The building battlefield: (in)consistencies in German policies for sustainable living

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Abstract

"400,000 new homes per year are needed in German cities." This figure has been cited repeatedly in political discussions, media, and statements of different groups for a couple of years now. Living space is needed to mitigate the (further) inordinate increase of rents in some cities and regions and to ease finding appropriate flats at affordable prices for low- and medium-income households. But how to activate investors and the real estate market?

Having the triangle of sustainability in mind with its ecologic, social and economic cornerstones the discussion – metaphorically spoken – currently pulls the three corners: Which should have the highest priority? The economically driven most favourable solution is lowering the requirements for new buildings such as the energy performance to make building cheaper. The social perspective prefers an increase of public social housing investments regardless of efficiency standards. And the ecological side argues that a high performance is needed to reach energy and climate targets in the buildings sector.

Starting at this point of discussion, firstly, the paper reflects the assumptions behind the numbers of new homes needed against a sufficiency background. Secondly, it presents current changes in German building policies: a new legislation for energy supply and efficiency is currently in preparation. It discusses the potential to integrate sufficiency aspects in building policies, focussing specifically on the new regulation, financial incentives, and energy advice. The paper analyses if and to what extent it is likely to balance the three cornerstones of sustainability by integrating sufficiency aspects into efficiency policies. Household experiences with prepayment meters are used as an example to illustrate the potential for tapping efficiency and sufficiency potentials in low-income households considering social, economic, and ecological aspects.

Based on the identified (in)consistencies, thirdly, it suggests further development in German policies to make better use of synergies between the ecologic, social and economic demands on buildings.

Introduction

Since about 2010, studies and media in Germany have regularly stated the urgent need for the construction of new dwellings in Germany (e.g. Prognos 2010) – about 400,000 per year until 2020 (Pestel Institut 2015). Steadily increasing rents in many urban areas and especially in the bigger cities like Berlin, Munich, Hamburg, Cologne are a burden not only for low-income households and young people like students and apprentices. Also, middle class households have difficulties to pay rents or to find an affordable accommodation – while cities have difficulties to find appropriate areas to build new dwellings.

At the same time, other cities and regions in Germany are losing inhabitants which leads to increasing vacancy rates in residential buildings. The loss of purchasing power is followed by the reduction of public and other services leading to a loss of function in cities and regions which, in reverse, leads to migration of inhabitants and rising vacancy rates – a downwards spiral (Bernt 2002: 41). This trend can be observed especially in East Germany but also in some (mainly smaller) cities and rural areas in West Germany (BBSR 2019).

Both trends affect the economic view on energy efficient new buildings as well as the refurbishment of existing buildings. While in growing regions the discussion focuses on the mitigation of further increasing rents, in shrinking areas it is about the economic efficiency and profitability of energy efficiency investment that cannot be achieved by increasing rents.

On the other hand, Germany has to implement European legislation regarding the efficiency of buildings as determined in the 2010 Energy Performance of Buildings Directive (EPBD) and the 2012 Energy Efficiency Directive (EED), joined in the 2018 Clean Energy for All Europeans package[1]. The German target to develop an almost climate-neutral building stock until 2050[2] needs further refurbishment and energy efficiency improvement in buildings: Since 2010, total building energy consumption has hardly shown any change (BMWi 2017).

The current political and public discussion about future building policies in Germany is roughly spanned between these three cornerstones which in their essence comprise the three sustainability aspects of ecologic, social and economic requirements. However, an aspect which is hardly considered in the discussion is the demand for living space per person which continuously increased over the last decades: In the year 2000 the average floor area per person was at 39.5 m^2 and at 46.5 m^2 in 2017. This development has been identified as a relevant driver of energy demand in buildings (e.g. UBA 2018; Bierwirth & Thomas 2015) but is not subject to policies so far.

Starting at this point of discussion, the paper further elaborates the different points of view within the current discourse as outlined above. It then scrutinizes the assumptions behind the identified needs for new dwellings in Germany based on the underlying understanding of "sufficiency in buildings" drafted in the following. The paper then describes main developments in German building policies such as the preparation of a new regulation on energy in buildings and discusses options for integrating sufficiency in policy making as a complementary strategy to efficiency efforts.

Discourse on building and housing in Germany

SOCIAL ASPECTS OF INCREASING RENTS

Households in 2013 paid up to almost 40 % of their income for housing expenditures. This has a particularly sensitive effect on the lowest income quintile of households as in the highest quintile it was 14 % of their income (Dustmann, Fitzenberger, Zimmermann 2018: 13).

In 2014, tenant households in Germany spent on average 27.2 % of their income on rents, ranging between the 16 federal states from 19.6 % in Saxony to 31.0 % in Bremen (Destatis 2019a). The last years show a slight decrease of the overall financial burden from housing expenditures (including also costs for water and waste water, heating and electricity, maintenance, insurances, mortgage in case of owners, and other costs for housing), actually from 31.8 % in 2008 to 26.3 % in 2017 (Destatis 2019b) but also as perceived by households (Destatis 2019c). However, about 70 % of all households in 2017 still expressed housing expenditures being somewhat of or a high burden, in households at risk of poverty this was 77.7 % (Destatis 2019c).

ECONOMIC ASPECTS OF INCREASING COSTS

The affordability of housing as a main starting point of the ongoing debate was further fuelled by a peak of immigration to Germany in 2015[3]. Within this discussion the increasing energy efficiency standards were often seen as a driver of construction costs and rents. A closer look on different cost categories shows that energy performance requirements are responsible for about 7 % of a total increase of 39.4 % between the year 2000 and 2014 for an exemplary multi-family building (see Table 1) closely followed by increasing costs for building land (5.2 %)[4]. The main driver in this example are increasing prices for building material with 15.5 %.

Eventually even more discussed is the increase of rents due to energetic refurbishment of existing buildings. Based on § 559 of the German Civil Code costs can be passed on to the tenant by increasing the rent up to 11 % of the investment[5]. But case studies show that this option is hardly ever fully used due to landlords' attitudes (März 2018; Testorf, Voigtländer, Zens 2010: 24) or the regional rental market (Pfnür, Müller, Weiland 2009). Furthermore, the yearly energetic refurbishment rate with about 1 % of the building stock is fairly low (Cischinsky & Diefenbach 2018: 77) so the highest increase can be seen in newly let dwellings (Möbert 2017).

ENVIRONMENTAL ASPECTS OF ENERGY EFFICIENCY IN BUILDINGS

So it can be concluded that efficiency has its part on increasing building and rental costs, however, it is by far not the only or main factor. Moreover, Germany has to enhance its efforts with regard to efficiency in buildings as energy use in the residential sector has remained on a high level for several years now (BMWi 2017). With regard to space heating the increasing floor area per person counteracts efficiency improvements on building envelopes and heating systems. At the same time the increasing rate and use of electronic devices in households reduces saving potentials of efficient appliances. This leads to a total energy use in households that is almost at the same level as 1990 (UBA 2018).

Overall, building and housing has been high on the political agenda in Germany for a couple of years now. In 2018 the German government held a national housing summit to develop a strategy for affordable housing. Though the development of floor area and rate of appliances is noticed by national bodies (e.g. BMWi 2017; UBA 2018), so far it is not considered as a political option to lower housing expenditures, building costs or energy use in buildings. In contrast, the results of the summit follow the only question: 'How to stimulate and activate investors to build more?' For example:

1. See: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans (accessed: 2019-01-24).

2. See: https://www.bmu.de/themen/klima-energie/klimaschutz/nationale-klimapolitik/klimaschutzplan-2050/ (accessed: 2019-01-24).

3. See: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/Wanderungen/Tabellen/WanderungenAlle.html.

4. Theses results have to considered against a wide spread of prices for building land in different regions and between urban and rural areas.

5. Cost for regular maintenance and subsidies are excluded.

Table 1. Building costs in different categories in the year 2000 and 2014 for an exemplary multi-family building in Germany.

Costs in	2000 (161.200 €/unit)	2014 (225.000 €/unit)	Building material	Energetic requirement	Building land	Municipal obligation	Planning	Tax	Technical norms/ standards	Outdoor area	Permissions
€ per m²	2.209	3.080	342	154	115	82	77	61	30	7	3
%	100	139.43	15.48	6.97	5.21	3.71	3.49	2.76	1.36	0.32	0.14

Source: Own calculation based on Walberg, Gniechwitz, Halstenberg (2015).

- facilitate the construction of 1.5 Mio new dwellings and homes
- support social housing with 5 Mio Euro from 2018 to 2021
- tax support for the construction of rented flats
- introduction of a subsidy for families with children for owner occupied homes (1,200 Euro per child per year for 10 years)
- affordable building land from the German government for social housing in municipalities
- support serial und modular building
- simplify construction planning and permission processes[6]

Questions like:

- Where do we need what kinds of buildings and housing concepts?
- How can we activate vacant existing buildings and simplify re-use (e.g. of vacant office and commercial buildings, vacant defect and, thus, uninhabitable buildings)?
- How can we support an optimised use of dwellings?

are not part of the discussion. Also the aspect if or how these activities are compatible with climate[7] (80–95 % less GHG emissions until 2050) and land use[8] targets (less than 30 ha per day until 2030) is not taken into consideration.

Analysis of assumptions in recent studies

But what is the basis of the 400,000 new dwellings needed per year until 2020 (calculated by Pestel Institut 2015)? The figure starts with a formerly calculated housing shortage of 242,000 dwellings per year until 2025 (BBSR 2010) and adds the (now higher) immigration to Germany. Further needs assume a positive migration balance of 300,000 persons per year and an average household size of 2.5 persons (Pestel Institut 2015: 11). Each (new) household needs – in this calculation – a new flat or home. Existing buildings and vacancies are not taken into account nor is an alternative estimation part of the short study assuming different compositions of households as can be found in co-housing concepts.

Also in national energy and climate scenarios for Germany the possibility of a reduced demand for living space is not part of the assumptions (Zell-Ziegler, Förster 2018). Although studies show that especially elderly people could imagine to reduce their living space (Thomas et al. 2018) or even consider the size of their dwelling as a burden (BMVBS 2011).

Sufficiency in buildings

Based on previous and upcoming publications sufficiency can be understood as a state between a minimum level of social needs and a maximum level of ecologic capacity (e.g. Darby & Fawcett 2018; Bierwirth & Thomas 2015) and related action with the outcome of reaching this state (Bierwirth & Thomas t.b.p.; Thomas et al. 2018, Thema et al. 2016). With regard to floor area in residential buildings this would encompass

- people having adequate space for living (enough but not too much)[9],
- individual action by adopting floor areas to actual needs and the size of a household,
- building and housing concepts to optimise the use of floor area and construction allowing the adaptation to changing needs,
- and sufficiency policies enabling and enforcing a reduction of floor area for individuals and households.

Furthermore, areas for sufficiency in buildings can be seen in the design and construction of buildings in terms of the choice of material and its potential for re-use and recycling, the equipment of dwellings and the inhabitants' use of energy regarding heating, cooling, and electronic devices.

The main focus in this paper is on the floor area per person. As mentioned above, preliminary findings identify options and also needs for living space reduction but a lack of political intervention. Thus, in the following the paper reflects on existing policies and discusses options of how to integrate sufficiency aspects.

6. See: https://www.bundesregierung.de/breg-de/aktuelles/gemeinsam-fuer-mehr-wohnungen-1522906 (accessed 2019-01-25).

7. Climate target for Germany: 80–95 % less GHG emissions until 2050 compared to 1990. The interim target of a 40 % reduction until 2020 will most probably be missed (see: https://www.umweltbundesamt.de/daten/klima/klimaschutzziele-deutschlands) (accessed 2019-01-25).

8. Land use target of less than 30 ha per day until 2030. The actual rate of land use for settlements and transport infrastructure is at about 60 ha per day. The interim target of max. 30 ha per day until 2020 will most probable be missed (see: https://www.umweltbundesamt.de/daten/flaeche-boden-land-oekosysteme/flaeche/siedlungs-verkehrsflaeche#textpart-4) (accessed 2019-01-25).

9. For a discourse on how to define what is ‚adequate' see Bierwirth & Thomas t.b.p. examining related regulation in Germany and definitions of under-occupied and overcrowded dwellings.

Table 2. Arguments related to the draft of the GEG.

Aspect of the GEG	Argumentation
Efficiency requirements for new buildings will remain on the current level as defined in the EnEV 2016.	• **Pro:** Associations of real estate and housing companies see current regulation as maximum for economic efficiency. • **Contra:** German environmental organisations, the network of energy efficiency companies DENEFF, BPIE, and others demand either stricter requirements for efficiency in buildings or their announcement for the near future as they do not see the current regulation fulfilling the requirements for NZEB.
Public buildings can be excepted from high performance requirements in case of economic difficulties or inefficiency	• **Contra:** Mostly, it is criticised that the public sector with its role model for other owners should not be excepted from the requirements. • **Further:** Instead a financial support for e.g. economically weak municipalities is suggested.
Determination of efficiency standard in certificates shall be changed from final energy demand to primary energy demand.	• **Pro:** Energy supply from renewable energies is supported. • **Pro:** Primary energy is the reference value for other requirements, too, such as KfW programmes. • **Contra:** Counteracts the principle of "efficiency first" as a high share of renewable energy supply can reduce the motivation to increase the efficiency of a building. • **Contra:** Less known and understandable, thus less informative for people • **Further:** Including CO_2 emissions of a building in certificates, eventually per area unit.
Energy certificates still can assess the energy performance of a building based on its construction details or – more easily – review the actual energy use of a building within the last three years.	• **Contra:** Certificates based on the final energy consumption do not (necessarily) reflect the real efficiency standard and should be either discarded or included into certificates based on the calculated energy demand. • **Further:** Energy certificates should be extended to a renovation roadmap to give longer-term orientation.

Source: Own compilation based on 15 statements on the first and 2 on the second draft of the GEG.

From a social perspective the focus of living space reduction is less relevant for low-income households as they generally live on less floor area per person than higher-income household (Destatis 2019d). However, as discussed above, the share of expenditures for housing is especially burdening this group. Therefore, the paper also discusses options for sufficiency policies on energy saving behaviour.

Building policies in Germany

To reach energy and climate targets, building policies in Germany mainly focus on energy efficiency and supply from renewable energies. They encompass various instruments of regulation, planning, funding, advice, and information. Due to the limited length of this paper, it focuses on a selection of instruments, more specifically on

- the elaboration of a new regulation on energy efficiency and energy supply in buildings including energy certificates for buildings,
- existing national funding programmes for energy efficiency in buildings and for urban development, and
- an energy saving advice programme.

REGULATION ON ENERGY AND EFFICIENCY IN BUILDINGS INCLUDING ENERGY CERTIFICATES

A new regulation on energy in the building sector is currently under preparation in Germany. It compiles the current regulatory framework of the Energy Conservation Act (EnEG), the Energy Saving Ordinance Energy Saving Ordinance (EnEV), and the Renewable Energy Heat Act (EEWärmeG), and is supposed to introduce nearly zero-energy buildings in Germany as required in the EPBD. The present – now second – draft of the upcoming Building Energy Act (GEG) is currently (Jan 2019) reviewed by selected organisations and associations. It is supposed to come into force in summer 2019 but has to pass the Federal Council first.

Some of the main arguments (pro and contra) are listed in Table 2[10]. However, neither the GEG drafts nor the reviewed statements consider wider sufficiency aspects. Single exceptions can be seen in:

- The Federal Association of Building Energy Advisors (GIH 2017) states in the preamble that also resource efficiency, 'grey energy' (as embodied energy in the material and construction of existing buildings), and sufficiency contribute to climate protection (GIH 2017: 1). In the following there are no suggestions to be found how to include these aspects into the new regulation.
- The Federal Association of Energy and Climate Protection Agencies (EAD 2017) refers to the increase of per capita floor area in Germany with regard to costs for building but without further addressing this aspect in their recommendations (EAD 2017: 4).
- Friend of the Earth Germany (BUND 2017) suggests to integrate the correct dimension of heating systems to the performance of a building (BUND 2017: 13).

10. Source: ublished on https://www.klima-allianz.de/news/detail/die-stellungnahmen-zum-entwurf-des-gebaeudeenergiegesetz/ and http://www.enev-online.eu/geg_news/190122_neuer_geg_entwurf_in_der_kritik.htm#4._Manifest%20zum%20GEG-Entwurf (accessed 2019-01-26).

- The Central Association of German Chimney Sweeps (ZDS 2017) suggest to restrict certificates to the energy performance but to include the consumption value, too (ZDS 2017: 2). The often observed discrepancy between energy demand and consumption would become obvious for the user and eventually lead to appropriate action in terms of behavioural change or efficiency measures.
- The German Corporate Initiative Energy Efficiency (DENEFF 2019) suggest to foster smart technologies and feedback systems to support energy saving behaviour. Further, it is pointed out that the calculated energy demand of decentralised hot water systems based on the size of a dwelling often overestimates the consumption of hot water. A user-related factor should be included (DENEF 2019: 20). However, the suggested factor refers to the respective technology and does not consider an actual consumption or number of users.

FUNDING PROGRAMMES

The main national funding programmes for buildings is provided by the KfW. They support energy efficiency in existing, listed, and new buildings, the reduction of barriers in dwellings for elderly and handicapped people, smart technologies, and security[11]. Even though the eligibility condition for energy efficient buildings define maximum costs per unit that are supported, however they do not necessarily motivate to build smaller, more flexible, or sufficiently used dwellings.

But this programme can also be used in the case of vacant non-residential buildings to re-use them for residential purpose. As such, it can contribute to a decreasing demand for new built homes.

ENERGY SAVING PROGRAMME

The "Stromspar-Check" is a nationwide free programme for low-income households and social welfare beneficiaries. Long-term unemployed people, trained as energy advisor, visit the homes, measure electricity consumption, give recommendation how to save energy, and give away small energy saving devices such as LEDs, thermo- and hygrometer, and water-saving fittings. Furthermore, energy efficient refrigerators are supported under certain conditions.

As such, the programme includes efficiency elements, such as efficient lighting bulbs, as well as sufficiency aspects of behavioural change that in interaction lead to the actual savings[12].

For all other households the consumer associations in Germany provide advice with regard to energy saving options.

Recommendations for improved building policy

Overall it can be stated, that sufficiency in buildings is not yet on the political agenda in Germany, although the example of the "Stromspar-Check" shows that sufficiency and efficiency can go along very well. In the following, different options are discussed how sufficiency could be included in the policies mentioned above.

BUILDING REGULATION AND ENERGY CERTIFICATES

In the end, the most efficient building is only contributing to Germany's energy and climate strategy if it is used sufficiently. Therefore, the new regulation for energy and efficiency in buildings, the GEG, could include targets for adequate floor area per person and/or definitions for under-occupied and overcrowded dwellings as an orientation for planers and investors.

It could also pave the way to reduce vacancies by introducing a tool for the registration of vacant buildings (residential and non-residential) and dwellings.

So far, the issuance of an energy performance certificate mostly includes an on-site visit and recommendations for energy efficiency measures. With regard to user behaviour, the integration of an energy consumption parameter, as suggestion by ZDS (2017), seems to be a good opportunity to recognise and assess existing discrepancies. In that case, it could be considered to include a brief energy saving check and respective recommendations on energy behaviour.

Several studies examined energy saving potentials of behaviour change by feedback systems[13] with an increasing focus on smart metering, in-home display (IHM) and mobile apps. This aspect would be worth integrating into the GEG. An important aspect here is that inhabitants not only get information about current use but are also enabled and informed how to influence their consumption (e.g. with central heating systems in multifamily houses).

The change of ownership is a – underexposed in German regulation so far – important window of opportunity for efficiency measures (Friege 2016). Weiß et al. (2018) discuss to link an obligatory on-site energy advice to it including an individual renovation roadmap (Pehnt 2015). In this case, the building's long-term usability, eventual need for adaptation in size, and other sufficiency aspects could be considered.

FUNDING PROGRAMMES

The funding programmes of the KfW could support these new aspects as described above. That means, the option of a reduced floor area could be part of the 'senior-friendly conversion' programme and support the separation of unused rooms or the division of a single-family house into two units.

Bonus payments could be considered (for both sides) if older persons or couples sell their homes to young families and move to smaller dwellings.[14]

The support of flexible ground floors and buildings (e.g. inter- and disconnectivity of rooms) offering the possibility to adapt in size to changing needs, innovative housing concepts that limit per capita floor area could be part of the energy efficient buildings programmes.

ENERGY SAVING ADVICE

The Stromspar-Check described above shows that sufficiency measures in low-income households can help reducing the housing expenditures for this group. The rollout of smart me-

11. See: https://www.kfw.de/inlandsfoerderung/Privatpersonen/index-2.html (accessed 2019-01-26).

12. Results are published in Seifried & Albert-Seifried (2015).

13. Hargreaves (2018) gives an overview of different feedback system and approaches.

14. Hiddenhausen, for example, rewards young people buying old homes (see: https://www.hiddenhausen.de/Hiddenhausen/Wohnen/Jung-kauft-Alt) (accessed 2019-01-26)

ters will make it easy to integrate PPM in the near future. In this context, energy suppliers should be obliged to offer PPM at the customer's request. In a study carried out by the author on behalf of the Ministry of Environment, Agriculture, Nature and Consumer Protection of North Rhine-Westphalia, 39 semi-structured interviews with current users of PPMs were conducted in several cities in the period from autumn 2016 to winter 2016/17 (Kopatz et al. 2017). An important finding in the project was that greater cost transparency provides an incentive to save energy. The survey showed that households with PPM have taken different measures to use energy more conscientiously and efficiently. Cost transparency was perceived by most users of PPM as the greatest benefit (see Figure 1).

85 % of the interviewees stated that the meter had induced electricity savings and 79 % of respondents stated they were now more concerned with their electricity consumption. There is a reason why this value is somewhat lower than the assumed saving effect. Ultimately, some households found the PPM less burdensome because they were no longer so concerned about electricity consumption, seeing it now as being "under control better". Savings were primarily achieved by more careful handling of electrical appliances or by shutting them off completely. Households also stated that they changed their nutrition from cooking a meal to cold dishes. How far this affects their health cannot be answered by our study (Kopatz et al. 2017, Wagner & Wiegand 2018).

16 of the households surveyed had exchanged large electricity-consuming appliances for others, noting that they had paid particular attention to electricity consumption when buying new ones. This aspect fits well to the support programme of exchanging old refrigerator in the actual Stromspar-Check. Same is true for the energy saving devices: At least 14 of the households surveyed had invested in a power saver, such as disconnectable plug connectors and timer switches. Some households had also taken a whole series of measures to reduce their electricity consumption. Especially no-cost measures had been applied (Kopatz et al. 2017).

The interviewees also reported how the savings were monitored by the meter in real time, which led to direct control of success. The assessment of their own electricity consumption as well as the consumption of individual appliances was not based on unit kilowatt hours, but on consumption in Euros. This visualisation of the electricity costs on the display played a major role in the saving effect: One advantage of PPM is that energy

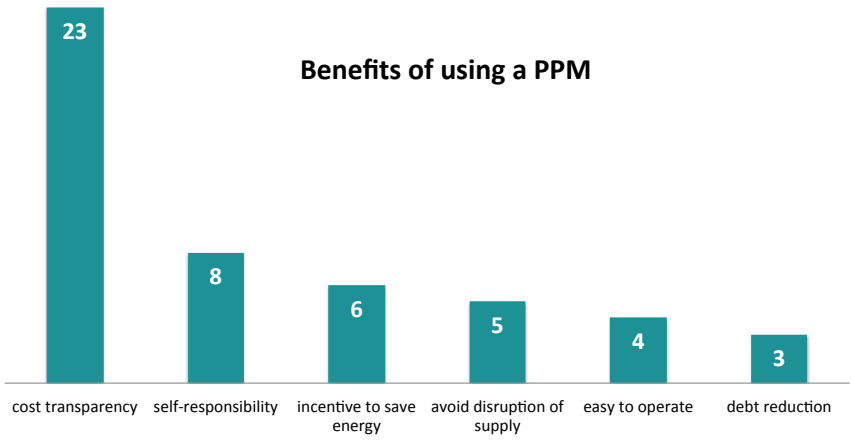


Figure 1. Benefits of using a PPM identified by users. Source: Kopatz et al. 2017.

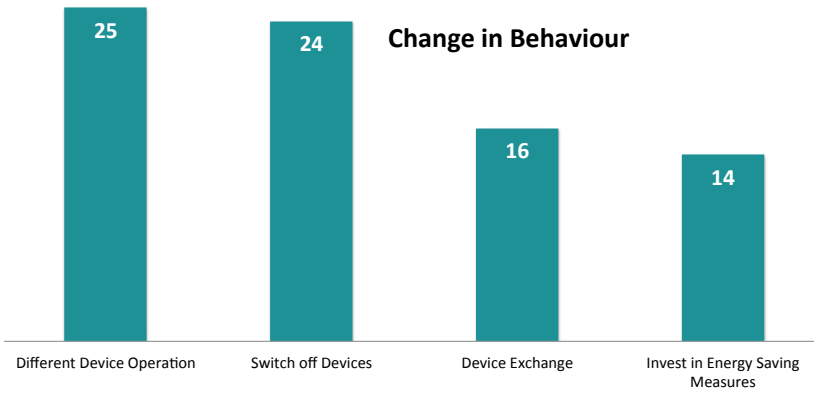


Figure 2. Behavioural changes in PPM users' electricity consumption.

saving measures lead directly to cost savings. With conventional billing, on the other hand, the savings only become effective with a delay when the annual account is drawn up after the annual meter reading. However, regarding the PPM market in Germany a regulation by state intervention is urgently required, since the electricity suppliers demand significantly higher prices for electricity from PPM customers to reduce their outstanding liabilities and, besides, they are not obliged to install user-friendly systems to load the PPM. Unfortunately, so far, the PPM market in Germany is completely unregulated (Wagner & Wiegand 2018) . Another problem to date is the access to credit recharging facilities. In most cases, there was only one option at each customer centre of the energy supplier. Households are therefore dependent on their opening hours. Technically, there are alternatives. Smart meters for example are interoperable and therefore they could also be recharged through online payment services. But alternatives have not yet been used for reasons of costs. Therefore, at least a legal regulatory requirement with regard to self-locking on weekends and public holidays would be pertinent (Kopatz et al. 2017). Some energy suppliers already have a corresponding regulation and offer a 24h online payment service, which is very much appreciated by PPM users (e.g. the municipal utilities Stadtwerke Duisburg and energierevolte.de a subsidiary company from Stadtwerke Düren).

Discussion and conclusion

The instruments – GEG, financial support, and energy advice – and their optimisation in this paper have to be seen exemplarily. Other important instruments and regulation related to building and housing could not be considered due to constraints in time and length of the paper, such as planning tools, the current rent law, and others. However, the complement of sufficiency aspects to existing efficiency instruments show the potential to support the effort of energy and climate policies in buildings.

An optimised use of existing buildings can reduce the need for new built homes and, thus, also support the target of at least halving the land use for settlements. The GEG as well as financial support programmes could support the adaptation of buildings by type of use and flexibility of dwellings. Especially against the background of rising costs for rents and construction this could have a positive social-economic effect on the residential market and help covering the actual urgent need for affordable dwellings in Germany.

Energy advice and PPM can support behavioural change to save energy. From a social perspective this is especially relevant for low-income households with difficulties to afford the costs for housing. But also in other households efficiency (such as efficient light bulbs) in combination with sufficiency (switching lights off if not needed) has the potential to decrease energy consumption and support energy and climate targets.

It is clear that a broader focus than just on buildings is needed to implement sufficiency on a wider scale. This could encompass energy pricing instruments, electricity sales caps and trade, revision of product regulations, and others (see Thomas et al. 2015, 2018). And it would need respective policies on the European level, too.

From a scientific perspective it would be interesting to analyse sufficiency policy options complementing efficiency efforts systematically. The consideration of sufficiency in policy design, scenario and potential analyses, its social and economic effects offers a wide field of approaches in future research.

For now, the aim of this paper is to intensify the discussion on sufficiency policy and lead into the direction of how to include it into existing efficiency policy. The cases analysed in this this paper show how well sufficiency works as a complementary strategy.

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