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Working Paper

When less is more

Sufficiency: Terminology, rationale and potentials

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Abstract

Environmental discourse identifies three potential pathways to sustainability: efficiency, consistency, and sufficiency. The notion of sufficiency in particular is as many-faceted as it is controversial. On the one hand, it often triggers fear and defensive reactions (being associated with foregoing certain things, eco-dictatorship or a backward orientation). On the other hand, some proponents promise a simplification of life, an economy of proximity, or the "liberation from overabundance".

In this paper, we define sufficiency, based on a literature review and discussion, as "modification of consumption patterns that help to respect the Earth's ecological limits, while aspects of consumer benefit change." These changes in benefit might be perceived as having to forego certain things, but need not necessarily be so. We argue that sufficiency has to play an important role in the repertoire of sustainability strategies: It is more than just a "last resort" when efficiency and consistency strategies fail. In many cases, it can be the cheaper, less conflict-laden, even the more elegant solution.

Finally, we discuss the potentials and limits of sufficiency. We recommend applying sustainability strategies first and foremost in strategic priority areas that are both ecologically important and promising. Using the example of household electricity consumption, we demonstrate potentials for sufficiency.

This paper is part of a research project dealing specifically with the question of how sufficiency can emerge in a society and how policy can help to shape this process. The outlook points to further work on this topic.

Contents

1. Introduction

It is generally agreed that the Earth's resources and carrying capacity are limited. The current production and consumption patterns of Western industrialized countries can surely not continue for long and in any case cannot extend to all people without undermining the ecological sustainability of the planet.

However, opinion is greatly divided on the right way out of the ecological crisis. The three possible strategies for sustainable development are efficiency, consistency and sufficiency. A first approximation of what these three terms mean is: less resource use per unit of service, ecologically sound technologies and the reduction of consumption.

The main disagreement occurs between proponents of the efficiency and consistency strategy on the one hand and proponents of the sufficiency strategy on the other hand. This is understandable given that the question being asked is whether well-established consumption habits can be perpetuated or not – and what this means for our economy.

Many questions relating to sufficiency have barely been addressed or no final solution has been found for them. What exactly is sufficiency? Why and in what areas is sufficiency needed? What contribution can it make to sustainable development? And, finally, can sufficiency be promoted by political measures which go beyond pleas and campaigns?

Oeko-Institut has now addressed and discussed these neglected questions in a research project. A key finding of the project is that sufficiency is a necessary building block in an equally necessary repertoire of sustainability strategies. And it is necessary and possible to promote it with the help of political instruments.

The results of Oeko-Institut's research project are published in two position papers, of which this one is the first. It focuses on the term itself, the necessity, the potentials and the limits of sufficiency. The second paper (Heyen et al. 2013) concentrates on the implementation of sufficiency in society and the role of policy in the process.

The term "sufficiency" is as many-faceted as it is controversial. Defensive reactions and anxieties (doing without certain things, eco-dictatorship, lack of enjoyment, technophobia, backwardness) are counterbalanced by certain promises (a simplification of life, an economy of proximity, moderation, liberation from overabundance) (Paech 2012). Opinions on sufficiency often depend on how the term is defined. Given this, we elaborate an understanding of the concept of sufficiency in this paper (Chapter 2). (Those in a hurry can start with the definition of sufficiency (Chapter 2.4), without having to retrace how it was derived). Subsequently it is explained why sufficiency is necessary and even attractive (Chapter 3). The discussion then concentrates on what problems sufficiency can (and cannot) be expected to solve (Chapter 4). An outlook is given and open questions for further research are provided in Chapter 5 and 6 respectively.

2. Terminology

2.1. Towards an understanding of sufficiency

If discussions in research and politics on the subject of sufficiency are examined, it quickly becomes clear that in general, there is some kind of common understanding, but that it is

diffuse and hard to pin down. Not infrequently definitions are contradictory, do not match the examples given or lay emphasis on very different aspects. In order to arrive at a stable and consistent definition, we first explain and substantiate, in Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**, the concerns that triggered our discussion of sufficiency. Against this background, current scientific and political discussions are then reviewed and requirements for a definition of sufficiency are derived (Chapter 2.3). The result is a definition of sufficiency which is presented and elucidated along with several implications (Chapter 2.4.).

2.2. Concerns

Oeko-Institut's objective is to contribute to the realization of a sustainable future. First and foremost, the goal is the development of production and consumption patterns which – universalized to the global level – do not infringe the ecological sustainability of the planet. This is also the point of departure for our reflections on sufficiency. **Therefore, the sufficiency definition of choice must make clear that it is a question of respecting ecological limits.**

This means that the authors are not engaged with ideological or philosophical concerns in this paper. On a scientific basis, no generally-binding statements can be made as to whether a less resource-intensive lifestyle involves foregoing certain things or leads to a greater quality of life. We are purposely leaving this question to be decided individually. On the other hand, it is well established – indeed, fact – that the natural capital available is limited. **The definition of sufficiency should be ideologically neutral and not emphasize either self-deprivation or loss of potential profit or benefit.**

Sufficiency is a strategy which focuses on individual consumer behaviour to a large extent. At the same time consumption does not occur in a cultural and political vacuum. Shifting all responsibility on to the individual consumer is neither fair nor constructive (Geden 2009; Grunwald 2010). Sufficiency thus needs to be perceived as a possible subject of public policy. **The definition of sufficiency should put an emphasis on individual consumer behaviour while also incorporating the possibility of political steering.**

2.3. Literature review and development of the sufficiency definition

Based on this understanding of the background, a number of conceptual and theoretical papers on sufficiency were evaluated (Alcott 2007; Alcott 2007; Bartelmus 2002; Calwell 2010; Hennicke 2002; Linz 2002, 2004, 2006 ad 2012; Linz et al. 2002; Linz and Scherhorn 2011; Meyer 2008; O'Neill et al. 2010; Paech 2012; Reichel and Seeberg 2010; Sachs 2002; Scherhorn 2008; Scherhorn 2002; Schneidewind and Palzkill 2011; Stengel 2011; von Winterfeldt 2007; Wilke 2002). In the following the identified nuances and differences of meaning are systematized and compared to the preconception sketched above and the demands for the definition derived thereby. In the process the identified meanings are sometimes sharpened for the purpose of analytical clarity. At the end of this process the term "sufficiency" is defined more precisely (Chapter 2.4).

2.3.1. Eco-sufficiency and sufficiency of goods

The term “sufficiency” is used, on the one hand, to signify the *effects* of a specific manner of production or consumption (impact level, eco-sufficiency (Scherhorn 2008 after Schrader 2001). According to this interpretation a mode of production and consumption is sufficient when it respects ecological sustainability overall.

On the other hand, the term is also used for the changes to lifestyle or consumption patterns themselves (behavioural level, sufficiency of goods). Sufficiency means, according to this interpretation, doing without certain goods, services and functions.

The two do not necessarily coincide. For example, extending the useful life of electrical appliances can, all things considered, lead to a *greater* burden on the environment when the appliances are old and inefficient.

Nevertheless connecting the two interpretations seems helpful. Limiting the term “sufficiency” to the level of impact makes it indistinguishable from the term “sustainability”. At the same time, limiting it to the behavioural level ignores the question of whether it actually benefits the environment. The term “sufficiency” should thus be reserved for actions which encompass *both* a change in consumption *and* a reduction in environmental impact caused thereby.

2.3.2. “Less consumption” or “different consumption”?

Sufficiency is frequently associated with a quantitative reduction of demand for goods and services (Linz 2004, p.7). This understanding touches on something fundamental; but it does not encompass the entire spectrum of actions referred to as “sufficient” (Calwell 2010). These include, for example, *eschewing or reducing particularly resource-intensive types of goods* (e.g. televisions, meat), *smaller size, fewer functions, less comfort* (a smaller apartment, a car with no air conditioning), *substituting some goods with ones of a qualitatively different nature* (a bike instead of a car), the *extension of useful life*, *a lower frequency of use* (e.g. of electrical appliances), *self-production* and *collaborative consumption*. We want to reflect this diversity of meaning in our use of the term.

2.3.3. Voluntariness and motivation

Sufficiency is frequently described as a voluntary, individual activity (Alcott 2007; Stengel 2011). It is distinguished from restrictions experienced by individuals due to state regulation or material necessity rather than ones actively chosen (see, for example, Stengel 2011 and more recently the German Enquete-Commission on Growth 2013, p.518, box 13). Sufficiency thus presupposes a certain degree of awareness – a “sufficiency orientation” (Wilke 2002).

The underlying motivation is understandable. It would appear cynical to embellish doing without certain things as a result of force or necessity with the term “sufficiency”. However, voluntariness and individual motivation are not necessary to our definition of sufficiency. For us, sufficiency is more a question of the *impact* of an action on the environment or sustainability – the “sufficiency effect” (Wilke 2002). Such an understanding of the term leaves room for sufficiency *policy.* Furthermore, only with a clear distinction between sufficiency orientation and sufficiency effect can the frequent cases be analysed in which (e.g. due to wrong information) no environmental benefit results in spite of there being a sufficiency orientation (see Chapter 2.3.1).

2.3.4. Sufficiency – foregoing or benefiting?

Sufficiency is often presented as “doing without” or “lower welfare” (Alcott 2007). At the same time terms such as “leading a gratifying life” and “striking the right balance” (Linz 2002, 2006) suggest that sufficiency could also bring about an individual benefit – e.g. “time prosperity” (Linz 2006) or “simplification and deceleration of life” (Sachs 1993).

All these definitions have in common that sufficiency is associated with a change in the (practical or symbolic) *benefit* of consumption. However, this change can be experienced in different ways: in the eyes of some people, the benefit generally decreases while in the eyes of others the benefit can increase.

We consider the observation important that sufficiency is a question of changes in consumption which affect the perceived or actual benefit. However, we want to eschew a general judgement of these changes. The personal- and milieu-specific evaluation of benefits can vary greatly. If we wanted to base a definition of sufficiency on subjective experience, the same action would be classified in different ways, depending on who is doing the action. A definition with such a fluctuating foundation would not constitute a solid basis for the development of sufficiency policy.

2.3.5. Sufficiency, efficiency, consistency

Sufficiency – and on this the expert community agrees – is only one of three complementary ways towards sustainability. The other two pathways are efficiency and consistency; and the advantages and disadvantages of these strategies are keenly debated. Surprisingly it is often less clear how these strategies are precisely defined. From time to time sufficiency, understood as “a change in behaviour”, is contrasted with the “technical” strategies of efficiency or consistency. Yet some simple examples show that this contrast does not carry much weight. Many measures that are mostly regarded as contributions to efficiency or consistency rely on behaviour – whether it is a case of filling the washing machine to full capacity, which should reduce the energy input per kilo of washing, or waste separation, which should lead to the waste being integrated in recycling management. It is not possible to eliminate this lack of clarity completely. Nevertheless a definition should aim to make – at least analytically – the distinction between the three strategies as clear as possible.

2.4. Sufficiency: an attempt at definition

The following definition attempts to incorporate these considerations:

We understand “sufficiency” as *modification of consumption patterns that help to respect the Earth’s ecological boundaries while aspects of consumer benefit change.*We refer to “aspects of benefits” rather than simply “benefits” to reflect that goods and services rarely have only one benefit. They almost always involve an array of different benefit aspects. A car takes you not only from A to B – it does so quickly, drily, effortlessly, and with the possibility of transporting additional people and goods. A bike cannot necessarily achieve all that – but it keeps us fit, lets us be outside in the fresh air, does not require a driving license or for a parking spot to be found. Using a bike instead of a car does not change the benefit, therefore, of “transporting a person from A to B” – but it does change many other benefit aspects. To reflect this, the term “bundles of benefits” is used in the following.

This definition fulfils what was demanded above, that is:

- It connects the behavioural level (“modification of consumption patterns”) with the impact level (“respecting the Earth’s ecological boundaries”) (see 2.3.1).
- It condenses diverse possible actions through the term “modification of consumption patterns” (see 2.3.2).
- It focuses on the sufficiency effects (“respecting the Earth’s ecological boundaries” ”) and does not make a statement about voluntariness or motivation (see 2.3.3).
- It eschews judgement relating to the “good life”: the changes in benefit are not classified positively or negatively (see 2.3.4).
- It is clearly distinct from efficiency and consistency strategies: since both strategies want to provide the *same benefit* in a more sustainable way – efficiency by quantitively reducing the resource input or the emission output in the generation of the same bundle of benefits; and consistency by qualitatively changing the resource input or emission output through new technologies, so that they can be embedded in natural cycles.

2.5. Questions of application and examples

Sufficiency or not sufficiency? It is not always easy to say in practice. In the following section, several challenges arising from the attempt to apply the definition in practice are discussed.

2.5.1. Levels of Sufficiency: The example of cooling appliances

How strongly must environmental impacts and benefits change for them to be classified under “sufficiency”? Can buying a refrigerator that is a little bit smaller be understood as sufficiency? Or cooking with the lid on since for some people it requires effort to think of it?

Our answer: sufficiency is not always sufficiency. Both the environmental impact and the bundle of benefits can change to different extents. These changes can be perceived as having to forego certain things to varying degrees, which can seem, in turn, more or less acceptable. And finally a strong change in benefits does not necessarily mean a strong decrease in environmental impact – or vice versa.

For the acceptance, legitimacy and practicability of sufficiency policy it is important to consider the different possible magnitude of benefit changes and relate them to the different magnitude of environmental advantages..

The following suggested classification, which draws upon the use of cooling appliances as an example, serves to assess acceptance; it thus builds upon the magnitude of benefit changes:

Table 1: Sufficiency categories based on magnitude of benefit changes. Source: Authors' own

Sufficiency level	Perceived restrictions or effort	Type of change in consumption pattern	Example
S1	None to slight	e.g. smaller appliance	Refrigerator with 3 star compartment (101 l/17 l) instead of a fridge-freezer (171 l/41 l)
S2	Medium	e.g. less convenient appliance	A cooling appliance with no freezer function
S3	Strong	e.g. time-intensive behav-ioural measures	Not using the refrigerator for 4 months each year, cooling food on balcony / windowsill
S4	Very strong	e.g. doing without appli-ance, complete change of practice	No refrigerator at all; buying different) foods, shopping more frequently, or / conserving food instead …

Perceived restrictions are always subjective. Yet it is possible for measures to be classified by *majority* assessment based on consumer surveys in order to provide a basis for political decisions.

2.5.2. Sufficiency, efficiency or consistency? The example of car-sharing

It is not always easy to decide which specific measures should be assigned? to which sustainability strategy. Let us take car-sharing as an example. Georg Wilke (2002) has elaborated different conceivable effects, listed as follows in slightly expanded form:[1]

- The size of the vehicle stock per kilometer travelled may decreasein society as a whole . The same volume of vehicle kilometers is brought about with fewer vehicles – an example of efficiency.
- The number of vehicle kilometers could also decrease, e.g. because a car is not always readily available – a sufficiency effect.
- More modern and more efficient vehicles may be utilized in car-sharing than is the case with privately owned cars – an efficiency effect.
- More vehicles with alternative drive systems and fuels (hybrid cars, electric vehicles) could be used – a consistency effect.
- Often smaller or less generously equipped vehicles are deployed – a sufficiency effect.

This example shows that complex services, actions, lifestyle choices or policy measures can seldom be classified as "only" a sufficiency, efficiency or consistency strategy. Rather, the

[1] Wilke also lists possible "non-sustainable" effects such as additional journeys with fun or representative vehicles that are already available or additional vehicle use by people without privately owned passenger cars. But these are not relevant in this context.

trio of terms serve as an analytical tool in order to elaborate diverse characteristics and possible effects of these measures.

3. Rationale for sufficiency

There are two reasons based on which we regard sufficiency strategies as important building blocks on the path towards sustainability. The first one is no surprise: efficiency and consistency will often not be enough to limit natural resource consumption to sustainable levels. The second one is perhaps more astonishing at first glance: sufficiency can at times be the strategy that is simpler and easier to accept.

3.1. Efficiency and consistency are not enough

In the following three reasons are presented to substantiate why efficiency and consistency strategies may not be enough to keep within the ecological limits of the planet: so-called rebound effects (Chapter 3.1.1) and economic growth and countervailing trends (Chapter 3.1.2) as the limits of efficiency; technological uncertainties (Chapter 3.1.3) as the limits of consistency, and questions of global justice (Chapter 3.1.4). Finally, sufficiency is shown as the "elegant" solution (Chapter 3.2).

3.1.1. Limits of efficiency: rebound effects

A common argument for the inadequacy of efficiency strategies is the so-called rebound effect.[2] Put simply, it is argued that a successful efficiency measure can trigger increased consumption, which erodes some of the resource savings made – and in unfavourable cases even overcompensates the saving. This can occur through different mechanisms, some of which are located on the level of households and individuals, and some on the level of companies or the economy. These effects include:

- Revenue effect: Money is saved by implementing an efficiency measure (e.g. an efficient heating system reduces the gas bill). The money saved can then either be used for more of the same, now more efficient commodity (e.g. heating of more rooms, often called the "direct rebound"). Or it is spent on other commodities (often called the "indirect rebound").
- Substitution effect: The price of a resource (e.g. water, electricity, petroleum) falls due to an efficiency measure. This leads to one resource being used more frequently instead of other resources, thereby "substituting" these.
- Psychological effects: An efficiency measure provides for a good "eco-conscience" so that more of the same commodity or another commodity is consumed (Peters et al. 2012; Santarius 2012).

[2] See the comprehensive definition of this effect in a recent analysis conducted on behalf of the EU Commission: "The rebound effect is an increase in consumption which may occur as an unintended side-effect of the introduction of policy, market and/or technology interventions aimed at environmental efficiency improvements. The increase is caused by behavioural and/or other systemic responses to the interventions, in particular where the efficiency gains bring reduced costs." ((Global View Sustainability Services et al. 2011), p. 28).

- Technology rebound: The price decrease of a resource enables new technologies which are based on this resource is and which were not previously profitable.[3]
- Accumulation of consumption: New, efficient technologies are used in addition to rather than in replacement of the old, less efficient ones (e.g. an energy-saving second car).
- Macro-economic or "emerging effects" (Jenkins et al. 2011): cumulative effects and interactions, which lead to an additional surge in growth on the level of the overall economy. Since these effects are methodologically difficult to isolate, quantify or ascribe to a specific efficiency measure, it is difficult to distinguish between them and "autonomous" growth trends (Chapter 3.1.2).

In this paper we want to reserve the term "rebound", as used in economic and social psychology literature, for increases in consumption which are *triggered by an efficiency measure*. It is usually given as the percentage of the efficiency-related saving that could not be realized.

Only for energy consumption has there been an attempt to determine the percentage empirically. Furthermore, a number of methodological difficulties have been encountered. Based on cross-evaluations of different studies (Jenkins et al. 2011; Global View Sustainability Services et al. 2011), the following statements can at least be derived:

- The direct rebounds for the energy consumption of households have been analysed most extensively, resulting in a rebound percentage of 10-30%.[4]
- In industrial production these direct rebound effects have been estimated at approx. 15% and in energy-intensive industry mostly at 20-60%.
- There are few estimations available of the indirect and macro-economic rebound available and they vary strongly. It is assumed that these are the highest effects. Estimations can amount, depending on the source, to between 15% and more than 100%.

Rebound effects thus reduce the effect of energy efficiency measures, even when the scale of the direct rebound effects in the households sector is mostly limited and by no means completely undoes the effect of the efficiency increase. On a macro-economic level the rebound effects are more uncertain and potentially higher.[5] It cannot always be precisely explained whether a surge in growth is actually attributable to a specific increase in efficiency and can thus be understood as "rebound". We will therefore discuss overall economic growth in the following section.

[3] This effect is the basis of the well-known "coal paradox" (Jevons 1866): following James Watt's invention of the new and much more efficient steam engine, English industry used not less but more and more coal as an increasing number of new possible uses for coal-fired steam engines were found.
[4] This is contested by Nadel 2012 following a review of the studies on which it is based. However (Frondel 2012; Frondel, M. and Vance, C. 2011; Frondel; Ritter et al. 2012) find significantly higher levels for private passenger car transport in Germany based on empirical panel data for 1997-2009: 57-62%, varying with car use: 90% rebound in the lowest decile and 50% rebound in the two highest deciles.
[5] The situation is different in newly industrialized countries where high rebound effects sometimes still occur.

3.1.2. Limits of efficiency: Economic growth and countervailing trends

Efficiency gains are often cancelled out by increases in consumption and production. From a purely logical point of view, efficiency – as an improvement of the relationship between input and output – does not necessarily lead to a reduction of input. It can also result in an increase in output.

Table 2: Efficiency and lighting consumption in the UK. Source: Frondel (2012), p.15

Seven Centuries of Lighting in the UK						
Year	**Energy Price**	**Efficiency**	**Price for lighting**	**Light consumption per capita**	**Total light consumption**	**Real GDP**
1300	1.50	0.5	3.00	-	-	0.25
1700	1.50	0.75	2.00	0.17	0.1	0.75
1750	1.65	0.79	2.10	0.22	0.15	0.83
1800	1.00	1.00	1.00	1.00	1.00	1.00
1850	0.40	4.40	0.27	3.90	7.00	1.17
1900	0.26	14.50	0.042	84.70	220.00	2.90
1950	0.40	340.00	0.002	1,528.00	50,000.00	3.92
2000	0.18	1000.00	0.0003	6,566.00	25,630.00	15.00
All indices for 1800 are normalized to 1						

A striking example is offered by Fouquet and Pearson (2006) (quoted in Frondel 2012): While the efficiency of lighting technologies in the UK increased a thousand-fold between 1800 and 2000, the consumption per capita (measured in lumen hours) increased six thousand five hundred-fold in the same period and overall consumption even increased twenty-five thousand-fold.

For resource consumption to fall, the rate of efficiency increase must be at least as high as the rate of economic growth. With an economic growth at 2% a year, efficiency has to increase by at least 2% a year – a big challenge.

3.1.3. Limits of consistency: Technological uncertainties

The promise of consistency sounds, if possible, still more attractive than that of efficiency: in principle unlimited consumption in harmony with nature. However, there are good reasons to not rely blindly on this promise. Competition for use of resources and land – wind power plant or nature reserve, food or fuel – demonstrates that renewable energies and raw materials are also limited.

At the same time the complete and equivalent replacement of all current goods and services in a “consistent” form is still a long way off. And it is highly risky to rely on the necessary technological advances occurring at the right time before climate collapse is nigh, fossil resources are exhausted and biodiversity is destroyed.

Lastly, consistency strategies are often not without risks and side-effects. Wind power plants need rare metals; CCS is high-risk; the debate about the consequences of bioenergy cultivation for biodiversity is well underway. For all these reasons consistency is essential – but not enough by itself to put sustainable development in motion (Linz 2002 and 2004).

3.1.4. Global development and global justice

The United Nations Population Division forecasts (as the medium variant) a global population of 9.3 bn in 2050 (http://esa.un.org/unpd/wpp/unpp/panel_population.htm). In the newly industrialized countries the middle and upper classes, which aspire to a level of consumption that is similar to the consumers in the "old" industrialized countries (and in some cases achieve it) are growing. At the same time it is necessary to enable a dignified standard of living for the poor. There is no legitimate argument with which the consumption demand of these people could be rejected. It is thus a question of what level of consumption can be applied globally. It is first and foremost the task of industrialized countries to set an appropriate example in terms of consumption levels.

3.2. Sufficiency as the elegant solution

Sufficiency is, however, by no means just a last resort when efficiency and consistency strategies fail. Neither efficiency nor consistency can be implemented free of charge. They can entail the need for substantial investments – the much-discussed costs of energy transformation (*Energiewende*) come to mind. In some circumstances investments are not even amortized, e.g. in the case of some extensive energy refurbishments of buildings. Comprehensive and controversial infrastructural measures – like the expansion of power grids and pumped storage hydro power plants – could be required or new risks involved, e.g. those associated with carbon capture and storage (CCS). Or the measures can only be implemented with the help of extensive policy interventions, e.g. an energy refurbishment obligation for old buildings. On many occasions sufficiency can constitute the simpler, cheaper, less conflict-laden – indeed, the more elegant – solution.

Let us look at the Blueprint Germany report (Oeko-Institut et al. 2009). Assuming an increasing living space per capita, the continued dominance of motorized private transport and an increasing number of electrical household appliances, the climate targets can only be achieved if there is a significant increase in the biofuel quota, a doubling of electricity storage capacities, comprehensive energy refurbishment of buildings and a huge expansion in the use of the controversial CCS. Systematically taking sufficiency into account could open up more opportunities for action, tap additional potentials, circumvent conflicts and possibly also reduce costs.

4. Potentials and limits

What can sufficiency achieve? And where (in what problem and need areas) do its strengths lie? In this chapter we want to provide a first basis for future, more detailed analyses. Firstly, we show the need areas which we believe the analysis of sufficiency potentials should address as a priority (Chapter 4.1). Then, using data from one of our own projects, we show sufficiency potentials using the example of the power consumption of households (Chapter 4.2). In this way sufficiency should not only become more concrete and more tangible; the

possible effects of different magnitudes of change or different levels of sufficiency (see Chapter 2.5.1) should also become clearer.

4.1. "Big points" and "key points" of sufficiency: On big potentials and priorities

The idea of the "big points" and "key points" of sustainability comes from Michael Bilharz (2008). "Big points" are the areas with the highest resource protection potential. "Key points" meet additional strategic criteria for triggering a large as possible social transformation towards sustainability. In this paper we refer to them as the *ripple effect* and the *potential for structural change.* In this context the "ripple effect" means that a measure is so compelling that it is likely to be replicated. The potential for structural change results from a measure changing the individual's situation or social practice in such a way that the environmental benefits are, with high probability, long-term (e.g. decrease in living space, which creates long-term conditions, in contrast to a decrease in heating temperature, which has to be decided over and again). These considerations should be used to determine the need areas actions, the sufficiency potentials of which should be examined as a priority.

To date, only in the field of energy and climate protection has it been relatively well researched which actions bring about the highest environmental benefits.[6] Attractive areas for sufficiency-orientated intervention are, in our view, the replacement of the passenger car with a more environmentally friendly means of transport, electricity conservation, the switch to a Mediterranean diet and reduction in living space. They rank among the top ten of the energy saving options in households (Grießhammer et al. 2010). Additionally, switching from a passenger car to a more environmentally friendly mode of transport, electricity saving, and changing one's diet are relatively compatible socially; a change of diet also has the potential for social structural change (change in agricultural practices). A decrease in living space may encounter more resistance and have a low "ripple effect", but a high potential for change in terms of both individual and social structures.

4.2. Sufficiency potentials: The example of electricity consumption in households

Sufficiency potentials specified in this section refer to power consumption in households for six different appliances. Some of the assumed reductions can be clearly determined; others were estimated. They are assigned to the different levels of sufficiency (Chapter 2.5.1). The point of departure is a two person household with modern conveniences, electric appliances that are already efficient and efficient usage (Table 3).

[6] A first attempt for resource conservation can be found in Meyer (2008).

Table 3: Point of departure for sufficiency measures: efficient two-person household. Source: Authors' own

Appliances	Consumption (kWh/a)	Energy efficiency classes and usage patterns
Fridge-freezer	160	A+++ (171 l/41 l)
Induction stove	160	
Washing machine	60	A+++; 5,5-kg capacity; 511 kg of washing; 23 x at 60°C, 63 x at 40°C
Tumble dryer	127	A class; 511 kg of washing
TV 117 cm /Net TV/integrated receiver	43	A+/ Blue Angel / 2h per day
Gamer notebook	40	4h/day

Sufficiency potentials: Fridge freezer

S1: The two-person household could use a smaller appliance – instead of a fridge freezer (171 l/41 l; see Table), for example, a refrigerator with a three-star compartment (101 l/17 l) and a consumption of 93 kWh (saving = 67 kWh).

S2: The household could do without a freezer and use a simple refrigerator instead. The smallest A+++ appliance included in the EcoTopTen has a capacity of 156 l and an energy consumption of 64 kWh (saving = 96 kWh).

S3: With considerable effort, the household could abstain from using the refrigerator (with a yearly consumption of 64 kWh) for at least four months a year (holiday for 1 month, putting food on the balcony or windowsill for 3 months). Additional saving = 21 kWh.

S4: The household could refrain from using a refrigerator altogether and instead shop for groceries more often, no longer buy perishable food, use it immediately or pre-treat it (total energy saving: 160 kWh).

Sufficiency potentials: Washing machine / washing

The quantity of laundry washed each year has significantly increased since the launch of the washing machine. By means of targeted measures (wearing an apron while cooking and working in the garden, wearing casual clothes at home, selecting particular colours when buying clothes, etc.), washing could be decreased by approx. 50% without any drop in hygiene. Saving = 30 kWh, category S3.

Sufficiency potentials: Tumble dryer

If it is not possible for clothes to be dried in the fresh air (balcony, garden) or in unheated rooms, use of an efficient tumble dryer is, at least in winter, better than drying the clothes in heated rooms with the windows tilted open. Without sufficient ventilation mould growth can occur (Rüdenauer, I. 2008). The following are examples of conceivable sufficiency measures:

- Not using the tumble dryer for at least six months a year (saving: 63 kWh; S3). If only half of the washing is actually washed (see above), the corresponding power consumption is halved again.
- Taking the wet washing to friends who have a garden or barn and dry it there (this is also possible in winter in dry air conditions). With a high level of effort, a high reduction in power consumption can be realized overall: 127 kWh (S4).

Sufficiency potentials: Induction stove

If cooking or baking is well planned, if possible in larger quantities (then stored or if the cooking is done together with friends/neighbours), a pressure cooker is used and a few dishes with particularly long cooking or baking times are avoided, approx. 50% electricity can be saved (= 80 kWh/S3).

Sufficiency potentials: TV

A smaller television appliance with a 58cm diagonal and a power consumption of 36 kWh enables a saving of 7 kWh (S1). The smallest appliance with a 45cm diagonal and a power consumption of 25 kWh enables a saving of 18 kWh (S2). If the television is used less regularly, 50% or 22 kWh of the power consumption can be saved (S3). If a television is dispensed with altogether, 43 kWh is saved (S4).

Sufficiency potentials: Gamer notebook

A less convenient appliance enables approx. 20 kWh to be saved (S2). If the notebook is only used for 2 hours a day, an additional 10 kWh is saved (S3).

The measures described above are summarized in Table 4.

Table 4: Sufficiency potentials of an already efficient two-person household. Source: Authors's own

	S1	S2	S3 (with S2 appliance)	S4	S3+S4
Fridge-freezer	67	96	117	160	160
Induction stove			80		80
Washing machine			30		30

	S1	S2	S3 (with S2 appliance)	S4	S3+S4
Tumble dryer			63	127	127
TV	7	18	30	43	43
(Gamer) notebook		20	30	40	40
Total	74	134	350	370	480

As can be seen, assuming an efficient comfortable household, sufficiency measures can achieve additional reductions. If the household consistently keeps within sufficiency level 3, an additional 350 kWh would be saved (= 30% compared to efficient comfortable household and 10% compared to an average household). A mixture of S3 and S4 sufficiency levels would result in a saving of 480 kWh. However, most of the specific reductions in each case are small.

If the savings in all six categories of sufficiency are assessed according to the GHG balance, the savings for S3 amount to approx. 204 kg CO_2e and for a mixture of measures of the S3 and S4 levels to approx. 280 kg CO_2e. Converted into litres of petrol, this means savings of 70 and 97 litres respectively.

In comparison: If car motorists drive the annual average kilometres travelled (12,000 km) moderately (efficient use) as recommended by the ADAC, they save 120 litres of petrol. If an overseas flight is avoided, approx. 10,000 kg CO_2e are saved.

The comparison suggests that – as discussed above – sufficiency measures should focus on areas in which the highest reductions can be achieved.[7]

4.3. Limits of the sufficiency strategy

In spite of all the potentials, a sufficiency strategy also has limits. These limits are not restricted to barriers to implementation or acceptance problems. Isolated sufficiency measures can – just like isolated efficiency measures – evoke rebound effects: Money or time is saved, which can be invested in other goods, or the conscience of the person concerned is calmed, leaving him/her to engage in environmentally damaging consumption elsewhere. As in the case of efficiency, the way in which the saved money or time is spent is key to the ecological benefit. Ultimately, only on the basis of *all* consumption activities can it be determined whether an individual's lifestyle is sufficient – and only on the basis of *overall* production and consumption can it be determined whether an economy is sufficient.

5. Outlook: Shaping sufficiency

In this paper sufficiency was defined as modification of consumption patterns that help to respect the Earth's ecological boundaries while aspects of consumer benefit change. On this

[7] In these calculations, the difference compared to efficient appliances assuming efficient use is determined. If average appliances are assumed, the potentials would naturally be higher.

basis the reasons are set out for why sufficiency has to be included alongside efficiency and consistency in the repertoire of sustainability strategies. Additionally, the potentials and limits of sufficiency were determined, e.g. in the case of energy and climate protection. Difficult challenges relating to economic growth were sketched out. A complementary paper (Heyen et al. 2013) focuses on the designability of sufficiency: sufficiency is understood in that paper as system innovation, i.e. many elements have to interact to generate sufficiency. An analytical framework is presented with which these elements can be examined. The necessity and the legitimacy of governmental intervention are substantiated and the challenges of a sufficiency policy are identified. Existing instruments promoting sufficiency are presented, possible further developments discussed and legal and strategic questions regarding development of a sufficiency policy are outlined.

6. Open research questions

Many issues could only be touched upon in this paper. We see a need for further research in natural sciences, engineering, economics and social sciences on the following aspects:

What are the ecological boundaries and the need for action beyond energy and climate protection – e.g. in terms of raw materials, biodiversity, land or water? What are the interactions, what risks of problem shifting could occur?

What is the problem-solving potential of efficiency, consistency and sufficiency strategies in different need areas, taking into account costs and rebound effects? What combinations of sustainability strategies are needed? In what areas is sufficiency especially needed?

What is a suitable policy mix of specific and general sufficiency instruments in view of the potential for decreasing environmental impacts, of efficiency, of legal and political feasibility, of distribution effects and of social acceptance?

What economic impacts of sufficiency and combined efficiency/consistency/sufficiency measures are actually to be expected? What strategies can be used to diminish the current dependence on growth?

How can social transformation be shaped (politically)? What role do different social stakeholders play in the transformation towards a sustainable culture?

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