Consumption versus Efficiency: Have We Designed the Right Policies and Programmes?

Benoit Lebot, Energy Efficiency Expert
Paolo Bertoldi, European Commission DG JRC
Phil Harrington, International Energy Agency

ABSTRACT

Traditionally, energy efficiency policies and programmes have been designed to improve the ratio between the energy consumed and the service provided, e.g., to get more kilometres per litre of petrol or to consume less energy per square meter of house. The challenge of mitigating climate change, as well as the need to achieve a sustainable and socially-equitable energy future, demands that we target absolute, and not just relative, reductions in energy demand. To this end, traditional energy efficiency policies and programmes need to be re-thought and re-focused to meet the goals of energy conservation and sustainable development.

The paper presents and discusses some examples of negative side-effects of European energy efficiency policies and programmes, including among others: promotion of energy saving lamps that are used longer periods than the lamps they replace; minimum efficiency standards and labels that favour larger refrigerators; and residential air-conditioner rebate programs, which reinforce the growing social norm that air-conditioning is a necessity. The risk is that characterising goods as 'efficient' encourages consumers to buy and use them, when otherwise they may not have. Another example is that of efficient cars that are advertised on the basis of how many extra kilometres one can drive with a single tank of fuel, encouraging additional car use.

This paper suggests a new policy concept to be added to the current policy tool-box: the idea that energy must be used in a socially-responsible manner. In addition, the concept of capping energy consumption behind certain level will be introduced. As an example of this new energy efficiency policy concept, the paper discusses how new buildings codes could introduce a maximum energy consumption per dwelling, with any additional consumption only able to be provided by renewable energy.

Is Energy Efficiency Enough?

Energy efficiency describes how much useful work, activity or service can be generated for each unit of energy consumed. From this simple definition, two important observations can be made about the nature of energy efficiency. First, what is 'useful' output is inherently subjective. What is judged useful by one person may be judged wasteful by another. Conversely, if personal utility is subjective, then it is not possible (on a neo-classical understanding of market-based consumer behavior) to sanction high, wasteful or 'conspicuous' energy consumption. If the consumer is willing to pay, then the consumption is assumed to be justified. Second, improving energy efficiency does not necessarily mean using less energy. Energy efficiency creates a range of direct benefits, or impacts, which range from less energy use to deliver the same service (energy savings), through to the same energy use to deliver more output (energy productivity). Indeed, with rebound effects (below) it is possible that energy efficiency may trigger more energy use over time, through a combination of direct and indirect effects, as the energy productivity effect of energy efficiency stimulates additional growth and energy consumption. This leads to a clear economic benefit, but also to a clear increase in greenhouse gas emissions

Short Discussion on the Rebound Effect

Economic analysis suggests four categories of possible rebound effects in response to the implementation of an improvement in energy efficiency.

Direct rebound effect: For the buyer of a more energy-efficient technology, the effective price of the energy service produced with it is now lower and this encourages increased consumption of the service. The likelihood that this effect occurs and is substantial varies with the type of energy service involved. For household purchases of various energy technologies, large direct rebound effects are quite unlikely due to the satiation of demand. Once basic needs and comfort levels are satisfied in relation to such services as refrigeration, carpet cleaning and space heating, a reduction in their prices is unlikely to lead to more consumption of them. In other cases there is greater scope; for example, improvements in fuel technologies may play a role in decisions to buy larger and more powerful automobiles. In industry, substantial direct effects depend on the extent to which technologies allow fuel to be substituted for other inputs in production processes and on the effect of improved energy productivity on a nation's international competitive position – that is, on the potential for reduced energy costs to allow firms to expand their markets without taking business away from other firms in the same country. For a given firm, the size of the productivity effect will depend on the proportion of its total production cost accounted for by energy and on the market price elasticities of the goods being produced.

Income effects on other goods: A household undertaking an efficiency improvement will use less energy and this will free a portion of the income that was being spent on energy; some or all of this freed income will be used to buy other goods and services, the production of which will require energy. Similarly firms will have a source of cash to use to expand their activities or distribute to employees and owners, who will spend some or all of it. However, the original reductions in household and business spending on energy also show up as a reduction in income received by the sellers of energy, meaning that some or all of shareholders, employees and input suppliers of energy companies will now have less income to spend. Thus, for the economy as a whole, one effect can offset the other. While this offset is not likely to be exact, the *net* effect of the redirection of income and spending flows can be either positive or negative and will in general be very small. Secondary rebound effects of this sort are therefore likely to be negligible.

Energy price feedbacks: The effects of improvements in energy efficiency can be spread throughout the economy through price effects. The most interesting question in this regard is what happens to the physical quantities of fuels saved as a result of the widespread use of a given improvement in energy efficiency. Fuel and electricity companies will find themselves with excess supplies, which they may try to market by lowering their prices. In the economist's idealised model of a competitive economy, prices would adjust until excess supplies are totally used up – the rebound effect would in that case be total.

Long-run effects on productivity, consumer tastes and economic structure: In this category are the effects suggested by green-critics when they argue that a focus on changing technology in order to solve environmental problems affects how people live and what they buy.

Lower energy consumption can also affect decisions made by entrepreneurs to introduce new products. Thus the long-term effect might be to increase purchases of energy-using goods and services and to be more dependent on them than before energy efficiency was improved. For instance, more fuel-efficient cars presumably make people more willing to live far from their place of work, which could mean that higher energy efficiency would lead to more fuel use in the long term than would occur if people had less fuel-efficient cars and lived closer to their work.

Efforts have been made to estimate direct rebound effects for particular categories of energy services, though the kinds of data needed for thorough empirical studies are not readily available and estimates are therefore rough and vary within wide ranges. The important result of such studies is that estimated direct rebound effects tend to be small, though at levels significant enough to be taken seriously. For instance, a survey of studies of data from the United States (Greening 2000) reports estimates for household rebound effects in space heating in the range of 10-30 percent, space cooling 0-50 percent, lighting 5-12 percent, household appliances zero and automotive transport 10-30 percent.

In sum, direct rebound effects appear to be relatively small – a direct rebound effect of, say, 10-20 percent signals a direct reduction in energy consumption of 80-90 percent. However, the possibility that the total rebound effect is much larger depends on the feedbacks that occur through the policy-induced energy price reductions and changing consumer tastes referred to in categories 3 and 4 above, but we are not aware of any estimates of the magnitude of these effects. Nevertheless, as we note below, it is an historical fact that energy demand in IEA member countries has continued to grow since the 1970s despite oil-shock induced price rises and decades of energy efficiency policies and programs. More research and more analytical work should be performed to better understand and possibly assess the rebound effect. Output of such work is likely to reorient some energy efficiency policies.

Some Examples of Missed Opportunities, Wrong Policies and Rebound Effects

- We know how to build houses that consume much less energy than houses built 30 years ago. However, newer houses are generally larger that the houses they replace, again leading to higher levels of energy consumption overall.
- Modern cars are often time more energy efficient than the older cars they replace. However, there are more cars on the road, we drive faster on the highways and experience more congestion in cities, travel more, and our cars are equipped with more and more energy consuming devices like air conditioners, onboard computers, etc. How can we expect to see energy demand in road transport go down?
- The Netherlands have one of the highest penetrations of compact fluorescent lamps per household in Europe. But CFLs are commonly used to light the garden at night.
- Since 1995, Europe has a mandatory energy label on refrigeration appliances. The label displays a scale of 7 of energy efficiency categories, from A (most energy efficient) to G (less energy efficient). The energy efficiency rating takes into account the size of the different compartments, as well as their indoor temperatures, and benchmarks against the energy consumption of the appliances. Despite these efforts to calibrate and compare refrigeration appliances in a unique format, there is a bias. It is easier for a larger unit to obtain a better energy efficiency category. Larger units therefore appear to consumers to be more energy efficient, even when they consume more energy.

- In Europe a significant market transformation of household washing machines toward more energy efficient unit has been observed as the result of the introduction of a mandatory energy labels. But over the recent years, more and more of the so-called energy efficient washers are managed with some advanced electronic controls. Unfortunately, the electronics that allows the control, is powered by an AC-DC power supply that constantly remains connected to the mains, drawing standby power round the clock. The test procedure of a clothes washer does not consider the energy being consumed when the appliance is not being used, so this consumption is not reflected in the energy label. As a result, washers consume 10% more energy yearly compared to the figure indicated on the energy label. 10% is comparable to the overall gain generated by the market transformation just mentioned.
- It has been reported that some rebates provided by an electric utility company were given to purchasers of plasma screen TVs, because the standby power level of the appliance was supposed to be efficient. By doing so, the utility is encouraging the replacement of a regular 80W TV set by a 300 W plasma screen TV set. Overall the switch to the new technology will generate more energy consumption.

Energy Demand – What Are The Trends?

It does not take much effort to note that our modern society has not managed to reduce its thirst for oil, gas, coal and electricity. A recent publication from the International Energy Agency (IEA 2004) shows how energy demand in IEA member countries has increased steadily since 1973, by 2.1% each year on average, interrupted only temporarily by the oil price shocks in 1974 and 1979. Despite this, aggregate energy intensity (energy per unit GDP) declined by almost 50% between 1973 and 1998, indicating that our societies are indeed consuming much less energy for a unit of production. However the rate at which energy savings are being realised appears to have been slowing steadily since the late 1980s reflecting, not surprisingly, the reductions in real energy prices that have taken place since 1986. Before 1973 energy prices were generally low, so when the price hikes kicked in after the first oil crisis, there was room for improving energy efficiency. As prices fell after 1986 the incentive for maintaining energy savings rates weakened.

An implication for policy is that despite continued effort to introduce energy efficiency programmes, policies for the rationale use of energy and energy conservation measures; and despite continued decoupling of energy demand growth from economic growth; energy consumption and associated greenhouse gas emissions have continued to grow[i]. However, the challenge of mitigating climate change as well as the necessity to develop a sustainable and socially equitable energy future demand that we understand how to achieve absolute reductions in energy demand and associated emissions. Have we designed the right policies and programmes for this end?

New National Climate Change Targets

The International Protocol to mitigate greenhouse gas emission agreed in Kyoto in 1997 has not yet come into force. As Russia keeps postponing its decision to ratify the text, the risk that the Protocol may never be enforced grows. However, several European countries are focusing their efforts with a longer-term perspective. Germany, France, United Kingdom, The

Netherlands and Switzerland have all announced ambitious objectives to reduce their emissions of greenhouse gas. The following table (table 1) summarises the officially announced long term targets:

Table 1. Greenhouse Gas Reduction Objective for Several European Countries

Country	Organisation	Date of Analysis	Objective in %	Horizon	Baseline
Germany	Federal Agency for the Environment	2002	- 80%	2050	1990
France	Mission Interministerielle sur l'effet de Serre	2003	-75%	2050	1990
The Netherlands	Climate Policy Working Group Project COOL	2001	-80%	2050	1990
United Kingdom	Royal Commission on Environmental Pollution	2000	-60%	2050	1997
Switzerland	Federal Office for Energy	1997	-60% residential –75% commercial –70% industry –45% transport –55%	2030	1990

The targets, aiming at an absolute reduction of between –60% to –80% of greenhouse gas emissions in 2050 compared to 1990 levels are compatible with the recommendations made by the Intergovernmental Panel on Climate Change (http://www.ipcc.ch/).

Beyond the threat of climate change linked to the rapid growth of greenhouse gas emissions from fossil fuels, other challenges linked to rising energy use include air quality concerns linked to noxious emissions from vehicles; nuclear wastes and air pollutants from power stations; energy security concerns, particularly for regions or countries reliant upon imported fuels; disputes over the location and installation of energy infrastructure, such as power-lines, wind-farms and power stations; and fuel poverty, which remains a significant issue in many developed countries.

The IEA's *World Energy Outlook* depicts a business-as-usual future "…in which energy use continues to grow inexorably, fossil fuels continue to dominate the energy mix and developing countries fast approach OECD countries as the largest consumers of commercial energy…[raising] serious concerns about the security of energy supplies, investment in energy infrastructure, the threat of environmental damage cause by energy production and use, and the unequal access of the world's population to modern energy" (IEA 2004). In short, today's energy systems are not sustainable.

To reach the sole new climate change targets, among all of the policies and measures to be developed and implemented, reducing the demand for energy should have the highest priority. Decoupling the economic growth from the total energy consumption needs to be organised at a rate never before experienced. To be precise, the rate of improvement in energy efficiency must exceed the rate at which demand for energy services grows, and that on a global scale, if we are to reduce total energy consumption. Short of accepting lower levels of energy services, only a dramatic improvement in energy efficiency can achieve this outcome.

Energy Conservation Offers the Most Significant Contribution to the Challenges

By using less energy to create the useful services that people demand, less greenhouse gas emissions and other pollutants are emitted, less primary fuels are demanded, less new energy supply infrastructure is required, and energy costs are reduced. Compared with other solutions, energy efficiency and energy conservation is generally less expensive (often profitable after a short payback period), and more readily available. While energy efficiency is not a whole solution to the challenges of an unsustainable energy system - and must be complemented by other policies such as those that encourage the use of renewable energy sources, fuel-switching toward low carbon fuel, technology development including carbon capture and sequestration, low energy/carbon spatial planning – efficiency and energy conservation should be the *first* priority in moving towards a sustainable energy system.

Despite the benefits of energy efficiency itself, which are generally understood and not challenged by policy makers, energy efficiency policy is generally weakly supported by all stakeholders, from policy makers, to the end-users. The main reason for this appears to be the pervasive but incorrect view that the market will deliver whatever level of energy efficiency is justified. To this must be added the wider reluctance of governments to intervene in market processes, misconceptions about the nature of energy efficiency policy, the diversity of end-use products and markets, and the political economy, all of which exacerbate the problem of lack of interest in energy efficiency. Despite this view, it is clear that the market systematically under-supplies energy efficiency relative to that which is economically optimal, and under-supplies it to an even greater degree relatively to that which is required for a sustainable energy system. Persuading policy makers to exercise their powers to make stronger and more effective efficiency and conservation policy is a crucial necessity.

Commercials and Advertisements: A Terrific Challenge to Energy Efficiency

It is estimated that the average North-American is hit with 1,500 to 3,000 commercials a day through the media (Secourpopulaire 2004). The figure is likely to be very similar for an average Japanese or European. By the time a child enters adulthood, she or he will be hit by a total of 10,000,000 commercials. Apparently, studies show that we only consciously see only between 5 to 10% of the daily avalanche of commercials. We may recall barely 1, 2 or 5 commercials a day. Commercials are meant to dictate how we should look, how we should act, and what we should have. Indirectly, commercial heavily affect our relation to energy and the way we consume it.

Since the liberalisation of energy markets, it is not rare to see billboards and newspapers advertisements promoting the electricity of a given provider purely on its low rate. Even when a national energy market is dominated by state-owned utility monopoly, like in France, electricity is advertised as a cheap, abundant and non-polluting product. With such a market and societal environment, how can we expect the average consumer to pay attention to energy savings or energy efficiency? Haven't we seen in UK some local utility companies proposing to credit the frequent-flyer account of its clients in proportion to the amount of energy they consumed? In Norway, if you are accepted to become a new client to a particular electric utility company, you are given a brand new TV set.

In France, during the 90s, massive advertising campaigns to promote air conditioning were regularly launched at the end of the spring season. The campaign was co-financed on one hand by manufacturers of air-conditioners and on the other hand by…the state-own monopoly utility. The rationale was simple: the company in question produces 80% of its electricity from nuclear reactors. During the summer, the load is below the electricity production. Advertising for a new seasonal end-use was for them a sound demand-side management strategy. And it worked. It is not rare in Europe to see advertisements of indoor winter comfort with lightly dressed people when snow is falling behind the windows. The image is not compatible with recommended indoor temperatures derived from energy efficiency campaigns, sometimes run simultaneously.

How can we expect the average consumer to pay some attention to the fuel she consumes while she drives, when it has become so easy and sometimes inexpensive to cross the country or travel overseas low-cost airlines? Yet bunker fuels are exempted from scrutiny under the Kyoto Protocol and carry no taxes. How many people know that, even if they drive a highly energy efficient car, just one trip by air could emit more greenhouse gases that all those they have consciously mitigated that year? How much do we think about it?

A European car manufacturer recently advertised in a TV spot a new model being so energy efficient, that you can drive it to just drop a letter in the mailbox around the corner next block and return home. Fortunately, the message was shocking enough to several consumer groups, and the commercial was withdrawn. But one can question why the commercial was accepted by the authorities in the first place? Who can assess how much effort it will take energy efficiency policy makers to just counter-balance the impact of this sole commercial? By the way, how many people noticed that when cars are advertised, the streets and roads are always empty? How often does this image correspond to reality?

Among the thousands of commercial messages that we receive daily, we may notice just a few dozens, and may recall no more than ten (a terrific deal for this latest top-of-the-range laptop plus the incredible bargain for spending a week in a sunny island). What are those commercial messages telling us? In more than 90% of cases: buy more, consume more, with inevitable consequences for energy consumption.

Other Trends in Society Are Working Against Energy Efficiency

Our modern corporations are addicted to advertising. The examples above illustrate how commercials and advertisements pose a true challenge to energy efficiency and energy conservation, especially in the context of the radical shift that climate change imposes on us. Many other trends, and sometimes policies, in society are tending to pull in the opposite direction, weakening overall incentives for improved efficiency. Energy market reform stands as another example. By improving the productivity of energy supply, market reforms have tended to lower electricity prices, particularly for the most energy-intensive users, while the price of energy-using equipment is also falling in real terms. In addition, incomes are rising and new types of consumer products are continually entering the market.

The efficiency with which energy is used in a society is, at any given point in time, a function of literally millions of individually-small decisions in the past – which refrigerator to buy, which heating system, which building design, which transport system, which process for an industrial plant. The information, incentives and policies that influenced one each of these millions of individual decisions over time eventually determine the sustainability of our human environment and social infrastructure. Once made, many of these decisions have very long-term consequences. Transport systems, patterns of urban development, and even buildings, may last and continue to influence energy consumption and greenhouse gas emission patterns for hundreds of years – long after the decision-maker and the immediate incentives surrounding that decision are forgotten. As example the choices made right now by countries such as China or India to promote the use of individual cars by building roads and motorways, rather than public transport systems and correct spatial planning may have huge implications for CO2 emission in the near future.

If we are to evolve a fundamentally more energy efficient human infrastructure, without diminishing choice, then the long-term consequences of these choices must be immediately apparent to the decision-makers at the moment they make their choices. Policy measures of differing types – from information provision through price incentives – can achieve this end. Further, minimum performance standards can set a limit to the impact that society is willing to accept, while other measures can encourage "beyond minimum" performance. Efficiency must be synonymous with quality (more efficient is better), and quality never sacrificed for efficiency.

For the case of energy efficiency regulations through norms, codes and standards, there is a discussion whether these policy tools encourage or not a greater penetration and use of the energy consuming goods they cover. They can become a common language for marketing more rapidly and more widely such products. If an air conditioner is known to pass the US or Japanese energy efficiency standards, then it's OK to purchase and use it wherever the customer is, in Europe or elsewhere. This may override the first question to be asked: has the customer done all that is possible to reduce cooling loads before installing an air conditioner?

Avenues for an Enhanced Energy Efficiency Future

The time has come to design energy efficiency policies as a contributor to absolute reduction in energy demand. For this, energy efficiency will have to become more than a minor element of a wider energy policy package. Very likely, energy efficiency and energy conservation should come in a global policy package that comprises all dimensions –such as the technology, the price signal, the behaviour, etc.

Furthermore it must be fully integrated not only within energy policies in general, but more importantly, into policies at the international, national and sectoral levels, including in city planning, transport, housing, building, industry and wider fiscal policies. It is when a house is being designed and built or when a decision to link two cities with a road or with a railway is being taken, or when an appliance is being manufactured, that energy efficiency and energy conservation can best be delivered.

There certainly exist many different ways to revisit energy efficiency. The following five points are proposed to structure the efforts to be made. Each point corresponds to a given dimension of the renewed ambition for a more energy efficient economy; that is, aiming for an absolute reduction in energy demand. They each represent a component of the policy package. They are of course complementary and do overlap at some level. They are:

1. Enhanced knowledge
2. Information, education and motivation
3. Stimulate research & development

4. Set energy efficiency norms
5. Use price signals

1. Enhanced Knowledge

Analysing where and why we use energy (what form, which quantity, etc…) is a prerequisite to any sound programme. Resources are lacking to just understand our relation to energy. The two oil shocks in the 70s taught us how to collect information on oil production, and we do so in real time. Statistical analyses on the supply side have become a routine everywhere. They are used to understand where the market is, where the prices for supplying electricity, oil, gas or coal go. Energy efficiency, by contrast, suffers from a lack of data that would enable both a global picture, as well as a detailed view at the level where policy makers or market actors could make informed decision in order to maintain or choose an energy efficient path. This dimension comprises efforts to be made on data collection on the end-use sector, develop energy efficiency indicators and understand the respective impact of human behaviour and technology in a given energy service.

Governments should therefore take responsibility for maintaining and enhancing research on that side of the economy of energy.

2. Information, Education, Motivation

Information, education and motivation are often quoted as pillars of any energy efficiency programme. However the time has come to revisit them in the market environment that we described earlier, acknowledging for instance the excess of advertising of all sorts in our daily life, in order to identify how to build a proper communication campaign. As an illustration, a concrete and simple idea would be to oblige advertisers to display the level of energy efficiency performance of an appliance, a car, a building, when the product is being advertised. In Europe, appliances, cars and buildings are progressively being labelled under the same format (7 categories from A –more energy efficient to G –less energy efficient). The category could be displayed as a mandatory information on the advertisement support. Some retailers already do so in their commercial brochures.

The 20-years of anti-smoking campaigns in OECD countries can teach a lot to energy efficiency advocates as to how to transform bad habits and adopt more responsible ones. First, direct promotion of cigarettes and cigars have been banned from any advertising campaign, then messages such as “smoking kills” have been place on the packages. Many countries have adopted some format for labelling appliances and cars. An extension of that could be to oblige the manufacturers and the retailers to display similar information. To push the idea even further, we could envisage that the energy efficiency category, identified in Europe with a colored arrow (as in shown in Figure 1), could be tattooed on the appliances or the cars for the second-hand market.

3. Stimulate Research & Development

Many supply side options for producing energy have been heavily supported by public research funding and activities. More should be done to promote research and development activities aimed at improving the energy efficiency of end-use technologies. For instance, top of the line fluorescent lighting present an energy efficiency of 100 lumens/Watt. It is recognized that in theory, the efficiency could reach twice that figure. Encouraging R&D activities to explore further how energy efficiency could be improved and to design a new generation of fluorescent lighting at level above 150 lumens/Watt or the new LEDs lighting technologies may have an overall important impact on our economies.

In addition, and with much less public funding than the nuclear fusion research, multiple R&D programmes could encourage the design of new generation of energy efficient end-use technologies in the field of combustion, enhanced heat exchange, enhanced electricity transformation (DC/DC, AC /AC, and AC/DC), reduce motor losses, enhanced motor drives, cooling compressors, lighting, computing, telecommunication as a complement to R&D efforts in renewable energy.

As said earlier, there is a need to reinforce research activities on the socio-economic impact of past and present energy efficiency programmes including the consumer behaviour and the rebound effect of. This is to better understand the relations and elasticity between energy efficiency, energy price and energy consumption in order to introduce or adjust, for instance, sound financial incentive such as a tax on energy to assure that energy conservation and related greenhouse gas reduction are achieved.

4. Set Energy Efficiency Norms, Develop Energy Savings Standards & Codes

Let's take the case of a house or an appliance. When being designed and built, the home builder or the appliance manufacturer has to respect safety norms. They do so by default. Safety norms have been designed sometimes long ago, often times through international standards. They have been set at levels that protect human life from accident, from casualty. The whole society accepts the costs of meeting the safety norms. In effect, they are insurances that we collectively pay to protect ourselves and future generations.

Safety norms do save human life. Energy saving norms can be designed and implemented to alleviate planet earth's risk vis-à-vis climate change. Hence energy conservation norms should be generalized in all sectors of the economy. New buildings should be by default energy efficient, same as new cars or new end-use equipment.

As discussed earlier, energy efficiency is not enough and energy savings must become the policy goal. This can be translated when setting regulation, codes, norms and standards. For instance, for a new refrigerator, a house, or a car – and on top of a mandatory energy label and a minimum energy efficiency requirement – policy makers should also think about setting a maximum energy consumption target, regardless of the size of the product or the service that is provided. A new house could not consume, for instance, more than 10 000 kWh in primary energy per year, comprising all end-use; a car no more than 150 gCO_2/km; a refrigerator no more than 100 kWh/year; etc. This would counteract the tendency of current energy efficiency regulations that make larger energy systems (appliances, houses) appear more energy efficient than smaller ones. For each end-use and each energy system, maximum consumption limits should be introduced.

There is no reason for not implementing specific energy savings regulation for some existing energy consuming systems such as buildings. In Europe, the Directive 2002/91/EC introduced the notion of mandatory energy performance obligation when large buildings (above 1000 m^2) are renovated. Germany has recently introduced thermal buildings codes for building renovation; for instance, a maximum of 120 kWh primary energy/m^2. In France a consortium from the building industry is lobbying the government to request a mandatory energy savings target of 50 kWh primary energy/m² for space heating for the renovation of 400 000 residential buildings per year, corresponding to the annual number of transactions. They argue that it is the only path for France to bring the building sector close to the 2050 greenhouse gas official target (Isolons la Terre contre le CO2 2004). However, even these targets could still allow buildings to continue to consume more energy over time. In the long run CO2 maximum budget for each household/buildings shall be introduced, leaving choice on how to meet it. It could be that people/building going beyond their allocated limit would have to pay to a fund that could be used to help the fuel-poor households to achieve low energy bills through energy efficiency measures.

There are numerous synergies between a renewed policy for setting energy efficiency and energy savings regulations and a enhanced scheme for energy labelling described in previous sections. In Europe, the Directive 2002/91/EC also introduces the concept of energy performance labelling and certification. Policy makers have the opportunity to link the future labelling and certification to energy performance obligation in both new buildings and the existing stock.

As most of the energy challenges that we are facing are global, energy saving norms (or standards or codes or regulation, whatever their nature) should be designed through international collaboration. To the least, international benchmarking of energy efficiency or energy savings norms can stimulate and influence the decision of analysts and policy makers. Also, standards, codes, norms and energy savings regulations could first be implemented in government procurement – this would allow the market, in a second step, to prepare for the energy efficiency requirement on a wider scale.

5. Use Price Signals

There exists an extensive literature on the impact of price signals on energy consumption. Of course, much more should be done to reinforce the role and the impact of the consumer's reaction to the price signal. The price of energy should at least reflect the known environmental externalities. As the cost to access conventional energy is likely to growth in the decades to come, countries could introduce a progressive tax on non-renewable energy resources. For instance a 2% tax per year for the next 20 years could help our economy progressively accommodate for the foreseen increase of fossil fuel, as proposed by Jean-Marc Jancocivi (Jancovici 2004) The amount collected could easily be recycled by government back to the economy in investment in energy efficiency policies and clean energy technologies. Hence the introduction of such tax can be neutral to the global economy. The tax collected on fuel transport could be recycled for building and maintaining clean public transport system, tax collected on electricity could fuel demand-side management programmes and energy efficient measures and technologies. Tax collected on stationary fossil fuel system could be invested in building renovations. Of course, since taxation affects the overall economy and can disturb market competition, it should best be applied in a co-ordinated way across all nations. International taxation of energy products could start with taxing kerosene for air travel.

The more energy efficiency labelling is enforced on energy consuming systems and equipment, the easier it is to invent variable Value Added Taxes (VAT) according to the energy performance or to organise some rebates schemes: the less energy efficient system are taxed heavier than the average ones and the money collected could alleviate the cost of the most energy efficient system. Similarly, labels and norms facilitate the obligations that governments can impose on energy utility companies to deliver energy savings at their clients' level, as it is currently being discussed in Europe in the elaboration of an energy service directive.

There exist many other possibilities to reinforce the role of price signal is order to reinforce overall energy savings strategies.

Last but not least, a personal carbon allowance could be considered to make individuals directly accountable for the CO2 emission they cause through the energy use (and in the case of electricity due the 'bad' choices of their suppliers). Individual would be educated to privilege low carbon choice in their electricity and heat purchases, as well as in their energy uses.

Conclusion

More than ever, the challenge of mitigating climate change demands that we revisit the use of energy and the role of energy efficiency in our economies. Drastic changes in consumption patterns will be necessary to achieve ambitious, long-term CO2 emission reductions necessary to stabilise atmospheric concentrations. More than energy efficiency, the objective now is to aim for absolute reductions in energy demand. The strategy to adopt is to privilege innovation, new technology, new services and new ways of doing business and, make full use of the price signal through energy or carbon taxation.

We need an "energy conservation revolution" to respond to the important challenges facing our societies. However, only modest steps have been taken. We need to understand why if we are to do better in the future. If developed nations do not do it, how can we even think that developing nations will not duplicate the mistake we made in our past and that still constitute a burden for our economies?

References

IEA 2004 *Oil Crises & Climate Challenges* (2004) -- *30 Years of Energy Use in IEA Countries*, ISBN 92-64-01882-4

Greening, L., D. Green, et al. (2000). "Energy efficiency and consumption - the rebound effect - a survey." Energy Policy. 28: 389-401.

http://www.secourspopulaire.asso.fr/Convergence/0109/dossier_concept_vendeur.html.

Jean-Marc Jancovici 2004 : www.manicore.com