Original research article

Human Scale Energy Services: Untangling a 'golden thread'

Lina I. Brand-Correa*, Julia Martin-Ortega, Julia K. Steinberger

Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK

A B S T R A C T

Prioritising human well-being while avoiding further damage to the planet is a key challenge in the era of climate change. This paper examines the role of energy as an intermediary between climate change and socio-economic outcomes, with the ultimate goal of identifying ways of decoupling human well-being from energy use. Building on Max-Neef's "Human Scale Development" framework and conceptualisation of human needs, we propose a novel community-level participatory approach to identify connections between energy services on the one hand and human need satisfaction on the other. This approach then enables communities to collectively consider and propose alternative ways to provide energy services. We compare the outcomes and reflect on the process of two exploratory workshops, undertaken in an urban and a rural area in Medellín (Colombia). Our results indicate that these communities view energy services as satisfiers of human needs, with significant differences between the communities. Furthermore, our approach enables the communities to broaden the solution space of energy service provisioning possibilities, thus constituting a promising alternative to the top-down technocratic perspectives currently prevalent in research and policy. We argue that this type of bottom-up approach is necessary to address the complex sustainability challenge of living well within environmental limits.

1. Introduction

Climate change poses great challenges to societies, chief amongst which is to preserve human well-being while avoiding durable harm to the planet's life support systems. These challenges are arguably greater for developing societies, which have yet to satisfy the basic needs of their growing populations. The poorest within these populations are likely to suffer the most adverse environmental consequences as a result of the multidimensional inequalities they face [1]. In this context, energy use is the key intermediary between environmental impacts and socio-economic outcomes. The UN's former Secretary-General Ban Ki-Moon described this crucial role of energy, when he stated that "Energy is the 'Golden Thread' that connects economic growth, social equity and environmental sustainability".[1] The connection between energy and environmental sustainability is widely understood, and there is also a large body of literature concerned with the connection between energy and economic activity. However, the direct link between human well-being and energy use is much less studied.

We argue that the 'Golden Thread' that weaves through to human well-being is not energy (measured in physical units, e.g. kWh or joules), but rather *energy services* (for instance illumination, thermal comfort, mobility). Energy services, rather than energy itself, are what people demand [2], the benefits humans derive from energy carriers [3], what contributes to people's well-being [4]. This research aims to further investigate the connection between energy services and well-being, and to elicit bottom-up proposals of alternative energy service provision. These new proposals may inform the decoupling of energy use from human well-being, with the ultimate goal of achieving high levels of human well-being within planetary boundaries [5–7].

In this paper, we develop, test and demonstrate a community-level participatory approach, adapted from the Human Scale Development framework of Max-Neef [8]. This approach is based on human needs theories [8,9]. In contrast with subjective and individualistic understandings of well-being, human needs consist of a finite, objective and universally comparable list of social pre-conditions for a "good life". In human needs theories, the focus is on the means employed to satisfy human needs: these means, called "satisfiers", are context-specific, and change according to time, place, culture, technology and so on [8,9]. This specificity lends itself well to be studied at the community level [8], where specific satisfier configurations are grounded.

Two communities, one rural and one urban, in the municipality of Medellín (Colombia) were selected as case study locations for our research. During the workshops, we first elicit the community's views on the interrelations between energy services and human needs. We then build on these interrelations, opening up the discussion to generate alternative possibilities to satisfy human needs through energy services

within each community. These community-based alternatives could eventually enable the decoupling of energy use and human well-being. In other words, the proposed approach is designed to lead to different ways of thinking of provisioning energy services in order to satisfy human needs. Furthermore, participation can be empowering for the communities involved through collective co-construction of knowledge [8,11–13]. Hence the value of this research resides not only in its specific results, but also in its participatory process (which has been previously recognised as important in relation to energy research [10]). This process can enable awareness building and self-reliant community action [8,11].

2. Literature and conceptual background

2.1. Previous research

The connection of Ban Ki Moon's 'Golden Thread' of energy to environmental sustainability is widely understood [14,15]. The energy sector has historically been responsible for around two thirds of global greenhouse gas emissions [16], leading to policy promotion of renewable energy, energy efficiency and carbon capture and storage as the main part of national and international commitments to reduce greenhouse gas emissions [17]. Additionally, a large body of research exists on the relationship between energy and the economy, including debates around the causality between energy (primary or final) and economic growth [18,19]. An emerging consensus is that useful energy (a category that is much closer to energy services) has been shown to be vital for economic growth [20–25].

The direct link between human well-being and energy use has been less studied, arguably because the focus of energy studies has traditionally been economic or technical, rather than social. Some exceptions can be found in quantitative research that has been carried out around the relationship between energy use (and ensuing fossil emissions) and human well-being at a national level [26–34]. These aggregate levels of analysis, however, fail to uncover the detailed linkages between specific types of energy use and social progress, as well as specific challenges faced by different communities, and thus are limited in their ability to inform directions for decoupling energy and human well-being. We thus agree with the perspective that participatory approaches are promising alternatives to mainstream top-down technocratic models to understanding energy use, and are especially well-suited to study its link to human well-being [35,36].

There exists a significant body of research around energy poverty and energy vulnerability, particularly focused on the UK and Europe [37–39]. In general, this research focuses on the lived experience of people in situations of fuel poverty (a more disaggregate level of analysis), and critically analyses the role of top-down policies in alleviating or aggravating such situations. In developing contexts, the focus has been mainly around the health impacts of energy provisioning [40,41], and the poverty and equity effects of access to energy in general [42] and electricity in particular [43,44]. At the household level there is also a body of literature assessing the energy requirements of households at different levels of income or through time [45–47]. However, these fail to link energy to human well-being, that is, they do not explore the reasons why people use energy, or the benefits they might gain from it. Notable exceptions are the work of Rao and co-workers, which has an explicit "decent life" lens [36,48], as well as the conceptual work of Day et al. [37] and Brand-Correa and Steinberger [4].

Thus, the relationship between energy and human well-being at the community level is still largely unexplored. We argue that this level of analysis is vital for answering questions around the cultural specificities of energy services as "satisfiers" of human needs, as well as for understanding the diversity of configurations in which energy services can satisfy human needs. Clear concepts are a necessary basis upon which to structure our analysis. Therefore, we now briefly outline our conceptual choices and the reasons why we believe they are conducive to our research goals.

2.2. Energy use through the lens of energy services (ES)

It is not raw energy sources (primary energy) or even fuels and electricity (final energy) which connect energy to human well-being, but rather the *services* that we obtain from energy. If energy is a "golden thread" linking social outcomes and sustainability, it is really energy services that weave through to human well-being. A precise definition of energy services (ES) has proved elusive. Fell [49] condenses the meaning of the term in previous research under the following definition: "energy services are those functions performed using energy which are means to obtain or facilitate desired end services or states". Following Cullen and Allwood [50], the ES (functions) that we used here are: illumination, heating, cooling, mechanical work, structure, food, information and communication, and mobility.

Cullen and Allwood's [50] categorisation stemmed from an attempt to map global energy flows from primary energy to energy services, in order to identify the aggregate potential of efficiency improvements, particularly at the "passive system" level [51]. We found this categorisation, which is largely consistent with others [2,3,52–55], a comprehensive starting point at the level of global energy uses.

We then adapted it for our purposes, in order to make it consistent with the community level. From Cullen and Allwood we kept the following categories: structure, (information and) communication, sustenance (renamed as "food"), "hygiene" (renamed "mechanical work") and illumination. We removed the service of "freight transport" and included it, together with passenger transport, in the broader category of "mobility". Finally, we separated "thermal comfort" into "heating" and "cooling", in order to clearly elucidate differences in climatic conditions.

We argue in favour of the concept of ES, in relation to human well-being and in the context of environmental degradation, for two main reasons (with more detail in [4]). Firstly, energy is an invisible entity and a complex concept, whilst ES are tangible and relatable in terms of day-to-day activities. Therefore, ES can be connected to need satisfaction. Secondly, by analysing energy through an ES lens, additional efficiency improvement possibilities can be introduced, particularly in terms of passive systems and service level measures [51,56]. These additional efficiency improvement possibilities can be translated into decoupling (i.e. less energy use (primary or final) for the same level of ES), which is key for sustainability.

2.3. Human well-being through the lens of human needs (HN)

The human needs (HN) understanding of well-being stems from the philosophical tradition of Eudaimonia,[7] as opposed to Hedonism (for a more detailed conceptual description of these two traditions see [4]). Eudaimonia relates to the process of living well [57], of flourishing [58,59], of being able to fully participate in society [9]. This is necessarily a social process that occurs over time [60], hence long-term sustainability is particularly relevant to achieving well-being.

HN are the preconditions necessary to achieve well-being in a eudaimonic sense. They are the basic requirements for people to be able to live well in society. Authors that address HN generally propose a finite list, highlighting a key difference from infinite wants (or preferences). Furthermore, needs are "self-evident (i.e. universal, recognizable by anyone), incommensurable (thus satiable, irreducible and non-substitutable) and non-hierarchical" [4].

There exist specific lists of needs developed by different authors, which have been determined in diverse ways.[2] Despite these divergences, Alkire [61] and Lamb and Steinberger [35] argue that the

---

[2] For example, Doyal and Gough [9] used the best scientific knowledge available (from both natural and social sciences) to determine their eleven intermediate needs. Nussbaum [86] and Max-Neef [8] determined their ten capabilities and nine needs respectively based on theories of justice and freedom, which also played a part in Doyal and Gough's [9] selection of two basic needs.

lists tend to converge around common dimensions. We have chosen to use here Max-Neef's [8] Human Scale Development classification of HN (subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom), mainly because the participatory methodology associated with his theoretical construction. We expand on Max-Neef's methodological approach in the next section.

A HN understanding of well-being is most relevant for analysing sustainability [60]. The universality of HN enables comparison between societies or communities, which is important when conducting empirical research. HN have a claim to strong sustainability; since they are non-substitutable and non-hierarchical, there is no possibility of improving or prioritising the fulfilment of one human need to the detriment of another (e.g. you cannot substitute ill health due to air pollution by improving your level of education). And, in contrast with the infinite wants and desires posited by neoclassical economics, HN are satiable.

Another important characteristic of HN is that there is a clear distinction between needs and "satisfiers" [8,9], between basic capabilities and specific functionings [58]. Thus, the HN approach takes into account the different contexts and cultural specificities of the communities. The exploration of satisfiers furthers expands the analytic space to seek more sustainable ways of fulfilling HN.

3. Methodology

3.1. Max-Neef's Human-Scale Development (HSD) needs and satisfiers approach

Max-Neef's approach to understand needs and satisfiers was initially intended to help grassroots movements in the 80s and 90s, particularly in Latin America, to take development issues into their own hands, and to break with the tradition of failed top-down development strategies in the continent [11]. This workshop-based approach was a tool to support participatory processes within communities, leading both to greater awareness of development challenges, and towards building self-reliance and improving human need satisfaction [62]. Since then, Max-Neef's Human Scale Development (HSD) approach has been widely used and adapted by researchers and practitioners of community-level sustainable development [11].

Max-Neef's [8] HSD approach centres on a matrix of nine *axiological categories* (or HN) on the vertical axis (see Section 2.3) and four *existential categories* on the horizontal axis. The latter are 'being' (personal or collective attributes), 'having' (institutions, norms, mechanisms, tools), 'doing' (personal or collective actions) and 'interacting' (spaces or atmospheres). During successive workshops the matrix would be filled with different types of satisfiers, which can be characterised in relation to whether they impede (destructive, inhibiting and pseudo satisfiers) or promote (singular and *synergetic*[3] satisfiers) human need fulfilment, or whether they are top-down (exogenous) or bottom-up (endogenous) in their conception and implementation [8]. This whole process empowers communities by enabling them to form a holistic view of their human need satisfaction and potential alternatives [11,62,63]. Hence, we considered Max-Neef's HSD approach to hold great promise for addressing the question of the link between ES and HN, and alternative ways of using ES as satisfiers.

A holistic view of human need satisfaction alternatives goes beyond market-based provision (having) and empowers communities to act where they can, thus improving their self-reliance [11]. For example, in the case of people facing unemployment and economic deprivation, the HSD approach allowed the community of Granada to think beyond the desire of "having" job creation as a main policy goal, and enabled them to see the interdependence of other social and environmental initiatives

when it came to need satisfaction (e.g. empowering workers, citizen participation and urban gardening) [64]. Therefore, we argue that the potential that Max-Neef's approach presents, in terms of revealing broad interdependencies between different satisfiers and needs, can be adapted to search for a systemic view of the relationship between ES and HN. We describe our adapted approach below.

3.2. Human Scale Energy Services (HUSES): an adaptation of Max-Neef's HSD approach

We adapted Max-Neef's HSD framework of HN and satisfiers to explore the connections between well-being and energy use. We have called this adaptation HUSES (Human Scale Energy Services). We elicited connections between Max-Neef's nine axiological categories of HN (see Section 2.3) and eight types of ES (see Section 2.2). Moreover, we used Max-Neef's existential categories (see Section 3.1) in order to enable the communities to think holistically about alternative strategies to provide an improved level of a selected energy service. The diagram in Fig. 1 shows how the workshop parts described below relate to Max-Neef's original matrix.

Next we present a summary of the adapted workshop structure used in this research (a more detailed workshop structure can be found in the supplementary information). This workshop structure was established after a piloting phase taking place in the UK but in Spanish with a combination of Spanish and Latin American participants. The piloting led to improvements in the workshop design and terminology employed. The workshop is divided in three main parts as described below.

3.2.1. Part 1: conceptual introduction of human needs and energy services
The goal of this stage of the workshop is to communicate the rather abstract concepts of human needs, satisfiers and energy services in a participatory workshop context, and establish whether these are relevant to daily activities and decision-making of the workshop participants.

Initially, participants are presented with eight categories of ES: illumination, heating, cooling, transport, information and communication, structure, food, and mechanical work. These ES are presented as things that require energy, but that can be provided in many different ways. We consider these categories to be broad enough to allow participants to think beyond specific or conventional energy sources and conversion devices. Participants are requested to provide examples of alternative ways of providing each energy service. These examples serve as a way to familiarise participants with concepts that might not be too obvious for them, as well as making sure there is agreement on the meaning of each energy service.

Subsequently, participants are presented with Max-Neef's nine HN: subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom. Each of these is discussed briefly by the whole group, and participants are asked to think whether they could "be well" without each of them (e.g. would you be able to "be well" without freedom?). Furthermore, they are asked to relate these needs to their day to day community life: does the list make sense? Is there anything missing? Is there anything that is not so important? How are these needs felt by the community? None of the participants suggested any revisions (see Section 5.1 for more details).

3.2.2. Part 2: relating energy services and human needs and the quest for the most synergetic energy service
The goal of this second stage is twofold: to explore how ES serve as satisfiers of HN, and to identify the most synergetic energy service with the purpose of using it in the third part of the workshop.

To avoid making the workshop too long and maintain participant engagement, the participants are divided into four groups. Each group is given two energy service cards as well as two stickers of each human need. In their groups, participants analyse one energy service at a time, considering about which HN – if any – it contributes to satisfy, and

---

[3] *Synergetic satisfiers* "are those which, by the way in which they satisfy a given need, stimulate and contribute to the simultaneous satisfaction of other needs" [62].
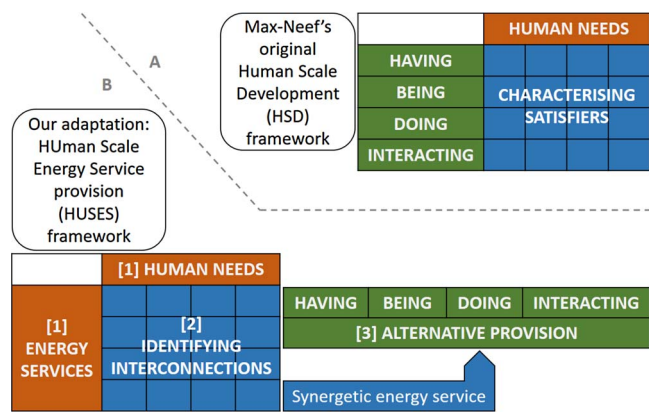
Fig. 1. Diagrammatic representation of our HUSES framework (A) in relation to Max-Neef's HSD framework (B).

sticking a sticker for each human need they identify as being satisfied by the energy service they are analysing.

Once all the groups have finished analysing their two ES, they present their choices to the rest of the participants as well as the reasons behind their choices. There is space for discussion of whether the choices make sense and whether there is agreement on the selected HN. At the outcome of this phase, the ES which connects to the largest number of HN is identified as the most "synergetic." The stickers provide a visual tool to easily identify the most synergetic ES.

3.2.3. Part 3: improved energy service delivery

The goal of the final stage is to envision a community-led pathway to obtain an improved level of (or greater access to) the energy service selected in part two. For example, if a community selected the energy service of cooling, the goal now is to propose alternatives to have a better access to cooling in the community, for whatever purpose (human needs) they have found cooling important. At this stage, participants are divided into two groups and asked to use the existential categories of being, having, doing and interacting [8]. Each group must come up with a plan to improve their current level of energy service provision at their community. The existential categories are explained using a simple example. Considering the cultural importance of football for many societies, and in Colombia in particularly, we derived a football-related example, which can be easily adapted to other sports that are more culturally relevant. We share the example below:

> "Imagine you are someone who wants to **be** a great footballer. In other words, you want to achieve the highest level of technical and tactical ability. I order to do so, you need to have certain attributes, you need to **be** a certain way. You need to be passionate, committed, responsible, hard-working, and so on. But the people that surround you also need to be a certain way, like supportive and encouraging. So the category of "being" is all about personal and collective attributes. You would also need to **have** certain things, for example a football, some sports kit and appropriate shoes. But then again, you would also need to have some more collective things, like a team to play with and a league to compete against other teams; perhaps even a professional league where you wouldn't have to worry about working and could focus on training and playing. So the category of "having" is related to institutions, norms, mechanisms and tools. You would also need to **do** a number of things, for example train, eat well, watch football matches, study tactic and technique, go to the gym, etc. Some of these things you could do alone and some need to be done in group, so the category of "doing" corresponds to personal or collective actions. Finally, you would have to **interact** in certain spaces and at certain times. For instance, you would need a football pitch and predetermined training times. Thus the category "interacting" relates to spaces, times and atmospheres."

Finally, after discussing how to achieve an improved level of energy

service delivery using the four existential categories, the two groups share the ideas with the rest of the participants and give feedback to each other, choosing an alternative that they all agree with. It is important to note here that the participants were not asked to address the environmental sustainability aspect of the proposed alternatives. Ways to integrate sustainability aspects in future research are explored in Section 6.3.

4. Case studies

Two case studies were used to test the validity and feasibility of our proposed approach. It is important to keep in mind that these constitute a test of a novel approach, therefore the specific case-study outputs, even though interesting in our view, are specific to these two communities. The value of the contribution presented in this paper hence lies fundamentally on the reflections over the method itself and on the value that the process tested here can have for communities more widely.

4.1. Study site(s): the country, the city and the communities

Colombia was chosen as a case study country for two main reasons. Firstly, one of the authors has a personal and funding connection to the country, and secondly Colombia has relatively low energy use and relatively high human well-being at a national-level [31]. Therefore, it is a good example of national-level decoupling of energy use and human well-being, i.e. it has achieved (on average) relatively high levels of human well-being with relatively low levels of energy use. However, the country is very diverse in terms of physical geography [65], as well as cultural and socio-economic characteristics, with high levels of inequality. Thus, enquiring into the local realities that can reflect specific geographical, cultural and socio-economic characteristics becomes particularly important in Colombia, in order to go beyond what is hidden in national-level averages.

The particular administrative area of the city of Medellín was chosen for two main reasons. The first reason relates to the city's socio-economic, historical and political particularities [66]. Medellín is Colombia's second biggest city. It has undergone a significant outward looking transformation, which has earned the city two awards in the past four years[4] for tackling violence, undertaking "social urbanism" projects and improving social participation [67]. However, the city still faces many inequalities and internal contradictions [68]. Medellín's particular approach to urban and regional planning (including a municipally owned utilities company and cable cars for public transport into marginalised communities), coupled with its many contradictions, make it an interesting case study. The second reason is practical, given the links we had with local NGOs that could support the fieldwork.

The specific communities that we worked with were El Faro and Palmitas. We acknowledge the complexities surrounding a definition of community [69], however in these two cases we are considering the inhabitants of El Faro and Palmitas to each be part of a community, given the shared experience they have of the territory (including, crucially for this work, shared energy and transport networks and infrastructure), the shared settlement history and the sense of identity determined by the political-administrative boundaries they belong to. The latter also facilitates unity for projects and initiatives facing local authorities.

The communities were selected because they are a good example of the sort of specificities and inequalities that lie hidden in national averages: both communities are deprived from access to basic levels of ES as well as having below average satisfaction of HN (see Table 1), i.e.

Table 1
Socio-demographic and historic characteristics of El Faro and Palmitas.

	El Faro (urban)	Palmitas (rural)
Area	6–7 ha[a]	5779 ha
Population	∼1500	∼6300
Households	∼300 – overcrowding	∼2500
Community	Mostly displaced (∼84%)	Mostly traditional farmers
History	Informal settlement	Formal settlement
Socio-economic status	Mostly poor households	Mostly poor households
Education	4% illiterate	7% illiterate
	20% no formal education	16% no formal education
	28% up to primary	44% up to primary
	45% up to secondary	30% up to secondary
	3% college or university degree	3% college or university degree

Note: Information for El Faro was taken from [71,72]. Information for Palmitas was taken from [73,74].

[a] Own estimation based on [70].

these communities represent a deviation of the national-level decoupling found for Colombia in previous studies. Therefore, these communities represent an interesting case to study what alternatives are available for real communities that are struggling both in relation to ES access and HN satisfaction, in a country where it is possible to achieve relatively high levels of HN satisfaction with relative low levels of energy use.

Furthermore, El Faro and Palmitas have a number of interesting similarities (see Table 1) and are both active communities that work closely with local NGOs (Techo and Penca de Sábila respectively), which facilitated access for the researchers. However, the communities also differ from each other in an important aspect. El Faro is located within the city, while Palmitas is lies on the outskirts of the city (see Fig. 2). Therefore, the way of life and economic activities have mainly urban characteristics in the case of the former and mainly rural characteristics in the case of the latter, allowing to explore contrasting issues with regards to the use of ES as satisfiers of HN.

4.2. Participant recruitment

Participants were recruited through local NGOs, which have regular presence in, and are trusted by, the communities. The NGO "Techo" is

Fig. 2. Map of El Faro and Palmitas (Medellín, Colombia, South America).
Source: Own elaboration.

an international organisation concerned with poverty alleviation, mainly working in Latin America. In Medellín Techo is currently working with several communities, including El Faro. "Penca de Sábila" is a national not for profit organisation concerned with environmental and social aspects of sustainability. In its "social and environmental management of the territory" programme, it is currently working with the rural community of Palmitas, amongst others.

Participants were not offered any incentive to participate in the workshop, except for refreshments. They were recruited through a "snowball" effect [13], where the community contact(s) with the respective NGO recommended and invited other members of the community who would have the time and the interest to participate, while trying to maintain a wide spread of views. The status of the NGOs in the communities as "insiders" assured us trusted access (even though we were complete "outsiders"), and the recruitment process ensured us that the participants in the workshops would be engaged and actively looking for alternatives to better their community.

As is common in this kind of research set up, more active community members were hence more likely to have attended our workshop, while the views of less engaged community members would not have been represented. It should be noted, though, that Colombia has a strong community-based approach to natural resources management and it is not uncommon for the population to engage in participatory process (see for example Brown et al. [76] and Waylen et al. [75]). Therefore, we expected to have a good level of participation and variety of perspectives.

Both workshops were undertaken in January 2017, on a Sunday for a duration of 3 h, and in a location central to each community in order to reduce barriers to participation (and thus minimise exclusion). The workshop in El Faro had 10 participants (5 male and 5 female). Similarly, the workshop in Palmitas had 11 participants (4 male and 7 female). In both cases the participants were adults of ages ranging from approximately 30 to 70 years. Accurate population representativeness is not key (nor always possible in practical terms) to qualitative research of this kind, but rather having rich data to understand the context and meanings of the communities involved [77]. Nonetheless, having this variety of participants reassured us that we had a good spread of different views from the communities, particularly male and female views.

5. Results

5.1. Understanding human needs and energy services

During the first part of the workshops (see Section 3.2.1), participants found the concept of ES very intuitive and they quickly came up with additional examples of different ways of provisioning each of them. For instance, participants from El Faro identified lightbulbs, the sun, the moon, candles and torches as different ways of providing lighting. Participants were even able to identify cases where two services were delivered by a single energy source, demonstrating a very good understanding of the concept. For example in the case of Palmitas, one of the participants asked: "what about the case of a bonfire? That provides me lighting but also heating".

Furthermore, participants from both communities related easily to the HN categories. When asked whether they felt there was something missing or something not so necessary for human well-being, neither of the communities contested the nine categories. Thus, human needs were self-evident for these two communities. Nonetheless, they did ask for clarification in certain aspects, for example in which categories health and work would fall into (subsistence/protection and creation respectively). When asked how they felt those needs in their particular communities, it was difficult for them to select a particular need that they were lacking most, reflecting how these communities perceived needs as being deeply interlinked, irreducible and non-substitutable (i.e. incommensurable), and non-hierarchical. For instance, the
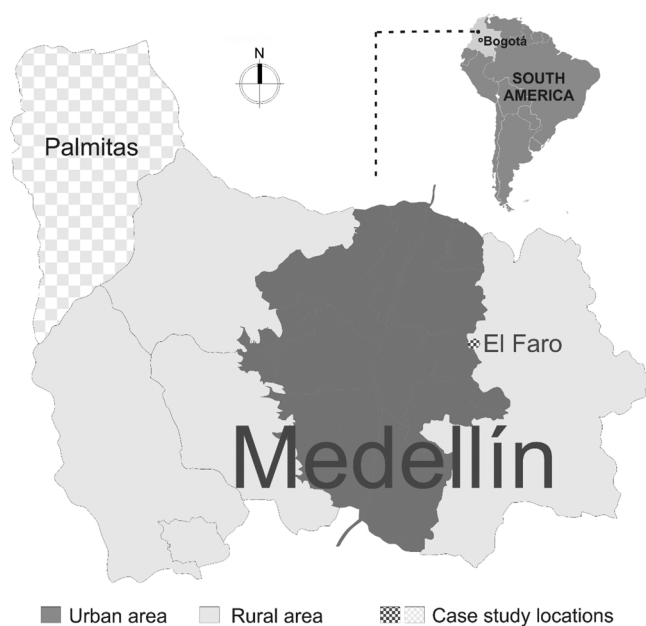
Table 2
Relating energy services and human needs in El Faro and Palmitas.

Energy Services (ES)	Subsistence	Protection	Affection	Understanding	Participation	Idleness	Creation	Identity	Freedom
Heating	⊕	☆							
Cooling	⊕	⊕					●		
Illumination	⊕	⊕		●	●		⊕		
Structure	●	☆	●		⊕	●	⊕	⊕	●
Mechanical Work	●	●		⊕	⊕	⊕	⊕	☆	●
Food	⊕	☆	⊕	●			⊕		●
Inform & Comm				☆	⊕	⊕	☆	☆	⊕
Mobility	●	●		●	⊕	⊕	⊕		⊕

Human needs (which the ES are satisfiers of)

Notes: ☆ El Faro; ● Palmitas; ⊕ El Faro and Palmitas.

community of Palmitas discussed how a lack of protection (from, e.g. landslides) would be linked to a lack in subsistence, creation and freedom. Similarly, the community of El Faro reflected on how communities had the capacity to "have" these HN, but that they were constantly being thwarted by top-down interventions that either deprived them or prevented them from satisfying their needs. These type of discussions reflected how both communities understood the underlying characteristics of HN: self-evident, incommensurable and non-hierarchical [4,61].

5.2. Identifying links between energy services and human need satisfaction

The second part of the workshops focused on relating ES and HN (see Section 3.2.2), with the findings summarised in Table 2. It is interesting to note that, from the perspective of these two communities, all HN require at least one energy service (reading down the columns in Table 2). Conversely, some ES were considered more important than others for human well-being by these communities (reading across the rows in Table 2). For instance, heating and cooling were, for both communities, the least synergetic satisfiers. This might be explained by the fact that Medellín has a temperate climate all year round, so space heating and/or cooling is not a main concern. Nonetheless, they were considered important satisfiers for subsistence, given their importance for food storage and cooking. Of course how synergetic a particular energy service is, is specific to each community. We suspect that if we carried out this sort of workshop in a temperate zone, heating would be considered a much more central satisfier, and cooling more important in a tropical climate.

The commonalities and divergences between the two communities in Table 2 are worthy of particular notice. The divergences are consistent with the expectation that satisfiers are specific to the particular circumstances of each community. But there might be some interesting elements to explore where commonalities are found, in terms of overlap of both selected and non-selected ES as satisfiers of particular HN (i.e. circle and star, and blank cells in Table 2, respectively). There is clearly an element of universality (between these two communities, but also beyond) in that the energy service of food is needed for subsistence. However, it is not clear whether we can say the same for the ES of cooling, heating and illumination in relation to subsistence, for example.

The nature of the workshops means the specific outputs would vary and very much subject to the individuals in the groups and their experiences and understanding of the workshop, thus explaining much of the selection of energy service as satisfiers of HN. However, it is worth highlighting some cases where the reasoning for selecting an energy service was strikingly similar. Continuing with the example of subsistence, heating and cooling were considered important in relation to cooking and food preservation, and illumination (from the sun) was recognised as vital for human beings. Illumination was also considered important for protection mainly in relation to street lighting (i.e. protection against violence). Another common line of argument in both communities was around the importance of structure as providing spaces to participate, create (and work), but also as providing a sense of identity (that is, where we meet, where we work, where we live, gives us a certain identity). Similarly, mobility was thought of an important satisfier for participation, idleness and creation, insofar it enables people to meet, go on holiday and go to work; it was also thought of as an important satisfier for freedom (i.e. being able to move to different places, close and far, is a sign of freedom in itself). Lastly, we found some common arguments around information and communication, where talking to others and having access to the media provides satisfaction of the need for understanding and idleness, as well as freedom.

In terms of the ES that the communities considered most important for human well-being (most synergetic), both communities considered structure, mechanical work, mobility, and information and communication particularly synergetic. How important each of the communities considered the ES to be varied, however. This might be explained, at least in part, by the urban and rural nature of their settings. In general Palmitas considered ES to satisfy more needs than El Faro. For example in the case of mobility, this could be explained by the fact that Palmitas is located in a relatively remote area when compared to El Faro, which, even though it does not have the best transport links, is located in the city.

5.3. Alternative energy service provisioning

The third part of the workshops focused on enabling the communities to think of alternative ways of provisioning the energy service which they selected as most synergetic (see Section 3.2.3): El Faro chose information and communication (satisfying six HN) and Palmitas chose mobility (satisfying seven HN). It is important to summarise here the specific circumstances that both communities were facing at the time of the workshops, since these would have been likely to influence their choice of the most synergetic energy service as well as their alternative way of provisioning it.

The community of El Faro was undergoing a process of gathering the community together for various projects during the time of the workshop, including the construction of a community centre with the support of the local NGO, mobilising the community for the establishment of a community-based water tank and finalising the process by which the community would be recognised as a formal neighbourhood. Hence communicating important information to all members of the community was a very strong need they had at the time. The community of Palmitas was not undergoing any particular consultation or participation process at the time of the workshop, but moving their agricultural production to a point where it can be commercialised was a concern, given that they were doing it on foot, which takes a lot of time, effort and it can lead to damages in the products (e.g. bruising of bananas).

However, despite the particular circumstances of each community, the process of the workshop is reproducible and important. From Table 3 we can see that by using the existential categories as a tool for communities to think about alternative ways to reach an improved level of energy service provision, they were able to go beyond traditional top-down demands to local government or other institutions. For instance, the community of El Faro did not focus on the local government giving

Table 3
Alternative energy service provision in El Faro and Palmitas.

Most synergetic energy service	Needs according to existential characteristics			
	Being (personal or collective attributes) – nouns	**Having** (institutions, norms, mechanisms, tools) – words	**Doing** (personal or collective actions) – verbs	**Interacting** (spaces or atmospheres) – times and locations
Information and Communication (El Faro – to improve participation in community initiatives)	Committed. Persuasive (to convince people that it is worthwhile to participate). United.	Everyone's phone/mobile number. Information "diffusors" (people willing to talk to their neighbours). Results or success stories. Volunteers.	Create a message that motivates people. Produce information to reach outside the community. Census with a clear message and an invitation to participate.	All around the community.
Mobility (Palmitas – to move the agricultural produce)	Associated. Collaborative.	Equipment for a cable car. Agricultural produce.	Apply for finance or do some fundraising activities. Install equipment. Coordinate schedules and routes for collection.	Foothills. Close to neighbouring producers.

them spaces and mechanisms to inform and communicate with each other, but rather they thought of a way of effectively talking to each other. Similarly, the community of Palmitas did not think of demanding for a better road network or improved public transport to move their agricultural produce, but rather they came up with a cable car system that could be operated and maintained by the community itself. Both alternatives were mostly self-reliant in their nature, something that is part of the strengths of Max-Neef's HSD approach, where community self-reliance is considered the first step for tackling bigger systemic structures [8].

6. Discussion

6.1. Energy services as satisfiers of human needs

The application of our methodology in the case of two communities allowed us to shed some light on the details of how energy services contribute to human well-being. We argue that our results not only point towards a confirmation that communities do actually see ES as satisfiers of HN, but that they were seen as very important for the well-being of the communities. In fact, all the analysed HN were considered to require at least one energy service as satisfier (see Table 2). This is in itself an interesting result, since it was a possibility in the design of the workshop that a particular energy service did not contribute to any human need. However, some HN required less physical pre-conditions or requirements than others. This was reflected in the number of ES related to each human need (see Table 2).

Exploring the specificities and commonalities found in the two communities also revealed certain recurring lines of argument which might point towards an aggregate reality that can be generalizable, or at least serve as a basis for making hypothesis worth exploring further. Although the particular situations and understanding of the individuals involved in the workshops undoubtedly influenced the choices represented in Table 2, we believe that some common and differing elements are worth highlighting. The similar reasoning deployed by both communities in justifying some ES (i.e. mobility, structure, and information and communication) as satisfiers of different needs, points towards a shared (perhaps even generalizable) agreement of the importance of these ES for human well-being in modern societies. However, there is a clear difference in terms of how important these ES are for each of the communities, which can be partially explained by their rural and urban settings. We consider this a very relevant area for future research.

6.2. Decoupling energy service provision from human need satisfaction

One could have expected, that if we are looking for decoupling opportunities, to find some HN which did not require any ES as satisfiers. However, we expect most opportunities for decoupling come from different ways of providing ES (i.e. changes in the socio-technical provisioning systems of ES) and different ways of satisfying HN (i.e. changes in the societal characteristics of need satisfaction) (see Fig. 4 in Brand-Correa and Steinberger [4]), not from denying or ignoring the physical dependence of human well-being.

An example of a change in the socio-technical provisioning system of a particular energy service would be related to alterations anywhere along the "energy chain" [50] and/or to changes in the material and cultural realities along the whole supply chain [78] of the energy service in question. An example of a change in the societal characteristics of need satisfaction would be related to social changes in the way needs are satisfied, in the way everyday social practices [79,80] are enacted.

The community of Palmita's proposed alternative way of delivering the satisfier of mobility (by using a cable car to move agricultural produce from farm to road, see Section 5), consists of an example of a change in the socio-technical provisioning system as well as in the societal characteristics of need satisfaction. It involves various alterations[5] along the energy chain (e.g. use of a small combustion engine to power the cable car rather than leg muscles, an improved level of the service, etc.) and changes to the material and cultural realities along the supply chain (e.g. less effort and time to move the agricultural produce, new infrastructure, etc.). A similar analysis can be done around the proposed alternative way of delivering information and communication by the community of El Faro (by talking to each other, see Section 5).

Thus, both proposed alternatives of delivering a particular energy service demonstrate the diversity of outcomes that can be obtained by using the HUSES approach, particularly by the use of the existential categories. This diversity appears both in the socio-technical provisioning systems and in the societal characteristics of needs satisfaction. We argue that this increase in the solution space is a positive step forward when trying to address the very complex problem of living well within environmental limits, and an improvement from the mainstream solution space of economic cost or technology-led solutions. A key element here is that the solutions come from the bottom-up, where

---

[5] We cannot assess the abovementioned changes in the socio-technical provisioning system in relation to efficiency nor environmental performance, since we have not precisely evaluated how much energy the different alternatives would require nor how much emissions they would produce.

locally generated knowledge can be used to overcome scientific, ethical and political challenges associated with establishing minimum requirements for human well-being [35,36,81,82].

The search for alternatives to provide ES using Max-Neef's existential categories was, from the communities' and NGO's perspective, the most important aspect of the methodology, where the value of the process is revealed in terms of enabling self-reliant ways of thinking about human need fulfilment. We received positive feedback from both the participants and the NGOs about the workshops in general, but in particular about the final part. In other words, by using the existential categories of "being", "doing" and "interacting", both communities were able to go beyond traditional aspirations of "having" and were able to critically reflect on their own role in provisioning satisfiers (in this case a particular energy service) to fulfil their needs. This goes in line with arguments that favour of the process of carrying out participatory approaches as a mechanism to empower communities [12,13].

6.3. Steps forward

It is important to note that during the workshops, the sustainability aspect of the proposed alternatives was not addressed directly, i.e. participants were not asked to think about the environmental impacts of the proposed alternatives. This is reflected in the case of Plamitas, where the community suggested an alternative that is actually more energy intensive than they previously had (from walking to cable car). This could be problematic, because we are ultimately interested in alternative ways of satisfying human needs within planetary boundaries. However, in very poor communities, where the initial levels of both energy services access and human need satisfaction are very low, the satisfaction of human needs may well involve higher levels of energy services use. Thus the focus must be on providing that energy in a sustainable way. An interesting avenue for future research will be to explore if that is also the case for affluent communities.

In order to include the sustainability element in future research, we propose two possibilities. The first one is to follow up the process with expert and stakeholder interviews or workshops (as outlined by [9]), where the alternatives can be assessed in relation to their sustainability potential, in the context of international commitments, national goals and so on. The stakeholders should include people with technical knowledge of energy service provisioning, as well as local authorities with the institutional capacity to support these initiatives.

The second one is to do an analysis of ES as satisfiers using Max-Neef's full matrix. That would enable the inclusion all HN and reflection on the type of satisfier that a particular energy service is. In our proposed approach, the relationship between ES and HN (Part 2, Section 3.2.2) is analysed separately from the discussion of a specific ES as satisfier (Part 3, Section 3.2.3). By carrying out the analysis simultaneously (as originally proposed by Max-Neef), communities could understand the interdependencies and contradictions between different satisfiers.[6] For example, mobility by the use of a private car can satisfy certain needs, but it can also go against the need for subsistence given the health impacts of pollution. Furthermore, communities can explore the different types of satisfier that certain ways of delivering ES constitute, and focus on synergetic and endogenous ways of delivering ES. Following the previous example, communities could realise that a private car is an exogenous pseudo-satisfier, and that initiatives such as the cable-car are potentially more synergetic and endogenous.

7. Conclusions

We are faced with a double challenge: climate change and other planetary boundaries are being breached [6] whilst many social foundations are not even close to being built. Raworth [5] has described this as an issue of remaining within a "doughnut", i.e. below planetary boundaries but above social foundations. The role of energy in staying within the doughnut is key. Our research aimed at contributing to the search for alternative ways of building social foundations without further breaching planetary boundaries, by using the concepts of energy services and human needs.

The design of the methodology was particularly tailored to help us address two concerns: (How) do energy services contribute to human well-being? And can a participatory approach enable communities to collectively construct energy service provisioning alternatives? By testing the methodology in the case of two communities in Colombia we were able to confirm that energy services are in fact perceived as satisfiers of human needs, but in different ways for different communities. This confirms the diverse nature of satisfiers, even when it comes to energy services.

Furthermore, the process of participatory workshops, using an adapted version of Max-Neef's [8] HSD approach we have called HUSES (Human Scale Energy Services), enabled the communities of El Faro and Palmitas to propose alternatives ways of provisioning the energy services of "information and communication" and "mobility" respectively. Such alternatives were self-reliant in their nature, and both communities realised their role in satisfying their needs. This is an encouraging result because, if is coupled with further stakeholder and expert interviews or workshops focused on the environmental sustainability of the proposals, it might lead to decoupling of energy use and human well-being, in the specific case of energy services.

Additionally, our results point towards interesting avenues for future research, particularly around the analysis of the socio-technical aspects of alternatives for provisioning energy services and satisfying human needs. For example, this would include linking the specific ways in which energy services are used as satisfiers to the theory of social practices [80,84], i.e. how the particular ways in which communities link energy services to human needs can be traced back to the co-evolution of social norms and technologies. Moreover, the general heterodox field of social provisioning and the specific method of systems of provision [78,85] could be used to understand the structures, processes, agencies and relations that led to the current (deficient) provisioning of particular energy services to the communities under study. We present this approach with the hope that it can be further refined through future research, and with the intention to provide a roadmap and a basis for continuing the explorations around decoupling human well-being from energy consumption.

Conflicts of interest

The authors declare no conflict of interest.

---

[6] Mattioli [83] describes these interdependencies and contradictions in the context of transport; how social and environmental goals are traded off more strongly when there is not a clear framework of human needs and satisfiers, and thus the focus is on what he calls "lower-order need satisfiers".

[7] See [87] for a detailed description of the different schools within Eudaimonia and Hedonism.

Acknowledgements

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.erss.2018.01.008.

References

[1] IPCC, Summary for policymakers, in: C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, L.L. White (Eds.), Clim. Chang. 2014 Impacts, Adapt. Vulnerability. Part A Glob. Sect. Asp. Contrib. Work. Gr. II to Fifth Assess. Rep. Intergov. Panel Clim. Chang. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014, pp. 1–32.

[2] R. Haas, N. Nakićenović, A. Ajanovic, T. Faber, L. Kranzl, A. Müller, G. Resch, Towards sustainability of energy systems: a primer on how to apply the concept of energy services to identify necessary trends and policies, Energy Policy 36 (2008) 4012–4021, http://dx.doi.org/10.1016/j.enpol.2008.06.028.

[3] V. Modi, S. McDade, D. Lallement, J. Saghir, Energy Services for the Millennium Development Goals, (2005) http://www.unmillenniumproject.org/documents/MP_Energy_Low_Res.pdf.

[4] L.I. Brand-Correa, J.K. Steinberger, A framework for decoupling human need satisfaction from energy use, Ecol. Econ. 141 (2017) 43–52, http://dx.doi.org/10.1016/j.ecolecon.2017.05.019.

[5] K. Raworth, Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist, Cornerstone, London, 2017.

[6] W.L. Steffen, K. Richardson, J. Rockstrom, S.E. Cornell, I. Fetzer, E.M. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, C.A. de Wit, C. Folke, D. Gerten, J. Heinke, G.M. Mace, L.M. Persson, V. Ramanathan, B. Reyers, S. Sorlin, Planetary boundaries: guiding human development on a changing plane, Science (80-.) 347 (2015) 1259855, http://dx.doi.org/10.1126/science.1259855.

[7] J. Rockström, W.L. Steffen, K. Noone, A. Presson, F.S. Chapin III, Planetary boundaries: exploring the safe operating space for humanity, Ecol. Soc. 14 (2009), http://dx.doi.org/10.1038/461472a.

[8] M. Max-Neef, Human Scale Development Conception, Application and Further Reflections, The Apex Press, New York and London, 1991.

[9] L. Doyal, I. Gough, A Theory of Human Need, The Macmillan Press, London, 1991.

[10] G. Walker, N. Simcock, R. Day, Necessary energy uses and a minimum standard of living in the United Kingdom: energy justice or escalating expectations? Energy Res. Soc. Sci. 18 (2016) 129–138, http://dx.doi.org/10.1016/j.erss.2016.02.007.

[11] M. Guillén-Royo, Sustainability and Wellbeing: Human-Scale Development in Practice, Routledge, London and New York, 2016.

[12] D. Hammett, C. Twyman, M. Graham, Research and Fieldwork in Development, Routledge, 2014, https://www.dawsonera.com/abstract/9780203649107.

[13] M. Skovdal, F. Cornish, Qualitative Research for Development. A Guide for Practitioners, Practical Action Publishing, Rugby, UK, 2015.

[14] IPCC, Summary for policymakers, in: T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, P.M. Midgley (Eds.), Clim. Chang. 2013 Phys. Sci. Basis. Contrib. Work. Gr. I to Fifth Assess. Rep. Intergov. Panel Clim. Chang. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2013, pp. 3–29 http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.

[15] IEA, CO2 Emissions from Fuel Combustion. Highlights, (2012) http://www.iea.org/co2highlights/co2highlights.pdf.

[16] IEA, Energy and Climate Change, World Energy Outlook Spec. Rep. (2015), pp. 1–200, http://dx.doi.org/10.1038/479267b.

[17] J. Rogelj, G. Luderer, R.C. Pietzcker, E. Kriegler, M. Schaeffer, V. Krey, K. Riahi, Energy system transformations for limiting end-of-century warming to below 1.5 °C, Nat. Clim. Change 5 (2015) 519–527, http://dx.doi.org/10.1038/nclimate2572.

[18] S.B. Bruns, C. Gross, D.I. Stern, Is there really Granger causality between energy use and output? Energy J. 35 (2014) 101–134, http://dx.doi.org/10.5547/01956574.35.4.5.

[19] I. Ozturk, A literature survey on energy–growth nexus, Energy Policy 38 (2010) 340–349, http://dx.doi.org/10.1016/j.enpol.2009.09.024.

[20] B. Warr, R.U. Ayres, N. Eisenmenger, F. Krausmann, H. Schandl, Energy use and

economic development: a comparative analysis of useful work supply in Austria, Japan, the United Kingdom and the US during 100years of economic growth, Ecol. Econ. 69 (2010) 1904–1917, http://dx.doi.org/10.1016/j.ecolecon.2010.03.021.

[21] D.I. Stern, A. Kander, The role of energy in the industrial revolution and modern economic growth, Energy J. 33 (2012), http://dx.doi.org/10.5547/01956574.33.3.5.

[22] C.J. Cleveland, R.K. Kaufmann, D.I. Stern, Aggregation and the role of energy in the economy, Ecol. Econ. 32 (2000) 301–317, http://dx.doi.org/10.1016/S0921-8009(99)00113-5.

[23] R.U. Ayres, V. Voudouris, The economic growth enigma: capital, labour and useful energy? Energy Policy 64 (2014) 16–28, http://dx.doi.org/10.1016/j.enpol.2013.06.001.

[24] D.I. Stern, The role of energy in economic growth, Ann. N. Y. Acad. Sci. 1219 (2011) 26–51, http://dx.doi.org/10.1111/j.1749-6632.2010.05921.x.

[25] C.J. Cleveland, R. Costanza, C.A.S. Hall, R.K. Kaufmann, Energy and the U.S. economy: a biophysical perspective, Science (80-.) 225 (1984) 890–897.

[26] J.K. Steinberger, J.T. Roberts, G.P. Peters, G. Baiocchi, Pathways of human development and carbon emissions embodied in trade, Nat. Clim. Change 2 (2012) 81–85, http://dx.doi.org/10.1038/nclimate1371.

[27] W.F. Lamb, J.K. Steinberger, A. Bows-Larkin, G.P. Peters, J.T. Roberts, F.R. Wood, Transitions in pathways of human development and carbon emissions, Environ. Res. Lett. 9 (2014) 14011, http://dx.doi.org/10.1088/1748-9326/9/1/014011.

[28] A.K. Jorgenson, Economic development and the carbon intensity of human well-being, Nat. Clim. Change 4 (2014) 10–13, http://dx.doi.org/10.1038/NCLIMATE2110.

[29] J. Goldemberg, T.B. Johansson, A.K.N. Reddy, R.H. Williams, Basic needs and much more with one kilowatt per capita, AMBIO 14 (1985) 190–200.

[30] A. Mazur, E.A. Rosa, Energy and life-style, Science (80-.) 186 (1974) 607–610.

[31] J.K. Steinberger, J.T. Roberts, From constraint to sufficiency: the decoupling of energy and carbon from human needs, 1975-2005, Ecol. Econ. 70 (2010) 425–433, http://dx.doi.org/10.1016/j.ecolecon.2010.09.014.

[32] W.F. Lamb, N.D. Rao, Human development in a climate-constrained world: what the past says about the future, Glob. Environ. Change 33 (2015) 14–22, http://dx.doi.org/10.1016/j.gloenvcha.2015.03.010.

[33] N.D. Rao, K. Riahi, A. Grubler, Climate impacts of poverty eradication, Nat. Clim. Change 4 (2014) 749–751, http://dx.doi.org/10.1038/nclimate2340.

[34] D.M. Martínez, B.W. Ebenhack, Understanding the role of energy consumption in human development through the use of saturation phenomena, Energy Policy 36 (2008) 1430–1435, http://dx.doi.org/10.1016/j.enpol.2007.12.016.

[35] W.F. Lamb, J.K. Steinberger, Human well-being and climate change mitigation, Wiley Interdiscip. Rev. Clim. Change (2017) 1–16, http://dx.doi.org/10.1002/wcc.485 e485.

[36] N.D. Rao, P. Baer, Decent living emissions: a conceptual framework, Sustainability 4 (2012) 656–681, http://dx.doi.org/10.3390/su4040656.

[37] R. Day, G. Walker, N. Simcock, Conceptualising energy use and energy poverty using a capabilities framework, Energy Policy 93 (2016) 255–264, http://dx.doi.org/10.1016/j.enpol.2016.03.019.

[38] S. Bouzarovski, S. Petrova, S. Tirado Herrero, From fuel poverty to energy vulnerability: the importance of services, Needs Pract. 2014 (2014) 32.

[39] L. Middlemiss, R. Gillard, Fuel poverty from the bottom-up: characterising household energy vulnerability through the lived experience of the fuel poor, Energy Res. Soc. Sci. 6 (2015) 146–154, http://dx.doi.org/10.1016/j.erss.2015.02.001.

[40] P. Wilkinson, K.R. Smith, M. Joffe, A. Haines, A global perspective on energy: health effects and injustices, Lancet 370 (2007) 965–978, http://dx.doi.org/10.1016/S0140-6736(07)61252-5.

[41] N. Bruce, R. Perez-Padilla, R. Albalak, Indoor air pollution in developing countries: a major environmental and public health challenge, Environ. Health 78 (2000) 15, http://dx.doi.org/10.1590/S0042-96862000000900004.

[42] S. Karekezi, S. McDade, B. Boardman, J. Kimani, Energy, poverty, and development, Glob. Energy Assess.–Towar. a Sustain. Futur. Cambridge University Press and International Institute for Applied Systems Analysis, Cambridge, UK; New York, NY, USA and Laxenburg, Austria, 2012, pp. 151–190.

[43] B. Attigah, L. Mayer-Tasch, The Impact of Electricity Access on Economic Development: A Literature Review, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Eschborn, Germany, 2013http://www.produse.org/imglib/downloads/PRODUSE_study/PRODUSE Study_Literature Review.pdf.

[44] A. Pueyo, R. Hanna, What Level of Electricity Access Is Required to Enable and Sustain Poverty Reduction? Annex 1–Literature Review, Institute for Development Studies (IDS) and Practical Action Consulting, Bourton-on-Dunsmore, 2015https://www.ids.ac.uk/files/dmfile/UtilisingElectricityAccessforPovertyReduction-LiteratureReview.pdf.

[45] M. Lettenmeier, S. Lähteenoja, T. Hirvilammi, S. Laakso, Resource use of low-income households—approach for defining a decent lifestyle? Sci. Total Environ. 481 (2014) 681–684, http://dx.doi.org/10.1016/j.scitotenv.2013.11.048.

[46] A. Druckman, T. Jackson, The bare necessities: how much household carbon do we really need? Ecol. Econ. 69 (2010) 1794–1804, http://dx.doi.org/10.1016/j.ecolecon.2010.04.018.

[47] S. Pachauri, An Energy Analysis of Household Consumption: Changing Patterns of Direct and Indirect Use in India, Springer, Netherlands, Dordrecht, 2007.

[48] N.D. Rao, J. Min, Decent Living Standards: material prerequisites for human well-being, Soc. Indic. Res. (2017) 1–20, http://dx.doi.org/10.1007/s11205-017-1650-0.

[49] M.J. Fell, Energy services: a conceptual review, Energy Res. Soc. Sci. 27 (2017) 129–140, http://dx.doi.org/10.1016/j.erss.2017.02.010.

[50] J.M. Cullen, J.M. Allwood, The efficient use of energy: tracing the global flow of energy from fuel to service, Energy Policy 38 (2010) 75–81, http://dx.doi.org/10.

1016/j.enpol.2009.08.054.

[51] J.M. Cullen, J.M. Allwood, E.H. Borgstein, Reducing energy demand: what are the practical limits? Environ. Sci. Technol. 45 (2011) 1711–1718, http://dx.doi.org/10.1021/es102641n.

[52] R. Fouquet, Long-run demand for energy services: income and price elasticities over two hundred years, Rev. Environ. Econ. Policy 8 (2014) 186–207, http://dx.doi.org/10.1093/reep/reu002.

[53] N. Nakićenović, A. Grubler, Energy conversion, conservation, and efficiency, Energy 18 (1993) 421–435, http://dx.doi.org/10.1016/0360-5442(93)90021-5.

[54] B.K. Sovacool, Conceptualizing urban household energy use: climbing the Energy Services Ladder, Energy Policy 39 (2011) 1659–1668, http://dx.doi.org/10.1016/j.enpol.2011.02.041.

[55] E. Jochem, A. Adegbulugbe, B. Aebischer, S. Bhattacharjee, I. Gritsevich, G. Jannuzzi, T. Jaszay, B.B. Saha, E. Worrell, Z. Fengqi, Energy end-use efficiency, World Energy Assess. Energy Chall. Sustain. United Nations Development Programme (UNDP), New York, 2000, pp. 173–217.

[56] E. Marshall, J.K. Steinberger, V. Dupont, T.J. Foxon, Combining energy efficiency measure approaches and occupancy patterns in building modelling in the UK residential context, Energy Build. 111 (2016) 98–108, http://dx.doi.org/10.1016/j.enbuild.2015.11.039.

[57] J. O'Neill, Citizenship, well-being and sustainability Epicurus or Aristotle? Anal. Krit. 28 (2006) 158–172.

[58] A.K. Sen, Development as Freedom, Oxford University Press, Oxford and New York, 1999.

[59] M. Nussbaum, Capabilities as fundamental entitlements: Sen and Social Justice, Fem. Econ. 9 (2003) 33–59, http://dx.doi.org/10.1080/1354570022000077926.

[60] J. O'Neill, Living well within limits: well-being, time and sustainability, Think-Piece SDC Semin. Living Well–Within Limits (2008) 1–13.

[61] S. Alkire, Dimensions of human development, World Dev. 30 (2002) 181–205, http://dx.doi.org/10.1016/S0305-750X(01)00109-7.

[62] I. Cruz, A. Stahel, M. Max-Neef, Towards a systemic development approach: building on the Human-Scale Development paradigm, Ecol. Econ. 68 (2009) 2021–2030, http://dx.doi.org/10.1016/j.ecolecon.2009.02.004.

[63] J. Jolibert, Addressing needs in the search for sustainable development: a proposal for needs-based scenario building, Environ. Values 23 (2014) 29–50, http://dx.doi.org/10.3197/096327114X13851122269007.

[64] M. Guillen-Royo, J. Guardiola, F. Garcia-Quero, Sustainable development in times of economic crisis: a needs-based illustration from Granada (Spain), J. Clean. Prod. 150 (2017) 267–276, http://dx.doi.org/10.1016/j.jclepro.2017.03.008.

[65] H.F. Kline, R.L. Gilmore, C. Garavito, J.J. Parsons, W.P. McGreevey, Colombia, Encycl. Br. (2017) https://www.britannica.com/place/Colombia . (Accessed 5 April 2017).

[66] E. Moncada, Urban violence, political economy and territorial control: insights from Medellín, Lat. Am. Res. Rev. 51 (2016) 225–248.

[67] P.C. Brand, Governing inequality in the South through the Barcelona model: social urbanism in Medellín, Colombia, Interrog. Urban Cris. Governance, Contestation, Crit. (2013), p. 17.

[68] C.S. Fukuyama Francis, Half a Miracle, Foreign Policy, (2011), pp. 26–28 Maye/June http://web.a.ebscohost.com/ehost/detail/detail?vid=56&sid=a212bad6-9461-428b-ad17-92a37687fcf4%2540sessionmgr4006&hid=4214&bdata=Jmxhbmc9ZXMmc2l0ZT1laG9zdC1saXZl#AN=60849592&db=a9h.

[69] C.S. Howarth, Towards a social psychology of community: a social representations perspective, J. Theor. Soc. Behav. 31 (2001) 223–238, http://dx.doi.org/10.1111/1468-5914.00155.

[70] Alcaldía de Medellín, Mapa División Político Administrativa Áreas Urbana y Rural Municipio de Medellín, (2015) https://www.medellin.gov.co/geonetwork/srv/spa/catalog.search#/metadata/9d753322-1b4a-4677-a290-094d7c0be2b9.

[71] Mesa de Vivienda y Servicios Públicos Domiciliarios Comuna 8, El Faro, Comuna 8: Diagnóstico y propuestas comunitarias para el mejoramiento integral del barrio, Mesa de Vivienda y Servicios Públicos Domiciliarios Comuna 8, Medellín, 2013.

[72] Alcaldía de Medellín, Plan de Desarrollo Local–Comuna 8 Villa Hermosa, Alcaldía de Medellín, Medellín, 2015.

[73] Alcaldía de Medellín, Plan de Desarrollo Local: Corregimiento San Sebastián de Palmitas, Alcaldía de Medellín, Medellín, 2015.

[74] Alcaldía de Medellín, Formulación Plan de Desarrollo Corregimental de San Sebastián de Palmitas–Segunda Fase, Alcaldía de Medellín, Medellín, 2008.

[75] K.A. Waylen, J. Martin-Ortega, K.L. Blackstock, I. Brown, B.E. Avendaño Uribe, S. Basurto Hernández, M.B. Bertoni, M.L. Bustos, A.X. Cruz Bayer, R.I. Escalante Semerena, M.A. Farah Quijano, F. Ferrelli, G.L. Fidalgo, I. Hernández López, M.A. Huamantinco Cisneros, S. London, D.L. Maya Vélez, N. Ocampo-Díaz, C.E. Ortiz-Guerrero, J.C. Pascale, G.M.E. Perillo, M.C. Piccolo, L.N. Pinzón Martínez, M.L. Rojas, F. Scordo, V. Vitale, M.I. Zilio, Can scenario-planning support community-based natural resource management? Experiences from three countries in Latin America, Ecol. Soc. 20 (2015), http://dx.doi.org/10.5751/ES-07926-200428.

[76] I. Brown, J. Martin-Ortega, K. Waylen, K. Blackstock, Participatory scenario planning for developing innovation in community adaptation responses: three contrasting examples from Latin America, Reg. Environ. Change 16 (2016) 1685–1700, http://dx.doi.org/10.1007/s10113-015-0898-7.

[77] E. Babbie, The Basics of Social Research, 6th ed., Wadsworth Cengage Learning, 2014.

[78] B. Fine, Why consumption matters, Ephemera 13 (2013) 217–248 http://eprints.soas.ac.uk/15968/7/13-2fine.pdf.

[79] E. Shove, G. Walker, Governing transitions in the sustainability of everyday life, Res. Policy. 39 (2010) 471–476, http://dx.doi.org/10.1016/j.respol.2010.01.019.

[80] I. Røpke, Theories of practice–new inspiration for ecological economic studies on consumption, Ecol. Econ. 68 (2009) 2490–2497, http://dx.doi.org/10.1016/j.ecolecon.2009.05.015.

[81] P. Baer, The greenhouse development rights framework for global burden sharing: reflection on principles and prospects, Wiley Interdiscip. Rev. Clim. Change 4 (2013) 61–71, http://dx.doi.org/10.1002/wcc.201.

[82] K. Raworth, Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist, Cornerstone, London, 2017.

[83] G. Mattioli, Transport needs in a climate-constrained world. A novel framework to reconcile social and environmental sustainability in transport, Energy Res. Soc. Sci. 18 (2016) 118–128.

[84] E. Shove, H. Chappells, L. Lutzenhiser, B. Hackett, Comfort in a lower carbon society, Build. Res. Inf. 36 (2008) 307–311, http://dx.doi.org/10.1080/09613210802079322.

[85] K. Bayliss, B. Fine, M. Robertson, Financialisation, Economy, Society and Sustainable Development, (2013).

[86] M.C. Nussbaum, Women and Human Development: The Capabilities Approach, Cambridge University Press, Cambridge, UK, 2000.

[87] K. Whiting, L. Konstantakos, A. Carrasco, L.G. Carmona, Sustainable Development, Wellbeing and Material Consumption: A Stoic Perspective. Sustainability. (under review), 1–21 (n.d.).