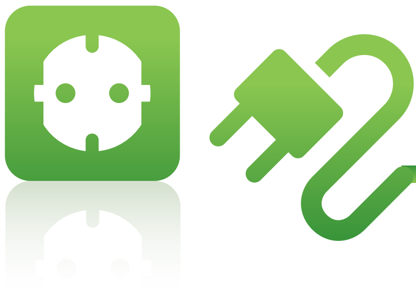
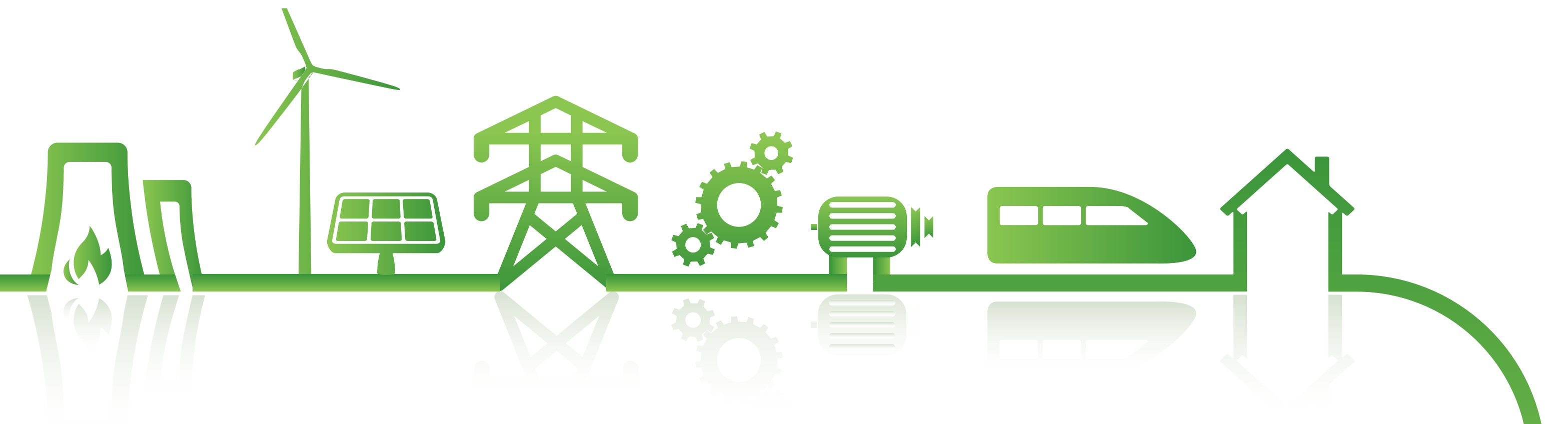
Integrating energy efficiency

across the power sector value chain

wbcsd electric utilities





Integrating Energy Efficiency across the Power Sector Value Chain

The Electric Utilities project has delivered thought leadership on sustainability in the power sector[1] since its inception in 2001. The developing energy and climate landscape stresses the importance of this WBCSD initiative and its ability to lead a fundamental rethink of the role of the power sector in sustainable development.

The vision of our geographically and technologically diverse group integrates three dimensions: energy security, "smart" low carbon power supply and universal access to electricity.

We believe energy efficiency is fundamental to each aspect of our vision. The power sector has a lead role in addressing energy efficiency as a driver for sustainable development and the necessary mitigation against global climate change.

The energy efficiency challenge

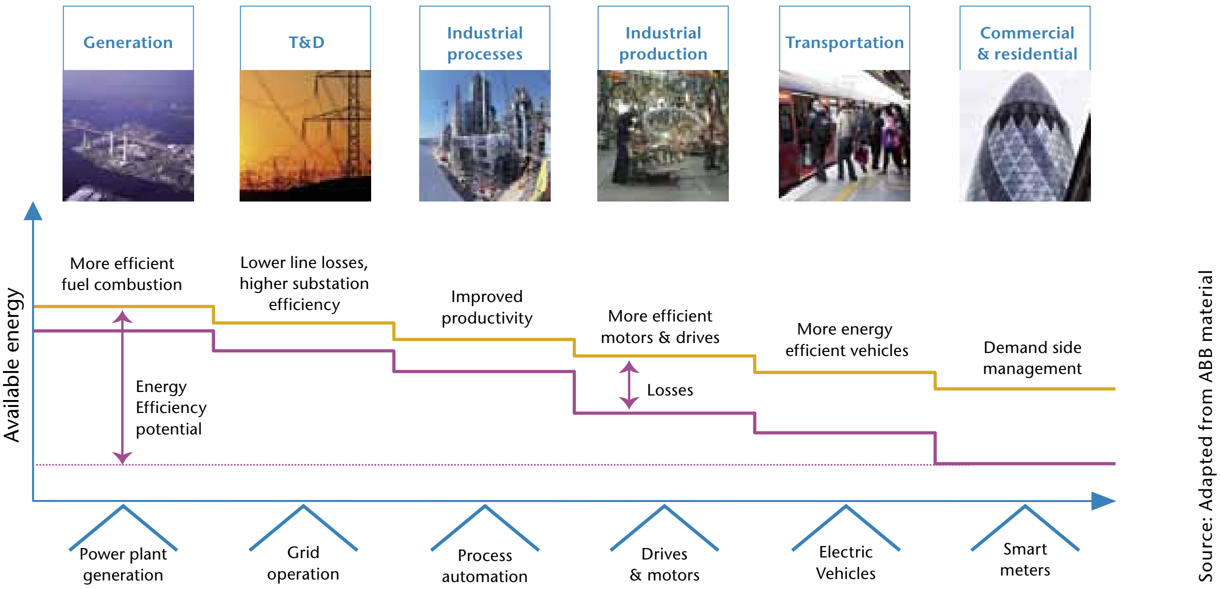
In the electricity sector, the challenge of climate change drives a three-pronged strategy- decarbonization of electricity supply, energy savings along the entire electricity value chain, and electrification of fossil fuelled processes – where there is a potential for net energy savings and emissions reductions. Energy efficiency is critical to all three aspects of this strategy.

Efficiency improvements in the electricity sector have the potential for big savings in total power use and large reductions in greenhouse gas (GHG) emissions. According to the International Energy Agency (IEA) Energy Technology Perspectives (ETP) 2010 Blue Map Scenario, energy savings in the electricity sector

Box 1. How does increased energy efficiency reduce carbon emissions?

In the electricity sector, most CO_2 emissions come from the fossil fuels used to generate power. Increased efficiency on the supply-side and the user-side saves fuel. Savings for existing infrastructure can be significant along the power sector supply chain (figure 1).

Figure 1. Energy efficiency across the power sector supply chain



1 WBCSD Electricity Utility Sector Project Report, "Power to Change" (2008) and earlier works.

could reduce carbon dioxide (CO_2) emissions by 7.3 Gigatonnes (Gt) in 2050 relative to business as usual (BAU), representing 17% of total emission reduction.

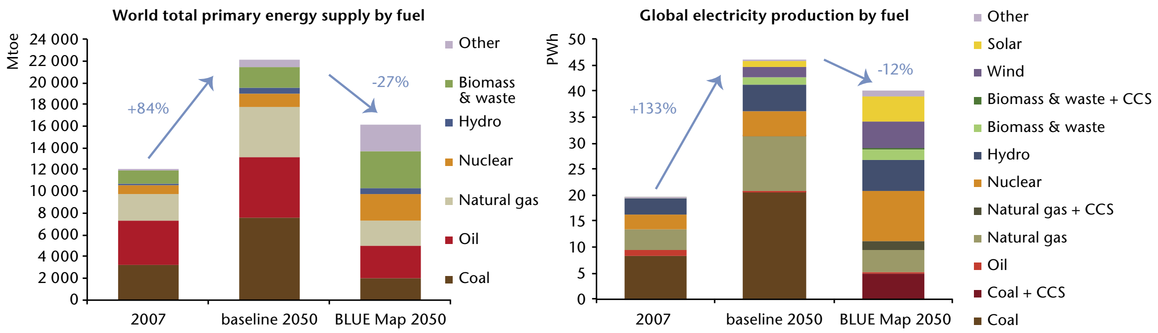
Many potential savings are readily available today with proven cost-effective technologies, such as ultra-supercritical coal and combined cycle gas turbine power plants, high voltage DC transmission, smart meters, green buildings, LED lighting, heat pumps and electric vehicles. Moreover, reductions in total energy costs often provide positive returns on investments. However, potential cost savings alone are sometimes an insufficient incentive to drive decisions. Improvements in energy efficiency can be hindered by:

- lack of knowledge or skills to recognize and achieve potential savings;
- low priority relative to other costs for many users;
- significant upfront costs, long pay-back periods and the risk that savings will not materialize; or
- energy cost subsidies and un-priced externalities such as climate change.

According to the IEA, improvement rates in overall energy efficiency have declined from a historical average of 2% per year to an average of 1% per year since 1990. Additional energy policies and efficiency measures are needed to realize untapped energy savings[2]. Their suitability varies due to differences in the ways decisions are made, such as:

- nature and location of potential energy savings;
- roles of key decision-makers: owners, tenants, operators, regulators, users; or
- electricity market and tariff structures, particularly subsidies and carbon costs.

The IEA ETP low carbon scenarios rely heavily on a low carbon supply of electricity. Globally, electricity use is growing faster than total energy use. In the IEA low carbon scenarios for 2050, electrification of the energy mix would be accelerated by substitution of low carbon electricity in some processes that are traditionally fossil-fuelled (Figure 2).



Source: IEA ETP 2010

2 In developing countries, energy efficiency measures are well suited to inclusion in nationally appropriate mitigation actions (NAMAs) given their accessibility and potential for cost savings. In July 2011, 27 of the 55 NAMAs registered under the UNFCCC represented energy efficiency NAMAs.

Efficiency in Power Generation

Where is the potential?

The potential for efficiency gains in power generation is two-fold: using high efficiency technologies for new power plants, and maintaining or restoring the efficiency of existing plants. Such measures could produce 25% of all the potential emissions reductions identified by IEA for the electricity sector in 2050, a yearly saving of 2.15 Gt of CO_2.

Increased efficiency of non-fossil power plants, such as renewables, also helps reduce CO_2 emissions because it enables these plants to produce more electricity from available resources, thus reducing the demand for fossil power. Where natural gas is available and affordable, it is preferable to coal in terms of both energy efficiency and CO_2 emissions.

In an emerging economy such as China where, on average, a new 600 Megawatt (MW) coal plant is commissioned almost daily, it is crucial to use the most efficient coal technology available. New ultra-supercritical coal plants offer a significant improvement in energy efficiency, which could reduce emissions by about 14% relative to a subcritical coal plant of the same size. Nationwide, this could translate to a saving of more than 0.4 Mtep per year countrywide.

As power plants age, their efficiency tends to decline due to wear, component failures, deferred maintenance, etc. Starts and stops, changes in load, and partial load operations also reduce plant efficiency. Loss of efficiency in fossil-fuelled plants increases fuel consumption and emissions – in severe cases by as much as 20%. Power plant energy audits can identify the losses and the means to bring emissions back in line with the original design *(business case 1)*.

Why isn't this potential being achieved worldwide?

In existing plants, opportunities to restore design energy efficiency are often passed over, despite the potential for fuel cost savings. In part this is due to a scarcity of capital for plant improvements, and in developing countries also because of lack of local capacity to carry them out.

For new plants, scarcity of capital may result in building cheaper plants. However, it is mostly a lack of experience that leads companies to build less efficient conventional plants, which are considered easier to operate.

Business case 1

Energy efficiency to supply increasing demand in South Africa

In 2006, **Alstom** undertook the upgrade of the six units of Arnot Power Station, a coal-fired plant owned by **Eskom**, from 350 MWe to 400 MWe per unit, while at the same time improving efficiency and extending the plant's lifetime. The project included retrofitting turbines and boilers to increase capacity to 400 MWe, a complete retrofit of high-pressure and intermediate-pressure steam turbines, upgrade of the low-pressure steam turbine and the replacement and upgrade of associated turbine pumps and auxiliaries.

The Arnot Integrated Retrofit Project, the first project in South Africa to result in a capacity increase through retrofit, is a good example of a technology developer, Alstom, working with a plant owner, Eskom, to ensure the existing plant is optimized and latent potential exploited, giving enhanced plant performance for the future. This project was a solution to bring more electricity to the grid quickly, in a country where demand, driven by economic and demographic growth, had clearly outstripped supply.

▼ **Arnot power plant (South Africa)**

Inappropriately low fuel prices, whether through subsidies or un-priced externalities such as carbon costs, can hinder fuel savings from becoming a priority and driver for investment in both new and existing plants.

How could the potential be realized more fully?

Policy and market mechanisms can work together to encourage power plant efficiency. Informal and formal plant energy audit programs can help to identify fuel and cost savings and establish a business case to support the necessary investment with a convincing economic case. To promote implementation, additional support may be needed in the form of capacity building and financing *(business case 2)*.

Individual projects to increase efficiency of new or existing plants are helpful in building capacity and experience. However, the large number of plants with significant potential for higher energy efficiency suggests that broader approaches are needed.

Market mechanisms, such as the Indian trading scheme *(box 7)* or the Clean Development Mechanism (CDM) can be effective in raising the efficiency of new plants, and in building local capacity for new, high efficiency technologies. In some countries today, investors can be incentivized through the CDM to deploy super-critical plant technology instead of sub-critical (methodology ACM0013). The difference in CO_2 emissions creates CO_2 credits, which can be sold to help offset the incremental costs of super-critical plant CDM projects. Up to August 2011 five CDM projects have been registered under this category, with financial additionality as the main barrier for approval of more projects.

Business case 2

Saving electricity in Statkraft power generation facilities

A project focus on “Energy efficiency in Statkraft’s power plants” has established ambitious targets for end-use energy efficiency in a hundred hydropower plants in Norway, aiming to cut their energy use by 35% in 2014 (around 35 GWh). The yearly consumption of electricity in all Statkraft’s buildings, warehouses and other hydro production facilities in Norway is approximately 100 GWh. This target will be reached through the installation of control systems, operation monitoring and energy surveillance systems (ventilation, lighting, heating, production equipment, etc) and by evaluating alternative solutions for equipment and maintenance, with an estimated investment of €11 million and potential €1.6 million per year of economic savings.

The initial financial incertitude of this kind of project has been partially mitigated by support from Enova, the Norwegian agency responsible for renewable energy and energy efficiency, with a €1.8 million grant, gradually disbursed to each subproject when energy savings are proven.

Efficiency and Power Grids

Where is the potential?

Most grids can operate at around 90% efficiency on average worldwide, although losses vary significantly. For example, grid losses can be much higher when power plants are far from users or in poorly controlled or over-extended systems. In addition to transporting power over long distances, interconnecting adjacent grids and delivering power to users, grids are required to perform new functions such as: incorporating variable output renewable energy, integrating distributed generation systems, and providing quality power for digital electronics.

In developing countries, grids are expanding rapidly, and urban load centers are being linked with remote power sources. New construction provides excellent opportunities to install high efficiency grid technology. For example, high voltage DC (HVDC) transmission offers energy savings potential of 15% to 40% over long distances. HVDC can also increase throughput capacity for existing corridors, and interconnect grids that are not mutually synchronized *(business case 3)*.

In most developed countries, power use is still growing, and ageing grids are operating closer to their capacity and stability limits. Energy-saving solid state devices could enable more precise control relative to their conventional electro-mechanical counterparts. New metrology and energy storage devices can alleviate inefficiencies arising from variable renewable power generation *(business case 4)*. Systems that improve grid reliability could also contribute to energy efficiency by eliminating losses associated with outages and outage-avoidance measures.

Power grids also provide opportunities for energy savings outside the grid. For example, intelligent coordination of supply and demand via the grid can save both energy and emissions by increasing the use of the most efficient and lowest carbon plants and reducing inefficient start-ups and partial load conditions at power plants. Demand side management (DSM) programs have employed market mechanisms and other means to shift load from peak to off-peak hours and to promote energy savings and forestall construction of new plants.

On the consumer side of the grid, "smart meters" hold new business opportunities for energy and energy-related information services by giving consumers access to the information they need to take actions towards saving energy.

Business case 3

ABB strengthening the power grid in Namibia

Strengthening the grid is essential in developing countries where energy demand is growing fast, the grid needs to be more integrated and electricity losses are still high. ABB is building the Caprivi Link Interconnector that connects electricity grids in Namibia and Zambia, enabling reliable power transfer between the east and west of the Southern African Power Pool. A 350 kV HVDC Light® system stabilizes two weak networks in Namibia, connecting the Caprivi region with the rest of the country and facilitating power trading in the expansive region of southern Africa.

The project has been financed through long-term funding by the European Investment Bank, Agence Française de Développement and Germany's KfW (with EUR 35million each), an interest rate subsidy from the EU-Africa Infrastructure Trust Fund (EUR 15million) and NamPower and the Development Bank of Namibia funding the rest.

Strengthening power grid (Namibia)

Why isn't the potential being fully realized?

Electricity delivery creates "natural monopolies" in power grids, because most of the time it is the most cost-efficient way to deliver power from one or multiple plants or companies to all the customers in an area. Therefore, grid companies are usually regulated in order to protect consumers and allow organized generation.

In many countries investment in power grids have not kept pace with growing demand. In part this is due to efforts by regulators to keep costs low for consumers. Some grid expansion can be deferred through demand management and outsourcing of small distributed power sources. Ultimately, grids must be strengthened to integrate variable output renewable generation and to meet growing and increasingly complex power needs. There has been strong regulatory support for integration of distributed resources and smart meters, but other opportunities for energy savings in power grids have been lost in the regulatory process.

How can the potential be realized?

Grid expansion is one of the best opportunities for investment in high efficiency power transmission. For example, China is among the leaders in deploying high voltage DC for long distance transmission. Smart grid projects may also include efforts to raise efficiency.

However, for most existing grids, industry regulators should recognize the need and approve investment, both to strengthen the grid with the most efficient technology and to reach beyond the grid for savings both upstream and downstream.

Business case 4

Automated line rating in E.ON Sweden

The European Union has set ambitious targets for renewable energy sources. In order to meet these targets, companies are exploring technology solutions to increase the efficiency of the generation and grid system.

E.ON is planning to connect a 50 MW wind power plant in Kårehamn in the northern part of the Öland island (Sweden) with the regional power grid. However, the regional power grid is already facing network congestion. To address this constraint, E.ON is implementing a dynamic line rating (DLR) system to determine available thermal capacity of the network connected to the new wind park. The metrology devices and temperature sensors installed within the network will send information on grid conditions to the control center, where the data will be analyzed and integrated with the operating Control and Data system. When wind power generation exceeds available thermal capacity of the network, automated down powering of the wind plant will be activated. The DRL system will allow existing network capacity, and thus connected generation capacity, to be efficiently utilized, while not compromising the reliability of supply to customers. This solution avoids investment in new overhead lines to reinforce the network, which would not be cost efficient, because the surplus network capacity would only be fully exploited during certain hours under specific weather conditions.

In a similar case in the UK, a DLR solution to address increased wind production augmented thermal network capacity by 90MW with an investment of only £0.5 million, much lower than investment in new overhead lines, which range between £3-5 million.

Efficiency in Commercial and Residential Use of Electricity

Where is the potential?

According to the IEA, savings potential of strong efficiency measures in electricity use is vast – as much as 5,700 TWh per year in 2050, a 13% reduction from BAU. Many energy savings opportunities are available today with affordable proven technologies.

Commercial and residential buildings represent a large proportion of total energy use and a huge opportunity for energy savings. While new buildings tend to be more efficient, there is still a large disparity in energy performance among them, in terms of lighting, space conditioning, etc. Moreover, due to the long life of buildings, it is important to upgrade existing buildings, in particular thermal insulation, and their operations. Large buildings may also provide opportunities to raise efficiency through high efficiency local generation of power and heat *(business case 5 and 6)*.

Energy savings through electrification

Low carbon scenarios *(box 2)* estimate a strong electrification of the energy mix, which has the cross benefit of reducing fossil fuel dependency in some sectors. In most countries, hybrid (HEV) and plug-in hybrids (PHEV) and battery electric vehicles (BEV) have a potential to reduce transport energy use and emissions. HEV and PHEV's regenerative braking enables reuse of energy that would be lost in petrol-powered vehicles. Another advantage for BEV is the ability to recharge at off-peak hours with relatively low impact on grid capacity. Electric vehicle (EV) programs require a long lead time (decades) to build up a fleet.

EVs compliment other low carbon transport measures such as biofuels, continued improvements in conventional engine performance and further reductions in weight and frictional losses. Public transportation is typically much more efficient than the equivalent travel in private cars. Moreover, electric rail, offers potential energy savings when compared to fossil-fuelled trains.

In terms of energy savings and improved air quality, most cities would benefit from increased investment in public electric rail and electric vehicle infrastructure and incentives to increase the portion of trips made by rail rather than cars.

Electric heat pumps for industrial water heating also offer energy savings relative to oil or gas-fired units. Heat pumps draw heat from the environment rather than burning fuel.

Business case 5

Virtual power plant in an Alstom office building

Alstom developed a pilot project to use its own office building in Massy (France) as a small, virtual pilot power plant, believing that buildings could become power plants in the future as distributed power generation sources. The project started in 2010 with the deployment of solar PV, micro-wind and batteries for storage, plus a complete system of monitoring, optimization and control installed in a control room. The system allows the company to manage energy inside the building with the objective to prove that storage and real-time control can better integrate renewable energy sources, storing energy in batteries at night, which could be used during the day, when demand is high. Alstom estimates that one third of the company electricity consumption could be saved through: better use of green generation; peak saving by anticipating the building consumption through measurements and the weather condition; optimizing generation, storage and consumption depending on availability.

The main challenge has been the social and behavioral dimension of the project. Employees using the building are key to successful implementation of the distributed control system, and needed confirmation that daily comfort would not be influenced by the project. On the contrary it could be improved, because employees could gain control of different devices inside the building.

▼ **Alstom office buildings (France)**

Why isn't this potential being realized?

The potential is not being realized in part because consumers are often not paying the true cost of energy. But even at its true cost, potential energy cost savings may not be among the biggest cost concerns for the majority of energy users. Huge energy savings opportunities are lost among users due to a lack of awareness, low priority, and reluctance to change.

Capturing a large number of relatively small energy savings, distributed among many users, is an enormous challenge in itself. But even where the opportunities are clear, principal agent problems can arise when those who pay for improvements do not benefit from the savings. The lack of up-front financing is among the most important barriers to these savings.

Residential and commercial energy users often need help to improve efficiency because they don't have the time, knowledge or expertise to do it alone *(business case 6)*. However, in traditional utility business models, companies are not rewarded for helping their customers to save energy.

ESCO business models

Energy Service Companies (ESCOs) help fill the expertise gap, particularly in the commercial sector, where the potential per customer is higher. ESCO business models run the full spectrum, from private consultants, with no share in the client's energy cost savings, to entrepreneurs who take over some or all of the energy management at customer facilities for a fee. These ESCOs introduce energy-saving measures, pay the client's reduced energy bills, and profit from the savings. ESCO's have been creative in making energy savings painless for the customer, at no or low up-front cost.

Business case 6

Commitment to improve GDF Suez energy efficiency in buildings

GDF SUEZ signed the WBCSD Manifesto with the commitment to improve energy efficiency of their commercial buildings. As part of this commitment, GDF performed a retrofitting of their office building in Dijon (France) including: changing the traditional heating and air conditioning systems to a water-to-water heat pump; recovering the heat generated by the ventilation system; setting up an automatic lighting system; installing low-energy elevators; and changing the outside envelopes of the building to double-skin facades, with solar panels on the facades (or: including solar panels of the facades).

These actions led to the reduction of the HVAC primary energy consumption from around 180 kWhpe/m^2 year to 72 kWhpe/m^2 year. The energy efficiency obligations and the generation of tradable energy-efficiency certificates encourage these types of investments in France.

▼ **GDF Suez office buildings (France)**

How can this potential be more fully realized?

Many programs and measures have succeeded in raising efficiency in use of electricity. Among the most common and successful initiatives to raise energy efficiency are:

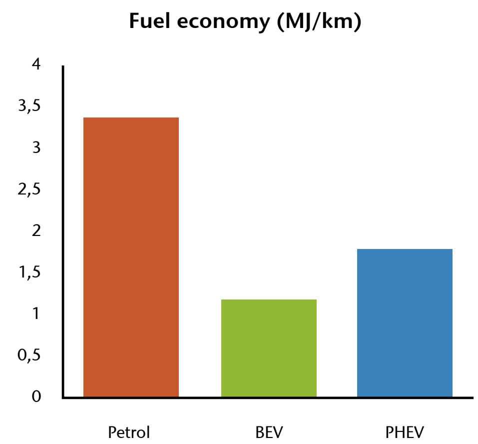
- Codes and standards establishing minimum acceptable energy performance
- Mandatory targets supported by financial incentives and other programs
- Appliance industry benchmarking, voluntary targets, and sharing of expertise
- Incentives for changing over to higher efficiency devices
- Affordable loans and grants for replacing old systems with more efficient ones
- Consumer education and product labeling

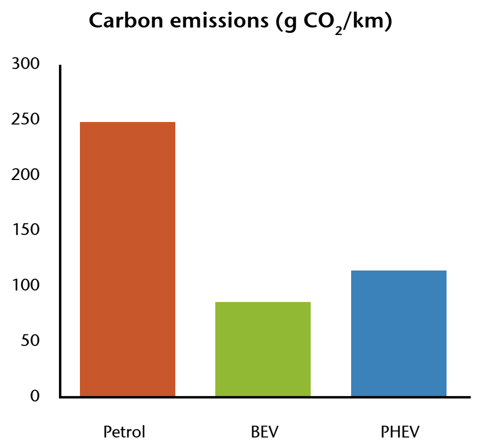
Yet much more remains to be done to capture the untapped potential of energy efficiency. New approaches are needed to capture energy savings among users whose attention is elsewhere. Direct incentives could be provided to utilities or ESCOs to reduce customer's electricity usage *(business case 7)*. New business models are also needed to gain economies of scale for energy savings along "the last mile" to the energy users, for example through the sale of energy services (lighting, space conditioning, hot water) rather than electricity.

Box 3. Energy savings and emission reductions through electric vehicles

An MIT "well to wheels" analysis showed that PHEVs and US grid-powered BEVs offer both energy and emissions savings of 50 % or more. As carbon intensity of the electricity is reduced, the benefits of electric and hybrid vehicles will increase.

Figure 3. Fuel economy and carbon emission in petrol vehicle, BEV and PHEV





Source: Electric Power Trains, Opportunities and Challenges in the US LDV Fleet, Kromer and Heywood, 2007

Business case 7

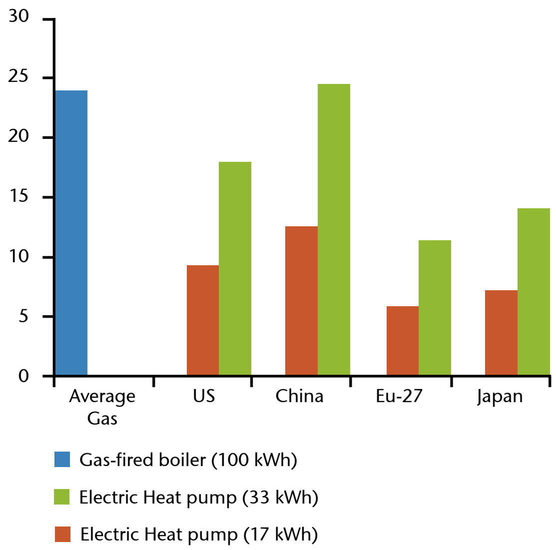
CLP building energy efficiency

CLP actively promotes energy efficiency improvements as part of its strategy to address growing demand for energy in Asia in a responsible manner. CLP provides free energy audits and advice to its commercial customers to help them reduce their energy costs, including successful cases such as:

- A hotel replaced its incandescent lamps with Compact Fluorescent Lamps (CFL) with 80% energy savings in lighting and decreasing air-conditioning costs due to the heat reduction.
- The installation of a dedicated dehumidification plant and heat pumps to improve a university's existing cooling and heating systems, produced HK$1 million savings annually on energy costs.
- A manufacturer replaced T12 fluorescent tubes with T8 tubes and electromagnetic ballasts with electronic ballasts and generated 28% savings on lighting costs, recovering its investment in a year.

To address funding, an important challenge for building energy efficiency, CLP provides interest-free loans under the Energy Efficiency Loan Scheme. Another challenge is that many customers (particularly SMEs) genuinely want to improve their energy efficiency but lack the proper information and business decision-making tools. By engaging customers, utilities can understand and help them develop their business case. In Hong Kong, clear government policies encourage and maintain the momentum of such initiatives; in particular they incentivize electricity companies to promote measurable energy savings by consumers.

Heat pumps work in the opposite way to refrigerators, bringing heat in, rather than taking it out. The amount of heat that can be drawn by a heat pump from the environment exceeds the amount of electricity needed to run the heat pump, resulting in an effective device "efficiency" of greater than 100%. While a gas-fired boiler would use 100 kWh to heat 1,000 liters of water from 18 to 90 C° degrees, electric heat pump only uses between 17 and 33 kWh. Carbon emissions vary depending on the electricity fuel mix (figure 4). With lower carbon electricity supplies, heat pumps can provide emissions reductions as well as energy savings.

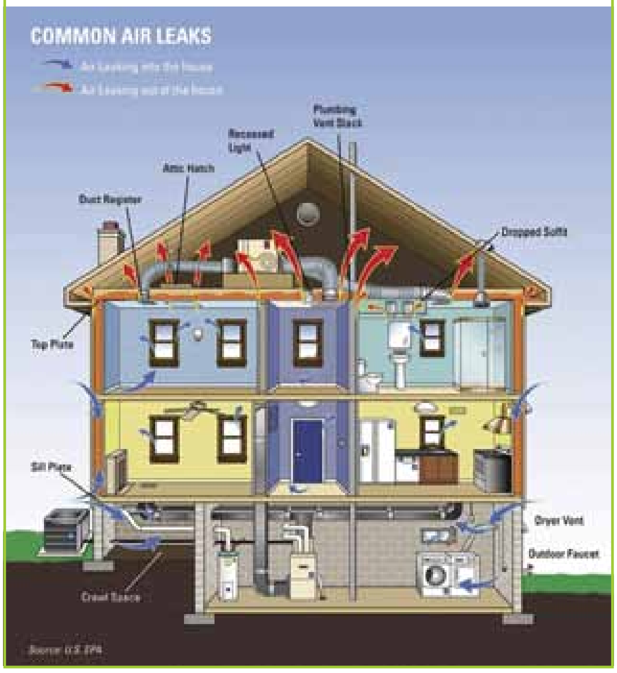


Source: IEA CO_2 emission from fuel combustion (2010) and IEA Heat pump centre.

Business case 8

California financial incentives for energy efficiency

Energy efficiency policies in California have contributed to relatively flat electricity usage per person in the past 30 years. The California Energy Action Plan (approved in 2003), places energy efficiency as the first priority in the loading order of energy resources, which means that cost-effective energy efficiency must be pursued before supply-side options. The California Long Term Energy Efficiency Strategic Plan provides a roadmap for a dramatic scaling up of state wide energy efficiency efforts.



Business case 8 (continued)

Southern California Edison (SCE) company has included energy efficiency savings targets in its long-term resource plans as the priority procurement resource, considering it alongside supply-side generation options. Between 2006 and 2010 the company has achieved 8,000 GWh of energy savings, equivalent to electricity demand of 1.1 million homes during a year. An important element of the California's business model for energy efficiency is the regulatory policy that includes:

- Lost revenue mechanism (decoupling). In California, cost recovery strategies have been designed to "decouple" utility financial health from electricity sales volumes, removing financial disincentives to energy efficiency. Rates are adjusted to make up for reduced sales due to energy efficiency and other factors, such as weather or economic fluctuations, to allow utilities to recover authorized revenue requirements.
- Energy efficiency program cost recovery. SCE recovers its energy efficiency program costs through two channels, the Energy Efficiency Public Goods Charge (a legislatively-mandated, non by-passable surcharge on customer bills) and the Energy Efficiency Procurement Funding. Currently, 75% of SCE's funding comes from the latter and 25% from the Public Goods Charge.
- Opportunity to Earn. California's shared savings incentive mechanism is structured such that if SCE meets or exceeds performance targets, shareholders would receive a portion of net benefits provided by SCE's energy efficiency programs. Utilities benefit only when they deliver benefits to customers above the costs of the program.

Efficiency in Industrial Use of Electricity

Where is the potential?

Besides electricity, energy-intensive sectors include aluminum, steel, metal casting, cement, glass, pulp and paper, textiles, chemical and fertilizer production, and oil refining. In most of these industries, there is a wide gap between the most efficient facilities and the least efficient ones. Part of the difference is due to age and size of facilities. Closing the performance gap has important energy savings potential.

Why isn't this potential being realized?

While energy intensive industries have made great progress in energy efficiency, opportunities for energy savings in less energy intensive industries are being lost due to low priority, lack of the necessary knowledge and skills and uneconomic investment opportunities. The business case for higher efficiency can be weakened by low energy prices.

Box 5. Power to Save

Energy efficiency is about saving energy, be it electricity or other fuels. However, it is not uncommon that industrial process efficiency improvements increase the total amount of electricity used in order to save a greater amount of fossil fuels. Digital controls can reduce waste of energy and materials, and recycling often requires electricity. In the steel industry, for example, electric arc furnaces enable the use of 100% scrap material as a feed stock, significantly reducing energy use as compared with blast furnaces using iron ore.

Box 6. WBCSD Cement Initiative

Through the Cement Sustainability Initiative (CSI), WBCSD member companies have galvanized the industry worldwide to define target performance and implement carbon and energy savings. Technology developments have enabled clinker material substitutions, alternative fuels, and significant savings in electricity use. As a result of increased efficiencies, the companies in the Getting the Numbers Right global cement database increased cement production by 52% between 1990 and 2009, whereas absolute total CO_2 emissions increased by only 30%[3].

Box 7. Energy Efficiency Trading Scheme in India

India has announced its Perform, Achieve, Trade scheme (PAT) to improve energy efficiency in eight energy intensive sectors, including power generation, accounting for about 65% of national GHG emissions. The scheme aims to reduce energy intensity by 20% to 25% by 2020, relative to 2005. Affected companies would have to meet energy efficiency targets by 2014 either through direct energy savings or through the purchase of energy saving certificates (Escerts) from other companies. Implementation is pending agreement on the energy saving targets for each sector.

3 WBCSD Cement Sustainability Initiative report, "Cement Industry Energy and CO_2 Performance: Getting the Numbers Right," 2009

How can this potential be more fully realized?

Benchmarking is an effective way to identify industrial energy savings potential. Normalized data for energy used per unit production quickly separate the leaders from the laggards. With support in the form of capacity-building and accessible financing, many of these energy savings opportunities can be realized *(box 6)*. Where the business case for higher efficiency is weak, efficiency programs and measures must provide a convincing cost perspective.

A number of jurisdictions have adopted binding energy saving targets and trading schemes covering multiple sectors, relying on market forces to find the most cost effective savings *(box 7)*.

Heat pump

Business case 9

Heat pump technology for industrial processes

The use of heat-pump technology *(box 4)* is expanding beyond residential air conditioning and hot water supply to industrial process such as cleaning, drying, and quick-freezing. Kansai Electric Power provided a technological solution to an existing manufacturing process of a food company, saving approximately 70% of annual energy use with a conventional heavy oil system (450t CO_2 of annual emission reduction). The company replaced and installed a multi-cooling and heating supply system for air conditioning and hot water for cooking, using grid electricity with heat pump technology. Further cost-savings and energy-savings were possible by load shifting to the night, heat-storage operation of the heat pump systems during the night when electricity prices are lower, and improving the power plants' load factor on supply-side.

The main challenge to replicate this solution is the high initial capital cost. Even if a low running cost makes life-cycle cost attractive, future business uncertainties deter investment, especially with a payback of more than 10 years. Some of the policy options that could address this barrier include investment subsidies, low-interest loans or leasing in cooperation with financial institutions. In the case of industries, it is difficult to install heat pump devices into the manufacturing process due to complex assembly lines designed for specific products. Collaboration with the power company can identify the different needs and develop specific system-electrification solutions.

Energy Prices and Energy Efficiency in the Value Chain

Extensive deployment of today's proven and affordable technologies could go far in achieving the potential energy savings, but existing market and regulatory environments are not driving deployment fast enough. Energy pricing measures can help to accelerate the increase in energy efficiency, either by increasing the potential for cost savings through higher energy prices, or by neutralizing market or regulatory factors that weaken the incentives for saving energy.

Energy prices are affected by a complex array of market and regulatory factors. Prices typically reflect the cost of fuel extraction and production, the strength and stability of market demand, and the transportation or delivery costs. In the electricity sector, market factors such as power offtake agreements and take or pay contracts for fuel or power also affect prices. In regulated markets, tariff structures and price controls on fuel and electricity are major factors in determining price of electricity. In liberalized wholesale electricity markets, the market structure itself can influence the consumer price of electricity. Even in liberalized retail markets, regulatory factors such as fuel import duties and mandatory tariff requirements can impact electricity prices.

Existing energy pricing measures reflect current efforts to address important objectives such as affordability, reliability, security, and the environment. New pricing measures to promote energy efficiency must balance energy savings with these other objectives. Moreover, pricing measures should take into account the diversity of energy-efficiency investment costs, the difficulty of properly assessing the external costs of energy use, including the cost of climate change, as well as the complexities of the existing energy price structures. Energy pricing mechanisms should incentivise energy savings without disrupting the delivery and use of energy.

Establishing a carbon price, explicitly or implicitly, is potentially one of the most powerful mechanisms available to reduce national GHG emissions.[4] The goal of carbon pricing is to create a change in the economy, whereby the market begins to differentiate between goods and services on the basis of their carbon footprints.

Pricing measures should be designed, as much as possible, as market based mechanisms allowing a progressive increase of energy efficiency in the whole value chain. Distortions in energy and carbon markets, such as subsidized or inconsistent prices, can deliver perverse outcomes including lower energy efficiency. Pricing measures should not undermine the benefits of market forces in optimizing the economy, fostering innovation and deploying new technologies.

4 For further discussion on carbon pricing, see WBCSD's *Carbon Pricing: The Role of a Carbon Price as a Climate Policy Instrument* (2011)

Recommendations

In general:

- Energy and climate policies should focus on realizing potential energy savings through higher efficiency throughout the electricity value chain: in power generation and grids as well as in end-use, particularly to reduce energy losses in buildings.
- Energy efficiency measures must provide a convincing cost perspective to those making the investment decisions, keeping the benefits of unleashing market forces.

Power generation:

- Energy efficiency programs and measures for power generation should focus on building capacity and providing a convincing cost perspective for:
  - utilizing the highest efficiency technologies for all new plants,
  - restoring design efficiency in existing plants.
- Specific policies to improve production efficiency include emission performance standards or emission trading systems, including CDM. The whole set of policies should be articulated to ensure overall consistency.

Power grids:

- Grid energy efficiency programs and measures should focus on recognizing investment needs to increase both efficiency and reliability, to enable new grid functions and to counteract inefficiencies arising from intermittent renewables and increased variability in demand.
- Grid measures should also pursue efficiency gains through intelligent coordination of supply and demand, as well as smart meters to facilitate energy saving by consumers.

End users:

- New energy-saving business models should be incentivized and supported as part of an integrated approach to commercial and residential energy efficiency.
- Energy savings and emissions reductions through electrification, particularly for ground transportation and heating, should be evaluated on the basis of the full energy value chain.
- Public investment in electric rail and electric vehicle transport infrastructure should be part of urban strategies to save energy, reduce GHG emissions and increase the use of public transportation.

Industrial use:

- Programs and measures for industrial energy efficiency should encourage sector benchmarking, and build capacity to raise efficiency towards best in class.
- Industrial energy measures should strengthen the business case for investing in higher efficiency, for example by providing financial support.

Pricing:

- Appropriate market mechanisms, which address the external costs of climate change (mitigation and adaptation), should be considered as a potential energy efficiency and climate policy instrument.
- Energy and carbon pricing measures should be complemented with other regulatory measures to promote the use of energy efficient appliances, such as labelling and standards.

WBCSD electricity utilities project members

ABB · AEP American Electric Power · Alstom · CLP Holdings 中電控股 · EDF · Eskom · GDF SUEZ · Hitachi · The Kansai Electric Power Co., Inc. · State Grid Corporation of China · Statkraft

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This publication was developed by the Electricity Utilities Sector Project working group, who wish to thank María Mendiluce and Takeo Tanaka of the WBCSD Secretariat for their contribution.

About the World Business Council for Sustainable Development (WBCSD)

The WBCSD is a CEO-led, global coalition of some 200 companies advocating for progress on sustainable development. Its mission is to be a catalyst for innovation and sustainable growth in a world where resources are increasingly limited. The Council provides a platform for companies to share experiences and best practices on sustainable development issues and advocate for their implementation, working with governments, non-governmental and intergovernmental organizations. The membership has annual revenues of USD 7 trillion, spans more than 35 countries and represents 20 major industrial sectors. The Council also benefits from a network of 60 national and regional business councils and partner organizations, a majority of which are based in developing countries.

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Disclaimer

This report is a result of collaborative work among executives from eleven member companies of the WBCSD Electricity Utilities Sector Project. This work was convened and supported by the WBCSD Secretariat. All member companies of the project have thoroughly reviewed drafts of the report. However, this does not mean that every member company necessarily agrees with every statement in the report.

ISBN: 978-3-940388-76-6
Photo credits: Provided courtesy of member companies and Flickr (Stephen Claire Farnsworth).
Printer: Atar Roto Presse SA, Switzerland. Printed on paper containing 85.9% PEFC certified fiber and 3.2% FSC certified fiber. 100% chlorine free. ISO 14001 certified mill.

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