EVALUATING POLICY INSTRUMENTS FOR REDUCING GREENHOUSE GAS EMISSIONS FROM BUILDINGS – DEVELOPED AND DEVELOPING COUNTRIES

Sonja KOEPPEL[1]
Diana URGE-VORSATZ Ph.D[2]
Veronika CZAKO[3]

1 Central European University, Budapest, Sonja.koeppel@mespom.eu
2 Central European University Budapest, vorsatzd@ceu.hu
3 Central European University Budapest, czakov@ceu.hu

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Summary

Approximately one third of the GHG emissions from buildings can be saved at a net benefit to society (IPCC 2007). However, this substantial potential is not realized due to numerous barriers. Various policy instruments such as building codes, subsidies and information campaigns are applied to overcome these barriers. Since they differ considerably in their effects and costs, 20 commonly used policy instruments were assessed in this study according to their emission reduction effectiveness, cost-effectiveness and success factors, based on over 80 case studies and evaluations of their implementation from over 50 countries.

Many policy instruments achieved high savings at low or even negative costs for society. The highest GHG emission reductions were achieved in the sample by appliance standards, building codes, DSM programs, tax exemptions and labelling. Appliance standards, energy efficiency obligations, DSM programs, public benefit charges and labelling were found as the most cost-effective instruments. Regulatory and control instruments were revealed in the sample as the most effective and cost-effective category of instruments if enforced well. Economic and fiscal instruments and fiscal incentives lead to diverging results. The effectiveness of voluntary and information instruments was usually lower, but depended on the context as well as on accompanying policy measures.

However, as no single policy instrument can overcome the numerous barriers alone, appropriate combinations of policy instruments are most effective. Developing countries require an integrated policy framework including regulations, incentives, capacity-building as well as measures to increase awareness and the trust of stakeholders such as demonstration programs. Choosing the most appropriate policy instruments is very difficult and requires a detailed analysis of the barriers present, the local environment in terms of institutions and existing energy market, the available resources and goal of the action.

1. Introduction

In 2002, 33% of all energy-related CO2 emissions worldwide were due to buildings (Price et al. 2006). However, buildings offer important energy saving potentials through technical, educational and other means: approximately 30% of this energy consumption can be saved economically or at a net benefit to society even at zero carbon price (IPCC 2007, Urge-Vorsatz and Novikova 2008). Considering the baseline projections, this estimate represents a reduction of approximately 45 EJ for buildings in 2020 (IPCC 2007).

Although this large cost-effective potential has been known for decades, many of these energy efficiency possibilities have not been realized. Actually, certain characteristics of markets, technologies, and end-users make difficult rational, energy-saving choices in building design, construction, and operation, as well as in the purchase and use of appliances. These market barriers and failures can be divided into six categories (Carbon Trust 2005): financial hurdles, hidden costs and benefits, market failures, behavioural constraints, information barriers and institutional/ structural barriers.

In order to overcome or limit the impact of these barriers, a wide variety of policy instruments and programs are used by policy-makers worldwide. However, the effectiveness and cost-effectiveness of these various policy instruments is poorly understood and rarely compared on an international level. Thus, this study developed at the Central European University originally for the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) (2007) and deepened for the UNEP Sustainable Buildings and Construction Initiative (UNEP-SBCI) (Urge-Vorsatz and Koeppel 2007) reviews comprehensively the policy mitigation options for the buildings sector.

This paper aims at assessing and comparing the various policy instruments available for CO2 mitigation in buildings through improved energy-efficiency, according to evaluation criteria such as emission reduction effectiveness and cost-efficiency. A special focus is placed on developing countries. The paper presents information on 20 policy instruments from around the world and provides an overview of the effects, strengths and weaknesses of these policy instruments. It also briefly presents the ongoing follow-up project which aims at elaborating a tool for supporting policy-makers in choosing the most appropriate policy instruments.

2. Methodology

First, the most important policy instruments to promote energy efficiency in the buildings sector were identified in the general literature on policy tools for energy efficiency (Crossley et al. 1999, Crossley et al. 2000, Verbruggen 2003, Grubb 1991, EFA 2002, Vine et al. 2003, and Wuppertal Institute 2002), classified into the following four categories and included in the first column of the table: regulatory and control mechanisms, economic/ market-based instruments, fiscal instruments and incentives and support, information and voluntary action.

Subsequently, we searched for as many ex-post evaluations of these instruments from as many countries as possible. Only a few ex-ante assessments were included in the analysis. In total, over 80 studies, review articles and other relevant publications from over 50 countries, covering each inhabited continent except for Africa were identified. All findings were collected in a database and a table showing the evaluation of the instruments, based on selected best practice examples – see Table 1. Due to space limitations this paper only shows the short version of the table, the long one is included in the report (Urge-Vorsatz and Koeppel 2007). The second column assesses the effectiveness in reducing emissions of each policy instrument in the buildings sector in a qualitative way either in absolute or in relative terms (i.e. compared to a logical baseline, such as the total national emissions in the particular location). The collection and analysis of all cases included in our database was used to assign grades such as “High”, “Medium” and “Low” to policy instruments for their effectiveness in reducing energy use and GHG emissions. Ideally, such grades should be assigned in a systematic objective way based on numerical limits of emission reductions, but this method was not possible due to lack of baselines in some cases. In addition, due to differences in the temporal and spatial scale the numerical values of emission reduction, even in relative terms, as well as the total emission coverage of the case studies and of the policy instruments could not easily be compared, even in relative terms. Thus, this criterion was evaluated in a qualitative way, based on emission reduction figures, but taking into account the overall applicability and potential of the instrument. According to the Delphi technique, an internationally recognized method for obtaining comments from experts in at least two rounds, the results of the comparative evaluation table were circulated several times for review to numerous experts recognized as leading scholars or practitioners in this field.

Column 3 of the table evaluates the cost-effectiveness of each policy instrument with qualitative verbal grades similarly to Column 2. In our study, the cost-effectiveness is viewed from a societal perspective, taking into account, when possible all the direct costs and benefits from the policy-making perspective, but excluding the indirect or external costs. However, many policy evaluations assessed the cost-effectiveness of energy savings only according to the cost required to conserve energy (capital costs and investment costs). These figures are often used to compare the costs of demand and supply side investments for “producing” a unit of energy, and therefore are not corrected for the benefits, i.e. saved energy costs. However, assessing societal cost-effectiveness requires including these financial benefits (Koomey and Krause 1989; Atkinson et al.1991). For this reason, in our calculations we subtracted the country-specific energy price from the cost per unit of saved energy before multiplying with the emission factor.

The final columns present success factors or success conditions, co-benefits and other remarks.

3. Results

3.1 Comparative assessment of policy instruments

As can be seen on table 1 and on figure 1, our study does not characterize any single policy instrument as the most effective or most cost-effective one, but it shows that many of the policy instruments can be effective and cost-effective when certain criteria are respected during their design, implementation and enforcement (success conditions). Appliance standards, building codes, voluntary labelling and tax exemptions achieved the highest CO2 emission reductions in our sample. Costs per tonne of carbon dioxide saved varied widely ranging from a net benefit of 216USD, i.e. a negative cost, to a positive cost of 109USD/ tCO2 saved. Appliance standards, utility DSM programmes, public benefit charges, energy efficiency obligations and mandatory labelling were identified as the most cost-effective policy tools in the sample, achieving significant GHG emission reductions at negative costs. Appliance standards were very cost-effective with negative costs of 65-190USD/tCO2. Appliance standards, energy efficiency obligations and tax exemptions were identified as most effective and cost-effective policy tools in our sample (see highlighted rows of table 1).

When comparing the four broad categories of instruments (see table 1), regulatory and control instruments have been found to be among the most effective policy instruments with particularly high negative costs (i.e. very low costs) of mitigation, although the rebound effect can limit the overall effectiveness and correct enforcement is necessary. Within this category, appliance standards, energy efficiency obligations and building codes were especially effective. Appliance standards and energy efficiency obligations were also very cost-effective.

Economic instruments are still difficult to evaluate since some of them such as Kyoto Flexible Mechanisms and White Certificate are still relatively new; but their effectiveness and cost-effectiveness seems to depend significantly on the instrument and the country. The effectiveness and cost-effectiveness of project-based mechanisms, such as the Kyoto flexible mechanisms (JI and CDM) are currently limited, probably due to high transaction costs involved with small projects in the building sector.

Fiscal instruments and incentives also lead to very diverging results: subsidies are not cost-effective in contrast to the reviewed cases in tax exemptions (income taxation). However, they are useful to kick-start the market for new energy efficient products especially in developing countries where funding is often lacking.

Table 1: Table summarizing the effectiveness and cost-effectiveness of policy instruments

Policy instrument	Emission Reduction Effectiveness	Cost-effective-ness	Special conditions for success, major strengths and limitations, co-benefits
Regulatory instruments			
Appliance standards	High	High	Factors for success: periodical update of standards, independent control, information, communication, education
Building codes	High	Medium	No incentive to improve beyond target. Only effective if enforced
Public leadership programs, incl. procurement regulations	Medium/High	High/Me-ium	Can be effectively used to demonstrate new technologies and practices. Mandatory programs have higher potential than voluntary ones. Factors for success: ambitious energy efficiency labeling and testing.
Energy efficiency obligations and quotas	High	High	Continuous improvements necessary: new energy efficiency measures, short term incentives to transform markets
Mandatory audit requirement	High, but variable	Medium	Most effective if combined with other measures such as financial incentives
Demand-side management programs (DSM)	High	High	Tend to be more cost-effective for the commercial sector than for residences.
Economic instruments			
Energy performance contrac-ting (EPC)/ESCO support	High	Medium/ High	Strength: no need for public spending or market inter-vention, co-benefit of improved competitiveness.
Cooperative procurement	High	Medium/ High	Combination with standards and labeling, choice of products with technical and market potential
Energy efficiency certificate schemes/white certificates	Medium/ High	High/Me-dium	No long-term experience. Transaction costs can be high. Institutional structures needed. Profound interactions with existing policies. Benefits for employment.
Kyoto Protocol flexible mechanisms (CDM and JI)	Low	Low	So far limited number of CDM &JI projects in buildings
Fiscal incentives			
Taxation (on CO_2 or fuels)	Low/ Medium	Low	Effect depends on price elasticity. Revenues can be earmarked for further efficiency. More effective when combined with other tools.
Tax exemptions/ reductions	High	High	If properly structured, stimulate introduction of highly efficient equipment and new buildings.
Public benefit charges	Medium	High	Success factors: independent administration of funds, regular monitoring &feedback, simple &clear design.
Capital subsidies, grants, subsidized loans	High	Low	Positive for low-income households, risk of free-riders, may induce pioneering investments.
Support, information and voluntary action			
Labelling and certification programs	Medium/High	High/ Medium	Mandatory programs more effective than voluntary ones. Effectiveness can be boosted by combination with other instrument and regular updates.
Voluntary and negotiated agreements	Medium / High	Medium	Can be effective when regulations are difficult to enforce, combined with financial incentives, and threat of regulation
Public leadership programs	Medium/ High	High/ Medium	Important as demonstration programs. Mandatory programs are usually more effective than voluntary ones.
Education and information programs	Low / Medium	Medium/ High	More applicable in residential sector than commercial. Success condition: best applied in combination with other measures.
Detailed billing and disclosure programs	Medium	Medium	Success conditions: combination with other measures and periodic evaluation.

Support, information and voluntary action instruments vary significantly in their effectiveness. However, awareness raising instruments are nevertheless important to complement other instruments by limiting the rebound effect. Voluntary instruments are usually less effective than mandatory ones. Public leadership programs are often effective and important, not only for the public sector.

These results can be explained by the especially numerous barriers to energy efficiency in the buildings sector which are probably higher than in any other sector (Urge-Vorsatz et al. 2007). Among them, high transaction costs for information search for example is a major barrier. Regulatory and control instruments eliminate these transaction costs by simply mandating the same measures for all actors which seems to be one of the reasons for their high effectiveness and cost-effectiveness.

These results are confirmed by other studies such as the Mure database (MURE 2007) which contains numerous policy instruments from various European countries (but usually not with quantitative values). According to this database, legislative – normative instruments for buildings, such as building codes, are most often ranked as effective compared to other instruments.

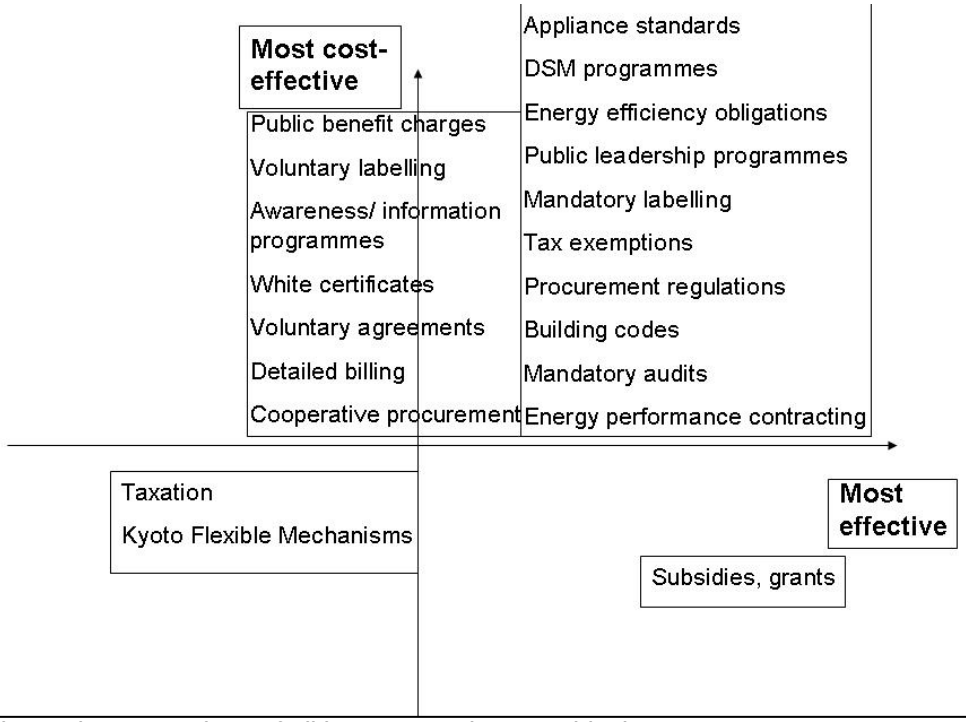

Figure 1 shows the comparison of all instruments in a graphical way.

Note: The positions of the instruments towards each other don't indicate differences in effectiveness- only the position of the instruments in one of the corners is important.

3.2 Combination of policy instruments

However, no single instrument can capture the entire or even a large part of the economic and low-cost mitigation potential in the sector alone. Due to the especially numerous and diverse barriers in the buildings sector, and to the variety of local conditions and cultures, a portfolio of instruments is necessary to overcome several barriers, to take advantage of synergistic effects and thus to maximize the impact of policies. Informative and financial as well as, to a lesser extent, market-based instruments are usually implemented in combination with other instruments which makes assessments of single policy instruments as we presented very difficult. The following policy instruments can for example be successfully combined:

- Standards and financial incentives
- Regulatory and information programs
- Public leadership programs and energy performance contracting
- Financial incentives or procurement initiatives and labeling

Combinations of policy instruments are especially important to achieve a market transformation which is however much less frequently aimed at and achieved for buildings than for appliances for example. In order to stimulate the market it is recommended to aim at and implement measures for achieving 3 different levels of building performance: a minimum performance level, mandatory for all buildings which can be reached through minimum standards; a best practice level which is often used as a basis for defining subsidies, tax exemptions, loans etc.; and finally a state-of-the art level which is often set a long-term target to provide incentives to industry to further improve (Klinckenberg et al. 2007). Table 2 shows possible combinations of instruments.

Table 2: A selection of possible policy instrument packages and examples of commonly applied combinations

Measure	Regulatory instruments	Economic instruments	Financial /Fiscal Incentives	Information instruments	Voluntary Agreements
Regulatory instruments	Building codes and labelling	Standards and ESCO support	Building codes and subsidies	Standards and information programs	Voluntary agreements with a threat of regulation
Economic instruments	Energy efficiency obligation and ESCO support		Cooperative procurement and subsidies	EPC and information campaigns	Cooperative procurement and information campaigns
Financial/Fiscal Incentives	Appliance standards and subsidies	Cooperative procurement and tax exemptions	Taxes and subsidies	Energy audits and subsidies Labelling and tax exemptions	Technology procurement and subsidies
Information instruments	Appliance standards and voluntary labelling	EPC and information campaigns	Labelling and subsidies	Labelling, campaigns, and retailer training	Voluntary standards and labelling
Voluntary Agreements	Voluntary agreements with a threat of regulation		Industrial agreements and tax exemptions	Industrial agreements and energy audits	

Source: adapted from IEA 2005b

3.3 Measures recommended for developing countries

Table 3 shows which policy instruments can overcome which type of barriers. Developing countries are facing special barriers such as lack of awareness, lack of financing for energy efficiency measures, shortage of qualified personnel and insufficient energy service levels (Urge-Vorsatz and Koeppel 2007). Stakeholders sometimes don't trust energy efficient technologies because of negative experiences with these. In addition, frequently, subsidized non-cost reflective energy prices provide little incentive for energy efficiency improvements (IPCC 2007). In many developing countries, the priority of the government is to improve access to electricity without understanding that energy efficiency improvements are also important in order to start with efficient technology from the beginning and thus limit the expected increase in demand to manageable levels. Often, energy shortages provide a good incentive to improve energy efficiency which happened for example in Brazil and South Africa where compact fluorescent lamps are already widely used (Glynn pers. Comm., Gomes, per. Comm.).

Table 3: Barriers to energy efficiency and selected policy instruments as remedies

Barrier category	Instrument category	Policy instruments as Remedies
Economic barriers	Regulatory-normative/ regulatory-informative	Appliance standards, building codes, energy efficiency obligations, mandatory labelling, procurement regulations, DSM programs
	Economic instruments	EPC/ESCOs, cooperative procurement, energy efficiency certificates
	Fiscal instruments	Taxation, public benefit charges, tax exemptions, subsidies/rebates/grants
Hidden costs/benefits	Regulatory-normative	Appliance standards, building codes
	Economic instruments	EPC/ ESCOs
	Support action	Public leadership programs
Market failures	Regulatory-normative/ regulatory/informative	Appliance standards, building codes, energy efficiency obligations, mandatory labelling, procurement regulations, DSM programs
	Economic instruments	EPC/ESCOs, cooperative procurement, energy efficiency certificates, Kyoto Flexibility mechanisms
	Fiscal instruments	Taxation, public benefit charges, tax exemptions, subsidies/rebates/grants
	Support, information, voluntary action	Voluntary labelling, voluntary agreement, public leadership programs, awareness raising, detailed billing
Cultural/ behavioral barriers	Support, information, voluntary action	Voluntary labelling, voluntary agreement, public leadership programs, awareness raising, detailed billing
Information barriers	Support, information, voluntary action	Voluntary labelling, voluntary agreement, public leadership programs, awareness raising, detailed billing
	Regulatory/informative	mandatory labelling, procurement regulations, DSM programs, mandatory audits
Structural/ political	Support, information, voluntary action	Public leadership programs

Sources: Adapted from IPCC 2007, Carbon Trust 2005, Urge-Vorsatz *et al*. 2007b

Due to these special barriers developing countries require an integrated policy framework combining regulations, (financial or other) incentives, demonstration initiatives, capacity building and measures to

increase not only the awareness about energy efficiency, but also to increase the trust of stakeholders (Urge-Vorsatz and Koeppel 2007). Capacity-building, technical assistance and training are indispensable to educate experts in these countries. As this will take time, external experts are needed at least for a transitional period (Lihidheb, pers. Comm.). In addition, demonstration projects in the public and private sector such as those selected and supported by MED-ENEC are important to overcome barriers such as the lack of knowledge and trust (Wenzel pers. Comm. 2007). Similarly, information and awareness raising programs can inform the population about the possibilities and potential for energy saving measures. To support, design and implement such programs, institutions specifically dealing with energy efficiency are needed. For example, most developing countries which are considered as relatively successful in terms of energy efficiency improvements such as Tunisia, Thailand, South Africa, Brazil and Mexico have created either energy efficiency agencies or departments dedicated to energy efficiency at the relevant ministries or even special ministries to publicize the importance of energy efficiency among the population (Wenzel pers. Comm. 2007).

Regulatory measures are important also in developing countries. However, compliance is often low due to lack of information, lack of political will, lack of enforcement, high share of black or grey economies (esp. in the construction industry) and especially lack of funding (Mueller pers. Comm. 2007). Thus, enforcement activities and financial resources to support implementation and compliance are necessary, but not sufficient: special efforts and incentives are needed such as awards, subsidies, loans or tax exemptions to facilitate energy savings. In fact, the lack of available financing to cover the investments necessary for energy efficiency measures is often the major barrier in developing and transition countries. Banks are often not willing to finance energy efficiency measures due to lack of knowledge and trust. Some countries such as Thailand or Tunisia have therefore introduced funds for energy efficiency measures which are fed by taxes on cars for example (du Pont 2006). In Brazil, utilities are obliged to spend 1% of their annual revenues for DSM-measures ESCO-financing is another possibility which is already widely used in some developing countries such as China, but much less in others such as India. However, energy performance contracting requires certain institutional structures for being successful which are not present in all developing countries (Urge-Vorsatz and Koeppel 2007). A number of less developed countries completely lack funds and therefore, international funding is thus one of the only options in these cases for reducing energy efficiency.

Finally, there is a need for regular monitoring and evaluation of energy efficiency programs and subsequent revision of programs- in developing as well as developed countries.

3.4 Development of a tool for helping policy-makers to choose most appropriate instruments

Current research (April 2008) is focusing on developing a software tool for supporting policy-makers in choosing the most appropriate combination of policy instruments under particular circumstances and policy targets. Since this is very difficult the tool includes a detailed analysis of the present barriers, the local environment in terms of institutions and existing energy market, available power and capacities and the available resources. The policy goal as well as the target area and target group of the action are also important factors determining the choice of the most effective policy tool package.

Finally, no policy instrument will be effective if its most important success conditions are not fulfilled. Success conditions depend on the instrument and may include regular update, appropriate enforcement, and combination with other policy instruments etc. Despite of the development of such a generic tool it has to be recognized that all policy instruments always must be adapted to the local context in their detailed design.

4. Conclusion and recommendations

This study has probably for the first time comparatively assessed 20 policy instruments for reducing GHG emissions from buildings in terms of their effectiveness and cost-effectiveness based on more than 80 quantitative evaluations of their implementation from over 50 countries. The highest GHG emission reductions in the sample were achieved by appliance standards, building codes, DSM programs, tax exemptions and labeling. Among the most cost-effective instruments were appliance standards, energy efficiency obligations, DSM programs, public benefit charges and labeling. In general, regulatory and control instruments such as appliance standards and building codes were revealed as most effective and usually also cost-effective category of policy instruments for the buildings sector if they are correctly enforced. Economic and market-based instruments as well as fiscal incentives vary widely in their effectiveness and cost-effectiveness: the latter are especially useful for stimulating the market for new products as well as for developing countries. Voluntary, support and information instruments are often essential in combination with others.

Developing countries require specific measures and support due to their lack in financing and human resources. However, each of these instruments can only overcome a limited number of barriers. Thus, in order to capture synergistic effects and address the broad range of barriers always present in every country, they have to be combined appropriately in policy packages. Since evaluations of policy packages are very rare, they could not be included in the paper. It is therefore recommended that a few typical, often used, well-matching combinations of instruments as well as some combined but actually confronting instruments should be evaluated in several countries. The paper summarized a new initiative to develop a tool that develops optimal policy package recommendations for particular circumstances. Finally, further comparative studies focusing also on developing countries as well as evaluations of (new) policy instruments for

mitigation options in buildings such as white certificates are needed in order to confirm our preliminary conclusions.

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