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Understanding energy services through a human needs lens: a proposed framework

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1. Introduction

The context of climate change poses great challenges to modern developed societies, amongst which is to maintain current levels of well-being without having a negative impact on the Earth's ecosystems. The challenges are even greater for developing societies, which have yet to satisfy basic human needs for a growing population and which are likely to suffer the most adverse environmental consequences as a result of the multidimensional inequalities they face (IPCC, 2014). In this context, energy can be seen as one of the links between environmental impact and human well-being: energy is the main source of greenhouse gas emissions (IEA, 2014), and the services provided by energy (such as heating, power, transport and light) are vital to support human development (UN SE4ALL, 2014).

This paper seeks to explore the relationship between energy services and human needs, and thus try to propose combined insights into energy and socio-economic systems. Human needs are understood here (building on the work of Manfred Max-Neef (1995, 1991), and Len Doyal and Ian Gough (1991)) as the social (as opposed to individual) conditions necessary for human wellbeing, which have both lower and upper limits (O'Neill, 2011). Human wellbeing is in turn understood as adequate social participation in a chosen form of life, an evaluation that is objective and universally comparable across cultures, as opposed to other subjective measures of wellbeing. The way in which human needs are satisfied (through "satisfiers"), however, is culturally specific (Max-Neef, 1991). Energy services are the functions we actually demand from energy systems: as with human needs, the way in which energy services are supplied may be culturally specific (Jochem et al., 2000; Shove et al., 2008). The main advantage of combining the concepts of human needs and energy services is that analysing their relationships could guide an improved delivery of energy services as satisfiers of human needs, within a climate constrained world.

In particular, this presentation will propose a framework relating the concepts of energy services and human needs. Energy services and their combinations within socio-economic systems are examined as satisfiers of human needs: consequently the level at which we demand energy services is expected to be culturally specific. Firstly, the theoretical framework of human needs (section 2) and energy services will be described (section 3). Secondly, a proposed framework for analysing different societies will be shown, consisting of a quantitative and a qualitative element (section 4). Finally, some concluding remarks and discussion of future research involving applying the proposed framework to undertake empirical analysis for Colombia (section 5). Such an exercise could shed light on the difference in level of satisfier use between different subgroups of society, and highlight some common ground in terms of the specific links between energy services and human needs. Analysis following the proposed framework would identify key areas for prioritising action in relation to both the improvement of energy services delivery and human needs satisfaction. This approach moves away from traditional assessment tools of energy systems and social

2. Human needs and satisfiers

In a climate constrained world, where it is essential to transition towards sustainable societies, a eudaimonic understanding of wellbeing is particularly well suited (O'Neill, 2011, 2008a). The eudaimonic tradition dates back to Aristotle, and it was more recently developed by Amartya Sen and many others. Eudaimonia understands human well-being as achieving a full and meaningful life within society (Sen, 1999). For an individual to be well, she must be able to fully and socially participate in her chosen form of life (Doyal and Gough, 1991). "Well-being is not just a matter of subjective experiences, it is a matter of what one can do or be in one's life" (O'Neill, 2006, p. 165).

Eudaimonia stands in contrast to hedonism, which dates back to Epicurus and was adopted by economists (starting with Jeremy Bentham) in the 18th century, as a way of theoretically developing the concept of utility – "utility is the property of any object that tends to produce the happiness or reduce the unhappiness of the party whose interest is considered" (Beckerman, 2011, p. 83). In the philosophy of hedonism, well-being is equal to having a positive balance between pleasure (positive emotion) and pain (negative emotion) (Dolan et al., 2006; Thompson and Marks, 2008).

The social element in the eudaimonic tradition, which is clearly lacking in the hedonic tradition, makes it particularly well suited to develop a sense of environmental conscience and responsibility (O'Neill, 2006). By looking at human well-being in private life, and by considering that different episodes in a life can be separated and assessed individually (thus the sum of those assessments constitutes the assessment of life as a whole), hedonism does not allow for intertemporal factors to be considered (O'Neill, 2006). Eudaimonia looks at human well-being in the public life, and recognizes the role of narrative and temporal structure of the assessment of a life, giving, therefore, importance to shared projects with past and future generations in our appraisal of life (O'Neill, 2008b).

Furthermore, in terms of upper limits to the material goods required for well-being, hedonic and eudaimonic traditions have very different viewpoints. In a hedonic world, excessive consumption is a cognitive flaw, it is the result of false beliefs about what constitutes well-being; therefore, it should be addressed by either improving a person's psychological state of mind or changing their understanding of what contributes to well-being[1] (O'Neill, 2008b; Trebeck, 2015). Alternatively, in a eudaimonic world, the role of certain institutions (e.g. markets and its capital accumulation logic, social practices, technologies) in mediating the achievement of well-being is recognized.

[1] It is in this respect that hedonism has become especially attractive for advocates of sustainable consumption: it is possible to decouple well-being from increased consumption, it is just a matter of convincing people what other elements (beyond consumption after a minimum level has been reached) are constituents of well-being (O'Neill, 2006).

Hedonic and eudaimonic accounts of well-being can be measured either subjectively (an individual's self-assessment) or objectively (by an agent different from the individual itself). An objective methodology to account for hedonic well-being is through income, given that utility maximisation became tightly interlinked with preference satisfaction[2] (i.e. consumption). More popular amongst green circles, however, are the subjective methodologies to account for hedonic well-being (O'Neill, 2006). Even though conceptually they cannot provide a good basis for sustainability, these type of subjective self-assessments of well-being (or happiness as it is usually referred to) have been widespread, even reaching policymaking (Trebeck, 2015).

Eudaimonic accounts of well-being can also be measured subjectively and objectively. An example of the former is the evaluative approach, which is based on the notion that individuals can evaluate how their life is going in general (Dodds, 1997) rather than balance their feelings (hedonic approach). Examples of the latter, which we prefer because they do not depend on economic signals and problematic self-assessments[3], include the capabilities approach of Sen and Nussbaum (materialised through the HDI - Human Development Index) and the human needs approach (which include the work of Doyal and Gough (1991) and Max-Neef (1991)).

Human needs (HN) are the preconditions to achieve well-being. One of the most crucial aspects of the HN approach is that needs themselves (the goals) are considered unchanging and universal, and that some objective harm will happen if they are not satisfied. HN are assumed to encompass the whole range of capabilities or dimensions of HW. For Doyal and Gough (1991) there are two basic HN categories which must be satisfied: physical health and autonomy, the latter being further divided into mental health, cognitive skills and opportunities. Those basic needs are necessary to achieve a minimally impaired social participation in a chosen form or life. Furthermore, Doyal and Gough (1991) identify eleven intermediate needs (or "universal characteristics of need satisfiers" (Gough, 2015)) that typically derive in the satisfaction of their basic needs (see Figure 1).

Similarly, Max-Neef (1991) has identified nine needs (subsistence, protection, affection, understanding, participation, leisure, creation, identity and freedom) that are expressed in four different ways: being (attributes), having (tools, norms), doing (agency) and interacting (social expressions in time and space). Following Alkire (2002) in her search for a defined set of dimensions of well-being, objective assessments seem to agree on most of the HN or factors identified as important for well-being. This is because there is a (eudaimonic) conceptual common ground between these approaches: both –achieving well-being or satisfying human needs- are the strongest source of motivation for human action (Alkire, 2002; Kamenetsky, 1992).

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[2] As economics developed, utility theory became grounded on a system of commensurable, continuous and transitive preferences, which are based on potentially infinite and insatiable individual wants (Kamenetsky, 1992)

[3] Some of the issues that arise from subjective self-assessments are: 1) Adaptive states of mind (i.e. individuals adapt their assessments once they have been in a situation long enough) (Dodds, 1997). 2) Positionality (relativity) of an individual's self-assessment of the impact of income and material possessions on their well-being (Easterlin, 2001, 1974).

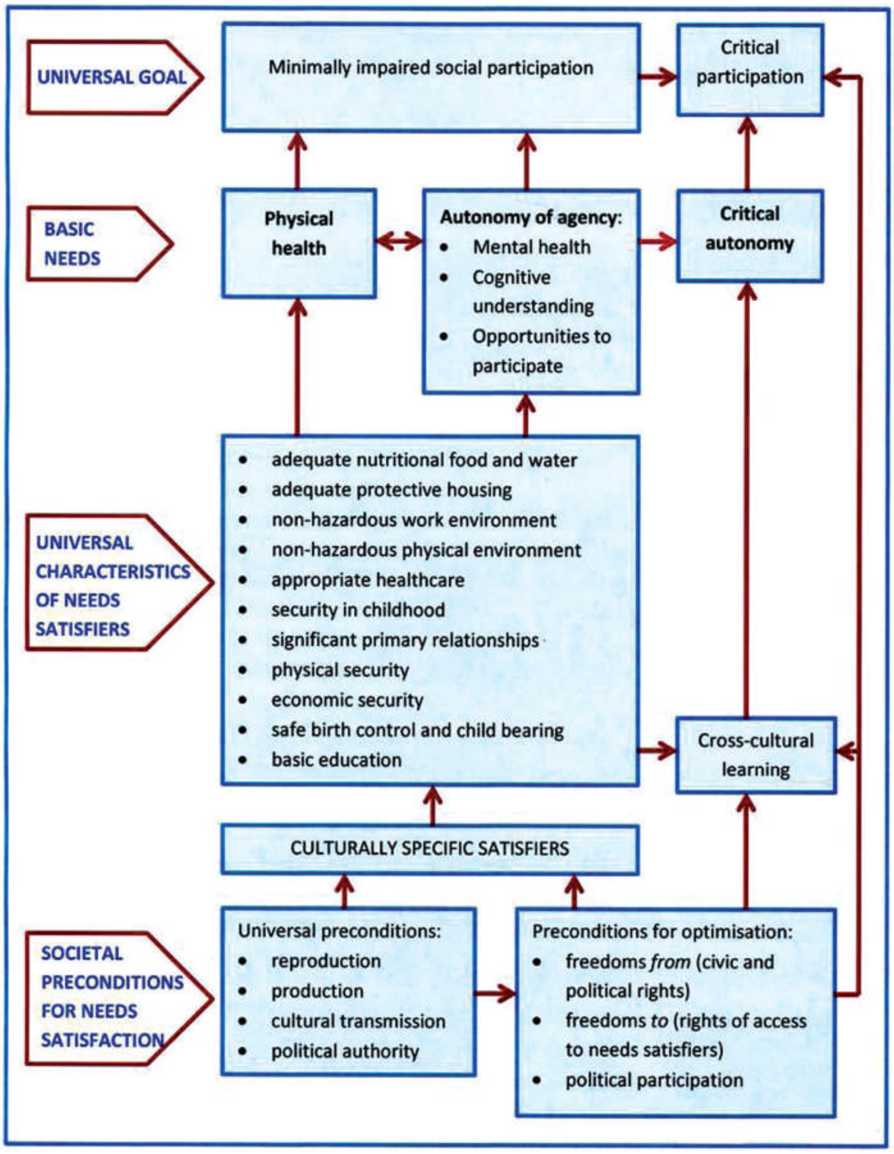

Figure 1. The theory of need in outline
Source: Taken from Gough (2015, p. 1196).

Needs, capabilities or values, should be self-evident (i.e. universal, recognizable by anyone), incommensurable (thus irreducible), and non-hierarchical (Alkire, 2002). In other words, needs are finite, satiable and well-define, which is key when considering environmental limits. The specific means used to satisfy HN, however, are culturally, socially and temporally flexible. Max-Neef (1991) coined the term "satisfier" to describe the culturally-specific ways universal needs have been fulfilled in practice. The flexibility associated to satisfiers has allowed Gough and colleagues (Abu Sharkh and Gough, 2010; Gough, 1994) to assess the success of different political regimes in satisfying human needs. Alternatively, Max-Neef has created a matrix of human needs (rows) by existential categories (columns), which is completed with "satisfiers" through a participatory processes[4].

[4] This participatory nature of Max-Neef's work is very important in terms of addressing the concerns around paternalism in objective assessments of well-being.

In relation to energy requirements, the flexibility of the "satisfiers" concept allows for cultural differences in energy use to be accounted for and best performing societies to be identified. The theoretical framework offered by human needs (which is based on a eudaimonic understanding of well-being) is thus the most appropriate one for addressing questions about our energy use choices and how these choices affect human well-being, through the concept of "satisfiers". And perhaps more fundamentally, a eudaimonic understanding of well-being justifies beyond moral dilemmas, but rather in relation to our own well-being, why we should care about the environmental impacts of our energy choices, i.e. of our use of energy as satisfier.

3. Energy services as satisfiers

Within traditional energy analysis, there are three main links in the "energy chain" of energy flows: primary energy, final energy and useful energy (Jochem et al., 2000) (see Figure 2). Energy balances report primary and final energy flows through the economy, but not useful energy flows. Primary energy generally refers to the energy extracted or captured from the natural environment (e.g. crude oil, coal, hydropower, etc.) (IEA and Eurostat, 2005). Final energy (also called secondary energy) generally refers to energy as it is delivered to the final economic consumer, after undergoing transportation and transformation processes (e.g. gasoline, diesel, electricity, etc.) (IEA and Eurostat, 2005).

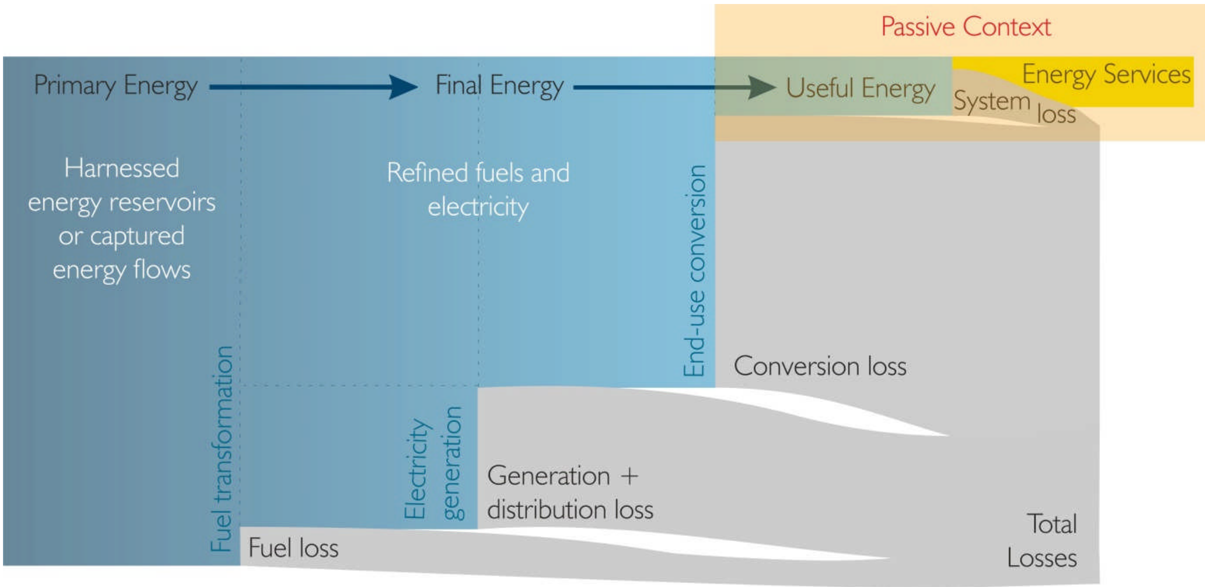

Figure 2. Energy chain from primary energy to energy services
Blue flows indicate energy units, whereas ES are measured in different units.
Source: Adapted from Cullen and Allwood (2010).

At the point of use, final energy undergoes one last transformation process as it passes through an end-use conversion device, for example furnaces, electric appliances or light bulbs. The end-use devices transform energy into a form that is useful for human purposes, hence the term "useful energy" as the outcome of this last conversion process. The types of useful energy are usually classified into heat (low, medium or high temperature), mechanical drive, light, electricity for appliances, and food (Brockway et al., 2014). Not many analyses focus on this part of the energy chain, with an exception being a growing amount of literature that comes from an exergy[5] perspective (Ayres et al., 2003; Brockway et al., 2015; Chen and Chen, 2009; Ertesvag, 2005; Nakićenović et al., 1996; Serrenho et al., 2012; Wall, 1990).

The final conversion step occurs within what Cullen et al. (2011) term a "passive system" (shown in Figure 2 as passive context). Within passive systems no more conversion processes occur, only energy dissipation given the irreversibility of the second law of thermodynamics. Thus "a passive system can be thought of as a reservoir or tank of stored energy" (Cullen et al., 2011, p. 1712). Cullen and Allwood (2010) identified three basic passive contexts: vehicles (for example cars, trains and airplanes), factories (within them the passive systems are the different machines and furnaces) and buildings for commercial and residential use (they themselves can be passive systems for heating and lighting, and the different appliances within them are also passive systems). Within a passive system, useful energy delivers energy services (ES) (Jochem et al., 2000). ES form the last part of the energy chain (Figure 2) and are therefore the ultimate "reason" why energy supply chains are developed.

ES can be defined as the benefits humans derive from energy carriers (Modi et al., 2005). ES, rather than energy itself, are what people demand (Haas et al., 2008). This makes ES the crucial concept to analyse when looking at the relationship between energy systems and HW in a climate constrained world. Cullen and Allwood (2010a) identified eight final services that can be measured using physical data and that are a small number of distinct but comparable categories (i.e. they are self-evident, incommensurable and non-hierarchical): passenger transport, freight transport, structure, sustenance, hygiene, thermal comfort, communication and illumination.

ES are a set of limited ends which people demand from energy, but the way they are delivered varies greatly between individuals and cultures. This is similar to the universality of HN, but the cultural specificity of satisfiers. A wider picture of potential efficiency improvement avenues appears by acknowledging this multiplicity of ES delivery possibilities. This in turn allows for possibilities of decoupling energy use from well-being, i.e. less energy use in the primary or final stages of the energy chain for the same ES delivery.

There are four different approaches to energy efficiency measures in the delivery of ES, as outlined by Marshall et al. (2016): conversion device, passive system, service control and service level. Potentially most interesting, service level efficiency measures imply a change in the nature or the level of the service required (Nakićenović and Grubler, 1993). Haas et al. (2008) refer to these as short term components of energy service demand, and are related to behavioural or cultural aspects. For passenger transport for example, car sharing is a change in the nature of the energy service, or driving less is a change in the level of the energy service. However, these service level measures are limited by larger systemic

[5] Exergy can be defined as "the maximum possible work that may be obtained from a system by bringing it to the equilibrium in a process with reference surroundings" (Kostic, 2012, p. 816). As Gaggioli & Wepfer (1980, p. 823) state, exergy "is synonymous with what the layman calls 'energy'. It is exergy, not energy, that is the resource of value, and it this commodity, that 'fuels' processes, which the layman is willing to pay for". For further details on exergy see Wall (2003, 1986, 1977), Kanoglu et al. (2012), Dincer (2002), Rosen (2006, 2002), Sciubba and Wall (2007).

aspects, such as transport infrastructure, population density, and quality of public transport, which Haas et al. (2008) refer to as long term components of energy service demand.

For societies concerned with improving well-being while reducing environmental impacts, understanding the relationship between ES and HN would allow the prioritisation of policy interventions on the most adequate energy efficiency measures in the delivery of ES. For example, if the delivery of transportation as an ES is found to be highly important for the satisfaction of health as a HN (by providing access to medical facilities), policymakers could decide whether to focus efforts on improving the efficiency of internal-combustion engines (conversion device), reducing the friction of cars and buses (passive system), traffic control measures (service control) or telemedicine[6] (service level through a change in the nature of the service).

4. Proposed framework

Our current context of environmental degradation and climate change, coupled with profound social deprivations, calls for "a profound shift […] in our intellectual approach to complex social problems" (Lamb, 2016, p. 185). This analytical framework builds upon established, but disconnected, areas of research. On the one hand, it approaches well-being through the lens of eudaimonia in general and human needs in particular, as described in section **Error! Reference source not found.**. On the other hand, the framework focuses on technical (non-food) energy requirements, analysed through the lens of energy services, as described in section **Error! Reference source not found.**. These approaches allow for robust (clear definitions), empirical (quantifiable metrics), systemic (holistic) analysis, which enables the study of decoupling human needs from energy use: both through the open nature of need "satisfiers" (Guillén-Royo, 2016) and the large efficiency potential in energy service delivery (Cullen et al., 2011).

In particular, the definition of the human needs categories is clear, which allows for quantifiable metrics of levels of need satisfaction. Additionally, the flexible nature of the "satisfiers" concept lends itself to holistic analysis of the factors that influence the energy demand associated with the achievement of well-being, and thus the possibilities and barriers for their decoupling. Similarly, the definition of energy services is clear, allowing for quantifiable metrics of energy service provision. Likewise, the flexibility associated with the energy services provisioning alternatives opens up additional avenues of efficiency improvements, and thus possibilities and barriers for decoupling energy services demand and primary energy supply.

The abovementioned flexibility of both "satisfiers" and provisioning of energy services is the key element of this analytical framework. As shown in Figure 3, it allows for the analysis of environmental characteristics (e.g. climate conditions) and the effect of different technologies (e.g. lock-in) on the specific energy service provisioning alternatives that a particular community has. In the same way, the flexibility of "satisfiers" allows for the analysis of social and cultural aspects (e.g. everyday practices), economic institutions (e.g.

[6] Telemedicine is the "delivery of health care services […] using information and communication technologies". (World Health Organization Global Observatory for eHealth, 2010, p. 9)

systems of provision, market logics) and infrastructure factors (e.g. transport systems) in relation to the specific human needs "satisfiers" that a community uses. It also allows to analyse the spaces where these "systemic factors" overlap.

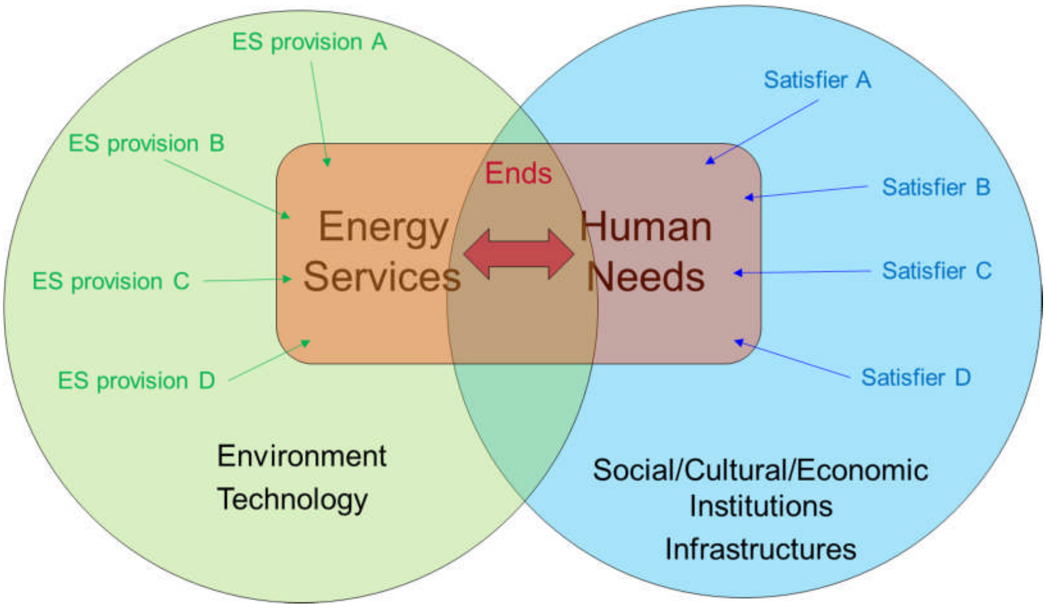

Figure 3. ES and HN analytical framework

A systemic analysis of this kind has the potential of bridging together areas of research that have studied environmental and social problems in a disconnected way. For example, theory of practices (Shove and Walker, 2010; Shove et al., 2008) and systems of provision (Bayliss et al., 2013; Fine, 2013), together with technological lock-in analysis (Unruh, 2000) and the consideration of climatic conditions, can be used to explain the choice of certain "satisfiers" and energy service provisioning alternatives.

More importantly, however, is the decoupling alternatives that this analytic framework allows us to identify. It points out the limitations of narrow approaches such as technical energy efficiency improvements (IEA, 2008) or economic incentives (OECD, 2011; UNEP, 2011). It is not possible to simply decouple communities from their energy use through economic and technological instruments: the systematic dependency of society on technologically-mediated resource use means that such change would also imply a fundamental change in the society itself, a process sometimes also described as co-evolution (Foxon, 2011).

Some of the most important decoupling opportunities are likely to be found at the community level, for example economies of scale through provision of efficient networks of energy service delivery (Knoeri et al., 2015). I.e. the existence or absence of collective supply systems (e.g. local supply networks or public transit) enables economies of scale, in contrast with highly individualised systems, where each household has to use its own forms of energy to procure goods and services. In such cases, the description of alternatives through technologies or markets only is overly simplistic, since the appropriate unit of analysis is not the single actor using the technology, but instead the community or other larger unit making the decisions which enable individuals within it to use more or less energy to satisfy their needs.

The conceptual frameworks of human needs and energy services, although being highly appropriate in trying to unveil the connection between energy requirements and human well-being, are challenging in terms of operationalising them. In the case of energy services there is a big limitation in terms of going beyond measures that depend on market or monetary based transactions and traditional centralised energy accounting. In the case of human needs there are no defined indicators or statistics for each of the human needs, but there are approaches that have been used in the past and that can be adapted (Gough et al., 2011; OPHI, 2015).

Considering the above, we propose a framework that has an element of quantitative analysis in order to find interesting trends in energy use and well-being, followed by an element of qualitative analysis in order to fill in the gaps left by the quantitative element, to find what can't be measured/quantified.

4.1. Quantitative research

The quantitative approach presented here is focused around households. This is justified because most energy modelling has been done at the macro level, using economic and energy data aggregated into economic sectors. Such an aggregation allows for easy interpretation in light of mainstream economic concepts, goals (economic growth) and policies. However, when the question is around development and human needs, the unit of analysis must be individual households at different levels of development and human need satisfaction. It is at the household level that development as well as deprivation phenomena are experienced. Furthermore, households are key drivers in energy use/CO2/GHG emissions once indirectness (embodiment) is considered.

Most previous research on household energy use has focused on the influence of expenditure patterns (and levels) and other socio-economic and demographic variables on direct and indirect energy demand (Cohen et al., 2005; Druckman and Jackson, 2008; Herendeen and Tanaka, 1976; Lenzen et al., 2006, 2004; Liu et al., 2009; Pachauri, 2007; Peet et al., 1985; Vringer and Blok, 1995; Weber and Perrels, 2000). There are only a handful of studies that carry out analysis of household resource use and CO_2 emissions in relation to well-being (e.g. Lettenmeier et al., 2014; Rao and Baer, 2012). However, to the best of our knowledge, there are no studies that analyse household energy use (with a particular focus on energy services) in relation to well-being (specifically using the human needs framework).

Therefore, the goal of this qualitative element is to study how different levels of direct and indirect energy use (calculated through household expenditure surveys, together with Input-Output tables and energy extensions) influence human well-being. Its main limitation is that only energy uses that are recorded through market transactions are considered, and furthermore only final energy consumption is considered. However, it has the advantage of giving a detailed picture of direct and indirect household energy needs, with the possibility of translating those energy needs into energy services. Subsequently, the identified levels of energy use will be analysed in relation to the levels of human need satisfaction (obtained through information from other household surveys).

4.2. Qualitative research

This qualitative element is also focused around households, to give consistency to the framework. It aims to unveil the specific links between energy services and human needs that cannot be deduced from the quantitative element, but it uses the findings from the latter in order to inform particular energy services and human needs in which to focus attention.

It uses Max-Neef's (1991) matrix of needs according to axiomatic and existential categories (see Figure 4). This matrix has been used very successfully in the past to assess development policies (Cruz et al., 2009; Guillén-Royo, 2016), but it has never been used to relate a particular resource (in this case energy) to the satisfaction of human needs. The aim is to fill in the matrix in workshops by limiting satisfiers to energy services. The concept of energy services would be explained to participants, but the energy services themselves would not be defined previously (except from a few examples). The workshops should be carried out in different sub-groups of society in order to obtain richer data in relation to different ways in which energy services are used as satisfiers, but also in order to be able to identify common elements which might be static and thus essential energy services for the satisfaction of human needs.

existential categories

axiological categories

	BEING	HAVING	DOING	INTERACTING
SUBSISTENCE				
PROTECTION				
AFFECTION				
UNDERSTANDING				
PARTICIPATION				
IDLENESS				
CREATION				
IDENTITY				
FREEDOM				

Figure 4. Max-Neef's matrix
Source: Adapted from Max-Neef (1991).

5. Concluding remarks and discussion of future research

Our current context of environmental degradation and climate change calls for "a profound shift […] in our intellectual approach to complex social problems" (Lamb, 2016, p. 185). We believe that the first step in doing so implies changing the way we understand human well-being: moving away from market based, individually focused, understandings of well-being towards more holistic views of well-being, that allow for the inclusion of social and environmental aspects to be considered. Human needs, a eudaimonic approach, measured objectively, provides such a view, and is particularly well suited for addressing sustainability issues.

Furthermore, when it comes to looking at the physical requirements for the achievement of well-being, we believe that energy is key in terms of enabling the satisfaction of human needs, but also in accounting for a major share of anthropogenic environmental impacts. However, it is not energy in abstract, but energy services what we actually demand from energy systems. Human needs and energy services have two important elements in common: on the one hand, they are universal, irreducible and non-hierarchical. On the other hand, the way they are satisfied or provided is culturally specific. This flexibility of the concepts is key, and it can open very interesting avenues for policy recommendations when trying to find the core relationship between the two, but also when assessing cultural specificities.

It is important, however, to go beyond interesting conceptual links and move towards empirical applications that can actually provide policy relevant information. In this sense, there will be a study conducted in the following years which will analyse the case of Colombia. Data availability in Colombia[7] make it a good country to conduct a study of the quantitative element of this framework. In terms of the qualitative element, the diversity of Colombia's regions, as well as its high levels of inequality, make it an interesting country to analyse beyond national aggregates. Furthermore, Colombia is usually located within what has been called "Goldemberg's corner" (Steinberger and Roberts, 2010), i.e. a space where countries have relatively low CO_2 emissions whilst having relatively high well-being (see Figure 5). Thus, it constitutes an interesting case study when trying to understand the relationship between human well-being and environmental impacts.

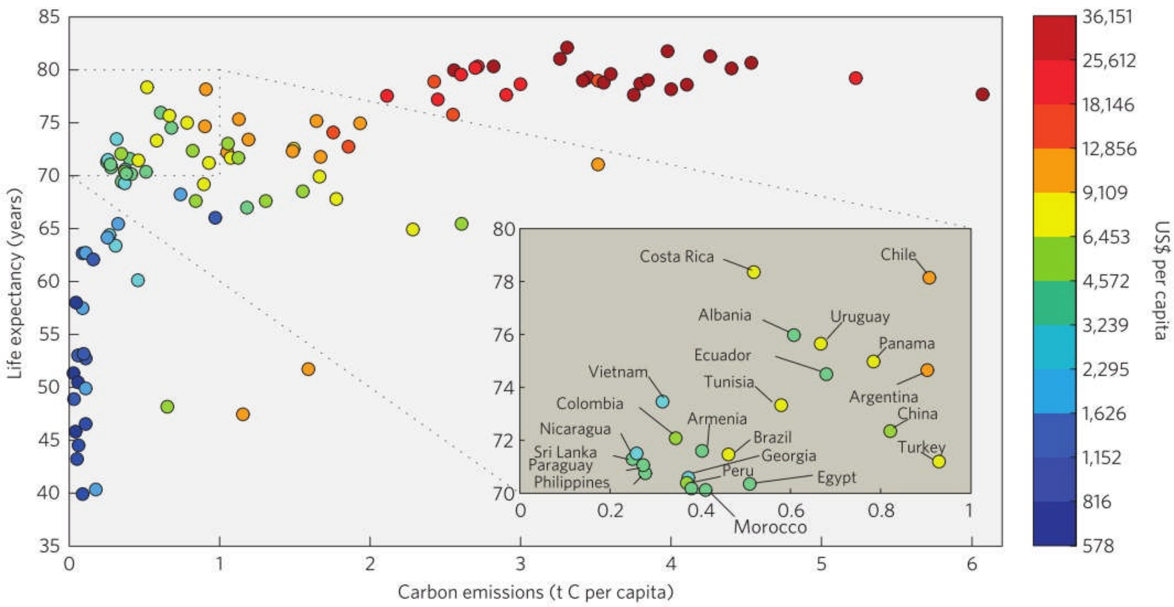

Figure 5. Colombia in Goldemberg's corner
Source: Taken from Steinberger et al. (2012, p. 3).

[7] The Colombian government allows access to the micro data of all their household surveys, which provides a very rich source of expenditure, energy and well-being data.

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