

A step-by-step model for a long-term renovation schedule – a proposal for a new building renovation instrument

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Abstract

In the long run, the demand for space heating in existing buildings has to be reduced by around 80 % in order to achieve ambitious climate protection goals. Current activities are not sufficient to reach this goal. Regulations, such as the German Energy Savings Decree, take effect mostly when renovations are being carried out anyway. In most countries, they do not trigger retrofit activities as such. Financial support is an important instrument but, because of the often limited public budgets, it cannot be the only one.

This paper develops a long-term renovation plan based on a step-by-step model. The core of this concept is an obligation to renovate a building when certain energy parameters (final energy demand and CO₂ emissions of a building) are exceeded. If that is not possible, technical or economic reasons have to be presented or a compensation fee paid. With this fee, financial funding for certain target groups can be provided (e.g. house owners with low income or social housing).

Every building has to meet the proposed values at any point in time. The final energy value is an indicator for the efficiency of the building envelope and of the heating system. The CO₂ emissions take into account the quality of the energy source as well, such as the share of renewable heating. If the parameters of a building exceed the standards the owner decides whether

he wants to renovate the whole building at once so it will meet the standard for the next decades or if he wants to renovate it step-by-step. Until 2050 the requirements should be reinforced every 5 years starting in 2017 to make sure that all buildings will have reached the very low energy standard.

This paper describes the concept, which is currently being discussed both on a federal level, based on a proposal by Friends of the Earth Berlin, and on a state level. It analyzes social, legal, economic and environmental pros and cons as well as the accompanying measures which are required to secure the social compatibility of such measures.

The need for a long-term renovation schedule

The international community faces the enormous challenge of reducing greenhouse gas emissions by at least 80 %, but presumably by up to 95 % compared to 1990, and to transform the entire energy sector in industry, commerce, trade, services and private households. The building sector is particularly important. In Germany this area alone accounts for 40 % of the final energy consumption and 30 % of energy related CO₂ emissions. Most old buildings were built before the first Thermal Insulation Regulations in 1977, the first regulation of building heat requirement. About two thirds of heating systems are not state of the art.

The existing laws and regulations in Germany, such as the Renewable Energies Heat Act (EEWärmeG) or the Energy Savings Decree (EnEV), as well as similar ones in Europe have so far failed to increase the real savings or to expand the share of renewable energy in the heating market. Aside from the numerous barriers for renovation, the renovation rate is far below required levels due to fact that the legal requirements

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for owners have only a few obligatory measures. Among these, German building owners, for example, are required to insulate the top floor ceiling and heating pipes in un-insulated parts of the building. Apart from these few obligations, building owners are only required to adopt climate protection measures if the corresponding components are retrofitted anyway (walls, windows, etc.).

Many other countries have no or only inadequate regulatory tools for existing buildings [GEA 2011]. The climate protection goals are only achievable if the heating demand of existing buildings drastically decreases, significant efficiency gains are made in the heating and cooling supply and that any remaining needs are fulfilled using renewable energy sources.

In many cases renovation strategies focus on providing financial support. However, given the presently restricted budget in Germany and other countries it is important to observe the limits of support instruments that are dependent on budget support. For example the important national subsidies such as the KfW energy efficient construction/renovation and the 2010 market incentive program for renewable heat were reduced or in some cases even stopped. Therefore the idea for creating a renovation schedule was born in order to promote renovations independently of financial subsidies. The concept was developed by a group of experts invited by the State association BUND (Friends of the Earth) Berlin, the Berlin Residents Association and the Chamber of Commerce and Industry as part of a discussion on a Berlin climate change bill. Background information can be found at www.stufenmodell.de. The following article builds on the Berlin proposal while developing it further.

The arrangement of a step-by-step model as a long term renovation schedule

THE BASIC PRINCIPLE

The main idea of the step-by-step model is to set the goal of mandatory standards for energy efficiency and greenhouse gas emission reduction of single existing buildings over the next decades (see Figure 1, element "2"). The limits get stronger in a regular rhythm that is to be determined (intermediate goals). At the end of the period, such as 2050, the goal of near-zero emissions for existing buildings can be achieved.

If the building owner cannot comply with the parameters he/she has to prove a case of hardship e.g. due to principal technical or economic limitations (Figure 1 option 4). The utmost attention should be devoted to building aesthetics and architecturally valuable buildings.

For flexibility a compensation levy can also be introduced (Figure 1 option 5) that would serve as an alternative to the compliance with limits. This tax would supply a funding pool from which a target group differentiated funding plan would be financed (e.g. house owners with low income or social housing).

The renovation schedule first obligates building owners whose properties have a particularly high heat loss and who have extremely inefficient heating systems, since these renovations are particularly cost efficient. Heating costs can be significantly reduced resulting in no or only a slight increase in monthly rent.

Necessary planning and investment security for owners is created due to the longevity of the schedule. A building owner can decide to "properly" renovate and thus meet the requirements for the coming decades or to proceed by carrying out individual renovation measures step-by-step. A long-term renovation schedule guarantees compatibility with life, renovation and investment cycles of existing buildings and individual components. The long-term goals and their regular strengthening encourage economic activity by the building owners.

Energy consulting will insure that the optimal path is followed for a building (Figure 1 element "1"). The owner can decide how to achieve the goals by freely choosing the means to do so. A long-term renovation schedule is not only open to technology but also has the advantage of offering the most economically viable and ecologically necessary path for each building from an existing housing stock.

PARAMETERS OF A RENOVATION SCHEDULE

The definition of the parameters that the renovation schedule is based on is dependent on the currently applicable laws and other legal frameworks. The determination of the parameters must meet the following requirements:

- The goal to reduce energy demand and CO₂ emissions must be met.
- The proof of compliance with the set limits must be simple, verifiable, and enforceable according to regulatory practices.
- The parameters must be as compatible as possible with established building instruments.

The first pillar of the goal is reducing the space heating demand to very low values of around 15 kWh/(m²*a) by 2050. The second pillar is to achieve "nearly zero emission" for the remaining heating demand. This typically requires high share of renewable energy carriers.

The Energy savings Decree (EnEV) in Germany is currently based on two parameters: the specific transmission heat loss H_T ' (essentially analogous to an average U-value of the building, taking into account the thermal bridges) as a characteristic of the quality of the building shell and the primary energy demand of the building. Nevertheless, the two characteristic parameters from the energy saving regulation are not necessarily appropriate for the renovation schedule. The consumption oriented energy certificate for buildings interferes here because it only indicates the final energy for heating, ventilation, hot water used, etc., but not the primary energy or the transmission heat loss H_T '. The latter is also not suitable for non-residential buildings since factors such as ventilation are not included in the calculation.

Therefore the parameter "final energy" is better for a simple verification in Germany. However, examining the final energy favors the use of electricity because high losses in the electricity supply are not reflected in the final energy demand. Therefore, for the second parameter, which describes the quality of the energy carrier, the exhaustible primary energy or the CO₂ emissions can be used. In the German EnEV the primary energy demand is calculated by multiplying the final energy demand of a building with a primary energy factor that represents the energy costs of providing the final energy. There are tabulated factors in Germany for this (such as 1.1 for heating oil and

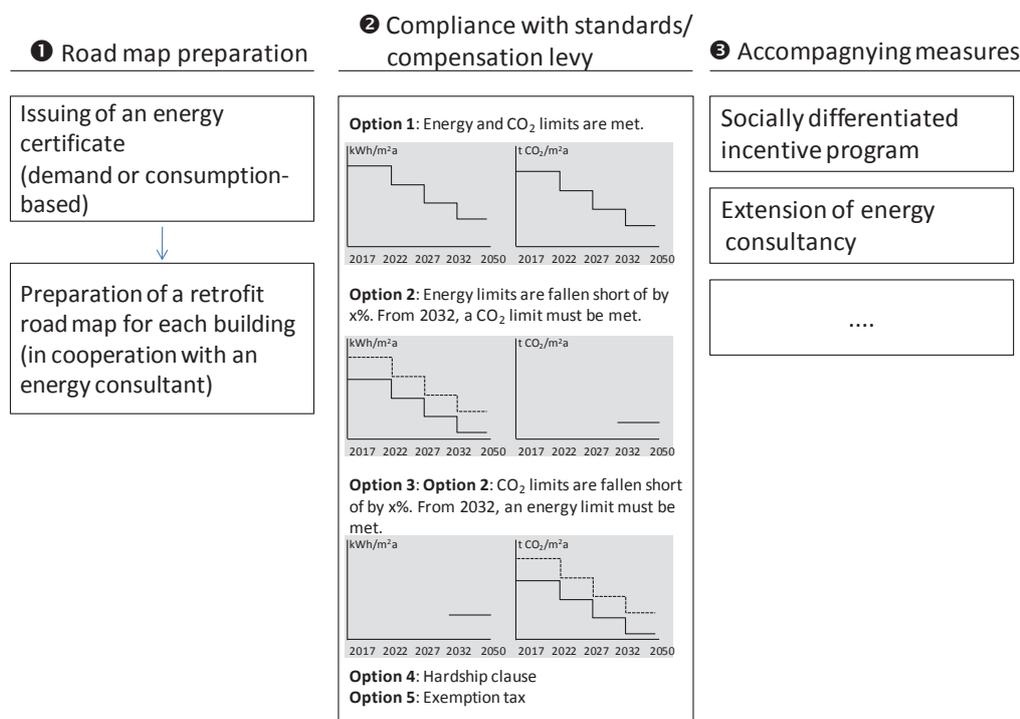


Figure 1: Principle of the long-term renovation schedule.

natural gas, 0.2 for solid biomass). The disadvantage of these values is that they don't reflect the differences between the CO₂ loads such as between heating oil and natural gas.

Therefore is it conceivable to determine a building's CO₂ or greenhouse gas emissions instead of the primary energy. To determine this, the final energy is multiplied with a specific CO₂ factor. This target reflects the supply side of the building since it depends both on the energy carrier (e.g. share of renewable) and the system efficiency.

This would offer the following parameters for a renovation schedule:

- the final energy use for the heat supply (including pumps and ventilation) of the building (in kWh/m²a).
- maximum CO₂ emissions in t/m²a.

For non-residential buildings, also lighting might be considered within the retrofit plan.

DETERMINING THE STANDARDS

The heterogeneity of the existing buildings makes it necessary to differentiate according to building type. It is clear that buildings in different sectors must be assessed differently. These include buildings from trade, commerce, services, industrial and residential as well as one, two, and multi family homes. This means that buildings differ depending on the year of construction, size and the type of use.

A proposal, developed as part of the analysis of a proposed Berlin climate change bill, suggested the differentiation between residential and non-residential buildings. The limits are chosen so that the first threshold value, effective from 2017 on, only affects a small part of existing buildings. These are based on modeling and empirical values for typical size and installation conditions (semi-detached, mid-terrace house, apart-

ment buildings with a different number of floors, prefabricated buildings). One and two family houses often result in up to 40 % higher energy consumption (see model calculations by the Berlin Chamber of Architects on www.stufenmodell.de). The step-by-step model could take the differentiation of residential buildings into account by assigning one and two family homes and certain multi-family homes a 20 %-40 % higher limit, depending on the size and installation situation. However, one might also argue that, to reduce the rebound trend toward larger houses and create an incentive for absolute savings, smaller houses should be assigned the same limit values as larger buildings.

Differentiation is even more important for non-residential buildings since office and administrative buildings have completely different usage conditions than, for example, industrial buildings. They require further differentiation because some have very different requirement and usage profiles. Unlike with residential buildings the database for non-residential buildings is extremely poor. Differentiation by size and installation conditions such as with residential buildings is not very useful.

Therefore the differentiation for non-residential buildings is based primarily on EnEV reference buildings and benchmarks. For more details on the process for non-residential buildings see www.stufenmodell.de.

To determine the CO₂ limits for 2017, 2022, 2027 and 2032, a very conservative final energy demand of 300 kWh/m²a was multiplied with gradually decreasing CO₂ emission factors (reflecting the increasing share of renewable fuels) of 250, 200, 166 and 120 g/kWh.

With residential buildings, **verification** takes place with the help of the energy certificate from calculated demand or measured consumption. If verification is provided by a consumption based energy certificate then 20 % will be added on the reported consumption. The reason for this "safety adder" is that

Table 1: Energy and CO₂ emission limits for residential buildings (proposed for Berlin).

Threshold as of	Energy limit kWh/(m ² *a) ¹	CO ₂ limit kg CO ₂ /(m ² *a)
Building > 500 m ² floor space, installed on one or both sides		
2017	200	75
2022	160	60
2027	120	50
2032	80	36
Building < 500 m ² floor space, installed on one or both sides or Building > 500 m ² free standing floor space : all values * 1.2		
Building < 500 m ² free standing floor space: all values* 1.4		
Consumption-based certificate: all values * 1.2		

¹ Final energy demand to provide heating and hot water

One might also argue that, to reduce rebound effects, small buildings should not be treated differently.

many empirical studies have proven that consumption data for buildings is – depending on age, type and standards of a building – typically well below the calculated demand due to various rebound effects. Therefore, to avoid penalizing demand-oriented energy certificates, a correction factor is necessary.

If the energy consumption value does not include hot water, then a surcharge is added to the energy consumption value for the use of a decentralized water supply. For non-residential buildings, which are much more complex, a verification must be based on the calculated demand.

While it deviates from the Berlin step-by-step model, the heterogeneity of existing buildings could be accounted for by giving the property owner the freedom to choose various renovation paths (see Figure 1):

(1) The building owner keeps final energy and CO₂ levels under the threshold value every year. This can be achieved through progressive action or through a fundamental renovation from the start.

(2) The owner of the building stays under the final energy threshold value by at least x % (e.g. 30 %). The CO₂ threshold must be met no later than 2032. This path corresponds to the strategy to insulate first and then to later install a heating form with lower CO₂ emissions.

(3) The owner of the building stays under the CO₂ threshold value by at least x % (e.g. 30 %). The energy threshold must be met no later than 2032. This path corresponds to the strategy of first using heating from co-generation or renewable energy sources and insulating later.

Hardship provisions

A renovation schedule is a significant intervention because it requires new policies from the building owner which are independent from existing policies. This kind of intervention is not unprecedented though. The introduction of environmental zones, for example, leads to the banning of cars with bad emission characteristics. However, a difference to the renovation plan is that this does not decrease the emission limit for older cars but indirectly achieves the exchange effect.

On the other hand an obligation for renovation directly affects the building and is linked to costs. Energy related renovation costs vary greatly depending on the region, building characteristics (construction year, location, technical features,

protected as a historic building, etc.), the professionalism of the implementation as well as other factors. A number of studies indicate the component or building related renovation costs as being €150-300/m² for renovation to a moderate standard of 60-90 kWh/m²a [IWU 2009; IBB 2010].

This balance sheet approach, however, does not analyze who bears the investment costs and who benefits from the savings in energy costs. In addition, residential capital gains and other “co-benefits” of the renovation are not considered. These include the increase in property value, increase in living comfort, reducing maintenance and service costs, preventing structural damage and economic benefits such as a boost for the regional economy and the avoidance of greenhouse gases and energy imports.

To investigate the additional costs for the Berlin case study the average renovation energy costs were calculated for the construction area of the roof, basement, facade and window components. These calculations were based on the above assumptions about limits and a comparison of different studies about the economic cost of energy renovation policies. The construction area was set in relation to the heated living space. As a result the ratio of clean up costs in € per heat demand reduction of kWh/m²a to the savings in kWh/(m²*a) becomes clear. With these values the total required investment for Berlin's existing buildings can be calculated according to the four proposed steps (Table 2). To determine the amount of annual energy cost savings, the annual savings were compared to an energy cost of €0,08/kWh.

During the first step the investments return on average after two years, in the second step after five years, in the third after 6.7 years and in the fourth step after 7.3 years. The cost in terms of living, renovation and investment cycles would still be economically viable even if the investment return period doubles a. g. because the actual consumption of the building is different from the calculated demand.

These statements about the economy are to be interpreted with caution since it incorporates many factors such as the change of residences and the rent amount in the context of the housing market. For example if the local comparative rent rises quickly then the “profitability” rises even faster for a tenant of an apartment with energy saving renovations. An apartment without renovations will cost as much as one with renovations after a few years. In this example, the owner of the building will

Table 2: Threshold levels, total investment cost and energy cost savings using the Berlin example.

Steps and limits + Ø 30% average due to building differentiation	Total investment needs in mill. €	Ø Annual savings in mill. € with energy costs of 0.08 €/kWh
(1) 200 kWh/(m ² *a)	116	53
(2) 160 kWh/(m ² *a)	974	192
(3) 120 kWh/(m ² *a)	2,336	348
(4) 80 kWh/(m ² *a)	4,271	585

(calculations by the Berlin Residents Association on www.stufenmodell.de)

have to carry a higher financial burden; the renovation might become unattractive to the owner.

It can also lead to social hardships that can be remedied by appropriate legislation. A flexible renovation schedule with accompanying measures is important for the social acceptance and legal stability of the proposal. One element of this flexibility is a provision for hardships: an exemption from the obligation to comply with the limits if special circumstances lead to an unreasonable burden or in any way lead to unusual hardship. The law can give no concrete definition because of the extreme differences in calculation methods. An expert must confirm the reasons for economic or technical hardship. Permissible exceptions could be a planned demolition of the building or the extensive protection of a historical building. Since the hardship provision enables the exemption from obligations, the provision must be worked out in practice and must hold up in court.

Tenant hardship could be avoided within the legal climate protection bill. A proposal for this would require that action be taken as long as certain heating cost levels are not exceeded. It is voluntary if building owners do more and so an increase in rent would not be attributed to the law.

In favor of the tenants, the hardship provision could require, through the step-by-step model, that the provisions of the law not commit to parameters that when implemented would lead to a rent increase exceeding the heating cost savings by several times.

Flexibility and Support

The step-by-step model is flexible in various ways. Some of the flexibility has already been described such as a) the **long-term** nature of the renovation schedule, b) the **choice between compliance paths** 1, 2 or 3, and c) the **hardship provision** with a cost limit and a review clause.

Further flexibility components could support the step-by-step model:

d) **Compensation levy.** A compensation levy is possible when a renovation is not carried out. This is measured by the degree that the target value is exceeded, such as exceeding the primary energy requirement by €1/100 kWh/m²a). It would not be allowed to add the exemption tax to the rent. This creates an incentive for landlords to renovate.

e) **Incentive program.** The compensation levy is paid into a fund that gives additional support for building renovation. This program should give socially differentiated funding depending on the social needs of owners or tenants, the location of the property and the ownership status (rented or not rented property).

Implementation and legal admissibility

This instrument will only be effective if it finds application. That's why the implementation is particularly important. To keep it as unbureaucratic and accountable as possible the parameters and record keeping were created to be as differentiated as necessary and as simple as possible. As with transport where only certain vehicles are checked for their compliance with the speed limit, a percentage of owners affected by the renovation will be reviewed. Accordingly, the owner of the building covered by a particular step would be asked for a quantified sample of 10 % for proof. Like traffic law offenses these would also be punishable by a fine.

Of course the legality of a step-by-step model is dependent on its configuration. During the preparation of a Berlin climate change bill it was found, through two legal opinions, that the step-by-step model does not violate the guarantee of ownership in the constitution [BBH 2010]. Legal regulations that prohibit the use of environmentally damaging property update the social obligation of property and are therefore permitted. In particular, the step-by-step model is not contrary to the proportionality principle. Due to the various options to comply with the retrofit plan, the step-by-step model ensures that past investments in a building or in construction techniques are not devalued. Atypical cases may be removed from the scope of potential liability through exceptions and exemptions if the intervention threshold is sufficiently defined for the majority of foreseeable cases. The step-by-step model does not impose unreasonable obligations on building owners because the owner retains control of his building and because the renovations normally increase the commercial value of the building [GGSC 2010].

Conclusions

Tackling the issue of increasing the renovation rate with new instruments is of major importance for the building sector. One approach is to improve information and knowledge. A second approach aims at removing financial barriers through financial support programmes or innovative financing mechanisms like the British Green Deal with Pay-as-you-save financing. The "renovation schedule" chooses a more regulatory approach and introduces a new obligation to renovate a building depending on the energetic quality of the building. The main advantage of that instrument is that it addresses all buildings at once and thus achieves a very broad effect.

On the other hand, the paper has shown that this obligation constitutes a major intervention. Therefore, vital for a successful renovation schedule is that it is coupled with a flexibility on

different levels: different technological options to comply with the law, a long-term timeline, the possibility to pay a compensation levy which will then be used to finance a socially differentiated incentive program, and a hardship provision.

In addition to that, it is of high importance that the renovation schedule does not replace existing building standards. For instance, in Germany, the Energy Savings Decree requires that if a component is renovated anyway, e.g. an outside wall, it has to have a certain maximum U value. The renovation schedule complements these requirements: it is meant to initiate an impulse to renovate. Thus, a higher renovation speed can be achieved.

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For more information as well as documents please see: www.stufenmodell.de.

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