World Energy Council
CONSEIL MONDIAL DE L'ENERGIE

ENERGY EFFICIENCIES: Pipe-dream or reality?

WEC Statement 2006

WEC Statement 2006

Published February 2006 by:

World Energy Council
5th Floor, Regency House
1-4 Warwick Street
London W1B 5LT
United Kingdom

Energy efficiency refers to the ratio between energy outputs (services such as electricity, heat and mobility) and inputs (primary energy). There are many sources of energy efficiency throughout the energy chain such as:

- Exploration and production of primary energies like oil, gas and coal
- Transmission and storage of primary energy
- Generation and transmission of electricity
- Distribution of energy and the provision of services in industrial, commercial, and residential activities.

Energy efficiencies can be realised in any country through a mix of government, industry and individual actions, but the potential for gain differs from country to country, depending on energy use patterns, the level of development, and the strength of national regulations and institutions.

Developing countries have great scope for realising energy efficiencies through the use of the newest technologies if they are affordable and available (for example, the use of modern heating and cooking systems), the introduction of best practices from experience in other countries, and changes in individual behaviour. However, in some situations energy prices at the final consumption level do not reflect the real cost of delivered energy because of subsidies and other practices with the result that the full potential for efficiency gains cannot be realised without institutional change. The greatest immediate gains are, therefore, still to be achieved in **transition and developed countries** with the highest per capita consumption of energy services.

Energy intensity, measured in terms of the amount of energy required to produce a unit of GDP, increases during the first stage of industrialization in developing countries before decreasing as observed in maturing economies. In developed countries the rate of growth in energy consumption is decoupled over time from the rate of growth of GDP resulting in a decrease of energy intensity. Part of this energy intensity decrease is, however, due to structural change in GDP (such as a stronger increase of tertiary activities versus high energy consuming industries). The response of energy demand to energy prices depends on several factors such as existing taxes or the type of service or payment system (flat rate tariffs for district heating in Central Europe, for example) or the quality of consumer information (electricity bills for households, for example). As relatively efficient technologies and practices move into the marketplace, initially lowering energy use, there is a potential rebound effect on energy demand (the savings from such technologies might lead consumers to use more energy in different ways).

This WEC Statement deals with the scope for energy efficiencies in all countries, whatever their stage of development. It stresses that, while energy efficiency programmes are necessary for sustainable energy development, they are not sufficient on their own to address all energy accessibility, availability and acceptability goals. Energy efficiency instruments and investments should be seen as one element of the bigger global energy system challenge.

1. WHAT IS THE SCALE OF THE ENERGY EFFICIENCY DIVIDEND?

It is remarkable how higher energy prices concentrate the mind!

It is often taken for granted, especially in the OECD countries, that the benefits of a modern life style can only be achieved with reliable and affordable energy services:

- heating/cooling to keep the indoor temperatures at comfortable levels
- mobility and commerce (local, regional and global) offered by road, rail, air and marine transport
- social benefits (better education and health care that result in longer life-expectancies and lower child mortality rates)
- increasing productivity (electrical equipment and appliances which not only make many industrial and domestic tasks much easier to accomplish, but also help achieve considerable savings in raw materials and waste)
- advanced communications and information technologies which depend on and promote reliable and affordable electricity supplies.

Enhanced energy efficiency appears to be an attractive "win win" option. Governments in many parts of the world are now seeking to place fresh focus on energy efficiency programmes which are seen as capable of delivering significant broad benefits in terms of WEC's key goals of energy accessibility, availability and acceptability. These are:

- Providing economic benefit through the more efficient use of energy as an important factor of production. And this should not be thought of simply in terms of benefit for the "rich world". It is also crucial to the provision of a minimum amount of affordable energy to every household in the world, the vital goal of ***Accessibility***;
- Easing the energy supply and demand balance thus promoting the ***Availability*** or reliability and security of supply and demand. Particularly as energy demand in the rapidly growing developing countries takes off, the moderating influence of greater energy end use efficiency allows time for the investment catch-up needed both to expand reserves (the tank) and the delivery systems to market (the tap); and
- Reducing fuel use, or at least maximising the outputs of the fuel that is used, thus contributing to meeting the goal of ***Acceptability*** in terms of local or global emissions but also public attitudes.

In industrialised countries, with universal electricity access, governments see energy efficiency programmes as a means of maintaining their competitiveness and energy-intensive industries, stretching supplies over a longer period of time, and avoiding greenhouse gas (GHG) emissions. Improvements in energy efficiency also support the WEC goals of energy accessibility, availability and acceptability (the three A's). The driving forces are somewhat different in developing countries. While reducing local pollution is of increasing importance to many developing countries, the need to reduce GHG emissions is generally allocated lower priority. Reducing energy investment requirements and making the best use of existing supplies to improve energy accessibility often rank higher in meeting developing country priorities.

Energy efficiency has improved considerably over the last 30 years in many countries, for instance, in the exploration, production and delivery of primary fuels to distant markets, thereby driving down costs to offset upward pressure on primary energy prices due to marketing and other factors. The average consumption of a refrigerator or a washing machine has been halved and the average fuel efficiency of cars has improved nearly as much, but the overall consumption of both electricity and mobility services in most countries has continued to rise. The impact of better building codes has been offset by investment in larger homes, with the result that, despite such codes, there is an upward trend in energy use in this sector in OECD countries. In a nutshell energy efficiency improvements appear to have been 'captured' by such consumers to increase their well-being by using energy in new ways, keeping their energy budgets at a constant share of their spending, whatever the final energy price.

Key Opportunities for Energy Efficiencies in the Energy Value Chain

- **Primary Production: the quantity of primary energy per unit of energy required to produce it**
- **Electricity Generation: the kilowatt-hours generated per unit of fuel input**
- **Primary Energy Transport (fuel transport, transmission and distribution): losses per unit of distance or unit of refined, processed or liquefied product**
- **Energy storage, for example, natural gas storage;**
- **Stationary fossil fuel end-use for heating and industrial purposes;**
- **Electricity transmission and distribution: technical and non-technical losses as a proportion of kilowatt hours fed into the system**
- **Mobility Use: fuel consumption per kilometre of distance travelled or tonnes of product shipped**
- **Other Uses: heat for industrial processes, heating/cooling or lighting costs as a proportion of building costs per square metre, consumption in the home for computers and appliances.**

Estimates of the gains which can actually be won vary dramatically. For example, when the UK White Paper on Energy was published in 2003, it put a 60% reduction in CO_2 emissions as the number one objective and argued that 25-40% of future UK energy needs could be met by improvements in energy efficiency. On the other hand, during the deliberations of the recent US Energy Task Force, some people argued that energy efficiency and conservation would not play much of a role in reducing US dependence on oil imports. In contrast, a recent International Energy Agency publication found that, while progress on energy efficiency in OECD countries has tapered off dramatically since the late 1990's, end use efficiencies alone could account for a 3.5 gigatonne reduction in global carbon dioxide emissions by 2030. **How? Where?** In particular **what** does it all mean for the large developing economies, which will account for such a high percentage of the increase in energy demand expected in the coming years?

The World Energy Council (WEC) has been working on specific aspects of efficiency in generation, network management and end use that can have **immediate pay-offs** and can impact all countries. The following sections focus on these areas of direct WEC analysis, but it is important to recognise that there are also other areas of enhanced efficiency opportunity, for example, resource extraction and processing, which are not dealt with in detail here.

EFFICIENCY OPPORTUNITIES ALONG THE VALUE-CHAIN

a) Power generation

Energy efficiencies in power generation can be achieved by improving the availability of existing plants or by replacing the existing power plant fleet (with an average worldwide efficiency of approximately 30%) by state-of-the-art technology achieving 45% efficiency today. Such actions would reduce the global CO_2 emissions by about one billion tonnes per year, or about 4% of global anthropogenic sources of CO_2 annually. As a more specific example, in the 1950's in Europe 700g of coal were needed to produce one kWh of electricity while today only 300g are required, a real improvement in efficiency but also a very positive result for environmental performance. With cleaner fossil fuel technologies and the use of waste heat in combined heat and power plants the reduction in emissions could be even greater. Nuclear power plants have also significantly improved overall efficiency through increased fuel burn up, recycling, and better operational procedures resulting in higher availabilities.

If the natural gas flared in Africa today were used for power generation, it could produce 200 Terawatt hours (TWh) of electricity per year, or about 50% of the current power consumption of the African continent and more than twice the level of power consumption in sub-Saharan Africa (excluding South Africa).

When it comes to improving the availability of power plants in operation today, analysis of their performance data presented in WEC's ***Performance of Generating Plant: New Realities, New Needs*** published in 2004 shows a substantial gap between the average power plant availability performance and that achieved by the best performing plants. Eliminating that gap would result in savings of US$80 billion per year. Since the existing plants could operate with higher availability, the need to build and operate additional capacity could be postponed. Such improvements could be implemented at an average benefit to cost ratio of 4:1 and only minor technology enhancements and equipment upgrades will be required. The majority of the improvement will come as a result of addressing certain management issues. In fact, if this area is not improved, new technologies will be unable to achieve their inherent superior performance potential.

It is important to note that remarkable strides have also been made in producing electricity with natural gas. The total energy efficiency of combined heat and power plants based on natural gas or coal can reach 85-90% efficiency compared with 40% for conventional power plants.

b) Transmission and distribution

Even the best managed electricity transmission and distribution systems cannot operate without losses. These losses can be technical, such as those occuring during long distance transmission or grid failures, or they can be non-technical, for example due to illegal connections to the distribution grid or non-payment for the electricity consumed. While the average worldwide losses in transmission and distribution are in the range of 10%, in some developing countries WEC's ***Pricing Energy in Developing Countries*** in 2001 showed that non-technical losses could reach up to 50% of the total electricity transmitted over the network. Technical losses can usually be decreased by the introduction of modern technologies and improved management practices, but it is the absence of comprehensive metering and ineffective payment systems which lead to high non-technical losses.

At a level more fundamental than transmission and distribution losses, enormous high-level efficiencies are potentially to be found in the regional integration of system design. Increasingly this is happening across national borders, as with the building of the single European electricity and gas markets and with the development of gas and electricity interconnections in Latin America. Supported by WEC analysis, Africa and other regions are also evaluating the efficiencies to be gained in integrated cross-border planning of energy infrastructure where third party choice and trade in energy services is not only more efficient but also protects against the market power of large companies. Africa and other developing regions are well placed to realise this potential, as their infrastructure is still at an early stage of development.

c) End-uses

Energy efficiency is not just a technical matter, it is also a matter of efficient services and the wise use of energy: the retail offer of the latest eco-efficient appliances, making a phone call instead of a physical visit, recycling, reducing heat at night, using modern building materials and insulation, all result in a decrease in energy consumption for identical or very similar services.

It should also be kept in mind that the considerations for individual end-users will typically be different to those of business and industrial ones. The bottom-line benefit of substitution of more efficient capital equipment is likely to be well analysed and transparent for the latter, whereas for individuals both the underlying information and the impact on personal expenditure may be much less clear. There are likely also to be significant differences in expected operating life of the equipment concerned.

Ultimately, however, end-uses choices for electricity, heating and mobility services are a matter of individual behaviour and the response to final energy prices, as well as environmental awareness and other factors. Eliminating the unnecessary consumption of energy, or choosing the most appropriate equipment to reduce the cost of energy, contributes to a decrease in individual energy consumption for the same energy services.

Making such decisions is certainly a matter of individual behaviour, but it is also, often, a matter of the availability of appropriate equipment: thermal regulation of room temperature or automatic control of room lighting are good examples of how equipment can help influence individual behaviour. Insulating a house makes it obviously more energy efficient: less energy is consumed for the same comfort. Similar conclusions can be drawn from industry experiences: each factory individually can decrease its energy consumption per unit of output with more energy efficient technologies.

While the costs of oil and natural gas extraction and delivery, processing liquids from gas and coal, and electricity have allowed transportation fuels – road, rail, air and marine – to remain relatively low, experience of energy efficiency policies and measures for vehicles and mobility demand have been mixed. At the same time, the increasing congestion and deteriorating air quality in rapidly growing cities is a strong argument for developing new technologies and policies. Today, technology can only provide an efficient solution and sustainable mobility with changes in basic infrastructure supported by clear energy policy.

Both for vehicles and for aircraft the immediate promise lies in achieving greater efficiency in the use of existing fuels. As noted earlier, average fuel efficiency of cars has nearly doubled over the past 30 years. The time needed for totally new options to penetrate the market is considerable because of the timescale for commercialising new technologies and the extent of the current capital stock of vehicles, but the fuel supply infrastructure is also critical. So the next steps are likely to be an increasing array of hybrid options, with a totally new fuel base still decades away. In any case, almost all OECD countries and an increasing number of non-OECD countries are implementing new or revised end-use efficiency measures, adapted to their national circumstances.

WEC/ADEME collaboration in ***Energy Efficiency: A Worldwide View*** completed in 2004 focuses on the evaluation of energy efficiency policies and measures their results in different operating and regulatory environments around the world. The research finds that market instruments (e.g. voluntary agreements, labels, information dissemination, audits and diagnostics), regulatory measures and standards are effective when the market fails to give the right price signals to favour insulated buildings or environmentally friendly appliances.

WEC's ***Energy End Use Technologies for the 21st Century*** published in 2004 estimates potential worldwide energy savings of as much as 25% by 2020 and over 40% by 2050. The scope for improvement is largest in the developing countries, and it is not static since it closely follows final energy services prices and technology development. On the other hand, developing countries can "leapfrog" the developed world by installing the most modern technologies immediately (such as water heat pumps), without having to replace embedded infrastructure. This can be achieved by helping developing countries to transfer, acquire and maintain the appropriate technologies.

3. THE ENERGY EFFICIENCY TOOLBOX

a) The price driver

Viewed historically, interest in energy efficiency has largely followed oil and other primary energy price fluctuations: the higher the price of oil, the stronger the interest in energy efficiency. Following a period of low oil prices at the end of the 20th century when little attention was paid to energy efficiency, higher energy prices have again propelled energy efficiency to the top of political and public agendas. It is therefore vital that final price signals reach consumers through cost-reflective pricing.

For final energy prices to drive high levels of efficiency, they should ideally reflect all long run costs, meaning that subsidies that may have helped a technology penetrate the market eventually need to be removed and identified externalities need to be included. The prices of energy and energy products often reflect only a part of the overall costs, the part tied to the immediate cost of primary supplies or electricity generation. Rarely do they include longer term environmental costs or the long run marginal development costs and cross subsidies among consumers. To achieve cost effective market prices, governments need to introduce sound legislation and stable investor-friendly regulations.

If final energy prices do not reflect true costs, decisions made by final consumers when purchasing equipment or making an energy efficient investment (e.g. retrofitting a dwelling) more often will not reinforce the drive towards global economic optimisation. There will be a gap between the actual achievements in energy efficiency and what could result if an accurate price system accounting for all costs involved were required by government policy and supported by clear regulations.

If price signals are to be felt, then at least some payment for energy services must be made. Metering and a workable energy payments system are, therefore, critical to the promotion of greater energy efficiency. At the same time, it is a practical political reality that abrupt and total withdrawal of subsidies may not be possible, particularly for poor remote rural populations and for the increasing numbers of poor people who are crowding into the urban and peri-urban areas of developing countries. Where tax credits or subsidies are maintained, however, they should be transparent, targeted and time-bound. Significant quantities of electricity in developing countries are stolen at this time through illegal connections – this is the worst "subsidy design" possible and experience shows that even very poor people are willing to pay something and will use electricity more carefully as a result.

Similarly, where political realities include energy taxation (for example, to cover the costs of externalities in end use prices), the principle of transparency regarding objectives and the level of taxation should be applied. Energy taxes themselves are often a source of serious distortion in the ways energy is used.

Energy efficiency policies that use direct or indirect price mechanisms (e.g. removing subsidies, incorporating externalities through market based mechanisms) are the most effective in lowering energy consumption trends. However, even without changing the overall price environment, energy efficiency policies should be pursued to correct market imperfections such as lack of information for small consumers about household improvements or the full operating costs of appliances, the building owner-tenant interest in thermal performance, and access to funding for technology improvements. Here again, legal standards, labels and information dissemination, along with an adequate payments system for energy are central to energy efficiency goals.

To achieve cost-reflective pricing, life cycle analysis is therefore an essential tool. This is a "cradle to grave" analysis of impacts and costs of a given energy source, be it biomass, solar, nuclear, conventional fossil fuels or any other fuel option. Life Cycle Assessment has been applied, for example, to comparative evaluation of alternative automotive fuels and technologies that are expected to become available in the near future. WEC's ***Comparison of Energy Systems Using Life Cycle Assessment*** published in 2004 has more detail on this.

Some of these costs are already reflected in final prices, but there are significant omissions, including typically health and environmental impacts that are geographically dispersed. Of course, emissions trading schemes such as the one now operating in the European Union do have the effect of internalising the cost of carbon mitigation in the energy prices.

b) Voluntary industry action plans

In Japan, the Nippon Keidanren's Voluntary Action Plan is based on individual industry action plans and has been effectively implemented to reduce greenhouse gas emissions. One of its principal components is to achieve quantifiable improvements in the energy efficiency of industrial processes, buildings, and other activities of the companies. Industry agreements in Sweden for supplying and using waste heat are paying off. Similarly, as mentioned above, the cooperation of electricity generators to share information with WEC on best practises to improve the operating efficiency and maintenance of all types of power plants has both capacity and emissions pay-offs. Voluntary measures clearly reflect the special circumstances of each country or region; measures by city leaders and others, for example, to address congestion must reflect the specific history and cultural attitudes of the public.

c) Standards, labelling, codes & information

Standards and building codes implemented in OECD countries over the last 30 years have resulted in a drastic reduction of energy consumption of new dwellings (up to a fourfold improvement). Standards for new products should fall within existing or tighter performance standards for broadly similar products, or such performance standards should be rapidly introduced. Labels are important in channelling technologies to the marketplace to ensure that energy efficiency is taken into account. Audits and diagnostics for households and small businesses provide useful information to reduce energy costs.

Given the low stock turnover of the buildings and the difficulty of improving the efficiency once the building is completed, governments have a role to play in defining optimal building codes including insulation standards, double-glazing, and efficiency standards for lighting, refrigeration, central heating and air-conditioning systems. Similarly it is important that vehicles be covered by consistent efficiency criteria, so that choice is not distorted.

To ensure effective operation of transmission and distribution systems, regulatory authorities should adopt an investment-friendly approach to regulation and ensure better management of entire transport networks by introducing relevant incentives and penalties for reliable service.

d) Joint industry-government partnerships on energy RD&D

WEC's recent work shows that robust research and development followed by demonstrations of new end-use technologies can potentially save at least 110EJ/year by 2020 and over 300 EJ/year by 2050. The success of such work depends on investments of about US$4 billion per year and decisions made today. Since it is almost certain that no single technology, or even a small set of technologies, will dominate in meeting all the needs of the globe in any foreseeable timeframe, new partnerships between industry and government are required to reduce the risks with incentives and policies that can help get end-use technologies from the laboratory or the test bed to market. In today's world it is often easier up to a point to meet new capacity requirements in the energy chain through investments in energy efficiency rather than the siting and building of new plants.

4. NEXT STEPS & CONCLUSIONS

The World Energy Council stands ready to play its part in realizing the potential of the energy efficiency opportunities available to all countries. In particular, it will:

- **Become** a "thought leader" for raising public and industry awareness around the world on "intelligent use of energy", working with active industry and government partners as appropriate to promote regional and global consensus on R&D as well as demonstration of new technologies and new materials;
- **Disseminate**, through its membership of nearly 100 countries, the important findings of its energy efficiency related work on regional integration of energy systems, pricing energy, life cycle analysis, performance of generating plant, energy efficiency policies and indicators and energy end-uses technologies;
- **Support** energy efficiency and energy saving initiatives as they emerge, such as the European Union's call for "energy-saving action plans" to be developed by member states over the coming nine-year period; and,
- **Promote** efficient energy technology transfer, installation and maintenance know-how in developing countries.

The World Energy Council believes, therefore, that the opportunities for enhanced energy efficiencies throughout the world are a reality, not a pipe-dream. Important gains in efficiencies have already been achieved but much more can be done with the tools at our disposal. It does signal, however, that further gains will not be easily won and will vary across countries and components of the energy value chain. While the greater potential for improved efficiencies lies in energy end-uses, including town planning and transport, the more immediate dividend lies in "up-stream" of end-uses.

BIBLIOGRAPHY:

Pricing Energy in Developing Countries, 2001

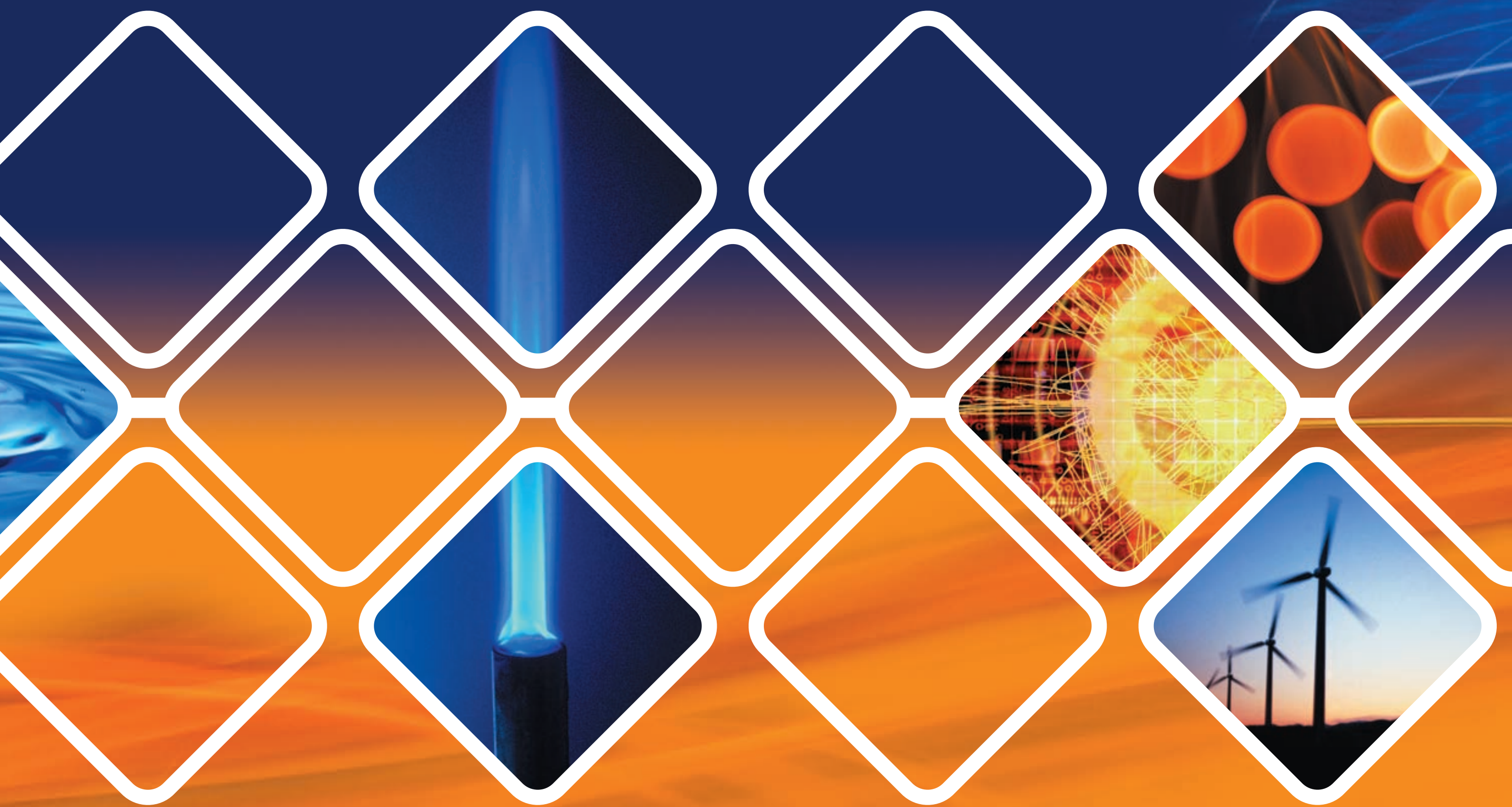
Comparison Of Energy Systems Using Life Cycle Assessment, 2004
ISBN: 0 946121 16 8

Energy Efficiency: A Worldwide Review, 2004
ISBN 0 946121 17 6

Performance of Generating Plant: New Realities, New Needs, 2004
ISBN 0 946121 19 2

Energy End Use Technologies for the 21st Century, 2004
ISBN: 0 946121 15 X

These reports are available for downloading on the World Energy Council website at www.worldenergy.org.



World Energy Council

Regency House, 1-4 Warwick Street, London W1B 5LT United Kingdom

TEL: (+44) 20 7734 5996 • FAX: (+44) 20 7734 5926

EMAIL: info@worldenergy.org • WEB: www.worldenergy.org