4

CHAPTER 4

The FTF view of energy challenges

4 The FTF view of energy challenges

Having set out the current global energy scenario and key challenges and aspects related to it, we will now present the FTF experts' predictions on the "problem" of satisfying energy supply.

In compiling this information, we drew mainly on two essential sources:

- Two working symposia attended by all members of the forum. At the symposia, world experts gave a number of presentations. This was followed by an opinions phase, where each member had a chance to set out their vision, in groups and individually.

- Questionnaires designed to determine members' opinions on key energy-related aspects and their impact on future scenarios.

The results obtained, backed by an up-to-date bibliography, are set out in this chapter. The conclusions have been organised into the following sections: prospects for the future with regard to production and consumption, possible energy scenarios, business opportunities deriving from changes in the energy model, the influence of the public sector on overcoming energy challenges and the impact of energy on the environment in coming years.

4.1. Energy production and consumption: Outlook for the future

The current trend towards unbridled **demand** seems likely to continue over coming decades as a result of the increasing role played by developing countries, strained supply and increasing pollution.

Forecasts suggest that global energy consumption will increase by 66.32% between 2000 and 2030, with an average annual growth rate of somewhat over 2%[47]. Developed countries are currently the largest consumers (accounting for 69% of total demand). By 2030, however, developing countries will make up 53% of energy demand.

As can be seen in Illustration 36, Asia, led by China and India, will contribute most to the increase in energy demand, with an average annual growth rate of approximately 3.7%.

47. World Energy Outlook 2004. International Energy Agency.

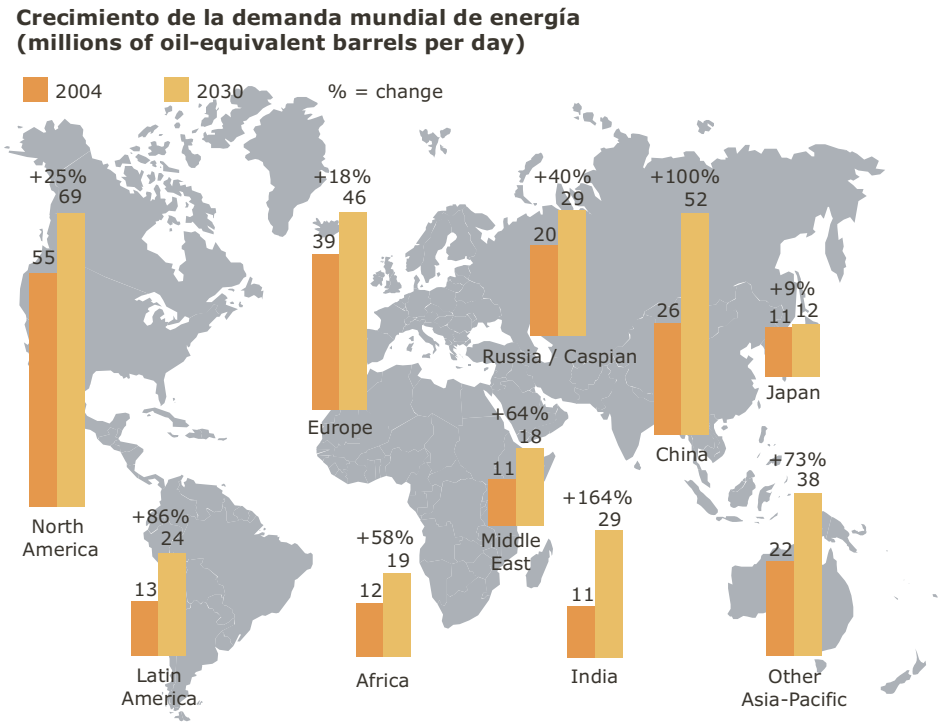

Illustration 36: Growth in world energy demand (2004-2030).
Source: ExxonMobil.

The fact that it will be the developing countries that consume most energy will have a massive environmental impact. Indeed, the relative importance of fossil fuels - which, as we have already seen, are responsible for practically all CO_2 emissions- will remain unchanged at around 91% as a consequence of growth in developing countries.

As a result, if political measures and new technologies do not remedy the situation, increased energy consumption will have very serious consequences for the environment.

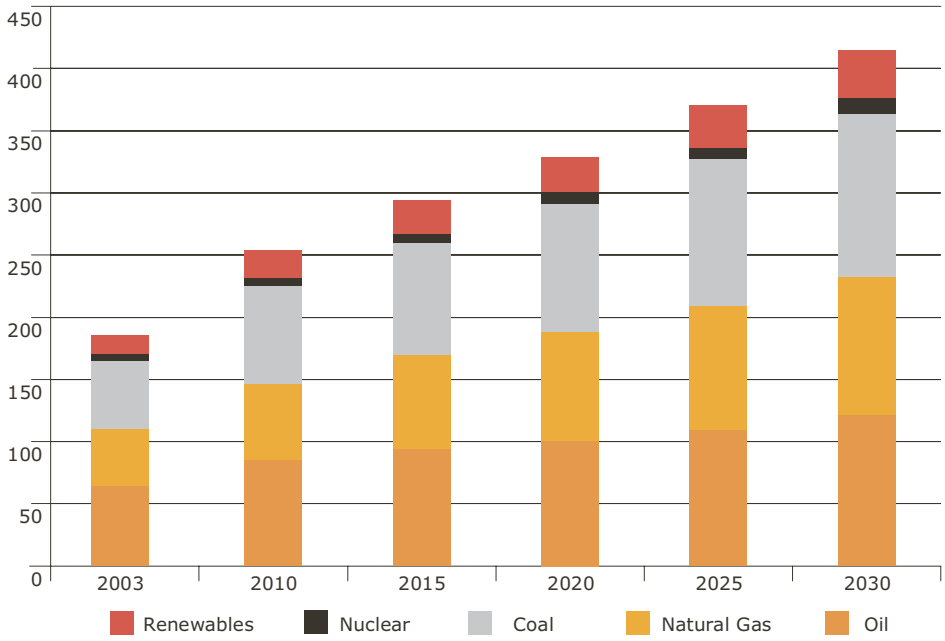

Illustration 37: Energy consumption by type of energy source in non-OECD countries.
Source: International Energy Outlook 2006.

According to all energy studies, energy **production**, like demand, will continue to concentrate almost entirely on fossil fuels. There does not appear to be an economically viable alternative which might replace them in the medium term.

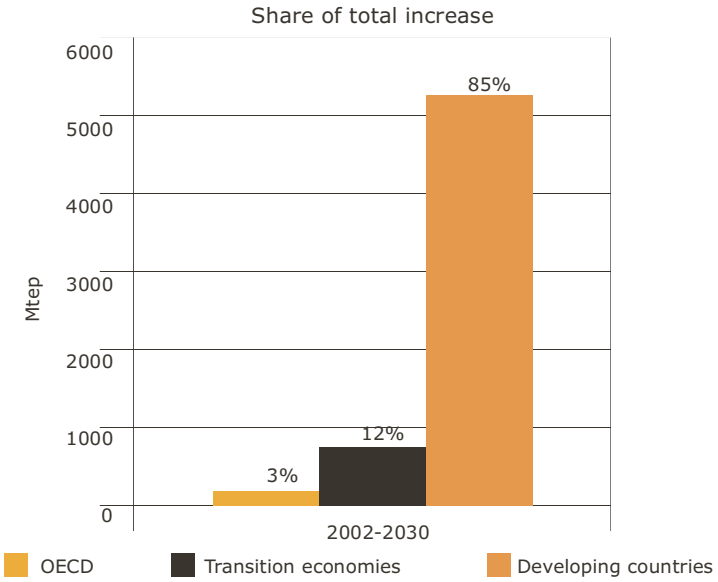

Illustration 38: Increase in energy production between 2002 and 2030 by region.
Source: World Energy Outlook 2004. International Energy Agency.

Once again, the greatest increase in energy production seems likely to occur in developing countries, which will mainly produce non renewable fuels that allow them to maintain rapid growth and development.

Fossil fuels

It is worth looking in greater detail at future trends in the area of fossil fuels.

Much of the increase in the demand for oil will be seen in the transport sector, where there are still few alternatives, although some progress will be made in this direction. Two regions will spearhead growth in oil demand: North America and, most particularly, Asian countries (except Japan and South Korea, which are in the OECD).

The strong economic growth of various countries of this area, combined with their industrialisation and the expansion of transport, will have a decisive influence on a large-scale rise in oil demand in these areas. It is estimated that average annual economic growth in the area may come to 5.5% between 2003 and 2030, contributing to an annual increase of 3% in oil usage.

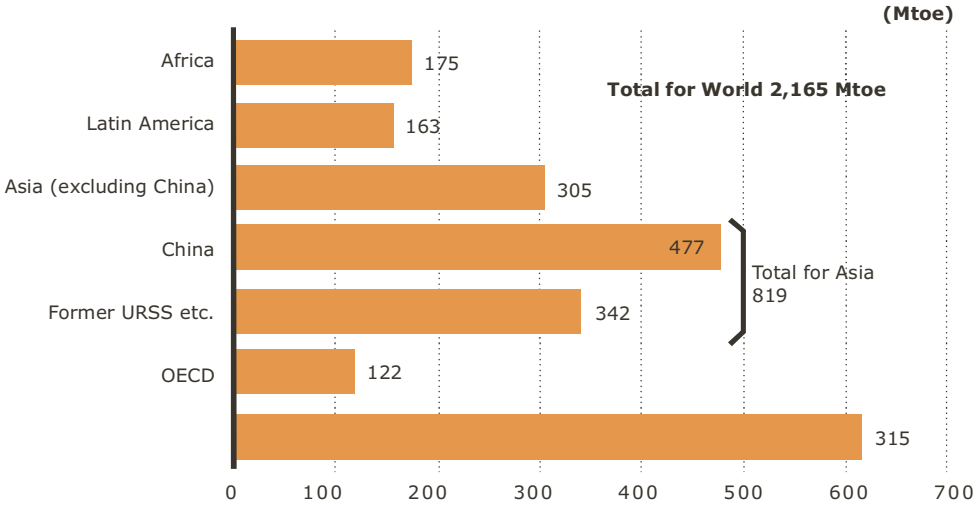

Illustration 39: Growth in oil demand by world region (2000-2030).
Source: World Energy Outlook 2002. International Energy Agency.

At the same time, oil production will continue to be dominated by OPEC countries, which will hold most of the reserves and dominate production over and above their competitors.

Reserves of OPEC and other producing countries are threatened by the proximity of a peak in production. Opinions vary as to when exactly this will occur, but by all estimations it is imminent. According to BP's annual statistical review, oil reserves will run out in 40 years time, which would place the production peak in the very near future.

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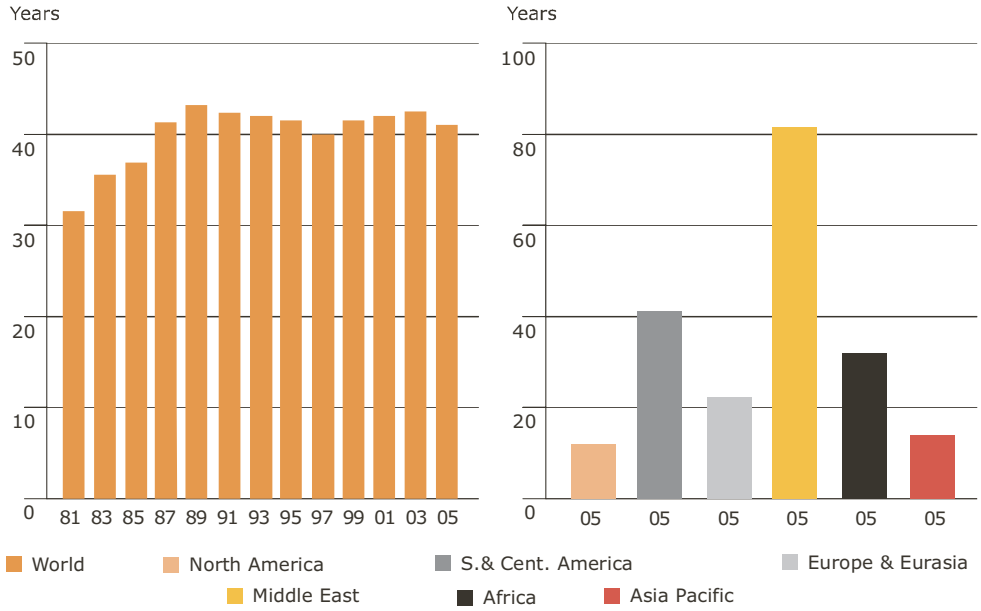

Illustration 40: Years till oil reserves to run out by region.
Source: BP Statistical Review of World Energy June 2006.

However, there is some cause for greater optimism, given that over the last 18 years the horizon for the exhaustion of global reserves has been held steady at 40 years. This means that, although production has increased, new deposits have been discovered that have kept the ratio stable.

As has already occurred in the case of oil, growth in natural gas will be driven by demand from non-OECD countries. However, in this case, the difference between growth in the OECD and non-OECD areas is not as large. Global consumption will rise 91.5% between 2003 and 2030, giving an average annual increase of around 3.4%[48]. Its main use will be in the industrial sector and for generating electricity.

48. International Energy Outlook 2006.

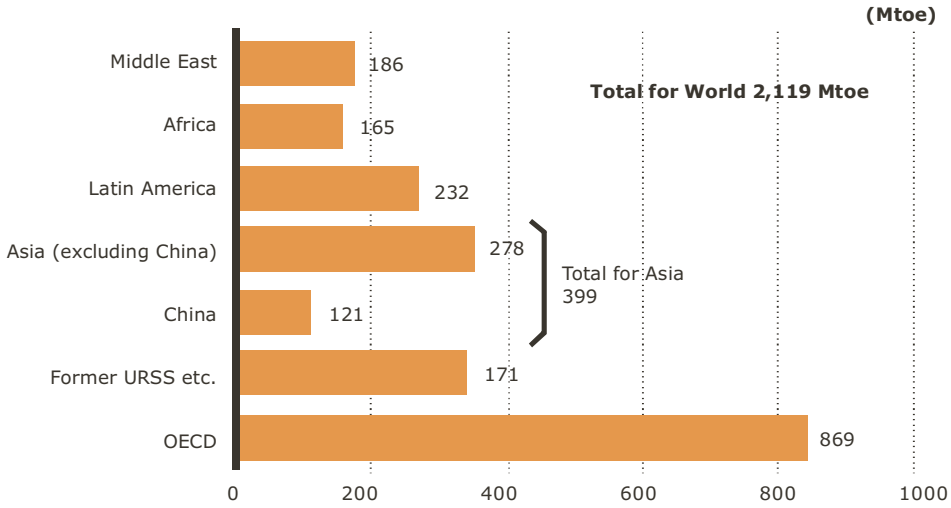

Illustration 41: Growth in natural gas demand by world region (2000-2030).
Source: World Energy Outlook 2002. International Energy Agency.

As for production of natural gas, the current predominance of non-OECD countries in Europe, Eurasia and Asia (primarily Russia, which accounts for 80% of production in this region) is very likely to remain unchanged in the future[49].

Reserves of natural gas are somewhat larger than oil reserves, but there will not be much time between the exhaustion of the two. The ASPO[50] places the production peak at around 2030 and, as we can see in Illustration 42, which compares gas production to reserves, final exhaustion is currently estimated at around 65 years.

49. International Energy Outlook 2006.

50. The Association for the Study of Peak Oil and Gas.

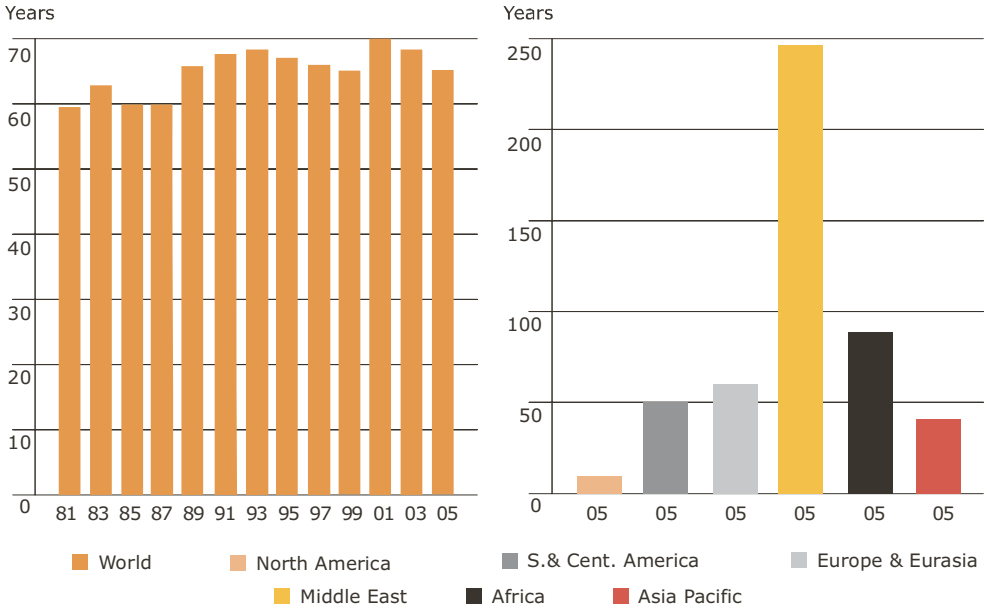

Illustration 42: Years that natural gas reserves will take to run out by region.
Source: BP Statistical Review of World Energy June 2006.

Russia's gas reserves may help turn it into a world power once more. Much of its exports are sold to Europe. Russian natural gas represents 25% of the continent's total imports, making it a key element in Europe's security of energy supply.

As for **coal**, demand will nearly double between 2003 and 2030, from 5.4 billion of tonnes in 2003 to 10.6 billion of tonnes in 2030[51].

The regions that will do most to drive demand are the non-OECD countries, and in particular non-OECD Asian countries. China and India will account for nearly 70% of the increase in global coal consumption. In both cases, strong economic growth is expected between 2003 and 2030[52] (at an average rate of 6% per year in China and 5.4% in India), and much of the increase in energy demand -particularly in industry and electricity- will be met with coal.

51. World Energy Outlook 2006. International Energy Agency.

52. World Energy Outlook 2006. International Energy Agency.

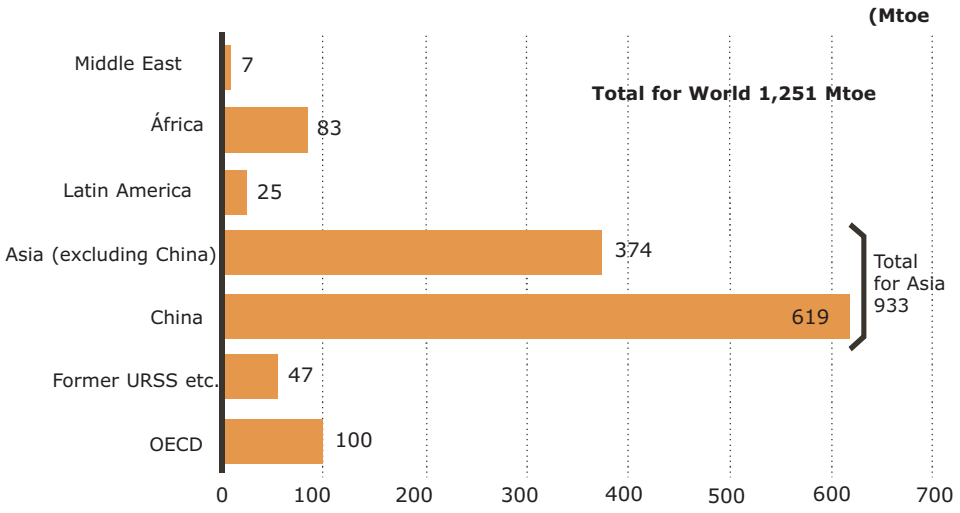

Illustration 43: Growth in coal demand by world region (2000-2030)
Source: World Energy Outlook 2002. International Energy Agency.

Coal will become the cheapest of all fossil fuels as the result of an increase in the price of oil and gas, and the existence of greater reserves. Indeed, as mentioned in previous sections, the global ratio of coal reserves to production is five times more than that for oil and three times more than that for gas, with exhaustion forecast at nearly two hundred years[53].

Alternative Energy Sources

Other alternatives energies will gradually come to play a more important role. Nuclear power will be increasingly used to satisfy electricity consumption as advances are made in safety and society is made aware of its environmental advantages. Renewable energy sources show a greater degree of uncertainty: although production will increase, the same does not seem likely to occur with demand. New technological advances will be essential for renewable energy sources to play a greater role in the energy mix.

Beginning with **nuclear energy**, it is important to stress that the forecasts for the future are uncertain. On the one hand, as explained in Chapter 2, there are regions, like Asia, that appear to have committed to nuclear energy, especially China, which is planning to build more than forty stations over the next fifteen years. Similarly, some European countries, such as France and Britain, continue to back this type of energy and are preparing improvements and even new facilities. However, Germany has a plan for dismantling its nuclear power stations and Italy appears to be headed in the same direction.

53. World Energy Outlook 2006. International Energy

The development of **renewable energy** over coming years will depend on technological progress and greater economic viability. The public sector, aware of the need to invest and diversify in this type of source for environmental reasons and because of the possible scarcity of fossil fuels, will play an important role in this mission, by providing incentives for production and demand.

Renewable energy production will increase in coming years, but it will continue to account for only 14% of supply, since output from non-renewable energy will also increase. Biomass will continue to be the leading form of renewable energy, but it will gradually lose ground to other more modern forms of energy as developing countries gain access to them. Hydroelectric output will see only a negligible increase, whereas geothermal, solar and wind power will experience much more rapid development; nonetheless, in 2030 they will continue to be the smallest of all renewable energy sources[54].

Among developed countries, the greatest growth in output from renewables will be in the European Union, which is also the only region in which the share of renewable energy in meeting consumption is expected to be greater in 2030 than it is today, as Table 4 shows.

	World	European Union	United States	China	Sub-Saharan Africa	Southern Asia	Latin America
2000	12%	6%	5%	17%	62%	39%	23%
2030	7%	9%	5%	6%	21%	9%	18%

Table 4: Consumption of renewable energy as a percentage of total energy consumption by region in 2000 and 2030.
Source: Cuadernos de Energía, No. 12, March 2006.

The relative share of renewable energy sources will be drastically reduced in developing countries. Nonetheless, it is these countries that will consume most renewable energy. Despite investment in renewable energy which will enable it to increase its share of production, growth in energy demand will continue to require fossil fuels to slake the energy thirst of developing countries.

Especially revealing are the data for Asian countries, which, although having the greatest demand, will see a reduction in the share of renewables to less than a third of the 2000 proportion. Behind these figures stands a move from biomass to more modern energy types, resulting from increased development. Developed countries will not see such major advances, reinforcing the hypothesis that, in the near future, non renewable energy sources will continue to form the pillars of the world's energy system.

54. Source: Renewables in global energy supply. International Energy Agency.

4.2. Scenarios

The future energy situation will be marked by the involvement of several different factors in meeting energy challenges. The battle to achieve energy sustainability will have different protagonists over time, but only with the participation of all of them will it be possible to attain the goal of guaranteeing the energy supply while at the same time respecting the environment.

Meeting this challenge will involve overcoming a series of different situations until a satisfactory solution is found. In this chapter we will analyse the scenarios forecast by FTF experts, which will give us a view of the way in which energy can develop towards sustainability.

Four scenarios have been defined. These are interrelated in time and each one is characterised by the different weight that the experts have given to each of the energy aspects analysed in Chapter 3: economic, political, social, environmental and technological.

Thus, the most immediate scenario facing us is characterised by the existing energy context. World economic growth, driven by the emergence of developing countries, will continue to depend on the consumption of fossil fuels, sidelining any environmental concerns. The lack of social awareness with regard to the possible exhaustion of fossil fuels and their environmental repercussions, together with a lack of regulation in the public sector, make a long road to sustainability seem likely. As a result, this first scenario is dominated by economic, political and social aspects.

The second scenario is characterised by a move towards energy efficiency. This transition will be gradual and some of the measures that need to be adopted will have to start being applied in the near future if their results are to be seen in the medium term future. This advance towards the second scenario will be the result of a rise in the price of oil and natural gas, leading to more efficient use of energy among society at large and an increased use of renewable energy sources. Environmental concerns will become more important and investment will increase in clean and efficient technology, also fostered by stricter regulations. Social and environmental aspects will play a key role in this scenario, although important technological developments will begin to make an appearance in the energy industry. This will make it possible to take a major step towards tackling the environmental challenge, but it will still be necessary to achieve security of supply before energy sustainability can be achieved.

Notes

The third scenario is based on significant technological advance and is therefore cloaked in uncertainty. The application of technology to energy sources, still with a great potential for development, together with the viability of new clean and renewable sources, could definitively resolve the problem of unsus-

tainability we now face. Nonetheless, the great unknown in this scenario is when and how technology will allow us to overcome the energy challenges, and we must therefore prepare ourselves for the possible exhaustion of fossil fuels by diversifying energy supply.

Finally, a fourth scenario has been defined which underlies the first two, adding elements that will radicalise the position. Military conflict aimed at ensuring energy supply, political instability among major fossil fuel suppliers and economic crises resulting from sudden rises in the price of oil and natural gas could cause the first scenario to develop more quickly towards the second, or aggravate some of the conditions of the current scenario.

We will now look at the scenarios in more detail, with particular stress on the key features of each one.

Scenario 1: continuation of the current situation

As already explained, the first scenario is a continuation of the current position. Industries' dependency on fossil fuels will continue to be the key feature of the energy mix, and this will in turn shorten the time till the possible exhaustion of these energy sources without any other source emerging that might enable present economic growth to be maintained. Renewable energy sources will continue to be play too small a part in meeting energy demand to be considered as a real alternative.

Moreover, in addressing the environmental challenge, new initiatives will be undertaken, but these will have little effect because economic interests will continue to take priority over all other factors.

Illustration 44 shows some of the features of this scenario and their relative importance. If we analyse these items, we see that the most relevant ones will be the economic, political and social aspects.

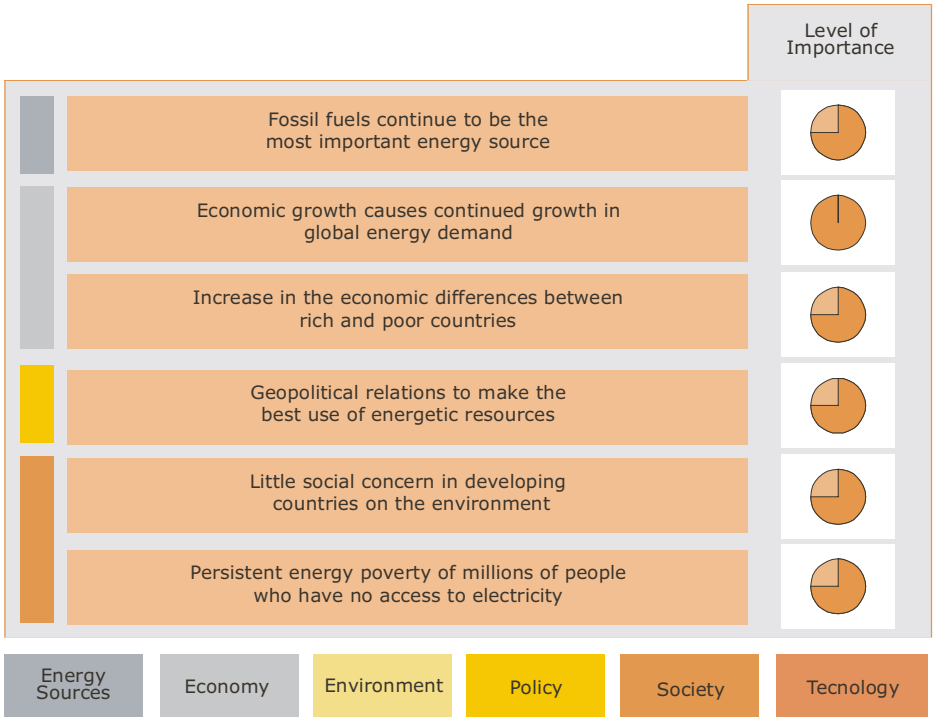

Illustration 44: Most important items in Scene 1.
Source: Drawn from conclusions within the Future Trends Forum.

Although energy demand will continue to rise as a result of continuing economic growth, this seems unlikely to reduce the differences between rich and poor countries; on the contrary, the existing gulf between the First and Third World may well become even greater. The difficulty of distributing wealth equitably will continue to be one of the most important focuses of attention and the main root of the problem.

Society in developing countries will continue to place little importance on the environmental problems of energy consumption, centring their attention instead on economic interests, growth and development. In principle it is not forecast that these countries will take measures to reduce emissions. Nonetheless, not all societies will have access to the most efficient forms of energy (such as electricity) and energy poverty will continue to affect millions of people.

Politically, governments will continue to play a highly important role in ensuring energy supply. Geo-political relations with different governments will make it possible to diversify suppliers in order to minimise the impact of depending on just one.

The outlook in this first scenario is not, then, a very promising one: a model based on "business as usual" without effective measures being taken will not lead to greater energy sustainability, nor towards improving the negative environmental impact of ever-increasing energy consumption.

Scenario 2: move towards energy efficiency

Movements already exist, particularly at an international level, intended to enhance awareness among governments, business and society at large as to the need to take measures to achieve environmentally-friendly energy sustainability. The idea that continued consumption of fossil fuels over coming years will inevitably lead to a rise in prices appears to be beginning to take hold in some areas, suggesting that a change in energy consumption habits and concern for the environment are two issues that need to be addressed in the near future.

In this second scenario, environmental and social aspects will become more relevant, and some progress will be made in existing technologies that will allow greater energy efficiency and the use of renewable energy sources.

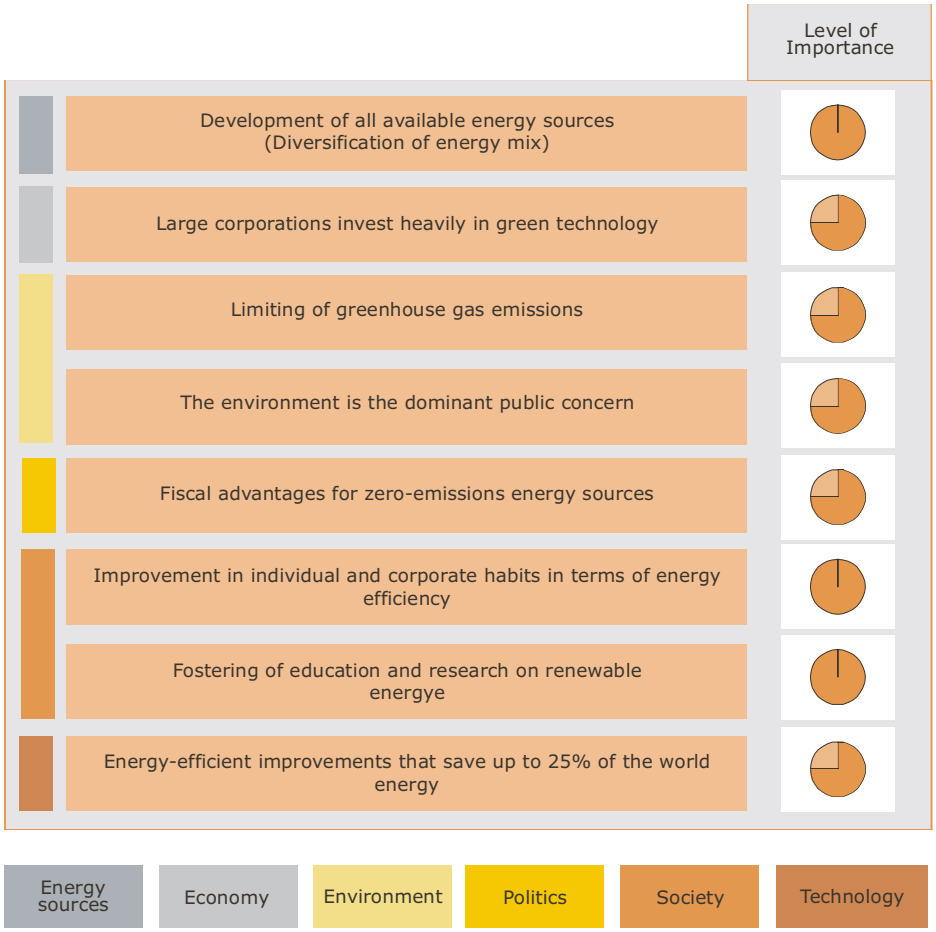

Illustration 45: Most important items in Scene 2.
Source: Drawn from conclusions within the Future Trends Forum

A change towards energy efficiency among business, governments and society at large involves an increased awareness among all market-influencing agents on the energy problem. This will be the most important step towards actually doing something about it.

The FTF experts stress that training and research into renewable energy will play a key role in this increase in social awareness. They recommend focusing on a more academic aspect in the short term, though they highlight the importance of social education in addressing the challenges of energy, i.e. in offering information on energy, favouring understanding of the different challenges faced and the implications of their use, and generating a climate of trust in the two-way transmission of information.

Environment concerns will foster new actions by the public sector to regulate emissions of greenhouse gases and achieve cleaner energy. They will try to offer a range of incentives (tax benefits, grants, economic incentives, etc.) the efficient use of energy and investment in green energy. Indeed, this is something that is already happening, and which the experts predict will spread widely, especially in the near future. The spur of creating a better world and saving our planet is leading the public sector to act, but only accompanied and complemented by other stimuli will it manage to achieve a wider response.

Other outstanding aspects of this scenario relate to the technology applied to diversification of the energy supply through investment in renewable sources. Through diversification, it will be possible to go from total reliance on fossil fuels to producing and consuming energy from other sources on a relevant scale, such as nuclear power and renewables; i.e., to take the first steps towards ending reliance on fossil fuels.

Investment in renewable energy, by both the private and public sector, will continue to increase and they will gradually gain ground in the energy mix, although these increases will take place in developed countries, given that less developed ones will reduce the role of renewable energy by cutting inefficient use of biomass as an energy source.

Despite this, renewable energy sources are not expected to become a real alternative to fossil fuels over coming decades. Instead they will be used to assuage growing environmental concerns, limit emissions of greenhouse gases and reduce dependency on fossil fuels.

Much of the environmental problem will be resolved by the development of new technologies, but global supply will continue to constitute the primary problem. For this reason, until such time as the technology allows for a definitive solution, we need to work on improving energy efficiency.

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Scenario 3: Is technology revolutionising energy?

In the long term, an increasing number of technological advances are likely to be made related to energy supply. Some uncertainties exist as to when and which technologies will be capable of making a difference. A transformation in values and increased social awareness may also drive this change forward.

There is no consensus as to when technology will manage to overcome the challenges of energy. While some experts consider that a horizon of 20-30 years for the development of new technologies that will revolutionise the energy supply is too optimistic, others think that these innovations will come in under 20 years.

What does seem clear is that, in the long term, the primary hypothesis we

should be working with involves a technological change that will affect the sector and make fossil fuels less important. Only in this way will it be possible to achieve the goal of guaranteeing energy supply.

The experts were unable to agree on the technologies that will spearhead this technological revolution. Some think that the first changes will come in the production technology of renewable energy sources such as solar power and biomass, allowing them to play a leading role in the energy mix, but that the main challenges will only be overcome with the development of a new energy source or transporter.

In this area, emerging technologies exist-such as hydrogen and nuclear fusion-which provoke even greater controversy. The former appears to be seen as a more realistic possibility than the latter, which is even slated on occasions for being mere science fiction. Nonetheless, the technological problems of hydrogen, as we saw in the chapter on "Energy and Technology", seem unlikely to be solved in the next few decades, although some advances will be made.

Finally, it is noteworthy that most of the experts agree that nuclear energy will play an essential role in this new scenario. Developments in the safe storage of nuclear waste will be essential in this process, and will contribute to bringing about a certain change in the public perception of this energy type. Based on all these issues, we think that the introduction of new technologies will bring sustainability to the energy model and open the way to a promising new future.

Scenario 4: Radicalism caused by energy scarcity

This is a complementary and more radical scenario, characterised by conflict, political instability, economic crises and extreme environmental concern, which ties in with the first two scenarios. It is unlikely to be materialised in its entirety, although some of the associated indicators (such as instability in the Middle East) may well occur, and indeed some are already occurring at this time.

Military conflict resulting from worsened geo-political relations as a consequence of the exhaustion of fossil fuels is one of the key indicators in this scenario. Indeed, instability in the Middle East, characterised by a rise to power of the Palestinian organisation Hamas (which does not recognises the state of Israel), the severe post-war situation in Iraq, growing international tension as a result of Iran's unilateral resumption of its nuclear programme and the politico-military crisis between Israel and the Lebanon exemplify the present and future insecurity of the area. This situation threatens the energy status quo and requires the international community to consider seriously the possibility of interruptions in supply.

The optimists among the FTF experts believe that the natural development of human culture is to move towards co-operation and not towards conflict. They also note that countries are very closely tied to the global economy, and that there are too many interests at stake to allow an escalation of tension to lead to a major global conflict.

Clearly any large-scale interruption in the supply of fossil fuels would cause a major economic crisis with repercussions throughout society worldwide. It happened in the 1970s for political reasons, but today the reasons would be quite different: an exhausted energy supply, incapable of satisfying burgeoning demand. The experts believe that the international community will do everything in its power to prevent matters reaching this extreme.

With regard to the environment, the situation will become more radical, as the effects of climate change begin to be felt. Rising temperatures, heatwaves, floods caused by melting ice and hurricanes and other phenomena will convince an increasing number of people that the planet is being destroyed. This will add grist to the environmentalist mill and will in many cases lead to a radicalisation of the movement's aims and actions.

The logical development of the scenarios allows us to be optimistic: although we cannot know when we will reach a position of energy sustainability nor what obstacles will have to be overcome on the way, it does appear that the solution is merely a question of time. The appearance of a technology that will resolve the energy problem will not be possible if businesses, governments and the public do not first become aware that the current situation must lead us towards improved energy efficiency.

4.3. Business opportunities

The energy challenge now being faced will have broad and varied consequences for both the private and the public sector. The need to innovate, for example, although common to all sectors, will be much more glaring in certain highly energy- dependent areas. This section will turn the spotlight the way in which technological advances, measures now being introduced and new ways of viewing energy are all creating business opportunities. Finally, we will examine the current vogue in the energy industry for mergers and take-overs and consider whether this is likely to continue or is merely a passing phase.

Innovation

As we saw in Point 4.2, one of the main driving forces behind the transition from Scenario 1 to Scenario 2 will be a rise in the price of oil. In view this situation, the FTF experts feel that the most likely consequences are for the machinery of innovation to be set quickly in motion, in a search for an alternative energy source, accompanied by a radical change in public consumption habits aimed at achieving greater efficiency.

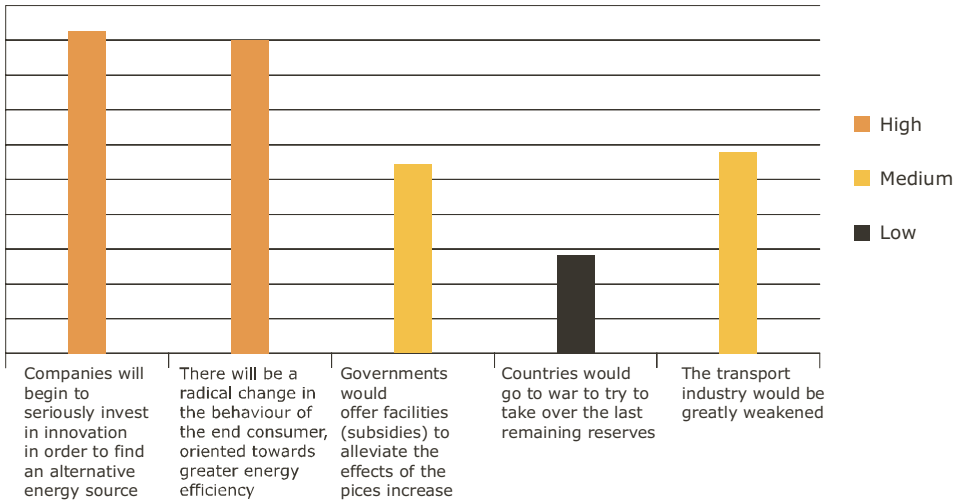

Illustration 46: Probability of different reactions to an ostensible increase in the price of crude oil.
Source: Drawn from conclusions within the Future Trends Forum.

This section will focus on the need for innovation; we will examine the sectors that would be most affected by a very significant increase in the price of fossil fuels and, which therefore have the greatest need to innovate.

The FTF experts agree that the sectors that need to cover the most ground in innovation are **transport** and the **motor industry**. The reasons are quite clear and are related to necessity, one of the main driving forces behind innovation. Transport consumes more oil and pollutes more than any other sector. The possible proximity of the oil peak raises the need to seek an alternative solution that will allow the industry to survive. Likewise, growing environmental concern requires companies to find ways of polluting less if they are to improve their public image. The experts speak mainly of overland transport, but also note the important advances in air transport and rather more subtle advances in sea transport.

The main areas of innovation in this industry will be the search for greater energy efficiency and a reduction in emissions. The aim will be to create engines that consume less, to make advances in biofuel technology, to make every more competitive hybrid vehicles and to integrate electronic applications that can help control energy consumption.

As well as creating new vehicles, investment in innovation will also have another equally important benefit, albeit a more concealed one. This is what might be termed the "green image": an automobile company develops hydrogen cars not only because it wants to sell vehicles using this technology (which may still be some time in coming) but also to create a greener business image.

Another industry in which greater innovation is urgently required is the **power industry**. The primary reason is the high rate of primary energy consumption, which currently centres on non renewable sources.

In this regard, the main area the experts mention is energy efficiency. To achieve this, developments will be made in CHP[55] and, above all, in new generation from energy plants, be they thermal, hydroelectric, nuclear, etc. As for the challenge of respecting the environment, coal-fired thermal power stations are beginning to innovate, in search of a technology that will allow them to capture and sequester CO_2 with zero emissions. Growth in nuclear power stations will essentially depend on whether the existing social opposition can be reversed.

The imminent exhaustion of oil supplies is forcing **producers** to make every effort to find innovative means of extraction that will be economically viable. Finding new deposits is becoming increasingly difficult, and research must therefore centre on trying to squeeze the most from every field. As a result, the main area of innovation will be in the technology used to access and extract energy resources. Companies will thus try to make up for the absence of new discoveries by reducing wastage from existing deposits.

55. CHP (combined heat and power), or cogeneration, is the simultaneous production, by the user, of two or more forms of energy (for example, electricity and heat/cold), from a primary energy source (primary energy sources are those found in nature). Source: Astureco-PFS Consultores.

Another industry with undeniable potential for improvement in energy efficiency and weight in energy demand involves the **construction of commercial and residential facilities**. Companies in this industry will have to focus on achieving continuous innovation. The most immediate points might be the consumption of light, climate control (heating, ventilation and air-conditioning) and electronic and computer applications. Home automatics is a fledgling industry which could help reduce energy demand in the residential area.

The experts also believe other sectors will be affected, albeit to a lesser extent. Industries such as power storage, renewable energy, metal and aluminium will be forced to innovate (although their need will not be as great or as immediate as those of the industries listed above) in their respective fields. Recycling, energy efficiency and flexibility will be the primary stresses.

There will also be a peremptory search for alternatives in the petrochemical industry, given its reliance on oil for manufacturing plastics, pharmaceuticals, fertilisers, paint, perfumes, etc.

New business opportunities

For the business world, energy will mean the birth of a technological market with new business opportunities. The possibilities that will emerge will vary greatly, ranging from the most recurrent development of the market for hybrid cars to more exotic applications, such as insurance and risk management products to deal with price fluctuations or climate-related incidents. Nonetheless, all the opportunities will have one thing in common: there will only be a business if society accepts the energy challenge it is facing.

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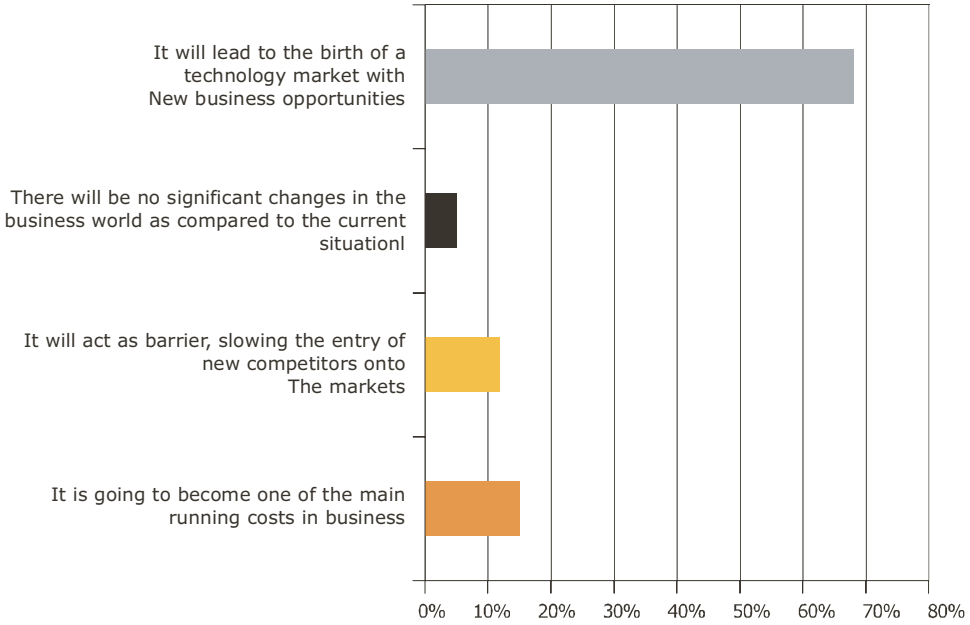

Illustration 47: What will energy mean in the business world.
Source: Drawn from conclusions within the Future Trends Forum

To some extent, the FTF experts draw a link between industries in which most business opportunities will arise and those in which most innovation is required. One example is transport and the construction of efficient buildings, where there will be new opportunities for investors. Nonetheless, they also see business possibilities in the manufacture of new materials, in technological applications for controlling energy efficiency and in the development of biofuels, among others. We will now examine in more detail some of the products and services that might be of interest for investors in these industries.

The urgent need for innovation in the transport sector will lead to new business opportunities in the **motor industry**. According to the experts, the clearest market opportunities are to be found in this industry. Examples of such products include the development of cars consuming alternative fuels, hybrid vehicles and electric automobiles. The application of all these items to public transport may also be important, as is happening in Madrid where buses powered by fuel cells are now being used[56].

The **technological and engineering industries** also hold out opportunities for business by seeking to optimise energy consumption, creating energy management systems that respond to price signals, manufacturing sensors for measurement and control of energy consumption and demand or developing much more efficient electronic applications. The aim will be to use technology and engineering to develop applications that consume energy efficiently.

56. Empresa Municipal de Transportes de Madrid (http://www.emtmadrid.es/about/history/2000.html).

Another of the industries that holds out the greatest opportunities for investors is the **construction of residential and commercial installations**. Technologies related to renewable energy applied to construction (solar panels) and materials for the production, storage and distribution of renewable energy (nanotechnology will allow for silicon to be replaced in the manufacture of solar panels), and the technology and materials that allow efficient energy consumption and monitoring systems for recycling energy and sustainability, are just some of the opportunities in this industry.

Finally, there is a broad range of industries, products and services with a slightly higher level of uncertainty. These include **agriculture**, where bio-fuels will be a powerful ally for increasing business. New types of biomass for producing biofuels or support from the chemical industry in developing products from energy agriculture (mixture of fuels, new fertilisers, etc.) are just some of the fields for new investment.

Finally, the FTF experts made an interesting observation: energy efficient products will create their own market niche, just as the so-called "green products" did. There will therefore be a chance to stand out from competitors by satisfying consumers who demand a product or service of specific value.

Concentration in the energy industry?

Over recent months there have been a number of moves towards mergers or take-overs among large companies in the energy industry. Enel, the Italian electricity monopoly, is currently immersed in a desperate race to buy Electrabel, the leading Belgian power company in the hands of Suez, and is even trying to buy out the French power utility. This manoeuvre has led the French state to lend its weight to the merger between Suez and Gaz de France, with an 80% public involvement. This protective instinct by governments is essentially rooted in a desire to assure energy supply, as it is the government that the public would blame for any major power cuts or gas shortages.

The French company EDF-until now the European leader-is also sharpening its claws. The chairman of the company, whose profits doubled in 2005, has announced a major operation for which it can call on €40 billion[57].

According to sources in the business world, there are various possible explanations for this process of business concentration. The trend towards consolidation, in particular between gas and electricity companies, is a technological phenomenon. Gas combined-cycle is emerging as the technological leader in electricity production, and the negotiating power of a company in the international gas market depends to a crucial extent on its size. The search for economies of scale or economies of scope, the possible synergies they could achieve, the need to access a given market or even the fact that it is the only

57. See http://www.uce.es/DEVERDAD/ARCHIVO_2006/07_06/DV07_06_13OPAendesa.html.

road to growth which the management considers viable may be amongst the chief reasons.

For the FTF experts, the impetus that is leading companies in the energy industry into a growing spiral of take-over bids, mergers and acquisitions is essentially due to three factors.

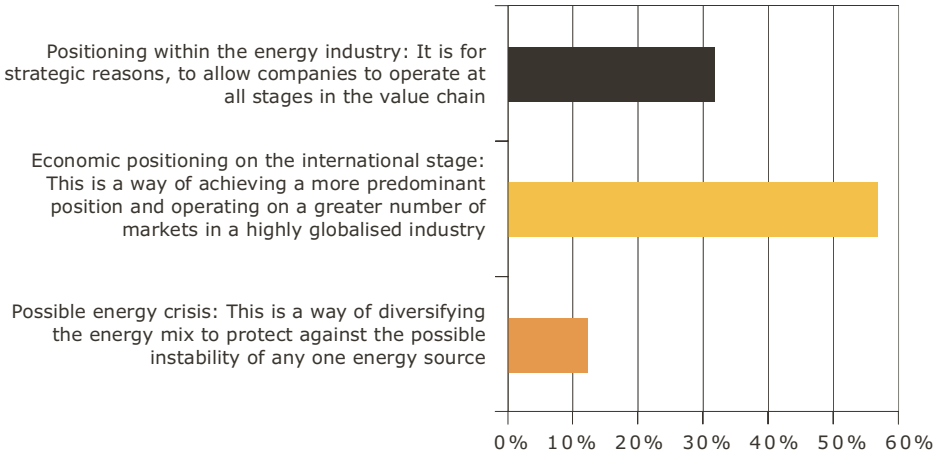

Illustration 48: Main reasons that lead to business consolidation in the energy industry
Source: Drawn from conclusions within the Future Trends Forum.

The first reason the experts give for this trend towards concentration is the search for economic positioning on the international stage. This is a way of achieving a more predominant position and achieving a presence in a greater number of markets in a highly globalised industry. In complex industries, as tends to be the case, being big is a competitive advantage.

The second reason involves positioning the companies within the energy industry. Concentration takes place for strategic reasons, since a greater control of the different links in the value chain allows companies to operate and function more stably, as well as controlling costs to achieve greater competitiveness.

The prospect of an energy crisis is another of the reasons the experts mention. Concentration is a way of diversifying the energy mix to protect against the possible instability of any one energy source; in other words, controlling different energy sources so that any disruption in one does not have catastrophic results for the company. In certain cases, a possible short-to-medium term energy scarcity can be envisioned in a world in which demand can be seen to be growing at a dramatic rate and diversifying the energy mix is one of the alternatives most often considered.

Another possible reason for the trend is the surplus cash-flow these companies enjoy. In cyclical industries like energy, which sell commodities with a low margin and where the current rise in the price has triggered a sharp rise in prices, many executives believe that the acquisition of new companies with growth potential can generate greater value for shareholders than paying back the money in the form of dividends.

This trend towards concentration has remained constant over recent years and is still ongoing at this time; indeed, the great majority of the FTF experts forecast that it will continue over the next few years.

The possibility of diversifying the energy mix, thus managing the risk of disruptions and fluctuations in the event of changes in circumstances, at a time of long term uncertainty about some energy sources, could lead to a continuation in this trend towards consolidation in the future. Moreover, economies of scale, and other advantages associated with size, such as bargaining power, the pressure that companies can bring to bear and greater capacity for investment, may also push the trend along.

Nonetheless, there are certain risks and consequences which might alter the trend. On the one hand, it is possible that rising profit expectations, will mean that ever greater premiums will have to be paid to buy energy companies, even if take-overs continue to be a cheaper and much less risky option than searching for new energy deposits. At the same time, there are certain structural limits to the concentration of the industry due mainly, to the massive degree of consolidation that has already been achieved. Also, a sudden fall in oil and gas prices could put an end to this trend overnight.

Recent political movements, however, seem to augur a continuation in the trend. Indeed, one of the items on the agenda at various meetings of EU heads of state and government has been to remove any obstacles to the creation of three or four large continental energy giants, since no restrictions should be placed on the restructuring of the industry. By 2007 the European energy industry is due to be completely deregulated: to date, except for Spain and the United Kingdom, where privatisation has already been undertaken-and to some extent Germany-the industry still remains under the protective mantle of the state.

Indeed, two major obstacles remain to the competitiveness of the energy industry in Europe. The first is the lack of interconnection. Without interconnection, a German company cannot sell the energy it generates to Spain, for example. The second is that regulation is fragmented and the playing field on which the different companies operate is not level. The distortion comes with the presence of state-sector companies, capable of taking over without being taken over - which means that a government can perform operations without formally violating EU regulations - and with the various protection systems introduced by national governments.

The scenario heretofore has made it possible to keep the energy industry off bounds, cultivating monopolies by making use of state resources, which no longer matches present requirements. In the words of Austrian chancellor Wolfgang Schüssel, who held the presidency of the European Union between January and June 2005, with the decision to favour energy concentration, "Europe is doing the same as China, Russia and the United States did before us". The trend must be towards an industry in which state-sector companies are privatised, all governments eliminate protections and a European regulator ensures competition and supply once interconnection capacity has been extended.

The German chancellor, Angela Merkel, made it clear recently that we will only be able to have an internal electricity market when we accept the European champions and stop thinking in national terms[58].

The experts agree with the thesis that in the medium term future there is only room in continental Europe for three or four strong energy groups: a quartet of candidates which could consist of E.ON (German), EDF (French), Enel (Italian) and RWE (German)[59].

In short, governments must work to make the European energy market a reality. We need to consider the possibility of a European regulator who would ensure supply, a level playing field for all companies and protection for consumers.

Much work still needs to be done, therefore, both with regard to the capacity for innovation associated with the energy market and the business opportunities for many industries, which depend directly or indirectly on energy. Nonetheless, it seems likely that we will have to wait until the need becomes acute, in terms of shortages of energy supply (with all its economic consequences), before there is a true change in the business mentality leading to decisions that will favour energy efficiency.

58. See http://www.elpais.es/articulo/internacional/Veinticinco/vinculan/seguridad/energetica/politica/exterior/europea/elpporint-cor/20060324elpepiint_3/Tes/.

59. See http://www.uce.es/DEVERDAD/ARCHIVO_2006/07_06/DV07_06_13OPAendesa.html.

4.4. Influence of the public sector

As we saw in the previous section, the FTF experts consider that in the event of a very pronounced increase in the price of oil, companies would begin to innovate in order to address the problem, but there would also be other more immediate consequence: a radical change in consumption habits, favouring greater efficiency (see Illustration 46). The public sector will play a fundamental role in promoting such a change in habits, in advance of the arrival of a hypothetical energy crisis. The decisions taken in this area, at national, supranational or international level, will be the keys to overcoming the new challenges in the energy area.

In the current context, international organisation and institutions seem likely to be the ones to take the first steps and begin to be more conscious of how critical the energy situation is. This section will look at the latest international initiatives related to the search for energy sustainability.

A second area will centre on the European situation and EU directives in this area, and will examine some of the repercussions that these initiatives are beginning to have at a national level. We will take the specific example of Spain.

Finally, after setting out the FTF's view of the primary measures that governments need to concentrate on to check energy demand and ensure supply, we will examine a successful example of the influence of the public sector: the state of California.

Conclusions of the G8 in St. Petersburg (July 2006)

One of the central issues dealt with at the summit of the world's eight most industrialised countries was energy. The meeting identified a number of challenges. It then looked at the road that needed to be taken to address them, consisting of the so-called "3 E's"[60]. Taking these principles as a base, the summit outlined a plan of action and a series of starting points which are summarised below[61].

The first point mentioned involves increasing the *transparency, predictability and stability of global energy markets*. The statement stresses that transparent, predictable national energy policies and regulatory environments facilitate the development of efficient energy markets.

Another key area involves improving the investment climate in the energy sector;. The G8 undertakes to take the necessary measures to facilitate investment to all links in the energy value chain.

60. Energy security, economic growth and environmental protection.

61. The complete G8 declaration and the detailed plan of action can be downloaded from http://en.g8russia.ru/docs/11.html.

Thirdly, it seeks to highlight *energy efficiency and saving*. To achieve this, the member countries have instructed their ministers to continue the dialogue on climate change, clean energy and sustainable development. They also stress the importance of engaging the private sector and other stakeholders in achieving these ends. At the same time, they invite organisations such as the World Bank and the IEA, to work on the improvement of internationally accepted standards, labelling and best practices, and public awareness campaigns. They also cite some specific measures for energy production and distribution and for the transport sector.

The fourth key point is the *diversification of the energy mix*. Here they propose measures in different areas related to diversification. Actions such as the encouragement of carbon sequestration seek to achieve a new cleaner type of energy, with lower CO_2 emissions. In the field of nuclear power, they recognise the different position of the member countries and reiterate their conviction on the paramount importance of safety, security and non-proliferation. With regard to renewable energy, the members restated their commitment to implement the measures set out in the "Gleneagles Plan of Action"[62] in 2005.

In the area of innovative technologies, the G8 proposes to work in partnership with the private sector (basically through measures to encourage investment and research) to accelerate utilization of innovative technologies that advance more efficient hydrocarbon production, since they expect that these will continue to play a leading role in total energy consumption well into this century, and to reduce their environmental impact.

The fifth section deals with the area of *securing critical energy infrastructure*. They seek to promote international cooperation in this area and identify the most vulnerable infrastructures, the nature of the risks they face and the best way of mitigating them.

Another section is devoted to energy poverty. The strategy in this area is based on developing national and local institutional capacities in developing countries, as well as working side by side with leading international organisations. According to the G8, however, most energy investment must come from the private sector. Local institutions would play the role of improving political structures and bringing in regulations to attract capital. Here, international financial institutions (IFIs) have an important role to play.

The last section refers to *climate change and sustainable development*. Here again the member countries reaffirm their commitment to the measures agreed in the "Gleneagles Plan of Action", the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol[63].

These guidelines from the G8 give some idea of the stance of the world's leading countries and some international organisations, with regard to the energy

62. See http://www.fco.gov.uk/Files/kfile/PostG8_Gleneagles_CCChangePlanofAction.pdf.

63. Only those G8 member countries that have ratified the protocol.

challenge. The decisions adopted by these institutions will have a global impact, although enforcing implementation at a national scale will require the involvement of national governments and increased awareness among society at large.

Specific energy policy measures in Europe

The European Union has already taken specific measures to improve energy efficiency among its member states. The green paper on energy efficiency, presented in 2005, sets out a clear framework of action aimed at rewarding energy saving at all levels.

One of the specific measures of energy policy centres on *buildings*, which represent one of the areas with the greatest potential for energy saving, as numerous projects carried out within the framework of the European Green Light Programme[64] have shown. For this reason, the European Commission needs to ensure strict implementation of the directive on energy efficiency in buildings[65], which will allow savings of approximately 40 million tonnes of oil equivalent between now and 2020. The commission needs to provide member states with the tools they need to prepare the framework for an integrated methodology for calculating energy efficiency in buildings.

The European Union has also sought to increase efficiency in *transport* and to this end has implemented voluntary agreements with the automobile industry, as well as developing labels showing the energy efficiency of vehicles. These agreements are intended to result in average CO_2 emissions of 120 g/km for all new cars registered in the European Union and the goal is for European, Japanese and Korean automobile manufacturers to commit to reducing CO_2 emissions to 140 g/km by 2008-2009 and bring influence to bear on consumers to choose cars that consume less[66].

For many reasons, the national area is the most suitable for introducing measures to favour energy efficiency. The action of the public authorities will reinforce the work of the EC, which would not in itself be effective in the long term. Some of the best practices that deserve to be extended are listed below.

Power transport involves up to a 10% loss of the electricity actually produced (2% in transmission and 8% in distribution); however, the managers of transport and distribution networks do not always have an incentive to make the necessary investments for making this saving. It is therefore essential to comply with the guidelines whereby the managers of the distribution networks are obliged to make all investments with a good cost-profit ratio and, as recompense, they will be entitled to keep an equitable percentage of the resulting net profits.

64. A European Commission initiative. It was launched in 2000 and is renewed on an annual basis (www.eu-greenlight.org).

65. Directive 2002/91/EC. The directive requires all buildings of over 50 square metres to be certified for energy efficiency in the event of new construction, sale or rent. The certificates must be accompanied by recommendations for economically improving the energy efficiency of the building. The member states must provide funding for implementing these recommendations.

66. The European car labelling system requires member states to ensure that consumers have information on fuel consumption and CO_2 emissions of new cars, so that they can make a reasoned choice.

There is great potential for energy saving in **power generation**, given that the average loss of energy in power production is 66%[67]. The European system of emissions rights trading is an effective instrument for encouraging electricity producers to reduce emissions and improve efficiency more profitably. The Commission plans to review the system in mid 2006. Here, attention centres on combined cycle power production, the encouragement of more distributed production and CHP as examples of technologies with a high potential for energy efficiency.

Some EU countries have already introduced "white certificates", which accredit the amount saved by suppliers or distributors through the application of energy efficiency measures, specifying an energy value and a duration. These certificates can, in principle, be exchanged and traded. If the agents cannot produce their quota of certificates, they could receive fines to an amount greater than the estimated value of the white certificates.

Finally, to take a particular case, we will examine the incentives that exist in Spanish tax law to encourage the use of renewable energy. Tax measures can be an effective instrument in the struggle against environmental degradation, in general, and to encourage the use of renewable energy sources, in particular, in that they can, on the "polluter-pays" principle, provide disincentives for actions that harm the environment while conversely encouraging others that make more rational use of resources.

Table 5 shows some of the main direct and indirect taxes where there are rebates for actions that encourage the use of renewable energy sources and respect for the environment.

67. Green Paper on Energy efficiency. European Commission, 2005.

Tax	
Direct tax	***Company Tax:*** 10% deduction on the amount of the investments made: • In investments in facilities intended to protect the environment. • In the acquisition of new industrial or commercial road vehicles with reduced levels of atmospheric pollution. • In new facilities and equipment for harnessing alternative or renewable energy sources.
	Tax on Mechanically Driven Vehicles.Tax rebates of up to 75%: • Depending on the type of fuel used by the vehicle, based on the environmental impact of burning the fuel. • Depending on the characteristics of the engines of the vehicles and their environmental impact.
	Tax on Economic Activities: • Production of renewable energy subject to tax (since it comprises an economic activity which is subject to the tax). • Rebate of up to 50% for use or production of renewable energy.
Indirect Taxation	***Taxes on hydrocarbons:*** • The use of biofuels is exempt from tax, as compared to the €402.91 per 1,000 litres paid on 98 octane petrol or €269.86 on diesel.

Table 5: Tax measures in Spain for encouraging renewable energy sources and respect for the environment
Source: "Incentivos fiscales a favor de las energías renovables". José María Cobos. Cuadernos de Energía. Number 12. March 2006.

FTF view of measures that can be implemented by the public sector

Notes

The FTF experts have assessed a range of actions that governments can take to influence energy.

On the **supply** side, they stress practices that could be used to optimise the quantity and quality (in terms of cleaner energy) of the available energy.

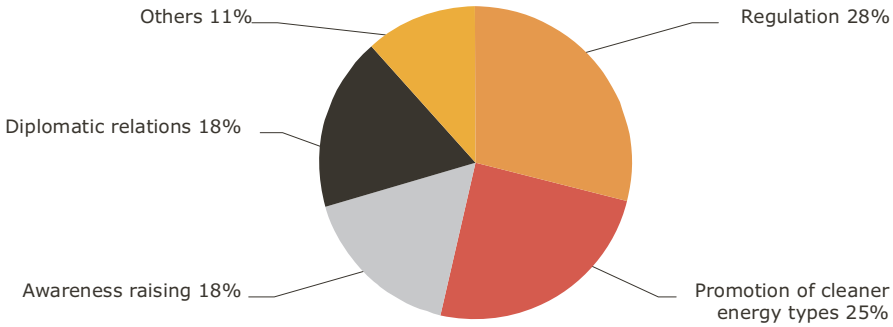

Illustration 49: Most effective government actions to achieve energy efficiency on the supply side.
Source: Drawn from conclusions within the Future Trends Forum.

The most effective measures, the FTF experts believe, involve *regulation*. The states' power to legislate could be a major instrument for favouring energy supply and can be applied to all energy-related industries.

There are several kinds of incentives which could be offered with a common objective: to ensure the sustainability of the energy model in the long term. Of these measures, the experts consider fiscal policies to be the most effective. The experts look favourably on measures such as offering tax benefits for being more energy efficient or redirecting research towards improvements in production capacity among renewables. Likewise, the levying of more taxes on fossil fuels will gradually lead to a reduction in demand, leading production companies to reduce supply and focus more on other sources.

Among the regulatory possibilities, there are some other very important measures complementing the fiscal policies, such as the awarding of grants, setting limits on CO_2 emissions and promoting emissions trading in CO_2. With regard to the first measure, before new grants are awarded, any that might harm sustainable energy development should first be done away with (for example, grants to fossil energy sources, such as coal). The other two measures are advancing apace with the Kyoto Protocol.

Notes

The experts also consider that one of the most influential actions that the public sector can take to affect energy supply consists of *measures to promote cleaner energy sources*. Governments have the power to investigate and promote them so that at some point they can become a real alternative to fossil fuels or even replace them.

From the point of view of energy supply, diplomatic relations that governments can foster in the geo-political area will help minimise the risk of disruption to the energy supply and ensure national supply.

On the **demand** side, the order of effectiveness of the proposed measures is similar to the supply side, but there are some differences. In addition, the action of the public sector does not target the same groups, as we will see below.

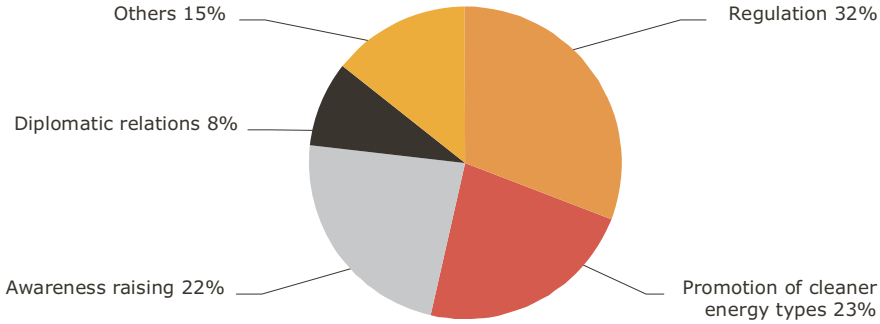

Illustration 50: Most effective government actions to achieve energy efficiency on the demand side.
Source: Drawn from conclusions within the Future Trends Forum.

Regulation is essential to contain demand. The incessant increase in demand calls for new initiatives that will enable significant savings to be made in energy consumption. Actions such as those taken in California (see below) are a clear example of successful intervention to reduce demand. In this area, fiscal policies are particularly important, since incentives in the form of taxes or grants represent an effective instrument for sustaining energy demand.

One possible use of fiscal policies involves energy sources. Deducting taxes or awarding grants for contracting and consuming renewable and efficient energy sources[68] can lead consumers to demand more renewable energy.

Measures related to raising *social awareness* play a more relevant role among the demand-side actions governments can use. This raising of awareness is intended to encourage more efficient energy-consuming habits among the public in order to curb demand. Even successfully making final consumers realise that we are faced with such a major challenge against which measures need to be taken would be a highly important step towards further actions in the future.

The experts also propose some more original measures, such as, for example, allowing people with hybrid vehicles to use special traffic routes.

68. In United States these measures, known as "Public good charges" have already been implemented.

The Californian example: a case study in successful public intervention

In 1974, electricity demand in the state of California was growing at a rate of 6% a year. Three quarters of all electricity generated came from oil. Twenty more nuclear plants were planned. Environmental organisations were bringing pressure to bear, demanding that growth in consumption be curbed through efficiency, use of renewables as an alternative to nuclear energy and an independent assessment for supply and demand. Faced with this situation, it was decided to set up the California Energy Commission (CEC), whose primary function was to address these challenges. The instrument used to achieve it would be *energy efficiency*.

The results speak for themselves. By 1990, growth in demand had fallen to 2% per year. Three quarters of all new energy services were provided by energy efficiency programmes. 25% of all new energy generated used clean and efficient natural gas (mostly CHP) and renewable sources. No new nuclear or coal-burning plants were built. Natural gas, rather than oil was used for generating power.

Illustration 51 compares trends in energy demand in California with the figure for the US as a whole.

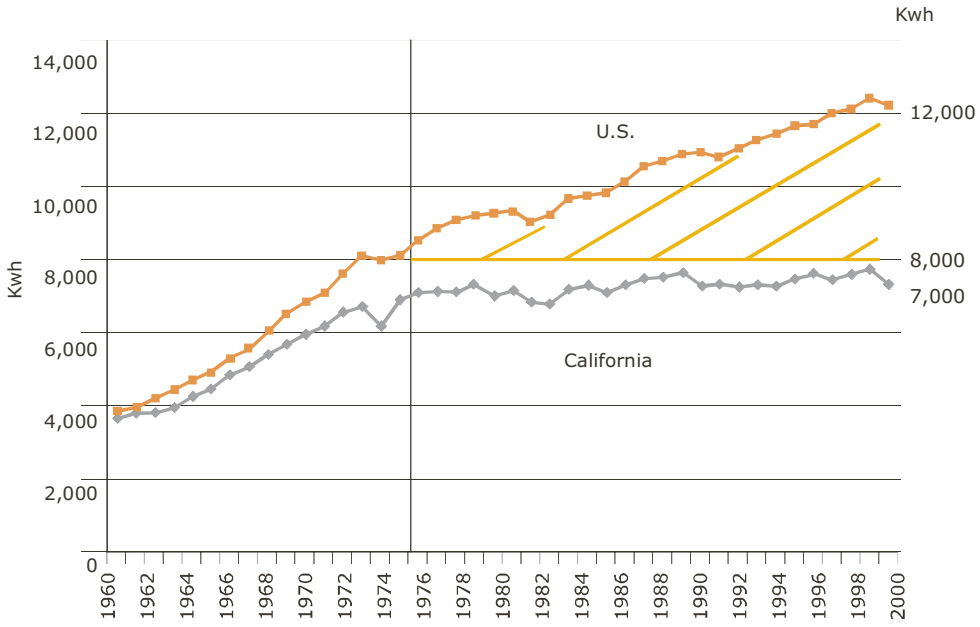

Illustration 51: Energy consumption per capita in California and the United States.
Source: California Energy Commission.

All this has resulted in a massive series of economic and environmental savings. In 2004, for example, sixteen billion dollars less was spent on electricity bills. Net savings, also including the costs of planning and conservation, come to around $1,000 per family per year.

In environmental terms, a fifty-percent cut in electricity use prevents the emission of 18 million tonnes of carbon a year, the equivalent of taking 12 million cars off the road. Given that California has 25 million automobiles, one could say that the reduction in pollution is equivalent to getting rid of half of all automobiles.

But what were the measures that achieved such extraordinary results? Using the same division as in the previous section, we shall distinguish between actions targeting supply and actions targeting demand.

The aim of the **supply**-side measures is to ensure an adequate supply of energy and, above all, electricity. To achieve this, it was decided to maintain between 15% and 17% of the reserve margins; to establish a mechanism for adapting public sector resources; to emphasise long-term energy contracts, thus encouraging investments and research, development and innovation; to seek greater transparency and dissemination of energy data; to promote an "energy market" in which the surplus energy produced could be sold, thus guaranteeing proper distribution; and to provide incentives for saving and the use of CHP (or cogeneration).

Another important supply-related area was infrastructures, which ultimately allow viable production and distribution of energy. To this end, action has been taken in the area of the oil infrastructure (improving productivity of onshore, and to a greater extent, offshore plants) and gas infrastructure (renewable plants, increasing storage and improving gas pipelines).

In terms of **demand**, the main aim is to reduce energy consumption through efficiency and the use of alternative resources, in pursuit of energy diversification. Demand-response programmes are the most effective option for impacting energy efficiency. Action is taken in the area of both tariffs and technological control. On the one hand, consumers are provided with financial incentives and technology for measuring energy in order to reduce electricity loads when prices and electricity demand are at their highest.

Developments in the way energy is measured (consumption, etc.) are playing an essential role and new IT developments are helping greatly. The ultimate aim is to apply the business maxim "what cannot be measured, cannot be managed". These actions offer "non-price" signals that clearly show when a spot reduction in demand would be highly beneficial, before a capacity bottle neck is reached.

Nonetheless, these measure needs to be supplemented with action on tariffs at times of high demand, sending out "price signals" so that consumers reduce demand or have to pay for the complete cost of the service.

Similarly, specific measures have been taken to reduce energy consumption in transport. Tax incentives, grants and actions to increase the cost of transport[69] are the measures most commonly used.

Finally, and perhaps most importantly, the level of energy awareness among Californians has been raised. This latent awareness has led to the setting up of a specific energy commission in the state (the only one of its kind in the US) to study, investigate, plan and take measures to address the issue of energy.

The CEC's plans and targets for the future are even more ambitious. For example, the construction and installation standards the CEC will implement are intended to save 5% every three years. Commercial buildings will have to cut consumption by 20% by 2015 and new homes will have to consume 50% less energy. In addition, renewable energy sources will have to make up 20% of the energy mix by 2010. More specifically, in the area of solar power, by 2017 one million solar roofs will have been built (3,000 MW in photovoltaic power).

California has become a global benchmark on the way energy efficiency and state-sector intervention can help curb growth in energy demand. The keys to the programme's success need to be closely examined so that they can be applied and used as "best practices".

The FTF experts evaluated the possibility of applying some of these measures in Europe and concluded that the most immediately important factor for more efficient use of energy in Europe is responsible education of the public and the creation of incentives that will influence consumer behaviour.

69. There are four pricing options : to set lower rates for vehicles that consume less, to set rates per gallon, to establish "pay-as-you-drive" vehicle insurance or to increase the tax on hydrocarbons.

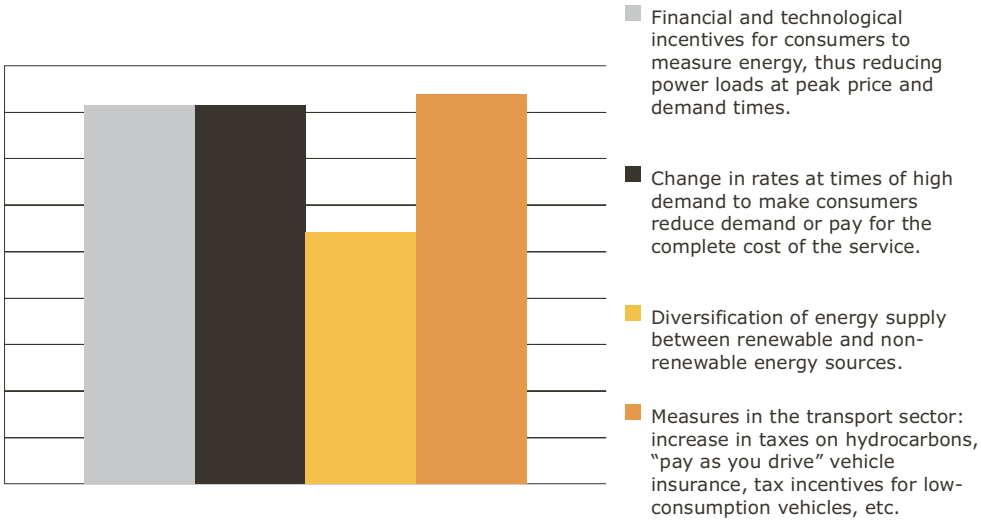

Illustration 52: What measures adopted in California would be most effective for controlling energy demand in Europe?
Source: Drawn from conclusions within the Future Trends Forum.

The measures for the transport sector also appear clearly applicable to the European area. The FTF experts also favour actions that will help measure energy consumption constantly and allow the cost to be passed on at times of a major increase in demand; in short, measures that will allow the final consumer to be aware of the energy situation and take individual and household measures to contribute to energy saving.

Notes

4.5. Environment

As we saw in Chapter 3, overcoming the environmental challenge is of key importance in achieving energy sustainability because of the negative impact the existing fossil-fuel-based energy model is having on the environment. Measures need to be taken today to address the problem and ensure that future generations can enjoy a clean and habitable planet.

This chapter will look at the forecast future trend in CO_2 emissions resulting from social and economic development worldwide and the possible environmental, social and economic impact of climate change resulting from such emissions.

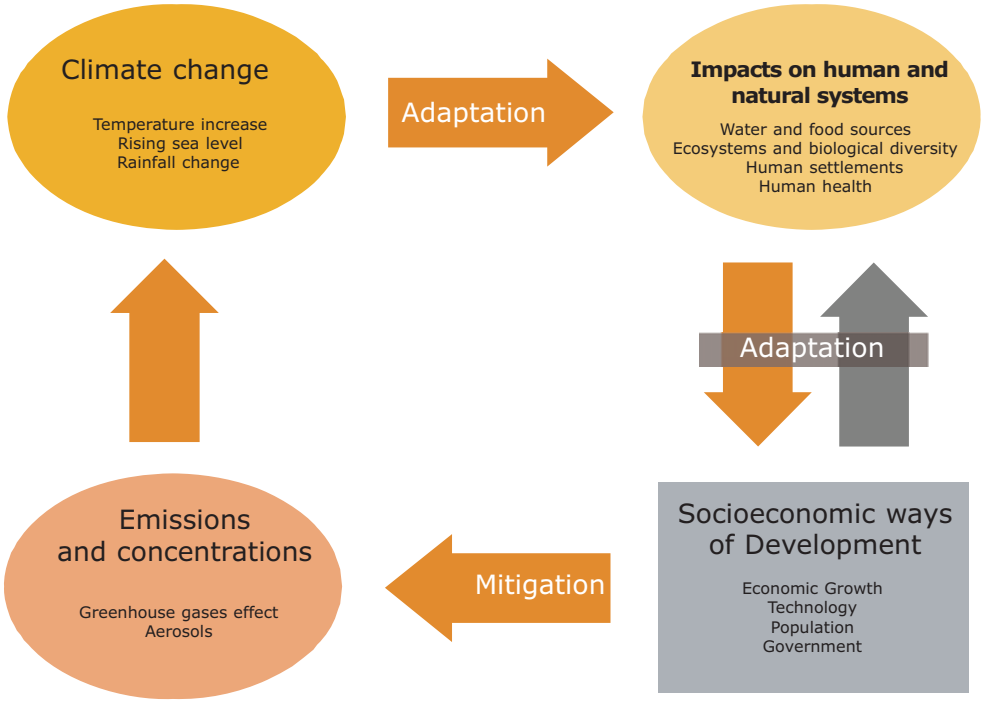

Illustration 53: Impact of emissions on the environment cycle
Source: Climate Change 2001, Synthesis report. Intergovernmental Panel on Climate Change.

Forecast for future CO_2 emissions

It is estimated that global CO_2 emissions will increase by 62% between 2002 and 2030, and that emissions in developing countries will exceed those of the OECD during the decade 2020-2030, as shown in Illustration 54.

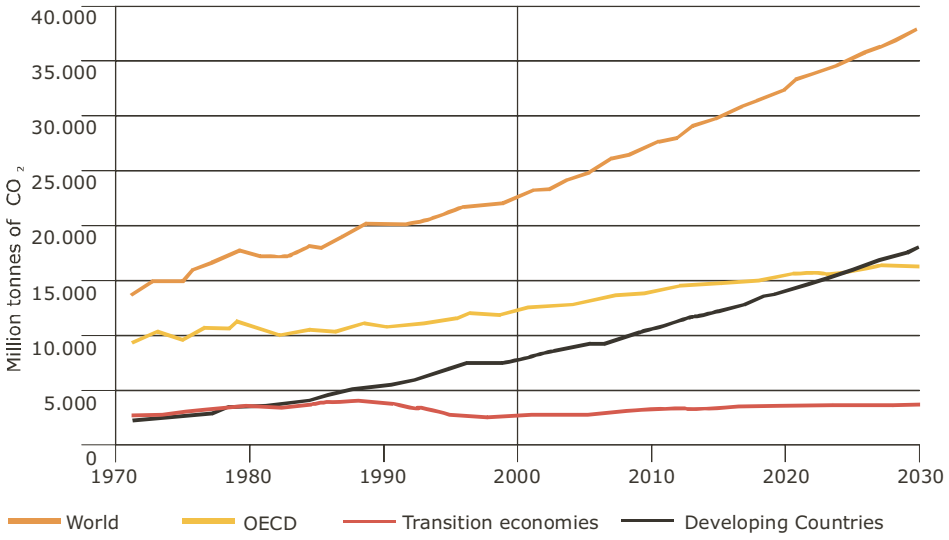

Illustration 54: Energy-related Co2 emissions (1970-2030).
Source: World Energy Outlook 2004. International Energy Agency.

Global CO_2 emissions from fossil fuel consumption are forecast to grow at a rate of 2% per year between 2002 and 2025[70]. Estimated emissions for 2025 project a total of 38,790 million metric tonnes, 81% up on 1990 levels. Oil and the coal are the fossil fuels that contribute most to these emissions.

Generally speaking, the economies of mature markets are growing at a slower rate than emerging ones and growth tends to be concentrated in less energy-intensive sectors. As a result, it is estimated that CO_2 emissions from mature market economies will grow at a rate of 1.1% per year from 2002 to 2025. North America stands at the head of the developed regions, contributing up to 1.5% per year to the increase in emissions in this period. However, for Western Europe and the mature Asian market, where growth in GDP is forecast to be considerably more modest, increases of only 0.5% and 0.6%, respectively are predicted.

Strong economic growth is forecast in emerging economies, caused mainly by industry and transport, which use energy intensively. As a result, it is thought that CO_2 emissions in emerging economies will grow nearly three times more than in the economies of mature markets, with an average of 3.2% per year from 2002 to 2025. The fastest increase in CO_2 emissions is anticipated in the emerging economies of Asia (primarily China and India).

70. According to figures taken from the International Energy Outlook 2005.

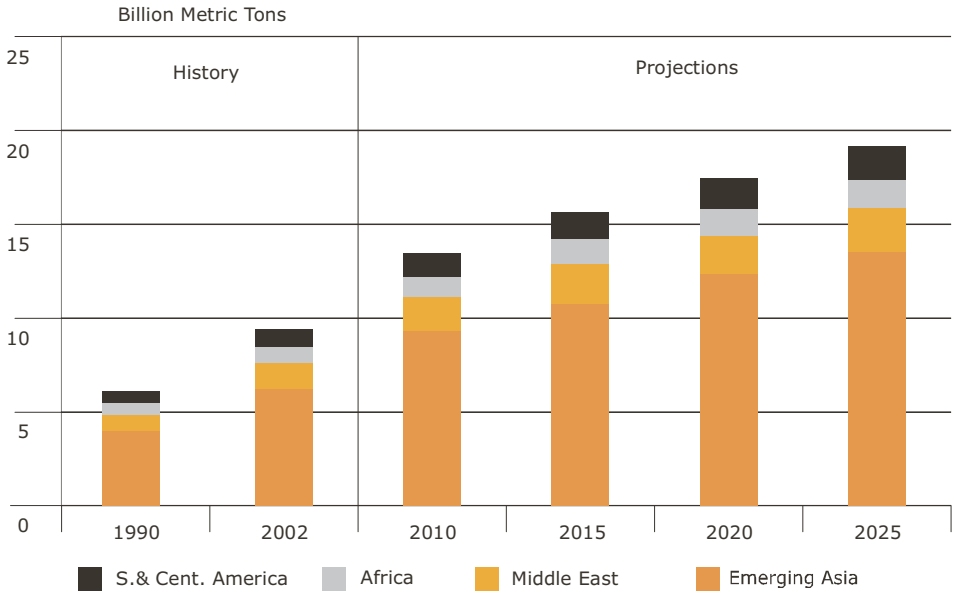

Illustration 55: Co_2 emissions in emerging economies (1990-2025).
Source: Energy Information Administration.

In order to reduce these predicted increases in CO_2 emissions into the atmosphere, the Energy Information Administration has set out a series of measures for each region, scoring each factor according to its importance.

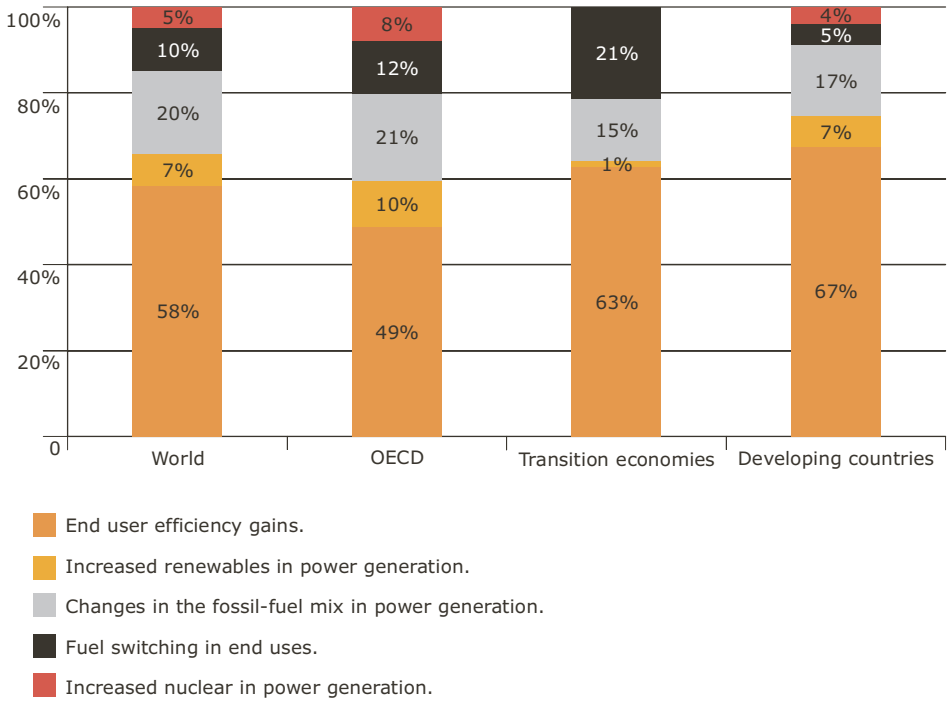

Illustration 56: Relative contribution of each factor to cutting Co2 (2002-2030).
Source: World Energy Outlook 2004. International Energy Agency.

Illustration 56 shows the results, which conclude that an improvement in efficient energy use would lead to a reduction of over 50% in CO_2 emissions, and that a greater use of renewables would lead to a fall of 20%.

With regard to the main CO_2-emitting industries and forecast emissions for 2030, the most pollutant industry at present is power generation, followed by transport, which releases 40% less. This trend will continue in the future, although the relative importance of both industries will grow ahead of the rest.

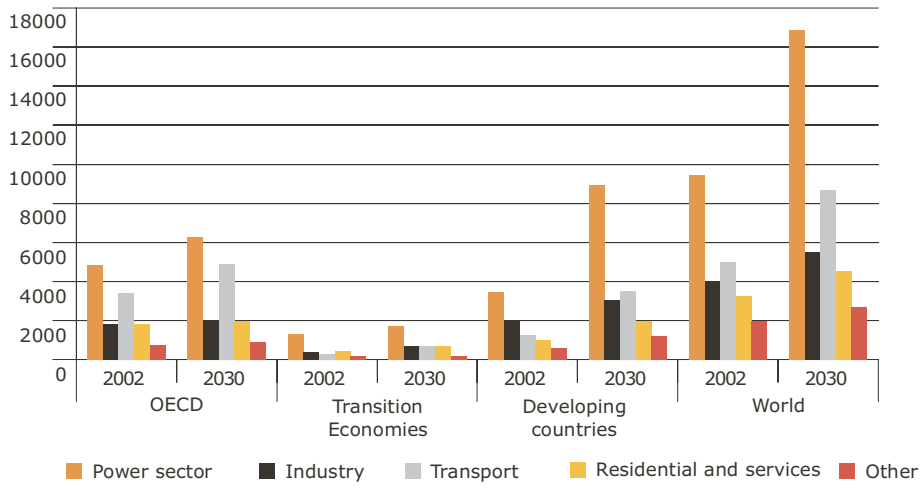

Illustration 57: CO_2 emissions by sectors (million tonnes).
Source: World Energy Outlook 2004.

The ever greater demand for energy among developing countries, which, as we have said, will mostly be met using carbon-intensive fossil fuels (coal or oil), is the factor that will contribute most to making power generation a pollutant industry in coming decades. These countries prioritise growth and development, sidelining environmental awareness (as, indeed, the now-developed economies did for decades).

Transport now accounts for 21% of global emissions of CO_2 and this figure will rise to 23% by 2030, driven by a growth in all areas of the world.

The industrial and residential sectors will not see such a sharp increase CO_2 as the first two, but this does not mean that they should be ignored when seeking means of reducing emissions. Indeed, energy consumption in both sectors will be crucial to determining how much energy has to be generated. In other words, if greater efficiency is achieved in these two industries, it will be possible to reduce CO_2 emissions by containing demand and by a subsequent reduction in supply.

Notes

Climate change

CO_2 emissions are one of the basic reasons why over the last century the average global temperature has risen by 0.6 degrees (in Europe it rose by one degree), an unusually fast rate of warming. Indeed, last century was the warmest century and the 1990s was the warmest decade in the last 1,000 years[71]. According to Nasa, the five hottest years were, in descending order: 2005, 1998, 2002, 2003 and 2004.

As we mentioned in Chapter 3, the Intergovernmental Panel on Climate Change (IPCC)[72] predicts that average global temperatures will rise this century by between 1.4 and 5.8 degrees Centigrade (between 2 and 6.3 degrees in Europe) as a result of human activity. This quantity is between two and ten times higher than the central heating value seen during the twentieth century and the speed of warming may well be unprecedented in at least the last 10,000 years, based on paleoclimatic data[73].

Two of the consequences will be an increase in average sea levels of between 0.09 and 0.88 metres between 1990 and 2100, and continued melting of glaciers and ice layers during the twenty-first century.

Obvious impacts include natural catastrophes and extreme phenomena (heatwaves, droughts, storms, hurricanes and floods) now occurring with ever greater frequency.

Nonetheless, forecasts suggest that by meeting Kyoto Protocol targets the temperature increase could be reduced by the year 2050, although FTF experts consider that most of the signatories to the agreement will not meet their objectives, thus limiting its impact on fighting climate change.

Furthermore, as Illustration 58 shows, the experts consider that emissions trading will not be an effective weapon in combating climate change, causing only a transfer and not a reduction in CO_2. Despite these doubts over the effectiveness of the Kyoto Protocol, the experts feel that developing countries should also sign up to the protocol's agreements, as a more immediate and effective measure.

71. EU website on climate change (http://www.climatechange.eu.com/).

72. Scientific forum established within the framework of the United Nations in 1988 to bring together thousands of climate experts from around the world.

73. Paleoclimate: Climate of a geologically old era.

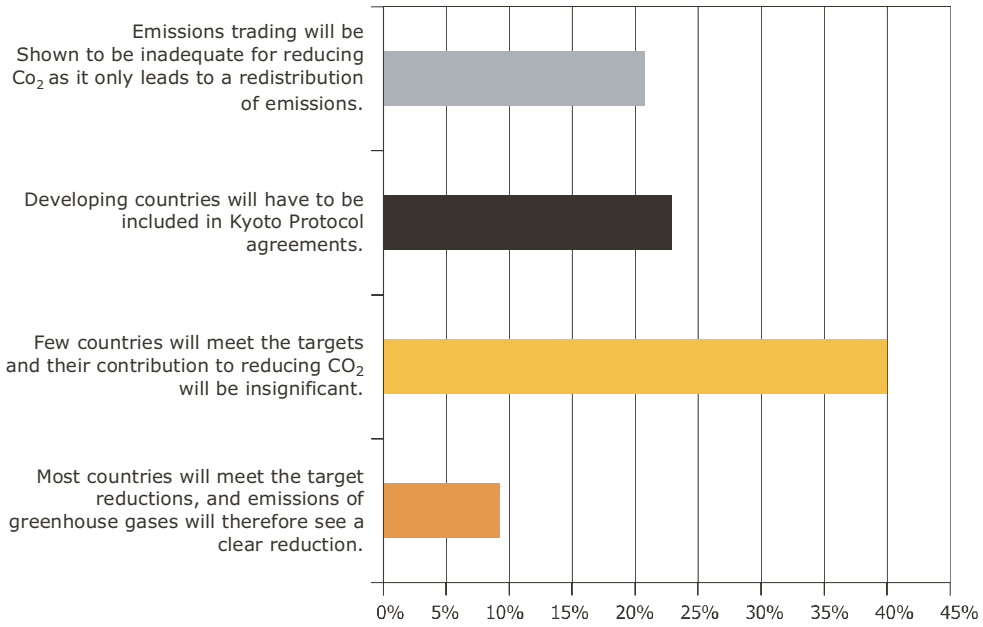

Illustration 58: Consequences of the Kyoto Protocol after 2012.
Source: Drawn from conclusions within the Future Trends Forum.

Environmental and socio-economic impacts

All the possible changes in climate will have a decisive influence on the make-up of natural systems (for example, many animals are being forced to emigrate as a result of changes in their ecosystem and more plant and animal species are becoming extinct every year) and in the resources societies can use (power cuts are becoming increasingly common, reservoirs have fallen to historic minimums, etc.).

We will now look in greater depth at the possible adverse effects throughout much of the world, especially in tropical and subtropical areas.

Ecological productivity and *biological diversity* will be altered by climate changes and a rise in sea levels, with a growing risk of some endangered species becoming extinct. It is predicted that the serious problems in ecosystems will be aggravated by factors such as fire, drought, plague, species invasion, storms and coral bleaching. The problems caused by climate change, added to others suffered by eco-systems, may cause very extensive damage or even the complete loss of some unique ecosystems and the extinction of endangered species.

Climate change will aggravate the water shortage in many areas of the world where the resource is already in short supply. In general, demand for water is increasing as a result of demographic growth and economic development, although in some countries it is falling thanks to greater efficiency in water use.

It is predicted that climate change will to a great extent reduce available reserves of water in many areas of the world, whereas in others, these reserves will increase. However, the quality of fresh water could be negatively affected by a rise in temperature.

In general, climate change may increase the *dangers for human health*, especially amongst populations with least economic resources in tropical and subtropical countries, but it will have important consequences worldwide. Climate change may affect human health directly and also indirectly through changes in diseases transmitted by animals, the quality of water and air, and the availability and quality of food. The real impact on health will be greatly influenced by local environmental conditions and socio-economic circumstances, as well as the capacity for social, institutional, technological and behavioural adaptation to reduce health threats.

Production of foodstuffs may be jeopardised. Global predictions are for agricultural production in the European Union (and the US) to increase only if there is an increase of no more than two degrees centigrade; if the temperature rises any more, production will fall. In tropical and subtropical zones, it is already predicted that the damage to agriculture resulting from warming will come when the temperature rises by 1.7 degrees. A higher average temperature could leave millions of people in danger of famine. A study carried out by the United Nations Food and Agriculture Organisation (FAO) predicts the loss of 11% of cropland in developed countries by 2080, with a subsequent reduction in cereal production.

Certain sectors of the *population* run a great risk of suffering serious social and economic consequences as a result of the rising sea level and storms. Many human settlements will be more exposed to an increase in erosion and flooding, and tens of thousands of people who live in deltas, low-lying coastal areas and on small islands run the risk of being displaced.

The economy suffers. Climate change could affect the working of ecosystems that supply our economies with important services and raw materials, as Hurricane Katrina did to American oil reserves. Similarly, an increase in the frequency of natural catastrophes as a result of extreme meteorological conditions will ultimately have large-scale economic repercussions. A report published in June 2005 by the Association of British Insurers drew attention to the probable increase in the costs of flooding resulting from climate change, which in Europe alone could come to more than $140 bn more per year by 2080.

The capacity for adaptation can reduce the adverse effects of climate change and may often lead to beneficial side-effects, but not all the damage can be avoided. In any case, faster and larger-scale climate change would raise more problems of adaptation and risks than slower and more extensive change. Natural and human systems have developed the capacity to adapt to a series of climate conditions, with a relatively low risk of damage, and a high capa-

city for recovery. Nonetheless, climate changes that result in more frequent adverse climate phenomena increase the risk of serious damage and incomplete recovery or even the collapse of the system.

4.6. End notes

Energy has been a key issue throughout history. It accelerates growth. and is an essential requirement for economic and social development. Changes in the energy system have marked the development of countries and businesses, and have enabled moves towards greater energy efficiency, which has in turn contributed to greater progress. A situation is now coming that requires a significant change in the energy model, if economic growth is to sustained.

This change arises out of the need to resolve a **problem** which, although many do not see it as being immediate, may have harsher consequences than anticipated if decision-making is delayed. Current energy supplies depend on fossil fuels, which are forecast to run out over the coming decades, and which have a negative impact on the environment.

The FTF experts were asked to define the general medium-term situation of energy and the most immediate solutions. As Illustration 59 shows, they defined the energy situation as a problem. In Section 4.2, we saw that the most immediate solution to this problem must involve changes in consumption habits and the promotion of renewables to alleviate the consequences of the energy model by minimising environmental impact and diversifying the energy supply till scientific advances can be made that will lead to a more radical change in this context.

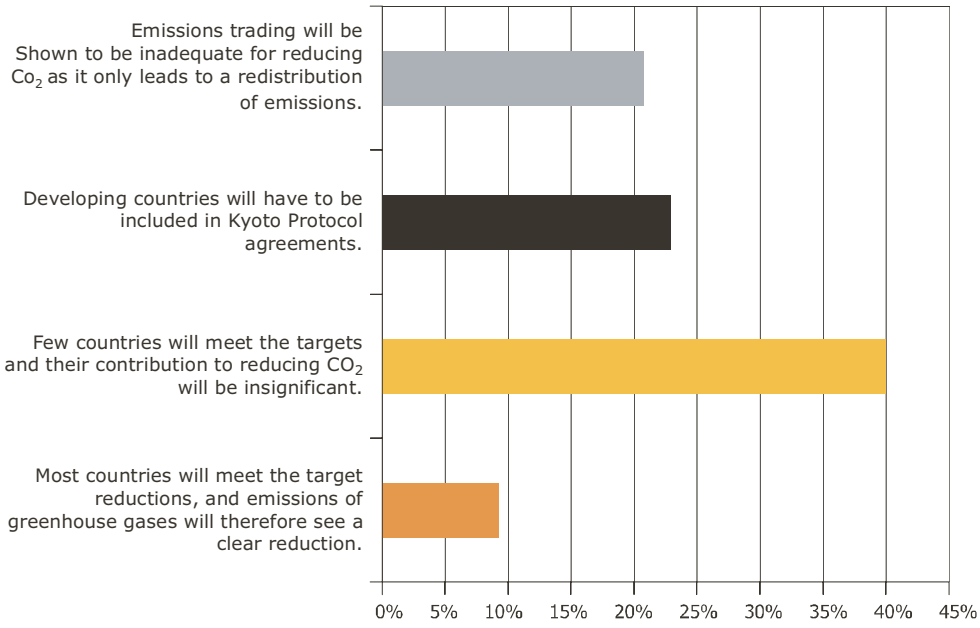

Illustration 58: Consequences of the Kyoto Protocol after 2012.
Source: Drawn from conclusions within the Future Trends Forum.

Uncertainty as to when a model of energy sustainability can be achieved requires us to take intermediary steps to facilitate a change in the current energy system.

The role of the public sector in the transition to overcoming the energy challenges will be fundamental. Governments must provide the necessary instruments to encourage efficient consumption habits, the use of renewable energy and greater respect for the environment. Only by raising social awareness of the existence of an energy problem will it be possible to move towards sustainability.

Demand for change among society, provoked by raised awareness and, particularly, by a possible rise in the price of traditional fuel prices will generate opportunities to develop new products and services that are more energy efficient. Similarly, a more revolutionary technological advance could create a new market around it. In any event, innovation must play a role throughout this process of change, both in order to search for transitory solutions and to find a longer term answer to this energy challenge.

Some industries, indeed, have already begun to move towards greater energy efficiency. Either on their own initiative or as the result of new demands of regulations, industries such as transport, building and agriculture have taken some steps, but there is still a long road ahead.

The FTF experts conclude that solving the energy problem we will face over coming years will require the participation of many different agents in order to ameliorate the consequences. Only with a rapid and adequate adaptation by governments, society and business can the economic and environmental impact of the change towards **sustainable development** be reduced.

Notes