INTERNATIONAL ENERGY FORUM

IEF Symposium on Energy Efficiency in Developing Countries

Hosted by the Ministry of Energy and Mines,
21-22June 2011, Jakarta, Indonesia

Background Paper

1 - Background

There is growing support for energy efficiency across the international community.

The G8 Heads of State meetings in 2005 Gleneagles, 2006 St Petersburg, 2007 Heiligendamm and 2008 Hokkaido Toyako reaffirmed the critical role that improved energy efficiency can play in addressing energy security, environmental and economic objectives.

In addition, the G20 Heads of state meeting in Pittsburgh in 2009 affirmed that "*Enhancing our energy efficiency can play an important, positive role in promoting energy security and fighting climate change*" and committed to "*Stimulate investment in clean energy, renewables, and energy efficiency and provide financial and technical support for such projects in developing countries*".

The first Ministerial meeting on Clean Energy in Washington, D.C[1], launched 11 initiatives to accelerate the global transition to clean energy. On Energy Efficiency the meeting launched five initiatives/programs as part of a Global Energy Efficiency Challenge to help cut energy waste around the world. These programs will help bring super-efficient consumer appliances to growing global markets, target energy savings in the buildings sector, improve the energy efficiency of industrial processes, and encourage the deployment of millions of electric vehicles.

The 11th IEF Ministerial meeting in Rom affirmed that improving energy efficiency through action plans, sectoral approaches and sharing of best practices in energy production, transportation and consumption is cost-effective and beneficial for both producing and consuming countries in enhancing energy market stability, environmental sustainability and economic development.

The 12th IEF Ministerial meeting in Cancun and the 4th Asian Ministerial Energy Roundtable in Kuwait welcomed the forthcoming IEF Energy Efficiency Symposium in 2011 and appreciated the commitment expressed by Japan to sponsor this event through an extra financial contribution. Ministers look forward to discussing findings and recommendations from the Symposium at the 13th IEF Ministerial in Kuwait in 2012.

2 - Introduction

The availability of reliable, affordable and secure energy is fundamental to economic stability and development. Energy is essential to humans in their daily lives and responsible for powering transportation, providing heat and driving the machinery that fuels the global economy. Global population is expected to grow from 6.6 billion today to more than 8 billion by 2035[2]. World Energy demand is growing significantly especially in developing countries due to rapid industrialization. Providing energy services to the world's growing population is challenge complicated by the need to reduce greenhouse gas (GHG) emissions and increasing energy

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[1] Clean Energy Ministerial meeting 19th July 2010 Washington, D.C.: Australia, Belgium, Brazil, Canada, China, Denmark, the European Commission, Finland, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, Norway, Russia, South Africa, Spain, Sweden, the United Arab Emirates, the United Kingdom, and the United States.

[2] United Nations Department of Economic and Social Affairs (UNDESA)

security. Most credible projections indicate that energy demand will increase by around 40 per cent by 2030 compared to the current level. Developing countries will account for most of these increases, by virtue of higher population and economic growth. However, a large part of the world population will continue to lack access to modern energy services.

Of all the energy options, the improvement of energy efficiency can provide the largest amount of energy in the future through many cost-effective opportunities while at the same time reducing greenhouse gas emissions. Many of these opportunities can be attained in a shorter timescale (and in a manner compatible with economic growth) than can investments in clean energy supply infrastructure, which though also needed. In addition, many energy efficiency measures can pay for themselves through reduced energy costs. Energy efficiency generates new income of its own, makes industries more competitive, improves consumer welfare and creates business opportunities. Despite the benefits, energy efficiency potential remains largely untapped. Factors such as irrational energy prices, perceived risks, technology availability, weak institutions, lack of information and skilled resources have hindered market development.

Energy efficiency meets major objectives of both developed and developing countries, whether importers or exporters of energy, and has been considered to be top of the list on most energy-policy proposals.

The objective of this paper is to provide background on the key issues to be discussed and debated at the IEF Symposium on Energy Efficiency in Developing Countries being held in Jakarta, Indonesia on the 21st and 22nd June 2011. The symposium will discuss the possibilities for energy efficiency improvements in developing countries and policy approaches to realise the full potential of energy efficiency. The Symposium will also discuss how best practices in developed countries can be shared with developing countries through technology sharing, cooperative schemes either among countries or through private public partnership.

The key topics to be addressed by participants include: energy efficiency as a solution for meeting the world's energy demand; drivers and barriers to energy efficiency; energy efficiency management across the demand and supply sides; policies, incentives and regulations for the promotion of energy efficiency in developing countries and the way forward towards more energy efficiency world.

3 - Energy efficiency: solution for meeting the world's energy demand

To start with there is a need to define what energy efficiency is. From an engineering perspective, efficiency in general is the ratio of outputs to inputs in any process. However, discussions of energy efficiency have come to mean increasing/improving energy efficiency. In this respect, reducing energy use is clearly part of the equation, but not the entire answer. "*Energy efficiency means getting the same benefit while using less energy – reducing the energy input required by a process without changing its output, either in quality or quantity. Efficiency means increasing the productivity of each unit of energy used. Sacrifice is not the point – efficiency should be economically and socially non-destructive*"[3].

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[3] World Economic Forum (WEF) and IHS CERA, "Towards a More Energy Efficient World", 2010

Increasing population together with economic growth in many developing countries has caused rapid changing of their energy consumption patterns in recent years. Controlling domestic oil and gas demand growth in producing countries is important to protect their export potential revenues. With the advent of existing energy efficiency technologies, there is huge potential to manage and control the demand growth in these countries. In addition, by improving energy efficiency, the producing countries could reduce domestic energy consumption and release energy resources to enhance the security of supply for importing countries.

The economic growth in the developing countries and the associated growth in global energy consumption provide a strong motivation for energy efficiency. Emerging countries and industrialized countries have become aware that energy efficiency is an important prerequisite to accommodating the expected economic growth and growth in energy consumption.

For example, demand for energy is growing significantly in most Asian countries due to rapid industrialization. According to a study by UNEP et.al[4], the five most energy intensive industrial sub -sectors include iron and steel, petroleum refining, cement production, pulp and paper, and chemicals account for approximately 45 percent of all industrial energy consumption in the region. A large amount of the energy consumed by the Asian industrial sector can be attributed to a lack of awareness in energy management, weak energy measures and policies. In this respect, studies indicate that as much as 23 percent of industrial end -use energy is wasted through inefficiency. Hence, finding ways to increase energy efficiency in the industrial sector in Asia is important because the global climate and the region's energy security are dependent on it. One of the key tools to achieve this goal is the implementation of energy efficiency polices.

Energy efficiency is instrumental in advancing economic and social development. In Africa for example, energy efficiency plays a role in helping to address the energy access and electrification challenge, and doing so affordably[5]. Energy efficiency is prevalent through the government's energy efficiency strategy and the National Business Initiative's Energy Efficiency Accord.

The issue of energy efficiency is therefore essential and vital for sustaining and securing the world's energy demand; "Energy efficiency will be the single most important source of energy available to the world's economies in the years to come"[6]. However, is often not given the right amount of attention it deserves.

Moreover, energy efficiency will contribute significantly to meeting the climate change challenge through reductions in GHG emissions and more generally improve the environment. Amongst limited feasible technical options currently available to help reduce the rate of growth of GHG emissions produced by the energy sector, energy efficiency technologies remain the most cost-effective. This is shown in numerous analyses by various organisations. According to the 450 Scenario[7], by 2030 energy efficiency will account for over half of the reduction in greenhouse gas

[4] United Nations Environment Programme (UNEP) et al, "Improving energy efficiency in industry in Asia, a policy review" 2006.
[5] The Energy Efficiency Investment Forum: Scaling Up Financing in the Developing World, Oct. 2006
[6] Rex Tillerson, Energy Efficiency – Unleashing the Power of Ingenuity.
[7] IEA World Energy Outlook, 2010

emissions. As such, many economies would benefit from developing clear goals and action plans towards improving energy efficiency in all sectors. There is abundant potential for energy efficiency improvements in the power generation, industrial, transportation, public, residential and commercial sectors.

Energy efficiency is therefore rapidly becoming one of the most critical policy tools around the world in meeting the substantial growth in energy demand. By all accounts, energy efficiency programs have always represented a win-win-win option[8] by providing positive returns to the government, energy consumers and the environment. Such programs can: conserve natural resources; reduce the environmental pollution and carbon footprint of the energy sector; ease infrastructure bottlenecks and impacts of power shortfalls; and improve industrial and commercial competitiveness through reduced operating costs.

However, energy efficiency gains from innovation are not easily realized. The full potential of energy efficiency fl can only be achieved with the combination of long-term investment; sound and stable policies from government; and the widespread use of energy-saving technologies and practices by consumers. Like all other energy challenges, the key to increasing energy efficiency is technology. The key to developing and deploying new technology is controlled investments and incentivised policies.

In addition, there is the issue of "energy efficiency gap" and how can we bridge this gap? According to Makovich[9], "energy efficiency gap is the difference between available cost-effective efficiency options and those that are actually implemented". Jaffe and Stavins[10] defined the "energy efficiency gap as the gap exists between current or expected future energy use, on the one hand, and optimal current or future energy use, on the other hand". The IEA report "Mind the Gap" recognised that an energy-efficiency gap exists between actual and optimal energy use. That is, significant cost-effective energy efficiency potential is wasted because market barriers prevent countries from achieving optimal levels. According to the report the market barriers take many forms, from inadequate access to capital, isolation from price signals, information asymmetry, and split-incentives. The critical question here is how to define and quantify the optimal level of energy use and efficiency?

Regarding the historical trends in energy efficiency, results from IEA[11] indicator analysis show that improvements in energy efficiency over the past three decades have played a key role in limiting global increases in energy use and CO2 emissions. Analysis for 16 IEA countries reveals that improved energy efficiency since 1990 led to annual energy savings of more than 16 EJ in 2005, which is equivalent to 1.3 Gt of avoided CO2 emissions and represents an estimated USD 180 billion of energy cost savings. However, the rate at which energy efficiency has improved since 1990 has been much slower than in the previous two decades.

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[8] McKinsey & Company, 2009. "Carbon Abatement Opportunities and Methodology" Presentation at the International Finance Corporation: Washington, D.C., September 2009.

[9] *Lawrence J. Makovich, Vice-President and Senior Advisor, IHS CERA,* "Energy Efficiency – An Investment Perspective", 2010

[10] Adam B Jaffe and Robert N Stavins, "The energy-efficiency gap," Energy Policy 1994 22 (10) 804-810

[11] International Energy Agency (IEA), "Worldwide Trends in Energy Use and Efficiency, in support of the G8 Plan of Action", 2008

A study by the World Energy Council (WEC)[12] shows that the amount of energy used per unit GDP is decreasing steadily in most world regions: 1.6% p.a. on average at the world level between 1990 and 2006. Almost two thirds of the countries in the world have decreased their energy intensity over this period - 40% (of the 70 countries reviewed) by more than 1% p.a. China experienced a significant improvement in its energy productivity between 1990 and 2000, at around 7.5% p.a., as a result of various factors: more efficient use of coal, switch from coal to oil, industry restructuring and higher energy prices. After 2000 this trend has however slowed down significantly, to slightly less than 1% p.a. In 2006 the Chinese government set an aggressive energy efficiency target in its Eleventh Five Year Plan. This plan calls for a reduction in the energy intensity of China's economy, measured as units of energy used per unit of GDP, of 20% in the five-year period from 2006 through 2010[13].

Excluding China, there is an acceleration of the energy productivity improvement at global level since 2000 due to the higher oil prices in 2005 and 2006 (1.5% p.a. compared to an average trend of 1.3% over 1990-2006). Energy productivity improvements in most world region since 1990 resulted in 4.4 Gtoe energy savings in 2006 and avoided 10 Gt of CO_2. China accounted for about 50% of this improvement, North America for 20% and Europe for 10%. In other words, if technologies and economic structures in the main world regions had remained at their 1990 level, in 2006 the world would have consumed 4.4 Gtoe more energy.

4 - Barriers to energy efficiency

There are a wide variety of sector-specific and cross-cutting energy efficiency improvement opportunities for industry. However, significant numbers of energy efficiency measures which are cost-effective are not always undertaken by countries/ industries.

In this respect the IEA report[14], Worldwide Trends in Energy Use and Efficiency, stated that even with currently available technologies, estimates show 30-40% efficiency potential across many sectors and countries, which have yet to be converted to investments. For example, 70% of the global public and buildings lighting, which consumes 20% total global electricity consumption, including in industrialized world, can save 50% energy even using current technologies. Over 90% of street lights around the world, including the industrialized world use technologies which consume 40% more energy than efficient high pressure sodium vapor lamps, a technology that has been around for over two decades, and is now being take over by even newer third generation technologies based on efficient LED and other high efficiency fluorescent technologies for street lighting. On the appliances front, IEA estimates indicate that switching to best available household appliances would save 40% of residential energy consumption, globally $130 billion per year in costs.

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12 World Energy Council (WEC), "Energy Efficiency Policies around the World: Review and Evaluation", 2008

13 Jiang Lin, Nan Zhou, Mark Levine, and David Fridley, "Taking out one billion tons of CO2: the magic of China's 11th five year plan?" Lawrence Berkeley National Laboratory, June 2007.

14 International Energy Agency (IEA), "Worldwide Trends in Energy Use and Efficiency: Key Insights from IEA Indicator Analysis." IEA/OECD: Paris, 2008.

Indeed, improving energy efficiency in developing countries can increase energy availability whilst reducing greenhouse gas (GHG) emissions. However, it faces many obstacles, including financing constraints. Consequently, many energy efficiency projects with prospects of a good financial return remain unimplemented. Therefore, there is a need for market development assistance in designing, packaging, and financing projects that would help realise such investment. In this respect, the World Bank financing programmes on energy efficiency are an important opportunity for developing countries to finance their energy efficiency projects. Indeed, the International Finance Corporation (IFC) has been developing and implementing programs aimed at promoting commercial financing of energy efficiency projects through local financial institutions since 1997 with a program in Hungary. It has grown since then to include operations in Eastern Europe, the Russian Federation, and East Asia. Financing energy efficiency is now an integral part of IFC's strategic focus on sustainability and climate change. In 2010, the World Bank's total lending for energy efficiency hit a record of $1.8 billion. The Bank's goal over the next two years is to achieve a threefold expansion of its energy efficiency investments. For example, the World Bank recently approved a US$200 million for the Energy Efficiency Project in Ukraine. The programme will finance investments in energy saving measures in industrial companies, municipalities and municipally owned enterprises and energy service companies.

The efficiency gap in the industry shows the existence of various barriers to energy efficiency improvement which prevent cost-effective potentials being realized. There are different ways of categorising the energy efficiency barriers, yet there is a significant overlap in those categorizations. In general energy efficiency barriers can be classified into five major categories, which are:

- Financial and economic barriers,
  - Energy prices, inefficient energy subsidies and price volatility
  - Market structure and functioning
  - Financial incentives
  - Lack of Fund
  - Costs
- Technological barriers
  - Lack of infrastructure
  - Lack of technical standards
- Behavioral barriers
  - Social, cultural, and behavioral norms and aspirations
  - Decision-making
- Knowledge/information
  - Lack of awareness, information, education and training
- Institutional and organizational barriers
  - Policies
  - Lack of legal and regulatory frameworks
  - Limited institutional capacity
  - Lack of coordination and slackness

The major constraints to increased energy efficiency financing and implementation are inherently institutional in nature. When institutions cannot enforce or govern energy efficiency regulations, the impact is often detrimental. If financial institutions are not geared towards lending for energy efficiency, which are not traditional asset-based deals and pose higher risk perceptions as they are driven by estimated energy savings, credit for energy efficiency is hampered. Many sectors have principal-agent or "split-incentive" barriers, where one entity, such as a builder, installs equipment while another one, such as an owner or tenant, pays the electric bills. Further, lack of information about energy efficiency and awareness amongst various stakeholders leads to market failure in energy efficiency sector. While some mechanisms, such as utility demand-side management (DSM) and energy service companies were developed to address these institutional challenges and have worked well in the OECD countries, experience has shown that the institutional mechanisms must be designed very carefully and adapted to fit local needs and situations[15].

Energy consumer behavior is crucial to improve energy efficiency. Consumers require knowledge and information about efficiency opportunities as well as the motivation and ability to implement them. Consumer preference for the status quo and familiar technologies can sometimes bias them against energy efficient options. Consumers take time to adopt new technologies. Additionally, some consumers do not find energy efficient options to be as appealing as the technology they are used to. For example, some consumers dislike compact fluorescent light bulbs because of their color, shape, mercury content or difficulty of disposal.

In addition, there are other more general barriers that affect the developing countries, in particular, these include[16]:

- Lack of consensus on best practices to promote energy efficiency (e.g. regulations, incentives/subsidies, market-based schemes and awareness/informational issues), the right balance between these practices, and the appropriate role of government;
- Overreliance on Western energy efficiency program models, which can help guide developing countries but need to be significantly adapted to suit local markets and conditions;
- Lack of energy efficiency data, which is compounded by the lack of internationally recognised indicators to adequately compare countries relative energy efficiency levels to take into account their economic structure, climate, geography, population, and other factors, and to effectively determine the real potential for improvements;
- Poor energy efficiency governance among energy efficiency and related institutions which can undermine government policy frameworks and initiatives, including inability to enforce or govern energy efficiency regulations and coordinate different level of government, the international community, the private sector and civil society;

[15] Taylor, Robert P., Chandrasekar Govindarajalu, Jeremy Levin, Anke S. Meyer, William A. Ward. "Financing Energy Efficiency: Lessons from Brazil, China, India and Beyond." The World Bank: Washington, D.C., 2008.
[16] Ashok Sarkar and Jas Singh, The World Bank, "Financing Energy Efficiency in Developing Countries –Lessons Learned and Remaining Challenges", October 2009.

- Fossil fuels energy subsidies which continue to diminish the returns from energy efficiency improvements; and
- Lack of institutions and capacities for public agencies to organise, transform and develop new and nascent markets for energy efficiency goods and services, and for local private sectors to adopt state-of-the-art energy efficiency technologies and practices.

The Energy Efficiency Investment Forum: Scaling up financing in the Developing World also identified a number of barriers to energy efficiency, these included:

- Lack of full economic costing of energy, subsidies and inadequate market signals.
- Perceived risks and relatively high transaction costs.
- Lack of technology availability.
- Poor implementation of energy efficiency projects and programs.
- Lack of awareness of energy efficiency potential and opportunities.
- High debt and equity costs.
- Small ventures and start-ups often lack business/management skills and collateral.
- Relatively weaker institutions.
- Lack of political will and policy commitments.
- Limited attraction by financial institutions due to low transaction sizes and unfavorable risk/return profile; as these are not a classic asset-based investment like supply-side investments.
- Lack of reliable and commercially viable financing to end-users, developers, contractors and manufacturers/vendors; the problem is not a lack of available funds but getting access to these funds at local and regional financial institutions.
- The energy efficiency market is diverse and complex; it has a range of end-users, a variety of end-use technologies and a number of market sectors and solutions are often customized and not always replicable.

5 – Energy efficiency across sectors and demand-side management (DSM)

5.1 – Energy efficiency across sectors

Opportunities for energy efficiency savings occur in every energy consuming area: industry, building, appliances and equipment, lighting and transportation. Understanding where energy is most used helps to focus energy efficiency saving programs and policies. However, different sectors dominate in different parts of the world. For instance the IEA statistics shows that, in China, the industrial sector is the largest consumer of energy; the residential sector is leading in India and in the United States transportation dominates. While in Europe the energy use is evenly distributed across sectors.

The industry sector accounts for nearly one third of total global primary energy supply. Final energy use in industry, including feedstock in the chemical and petrochemical sector, was 116 EJ in 2005. Estimates by the IEA[17] shows that there have been substantial improvements in energy efficiency in all major energy-intensive industries and in all world regions. This is often as a result of the introduction of new, more efficient technology. The results also show that on average, Japan and the Republic of Korea have the highest levels of industrial energy efficiency, followed by Europe and North America. While, energy efficiency levels in developing and transition countries show a mixed picture. Generally, the efficiency levels are lower than in OECD countries but, where there has been a recent, rapid expansion using the latest plant design, efficiencies can be high. A significant potential for further energy savings remains. The IEA analysis indicates that application of proven technologies and best practices on a global scale could save between 25 EJ and 37 EJ of energy per year, which represents 18% to 26% of current primary energy use in industry. The largest savings potentials can be found in the iron and steel, cement, and chemical and petrochemical sectors. The industrial motor-driven systems alone use more than 2194 billion kWh (8 EJ) annually on a global basis and offer one of the largest opportunities for energy savings[18]. The International Energy Agency estimates that optimisation of motor driven systems could reduce global electricity demand by 7% through the application of commercially available technologies and using well-tested engineering practices. Many Industrial companies aggressively pursue energy efficiency as a way to improve their profitability and competence. As energy is a significant operating cost, especially for companies in energy-intensive industries. Long-lived assets and disaggregated efficiency opportunities are recurring themes in the industrial sector. Many companies set specific energy efficiency goals and embed them into the performance objectives of managers.

Buildings account for about 40% of energy used in OECD countries, and one-third of the world's primary energy use, the results of many studies show that the potential of cost effective energy savings for these end-uses is huge. Estimates by the IEA indicate that the potential savings from improvements in the end-uses of heating, cooling, ventilation and hot water is at least 500 Mtoe per year by 2030. Energy efficiency is more feasible in new buildings and this should be addressed in energy efficiency standards at the national or province level. Improving the energy efficiency of buildings requires work by all countries and/or provinces. Some countries lack energy efficiency standards for new buildings. In other countries, energy efficiency standards apply only to certain types of buildings. In most OECD energy efficiency standards for new buildings already exist. However, most of the standards are below the economically optimal level when considered over a 30-year building life. There is significant potential to increase the energy efficiency requirements in these standards and to approach the conservation optimum calculated over a building's 30-year lifetime. There is also a need to encourage maximum energy-efficiency performance in new buildings and to ensure that these buildings are available in the market place. Construction of these high-energy-efficiency performance buildings which use very low or even no net energy is technically and commercially

[17] International Energy Agency (IEA), "Worldwide Trends in Energy Use and Efficiency: Key Insights from IEA Indicator Analysis." IEA/OECD: Paris, 2008.
[18] Lawrence Berkeley National Laboratory, Alliance to Save Energy, and Energetic, 2005

feasible. Existing buildings represent a major potential for energy savings: through renovation, the total energy consumption of existing buildings can be halved over 30 years[19].

Appliances and equipment represent one of the fastest growing energy loads in most countries. Residential appliances account for over 30% of electricity consumption in most countries, and represent one of the fastest growing energy loads. The IEA estimated that at least one-third of this could be saved cost-effectively by 2030. Industrial motor systems currently use 40% of the world's electricity and lighting another 19%. The cost-effective savings potential for these end-uses by 2030 is approximately 25% and 38% respectively, according to the IEA. Experience shows that mandatory energy performance requirements and labels have proved to be a highly cost-effective policy tool for increasing energy efficiency of equipment without reducing consumer choice or prompting sustained increases in prices.

Conventional incandescent lights are highly inefficient with only 5% of the input energy being converted into light and the rest being converted into waste heat. Saving energy by adopting efficient lighting technology is particularly cost-effective. For instance, the compact fluorescent lamps are between 4 to 5 times more efficient. The IEA estimated that the world incandescent lamps accounted for 970 TWh of final electricity consumption in 2005 and given rise to about 560 Mt of CO2 emissions. About 61% of this demand was in the residential sector with the demand in commercial and public buildings. If current trends continue incandescent lamps could use 1610 TWh of final electricity by 2030. In the hypothetical case that all these lamps were to be replaced by compact fluorescent lamps, the IEA estimated a saving of roughly 1200 TWh and 700 MtCO2 in 2030. In addition, there are other higher efficiency alternative lamp technologies already available in the market and others appearing or are imminently expected.

Between 1990 and 2005, estimates by the IEA show that global final energy use in transport increased by 37% to 75 EJ. Transport energy use grew quickly in non-OECD countries. Road transport, accounting for 89% of the total, is by far the main contributor to the increase in overall transport energy consumption, between 1990 and 2005, road transport energy use increased by 41%. There are significant energy savings potentials in the transport sector through efficiency improvements and changing transport policy to focus on movement of people and goods, not simply movement of vehicles. The IEA WEO Alternative Policy Scenario estimates that measures in the transport sector will produce 7.6 million barrels per day of savings in global oil demand by 2030, this represent around 60% of all the oil savings in the WEO Alternative Policy Scenario. Implementation of appropriate mandatory fuel efficiency standards for cars and small trucks (light duty vehicles) in all countries is a necessary condition for achieving the significant energy savings in this sector. Additional measures are also needed to realise savings, such as the deployment of fuel-efficient tyres and proper tyre maintenance. However, changing the way individuals think about transportation is a much larger opportunity, avoiding unnecessary trips and shifting transport to more efficient modes.

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[19] International Energy Agency (IEA), "IEA energy efficiency policy recommendations to the G8 2007 Summit, Heiligendamm ", 2007

5.2 – Demand-side management (DSM)

Demand-Side Management (DSM) refers to cooperative activities between the utility and its customers to implement options for increasing the efficiency of energy utilisation, with resulting benefits to the customer, utility, and society as a whole. DSM is an important element of the overall portfolio of resources required to meet the increasing demands for energy. DSM is often understood to include two components: energy efficiency and demand response. Energy efficiency is designed to reduce energy consumption, attempting to permanently reduce the demand for energy and concentrate on end-use energy solutions. Demand response is designed to change on-site demand for energy in intervals from minutes to hours and associated timing of electric demand/energy use (i.e. lowering during peak periods) by transmitting changes in prices, load control signals or other incentives to end-users to reflect existing production and delivery costs.

DSM is a set of tools and practices taken by utilities to influence the amount and/or timing of customers' energy demand to use electricity most efficiently. DSM decreases the cost of meeting customers' energy needs through increased investment in end-use energy efficiency and load management. Demand-side resources can reduce or postpone investment in generation, transmission, and distribution capacity, and decrease fuel consumption, and improve environmental quality. DSM also reduces emissions of acid rain related pollutants and damaging greenhouse gases. DSM has been demonstrated to be a fast, inexpensive, and effective way of addressing power shortages without hurting productivity.

The concept of DSM was developed in response to the potential problems of global warming and the need for sustainable development, and the recognition that improved energy efficiency represents the most cost effective option to reduce the impacts of these problems. The implementation of DSM programs is likely to[20]:

- Improve the efficiency of energy systems – through improved generation efficiency and system load factor
- Reduce financial needs to build new energy facilities (generation) – through deferral of capital expenditure resulting from peak demand reduction through DSM
- Minimise adverse environmental impacts – reduction of GHG emissions through efficient generation and minimizing thermal generation.
- Lower the cost of delivered energy to consumers – lower generation costs and lower customer bills through the use of energy efficient equipment and appliances.
- Reduce power shortages and power cuts – improved system reliability though decrease in demand.
- Improve the reliability and quality of power supply – through demand reduction in distribution systems

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[20] International Institute for Energy Conservation (IIEC), "Demand-Side Management best practices guidebook", 2009

- Contribute to local economic development – increased employment through reallocation of capital to other development projects.

China has a long history of load management and energy efficiency programs. The DSM programs in China have focused on four areas[21]:

- Load management: significant load management efforts have been implemented in the past few years. These efforts have included substantial shifts to time-of-use (TOU) power pricing with large differences between peak and off-peak prices; interruptible tariffs that compensate consumers for voluntary demand reductions during peak periods; and off-peak storage techniques like ice-storage air conditioners and heat-storage electric boilers. In addition, many large customers have lowered their contribution to peaks by shifting production schedules, and are participating in other government mandated load management efforts.
- Energy efficiency: economic and environmental benefits have been achieved by the adoption of a number of policies and measures to encourage the use of efficient equipment such as energy-saving lamps, adjustable-speed motors and water pumps, and high-efficiency transformers.
- Energy conservation: the shortages of generating capacity and fuel have caused government to adopt energy conservation measures and practices such as changing thermostat settings and reducing hours of operation.
- Fuel substitution: Local governments have formulated policies to replace coal burning facilities with more efficient and less-polluting technologies to reduce local air pollution problems.

In India[22], the Indian government has promoted energy efficiency through initiatives such as equipment labels, outreach activities, and voluntary building codes. Occasionally, it has implemented DSM pilot programs. At the beginning of December 2007, India signed three agreements with US institutes promoting DSM programs in two states, Maharashtra and Delhi, and at the national level. The key driver behind the interest in DSM in the two states was the chronic power shortage situation. Consequently, energy efficiency was viewed mainly from a resource acquisition perspective. In February 2010, The Maharashtra electricity regulatory commissions issued draft regulations for implementation of DSM programs and conducting cost-effectiveness analysis of DSM programs. The regulations directed all distribution utilities in Maharashtra to make DSM an integral part of their day-to-day operations, and undertake planning, designing and implementation of appropriate DSM programs on a sustained basis. In addition, they should submit 5-year DSM plans along with the multi-year tariff filings; include all justifiable costs in any DSM related activity, including planning, designing, implementing, monitoring and evaluating DSM programs, to their Annual Revenue Requirement (or Rate Case); implement quick acting DSM programs that provide long-term savings including those that help

[21] Zhaoguang Hu, David Moskovitz and Jianping Zhao "Demand-Side Management in China's Restructured Power Industry", December 2009

[22] Ranjit Bharvirkar, Jayant Sathaye, and Amol Phadke, "US-India cooperation on Demand-side Management (DSM): Expanding Maharashtra and Delhi Programs to National-level", LBNL-3507E, 2009

reduce peak demand peak shifting and associated costly power purchase (e.g. demand response), specifically, in the urban centers; form a DSM Consultation Committee that is appointed by the Commission and consists of all relevant stakeholders. Following Maharashtra's example, in May 2009, Delhi regulatory commission made a provision for DSM activities with a budget of around $7 million for utilities in Delhi. The utilities were ordered to submit DSM program proposals similar to Maharashtra. The utilities are in the process of filing several proposals targeting lighting, pumping, and water-heating end-uses. The DSM program design by utilities in Delhi has referred extensively to the designs developed in Maharashtra and the draft regulations issued by Maharashtra regulatory commission.

6 – Policies, incentives and regulations for the promotion of energy efficiency

What are energy efficiency policies? Energy efficiency policy, according to the World Energy Council (WEC), refers to: "*All public interventions (policy instruments) aiming at improving the energy efficiency of a country, through adequate pricing, institutional setting regulations and economic or fiscal incentives*"[23].

6.1 – Policy instruments

There are a number of means to categorise policy instruments, depending on the approach and objective of the study. The following is a combination and simplified version of the classifications used by the World Energy Council (WEC), International Energy Agency (IEA)[24], OECD, UNEP[25], etc.

Legislative instruments: the objective of these instruments is to command and control governs behavior, and these are enforced by governmental institutions at national, provincial or local level. There are three types of legislative instruments:

Laws & regulations: law sets out the legal rules that govern a specific action, process, product etc. A regulation on the other hand supports a law by outlining how the law should be implemented. A proper regulatory framework, with an energy efficiency law and/or national programmes with official quantitative targets of energy efficiency improvements, can provide a long lasting context for energy efficiency policies and avoid the negative effect of "stop and start" actions.

Standards: provide technical and design guidance notes, for example standards for energy equipment used by industry.

Codes of practice: give practical advice and guidance on how to comply with legislation, for example a building code. All European countries and most other OECD countries have energy

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[23] World Energy Council (2001) *Energy Efficiency Policies and Indicators,* London: WEC, available at: [http://www.worldenergy.org/wec-geis/publications/reports/eepi/introduction/introduction.asp]

[24] International Energy Agency (IEA), (2006), *"Energy Efficiency Database Online",* available at: [http://www.iea.org/textbase/pamsdb/search.aspx?mode=ee]

[25] United Nations Environment Programme Division of Technology, Industry and Economics (UNEP), "Improving energy efficiency in industry in Asia", 2006

efficiency standards for all new buildings. Some non-OECD countries outside Europe have recently established standards for service buildings.

Economic instruments: the purpose of using economic instruments is to provide economic rewards or costs that govern behavior, and these come in many shapes and forms including:

Fiscal instruments: such as taxes and fees/charges which can be levied on both producers and consumers in a production process. Examples include taxes on GHG emissions, fees/charges on fuels and energy utility charges. Tax reductions on energy efficient equipment or investments have been introduced in many countries and almost equally in all regions

Subsidies: to encourage less polluting behavior, such as grants (non-repayable forms of financial assistance), soft loans (loans with interest rates below market rates) and tax allowances (tax exemptions, tax rebates and accelerated depreciation). Subsidies are viewed as a temporary measure to mobilise consumers, to prepare for new regulations, or to promote energy efficient technologies by creating a larger market than would exist otherwise, with the objective of a cost reduction for the subsidised energy efficient technologies.

Property and tradable rights: provide secure and well-defined rights to resources, which may or may not be tradable. For instance, rights to land and water, licenses that enable use within a geographic areas or access to facilities, rights to develop resources, such as a natural gas finding. Property rights can also emerge in creating a market for environmental products, e.g. tradable emission permits.

Bonds and deposit refunds: to ensure that resource companies are encouraged to minimize environmental damage, have adequate finances to undertake restorative works. The bond is returned when environmental performance requirements have been met. Deposit refund schemes are aimed at encouraging users of products with potentially polluting by-products to dispose of them in a reasonable manner by returning the deposit upon disposal, for example beverage and battery disposal.

Liability systems: either they seek to (a) establish, and enable enforcement of, legal liability for damage to the environment, people or to prosecute for non-compliance with laws, regulations or the payment of taxes, fees and charges or (b) pool and share liability risks through common insurance policies.

Voluntary instruments: it is ethics that govern the behavior, which is based on a will to change a behavior for the benefit of an entire community. There are countless types of voluntary instruments, including:

Voluntary agreements: involves a commitment from a business to engage in energy conservation in one way or another, either through voluntary monitoring, auditing, reporting or labeling of products and equipment or meeting certain emission targets for instance. Voluntary agreements may also include covenants between government and private businesses or sectors, such as packaging covenants.

Programs and projects: aimed at increasing both public awareness, and technical skills and know-how of workers in a particular sector. Examples include participation in multilateral projects, the production of booklets, journals, books, web sites, demonstration projects and training programs. This may also include the development of associations and centers, focused on monitoring, benchmarking, auditing, labeling, education, data gathering, coordination and facilitation of informational services among other things.

Research and Development: involves research and development of new technologies, such as low emitting industrial equipment and technologies to better use wasted heat.

Some policy measures are working well and can be considered successful, but commercial systems are playing a greater role.

Regulations on domestic appliances and buildings have proven to make energy saving. Voluntary/negotiated agreements have also led to energy efficiency improvements, especially in energy intensive industrial branches, with cars and with some electrical appliances (e.g. washing machines in Europe), even if the results could have been more ambitious (e.g. in the case of cars in Europe). Tax credits have also shown good results to stimulate the market for renewables and efficient appliances that would not have been purchased by consumers without these financial incentives.

A proper regulatory framework, with an energy efficiency law and/or national programmes with official quantitative targets of energy efficiency improvements, can provide a long lasting context for energy efficiency policies and avoid the negative effect of "stop and start" actions[26].

6.2 – Energy efficiency policies

The potential of energy conservation is clear. The optimum use of resources is among the most valuable initiatives that can be taken to face the energy efficiency barriers. Within this context, public policies and regulation are crucial. Price incentives and business opportunities, together with suitable and transparent rules, are required for successful public policies. Public policy is also essential to accelerate the adoption of advanced efficiency standards for household and industrial appliances and equipment, and to promote innovative financing schemes for energy efficiency. Before 1973, energy efficiency was not a public policy issue in most places. Until the early 1970s, prices for oil, gas and coal were relatively low and stable. However, the oil prices after 1973 made explicit the critical role of energy in the world economy, which was taken for granted before that. The push for energy savings and efficiency led to a series of new policies, laws and mandates to increase vehicle, building and appliance efficiency, particularly in the United States, Europe and Japan. Japan, highly conscious of its limited resources, put a high emphasis on efficiency. France set up a separate agency to promote energy efficiency. The United States introduced automobile fuel efficiency standards and began to implement standards for appliances[27].

Consideration of energy sectors clarifies the roles that policy can play in encouraging efficiency. Efficiency at any cost is not the goal. However, policy does have the power to remedy some

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[26] World Energy Council (WEC), "Energy Efficiency Policies around the World: Review and Evaluation", 2008

[27] World Economic Forum (WEF) and IHS CERA, "Towards a More Energy Efficient World", 2010

economic inefficiencies and information deficits and to create the "soft infrastructure" needed to promote energy efficiency.

One crucial way for government to encourage efficiency across the entire economy is through the price of energy. Governments have the ability to include the cost of externalities in energy prices, and doing so is a powerful encouragement for efficiency. Calculating the cost of externalities can be challenging, however, increasing energy prices is politically not accepted. Conversely, subsidising energy prices lessens the drive for efficiency. Removing generalised, untargeted and an efficient energy subsidies and targeting low-income people and helping them invest in energy efficiency can reap benefits for an entire economy. Another way of targeting efficiency is through tax credits or other fiscal incentives.

Governments can encourage technology innovations to make efficiency cheaper or easier, through spending on research and development of new technology or directly toward helping consumers buy efficient products. Governments also have the ability to use planning tools to encourage energy efficient development. This is evident in the transportation sector, where decisions about urban planning and land use can have a vast impact on the overall efficiency of transportation. Governments can also mandate more efficient technologies and provide benchmarks, comparative frameworks and rankings.

The best policy intervention is not necessarily the one that results in the greatest efficiency increase. When considering policy options, governments must compare the cost of a new program to the efficiency lost by maintaining the status quo. For example, the transaction cost for making many small efficiency improvements across homes and businesses may be very high. Determining the cost-efficient level at each location would likely cost more than the energy that would be saved. In this case, product standards and rankings are a good policy intervention, since they can improve average efficiency levels without resulting in high information-gathering costs for consumers. Standards would not be the most energy-efficient solution to this problem, but they would likely be the best balance between efficiency and cost.

Political will and commitments are essential to the advancement of energy efficiency projects and programs. Policies should be long-term in nature and encourage proper market and pricing signals. Legal and institutional frameworks need to be supportive. Regulatory interventions are required to implement standards and certification programs; monitoring and enforcement is appropriate. Policies must consider both demand and supply aspects, and both mandatory and voluntary measures are working in the market.

In the United States (US) there is no comprehensive policy strategy for energy efficiency. However, three Energy Policy Acts have been passed, in 1992, 2005, and 2007, which include many provisions for conservation, such as the Energy Star program, and energy development, with grants and tax incentives for both renewable energy and non-renewable energy. The US energy efficiency policies reflect the interplay of federal, state, and local jurisdictional levels. There is a harmony among policy goals at all three levels, with each jurisdiction focusing its operations on its own unique geographical scope. For example, in the building sector, energy efficiency policies historically map to different jurisdictions in the United States. The federal government creates nationwide appliance standards, providing uniformity for manufacturers and thereby reducing the burden of providing different equipment for each state market. The federal government also provides large-scale financial incentives early in the commercialisation process. Widespread education through labeling, and support for research and development. Most state governments have authority over the design of building codes, although until recently this was the domain of localities. With jurisdiction over electric utilities, many state governments also provide financial incentives as part of demand-side management programs, and some states set standards for appliances not governed by federal legislation. Finally, local jurisdiction primarily focuses on building code enforcement, and, in some states, building code design. Some local governments also influence efficiency by offering incentives to developers, such as expedited permitting for efficient buildings, and by modeling efficiency in municipal buildings. Some local governments also offer financial incentives for energy efficiency, such as appliance rebates[28].

To ensure the effective implementation of energy conservation and efficiency improvement, the Chinese government established Leading Group on Energy Conservation and Emissions Reduction. Most provincial, municipal and county governments as well as large enterprises established similar entities within their organisations. The central government also created energy conservation and emissions reduction targets for all regions as well as the top 1,000 energy consuming enterprises; it also issued a plan to monitor statistics and assess implementation for each region and the key enterprises. The provinces established similar systems to evaluate progress. To ensure that energy conservation objectives are reached, the government commenced a programme to retire inefficient productive capacity in industries, focusing specifically on the electric power, iron and steel, aluminum and cement sectors[29].

The Chinese government launched key energy conservation projects, promoted energy-saving construction (i.e., energy-saving light bulbs), started a programme to benchmark energy efficiency of key energy-intensive industries and identified three key areas for focused encouragement of energy conservation and efficiency: industry, construction and transportation. In addition, China's government launched the *Top-1,000 Enterprises Energy Efficiency Programme*[30] and put forward energy-use auditing of key enterprises, which includes the drawing up of energy conservation plans and the reporting of energy consumption.

To promote energy conservation and efficiency, China's central government increased the taxable amount for coal, oil and natural gas; implemented policies that encourage the use of energy-saving technology; carried out price and tax reform for finished-oil products; and implemented many other economic measures that promote energy conservation. Furthermore, the establishment and refinement of energy conservation laws and regulations provides the legal support for China's push towards greater energy conservation and efficiency.

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[28] Elizabeth Doris, Jaquelin Cochran, and Martin Vorum, National Renewable Energy Laboratory, "Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government", December 2009
29 Li Junfeng, Energy Research Institute, National Development and Reform Commission, China, "Energy Conservation and Energy Efficiency in China", 2010
[30] Jiang Yun, China Energy Conservation Association, "A Brief Introduction on Top-1000 Enterprises Energy Efficiency Program", June, 2007

In Europe, reducing energy consumption and eliminating energy wastage are among the main goals of the European Union (EU). According to the EU in Europe there is significant potential for reducing consumption, especially in energy-intensive sectors such as construction, manufacturing, energy conversion and transport. At the end of 2006, the EU pledged to cut its annual consumption of primary energy by 20% by 2020. To achieve this goal, it is working to mobilise public opinion, decision-makers and market operators to set minimum energy efficiency standards and rules on labeling for products, services and infrastructure. In the following a list of the EU's policies and legislations on energy efficiency[31]:

Policy orientations:

- Energy efficiency for the 2020 goal
- Action Plan for Energy Efficiency (2007-12)
- Green Paper on energy efficiency
- Competitiveness and Innovation Framework Programme (CIP) (2007-2013)
- The Global Energy Efficiency and Renewable Energy Fund
- "Intelligent Energy for Europe" programme (2003-2006)
- Action Plan for energy efficiency (2000-2006)

Delivering energy efficiency

- Energy end-use efficiency and energy services
- Cogeneration
- Energy efficiency: energy performance of buildings
- Energy efficiency of products
    - Tyre labelling
    - Eco-design for energy-using appliances
    - Household appliances: energy consumption labelling
    - Energy efficiency of office equipment: The Energy Star Programme (EU - US)
    - Energy efficiency requirements for ballasts for fluorescent lighting
    - Hot-water boilers
    - Domestic refrigeration appliances: energy efficiency

The Japanese government has promoted energy conservation needs to be facilitated by a framework of laws and policies. The Act on the Rational Use of Energy (Energy Conservation Act) aims to enhance energy management and improve the energy conservation performance of equipment and buildings. The government provides support in terms of budgets, taxation and national programmes through such means as providing assistance for the introduction of energy-saving equipment. The Voluntary Action Plan on Environment, in which 108 types of industries participate, has also played an important role in promoting the energy conservation movement in

[31] http://europa.eu/legislation_summaries/energy/energy_efficiency/index_en.htm

Japan. The Energy Conservation Act, which has a 30-year history, requires energy management in wide-ranging fields, including the industrial, residential and transportation sectors. From a worldwide perspective, legislation that imposes energy conservation regulations on the industrial sector is quite rare. Because nearly 90% of energy consumption in the industrial sector is subject to regulation under the Energy Conservation Act, the sector has actively made efforts to promote energy conservation. As a result, energy consumption has remained almost the same for nearly 30 years. In the meantime, energy consumption in other business sectors has increased significantly in recent years. The Act's revision in 2007 further strengthened energy conservation measures by expanding the regulation's coverage. The Top Runner Programme, based on the Energy Conservation Act, has had far-reaching effect on both energy and on strengthening industrial competitiveness. This programme aims to raise fuel efficiency standards for automobiles and energy conservation standards for electric appliances above that of the most energy efficient product in the current market within the target fiscal year. Backed by such programmes and other efforts, the development of innovative energy conservation technologies has been accelerated, significantly contributing to the promotion of energy conservation and the creation of new demand and employment. One such innovation, hybrid vehicles, is having worldwide impact. Hybrid vehicles were developed by Japanese automakers ahead of other manufacturers and are dramatically improving fuel efficiency[32].

In India [33] the Energy Conservation Act from 2001 includes among other things the establishment of a *Bureau of Energy Efficiency*, which carries out the majority of the mandates included in the Act, such as establishing systems and procedures to measure, monitor and verify energy efficiency results in individual sectors and at a macro level; influence multi/bi- lateral and private sector support in the implementation of Energy Conservation Act; and demonstrates delivery of energy efficiency services through publications and reports. For industry specifically, the Act mandates:

- Commitment to national energy conservation and efficiency efforts and programs.
- Adhering to energy standards and equipment labels, when they apply.
- Appointment of energy managers at every industrial facility, and
- Carrying out of mandatory energy audits on an annual basis.

Russia is also focusing on energy efficiency. In the past, abundant supplies of domestic energy made efficiency a lower priority for Russians. However, during the global economic downturn the Russian economy suffered from the global economic crisis more than its competitors. Therefore Russia plans for an energy efficient model of economic development to be globally competitive, and at least catch up with most advanced countries with regard to energy intensity. In this regard, President Medvedev set the goal of increasing the energy efficiency of the Russian

[32] Masayuki Naoshima, Minister of Economy, Trade and Industry, Japan, "Japan's Energy Conservation Policies: A Model for the Future", 2010
[33] United Nations Environment Programme Division of Technology, Industry and Economics (UNEP), "Improving energy efficiency in industry in Asia", 2006

economy by 40% by 2020[34]. In addition, President Medvedev has affirmed that energy efficiency and energy conservation are among the five strategic priorities for Russia's technological development. In November 2009 the Russian Duma passed the Law "On energy conservation and increasing energy efficiency…" In 2010 a Coordination Council for Energy Efficiency & Energy Conservation within the all-Russia party "United Russia" was created and began to operate.

7 – The way forward towards more energy efficiency in developing countries

In emerging and developing economies where the growth in energy demand is accelerating, energy efficiency has the potential to be an integral part of future energy supply strategies. The cost of saving energy through the particularly large, untapped demand-side energy efficiency potential in developing countries is cheaper than the cost of adding new supply capacities. In the industrial sector, the priority should be given to reducing consumptions of the energy intensive sectors such as steel and cement, and improving technologies management. For the transport sector, the priority actions include improving vehicle efficiencies, public transport, intelligent transport management and city planning. The power sector requires long-term policies, resource planning and portfolio management and committed investments. Power sector needs to make cost-effective energy efficiency the first source in the loading priority over any supply options. Line losses are also critical problem in many developing countries, due to technical, commercial and/or administrative reasons. In the building Sector priority should be given to investments in energy efficiency standards and labeling programs. Other priority areas in this sector include building codes, zero emission buildings, improved materials, control system technologies, and Green Buildings.

To achieve their energy efficiency goals in the various sectors developing countries need to build capacities to strengthen the skill of their institutions and individuals in a number of areas. These include establishing energy audit procedures, implementing energy audit training and recommended improvements, developing systems for energy database benchmarking and guidelines, establishing energy management systems, creating certification systems for energy managers/auditors, developing energy management guidelines, and conducting technology transfer/dissemination.

Initiating energy efficiency in developing countries requires supportive government policies backed by strong local institutions, a robust private sector, educated consumers and active financial institutions, all of which contribute to the potential savings from both supply- and demand-side efficiencies. Most importantly, the roles, responsibilities and accountability of each of the key players need to be clearly defined and understood. These policies need a range of measures to accelerate deployment of energy efficiency, typically targeting a particular sector and end-user group such as the industrial, residential, commercial, utility and transport sector. Examples of the types of policy measures employed are energy efficiency codes, Standards and Labeling; mandatory energy efficiency targets; financial incentives such as tax incentives, low-

[34] Arkady Dvorkovich, Aide and Economic Advisor to the President of the Russian Federation, Russia, "Raising Russia's Energy Efficiency – From Vision to Action", 2010

interest loans and targeted subsidies; bulk procurement programs and competitions; and voluntary agreements, among others. In addition, these policies require a set of market transformation programs, these programs combine many of the policy measures into a comprehensive package that seeks to favorably influence and drive the energy efficiency market. Market transformation policies try to address a set of barriers through a mix of incentives, information, targets and standards[35].

Tackling inefficient energy subsidies is important to improve energy efficiency in developing countries. Energy subsidies that protect consumers from energy prices may meet some social objectives and protect consumers from volatility. But they discourage energy efficiency investments and reduce or remove the incentive for consumes to be energy efficient in their daily decisions. In many developing countries, energy subsidies are a controversial and often very difficult and sensitive matter. On one hand, subsidies are seen as an element for social stability and a stimulus to economic growth. As developing countries seek to promote energy efficiency, the issue of subsidies becomes especially significant. In September 2009, leaders at the G20 meeting in Pittsburgh affirmed that "*inefficient fossil fuel subsidies encourage wasteful consumption, distort markets, impede investment in clean energy sources and undermine efforts to deal with climate change*". They noted that many countries are reducing fossil fuel subsidies while preventing adverse impact on the poorest. Building on these efforts and recognising the challenges of populations suffering from energy poverty, they agreed to "*rationalize and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption*".

Singapore provides an example of phasing out subsidies and at the same time helping low-income households pay for energy without introducing distorting subsidies. All consumers in Singapore face the full cost of electricity in their bills. However, the lower-income families receive a 'Utilities Save' rebate to help lighten their burden.

In response to the Pittsburgh agreement many economies both within and outside the G20 have in recent years implemented or proposed reforms to bring their domestic energy prices into line with the levels that would prevail in undistorted market or to rationalise support given fossil fuel producers, see table below.

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[35] US Energy and Security Group, "Renewable Energy and Energy Efficiency Policy Analysis Report", 2007

Selected plans for subsidy phase-out

Country	Description of announced plans
Angola	Cut gasoline and diesel subsidies in September, 2010, leading to a price increase of 50% and 38% for gasoline and diesel respectively.
Argentina	Proposes to reduce household subsidy for propane gas as natural gas access is expanded.
China	Oil product prices were indexed to a weighted basket of international crude prices in 2008. Natural gas prices increased by 25% in May 2010. China has already removed preferential power tariffs for energy-intensive industries.
Egypt	Plans to eliminate energy subsidies to all industries by the end of 2011.
India	Abolished gasoline price regulation in June 2010 and plans to do the same for diesel. The price of natural gas paid to producers under the regulated price regime was increased by 230% in May 2010. State-owned Coal India Ltd. announced that it would benchmark its premium grade coal to world prices.
Indonesia	Plans to reduce spending on energy subsidies by 40% by 2013 and fully eliminate fuel subsidies by 2014. Electricity tariffs were raised by 10% in July 2010. Has an ongoing programme to phase out the use of kerosene in favor of LPG.
Iran	Plans to replace subsidized energy pricing with targeted assistance to low-income groups over the period 2010-2015. Reforms call for the prices of oil products, natural gas and electricity to rise to market-based levels.
Malaysia	In July 2010, announced reductions in subsidies for petrol, diesel and LPG as the first step in a gradual subsidy-reform programme.
Mexico	Subsidies to gasoline and diesel are expected to disappear by the end of 2010, and the gap of LPG prices is expected to close in 2012.
Nigeria	Plans to remove subsidies on petroleum products by December 2010, or latest end of 2011.
Pakistan	Plans to phase out electricity subsidies and has implemented a tariff increase of around 20% in 2010.
Russia	Natural gas prices for industrial users are to continue increasing toward international levels through 2014 based on the balancing of revenues from domestic and export sales. Pricing in the wholesale electricity market is scheduled to be fully liberalized in 2011.
South Africa	Plans to increase electricity tariffs by approximately 25% per year over 2010-2013.
UAE	Commenced reducing gasoline subsidies in April 2010 and plans to bring them in line with international market levels. Diesel prices are already largely deregulated.
Ukraine	Raised gas price for households and electricity generation plants by 50% in August 2010 and plans to raise them by another 50% from April 2011.

Sources: IEA World Energy Outlook 2010

Technologies will play a crucial role in enabling energy efficiency on the supply and demand sides of energy. Technology will affect the choice and costs of future energy systems. There are a large number of existing technologies that can be tapped to improve overall energy efficiency (productivity) in different sectors. The development and global implementation of new, cost effective energy technologies in all energy consuming sectors is an effective way to improve energy efficiency. This approach is best facilitated by relying on voluntary initiatives and market-oriented measures, including government support for R&D and elimination of barriers that may inhibit product acceptance and use in the marketplace along with implementation of the necessary infrastructure.

For instance, in the US there are near-term and highly cost-effective upgrades that might improve the new car fuel economy from 27.5 miles per gallon today to 40 miles or more per gallon by 2030. When spread throughout the full fleet of existing light duty vehicles, this single measure might reduce total transportation fuels by 20 percent or more by 2030. US Environmental Protection Agency's (EPA) Energy Star program, for example, suggests that energy consumptions and greenhouse gas emissions can be reduced by 30 percent or more with existing technologies. Lawrence Berkeley National Laboratory (LBNL) indicates that the energy now wasted in US's industries and electric utilities could be converted into another source of supplemental heat and power for use elsewhere by using "waste-to-energy" technologies. It noticed that, in effect the energy now wasted in the mining, refining, and processing of fossil fuels, as well as in the generation of electricity, could become a source of both supplemental heat and electricity for use in US's industries and buildings. In this connection, the report suggests that "waste-to-energy" technologies have the economic potential to meet as much as 20 percent of US's current electricity requirements[36].

Another technological innovation is the smart home appliances, these appliances have technology built into them that, in some cases, can communicate with and allow control by utilities for load management. In other cases, the technology allows for independent action. This technology has value in two ways: first, smart appliances can be used to shave electrical energy peaks and prevent or delay the need for new generation, new transmission lines or new distribution lines. Second, smart appliances could be used to prevent expensive blackouts by under-frequency load shedding. The impact of Smart Appliances can be substantial, because home appliances represent 35 percent of residential energy use[37]. Major appliances that are candidates for smart appliance technology include clothes washers and dryers, refrigerators and freezers, dishwashers, stoves, microwave ovens and room air conditioners.

In Europe, Innovative Information and Communication Technologies (ICTs) such as 'smart meters' to monitor and optimise energy efficiency will be used soon to help the EU achieve its 2020 energy efficiency goals[38].

Most credible projections indicate that over 70% of new energy demand by 2030 will come from developing countries. For rapidly growing economies, the right investments in production processes and using the best possible technology available have the potential to achieve major energy savings in developing countries. For instance, China, which is the second-energy consumer after the US, gets nearly 70 percent of its energy from coal-fired power plants; many of them equipped with substantial pollution controls. The IEA estimated that the average thermal efficiencies on the Chinese coal plants are 28%, compared to around 38% in OECD countries. Some 300 million tons of coal could be saved by raising the efficiency of boilers and other coal fired plants by 30-35% and potential savings up to 400 million tones could be achieved by adapting existing technology[39]. Initial areas to target are coal mining, coal washing and the more efficient design of boilers and environmental equipment for new power plants.

Governments can facilitate and create the policy frameworks, which encourage the industry to engage in technology cooperation, to work with their partners in developing countries to invest in clean energy and efficient technologies. Governments should keep all energy options open and avoid choosing "winners" and "losers" among technologies, at the same time considering investment requirements for the range of options in the energy mix.

To enhance the cooperation and dialogue on energy efficiency and energy saving, the governments of Canada, the People's Republic of China, France, Germany, India, Italy, Japan, the Republic of Korea, the Russian Federation, the United Kingdom, the United States of America, and the European Community, represented by the European Commission, established

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[36] John A. Laitner, American Council for an Energy-Efficient Economy, "The Energy Efficiency Technology Resource",
[37] Bonneville Power Administration, "Energy Efficiency Technology Road Map", 2006
[38] Technology & Energy Efficiency, http://www.euissuetracker.com/en/focus/Pages/Technology-and-Energy-Efficiency.aspx

[39] International Energy Agency (IEA), "Coal in the energy supply in China", 2007

an International Partnership for Energy Efficiency Cooperation (IPEEC). Their objective is to take the necessary steps to facilitate those actions that yield high energy efficiency gains. The Partnership provides a forum for discussion, consultation and exchange of information. One of the activities of the IPEEC is The Worldwide Energy Efficiency Action through Capacity Building and Training (WEACT). The purpose of the IPEEC/WEACT program is two-fold: (i) to raise the awareness of high-level government officials as regards the importance of energy efficiency to sustainable economic development; and (ii) to increase the capacity of middle-income and developing countries to formulate, design, and implement energy efficiency policies.

8 – Conclusions

This background paper demonstrates that energy efficiency is the fastest, cheapest and cleanest solution for meeting future world's energy demand and enhancing energy security in an environmentally sustainable manner through many cost-effective opportunities. It is as much an energy source as any option in the marketplace today, including conventional fuels. The paper explores the energy saving opportunities in different energy sectors and provides a background for understanding the drivers and barriers. It recognised the benefits of energy efficiency in lowering energy costs, improving air quality, reducing greenhouse gases, meeting growing world demand, and deferring infrastructure costs.

Energy efficiency is a fundamental element in progress towards a sustainable energy future. As global energy demand continues to grow to meet the needs and ambitions of people across the world, actions to increase energy efficiency will be essential.

Energy efficiency is a global issue and therefore it requires global action; it has an important role to play both in developed and developing countries. In developing countries, the potential for improvement is even greater, as rapidly expanding economies offer enormous opportunities for investment in energy efficient technologies. The right policies and actions are essential to ensure that this potential is held and the numerous benefits of energy efficiency are achieved. These policies should be supported by proper regulatory framework, with an energy efficiency law and/or national programmes with official quantitative targets of energy efficiency improvements, to provide a long lasting context for the policies and avoid the negative effect of "stop and start" actions.

In this respect, the European Union has launched a major policy initiative on energy efficiency, within which it identifies the potential to reduce energy use by 20% through cost-effective demand and supply-side actions. The G8 has identified energy efficiency as a key area for action that can deliver reduced greenhouse gas emissions while improving competitiveness, health and employment. The G20 Heads of state meeting confirmed that "*Enhancing our energy efficiency can play an important, positive role in promoting energy security and fighting climate change*" and has committed to "*Stimulate investment in clean energy, renewables, and energy efficiency and provide financial and technical support for such projects in developing countries*". The IEF Ministerial meeting affirmed that improving energy efficiency is cost-effective and beneficial for both producing and consuming countries in enhancing energy market stability, environmental sustainability and economic development.

Despite the benefits, however, energy efficiency potential remains largely untapped. Factors such as irrational energy prices, perceived risks, technology availability, weak institutions, lack of information and skilled resources have hindered market development.

So far major progress has been made across the world to improve energy efficiency, however more is anticipated, and more still can be done in this area. In addition, significant numbers of energy efficiency measures which are cost-effective are not always undertaken by countries/industries.

In developing countries, investing in more efficient technologies would accelerate energy efficiency improvement in the future. This will be especially important as even with efficiency gains, improved access to affordable energy will require strong growth in absolute energy requirements. Many developing countries have also implemented major efficiency policies.