International comparison of energy labeling and standards for energy efficient and green buildings

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ABSTRACT
This paper discusses the approaches of the European Union, Germany and India to reduce GHG-emissions and mitigate climate change impacts from buildings through the establishment of energy performance standards and green building certifications. From the study of the roadmaps of the EU, Germany and India, it is quite clear that the EU and especially Germany are focussing on stringent mandatory energy standards towards 'nearly zero energy buildings'. On the other hand, India concentrates on green buildings with voluntary green building certification (GRIHA) to address the environmental challenges of the construction sector due to rapid urbanization in the country. The paper discusses the implication of mandatory vs. voluntary schemes and outlines the importance of combining the two approaches within an effective policy package. Finally, it discusses how the barriers of the implementation of energy standards and green buildings can be removed through social learning on effective policy packages.

KEY WORDS: Mandatory energy standards, voluntary green building certifications, effective policy packages, social learning

1. INTRODUCTION
About 40 percent of the global energy consumption is used in buildings. This corresponds to one third of the global greenhouse gas (GHG) emissions in both developed and developing countries (UNEP 2009). The IPCC's Fourth Assessment Report (2007) shows that the potential for GHG emissions reductions from buildings is high. The alarming trend of rising energy consumption can be tackled by increasing energy efficiency in buildings. Lock-in effects into built infrastructure with unnecessary high-energy consumption can be avoided for new buildings in developing countries by using cost-effective technologies. Up to 80% of energy can be saved by retrofitting the building stock up to 2050 compared to 2008 levels in developed countries like Germany (BMWi / BMU 2010). Thus, based on life-cycle-costs accounting (LCA) energy efficient buildings are cost-effective options to address energy and environmental challenges (Hong et al. 2007), e.g. through the application of measures such as passive design and natural lighting, energy efficient lighting, heating and cooling systems, and considering the use of renewable energy sources (Attmann 2010). Likewise, from the broader perspective of environmental protection and resource efficiency, green buildings – including the efficient use of energy - reduce the environmental footprint of buildings. According to the Office of the Federal Environmental Executive of United States of America (2003), green building is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal - the complete building life cycle. It requires an integrated design approach and when these efficiency measures are applied throughout the building life cycle (from design and construction to renovation and deconstruction), it conserves and restores natural resources by increasing energy, water and material efficiency improves water and air quality, reduces waste and its proper disposal reducing the adverse effect on the natural environment. The benefits of energy efficient and green buildings are not only bound to environment protection but also include an economic return by saved resource costs and in many cases through higher rent and sales value. It also provides a higher quality of the indoor environment.

The approaches to foster energy and resource efficiency in buildings differ among the countries around the world. While the European Union focuses on energy efficient buildings within a mandatory framework directive (Energy Performance of Buildings Directive / EPBD), India concentrates mainly on a voluntary certification scheme for green buildings.

This paper is to identify firstly (section 2) the main characteristics of both approaches. Then, the development and the roadmaps for energy efficient and green buildings respectively are depicted for both regions (section 3).

Section 4 discusses the implications of a mandatory vs. voluntary policy arrangement along the European energy efficiency and the Indian Green Building approach. Especially, the importance of combining the two approaches within a more effective policy package is outlined. Lastly, section 5 shows the perspective on how global information barriers on the implementation of energy standards and green buildings can be removed through social learning on (best) available technologies (BAT) and effective policy packages. A global web-based knowledge platform can contribute to close the information and implementation gap by providing customer and solution oriented comprehensive knowledge on BAT and to overcome the problem of scattered information on successful policy packages.

2. ENERGY STANDARDS AND GREEN BUILDING CERTIFICATIONS

To regulate the energy performance of building design and construction, building standards are required. They are considered as the most effective and cost-effective policies in reducing greenhouse gas emissions from existing as well as new buildings (UNEP 2009). 'Existing energy standards range from voluntary guidelines to mandatory requirements and may apply to one or more building types' (Janda 2009) (see Figure 1). These standards are more successful when mandatory (UNEP 2009). In most developed countries, the energy standards are mandatory, but their effective enforcement is key for the expected energy savings. International data on evaluated impacts of the standards are scarce and not always comparable. For example, in the US (taking a study until 2004 with baseline in 2000), the energy saved through buildings was up to 15-16% (Nadel 2004). In the EU the energy saved by new residential buildings was up to 60% compared to the average building stock built before the first oil shock (WEC 2008). However, in most of the developing countries, the energy standards are in a voluntary or proposing phase and their effectiveness may be comparatively low due to the difficulties with enforcement and corruption (Koeppel and Urge-Vorsatz 2007). But also in developed countries a high compliance with mandatory standards still remains a challenge.

Similarly, to evaluate and measure the performance of green buildings various international systems of building certifications are developed throughout the world though their coverage varies (only commercial or limited to new buildings and focus on building operations or on design). They are voluntary systems developed through non-governmental or governmental organisations. Some of them are for example: LEED (Leadership in Energy and Environmental Design) from US, BREEAM (Building Research Establishment's Environmental Assessment Method) from UK, DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen e.V. / German Sustainable Building Council) from Germany and GRIHA (Green Rating for Integrated Habitat Assessment) from India. Those certification systems address various environmental issues such as management, energy, transport, health and well-being, water, materials, land-use and ecology, pollution, and sustainable sites, and their value for 'weightings' differs.

Figure 1. Status of energy standards in 2009
Source: Janda 2009

Both energy standards and green building certifications are developed according to the countries' climate condition, occupant behaviour, construction practice and economic situation. Looking at the trend in different countries especially in developed countries, the adoption of voluntary or mandatory energy standards are 'based on the capacity of the existing apparatus' (Liu et al. 2010). One of the results of the latter study is that the countries with stronger infrastructure for building / structural / fire standards, mechanical standards, and electrical standards in place have adopted mandatory energy standards. While other countries without these backgrounds firstly adopt voluntary energy standards (starting with commercial buildings) and once political support for energy efficiency is strong, the energy standards are changed to mandatory standards (Liu et al. 2010). Likewise, the adoption of a voluntary scheme for green building certifications in different countries reflects a similar logic. They are initiated as market incentives having benefits including lower operating costs, increased asset values, higher rent and provide healthier and safer environment. Once the standards for various aspects of green buildings (such as energy, water, material, indoor environment etc) are economically convincing and politically supported it might be debated whether and how the certification of green buildings should be made mandatory.

3 ENERGY STANDARDS AND GREEN BUILDING CERTIFICATIONS IN EUROPE, GERMANY AND INDIA

Europe, Germany and India (developed and developing countries) are investigated as case studies in order to compare the development of energy standards and green building certifications and their preferences depending on the country's current development situation and priorities. The roadmap for Europe / Germany shows the priority on the development of stringent energy efficiency standards. The driving force behind this development is the building sector`s contribution to climate mitigation strategies and to targeted GHG-reduction policies. However, India enforces the introduction of a green building certification in an early phase of economic development even when the energy standards are not mandatory. The rationale behind this strategy is to foster the contribution of the built environment to the comprehensive agenda of sustainable development, climate mitigation being only one important goal.

3.1 Europe / Germany

The EU provides a mandatory framework directive with the obligation for its member states to set minimum energy performance standards (MEPS).[1] The first European building directive on energy efficiency went into force in 2002: The Energy Performance of Buildings Directive (EPBD 2002). During the following years the member countries started to implement energy efficiency standards as well as Energy Performance Certificates (EPC). Germany, for example, implemented its energy saving ordinance (Energieeinsparverordnung, EnEV) setting mandatory performance standards and establishing an EPC called 'Energieausweis'.

An important driver for the European buildings market is the fact that some countries in Northern Europe (e.g. Sweden, Denmark) and later Germany strengthened their performance standards stepwise. Hence, its European markets for new buildings were pushed towards a better energy performance during the last 20 years already. However, as there is a substantial lack of effective control mechanisms, compliance is one of the most important implementation issues.

In 2010 the EU published its recast EPBD. Key characteristics are that new public buildings have to be 'nearly zero energy buildings' (nZEB) by 2018 and all new residential and commercial buildings by 2020. However, the definition within the directive only states that such buildings must have a "very high energy performance and the nearly zero or very low amount of energy required should to a very significant level be covered by energy from renewable sources including renewable sources onsite or nearby" (Article 2, Dir. 2010/31/EU).

The European conceptual approach for nearly zero energy buildings can be described with figure 2 (see Laustsen 2008, ECEEE 2011). Though an exact definition has to be developed by the EU in the following years (on-site balance, grid-based balance of energy demand and supply), figure 2 shows that the energy demand for a nearly zero energy buildings will be targeted stepwise by the following years (2000, ZEH 50, ZEH-25, ZEH 0) until the net zero energy line is reached. Simultaneously, the residual energy demand, as stated in the EPBD definition, should be covered by renewable energy systems.

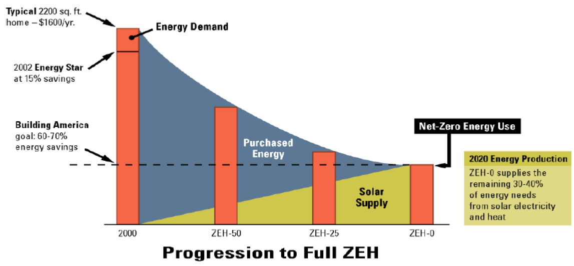

Figure 2. Progression to Full Zero Energy Houses
Source: Laustsen 2008, ECEEE 2011

The second key characteristic of the EU approach is that cost-optimality of the energy performance standards has to be verified by each member country using a given framework methodology. A net present value method provided by an amendment to the recast EPBD by end of June 2011 has to be used by each country's authorities to check the cost-optimality of the current standards. In case of deviation, e.g. too lax standards, the member countries have to justify it within the annual report to the commission.

The EU, hence, doesn't set standards itself, but forces the member countries to set cost-optimal energy efficiency standards (ECEEE 2011). To show how they can translate into national law - also under the cost-optimality criteria - the development of the German standards is depicted. Figure 3 shows how MEPS is developed in Germany during the past 30 years (from 2002 under the EPBD).

[1] By setting an upper limit for the allowed energy consumption of a building, minimum energy performance standards (MEPS) can be used to exclude the most inefficient buildings, technologies, components, etc. from the market. It is a prerequisite for MEPS that a valid and accepted methodology for measuring energy consumption and efficiency is either in place or being established. While MEPS at cost-effective levels should be made compulsory by law, higher standards (up to Zero Energy Buildings) can first be established on a voluntary basis. As these higher standards become common practice and cost-effective, they should be made the new MEPS.

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During the past 30 years minimum energy requirements for the primary energy demand for heating was strengthened stepwise. The first EnEV requirement in 2001 pushed the requirements under the 100 kWh/m^2/year threshold, the latest recast in the year 2009 to 70 kWh/m^2/year and another tightening of 30% is planned in 2012.

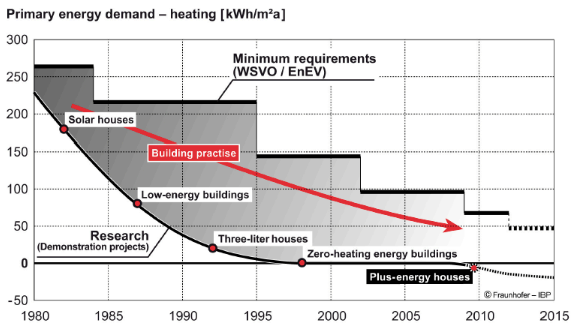

Figure 3. Development of MEPS for new buildings in Germany
Source: Erhorn and Erhorn-Klutting 2009

Moreover, Germany started to encourage the performance of green buildings in 2007 with the establishment of the voluntary DGNB certification scheme. Its first version was published in 2008 for new office and administrative buildings. It is optimally adapted to the built environment in Germany and Europe. As mentioned above mandatory energy efficiency standards are tightened stepwise in Germany. Standards for additional criteria of green buildings such as water, material and indoor environment quality are used to ensure good quality of life of occupants and environment (compared to developing countries). Those standards are well addressed in the DGNB scheme and they should be understood in the context of tightening mandatory energy efficiency standards. The holistic approach to incorporate the criteria of green buildings focuses especially on ecological, economical and socio-cultural issues in the planning, construction and operation of buildings for sustainable buildings. Figure 4 shows that the focus among the criteria for green (office) buildings in Germany is management, indoor environmental quality, social aspect and site / location (although site/location is presented separately and is not included in the overall grade of the object).

3.2 India

The development of the energy standards in India does not have a longer history than 2001 with the establishment of Energy Conservation Act (EC Act). The EC Act came in force in March 2002 with the establishment of Bureau of Energy Efficiency (BEE) under the Ministry of Power, Government of India. Its primary objective is to reduce energy intensity of the Indian economy. It developed the minimum energy performance standards and labelling design for equipment and appliances. In May 2007, BEE developed the Energy Conservation Building Code (ECBC) on a voluntary basis to set minimum energy

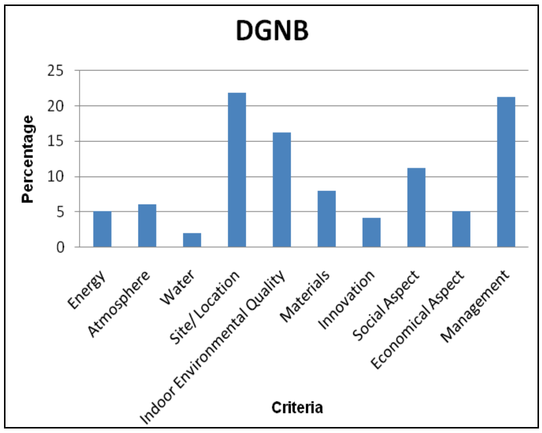

Figure 4. Weightings of green building criteria in DGNB
Source: Own illustration

efficiency standards for the design and construction of new commercial buildings having connected load of 500kW or contract demand of 600 kVA and for 2010, ECBC incorporated also smaller offices and high rise residential buildings of 100kW or contract demand of 120kVA (Shankar n.d.) (see figure 5 for a roadmap). ECBC has provisions for building envelopes (except for unconditioned storage spaces or warehouses), mechanical systems and equipments (including heating, ventilation, and air conditioning), service hot water heating, interior and exterior lighting, and electrical power and motors. However, it is not applied for buildings that do not use either electricity or fossil fuel, equipment and portions of building systems that use energy primarily for manufacturing processes, and multi-family buildings of three or fewer stories (BEE 2009). ECBC set the building energy consumption requirement at 110kWh/m^2/year while the national benchmark is 180kWh/m^2/year (Shankar n.d.). Figure 6 shows the case studies and energy savings in ECBC compliant commercial buildings. ECBC is planned to be mandatory soon. But 'implementation of ECBC at the State level and incorporation of ECBC provisions in real building designs continue to pose several challenges' (Kumar et al. 2010).

Moreover, India has another building standard called National Building code of India, 2005. It was first published in 1970 and revised in 1983, 1987, 1997 and the latest one was in 2005. It is a national model code but not mandatory 'providing guidelines for regulating the building construction activities across the country' (NBC 2005). In the ECBC, only a few provisions of NBC have been incorporated.

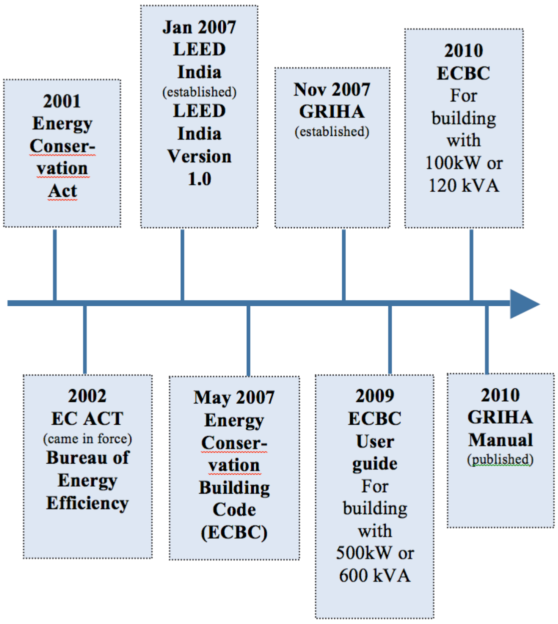

Figure 5. Roadmap for the development of Energy Standard and Green building certification in India
Source: Own illustration

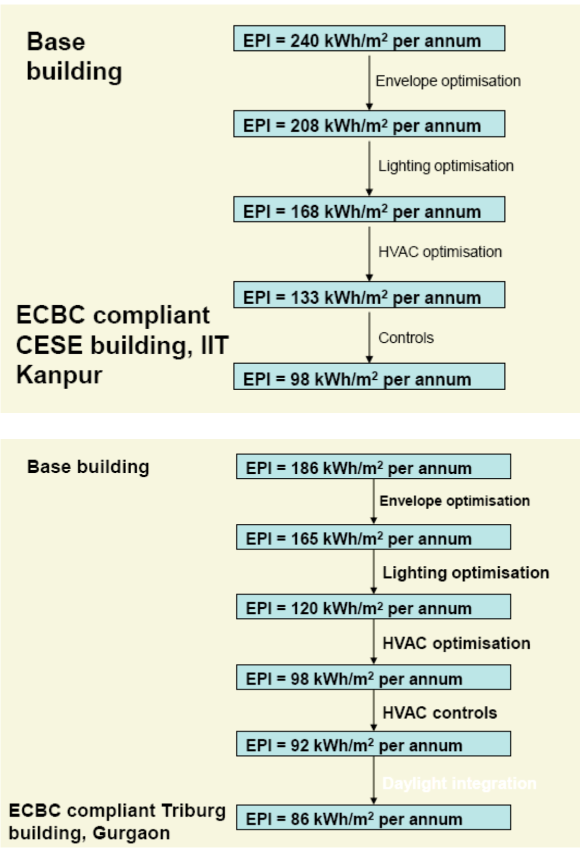

Figure 6. Case studies on energy saving in ECBC compliant buildings
Source: *Shankar n.d.*
Note: EPI-Energy performance Indicator

After the short period of the establishment of energy standards, it was decided to establish another voluntary system (besides ECBC) with two green building certification systems: LEED India in January 2007 and GRIHA in November 2007 (for new buildings-commercial, institutional, and residential of varied functions). They both refer to the ECBC for an energy efficiency requirement. LEED India is an indigenized US LEED certification system developed by the Indian Green building Council while GRIHA is a national green building certification system developed by The Energy and Resources Institute (TERI) and Ministry of New and Renewable Energy (MNRE), Government of India. The establishment of GRIHA (national rating system) is considered as quite advanced within developing countries. India is facing a rapid urbanization that caused a tremendous increase in energy demand in urban areas and critical water supply (for drinking, cooling and landscaping-agricultural fields) as well as an increase in infrastructure and construction development disturbing nature and ecology (increasing heat island effect). Beside that, most urban areas lack proper segregation, management and treatment facilities for solid waste. To stop or minimize negative impact of construction activities on the environment, it is extremely important for India to step forward towards green buildings and to establish a nationally adapted own certification scheme like GRIHA (with suitably selected criteria for the Indian context). The weightings for various green building criteria for office building in GRIHA are shown in figure 7. It emphasizes criteria such as energy, water, site / location and materials by recognizing urgent current needs of the country.

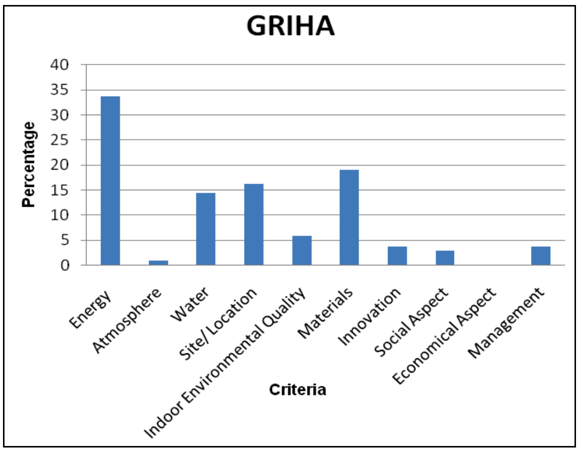

Figure 7. Weightings of green building criteria in GRIHA
Source: Own illustration

Thus, (green) building standards (for energy, water, material etc.) are set by countries considering their specific needs, climatic requirement and conditions of infrastructure. Although 'building energy standards that are stringent for one country may be ineffective in another country, depending on climatic conditions, occupant behaviour, existing building stock, and construction practices' (Janda 2009), raising the standards within a specific country and certain period of time will be a necessary step to decouple GDP, population and buildings sector growth from the use of nature. Rising the resource efficiency (the 'greenness') of buildings ensures on the one hand that the adverse impact of buildings on the environment is minimised. On the other hand many positive economic (e.g. reduced energy costs) and social (e.g. comfort) side benefits will occur. If the societal benefits are overwhelming the question arises, why they should not be targeted in a more strategic way and to advance from voluntary to mandatory options in a step-wise approach. This is discussed in the following section.

4. MANDATORY VS. VOLUNTARY SCHEME (ROLE OF INCENTIVES)

Mandatory energy standards are binding instruments. Any building must not exceed energy demand beyond the standard. They intend to prevent constructing inefficient buildings: the "dirty end" of the energy performance distribution of the buildings stock can be cut. The red line in figure 8 shows a market distribution of the energy consumption in a building stock without any intervention. A minimum standard (at point D) can shift the right end ("dirty end") of the distribution (arrow to the left) forming blue bell shaped distribution. But mandatory energy standards are 'critical to compel the supply chain to begin to develop and produce more energy-efficient buildings and to integrate energy efficiency requirements into standard practices' (Liu et al. 2010). Therefore, market transformation together with standards and incentive systems can reinforce each other and cause an accelerated joint impact. One of the drivers could be raising awareness and information on financial benefits of such buildings to market stakeholders (developer / owner). Examples for incentives are subsidized loans/ interest rates, tax benefits, awards and also 'green building certifications'. Though they are administered on a voluntary basis, they pull the market towards more energy efficient buildings and support to introduce more stringent energy standard. The green dotted line in figure 8 is the positive result of standard and incentives.

An example of the combination of a mandatory energy standard with market incentives can be found in Germany. MEPS are defined by reference buildings within the mandatory building code and an incentive system (subsidized loan) is provided by the state owned bank "Kreditanstalt für Wiederaufbau" (KfW) that supports more energy efficient renovation and new buildings in comparison to the current standard. The better the performance of a building relative to the current standard the more attractive the financial conditions are (soft loans). As the standards will be driven by the cost-optimal criteria in the future in Europe (see section 3) the financial incentives will also be more demanding.

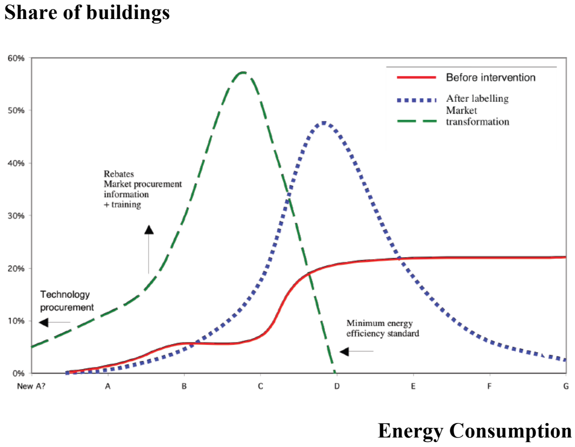

Figure 8. Schematic presentation of an integrated policy package
Source: Following Tholen and Thomas 2011

In case of green building certifications as a voluntary scheme it is up to the investor's decision if he perceives economic benefits and if he wants to realize them. Economic benefits of green buildings include energy and water cost savings, higher building value, increased rent and occupancy, productive and health benefits for office occupants or increased reputation value for public companies etc (Yudelson 2009). Although the upfront costs of green buildings can be higher than conventional ones, throughout the life span of such buildings, the invested costs are often paid back within a reasonable time period depending on the building typology and location. Empirical studies on US green certified office buildings show that they offer rental rates roughly 3% higher per square foot than non certified ones and its selling prices are higher by about 16 percent (Eichholtz et al. 2010).

The same holds true for green buildings in India. The case study of the green building 'IIT Kanpur' shows that an 18% higher upfront investment is paid back in 4.8 years and that the life cycle costs over 25 years for the building is lower than in conventional buildings in India. The study shows that 'green buildings are a boon for investors, yielding high returns as compared to investments in conventional investments, in a shorter duration' (Shah n.d.). Hence, a voluntary scheme for green buildings can be an effective driver of market transformation if the decisive target groups are made aware of the market benefits.

Considering the positive impact of green buildings in reducing overall environmental and economic adverse impacts, it can be argued that green building certifications should be made mandatory and formally enforced in a step wise process. Government intervention is required for their enforcement and proper mobilization. By this stepwise process and once it is set as mandatory certification standard it will cut “dirty ends” of ‘not green’ buildings. For this, possible barriers are required to be removed. As an initial step for countries to go for green buildings, mandatory energy standards are to be set as a baseline. As described in section 2 most of the developing countries up to now are lagging energy standards; the topic below describes why mandatory energy standards could not be set in those countries.

4.1. Mandatory Energy Standards for Developing Countries

An apparent reason why Europe goes for mandatory and step-wise tightened building standards is the fact that the contribution of the building sector is crucial to reach the national CO_2 reduction targets. But what about the economic and social driving forces? Climate mitigation policies in the past were often perceived as being only a part of a “burden sharing” regime instead of looking into the economic benefits and many positive side effects connected with climate mitigation technologies and strategies. This holds especially true for the building sector: Driving new and existing buildings in the direction of resource efficiency reduces resource costs (e.g. energy, water) and import dependency (e.g. oil, gas) and increases green business fields and new jobs in the national economies (ADAM 2009, Edenhofer et al. 2009). Thus, even without climate change it would make sense to foster investments in energy efficient and green buildings. Thus fostering the process of efficient buildings by mandatory standards in developed countries is also driven by macroeconomic considerations.

But, what are the reasons for developing countries not to set mandatory standards as well? The global negotiation process and discussion on the “common but differentiated responsibilities” (Kyoto Protocol) to reach the 2°C aim in 2050 is currently stuck. Up to now, for developing countries the connotation of climate mitigation as a “burden sharing” regime is even stronger than in developed countries. In so far, mandatory building standards might be perceived as a responsibility of Annex-I countries with binding reduction obligations. However, leaving climate change aside, energy efficiency standards are an important element on the way to a sustainable economy everywhere, may be – in the long run - in rapidly developing South even more than in the North. Though in depth macroeconomic analysis of the building sector is much more available for Europe or the US, the positive side effects like reducing import dependencies, rising security of supply, reducing energy and resource costs and participating in the development of green “lead markets” are at least of equal importance for developing countries. Additionally in the long run, the heavy burden of “lock-in” effects and “lost opportunities” could have been avoided in emerging countries like China or India with rapidly growing economies and building sectors.

One important reason why developing countries do not implement mandatory standards might be the economical barrier of (sometimes) higher upfront costs for energy efficiency measures and too long pay back periods. Therefore, the implementation of mandatory and ambitious standards in developing countries should be financially supported in the context of a new climate mitigation regime (e.g. as NAMAs). Even in developed countries higher upfront costs and long payback periods are still one of the most important barriers for energy efficiency, e.g. for retrofitting the existing building stock (Höfele and Thomas 2011). This is why in Germany a financial support strategy of annually at least 2 bn € public subsidy is discussed.

However, another major barrier is the lack of comprehensive and easily accessible information about available technologies, economic benefits and effectiveness of policies and measures on energy efficient buildings. For example policies are often not evaluated, made comparable and published for a global audience once implemented in a country. Hence, if effective policies and measures or even policy packages do exist in some countries, policy makers elsewhere do not have access (e.g. due to resource restrictions) to the scattered information in the world.

5. PERSPECTIVES: FOSTERING EFFECTIVE POLICIES BY BRIDGING THE GLOBAL INFORMATION GAP

This paper gave an overview of different approaches to high performance buildings - on the one hand for India and its voluntary certification approach for green buildings and on the other hand for Europe’s approach on “nearly zero energy buildings” and cost optimal energy performance standards on its way. The discussion of both approaches has shown that both can transform the building market differently. Therefore, a combined approach is recommended: mandatory energy efficiency standards to cut the “dirty end” of the building stock and accelerate the needs of climate protection, especially in developed countries. However this holds true for developing countries as well concerning the perspective of sustainable development, differentiated responsibilities for climate protection. Standards are recommended to reach a sustainable development path becoming less vulnerable of oil price shocks and of import dependencies. Voluntary certification is needed to push the markets towards an even better performance than the mandatory standard. Studies (see above) show that certified buildings are sold at better prices in the market. The distribution of the (green or energy efficiency) performance of the building stock can be pushed towards more resource and energy efficiency by a certification scheme (as the blue and green curve in figure 8). However, to guarantee that comprehensive policy packages work, other policies and measures are highly recommended to flank standards and certification schemes (e.g. support programmes for energy efficient construction, see Höfele and Thomas 2011). Only such policy packages make sure that all the relevant barriers are addressed properly.

The above international comparison of policies supporting efficient and green buildings is furthermore an example of global social learning. It is self evident that technologies and policies and measures have to be adapted to the national conditions (e.g. development stage, climate zone) of countries. But the building sector is globalizing according to technologies, management tools and policies. Thus the lessons learned from other countries and the information on BAT, good policies and good practice examples globally are of utmost importance to decide on effective national strategies.

With this background the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (FME) and the Wuppertal Institute for Climate, Environment and Energy (WI) have started to set up the web-based international project 'bigEE – Bridging the Information Gap on Energy Efficiency in Buildings' together with country partners in China and India, South Africa to join soon.

To overcome the worldwide information gaps on BAT, energy saving potentials, implementation barriers, appropriate policies and measures and good practice examples, an international web-based platform can be helpful to address relevant actors such as policy makers, investors, architects and engineers. Transforming the worldwide market for buildings towards increased energy and resource efficiency does need guidance concerning the availability of scientifically reviewed information. Complexity has to be reduced to the basic messages, but should be connected with a quick access to in depth information via a well-organized web platform.

Most policy-makers and investors lack oversight on the potential and cost-effectiveness of energy-efficient buildings and buildings technologies, as well as information on good practice in energy efficiency policies and what they could achieve. While there is already a lot of information available, it is often not easily accessible in a user-friendly way: it is scattered, there are multiple sources, and it sometimes is even contradicting. Therefore, internet-based information platform bigEE shall provide user-targeted comprehensive, well-structured and comparable data on energy efficient technologies, potentials, costs and economic benefits, and successful policies. For all types of building and building connected technologies and appliances the platform will provide both information of universal interest and information for selected partner countries and sectors. Information will rely on a network of international partner institutions and agencies. It shall be evidence-based, independent and comparable. Thus, the cooperation with major international institutions including UNEP, the IEA (Sustainable Buildings Network), the World Business Council on Sustainable Development (WBCSD) and with research based networks is intended. At the end of the year 2011 Wuppertal Institute will launch the platform bigEE ("bridging the information gap on energy efficiency in buildings") to the audience.

REFERENCES

ADAM 2009. *ADAM 2-degree scenario for Europe – policies and impacts, Project No: 018476-GOCE, ADAM Adaptation and Mitigation Strategies: Supporting European Climate Policy Instrument: Integrated Project (IP), Global Change and Ecosystems, Deliverable D3 of work package M1 (code D-M1.3)*, http://adamproject.info/index.php/Download-document/473-D-M1.3.html (Accessed 8th 2011).

Attmann, O., 2010. *Green Architecture: Advanced Technologies and Materials*. USA: McGraw-Hill.

BEE (Bureau of Energy Efficiency) 2009. *Energy Conservation Building Code: User guide.* India: BEE.

BMWi (German Federal Ministry of Economics and Technology) and BMU (Federal Ministry of Environment, Nature Conservation and Nuclear Safety) 2010. *Energy Concept for an Environmentally Sound, Realiable and Affordable Energy Supply.* http://www.bmu.de/english/energy_efficiency/doc/46516.php (Accessed on 12th June 2011).

ECEEE (European Council for an Energy Efficient Economy) 2010. *Steering through the maze #3.* Stockholm. www.eceee.org/buildings (Accessed 3rd June 2011).

ECEEE 2010. *Cost optimal building Performance requirements. Calculation methodology for reporting on national energy performance requirements on the basis of cost optimality within the framework of the EPBD.* www.eceee.org/buildings (Accessed 12th June 2011).

ECEEE 2011. *Net zero energy buildings: definitions, issues and Experience.* www.eceee.org/buildings (Accessed 10th June 2011).

Edenhofer, O., Carraro, C., Hourcade, J.-C., Neuhoff, K. Luderer, C., Flachsland, C., Jakob, M., Popp, A., Steckel, J., Strohschein, J., Bauer, N., Brunner, S., Leimbach, M., Lotze-Campen, H., Bosetti, V., de Cian, E., Tavoni, M., Sassi, O., Waisman, H., Crassous-Doerfler, R., Monjon, S., Dröge, S., van Essen, H., del Rio, P. and Türk, A. 2009. *The economics of Decarbonization. Report on Energy and Climate Policy in Europe.* Potsdam: Potsdam-Institute for Climate Impact Research. http://www.pik-potsdam.de/members/edenh/publications-1/recipe_report.pdf (Accessed on 10th June 2011).

Eichholtz, P., Kok, N., and Quigley, J. M. 2010. *Doing Well by Doing Good? Green Office Buildings.* Berkeley: University of California. http://urbanpolicy.berkeley.edu/pdf/AER_Revised_Proof_101910_wcover.pdf (Accessed on 6th June 2011)

Erhorn, H., and Erhorn-Klutting, H. 2009. *Impact, Compliance and Control of EPBD Legislation in Germany.* http://www.asiepi.eu/fileadmin/files/WP3/09_Germany.pdf (Accessed on 10th June 2011)

Hoefele, V., and Thomas, S. 2011. *Combining theoretical and empirical evidence: policy packages to make energy savings in buildings happen.* ECEEE 2011. www.bigee.net

Hong, W., Chiang, M. S., Shapiro, R. A., and Clifford, M. L., 2007. *Building Energy Efficiency: Why Green Buildings Are Key to Asia's Future.* Hong Kong: Asia Business Council.

IPCC (Intergovernmental Panel on Climate Change) 2007. *Climate Change 2007: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*B. Metz, O.R. Davidson, P.R. Bosch, R. Dve, L.A. Myer (eds.). Combridge, U.K. and New York, U.S.A.: Cambridge University Press.

Janda, K. 2009. *Worldwide status of energy standards for buildings: a 2009 update.* ECEEE 2009 Summer Study.

Koeppel, S., and Ürge-Vorsatz, D. 2007. *Assessment of policy instruments for reducing greenhouse gas emissions from buildings.* Report for the UNEP-sustainable Buildings and Construction Initiative. Budapest: Central European University.

Kumar, S., Rawal, R., Seth, S., and Walia, A. 2010. Energy Conservation and Commercialization (ECO III): Developing and energy Conservation Building Code Implementation Strategy in India. India:BEE.

Laustsen, J. 2008. *Energy Efficiency Requirements in building codes, energy efficiency policies for new buildings.* IEA. Paris.

Liu, F., Meyer, A. S., and Hogan, J. F. 2010. *Mainstreaming Building Energy Efficiency Codes in Developing Countries: Global Experiences and Lessons from Early Adopters.*Washington D.C.: The World Bank.

Nadel, S. 2004. *Supplementary Information on Energy Efficiency for the national Comission on Energy Policy.*Washington DC: American Council for an Energy-Efficient Economy.

NBC (National Building Code) 2005. *National Building Codes of India 2005.* India: Bureau of Indian Standards. http://www.bis.org.in/sf/nbc.htm (Accessed on 6th June 2011).

Office of the Federal Environmental Executive 2003. *The Federal Commitment to Green Building: Experience and Expectations. US.* http://www.ofee.gov/guidance_reports_archives.asp (Accessed on 5th June 2011)

Shah, S. (n.d.). *Study of life cycle costing for GRIHA rated green buildings in India. Ahmedabad: CET University.* http://www.cept.ac.in/index.php?option=com_content&view=article&id=187&Itemid=343 (Accessed on 12th June 2011)

Shankar, G. (n.d.). *Energy Efficiency Initiatives in buildings. India: Bureau of Energy Efficiency.* http://www.emt-india.net/Presentations2011/04_Building_09June2011/BEE.pdf (Accessed on 10th June 2011)

Tholen, L., and Thomas, S. 2011. *Combining theoretical and empirical evidence: policy packages to make energy savings in* *appliances happen.* EEDAL 2011. www.bigee.net

UNEP (United Nations Environment Programme) 2009. *Building and Climate Change: Summary for Decision-Makers.*

WEC (World Energy Council) 2008. *Energy Policies around the world: Review and Evaluation.* UK:World Energy Council.

Yudelson, J. 2009. The business case for Green Buildings. In: M. Cesarz, L. Polisano, M. Robinson and J. Yudelson, eds. *Sustainable Investment and Places- Best Practices in Europe.* Hamburg: Union Investment Real Estate AG. 88-91. http://www.prime-property-award.de/downloads/difa/3207fad71eec2a9d801494e4af000462.0.0/UI_PPA_Buch_2009.pdf (Accessed on 15th June 2011).