangements is one hour of help per month per m² (Steffen, 2014). In Germany 36 university cities (9% of the 400 in total) offer support for bringing together people in search for room and those in search for help (wohnenfuerhilfe.info).

6. Engaging with stakeholders

As emphasised in chapter 1 already to reach climate and energy goals need sufficiency instruments which reach far beyond individual decisions. Instead concerted action is needed, for the time being mostly to make the various important stakeholders aware of their possible contributions to the necessary results. This chapter therefore highlights the role of planners and architects, housing companies, installers and construction firms as well as the importance of transparent processes (Carrera, Wassermann, & Zech, 2012) All those groups carry out valuable pioneer work already; nevertheless, a broader diffusion of sufficiency thinking and acting is necessary and possible.

In the end however, only political regulatory framing will be able to induce a limit in energy, resource and space consumption per person. (Steffen & Fuchs, 2015). Politics and policies should recognise sufficiency as a field of action instead of referring to individual decisions and lifestyles (Bierwirth & Thomas, 2015). Thus the final considerations are given to various thinkable instruments and first steps to their implementation.

6.1. The design role of planners and architects

As indicated in chapter 3 already architects and designers have the potential to play a crucial role in communicating sufficiency as well as paving the way through practical leadership. So far social sustainability is not an issue in main stream architecture (Zarghami, Fatourehchi, & Karamloo, 2017a). Contribution to 'a good life' is mainly perceived in the sense of providing more space. However, the self-understanding of architects starts to change from 'as much as possible builders' towards 'space problem solvers'(Steffen, 2014). This holds true for the home in sense of the house as well as of the neighbourhood. In the current era of corporate-led urban development and the commercialisation of public space, critical architects, urbanists and citizen groups are exploring strategies and ways to democratise the city. Within these groups there is marked interest in creating and safeguarding urban commons – spaces not primarily defined by their formal ownership but by how citizens use them (Bradley, 2015).

Architects and planners can develop a vital function for the advancement and integration of sustainability practices in societies. They are capable of communicating and presenting the pro and contras of sufficiency solutions through working with clients, customers and other relevant disciplines such as engineers or economists. Therefore it is necessary to expand the scope of design education and practice beyond style and fashion, economic issues (mainstream design) and environmental concerns (Ecodesign) to include social and institutional issues whenever possible.

Sustainable design for sufficiency homes is based on co-creation, co-design and synergistic learning. Social innovation practiced and promoted more and more by designers is only possible through mutual learning, team working, inter- and trans-disciplinary thinking and practice. Reciprocity, teaching and learning through participation involving stakeholders, form the foundation of sustainable solutions in general and especially sufficiency solutions. Planners and architects in such processes would become facilitators rather than the creators of sufficiency solutions – a challenge to design's collaboration and communication capabilities.

Vital for the process is to recognise the interrelatedness of the different levels and aspects of the housing related problem and processes and to define and analyse them from multiple perspectives. Awareness is an important step in this context for providing consumer satisfaction with a minimum of negative environmental impacts and a positive balance of social effects. Special skills related to eco-efficient and sufficient production and resource use allow becoming familiar with technological advancement, dematerialisation, zero carbon considerations, new and sustainable materials, and, waste considerations. Of equal importance is the integration of service provision by designing homes

in a context of Product-Service-Systems (PSS) and maximising user satisfaction by appropriate material/dematerialised option (Blincoe et al., 2009; Joachim H. Spangenberg, Fuad-Luke, & Blincoe, 2010).

Fuhrhop provides as example for sufficiency enhancing solutions to remove respectively newly build walls or even stairs between apartments where one of the owner or tenant needs less space while the other need more (Fuhrhop, 2014).

6.2. Housing companies and cooperatives

Examples provided above show that communal or private cooperatives (see 3.5) as well as private companies (see 4.2) already develop interesting approaches towards sufficient homes.

Especially non-profit cooperatives are devoted to support the common good through their statutes already. Gessler and colleagues report from Switzerland, that subsidized flats thorough their occupancy regulations are requiring a specific number of tenants per amount of m². This holds true for existing flats and also limits the tendency to ever larger individual space in new build homes. In this sense, the GAG Immobilien AG Köln for example, an incorporated company, considered to retreat from stock market to be able to build smaller again.

To keep tenant relationship housing association, at least large ones, are in a good position to offer an exchange programme for apartments, e.g. for the widowed senior. Beside the knowledge where adequate flats are available they also have the possibility to adequately consider the price and ensure that the rental agreement for the new flat is less expensive than the old one (see 5.1) (Thomas et al., 2015). Another incentive would be to practically help with moving through offering packing and transport service (Fuhrhop, 2014).

Beyond space aspects real estate companies of course also have relevant influence on a sufficient operation of houses and – to a limited extend – can influence mobility patterns, e.g. through providing bicycle facilities, or privileged parking space for car sharing (Gessler, Gugerli, & Altenburger, 2013).

Finally, in case of letting furnished or partly furnished flats, equipment with not only more efficient but also smaller appliances can help to reduce energy consumption (Pfäffli, 2012).

6.3. Middle actors

Next to planners and the housing companies some crafts professions (e.g. builders, heating installers, plumbers and electricians) play a rather practical role in shaping sufficient or un-sufficient behaviour. Literature perceive them as intermediaries or ‘middle-actors’ (Parag & Janda, 2014; Wade, Hitchings, & Shipworth, 2016). Their sphere of influence is less on space and its use but e.g. heating habits or other energy provision. Distinctively, they work, directly or indirectly, to implement or to advise on energy related decisions (e.g., choice of heating systems) They distil information, mediate social or technical relations, set behavioral norms, or motivate community action (Blumer, Wemyss, & Moser, 2015). Professionals in the refurbishment industry are in a good position to increase home and building owners’ agency by informing and advising their customers of the energy improvement options, new technologies and materials. Therefore, builders e.g. are crucial to mediating between consumers and technology, to enabling the physical changes needed, to spread the message of sufficiency behaviour and finally to train the home users how to adopt behaviour to meet carbon-reduction targets. They can improve customer capacity by providing them with

efficient infrastructure and explaining to them the importance of their handling to ensure a sufficient use of them.

A hindrance on the way to fully exploit these potential is that professionals might choose those products more familiar to them instead of offering a range of options. Whilst this limited selection of devices can also be linked to brand loyalties, another reason is that for such products they no longer need to consult manuals and user guides and thus better cultivate their status as experts. Thus, this preservation of an expert identity can contribute that e.g. heating installers are reluctant to accept different and better solutions (Wade et al., 2016) as it would mean a longer process before they have learned about other products and they can train their clients.

6.4. Municipalities

Municipalities are the administrative units closest to provision of homes to their citizens. Thus they are in a key role to consider sufficiency issues properly. Many initiatives can be and have to be done locally and in co-operation.

Due to their close link to citizens communities are in a key position for closing the gap a narrow focus on efficiency has caused. However, as they have limited access to hard policy instruments, municipalities need to rely on leading by example and providing a fertile ground for local action – not at least supporting initiatives initiated by the stakeholders elaborated upon in the previous sections. On a community level there are plenty of activities and many municipalities have shown the way forward (Bangens & Nilsson, 2015).

One area for communities of great importance is to support dwelling exchange or, more general, to take care that enough flats of reduced size – and of lower price – are offered. An information instrument requiring limited effort is a local internet based platform for dwelling exchange. However, as a voluntary approach, it will not be contentious but its effectiveness is might also be limited (Thomas et al., 2015).

Larger impact might come from an obligation to report vacancies to the authorities and or a public register (Thomas et al., 2015). Also rebuilding may help to create required smaller flats. Thomas and colleagues provide examples from some large German cities: In Frankfurt, for example, after years of vacancy a huge office building with 14 floors had been rebuilt and divided in almost 100 apartments. All over Frankfurt there are nearly 2 mio m² of empty office space, which, calculated to living space would allow almost 27.000 flats of 75 m² each. In Munich the picture is similar. There it is 1,8 mio m² and Hamburg could offer 1.2 mio m² of empty office space. Particular funding programmes may help to use this potential and of course a change of building regulation (Thomas et al., 2015). A further trend to be counteracted by municipalities is turning two flats into one luxury apartment, as happening in attractive and high price inner cities, e.g. Cologne. A ban on such flat fusion would play out as an effective instrument.

Sufficiency consultancy already was mentioned as an instrument in chapter 3. Municipalities actually would be a trustable host of such institutions. Beyond a purely digital platform sufficiency consultancy could bring together elderly people interested to move to smaller homes with families or people interested in shared apartments. Well organised such a sufficiency centre (in very large cities even various centres for the different quarters) would have the best chance to ensure people can stay at least in their neighbourhood when they move (Fuhrhop, 2014).

All such efforts can help to reduce the need to further devote land for residential areas, a costly approach for municipalities when they like to attract new inhabitants (see also 6.6).

6.5. Importance of participation and planning processes

In case of larger processes for sufficiency of homes, beyond individual decisions, one of the main messages to be derived from sufficiency research is the need to include the (future) inhabitants of newly build or redesigned homes in due time. Acceptance also for unconventional concepts, even for inconvenience during the process of refurbishing (Bierwirth, 2015), have a much higher chance to be carried out smoothly when those effected are involved in the development process.

Creative and structured communication processes help to build trust between planners, designers and architects on one hand and the inhabitants on the other. The prominent role of the former group was pointed out in 6.1 already.

In a moderated process

- the different interests and the different needs of the participants has to be discussed and defined
- the advantages and disadvantages of more sufficient solutions have to be openly discussed
- various alternatives have to be presented by different experts how the formulated needs could be considered and how to apply solutions to individual situations
- pro and contra arguments of sufficiency solutions need to be openly considered and final solutions agreed upon commonly.

(Steffen & Fuchs, 2015)

6.6. Public policies

Last but not least public policies are of vital importance to create the framework conditions for sufficiency thinking and acting. They can target energy consumption directly or indirectly restricting the space on which – residential – energy is consumed.

6.6.1. Energy related policies

Policy frameworks enabling sufficiency support energy savings resource protecting behaviour and disable energy intensive ones. Very general said: they create an environment in which products as well as infrastructures can flourish which need much less energy.

Clear and direct price signals are one element in this context. Progressive tariffs are one interesting approach here. As examples from Italy (and California) show, they seem to function well in the liberalized electricity markets. Social and energy related political interests seemed to be important functional conditions for the launch and implementation of progressive tariffs in the electricity sector, both in Italy and in California (Dehmel, 2011). A further step could already intervene in the design phase. Also energy using products might be developed under the requirements of progressive efficiency demands. According to such a concept larger TV sets then would have to be more efficient in relation to screen size than smaller ones (Brischke & Spengler, 2011).

6.6.2. Targeting space

As mentioned various time throughout this report already energy consumption per person is supporting sufficiency approaches in a better way than energy use/m². This holds true for public loans but could be as well become main criterion in regulations (in Germany e.g. the Energy Saving Ordinance) or certification schemes (e.g. those developed by the Germany Sustainable Building Council (Mårtensson, 2016; Steffen & Fuchs, 2015).

Policy may support such approaches e.g. through public architectural competitions or requiring that any such competitions should include guidelines and requirements for less living space per person (Thomas et al., 2015).

One obstacle to overcome regarding smaller or even compact housing is the strict building regulations and the requirements of accessibility. The *BoKompact* student house example (see 4.3) provided an example how regulations could be adopted (Mårtensson, 2016).

As pointed out all over the text, political support for more sufficient living is not only to save energy and space but also contributes to develop the necessary living conditions for an ageing society. Especially a promotion of more collaborative forms of living plays a vital role here (Bierwirth, 2015).

An interesting element in the overall picture is to reconsider urban respectively sub urban development plans. In Germany for more than two decades a sustainability target is to reduce the area newly converted from agricultural land to settlement area to 30 ha per day by 2020. Long term targets envision about 20 ha/day in 2030 and formulate the vision of nearly zero new soil sealing in 2050 (BMUB, 2016). These targets however, are far from being met. The factual number is at about 60 ha/day. This is because cities e.g. in Germany are in competition to each other. The main argument for ongoing soil sealing is to foster turnover and job creation in a specific municipality through the constant development of new settlement, commercial or industrial areas. Thus, interesting new building projects in the housing market are created to attract young families. The hope is each additional taxpayer will increase the income of the city. This creates a major obstacle for sufficiency thinking is the concern is that other, neighbouring municipalities otherwise would take the opportunity and then benefit from an enlargement instead. Such calculations however are not necessarily verified by solid calculations. One third of the planned settlement projects analysed in a sufficiency project in Germany would have been a losing deal for the community. The costs to provide the local public infrastructure would have been higher than the financial surplus (UBA, 2016).

To bring this escalating circle to a hold a space/surface moratorium seems to be a solution to consider. The most radical approach would be to allow the building of new houses only to cities with a growing number of inhabitants. New buildings also in constant or shrinking cities would be still possible this way but only under the condition that area of a similar size is de-sealed. Such a moratorium could generate a new wave of architectural and planning creativity to improve available building stock, not at least for the changing demand of housing opportunities (Kopatz, 2014, 2016). Such a regulation would potentially be the most powerful, but certainly a very contentious instrument.

6.6.3. Limit new soil sealing through tradable permits

A less strict element are tradable permits for soil sealing. From 2012 to 2017 the Federal Environment Agency in Germany experimented with such a concept. The target of 30ha/day was taken as the upper limit for Germany. Free certificates were given to participating cities. The criterion for the allowances were the number of inhabitants of a city (UBA, 2016). In case of new building plans, the corresponding certificates have then to be filed by the planning authorities. As required, they may buy or sell contingents of certificates. This would satisfy the needs of growing cities but also give an incentive to all municipal authorities to limit new build of dwellings (Thomas et al., 2015)

The experiment fruitfully strengthened the development of the inner cities. Spaces between buildings or other unused space was activated in a way that they fully compensated the space avoided at the edge of the cities (UBA, 2016).

An accompanying study on legal issues showed that the permit solution could be integrated in communal building planning rather easily. Accompanying measures helpful on the way would be further planning obligations to steer and restrict settlement area and the further development of monitoring requirements (Bovet, 2017).

6.6.4. Inducing sufficiency in a circular economy

Finally, the sufficiency aspect in and for homes is also an aspect on the way to a circular economy. So far developing settlement areas seem to be a one way process. To close the circle could be fostered through 'take back' obligations for building. A comparable instrument is established already long out through history in the German mining law where mining areas have to be re-naturalised after the active period. Financial and technological planning for the taking back then would have to be established with the building permission (BMUB, 2016). Also open source approaches could help in a circular economy as they would transperantly show construction principles and materials used and thus support more sustainable solutions (Petschow & Peuckert, 2016; Zimmermann, 2016).

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