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Energy efficiency policy

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1. Introduction

Access to all forms of energy at affordable prices is an impetus for economic and social development of the society. At the same time, energy sector is responsible for approximately 75 percent of total greenhouse gases emissions, which makes it the main provocative of climate change. The convergence of international concerns about climate change and energy security in the past decade has led to the increased awareness of policy-makers and general public about energy issues and creation of new energy paradigm, the focus of which is **energy efficiency**. Energy not used is arguably the best, the cheapest and the least environmentally damaging source of energy supply and nowadays the concept of "negawatts" in energy strategies worldwide is being introduced. However, energy efficiency being typically demand side option is hard to implement due to the variety of stakeholders, i.e. players in the energy efficiency market that need to be stimulated to adopt energy efficiency as a way of doing business and ultimately a way of living - the change of mindset is needed. As higher efficiency of energy use is indisputably a public interest, especially in the light of the climate change combat, policy interventions are necessary to remove existing market barriers hindering the fulfilment of potentials for cost-effective efficiency improvements. Policy instruments to enhance energy efficiency improvements must stimulate the transformation of the market towards higher efficiency, with the final aim of achieving cleaner environment, better standard of living, more competitive industry and improved security of energy supply. Moreover, they have to be designed according to the real needs of the market (*tailor-made*), and have to have the flexibility and ability to respond (*adapt*) to the changing market requirements in order to achieve goals in the optimal manner.

Although there are excellent policies in place worldwide, with the European Union (EU) being the indisputable energy efficiency and climate change combat leader, the results in terms of reduced energy consumption are missing in the desired extent. Therefore, energy efficiency policy making needs new, innovative approaches the main feature of which is dynamics. Dynamic policy making means that it has to be learning, continuous, closed-loop process which involves and balances policy design, implementation and evaluation. The aim of this chapter is to explain these three main pillars of effective energy efficiency policy making, focusing especially on implementation issues, which are usually highly neglected in policy making process but are crucial for policy success.

2. Understanding energy efficiency policy making

2.1. Energy efficiency concept: avoid, reduce, monitor and manage

The basis for understanding the concept of energy efficiency is energy flow, from primary energy contained in energy carriers to the useful energy consumed through various activities of the society (Fig. 1).

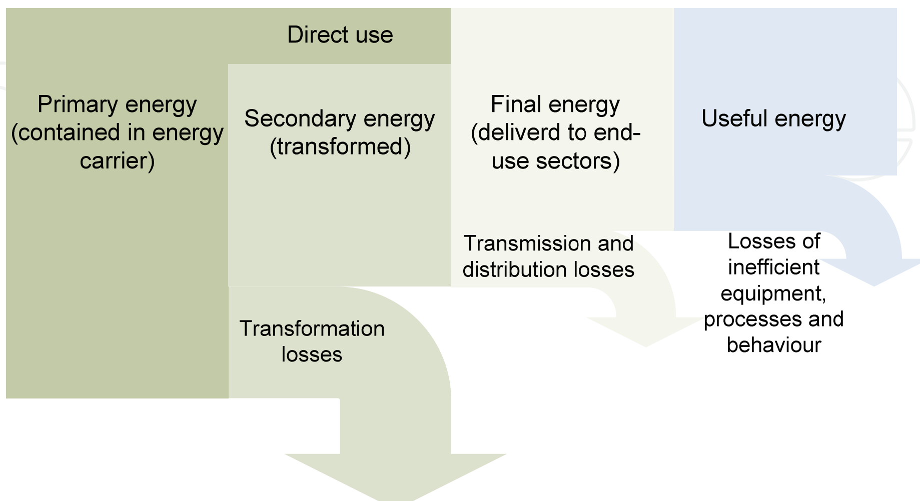


Fig. 1. Energy flow - basis for understanding energy efficiency

Energy efficiency is all about tackling energy losses. As shown in Fig. 1, it boils down to the very simple and understandable equation:

$$E_{useful} = E_{primary} - E_{losses} \quad (1)$$

Losses occur in processes of energy transformation, transmission, and distribution as well as in the final uses of energy. While reducing losses in the first three activities is mainly a matter of technology, the latest should be tackled by both technical and non-technical measures. Often unnecessary uses of energy could be avoided by better organisation, better energy management and changes in consumers' behaviour and increasingly so by changing lifestyle, which is the most difficult part. Energy efficiency has to be considered as a continuous process that does not include only one-time actions to avoid excessive use of energy and to minimise energy losses, but also includes monitoring and controlling energy consumption with the aim of achieving continuous minimal energy consumption level. Therefore, energy efficiency improvements rest on the following pillars (Morvaj & Bukarica, 2010):

- **Avoiding** excessive and unnecessary use of energy through regulation (e.g. building codes and minimal standards) and policies that stimulate behavioural changes;
- **Reducing** energy losses by implementing energy efficiency improvement measures and new technologies (e.g. waste heat recovery or use of LED lighting);
- **Monitoring** energy consumption in order to improve knowledge on energy consumption patterns and their consequences (e.g. smart metering and real-time pricing).
- **Managing** energy consumption by improving operational and maintenance practices.

To ensure continuity of energy efficiency improvements, energy consumption has to be managed as any other activity. Actually, energy management can be denoted as a framework for ensuring continuous avoidance of excessive energy use and reduction of energy losses supported by a body of knowledge and adequate measuring and ICT technology (Morvaj & Gvozdenac, 2008). It should not only consider techno-economic features of energy consumption but should make energy efficiency an ongoing social process. It also rests on the fact that energy has to be priced in a manner that more accurately reflects its actual costs, which include, inter alia impacts on the environment, health and geopolitics, and that consumers have to be made aware of these consequences of energy use. These main pillars for achieving energy efficiency improvements have to be taken into account in the policy making process - "avoiding" and stimulation of "reducing" shall be a main driver in design of policy instruments, while for "monitoring" and "managing" implementing capacities with appropriate capabilities and supporting infrastructure shall be ensured.

2.2. Rationale behind energy efficiency: means not an end

Energy efficiency shall be regarded as a mean to achieve overall efficient resource allocation (Dennis, 2006), rather then the goal in it self. As a consequence of improved energy efficiency, other public policy goals will be achieved as well, the most important of which are the goals of economic development and climate change mitigation.

In economic terms, and taking into account the fact that energy costs typically account to 15 to 20 percent of national gross domestic product, the significance of energy efficiency is evident - reduced energy consumption lowers the costs for energy. For example, it is estimated that the EU, although the world's most energy efficient region, still uses 20 percent more energy than it would be economically justified, which is the equivalent to some of 390 Mtoe (European Commission, 2006) or the gross inland consumption of Germany and Sweden together (Eurostat, 2009).

Furthermore, global consensus is emerging about consequences of inaction for mitigation of an adaptation to climate change, and clear quantifiable targets (limiting CO_2 concentration and temperature increase) within the given time frame (until 2012, than 2020 and finally 2050) need to be achieved if wish to avert a major disasters in the foreseeable future**.** For the first time energy policy making is faced with such strict constraints, which require a radically different approach in the whole cycle of policy making with special emphasis on policy implementation. Energy efficiency is globally considered to be the most readily available and rapid way to achieve desired greenhouse gases reductions in the short to medium term. And taking into account the possible grave threats of climate change, the time scale in energy policy has never been more important.

Let us briefly look at the evolution of energy policy making and the role of energy efficiency (Fig. 2.). The standard energy policy making approach implied balancing of energy demand and supply and slow evolution of policy goals, mixes and objectives as a response to various external changes and drivers. The standard energy policy making was not faced with serious constrains and specifically not time constraints for achieving certain results and objectives. The time scales of energy policies were rather long, actions were gradually undertaken (leading often to under investing in energy sector) and mainly left to the decisions of energy companies, which led to the critical neglect of energy policy implementing capacities at various levels of jurisdiction and in the society in general.

Nowadays, energy policy is entering a new constrained phase, with time as the main constrain being imposed by the desire to combat climate change.

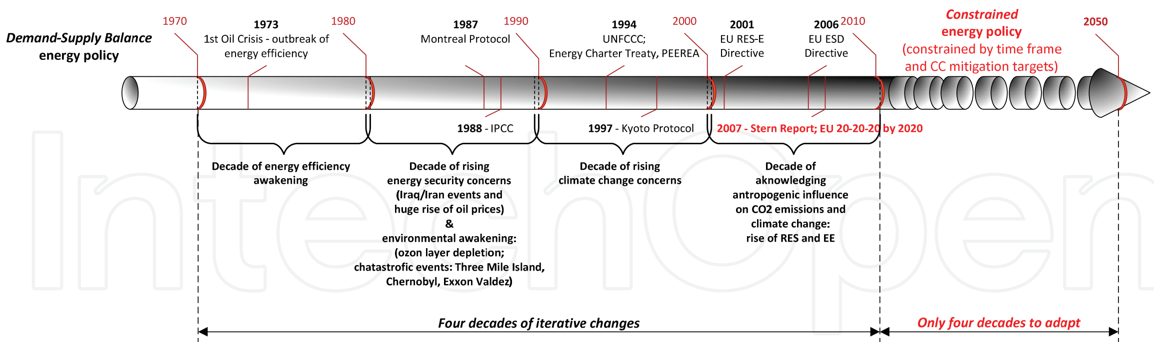


Fig. 2. Gradual changes of energy policy accents due to various drivers (Morvaj & Bukarica, 2010)

Energy efficiency solely can deliver the desired greenhouse gases reduction targets to the large extent. To confirm the statement, the EU has been taken as an example. It is estimated that fulfilling 20 percent target for energy efficiency improvements by 2020 would mean reducing greenhouse gases emissions by 780 million tonnes, more than twice the EU reductions needed under the Kyoto Protocol by 2012 (European Commission, 2006). Since the EU has committed to reduce its greenhouse gases emissions by 20 percent compared to 1990 by 2020 and since the EU's greenhouse gases emissions in 1990 amounted 5,564 million tonnes (European Environment Agency, 2009), it is evident that 20 percent of energy efficiency improvement can deliver almost three fourths of desired greenhouse gases reduction target. The power of energy efficiency as a tool for climate change combat is therefore obvious.

2.3. Levels of energy efficiency policy: from enabling to implementing

Taking into account the role energy efficiency plays in reaching global goals of climate change combat, it is understandable that there is a need for coordinated actions at all levels - international, regional (e.g. European Union) and national to ensure enabling environment for energy efficiency improvements by formulating appropriate policy instruments. However, the real power to change is local. Policies have to be designed in a way that enables local implementation in homes, public services and businesses. The interconnection between levels of energy efficiency policy is illustrated in Fig. 3.

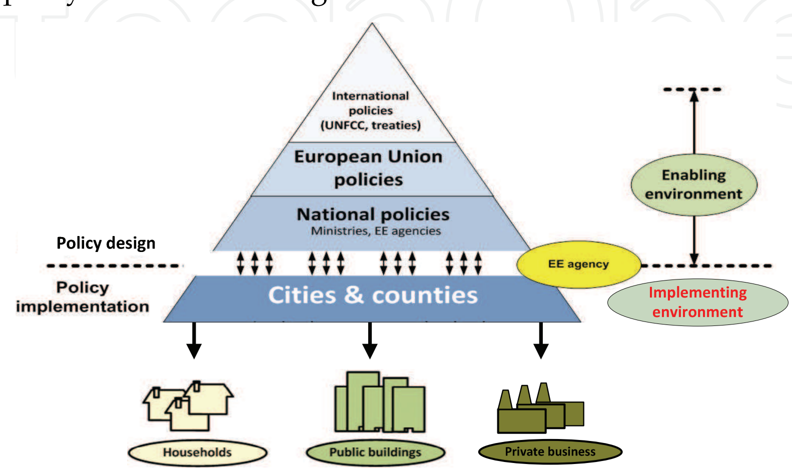


Fig. 3. Levels of energy efficiency policy

2.3.1. International aspect of energy efficiency policy

Due to its significance, energy efficiency is the topic of international agreements related to climate change combat, environmental protection and security of energy supply. Money and effort are put into promotion of energy efficiency by numerous international institutions, as briefly demonstrated in Table 1.

International treaties and agreements on Climate Change and EE		
Name of the document	***Year***	***Main features***
Energy Charter Treaty	1994	Legally-biding multilateral instrument, obliging parties, *inter alia*, to reducing negative environmental impact of energy cycle through improving energy efficiency
Energy Charter Protocol on EE and Related Environmental Aspects (PEEREA)	1994	Recognises EE as considerable source of energy and obliges parties to promote EE and to create framework which will induce both producers and consumers to use energy in the most efficient and environment friendly way as possible
Kyoto Protocol to United Nations Framework Convention on Climate Change (UNFCCC)	1997	Obliges parties to reduce GHG in time period 2008-2012. Defines flexible mechanisms that will ease the achievement of targets at the least cost
International institutions/programmes for energy efficiency		
Institution/Programme	***Year***	***Main features***
Global Environment Facility	1991 - 2009	GEF is main financial mechanism of UNFCCC; GEF has supported 131 EE projects with portfolio of approximately 850 million USD
World Bank Group	2005-2009	Renewable energy and EE at the heart of WBG energy agenda; in period 2005-2009 over 4 billion USD given for EE projects world wide
United Nations Development Programme, United Nations Foundation	/	Energy as an important factor in reaching Millennium Development Goals and reducing Poverty; Calls for international "Efficiency First" agreement; Number of EE projects financed world wide
International Energy Agency	/	EE one of six broad focus areas of IEA's G8 Gleneagles Programme - IEA submitted 25 policy recommendations to the G8 for promoting EE that could reduce global CO2 emissions by 8.2 gigatonnes by 2030.

Table 1. International treaties and programmes for energy efficiency (Morvaj & Bukarica, 2010)

As seen from Table 1, international treaties and programmes are supported by various financing tools, bilateral and international donors, but there is very little focus on how to implement policy measures and instruments, hence the real results in terms of sustainable and verifiable energy efficiency improvements and greenhouse gases reductions are missing. It is absolutely crucial to shift the focus of international policies towards real-life application, respecting in this process different local circumstances.

Namely, the drivers for energy efficiency and implementing environments differ significantly on the global scene. Four "blocks" could be identified as shown in the Fig. 4. The EU, followed by some other OECD countries, is certainly a forerunner in combating climate change and in related energy efficiency activities. USA and BRIC countries are the most vocal in defending their national interests and resisting any firm commitments for CO_2 reduction. Developing countries collectively represent a significant block in terms of greenhouse gases emissions. Energy efficiency is for them a win-win approach for reducing the greenhouse gases emissions while also reducing costs of energy for their fragile economies. Therefore, energy efficiency in developing countries should be addressed immediately and incorporated in energy policies with strong supporting implementation mechanisms.

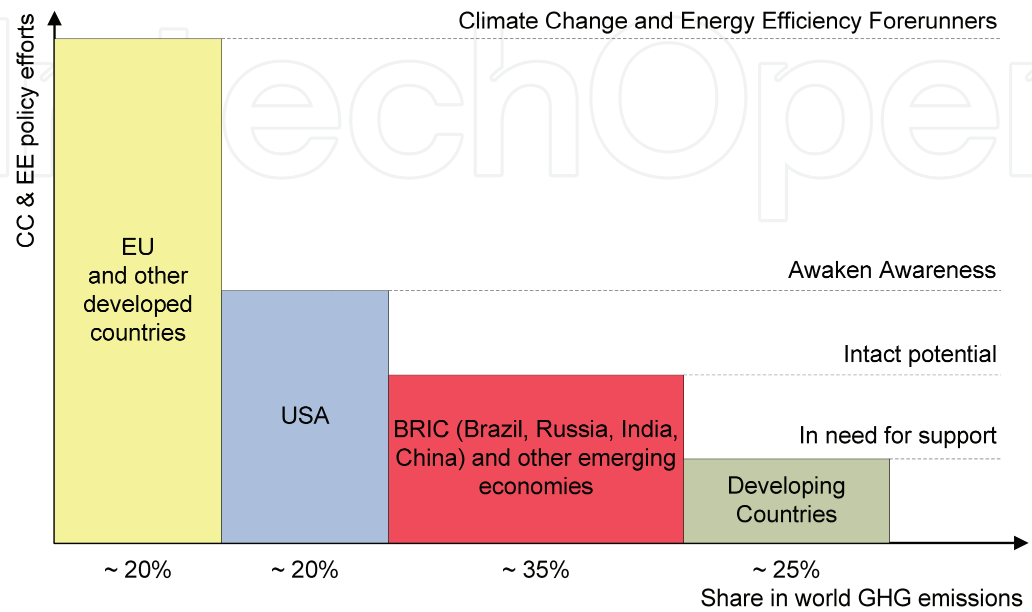


Fig. 4. World differences in climate change and energy efficiency policies adoption (Morvaj & Bukarica, 2010)

The efforts from the international level are extremely useful and necessary, but they are still not enough, i.e. they are generic in their nature, hence are not able to deliver real results. International policies, programmes and aids shall be brought down to the national and local level in every "block", where conditions for policy implementation are different, requiring thus tailor-made solutions in both policy instruments and implementing capacities.

2.3.2. Regional energy efficiency policy: case EU

The indisputable "energy efficiency forerunner" in the world is the European Union (EU). The EU has strongly stressed its aim to achieve the "20-20-20" targets by 2020: to reduce greenhouse gases emissions minimally 20 percent (with the intention to even achieve 30 percent greenhouse gases emission cut by 2030); to increase the proportion of renewable energies in the energy mix by 20 percent and to reduce primary energy consumption by 20 percent. In order to achieve the energy efficiency improvement goals, the EU has introduced a well thought of set of voluntary and some mandatory polices. The most important policy and legislative documents related to energy efficiency in the EU are summarised in the Table 2.

EU policy documents on EE		
Name of the document	***Year***	***Main features***
EE in European Community – Towards a Strategy for the	1998	Analyse available economical potential for improvements in energy efficiency, identifies barriers

Rational Use of Energy (COM (1998)) 246 final)		and gives proposals to remove those barriers. Estimates that saving of 18% of 1995 energy consumption can be achieved by 2010 (160 Mtoe).
Action Plan to Improve EE in the European Community (COM (2000) 247 final)	2000	Sets a target for energy intensity improvement by an additional 1% per year compared to a business as usual trend resulting in 100 Mtoe avoided energy consumption by 2010.
Green Paper on EE or Doing More with Less (COM (2005) 265 final)	2005	Expresses urging need to put energy saving policy higher on the EU agenda and estimates that EU is using 20% more energy then economically justifiable and if additional efforts are not made, this potential will not be fulfilled by current policies.
Action Plan for Energy Efficiency: Realising the Potential (COM(2006) 545)	2006	Sets energy saving target of 20 percent by 2020 (390 Mtoe) and defines 6 priority policy measures (energy performance standards; improving energy transformation; focusing on transport; providing financial incentives and ensuring correct energy pricing; changing energy behaviour; fostering international partnership).
Second Strategic Energy Review - An EU Energy Security and Solidarity Action Plan (COM/2008/0781)	2008	Reinforces EE efforts to achieve 20% target - calls for revision of directives on energy performance of buildings, appliance labelling and eco-design, strongly promotes Covenant of Mayors, use of cohesion policy and funds and tax system to boost energy efficiency.
EU EE legislation (directives)		
Directive 92/75/EEC on energy labelling of household appliances and implementing directives	1992	Prescribes obligatory EE labelling for 8 groups of household appliances.
Directive 2002/91/EC on the energy performance of buildings (Proposal for a Directive on the energy performance of buildings (recast) [COM(2008)780])	2002 (recast proposed in 2008)	Calls for minimum energy requirements for new and existing buildings, energy certification and regular inspection of boilers and air conditioning systems.
Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market	2004	Facilitate the installation and operation of electrical cogeneration plants.
Directive 2005/32/EC establishing a framework for the setting of eco-design requirements for energy-using products and implementing directives	2005	Defines the principles, conditions and criteria for setting environmental requirements for energy-using appliances.
Directive 2006/32/EC on Energy end-use Efficiency and Energy Services	2006	Calls for establishment of indicative energy savings target for the Member States, obligations on national public authorities as regards energy savings and energy efficient procurement, and measures to promote EE and energy services.

Table 2. EU policy documents for energy efficiency (Morvaj & Bukarica, 2010)

The analysis of these documents clearly shows the commitment and huge policy efforts to boost energy efficiency improvements. Despite that, the EU is far from reaching its 20 percent energy efficiency improvement target by 2020. The results of the policy implementation are missing in the desired extent, leaving the huge potential of "negawatts" idle. With the current legislation and policy instruments in place, a reduction of only 8.5 percent will be achieved. Even taking into account additional measures in the pipeline, at the best only 11 percent reductions will be achieved, as shown in the Fig. 5 (European Commission, 2009). However, the EU policy only provides the framework national policies have to cope with. It is, to the largest extent, the task of national policies to deliver actual energy efficiency improvements. Obviously, they are failing to do so.

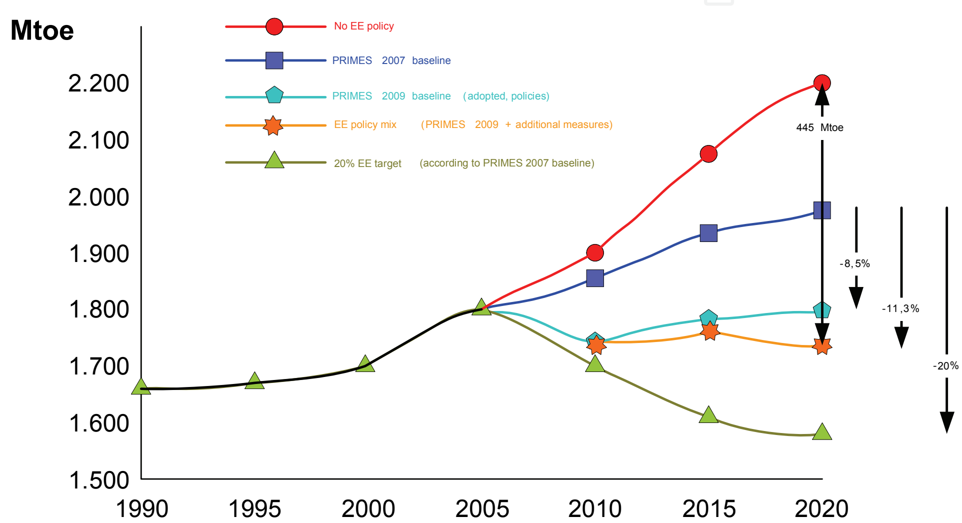


Fig. 5. Development and projection of Gross Inland Energy Consumption for EU by 2020 (European Commission, 2009)

2.3.2. National energy efficiency policy: (not) delivering targets

In national energy efficiency policy there is a symptomatic unbalance between efforts for preparing polices, and preparations for policy implementation. The vast majority of policy makers are focused on incorporating requirements of international policies and requirements into national strategic and legislative frameworks, without thorough consideration of national circumstances, i.e. without taking into account the level of energy efficiency market maturity in a country. Moreover, there is a general lack of focus on policy implementation and a sort of general expectation that implementation is straightforward, will hopefully happened by itself, hence there is no need to put too much efforts into that. Current national energy efficiency policies are persistently missing or underachieving the desired results. There are number of reasons behind this policy failure, but the problem is essentially threefold:

1. **Policy makers do not fully tackle all stakeholders relevant for energy efficiency**, i.e. not all market players are tackled with appropriate policy instruments that would remove market imperfections and enable sustainability. There is a need for all-a-compassing, tailor-made policies, adaptive to specific changing market conditions.

2. **Policy making needs to appreciate specific implementing environment conditions and time constraints for implementation**, thus focusing on creating sufficient and appropriate implementing capacities that are adequate for achieving the targets. A model for developing implementing capacities shall be established.
3. **Policies are not static**, meaning that policy making is not on-time job. It requires well established procedures for policy monitoring and evaluation that will reveal what works and what does not work in the practice and provide inputs for policy improved redesign.

Obviously, new approach in overall energy efficiency policy making is needed, the main feature of which is dynamics.

2.4. Policy dynamics: key to effective energy efficiency policy making

For energy efficiency policy to be successful its creation has to be a learning process based on both theoretical knowledge and empirical data. This learning process can be the most appropriately described by the closed-loop process (Fig. 6) consisting of the following stages:

- **Policy design**:
  - **Policy definition**: objectives, targets, approaches for different target groups, legal and regulatory frameworks;
  - **Policy instruments development**: incentives, penalties, standards, technical assistance, financing support;
- **Policy implementation**: institutional framework, stakeholders, human resources, capacity and capability development, supporting infrastructure (ICT);
- **Policy evaluation**: monitoring of achieved results through energy statistics and energy efficiency indicators, qualitative and quantitative evaluation of policy instruments' impacts.

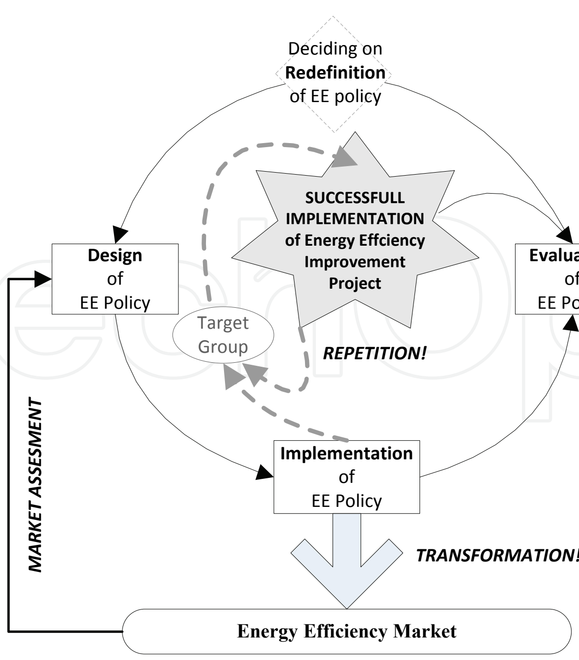


Fig. 6. Dynamics of energy efficiency policy (Bukarica et al., 2007)

Energy efficiency policy in its essence shall be a market transformation programme. Market transformation programmes are strategic interventions that cause lasting changes in the structure or function of markets for all energy-efficient products/services/practices (Brinner & Martinot, 2005). The effective market transformation programme rests on the following key pillars:

- mix of policy instruments created to **remove market barriers** identified throughout all stages of the individual energy efficiency project development;
- policy interventions **adaptive to market conditions** ensuring sustainability of energy efficiency improvements through replications of successfully implemented energy efficiency projects;
- **policy instruments tailored** to enable all market players (government, private sector, consumers, equipment producers, service providers, financing institutions, etc.) to find their interest in improved energy efficiency;
- energy efficiency improvements achieved as the result of **supply-demand interactions based on competitive market forces**.

Therefore, prior to the start of energy efficiency policy design the market assessment shall be preformed. It shall reveal the maturity of the market. This is extremely important, as different instruments have different effects and are therefore appropriate at different market maturity levels, i.e. some measures could stimulate market introduction, whereas other measures could accelerate commercialisation, or increase the overall penetration of energy-efficient products and services (Brinner & Martinot, 2005). Market analysis is required to identify market forces that have to be strengthened by incentives or diminished by penalties. The policy instruments should be carefully designed and mixed in order to tackle identified market barriers.

Conceptually, the typical energy efficiency policy cycle starts with strategic planning and determination of targets leading to the design of specific instruments to tackle different target groups, i.e. market players. The implementation of policy instruments follows and one cycle is concluded with the evaluation of policy impacts. The results of the policy evaluation process are then fed into the planning, design, and implementation processes, and the cycle repeats itself (Vine, 2008). Every stage in this dynamic loop requires methodical and systematic approach and will be given all due attention in the subsequent sections.

3. Main postulates for defining effective energy efficiency policy

3.1. Understanding energy efficiency markets

The starting point in creation of any policy is to understand how market operates and how well developed it really is. Unlike the economic theory that assumes perfect competition, the real markets are imperfect due to various barriers preventing market forces to deliver desired results. The task of any policy is to identify these barriers and to develop market-based incentives and well-designed, forward-looking instruments for their removal (Dennis, 2006).

Policies usually define various instruments to support implementation of energy efficiency measures in energy end-use sectors (households, services, industry, transport). Very often, the proposed instruments are generic and designed without a proper appreciation of the situation on the ground – an energy efficiency market place where energy efficiency measures need to be adopted by consumers, supported by energy service providing companies. Addressing end-users solely is not nearly sufficient to ensure self-sustainable energy efficiency improvements. The concept of energy efficiency market shall be introduced and understood for creating and implementing energy efficiency policy.

Energy efficiency market is not exactly one market but a conglomeration of various and very diverse businesses acting in the field and having different interests in energy efficiency realm. Energy efficiency market's supply side includes providers of energy efficient equipment and services as well as institutions involved in financing and implementation of energy efficiency projects (banks, investment funds, design engineers, constructors, etc.). The demand side of energy efficiency market includes project sponsors with ideas for energy efficiency improvements (end-users, i.e. building owners and renters, building managers, public sector institutions and local authorities, industries).

The performance of energy efficiency market is evaluated according to the actual energy efficiency improvements delivered, i.e. according to number of successfully implemented energy efficiency projects. Basically, the energy efficiency market transformation depends on the success of the project development process. Development of an energy efficiency project goes through various stages, from the very initial idea, until the final and actual implementation of the project that operates and yields results in terms of reduced energy consumption and emissions (Fig. 7). Due to various market barriers, only few of a variety of identified opportunities for energy efficiency improvements reach the stage of a bankable project, becoming actually implemented; hence the narrowed pipeline presentation is chosen.

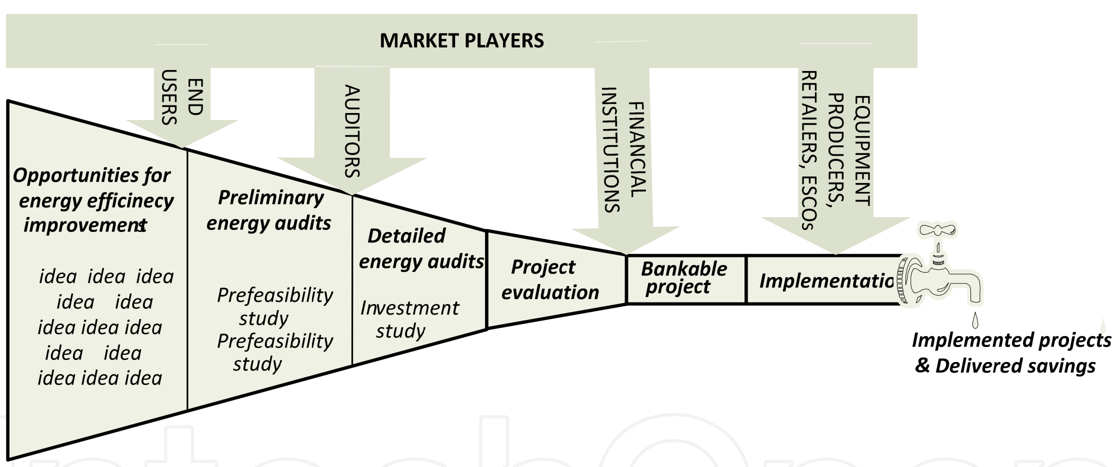


Fig. 7. Understanding energy efficiency projects' development cycle and energy efficiency markets (Bukarica et al., 2007)

3.2. Definition of policy instruments for market transformation

One of the main reasons for energy efficiency policy failure lies in the preference of policy makers to use universal solutions in definition of energy efficiency policy and basically to copy-paste policy instruments from others without considering the specificities of own country's energy efficiency market. There are, of course, some general market barriers for energy efficiency which require such universal solutions (Table 3), but they are not nearly sufficient to provoke market transformation and to fulfil the final goal - creation of self-sustainable energy efficiency market.

Primary Barriers	**Effects**	**Solutions**
Incomplete (imperfect) information	Affects both demand and supply side of EE market leaving the demand underdeveloped and supply side disinterested	Dedicated promotional and informational campaigns; Energy labelling of appliance, equipment, buildings and cars
EE as public goods	Markets tend to undersupply public goods	Stimulating Research and Development of energy efficient technologies; Voluntary agreements with manufacturing industries
Externalities	Energy price does not reflect the adverse environmental and human health effects of energy consumption nor impacts of political instabilities related to energy supply; Positive externalities of improved EE should also be taken into account.	Correct energy pricing and energy taxation; Environmental fees (but usually imposed to large consumers only); Tax credits for EE investments ; Minimal efficiency standards; Utilising purchasing power (green public procurement and consumers' awareness)
Market power (imperfect market structures)	Remains of monopoly in energy sectors prevent development of truly competitive energy markets and restructuring of utilities to become energy service companies; Improper structures of energy prices based on historical average costs and not on short-run marginal costs	Transforming utilities to become energy service companies; Smart metering and real-time pricing; Smart appliances
Secondary Barriers - consequences of primary barriers	**Effects**	**Solutions**
Lack of access to capital	Makes it difficult or impossible to invest in energy efficiency	EE (revolving) funds (as initial driver of demand for energy efficient solutions); Transforming utilities to become energy service companies
Mindset (rather then market) barrier	**Effects**	**Solutions**
Consumers' behaviour	Optimal decisions will not be made regardless sufficient information provided due to bounded rationality	Energy and climate literacy (a top educational priority in schools and in the public discourse)

Table 3. General market barriers to energy efficiency and universal solutions (Morvaj & Bukarica, 2010)

Instead of routine proposals of generic policy instruments, specific status of energy efficiency market in a given jurisdiction has to be understood, and for every stage in the energy efficiency project development process specific barriers must be identified and support policy instruments designed to ensure project pipeline throughput (Bukarica et al. 2007). In other words, policy instruments have to be **tailor-made** for specific market circumstances.

Energy efficiency market has a variety of players with different backgrounds and as such is highly influenced by behavioural, socio-economic and psychological factors that govern market players' decisions. All these influences have to be taken into account when defining policy instruments for energy efficiency improvement. As indicated in the Fig. 8, combination of policy instruments has to be used to remove both supply and demand side barriers, i.e. both supply and demand side have to be addressed simultaneously when markets are "stuck". In other words, producers/service providers have to be stimulated to produce/offer more efficient products/services, while consumers have to be stimulated to by such products/services. What this means is that if there is no demand for energy efficient products/services suppliers are not interested in improving their performance by themselves and vice verso, if there is no efficient products/services offered in the market, there is no demand for them either. Policy instruments have to be designed to move this situation from the deadlock and to fulfil the ultimate goal of market transformation - to achieve public benefits from increased energy efficiency as accepted mode of behaviour (Bukarica et al., 2007).

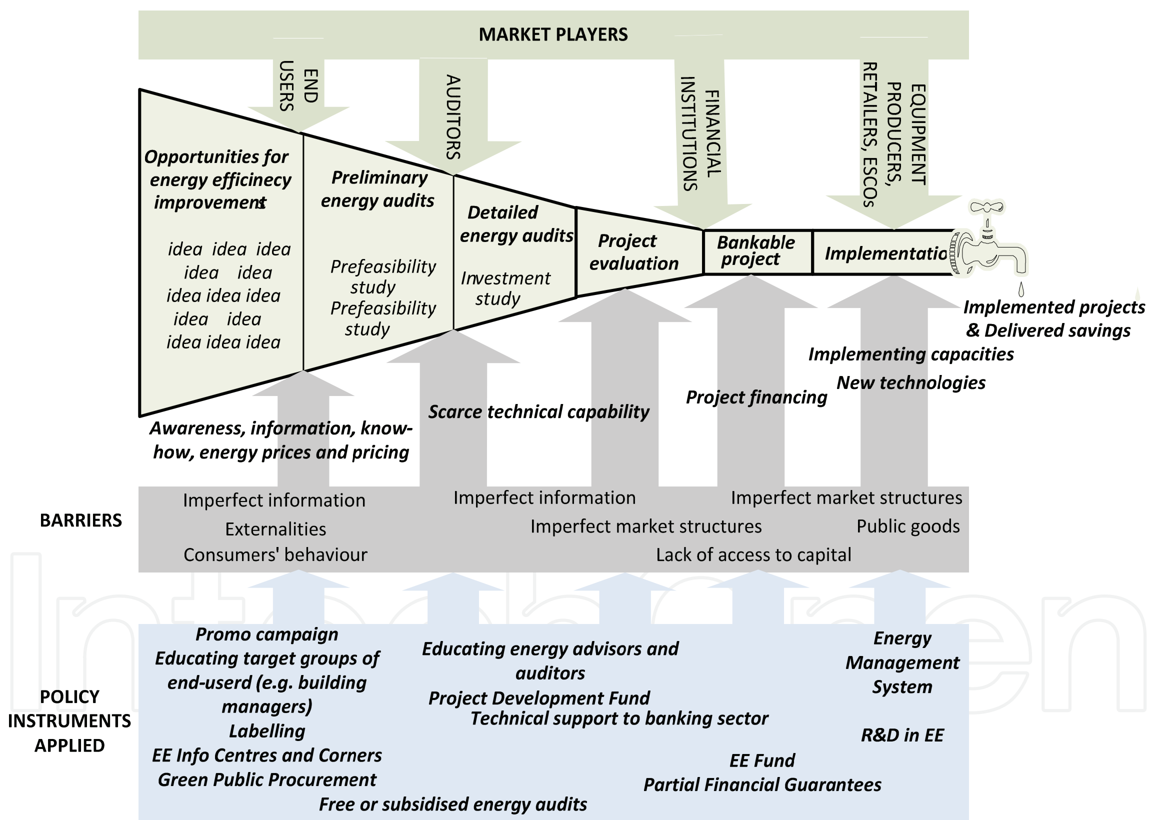


Fig. 8. Defining energy efficiency policy instruments based on actual status of a specific energy efficiency market (Morvaj & Bukarica, 2010) (*Note: the scheme was developed during market assessment and creation of energy efficiency policy in the Republic of Croatia*)

Policy-makers have to understand that policy instruments are not equally relevant at all points in time – the requirement for different instruments vary with maturity of the market and timing of utilisation. Therefore, policies have to be **adaptive** to changing market conditions.

Adaptive policy response means that utilisation of instruments and funding designated for their implementation must correspond to the market demands. E.g. offering partial financial guarantees to the banks will have very modest impact in markets where there is no demand for energy efficiency projects and banks do not find the interest to offer specialised financial products for the. As a general guideline, instruments for awareness raising and technical assistance are more important in developing energy efficiency markets, while with its maturity financial incentives become increasingly desired.

- **Not all policy instruments are suitable for all markets**:
  - Understand the maturity level of country's energy efficiency market and tailor policy instruments to overcome identified barriers;
  - Use experiences of others, but do not copy-paste without taking into account real market situation - what works in one country, does not have to work in other;
  - Every policy instrument has its right timing for implementation - take one step at time to ensure smooth transformation of the market i.e. smooth transition from one phase to another as shown in Fig. 7;
- **Not all policy instruments are suitable for all market players** - be specific in determining target groups for a certain policy instrument (e.g. voluntary agreements are not suitable for households consumers, while appliance labelling will have little to do with large industry consumers);
- **Not all policy instruments are suitable for all energy end-use sectors** (households, public services, private services, industry, and transport) - sectors' specificities shall be taken into account;
- Sometimes it is useful to determine **package of instruments** (combinations of two or more instruments, e.g. building code in combination with subsidies for demonstrating achievement of higher standards or promotion campaign for cleaner transport in combination with subsidies for purchasing hybrid cars) to increase policy effectiveness and efficiency;
- **Identify sectors that can be the best tackled by policy** and that would have the largest immediate and spill-over effects:
  - Experience shows that putting policy focus on public sector is both easiest to implement and it provides the largest spill-over effect to other sectors by demonstrating effects of energy efficiency improvements, but it also has a potential to transform the market in a short span of time due to large purchasing power of the public sector;
  - Buildings usually consume more then 40 percent of country's energy demand, therefore this sector offers the largest potential for energy efficiency improvements (especially existing building stock) that could be achieved through advanced building codes and energy performance standards;
- **Look for local best practices and make them national** - often there are local initiatives in a country that have great results and capability for replication;
- **Be aware of your implementing capabilities** - available budget and, even more important, institutional capacities needed for implementation of policy instruments.

Box 1. "Quick-win" guidelines for designing successful energy efficiency policy instruments

4. Energy efficiency policy implementation

4.1. Understanding implementing environment

The immediate questions aimed at understanding the "implementing environment for energy efficiency policies" are:

- **Who has to do what?** In other words, what are the roles and responsibilities of different stakeholders.
- **Were the implementation has to happen?** The answer, although as simple as possible, is often overlooked - policy needs to be implemented where energy is used everyday – and this is at our places of work and at our homes.

It is very simple fact that all energy delivered is consumed directly by people or indirectly through different institutional and business forms created by people (Fig. 9), during the course of our professional and private life. Therefore, for implementation of energy efficiency measures and a full policy uptake, the mobilisation and cooperation of all stakeholders is needed. The international institutions and efforts form an umbrella of this implementing environment, dictating the framework for policy creation and implementation (as discussed in the section 2). At national level, four key groups of stakeholders, i.e. vertical social structures can be identified (Fig. 9), all of which have their specific roles in energy efficiency policy implementation and their activities (or lack thereof) influence the energy efficiency market.

The primary role of the **public sector institutions** is to ensure national policy implementation in all end-use sectors (households, services, industry and transport). However, at the same time the public sector, same as **businesses**, are the realms where policy is actually being implemented. **Civil society organisations** and **media**, on the other hand, play the key role in providing information and promoting energy efficiency on the wide scale, which will, in the long run, enable changing the consumers' mindset towards more energy efficient behaviour.

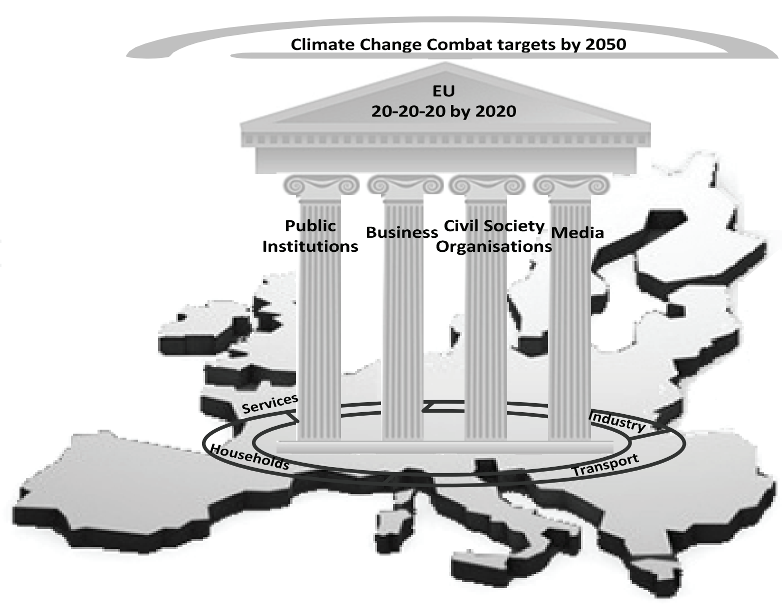


Fig. 9. Main pillars of implementing environment for energy efficiency policy

4.2. Roles and responsibilities of key stakeholders

Public institutions play, with no doubt, pivotal role in enabling and enhancing policy implementation. However, the governments, i.e. competent ministries themselves rarely have the capacities to deal with policy implementation issues. Therefore, in many countries specialised national energy efficiency agencies are established as governmental implementing bodies. They have a crucial role in initiating energy efficiency programmes, coordination of activities and especially in monitoring and evaluation of policy implementation.

To support this statement, a fact that nowadays more than 70 percent of European population lives in cities has to be emphasised. Even more so, in 2009 for the first time in history official statistics have reported that globally more than 50 percent of world population lives in cities. Hence cities are obvious places where vigorous, continuous and focused implementation of energy efficiency measures needs to be carried out by all key stakeholders (see Fig. 3).

Being closest to places where energy is consumed and still having executive powers, local authorities more than ever have a pivotal role to play at reducing energy consumption. Actions that local authorities (and public sector in general) should undertake are twofold:

- Firstly, energy consumption in facilities and services in their jurisdiction should be properly managed. This means that local authorities shall demonstrate their commitment by implementing energy efficiency improvement measures in all buildings in their jurisdiction (office buildings, schools and kindergartens, hospitals, etc.) as well as in public services they provide (public lighting, transport, energy and water supply).
- Secondly, information must be made publicly available and cooperation with civil society organisations, businesses and media has to be established to improve citizens' awareness and facilitate change of energy related behaviour and attitude.

Building local capacities to perform these activities is the most important precondition for successful policy implementation and delivering policy targets. Introduction of full-scale energy management is instrumental there, which could be a backbone for evolution of "smart cities" and sustainable urban development (Paskaleva, 2009).

In all business sectors, the climate change awareness and social responsibility are driving companies to demonstrate their "greenness". The new "green" revolution in the corporative world is led by the biggest - Google and Microsoft are going solar, Dell is committed to neutralising carbon impact of its operations, Wal-Mart aims at completely renewable energy supply, crating zero waste and selling products that sustain resources and the environment (Stanislaw, 2008). However, while corporations do have money and human capacities to turn their business towards more efficient and environmentally friendly solutions, small and medium enterprises (SMEs) need role-models and support to improve their energy efficiency, hence the overall business performance. The 2007 Observatory of EU SMEs indicates that only 29 percent of SMEs have instituted some measures for preserving energy and resources (46 percent in the case of large enterprises) and that only 4 percent of EU SMEs have a comprehensive system in place for energy efficiency, which is much lover then for large enterprises (19 percent) (European Commission, 2009). Again, energy management is the solution.

And finally, policy makers together with civil society organisations, businesses and media have to work together to ensure that energy and climate change literacy (Stanislaw, 2008) becomes a top educational priority in schools and in the public discourse. In this task, civil

society organisations and media have particularly important role, since they formulate the public opinion and are able to establish a new "green" ethic in rising generations.
Therefore, the solution for ensuring proper implementing environment for energy efficiency policies lies in bringing together and mobilizing for action all stakeholders so that every pillar of the society contributes fully according to their own means for achievement of energy efficiency policy targets. Strong links, as demonstrated in Fig.10, between each and every stakeholder shall be established, not only whilst implementing policy, but immediately during the process of energy efficiency policy design. Either link is equally important as the current practice has indicated that policy making lacking feedback from all stakeholders results in weak and slow implementation. The Fig. 10 aims to illustrate the need for stakeholders' interactions in various energy efficiency activities, and points that such coordinated and collaborative approach will influence citizens and eventually transform the market and society towards higher efficiency.

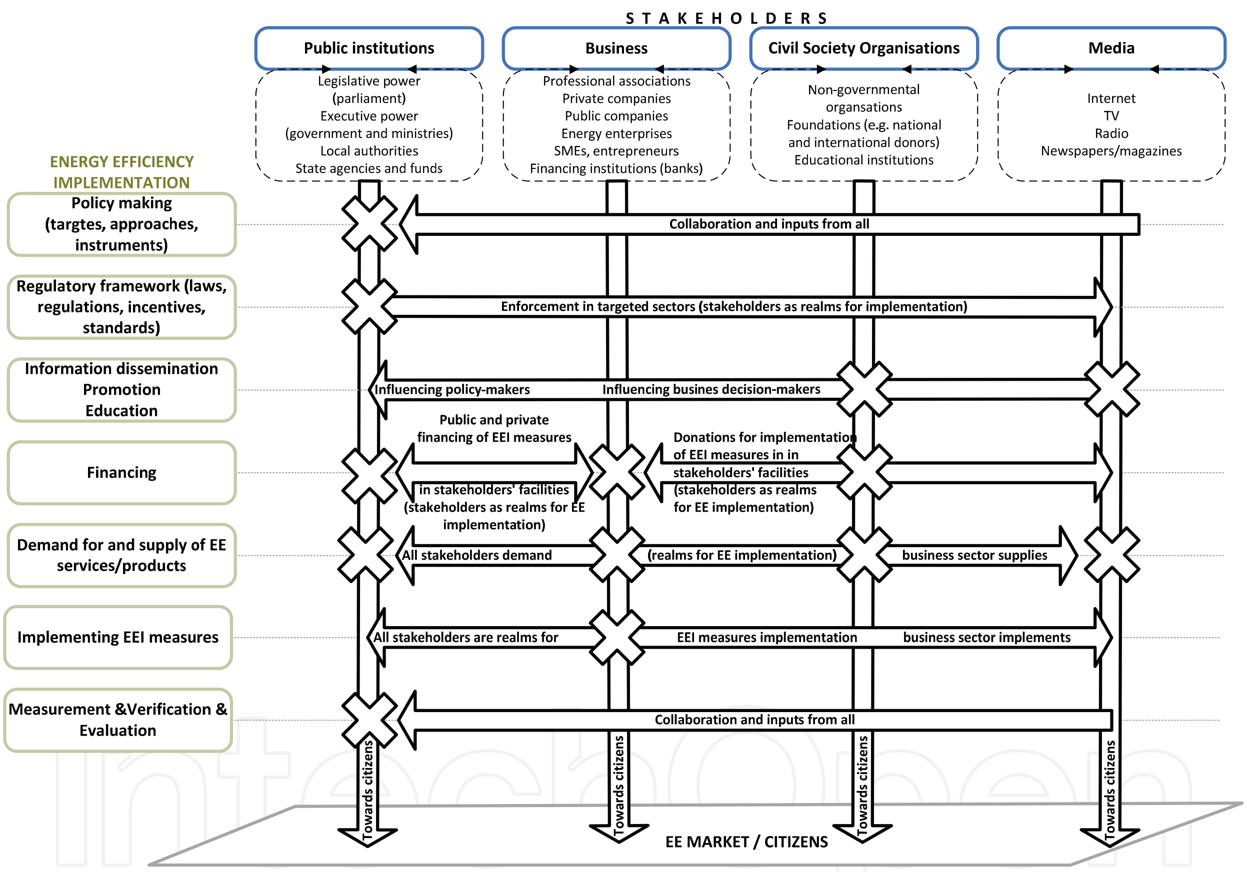


Fig. 10. Stakeholders' interactions in different energy efficiency activities

4.3 Building implementing capacities through Energy Management System

Implementing capacities can be successfully strengthen through the process known as Energy Management System (EMS). It comprises a specific set of knowledge and skills based on organizational structure incorporating the following elements:

- people with assigned responsibilities
- energy efficiency monitoring through calculation and analysis of:
  - energy consumption indicators
  - energy efficiency improvement targets

- continuous measuring and improvement of efficiency.

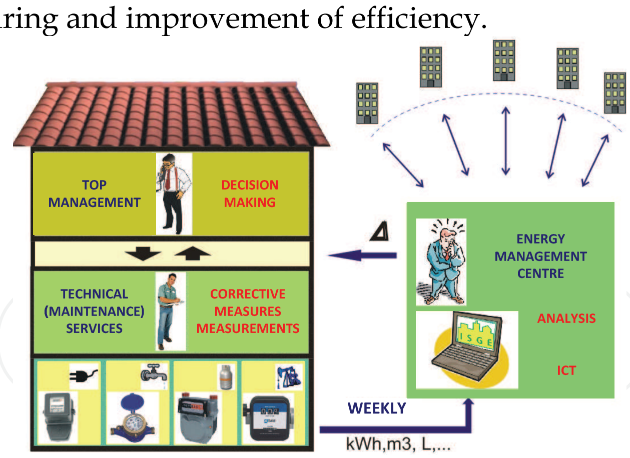


Fig. 11. Concept of energy management system (Note: EMS is equally applicable in public and business sector)

The process of introducing energy management starts from the decision of adopting an energy management policy statement. It then leads to an energy management action plan being adopted at the top management level. Measurable goals to be achieved are set within the plan. The plan with defined goals is made public. This act ensures a constant support of the top management and all employees to the implementation of energy management project. This is followed by introduction of organizational infrastructure to deliver the plan. A dedicated energy management team is appointed which assumes the obligation of overall energy management on the level of a city or a company. Furthermore, every facility in the structure of a company or in the ownership of a city has to have a person (usually technical or maintenance) appointed as the one responsible for the local energy management. And finally, all members of energy management team shall be adequately educated and trained to perform their tasks. This way capacities and capabilities for implementation of energy efficiency projects are ensured. Additionally, they need to be supported by appropriate ICT tool for continuous collection, storage, monitoring and analysis of data on energy consumption. Moreover, energy management team is also responsible for further educational and promotional activities to change employees' behaviour and attitudes towards energy consumption at the work place and for initiating green public procurement activities to stimulate market transformation by utilizing public sector's huge purchase power. And last, but not the least, energy management teams, especially those established within pubic sector (i.e. local authorities) are reaching out to the citizens by publicly announcing their activities and by providing advisory services. This comprehensive process of energy management system introduction is shown in the Fig. 12. Although it shows the process applied in the cities, it could be easily adjusted for business sector as well.

Once it is understood that policy implementation is happening locally, capacitating both public and commercial business market players for implementing energy efficiency policy through systematic introduction of energy management practices becomes the key to the policy success.

Another look at the Fig. 8 reminds us that implemented projects are only vehicle that deliver actual energy consumption reductions and they appear merely like a drops at the end of pipeline that involves huge number of actors, actions, barriers and instruments to overcome them. Without strong, focused, competent and effective capacities for implementing energy efficiency policies it is unlikely to expect that projects would flow from the pipeline and that the targets would be delivered.

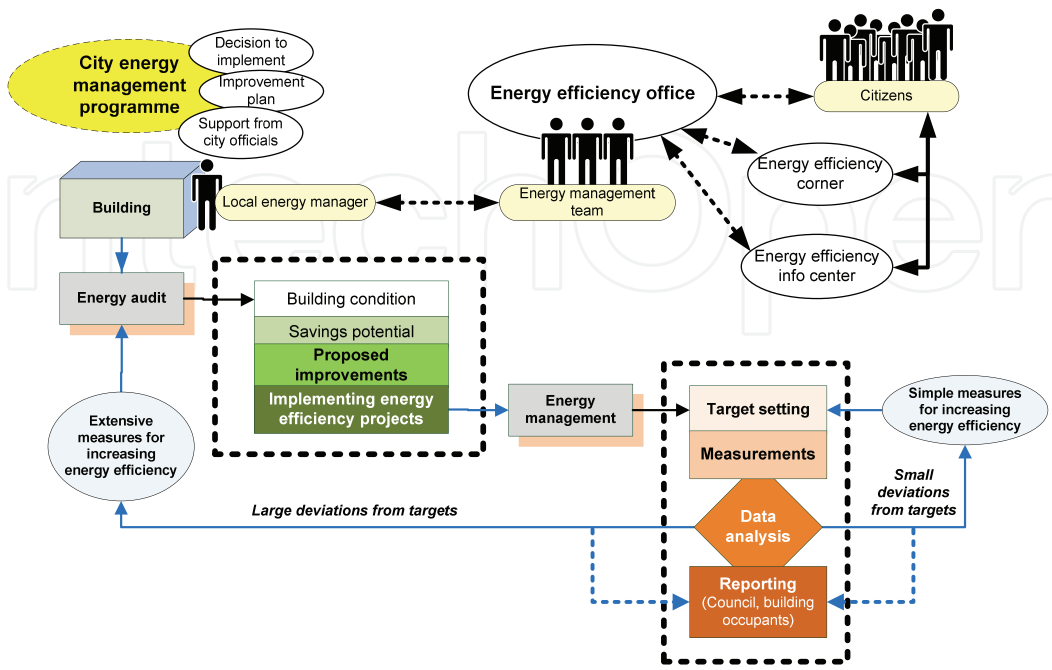


Fig. 12. Energy management process in a city (Note: The scheme is applied in the cities of the Republic of Croatia. The process is easily adjusted for business sector.) (Morvaj et al., 2008)

5. Evaluating energy efficiency policy: measurement and verification (M&V)

5.1. General issues on policy evaluation

In the energy efficiency policy cyclic loop policy evaluation has an essential position, although it might not appear so. Namely, evaluation procedures are at the same time an integral part of policy design phase as well as both parallel and consecutive activity to policy implementation.

The first step in policy design shall be establishment of a plausible theory on how a policy instrument (or a package of instruments) is expected to lead to energy efficiency improvements (Blumstein, 2000). Based on well-reasoned assumptions (theory) policy instruments mix shall be created. Well-reasoned means that strong believe exists that exactly this instrument will lead to cost-beneficial improvements in energy efficiency market performance. Policy makers should have as precise as possible conception of impacts that policy instrument will deliver, prior to its implementation. This is referred to as ***ex-ante*** or beforehand policy evaluation during which impacts (social, technological and financial) of policy instruments are forecasted. Expected impact in terms of reduced energy consumption and cost-effectiveness of the instruments are evaluated and compared to business-as-usual scenario in which no instruments are applied. However, often policymakers do not have enough experience and knowledge to confirm the established theory is right. Therefore, policymaking has to be publicly open process involving all stakeholders and market actors that could contribute to the overall understanding how the policy instrument is intended to work.

Unlike *ex-ante* evaluation of a policy, *ex-post* approach is applied after a certain time of the policy instrument implementation, effects of which should be evaluated to answer two key questions (Joosen& Harmelink, 2006):

- What was the contribution of policy instrument in the realisation of policy targets (**effectiveness of policy instruments**)?
  - Effectiveness of a policy instrument is measured as its net impact in the relation to the policy target set in the design phase. Net impact is equal to the difference between amount of energy used prior and after instrument is implemented. These are net energy savings but also related net CO_2 emission reductions that can be attributed to specific energy efficiency instrument taking free rider, spill over, rebound effect and other possible effects into account. Net impact is determined according to the previously defined baseline scenario.
- What was the **cost effectiveness of policy instruments**, and could targets have been reached against lower costs?
  - Cost effectiveness is the ratio between the additional costs caused by the instrument for the end-user, the society as whole or the government, and the net impact of the investigated instrument. Government costs are related to implementation, administration, enforcement of regulations, monitoring and evaluation, subsidies and tax relieves. In other words, cost effectiveness is used to determine how well public money is used to achieve socially beneficial goals. For end-users costs are determined by energy price, marginal investment and marginal operation and maintenance costs of energy efficiency measure.

However, instruments of energy efficiency policies might have other effects as well, so the third question it should be raised is:

- What **other impacts** did the policy achieved outside its main realm?
  - Most usually mentioned side effects of energy efficiency policy are environmental benefits and creation of new jobs, which are a positive effects in terms of ecological, social and economic stability and progress. However, sometimes negative effects are also possible to appear. E.g. CFLs are using far less energy and have longer life time and in a world's combat against climate change they are now starting to completely replace "old" incandescent light bulbs. However, CFLs do bring some other hazards, like small amount of highly toxic mercury they contain. Policy makers have to be aware of these relationships and often trade-offs have to be done - in this case, the trade-off has to be done between efficiency and potential health risk.

Answering these questions is referred as *ex-post* evaluation. It goes beyond evaluation of final delivered energy savings and tries to reveal success and failure factor enhancing in that way our knowledge about market performance. Enhanced knowledge gives the opportunity to improve effectiveness of policy instruments and to redefine our policy. Here both qualitative and quantitative assessments are needed and should be preferably supported by empirical data about policy performance. The backbone is cause-impact relationship, supplemented by indicators that measure the existence of cause-impact relationship, then failure and success factors should be listed (qualitative) and relationships with other policy instruments should be emphasised (other instruments can enhance or mitigate the impact of analysed instrument). In evaluation process empirical data are also very important as they are additional and often the only indicators of certain instruments impacts.

Both *ex-ante* and *ex-post* evaluation need to be supported with quantitative data, i.e. with data on energy efficiency improvements actually realised by implementation of policy instruments and energy efficiency improvement projects. The tools used for this purpose are referred to as **measurement and verification (M&V)** of energy savings. M&V is absolutely crucial part of any energy efficiency policy – it captures the overall improvement in energy efficiency and assesses the impact of individual measures. M&V procedures include two major methodological approaches: **top-down** and **bottom-up**. Both approaches must be combined to appropriately and as exact as possible evaluate the success of national energy efficiency policy and the magnitude of energy efficiency improvement measures' impact. Both approaches will be briefly explained hereafter, although it has to be emphasised that the detailed elaboration of M&V principles goes far beyond the scope of this chapter.

5.2. Top-down M&V methods

A top-down calculation method means that the amount of energy savings is calculated using the national or large-scale aggregated sectoral levels of energy saving as a starting point. This is purely statistical approach, often referred to as "energy efficiency indicators" because it gives an indication of developments.

Top-down methodology is based on collection of extensive data sets for not only energy consumption but also for various factors influencing it, and on calculation and monitoring of energy efficiency indicators. There are six types of indicators most commonly used. These are as follows[1].

1. **Energy intensity** – ratio between an energy consumption (measured in energy units: toe, Joule) and an indicator of activity measured in monetary units (Gross Domestic Product, value added). Energy intensities are the only indicators that can be used every time energy efficiency is assessed at a high level of aggregation, where it is not possible to characterize the activity with a technical or physical indicator, i.e. at the level of the whole economy or of a sector.
2. **Unit consumption or specific consumption** – relates energy consumption to an indicator of activity measured in physical terms (tons of steel, number of vehicle-km, etc.) or to a consumption unit (vehicle, dwelling …).
3. **Energy efficiency index (ODEX)** – provides an overall assessment of energy efficiency trends of a sector. They are calculated as a weighted average of detailed sub-sectoral indicators (by end-use, transport mode...). A decrease means an energy efficiency improvement. Such index is more relevant for grasping the reality of energy efficiency changes than energy intensities.
4. **Diffusion indicators** – there are three types of such indicators: (i) market penetration of renewables (number of solar water heaters, percentage of wood boilers for heating, etc.); (ii) market penetration of efficient technologies (number of efficient lamps sold, percentage of label A in new sales of electrical appliance, etc.); (iii) diffusion of energy efficient practices (percentage of passenger transport by public modes, by non motorised modes; percentage of transport of goods by rail, by combined rail-road transport, percentage of efficient process in industry, etc.). Diffusion indicators have been introduced to complement the existing energy

[1] These indicators are developed within ODYSSEE project and are used Europe- wide. More can be found at: http://www.odyssee-indicators.org/

efficiency indicators, as they are easier to monitor, often with a more rapid updating. They aim at improving the interpretation of trends observed on the energy efficiency indicators.

5. **Adjusted energy efficiency indicators** – account for differences existing among countries in the climate, in economic structures or in technologies. Comparisons of energy efficiency performance across countries are only meaningful if they are based on such indicators. External factors that might influence energy consumption include: (a) weather conditions, such as degree days; (b) occupancy levels; (c) opening hours for non-domestic buildings; (d) installed equipment intensity (plant throughput); product mix; (e) plant throughput, level of production, volume or added value, including changes in GDP level; (f) schedules for installation and vehicles; (g) relationship with other units. Some of these factors are relevant for correction of aggregated indicators, while some are to be used for the individual facilities in which energy efficiency measures are implemented.
6. **Target indicators** – aim at providing reference values to show possible target of energy efficiency improvements or energy efficiency potentials for a given country. They are somehow similar to benchmark value but defined at a macro level, which implies a careful interpretation of differences. The target is defined as the distance to the average of the 3 best countries; this distance shows what gain can be achieved.

The main advantages of the usage of top-down methods is their simplicity, lower costs and reliance on the existing systems of energy statistics needed for development of a country's energy balance. On the other hand, these indicators do not consider individual energy efficiency measures and their impact nor do they show cause and effect relationships between measures and their resulting energy savings. Developing such indicators requires huge amount of data (not only energy statistics, but whole set of macro and microeconomic data that are influencing energy consumption in all end-use sectors is needed), and data availability and reliability are often questionable in practice, sometimes leading to the huge need for modelling and expert judgement to overcome the lack of data. Nevertheless, energy efficiency indicators are inevitable part of energy efficiency evaluation process (both *ex-ante* and *ex-post*) as they are the only means to benchmark own performance against the performance of others, to reveal the potentials and help determine policy targets, to quantify the success/failure of the policy instruments and to track down the progress made in achieving the defined targets.

5.3. Bottom-up M&V methods

A bottom-up M&V method means that energy consumption reductions obtained through the implementation of a specific energy efficiency improvement measure are measured in kilowatt-hours (kWh), in Joules (J) or in kilogram oil equivalent (kgoe) and added to energy savings results from other specific energy efficiency improvement measures to obtain an overall impact. The bottom-up M&V methods are oriented towards evaluation of individual measures and are rarely used solely to perform evaluation of overall energy efficiency policy impacts. However, they should be used whenever possible to provide more details on performance of energy efficiency improvement measures. Bottom-up methods include mathematical models (formulas) that are specific for every measure, so only the principle of their definition will be briefly explained hereafter.

M&V approach boils down to the fact that the absence of energy use can be only determined by comparing measurements of energy use made before (baseline) and after (post-retrofit) implementation of energy efficiency measure or expressed in a simple equation:

$$\text{Energy Savings} = \text{Baseline Energy Use} - \text{Post-Retrofit Energy Use} \pm \text{Adjustments} \qquad (2)$$

The baseline conditions can change after the energy efficiency measures are installed and the term "Adjustments" (can be positive or negative) in equation (2) aiming at bringing energy use in the two time periods (before and after) to the same set of conditions. Conditions commonly affecting energy use are weather, occupancy, plant throughput, and equipment operations required by these conditions. These factors must be taken into account and analysed after measure is undertaken and adjustments have to be made in order to ensure correct comparisons of the state pre- and post-retrofit. This kind of M&V scheme (often referred to as *ex-post*) may be very costly but they guarantee the detections of real savings. The costs are related to the actual measurement, i.e. to the measurement equipment. To avoid a large increase in the M&V costs, only the largest or unpredictable measures should be analysed through this methodology.

Individual energy efficiency projects might also be evaluated using well reasoned estimations of individual energy efficiency improvement measures impacts. This approach (*ex-ante*) means that certain type of energy efficiency measure is awarded with a certain amount of energy savings prior to its actual realisation. This approach has significantly lower costs and is especially appropriate for replicable measures, for which one can agree on a reasonable estimate. There are also some "hybrid" solutions that combine *ex-ante* and *ex-post* approaches in bottom-up M&V. This hybrid approach is often referred to as *parameterised ex-ante* method. It applies to measures for which energy savings are known but they may differ depending on a number of restricted factors (e.g. availability factor or number of working hours). The set up of a hybrid approach can be more accurate than a pure ex-ante methodology, without a substantial increase of the M&V costs.

5.4. Establishing evaluation procedures supported by M&V

The success of national energy efficiency policy has to be constantly monitored and its impact evaluated. Findings of evaluation process shall be used to redesign policies and enable their higher effectiveness. Regardless to its importance, policy evaluation is often highly neglected. Policy documents are often adopted by governments and parliaments and afterwards there is no interest for impacts they have produced. Therefore, setting up the fully operable system for evaluation of energy efficiency is a complex process, which requires structural and practice changes among main stakeholders in policy making. Additionally, it has to be supported by M&V procedures, which require comprehensive data collection and analysis systems to develop energy efficiency indicators that will quantify policy effects.

6. Conclusion

Evidently, energy efficiency policy making is not one-time job. It is a continuous, dynamic process that should create enabling conditions for energy efficiency market as complex

system of supply-demand interactions undergoing evolutionary change and direct that change toward efficiency, environmental benefits and social well-being. However, there are number of barriers preventing optimal functioning of energy efficiency market, which should determine the choice of policy instruments. Policy instruments have to be flexible and able to respond (adapt) to the market requirements in order to achieve goals in the optimal manner, i.e. to the least cost for the society. Due to fast changing market conditions, Policy instruments can no longer be documents once produced and then intact for several years. Continuous policy evaluation process has to become a usual. Future research work to support policy making shall be exactly directed towards elaboration of methodology that will be able to qualitatively and quantitatively evaluate effectiveness and cost-effectiveness of policy instruments and enable selection of optimal policy instruments mix depending on current development stage of the energy efficiency market.
Evaluation procedures will advance and deepen our knowledge on success or failure factors of energy efficiency policy. The analysis of current situation shows that policies world-wide tend to fail in delivering desired targets in terms of energy consumption reduction. The main reason lies in the lack of understanding and focus on implementing adequate capacities, which are far too underdeveloped, insufficient and inappropriate for ambitious goals that have to be achieved. It has to be understood that policy implementation will not just happen by it self, and that capacities and capabilities in all society structures are needed. Embracing full-scale energy management systems in both public service and business sector can make the difference. Additionally, with the positive pressure from civil society organisations and media, understanding the interdependences of energy and climate change issues will improve, gradually changing the society's mindset towards higher efficiency, and eventually towards the change of lifestyle.

7. References

Morvaj, Z. & Bukarica, V. (2010). Immediate challenge of combating climate change: effective implementation of energy efficiency policies, *paper accepted for 21st World Energy Congress,* 12-16 September, Montreal, 2010

Morvaj, Z. & Gvozdenac, D.(2008). *Applied Industrial Energy and Environmental Management*, John Wiley and Sons - IEEE press, ISBN: 978-0-470-69742-9, UK

Dennis, K. (2006). The Compatibility of Economic Theory and Proactive Energy Efficiency Policy. *The Electricity Journal*, Vol. 19, Issue 7, (August/September 2006) 58-73, ISSN: 1040-6190

European Commission. (2006). *Action Plan for Energy Efficiency COM(2006)545 final*, Brussels

Eurostat. (2009). *Energy, transport and environment indicators*, Office for Official Publications of the European Communities, ISBN 978-92-79-09835-2, Luxembourg

European Environment Agency. (2009).*Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009*, Office for Official Publications of the European Communities, ISBN 978-92-9167-980-5, Copenhagen

European Commission. (2009). *Draft Communication from the Commission to the Council and the European Parliament: 7 Measures for 2 Million New EU Jobs: Low Carbon Eco Efficient & Cleaner Economy for European Citizens*, Brussels

Bukarica, V.; Morvaj, Z. & Tomšić, Ž. (2007). Evaluation of Energy Efficiency Policy Instruments Effectiveness – Case Study Croatia, *Proceedings of IASTED International conference "Power and Energy Systems 2007"*, ISBN: 978-0-88986-689-8, Palma de Mallorca, August, 2007, The International Association of Science and Technology for Development

Briner, S. & Martinot, E. (2005). Promoting energy-efficient products: GEF experience and lessons for market transformation in developing countries. *Energy Policy*, 33 (2005) 1765-1779, ISSN: 0301-4215

Vine, E. (2008). Strategies and policies for improving energy efficiency programs: Closing the loop between evaluation and implementation. *Energy Policy*, 36 (2008) 3872–3881, ISSN: 0301-4215

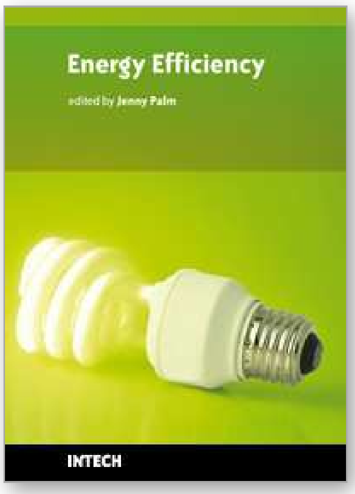
Bulmstein, C.; Goldstone, S. & Lutzenhiser, L. (2000). A theory-based approach to market transformation, *Energy Policy*, 28 (2000) 137-144, ISSN: 0301-4215

Paskaleva, K. (2009). Enabling the smart city: The progress of e-city governance in Europe. *International Journal of Innovation and Regional Development*, 1 (January 2009) 405–422(18), ISSN 1753-0660

Stanislaw, J.A. (2008). *Climate Changes Everything: The Dawn of the Green Economy*, Delloite Development LCC, USA

Morvaj, Z. et al. (2008). Energy management in cities: learning through change, *Proceedings of 11th EURA conference, Learning Cities in a Knowledge based Societies*, 9-11 October 2008, Milan

Joosen, S. & Harmelink, M. (2006). *Guidelines for the ex-post evaluation of 20 energy efficiency instruments applied across Europe*, publication published within AID-EE project supported by Intelligent Energy Europe programme.



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Global warming resulting from the use of fossil fuels is threatening the environment and energy efficiency is one of the most important ways to reduce this threat. Industry, transport and buildings are all high energy-using sectors in the world and even in the most technologically optimistic perspectives energy use is projected to increase in the next 50 years. How and when energy is used determines society's ability to create long-term sustainable energy systems. This is why this book, focusing on energy efficiency in these sectors and from different perspectives, is sharp and also important for keeping a well-founded discussion on the subject.

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