Are economic principles a driver or a barrier for energy efficiency and climate policy?

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Abstract
Economic principles are at the heart of key policies addressing or affecting energy efficiency. Minimum energy performance standards are typically based on an economic efficiency principle, where the ambition of the minimum requirements depends on economic costs and benefits. Examples from different governance levels include the least-life-cycle-costs approach in the EU Ecodesign Directive, the cost-optimality approach in the EU Energy Performance of Buildings Directive and the German building codes, where the requirement for micro-level cost efficiency acts as barrier for setting more ambitious standards. Also, some public procurement approaches are based on economic principles, where requirements to include life-cycle costs and/or external environmental costs can provide a driver for the uptake of energy efficiency technologies. In view of the fundamental role of energy efficiency policy for reaching climate targets, this article addresses the question how innovative approaches to use economic principles in policy formulation can foster the deployment of energy efficiency solutions. To this end, we analyse different approaches for using economic principles in minimum energy performance standards and in public procurement processes, including the recently introduced requirement to consider the costs of climate action in Federal procurement processes specified in the German Federal Climate Change Act. We derive recommendations on how to use economic principles in policy formulation as a driver rather than a barrier for the deployment of energy efficiency solutions.

Introduction
Energy efficiency is a key priority in the climate policy strategies of the EU and its Member States. The energy efficiency first principle reflects the EU Commission's view that "energy savings are the easiest way of saving money for consumers and to reduce greenhouse gas emissions"[1]. Energy efficiency measures are an important element in the transition towards a sustainable energy supply, cut greenhouse gas emissions, improve security of supply and reduce import bills, while also promoting the EU's competitiveness (European Parliament 2020).

While energy efficiency is generally seen as a key element in a cost-effective transformation of the energy system, the focus on cost-effectiveness can severely limit the potential of energy efficiency policy in achieving ambitions climate and energy targets. A large body of literature focuses on the adoption and non-adoption of cost-effective energy efficiency measures in the context of the energy efficiency gap (see e.g. Hirst and Brown 1990; Koopmans and te Velde 2001; International Energy Agency 2007; Gillingham and Palmer 2014; Hirst Gerarden et al. 2017). However, the adoption of cost-effective measures, particularly when taking the private investor perspective or myopic decision making, is insufficient for reaching the highly ambitious targets for reducing greenhouse gas emissions according to the Paris Agreement.

In this article, we analyse different metrics for assessing and evaluating costs and benefits and argue that their application considerably influences the outcome of energy efficiency policies. The design of energy efficiency policies is frequently guided by economic principles to set the ambition level of the

1. https://ec.europa.eu/info/news/energy-efficiency-first-accelerating-towards-2030-objective-2019-sep-25_en

policy instruments, where the methodological approach influences the outcome. Based on an analysis of the use of economic principles in existing energy efficiency and climate policies, this article investigates how economic principles can be employed in an adequate way and as a driver rather than a barrier to energy efficiency.

We focus on two areas where economic principles have a key impact on the uptake of energy efficiency policy: The design of the ambition level of minimum energy efficiency standards and the use of economic principles in public procurement. For both areas, we derive recommendation on how to make use of economic principles as a driver rather than a barrier for energy efficiency.

Methodological approach and definitions

Our work focuses on the use of economic principles in the context of energy efficiency policy-making. An 'economic principle' is an explicit or implicit monetary requirement, acting as a restriction to environmental policy choices. We analyse how different approaches for applying cost-effectiveness requirements affect the outcome of energy efficiency policy measures. To this end, we distinguish between different types of economic costs and benefits that affect different economic agents.

- *Costs and benefits at regulated entities level (private decision-makers):* refers to households and private companies who determine energy services in their decisions on consumption and production, face costs (and benefits) related to the implementation of a regulation, i.e. physical compliance costs as well as administrative and transaction costs but also costs or savings in terms of operation and maintenance.
- *Cost and benefits at regulator level:* refers to policy making institutions that face costs and potentially savings related to the implementation and monitoring of a regulation.
- *Costs and benefits at whole economy level:* refers to the level at which direct and indirect socio-economic costs and benefits have to be taken in to account, such as welfare, distributional and employment effects but also avoided negative environmental effects or climate damages, as a result of the regulation.

Given these various costs and benefits, climate policy faces the challenge to determine the (optimal) level of mitigation. Economic theory sets the optimal level of mitigation where marginal abatement costs equal marginal damage costs, i.e. where the mitigation cost of an additional emission unit balances with the damage costs of this additional unit of emission (Tietenberg and Lewis, 2018). However, in reality, these costs are often not known and climate policy aims to limit global warming to 1.5 or the most 2 degrees and national governments pledge emission reductions contributions towards this goal, independent of cost-considerations.

Mitigation costs from a regulated entity's perspective usually include compliance costs and changes in operation and maintenance costs and decision making is based on short payback periods or high profitability. Environmental costs are often disregarded, if appropriate pricing instruments are missing or insufficient and the polluter pays principles is not fully implemented by environmental policy. Contrary, taking a whole economy perspective welfare is highest when environmental costs are included and polluter-pays principles are applied.

Our work assesses how the application of different cost categories influences the ambition level of energy efficiency measures by comparing the use of alternative cost-effectiveness metrics in different policy instruments. For the analysis of the use of cost-effectiveness metrics in setting the ambition of minimum energy efficiency standards, we identify a set of barriers that may hamper the introduction of adequate and ambitious requirements.

Subsequently, we discuss the role of these barriers in setting minimum requirements for three case-studies: The cost-optimality requirements in the EU Energy Performance of Buildings Directive (EPBD), The German Building Energy Act (GEG) and the minimum energy requirements set in the framework of the EU Ecodesign Directive. We conclude with recommendations.

Economic principles as a barrier: private cost-effectiveness in minimum energy performance standards

The use of economic principles can act as an important barrier when designing regulations that define minimum energy efficiency standards such as building codes and minimum energy performance standards (MEPS). The extent to which economic principles act as a barrier depends on whether and in which way cost-effectiveness requirements are used to guide the specification of the ambition levels.

IDENTIFICATION OF BARRIERS

Barrier 1: Inconsistency between energy and climate targets and cost-effectiveness requirements

In view of the ambitious energy and climate policy targets at international, EU and national levels, the rationale for setting minimum energy efficiency standards needs to align with the energy demand reductions that are required to meet the targets. Energy efficiency minimum requirements should thus be set at a level that allows a cost-effective transition of the energy system towards the nationally and internationally agreed energy and climate targets. In practice, however, the approach for defining the ambition level of minimum requirements often involves an assessment of the life-cycle costs of the different technical options from a private investor (not a system) perspective and orients the standard-setting towards a minimization of life-cycle costs.

Barrier 2: Inadequate consideration of environmental costs

If private cost-effectiveness requirements are applied, the extent to which using cost-effectiveness as a key criterion to set minimum requirements leads to an inconsistency with national and/or international climate targets depends on the way in which external environmental costs are included in the calculation. This can happen in two ways, or a combination of both:

1. External environmental costs can be considered by estimating the mitigation or damage costs and including them as a separate factor in the calculation.

2. In an ideal world, where all external costs are internalized, environmental damage costs would automatically be included in the calculation, as the polluter-pays principles applies.

Barrier 3: Interpretation of cost-effectiveness and reference

The use of cost-effectiveness requirements can be introduced in several ways, with differing impacts on the ambition of the standard: A key distinction is the question if private cost-effectiveness acts as an upper or as a lower limit for the ambition of the standard. In the former, minimum standards can only be introduced at an ambition level that is consistent with private cost-effectiveness. In the latter, private cost-effectiveness provides a lower limit for the introduction of minimum requirements.

Barrier 4: Inadequate consideration of subsidies in private cost calculations

If private cost-effectiveness requirements are applied when setting energy efficiency minimum requirements, the cost calculations overestimate the real costs that are borne by the investor, if available public funding sources are not included in the calculation. For energy efficiency measures that are not cost-effective from a private investor perspective without funding, the minimum requirements are therefore set at a level that is lower than the cost-effective level including funding.

ANALYSIS OF BARRIERS: COST OPTIMALITY REQUIREMENTS IN THE EPBD

With the buildings sector being responsible for approximately 40 % of EU energy consumption and 36 % of the greenhouse gas emissions[2], buildings are crucial for achieving the EU´s energy and environmental goals. The Energy Performance of Buildings Directive (EPBD), along with the Energy Efficiency Directive (EED) provide the key legislative elements to reduce energy consumption in the buildings sector and to contribute to the EU energy efficiency targets.

Within the framework of Art. 4 (1) of the EU Buildings Directive (EU) 2018/844 (EPBD), the EPBD introduces the concept of cost optimality to guide the EU Member States when setting national minimum standards for buildings. The framework for calculating cost optimality is set out in the Delegated Regulation (EU) No. 244/2012, distinguishing between two calculation methods: 1) Macroeconomic perspective and 2) Financial perspective. Member states are free to choose which perspective is applied for setting the minimum standards.

The ambition levels of the minimum requirements should not be more than 15 % below the ambition of the calculated cost-optimal levels, otherwise the Member States have to justify the deviations. It is important to note that, in principle, the requirements for considering cost optimality refer to the minimum ambition of the efficiency standards, where Member States may choose to set more ambitious standards.

The cost optimality requirements set in the EPBD are analysed with respect to the barriers outlined in the previous section in Table 1[3].

ANALYSIS OF BARRIERS: THE GERMAN BUILDING ENERGY ACT (GEG)

The Building Energy Act (GEG) was introduced in the year 2020 and sets the requirements for the energy performance of buildings in Germany. It merges the previous building legislations set out in the Energy Conservation Act (EnEG), the Energy Conservation Ordinance (EnEV) and the Renewable Energy Heating Act (EEWärmeG). One of the key aims of the Building Energy Act is to support the achievement of the Federal Government's energy and climate policy targets (GEG § 1 (2)). Key targets for the buildings sector include the sectoral reduction target for greenhouse gas emissions set in the Federal Climate Change Act (Bundes-Klimaschutzgesetz).

The economic cost-effectiveness principle is enshrined in § 5 of the Building Energy Act, stating that for the requirements set within the legislation it needs to be ensured that the (private) costs related to implementing the measures to meet the requirements are recovered through the corresponding energy cost savings during the expected useful life of the building components. This means that, unlike the cost-optimality framework in the EPBD, the aim of the cost-effectiveness requirements is to set an upper limit to the ambition of the standards.

The assessment of the German Building Energy Act with respect to the barrier is provided in Table 2[4, 5].

ANALYSIS OF BARRIERS: LEAST-LIFE-CYCLE COST APPROACH IN THE MEERP

The EU Ecodesign Directive (Directive 2009/125/EC) establishes the framework for setting minimum requirements for energy-related products. The Ecodesign Directive sets the framework for establishing product group-specific implementing measures that specify requirements for energy efficiency as well as other environmental impacts. The minimum standards set out in the implementing measures are based on preparatory studies, which are conducted following a defined methodology (Methodology for ecodesign of energy-related products, MEErP). The methodology includes a comprehensive assessment of the relevant environmental aspects as well as the impact on the economy and on consumers.

The calculation of life cycle costs is an element of the MEErP methodology (Task 5) and includes the calculation of consumer life cycle costs and societal life cycle costs including external environmental damage (societal cost) of air emissions.

The assessment of the MEErP methodology with respect to the barriers is presented in Table 3.

Economic principles as a driver: external environmental costs in public procurement

German procurement law – which regulates government spending – strictly follows the economic principle of efficiency[6]. Needs must be met at least cost. In procurement law, the principle of

2. https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

3. "Here, the 'cost of greenhouse gas emissions' is used to reflect the monetary value of the environmental damage caused by CO_2 emissions due to energy consumption in buildings": Delegated Regulation (EU) No. 244/2012 Art. 2 (19).

4. "With the introduction of a carbon pricing scheme covering the emissions from the buildings sector in Germany in 2021, environmental costs will partly be included in the calculation for the next revision of the building code": https://www.bundesregierung.de/breg-en/issues/climate-action/preis-fuer-co2-1795850.

5. "At the same time, the newly introduced subsidy scheme for energy efficient buildings provides a comprehensive framework providing subsidies of up to 50 % for a wide range of energy efficiency and renewable energy measures in residential and non-residential buildings": Bundesförderung für effiziente Gebäude (BEG). https://www.bmwi.de/Redaktion/DE/Artikel/Energie/bundesfoerderung-fuer-effiziente-gebaeude-beg.html

6. § 6 Abs. 1 Haushaltsgrundsätzegesetz, § 7 Abs. 1 Bundeshaushaltsordnung.

Table 1. Analysis of barriers for cost-optimality requirements in the EPBD.

Barrier 1: Inconsistency between energy and climate targets and cost-effectiveness requirements	The cost-optimality approach used in the EPBD is insufficient to ensure a transformation of the building stock towards energy efficiency levels necessary to meet the energy and climate targets. As the member states are free to set more ambitious standards beyond the cost-optimality level (see text on barrier 3), the approach is in principle not fundamentally contrary to the key energy and climate targets of the EU, however, it is likewise not suitable to ensure the transition towards the required energy efficiency levels as the levels of deep-renovation required for the decarbonization of the EU building stock do not always match the cost-optimal level.
Barrier 2: Inadequate consideration of socio-economic costs	Environmental costs are included in the macroeconomic perspective and play no role in the financial perspective. Here, the "cost of greenhouse gas emissions" is used to reflect the monetary value of the environmental damage caused by CO_2 emissions due to energy consumption in buildings. The basis for the calculation of the costs of greenhouse gas emissions are the Commission's projections on the price development for CO_2 allowances in the EU ETS. As Member States are free to choose between the macroeconomic and the financial perspective when defining the ambition level, the inclusion of socio-economic costs is optional and not mandatory. Furthermore, the price development of the allowances in the EU ETS does not necessarily reflect climate damage costs nor the stringency of climate targets.
Barrier 3: Interpretation of cost-effectiveness and reference	In the EPBD, the cost-optimal level is calculated to ensure that the building standards to be introduced in the member states do not fall below the ambition of the cost-effective efficiency level by more than 15 %, i.e. the calculations serve as a lower limit for the ambition level of the standards. Therefore, the approach does not act as a fundamental barrier for setting higher standards but in practice fosters the uptake of cost-optimal levels, which do typically not correspond to ambition levels consistent with the EU energy and climate targets.
Barrier 4: Inadequate consideration of subsidies in private cost calculations	According to Delegated Regulation (EU) No. 244/2012 Annex 1, paragraph 4.3., "ideally also the subsidies available for different variants/packages/measures are to be included into the calculation, but Member States can choose to leave subsidies aside, ensuring however that in that case both subsidies and support schemes for technologies, but also possibly existing subsidies for energy prices are taken out". The inclusion of subsidies is thus *encouraged but not mandatory*. In practice, for the example of Germany, the (extensive) subsidy programs and exemptions are not included in the calculation.

Table 2. German Building Energy Act (GEG).

Barrier 1: Inconsistency between energy and climate targets and cost-effectiveness requirements	The German Building Energy Act (GEG) presents an inconsistency between the cost-effectiveness requirements and the energy and climate targets. The inconsistency is directly reflected in the objective of the law stated in § 1, where the aim of the law in supporting the achievement of the climate and energy targets is presented under the condition of the principle of economic cost-effectiveness. With the concept of economic effectiveness being interpreted in a narrow private-cost perspective, the ambition level of the minimum requirements is solely defined by an economic principle unrelated to the energy and climate targets.
Barrier 2: Inadequate consideration of socio-economic costs	The cost-benefit analysis providing the basis for setting the ambition level in the German building code considers the investment and maintenance costs as well as the respective energy cost savings. Focusing on private cost-effectiveness, external environmental costs are not included in the calculations. Environmental costs can thus only be included indirectly in the calculation if they are reflected in the energy costs, e.g. via carbon pricing. With the introduction of a carbon pricing scheme covering the emissions from the buildings sector in Germany in 2021, environmental costs will partly be included in the calculation for the next revision of the building code. However, the environmental costs are not fully included for the following reasons: 1) the CO_2 prices adopted do not adequately reflect environmental costs and 2) the next revision of buildings codes is not due until 2023, which means that CO_2 pricing will not be included in the calculation for two more years.
Barrier 3: Interpretation of cost-effectiveness and reference	As the German Building Energy Act has been introduced only recently by merging the previous building legislations, the minimum requirements have not been revised since its introduction. Within the previous legislations under the Energy Conservation Ordinance (EnEV), economic benefits of new requirements were evaluated in comparison with the previously applicable requirements. However, focusing on an incremental improvement with respect to the previous ambition level does not exploit the full potential of setting the standards under the condition of investment costs being recovered over the use-time of the measure, as stated in the law. The discrepancy is increasing as CO_2-prices increase, and more ambitious standards are economically viable.
Barrier 4: Inadequate consideration of subsidies in private cost calculations	The available subsidies are not included in the cost-benefit calculation for defining the ambition level of the minimum requirements. At the same time, the newly introduced subsidy scheme for energy efficient buildings provides a comprehensive framework providing subsidies of up to 50 % for a wide range of energy efficiency and renewable energy measures in residential and non-residential buildings. Including subsidies in the cost-benefit analysis would therefore substantially increase the ambition level of the standards.

Table 3. Analysis of barriers for the least-life-cycle cost approach in the MEErP.

Barrier 1: Inconsistency between energy and climate targets and cost-effectiveness requirements	Life-cycle costs are a key criterion when evaluating different ambition levels for setting the minimum requirements, whereas the level of energy efficiency improvements needed to meet the EU energy and climate targets is not included in the assessment.
Barrier 2: Inadequate consideration of socio-economic costs	Within the calculation methodology, the environmental costs are considered in the framework of "societal life cycle costs". The concept includes the following four indicators: global warming potential (GWP), acidification potential (AP), volatile organic compounds (VOC) and particulate matter (PM). Although societal life cycle costs must be calculated, they are usually only used as a comparison to see if the life cycle costs without including external environmental costs are robust and do not deviate too far from the societal life cycle costs (LCC including external costs). The impact of CO_2 emissions is taken into account based on the prices of the emissions allowances in the EU ETS and are thus considerably below the level of economic damage costs.
Barrier 3: Interpretation of cost-effectiveness and reference	The least-life-cycle cost approach is used as the basis for assessing economic efficiency. The ambition of the minimum requirements would increase, when switching to the approach of equal-life-cycle costs, i.e. the point at which lifecycle costs are equal to those of the base case (see e.g. Toulouse, 2013).
Barrier 4: Inadequate consideration of subsidies in private cost calculations	Subsidies are not taken into account in the cost-benefit calculation. Since the ecodesign standards are set at an EU level, the inclusion of subsidy programs of individual member states would not be applicable for all Member States.

economic efficiency is reflected, among others, in the award criterion: Procuring entities must award any contract to the most economical bid (Dörr 2015). This can be done using the lowest price principle in relation to qualitative assessment criteria (cost-utility assessment) (BMF 2019). In addition to the obligation of economic efficiency, however, procurement law also allows aspects of quality and innovation as well as social and environmental aspects to be taken into account when defining needs and the awarding of contracts (§ 97 Abs. 3 GWB[7]).

With respect to environmental aspects, the polluter pays principle requires that costs to prevent, clean up, and compensate for pollution be attributed to the polluter (Tietenberg and Lewis 2018). Polluters are supposed to integrate these costs into their economic calculations.

Public procurement law in Germany today allows for the direct consideration of external environmental costs. However, there is no obligation to do so. In line with Directive 2014/24/EU, environmental costs can in principle be taken into account by considering life cycle costs in the award decision. The German public procurement law allows the consideration of "costs arising from the external effects of environmental pollution associated with the performance during its life cycle, provided that their monetary value can be determined and verified in accordance with paragraph 3; such costs may include costs of the emission of greenhouse gases and other pollutants as well as other costs for the mitigation of climate change" (§59 (2) No. 5 VGV).

To date, however, environmental costs are still insufficiently considered in the context of economic efficiency calculations not only by private investors, but also by public actors (e.g. procurement agencies). Reasons for this include a) challenges in terms of identifying environmental effects and monetizing their costs and b) lack of obligations to include such environmental costs. Both of those, however, can be overcome.

1. Challenges of monetizing external environmental effects: To consider external costs, information is needed on environmental parameters, such as levels of GHG emissions, air pollutants, or noise. These can be required from tenderers or be derived using simple calculation tools. The scope and boundaries for such calculations are not defined. Guidance is provided, for example, in Porsch et al. (2015), but is not mandatory to use. Applicable cost rates (e.g. damage costs per ton of CO_2e) are provided by the Federal Environment Agency for GHG emissions, air pollutants, environmental costs of electricity and heat generation, and passenger and freight transport (including land use, fragmentation, noise) via Methodological Convention 3.0 (Umweltbundesamt 2019). For consideration of life cycle costs in public procurement, guidance, templates, excel tools and best practice examples are provided by the German Environmental Agency (www.beschaffung-info.de) and the competence center innovative procurement (https://www.koinno-bmwi.de/informationen/toolbox/detail/lebenszyklus-tool-picker-1/). Using these guidelines and tools, however, is not mandatory.
2. Obligation to include external environmental costs: The German Climate Law came into force in 2019 and set legally binding emissions pathways on a sectoral level. For federal public expenditure, the Climate Law requires an extended cost assessment (§13, 3): "When applying economic efficiency criteria, comparative considerations shall be based on the costs and savings over the respective entire lifetime of the investment or procurement. The expected climate costs are to be taken into account in an appropriate manner." Investments will thus no longer be selected based on the shortest payback period but based on highest present value over the lifetime of the investment. Furthermore, present values need to include the costs and benefits of climate change, taking into account the economic benefits of avoided damage costs (Scharlau et al. 2020). Currently, however, the requirement only applies to public expenditure on the federal level. It does not include state or local level public expenditure or procurement.

7. Gesetz gegen Wettbewerbsbeschränkungen, German law against restraints of competition.

Conclusions and policy recommendations

Acknowledging principal environmental policy decisions and considering the importance of economic considerations in policy decisions, our analysis shows that economic principles can act both as a barrier and as a driver for the uptake of energy efficiency measures. In order to increasingly apply economic principles in policy formulation as a driver rather than a barrier for the deployment of energy efficiency solutions, conclusions and recommendations are derived.

In the context of setting the ambition levels for minimum energy efficiency standards (in the EU Energy Performance of Buildings Directive (EPBD), The German Building Energy Act (GEG) and the EU Ecodesign Directive), key elements that prevent economic principles from acting as a barrier include the following:

- Cost-effectiveness and cost-optimality should not be used as a key criterion for setting minimum requirements in case this leads to requirements that are not consistent with the primary and ambitious energy and climate policy targets in place.
- Whenever cost-effectiveness or cost-optimality is used as a criterion, it is essential that environmental costs are included into the calculation, either by introducing them as a factor in the calculation or by internalizing environmental costs, e.g. by carbon pricing (or a combination of both).
- If cost-effectiveness or cost-optimality criteria are applied, they should be oriented towards an interpretation that supports high ambition levels, e.g. using equal-life-cycle costs instead of least-life-cycle costs.
- If subsidies are in place in order to support the transition towards decarbonized energy systems, these should be taken into account when setting minimum energy efficiency standards. Likewise, the introduction of ambitious standards (oriented by the energy and climate targets) should be combined with the introduction of subsidies in order to avoid negative social implications.

In the context of using economic principles in public procurement, the following conclusions and recommendations follow from our analysis:

- It is not sufficient for public procurement law to allow for consideration of environmental costs.
- Legislators and administrations have to provide clear indications whether and how environmental targets and aspects are to be taken into account in investment and procurement decisions (e.g. by including environmental costs in accordance with the polluter-pays principle).
- It is important to provide guidelines and tools so that calculations can be performed in a harmonized and consistent manner. The existing set of guidelines in Germany can be used but will need to be adapted to include step-by-step guidance on how to include environmental costs. Environmental damage cost rates are provided within the Methodological Convention Tool by the Federal Environmental Agency (Umweltbundesamt 2019).
- Training programs will need to be offered for public procurement agencies as well as decision-makers and relevant employees in the administration to build up capacity with environmental costs assessment. In 2020, Germany set up a Sustainability Office within its Federal Academy of Public Administration to offer needs-based training, documents and good examples, as well as methodological knowledge for executives and employees of federal authorities. This also includes a new lecture series "sustainable public authorities", which takes up the topic of environmental costs.

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