

# Public attitudes to coal-fired power plant

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## **Abstract**

Though coal remains the world's most abundant, safe and secure form of energy, the public's perception of coal-fired power plant is not always favourable. Much of the environmental concerns regarding coal-fired plant focus on emissions such as SO<sub>2</sub> and NO<sub>x</sub> emissions, mercury emissions, particulates and ash disposal. However, the greatest concerns are those relating to CO<sub>2</sub> emissions leading to the greenhouse effect.

Public attitudes to coal-fired power plant or indeed any source of energy are important in shaping government policies. Such attitudes are also important in determining whether new coal projects can proceed. This report describes the public's attitudes towards coal-fired power plant in several countries in the developed and developing world. It principally collates opinion poll data available on energy, environment and the use of coal for power generation. It also reports what local, national or international organisations say about coal-fired plant. The report also examines what information is available to the public from the industry itself. The report investigates what the general public and concerned organisations say should be done to reduce the greenhouse effect. It addresses whether some types of coal-fired plant have a greater degree of acceptability than others. The report surveys how arguments in favour and against the use of coal vary in different countries.

The report concludes that even though the proponents of coal-fired plant emphasise issues such as availability, security of supply, cost and reductions in major pollutants, the concerns regarding global warming are so overwhelming that widespread public acceptance is unlikely to be achieved until technologies are available to enable a large-scale, economically-viable, coal plant to operate with low CO<sub>2</sub> emissions.

## Acronyms and abbreviations

ABEC	Americans for balanced energy choices
BACT	best available control technology
CATF	Clean Air Task Force
CCT	clean coal technology
CCGT	combined cycle gas turbine
CCS	carbon capture and storage
DTI	Department for trade and industry (UK)
EPA	Environmental Protection Agency (USA)
EU	European Union
EURACOAL	European Association for coal and lignite
FBC	fluidised bed combustion
GHG	greenhouse gases
IGCC	integrated gasification combined cycle
IPP	independent power producer
MACT	maximum achievable control technology
PCC	pulverised coal combustion
US DOE	Department of Energy (USA)
WWF	World Wildlife Fund

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# I Introduction

The global use of coal for power generation continues to increase. Nearly 40% of electrical power worldwide is supplied by coal-fired plant. In the USA more than half of electricity is generated by coal-fired units. In a balanced energy portfolio of coal, gas, nuclear and renewable sources of power generation, coal-fired generation has a number of advantages. Coal is easy to store and transport and can be obtained from a diverse range of suppliers worldwide. Pulverised coal combustion (PCC) units are able to operate at varying loads, which is particularly useful in meeting peak demand and compensating for the intermittency of some renewable sources. In addition, with the current high prices for natural gas, coal-fired generation is frequently the lowest cost option for power generation. However, coal-fired generation suffers from considerable environmental concerns, the principal one being its high CO<sub>2</sub> emissions.

Public attitudes to coal-fired power plant or indeed any source of energy are important in shaping government policies. Such attitudes are also important in determining whether new coal-fired projects can proceed. Concerns about acid rain in the 1970s and 80s compelled many governments to legislate to limit SO<sub>2</sub> and NO<sub>x</sub> emissions from power stations. The rapid reduction in the growth of nuclear power in the 1980s and 90s was due to public concerns regarding accidental leaks of radiation from nuclear plant and issues relating to disposal of nuclear waste. In democratic countries where information is freely available on the operation and emissions from a given energy source, and it is openly possible to voice concerns, local or national pressure groups may form to oppose a given type of plant. In developing nations in which there may be a shortage of electricity, the need for additional power may limit any public opposition to a proposed power plant. Within a country, demographic variables such as education, income and age will play some role in shaping the public's attitudes to matters concerning energy and the environment. The young and the well educated tend to be more concerned about the environment than the old and the poorly educated (Smith, 2002).

Though coal remains the world's most abundant, safe and secure form of energy, the public's perception of coal-fired power plant is not always favourable. The coal industry is much older than many other energy industries and one hundred years ago much of the industrial world was almost entirely dependent on coal. For many, coal still conjures up belching chimney stacks and smogs. Though the industry has made considerable improvements in cleanliness, efficiency and safety over the past forty years, the public is not always aware of these improvements in environmental and social performance. Much of the environmental concerns regarding coal-fired plant used to focus on emissions such as SO<sub>2</sub> and NO<sub>x</sub> emissions, mercury emissions, particulates and ash disposal. However, the greatest current concerns are those relating to CO<sub>2</sub> emissions leading to the greenhouse effect. These concerns can be assuaged to some extent by reducing CO<sub>2</sub> emissions per unit of energy generated by improving the efficiency of the plant or cofiring biomass. However, to gain

full public acceptance, in the longer term, it will be necessary to install coal-fired plant with very low levels of environmental emissions (Griffiths, 2004).

This report describes the public's attitudes towards coal-fired power plant in several countries in the developed and developing world. It principally collates opinion poll data available on the public's attitude towards energy, environment and the use of coal for power generation. It also reports what local, national or international organisations say about coal-fired plant. This type of information will influence public attitudes. It is in the nature of things that such organisations representing the public or environmental groups generally oppose the construction of new coal-fired plants or the operation of existing ones. The report also examines what information is available to the public from the industry itself. The report will investigate what the general public and concerned organisations say should be done to reduce the greenhouse effect. It will address whether some types of coal-fired plant have a greater degree of acceptability than others. The report will survey how arguments in favour and against the use of coal vary in different countries.

## 2 Public attitudes in different regions

### 2.1 The USA

Over 50% of electricity generated in the USA comes from domestic coal and there has been renewed interest in building new coal-fired projects in the new century, largely due to the spiralling cost of natural gas, which had been the near unanimous fuel of choice for new plant in the previous decade. In addition to cost, there are reasons relating to supply and security which also favour coal. The USA has coal reserves sufficient for 250 years' supply at the current consumption rate and since the events of 9/11, the ability to use a domestic resource is an additional advantage. In the USA, utilities are building new coal-fired capacity and it is estimated that in the next five years, 20,000 MWe of coal-fired capacity will be built (Gerard, 2004). Though there have been considerable reductions in SO<sub>2</sub> and NO<sub>x</sub> emissions in the USA over the last 30 years, there are intense concerns worldwide regarding US CO<sub>2</sub> emissions which account for 25% of total global emissions. Though the USA federal government has not signed the Kyoto protocol, many state governments are providing economic incentives to encourage the use of renewable energy. In addition, considerable research and development by the federal and some state governments have been undertaken on Clean Coal Technologies (CCT) to reduce all emissions from coal-fired power plants.

#### 2.1.1 Public attitudes

Though there is considerable global concern about global warming, according to surveys, this is not a major concern for the American public. An internet survey was conducted by MIT (Massachusetts Institute of Technology) and the University of Cambridge (UK) in 2003, in collaboration with

Knowledge Networks, on American attitudes towards climate change mitigation. The survey obtained views from 1205 people representing a general population sample of the USA. The survey covered twenty-two issues listed in Table 1 and the respondents chose the three most important issues. The environment was thirteenth on the list. When the respondents were asked to chose their first and second choices of the ten most serious environmental problems facing the USA listed in Table 2, global warming was chosen as the sixth most serious issue out of those in the survey. Even among those who listed the environment as one of their top three concerns, global warming was the third highest concern behind water pollution and destruction of ecosystems. When asked about the trade-off between the environment and the economy (Table 3), the public were fairly evenly divided but the environment was considered to be moderately more important. The same respondents were asked what should be the US DOE's priorities (Table 4). There was considerable support for research into new energy sources but very little for cleaner burning of coal. The data suggest that the environment is not a major priority for the US public and global warming is not a major concern for those concerned about the environment (Curry, 2004). These sentiments may have changed more recently following Hurricane Katrina and the devastation of New Orleans, as it has been suggested that increased global warming might lead to the increased incidence of hurricanes. The results of this survey have been compared with similar surveys in the UK, Sweden and Japan. For example, when the respondents were asked what should be done about global warming, only 17% of those from the USA thought that global warming has been established as a serious problem requiring immediate action whereas 41% in the UK, 35% in Sweden and 54% in Japan thought it was a serious problem (Table 5) (Reiner and others, 2006).

**Table 1 Most important issues facing the USA (Curry, 2004)**

Issue	% listing in top three	Issue	% listing in top three
Terrorism	42	Taxes	11
Healthcare	35	Environment	9
Economy	35	Poverty	8
Unemployment	30	Aging population	5
Family values	20	Income inequality	4
Education	19	AIDS	4
Federal budget deficit	15	Abortion	4
Foreign policy	14	Racism	4
Crime	14	Welfare	3
Social security	13	Inflation	3
Drugs	12	Stock market	2

**Table 2 Most important environmental problems (Curry, 2004)**

Environmental problem	First choice, %	Second choice, %	Total, %
Water pollution	17	22	39
Destruction of ecosystems	16	15	31
Toxic waste	14	17	30
Overpopulation	15	8	24
Ozone depletion	11	11	22
Global warming	11	10	21
Urban sprawl	8	8	16
Smog	5	6	11
Endangered species	2	2	4
Acid rain	1	1	2

**Table 3 Public preference between the economy and the environment (Curry, 2004)**

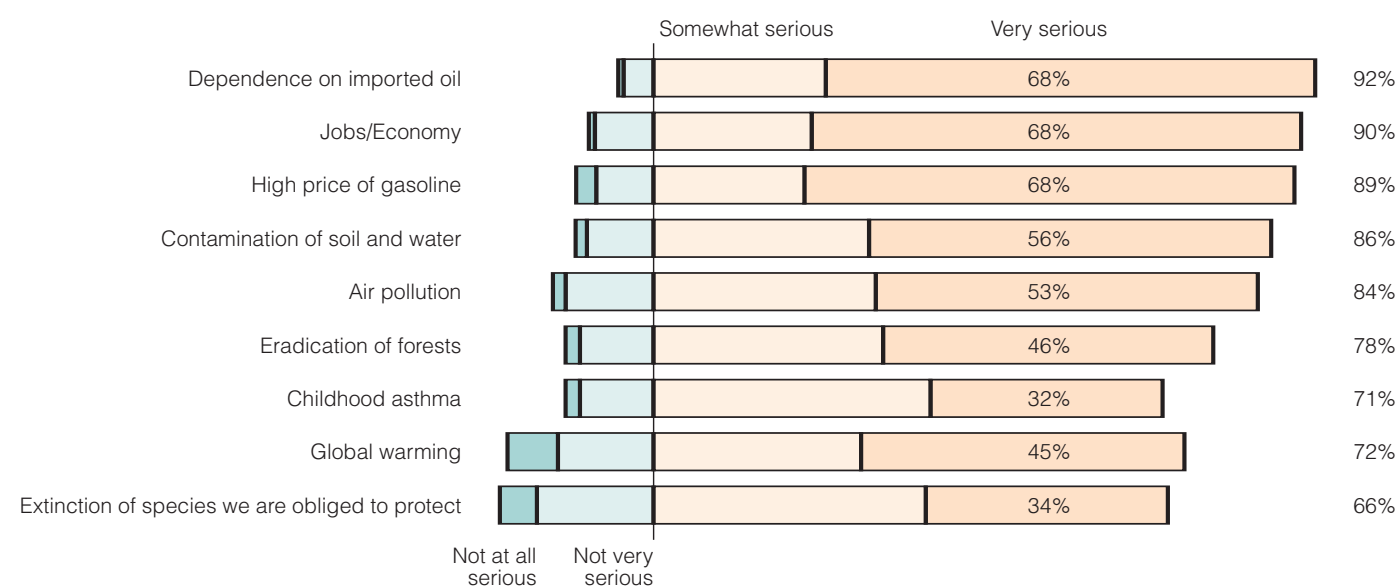
Statement	% agreeing
The highest priority should be given to the environment even if it hurts the economy.	9
Both the environment and the economy are important but the environment should come first.	45
Both the environment and the economy are important but the economy should come first.	39
The highest priority should be given to the economy even if it damages the environment.	8

**Table 4 Public opinion on US DOE priorities (Curry, 2004)**

Priority	First choice, %	Second choice, %
New energy sources	30	17
Anti-terrorism and security	19	13
New oil and gas reserves	12	10
More energy efficient cars and trucks	9	12
Clean drinking water	7	12
Energy conservation	7	11
Managing toxic waste	4	7
Mass transportation	4	4
Nuclear waste disposal	2	5
Nuclear power	3	3
Atmospheric carbon removal	1	3
More energy efficient buildings	1	2
Hydropower	1	1
Cleaner burning coal	1	1

A more recent poll for the Yale School of Forestry & Environmental, conducted by Global Strategy Group in 2005, of 1000 adults nationwide confirmed that global warming is not the major concern for the American public. There was concern about the state of the environment in that 59% of the sample thought that the state of the environment was only fair or poor whereas only 39% thought it was excellent or good. Over two-thirds (68%) of those questioned thought that the federal government wasn't doing enough on the environment and should do more. When given the choice of the nine concerns listed in Figure 1, 92% thought there was a somewhat serious or very serious problem with the US dependence on imported oil, whereas only 66% thought there was a problem with global warming. In order to reduce this dependency, the most popular solution was to require the automotive industry to manufacture more fuel efficient cars (93%); only 33% thought it was a good idea to build more coal-fired power plants (Figure 2). Three-quarters of Americans believed that it was possible to protect the environment and still have a strong economy. There was confusion amongst the public on the factual evidence concerning the environment on which to make their decisions. A majority (53%) said that there was so much information and disagreement in the media that they didn't know whom to believe about what was best for the environment. Only 42% thought they had enough information about what was best (Yale, 2005). There is a high degree of cynicism on the factors which determine environmental

	USA	UK	Sweden	Japan
Global warming has been established as a serious problem and immediate action is necessary.	17	41	35	54
There is enough evidence that global warming is taking place and some action should be taken.	36	33	45	34
We do not know enough about global warming and more research is needed before we take any action.	24	18	13	8
Concern about global warming is unwarranted	7	4	2	0
Not sure	16	4	3	3



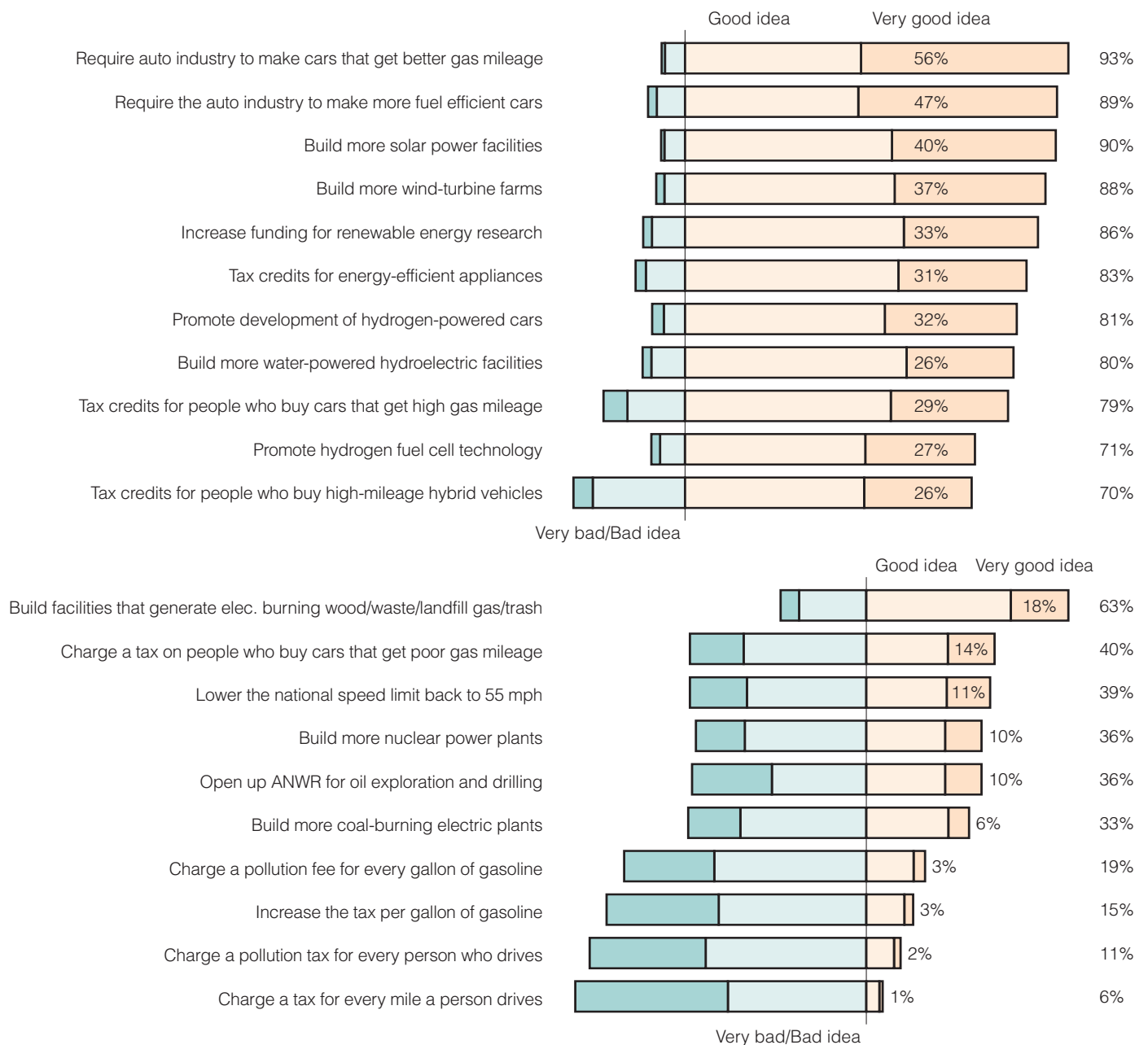
**Figure 1 Major US concerns** (Yale, 2005)

regulation. In a national public opinion poll commissioned by the Centre for Energy and Economic Development in 2000 of those who make energy policy as well as those who are close observers of the process, the majority opinion was that environmental regulations were more likely to be based on the political agenda rather than on sound science. On those who make the policy, 30% thought regulations were based on sound science and 49% on the political agenda. Amongst those who influence policy, the corresponding figures were 24% and 59%. There was an even greater degree of cynicism in Washington where 89% of opinion leaders thought that environmental policies were based on the political agenda and only 1% on sound science (Miller, 2002).

The most recent polling data suggest that the American public are becoming more concerned about global warming. A Los Angeles Times/Bloomberg poll of 1478 adults, conducted in July/August 2006, showed that 73% thought that global warming was a serious problem and 19% thought it was not a problem ([www.pollingreport.com/enviro.htm](http://www.pollingreport.com/enviro.htm)). Another poll conducted by GlobalScan Incorporated in late 2005-06 in conjunction with World Public Opinion showed that 76% of those sampled in the USA thought that global

warming was a serious problem and 21% thought it was not serious. Though the proportion considering global warming to be a serious problem in the USA is increasing, it is still lower than the world average in this survey of 90% and the US proportion which did not consider it to be a problem of 21% was considerably higher than the world average of 8% ([www.worldpublicopinion.org](http://www.worldpublicopinion.org)).

The US public are clearly not fully aware that the majority of their electricity is produced from coal. The results of a nationwide survey of a thousand adults in 2004, conducted by Bisconti Research Inc with NOP World for the Nuclear Energy Institute, are shown in Figure 3. When asked 'What are the sources of electricity used most in the USA today?', only a third named coal. This figure was a substantial increase over the 18% answer in 1997. In the same survey, when asked 'Which sources of electricity will be used in the USA most in 15 years from now?', those mentioning coal was only 13% (Figure 4) (Bisconti, 2005). A Market Strategies poll shows increasing levels of support for the use of coal to generate electricity (Figure 5). By 2001, 60% of the general public and 65% of opinion leaders supported the use of coal. The same poll shows that coal is regarded



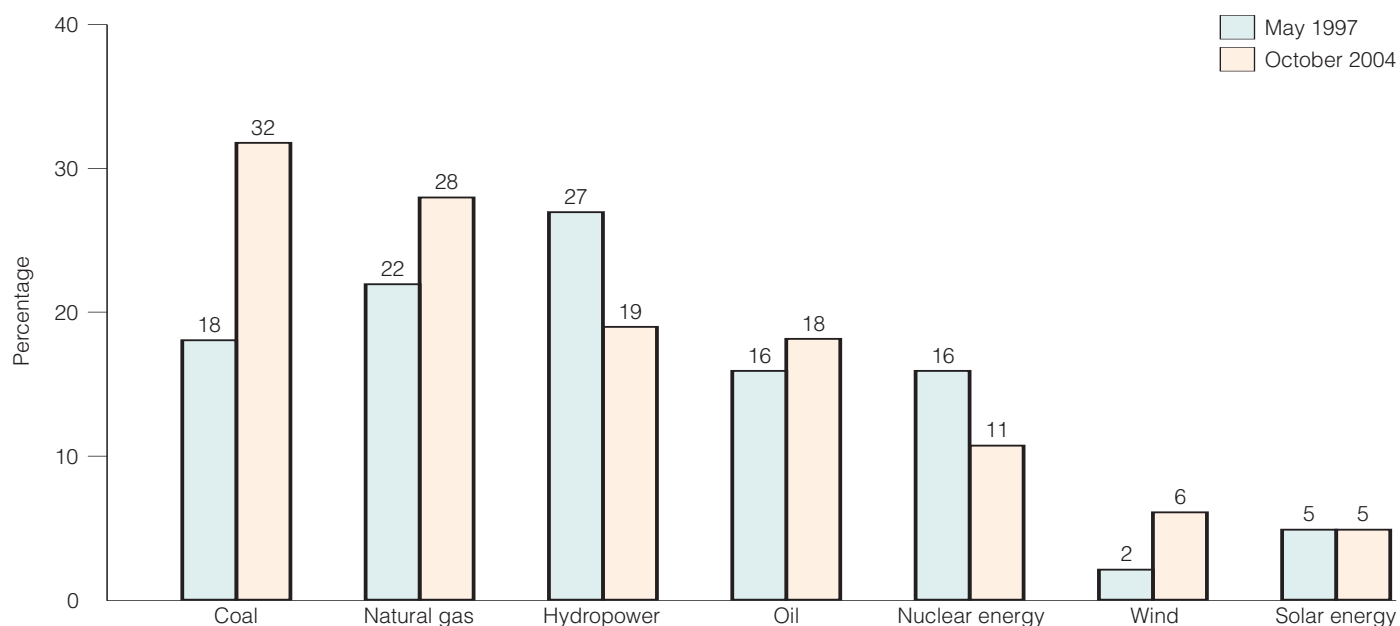
**Figure 2 US attitudes to solutions to reduce oil dependency (Yale, 2005)**

increasingly as a cleaner source of energy (Figure 6) (Miller, 2002). However, in environmentally-conscious California, a poll of a thousand adults taken after the 2000 energy crisis indicated that the greater proportion by 48 to 40% opposed relying on building more coal-fired plant to provide more electricity (Table 6). This level of opposition was much lower than in the 1970s and 80s when the percentages opposing were in the range 60–70%. The public also narrowly opposed the permitting of more oil and gas well drilling in state tidelands along the Californian coast. The same poll showed that the majority by a 59 to 36% margin favoured the construction of more nuclear plant. There was also a majority by a margin of 53 to 39% to relax air quality standards in some areas to get older power plant back on line. In spite of the energy crisis, the vision the Californian public had on coal-fired plants and offshore oil drilling was somewhat negative and the public did not see either of these energy sources as being the solution to the states's energy needs

(DiCamillo and Field, 2001). In the USA as a whole, a nationwide poll conducted by the Washington Post and ABC News in June 2001, showed that 54% of the population supported, of which 33% strongly supported, increased coal mining to address the country's energy needs whereas 38% opposed. The same poll showed that 68% supported increased oil and gas drilling. There is clearly less opposition to coal and oil in the nation as a whole than in California ([www.washingtonpost.com](http://www.washingtonpost.com)).

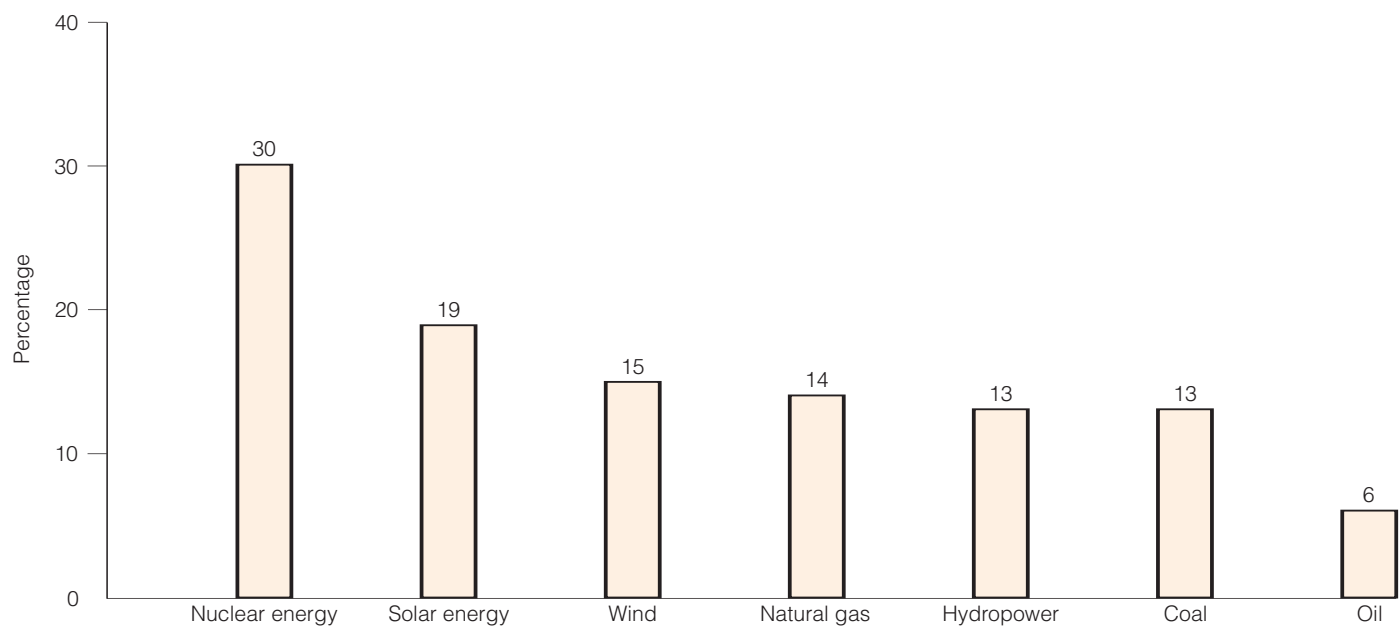
There is a public desire for more renewable energy in other western states. A statewide poll conducted in Colorado in 2003 found that 82% of Coloradans thought utilities should focus on renewable sources such as wind, solar or hydro to generate additional electricity. The same poll showed that 84% want utilities to use more renewable energy with 63% saying a lot more and 21% saying somewhat more. In addition 78% of those sampled wanted the state legislature to

What are the sources of electricity used most in the USA today?



**Figure 3 Knowledge of sources of US electricity supply** (Bisconti, 2005)

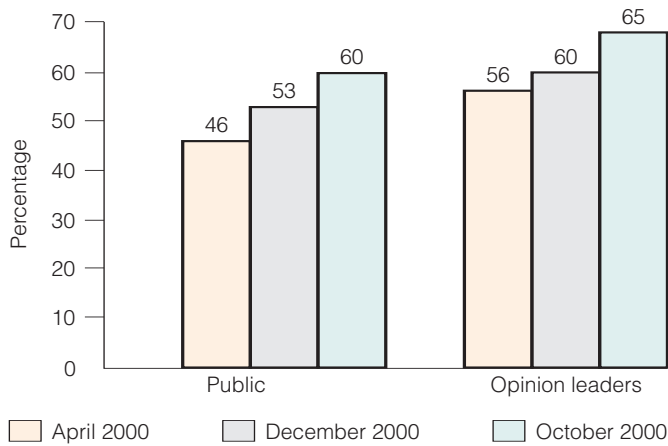
Which sources of electricity will be used most in the USA 15 years from now?



**Figure 4 US attitudes to future sources of electricity** (Bisconti, 2005)

require utilities to produce 10% of their electricity from renewable sources within the next 10 years. Following public consultation, publicly owned utilities have begun to use cleaner energy sources. For example, as a result of a public poll in 2002, the City of Fort Collins utility implemented both renewable and energy efficiency standards that are intended to increase the utilities' efficiency by 10% by 2012 and proportion of renewables to 15% by 2017 (Gilliam, 2004).

The renewed interest in coal-fired plant and their construction in the recent past has met some public opposition. For example, when the Peabody Coal Company proposed the construction of the 2x275 MWe Prairie State Power Plant in Washington County Illinois, the opposition to the plant was mainly on health and environmental grounds. The local opponents claimed that the plant would add 25,000 tonnes of toxic air pollutants. They claimed that children, elderly and asthmatics would be at greatest risk from additional smog



**Figure 5 Support for use of coal for electricity generation (Miller, 2002)**



**Figure 6 Proportion in the US regarding coal as increasingly cleaner (Miller, 2002)**

	Favour, %	Oppose, %	No opinion, %
May 2001 all adults	40	48	12
Registered voters	38	52	10
Democrats	32	57	11
Republican	45	42	13
Others	40	58	2
1981 all adults	30	66	4
1979 all adults	35	60	5
1978 all adults	26	71	3

and soot. In addition, Peabody's outdated coal-burning technology would use 68 million litres of water daily from the Kaskaskia River and threaten wildlife and fish

populations. They suggested that the existing coal-fired plants were the state's largest sources of air pollution causing asthma attacks, emphysema and even premature deaths. They quoted the US EPA stating that the existing Baldwin Power Plant was responsible for 5000 premature deaths in the past 20 years. The existing coal power plants in Illinois produced 80% of toxic mercury emissions and mercury is a neurotoxin that causes brain damage in young children. The opponents claimed that Peabody would add 270 kg of additional mercury to Illinois' rivers, lakes and streams. They claimed that mercury causes mental retardation in children whose mothers are exposed to the toxin, primarily through the consumption of fish. They also suggested that the economy of Illinois would be harmed in the following ways:

- increased healthcare costs as more air pollution means more hospitalisations;
- loss of tourism dollars as fishing would be affected by the contamination of lakes;
- increased business costs as the additional pollution from Peabody would result in existing businesses having to reduce emissions even further;
- increased taxes as Peabody was seeking state subsidies to build the plant;
- increased global warming (Illinois Sierra Club, 2004).

There are campaigns opposing the construction of power plants based on conventional technologies in the western States as well. The Clean Air Task Force (CATF) serves as the founding partner of a multi-state campaign to block new proposed coal-fired plants, based on conventional technologies, in Montana, New Mexico, Wyoming, Colorado and Utah. Their main case was that conventional coal-fired plants threatened to create a 60-year stream of CO<sub>2</sub> which could not be easily removed as well as a stream of toxic waste. They cited the superior environmental performance and potential climate friendliness of gas-fired power and IGCC (Integrated Gasification Combined Cycle) technology. In conjunction with their allies, Environmental Defense and Western Resource Advocates, CATF have provided expert testimony and strategic advice in a series of siting cases. In New Mexico and Montana, CATF and its allies won preliminary victories when state regulators agreed that project applicants must examine IGCC as an alternative to their proposals. CATF has also been working to prevent the EPA from prohibiting states from subjecting new coal plant proposals to scrutiny against alternatives such as IGCC and the efforts have had some success in that the Illinois EPA changed its permitting procedures to require developers of new conventional coal plants to evaluate IGCC as an option for meeting best available control technologies (BACT) (Clean Air Task Force, 2005).

In New England, there have been protests against the pollution produced by Connecticut's 'Sooty Six' power plants by state environmentalists. They claimed that these six stations were responsible for four hundred deaths per year, childhood asthma attacks, climate change and mercury contaminated fish. The plants located in Bridgeport, New Haven, Middletown, Norwalk, Montville and Milford are thermal plants that burn fossil fuels but are not required to meet the same air pollution standards as newer plants as they were built prior to the 1977 Clean Air Act. The protesters

emphasised how old these allegedly dirty power stations were and, given that they were still operating, they must meet modern emission standards. They claimed it is unfair that these plants operate under a loophole at the expense of the health of the citizens. In 2001, the Connecticut Legislature passed a law to clean up the Sooty Six but the Governor vetoed the bill (De Saram, 2001). More recently, in April 2004, state and national conservation groups sued the federal government to force the EPA to require maximum available reductions in mercury and other toxic air pollutants emitted by coal-fired and oil-fired power plants as required by the Clean Air Act. These standards were long overdue as under the Clean Air Act, the EPA should have issued these standards in December 2002. The plaintiffs claimed that coal-fired power plants emit more than 40% of the nation's mercury emissions and these emissions were largely unregulated. The plaintiffs claimed that in January 2004, EPA scientists themselves released new research indicating that 630,000 newborn babies in the USA had unsafe levels of mercury in their blood, doubling the previous estimate. This new estimate equated to one in eight American women of childbearing age having mercury levels in their blood above what was considered safe for a developing foetus. Hence forty-four states have issued advice warning women of childbearing age and young children against eating some types of fish. The plaintiffs further claimed that, though by 2000 the EPA was aware that a 90% reduction was achievable, in December 2003, the Agency proposed an alternative that would allow much less stringent reductions of new sources of mercury and other hazardous air pollutants from the coal and oil-fired utility industry. The proposal would have allowed trading of mercury emissions with no geographic boundaries and under this approach, existing coal- and oil-fired power plant sources would not have been directly regulated and only subjected to guidelines. Hence the lawsuit sought a court-ordered judgement that a Maximum Achievable Control Technology (MACT) standard was required under the Clean Air Act and sought to establish an expeditious and enforceable schedule for the issuance of a final MACT standard (Clean Air Task Force, 2004).

In the USA, the construction of any new major emission source such as a greenfield power plant is subject to New Source Review (NSR). If the source is located in an attainment area, it will trigger Prevention of Significant Deterioration (PSD) permitting as required by the 1990 Clean Air Act Amendments (CAA) for major stationary sources of air pollution in attainment areas. A major source is any stationary source with the potential to emit more than 90.7 tonnes of pollutants per year. An attainment area is defined as an area where the air quality is in compliance with the National Ambient Air Quality Standards (NAAQS). The PSD regulations require that new major stationary sources obtain a PSD permit prior to construction to ensure compliance with the applicable NAAQS. In order to obtain a PSD permit, an applicant has to perform a Best Achievable Control Technology (BACT) analysis, conduct an ambient air quality analysis, perform an additional impacts analysis, demonstrate that the project does not affect a Class 1 area and undergo adequate public participation. In order to satisfy the last requirement, the developer must observe specific public notice requirements and a public comment period

before the reviewing agency takes final action on a PSD application. A public meeting is held, after the public comment period, to build public goodwill by allowing stakeholders to voice their concerns. When presenting the pertinent information to a non-technical audience, the information must be clear and accurate without creating undue alarm. Fulfilling the requirements for public notice and comment period may entail a one-off presentation or a comprehensive community relations programme. It will be necessary to survey public opinion before and after the community relations activity or campaign and develop key messages.

It has been suggested that the following steps can help to ensure that public meetings present the relevant information about the new facility without stalling progress on the project:

- ensure that the regulatory agency has no reservations regarding the permit application;
- assume that there will be objections from the public and prepare answers to hypothetical questions or comments;
- conduct a 'dry run' with knowledgeable people questioning the company representatives;
- educate the public beforehand about the positive aspects of the plant;
- ensure that someone unconnected with the developer, such as the local Chamber of Commerce, attends in support of the facility;
- be prepared to produce graphics showing how the plant operates, particularly regarding pollution control equipment and emergency response planning.

The public participation step of PSD permitting does not have to result in a barrier for developers as long as they are prepared adequately and develop a positive message about the new facility's impact on the community (Daves, 2002). The public's acceptance of a plant would depend on the economic situation of the locality. For example, an assessment has been made of siting a new coal-fired plant in the Illinois Coal Basin. This region has been an economically depressed region compared to the rest of the USA. Rural areas in central and southern Illinois have not enjoyed economic development progress as other parts of the country. Much of this was due to the reliance on two industries: agriculture and coal mining. The agricultural community faces the same difficulties as those elsewhere. The Illinois coal industry has declined considerably over concerns of air quality issues and the high sulphur content of local coals. The construction of a coal-fired power plant typically creates a great number of temporary and permanent operating jobs. They also create jobs in mining and other related industries. Hence the proposal of a generating facility would be expected to gather support from local citizens due to the creation of jobs in a depressed industry and area. However, there may be concerns from non-local residents relating to air quality and water resource issues (Hill and Frigo, 2001).

## 2.1.2 US organisations opposing coal-fired plant

When considering public attitudes to coal-fired power plants,

it is instructive to consider what information is freely available to the public on relevant topics which would influence their views. It is impractical to try to assess all the information presented to the public on TV, radio and in newspapers but it is possible to describe information available from major national organisations which are either in favour or against coal-fired power plants. Some of the major organisations in the USA which campaign against coal-fired power plant are Clean Air Task Force (CATF), Environmental Defense and Western Resource Advocates. CATF was founded in 1996 and is a non-profit organisation which aims to restore clean air and healthy environments through scientific research, public education and legal advocacy. Controlling power plant emissions has been a major focus of their work. They have published several reports in recent years which are well-written, well-presented, adequately referenced and seemingly authoritative which are very critical of coal-fired power plants. For example, in their recent report *Dirty air, dirty power: mortality and health damage due to air pollution from power plant*, they claim that asthma attacks, respiratory disease, heart attacks and premature deaths are among the serious health problems caused by air pollution from the electric power sector ([www.catf.us/publications](http://www.catf.us/publications)). The report claims that fine particulate pollution from US power plants shortens the lives of nearly 24,000 people each year, including 2800 from lung cancer. They claim that the number of life-years lost by individuals dying prematurely from exposure to particulate matter is 14 years. They further claim that 90% of the deaths due to fine particle pollution could be avoided by capping power plant sulphur dioxide and nitrogen oxide pollution at levels consistent with the installation of today's best available emission control technologies. In another report entitled *Wounded waters: the hidden side of power plant pollution*, CATF claim that though power plants are widely recognised as major sources of air pollution, less well recognised is the damage they cause to water, both as large users and polluters. They claim that the electricity generation industry withdraws about 15% of the total freshwater flow in the USA and discharges hundreds of billions of litres of heated and treated waters each day. The types of environmental damage they claim include entrainment and impingement of fish and shellfish in cooling water intakes and the discharge of water at temperatures as high as 60°C with consequent damage to aquatic ecosystems. In a report entitled *Unfinished business: why the acid rain problem is not solved*, CATF claim that though reductions in the emissions of acidic compounds have been followed by reductions in deposition, the problems of devastated forests, lakes and streams due to acid rain have not been solved and without additional cuts in these emissions the problems associated with acid rain will persist for many decades. In another of their reports entitled *Not in my lifetime: the fight for clean water in town of Pines, Indiana*, they claim that the residents of Pines have discovered that their drinking water has been contaminated by coal combustion waste generated at a nearby coal-fired power plant. They claim that for the past 19 years the Northern Indiana Public Service Company (NIPSCO) has been disposing coal combustion waste at a nearby landfill which is in contact with a shallow aquifer which provides drinking water for the town. The residents of the town have

now resorted to legal action and 90 residents have filed a multi-party civil lawsuit against NIPSCO and Brown Inc, the latter being the owners of the landfill. CATF consider that the story of Pines teaches us a lesson of failed environmental policies at both state and federal level.

Another organisation which frequently campaigns on environmental issues is Environmental Defense, which is a non-profit national organisation founded in 1967 that aims to create innovative, equitable and cost-effective solutions to society's most urgent environmental problems. Environmental Defense claim that 21% of NO<sub>x</sub> discharged in the USA annually is from power plants but efforts to regulate NO<sub>x</sub> emissions year round have stalled resulting in a rising threat to health. They claim that though the US Environmental Protection Agency (EPA) has taken the important step of creating a mandatory NO<sub>x</sub> reduction programme for smog-plagued eastern states, this programme only applies during the summer ozone season. Only a handful of states, namely Massachusetts, New Hampshire, North Carolina, Texas and New York have taken the lead in cutting NO<sub>x</sub> emissions all year round. They suggest that individual states can no longer wait for the federal government to protect their citizens from the danger of NO<sub>x</sub> pollution and that the economic benefits of year-round NO<sub>x</sub> reduction far outweigh the costs. They also claim that power station smokestacks are public health enemy number one for their contribution to deadly fine particulate pollution across the eastern States. These particulates are a mixture of soot, smoke and aerosols formed from SO<sub>2</sub> and NO<sub>x</sub> emissions. As far as SO<sub>2</sub> is concerned, they claim that although overall emissions have decreased and less acid rain is formed, these emissions must be further reduced dramatically to curb the formation of sooty particles and protect public health. According to Environmental Defense only a quarter of power plants in the USA have installed FGD though scrubber technology has been available for 30 years. They claim to have identified 155 coal-fired power plants immediately in or near areas with unhealthy levels of particulate pollution and that EPA's proposed Clean Air Interstate Rules are inadequate (Environmental Defence, 2005a,b).

In a recent publication produced by Environmental Defense on mercury pollution in western States, a senior EPA scientist estimates that 630,000 newborn babies in the USA have unsafe mercury levels in their blood. They further cite two further studies which shed light on the potential benefits to human health from lowering mercury pollution from US power plant. They quote one study by the Harvard Center for Risk Analysis which estimated that reducing power plant mercury emissions by 60% could result in up to a \$5 billion annual health benefit due to prevention of heart attacks. A second study by the Mount Sinai School for Medicine estimated that the annual health costs of neurotoxic effects on children due to pollution from US power plants to be \$1.3 billion. They estimate that coal-fired power plants are the largest source of mercury and account for about 41% of mercury pollution in the USA. They state that the rising mercury pollution in the American west could be prevented by cost-effective control technologies available today and EPA's adherence to statutory protection under the Clean Air Act. This Act's hazardous air pollution control programme

requires each existing coal-fired power plant to limit mercury emissions by the maximum amount achievable and to comply with these limits no later than 2009. They complain that the EPA proposal to exempt coal-fired power plants from the human health protections of the hazardous air pollution programme and the Clear Skies Act, S131, which also exempts coal-fired plants from making maximum reductions in mercury pollution, will allow rising mercury pollution in the West (Copeland and others, 2005).

### 2.1.3 US organisations favouring coal-fired plant

Amongst the organisations which circulate information in support of the coal industry is the National Coal Council. This advisory council was founded in 1985 and provides information relevant to the use of coal in an environmentally sound manner which could lead to reduced dependence on other less abundant, more costly and less secure sources of energy. The members of the Council are appointed by the Secretary of Energy and represent all segments of coal interests and geographical areas. In a series of short reports entitled *Coal – a secure US energy source*, *Coal – continued commitment to a clean environment*, *Coal – the essential, secure, affordable and environmentally compatible US energy source*, they discuss how US coal consumption has doubled from 1970 to 1999. This, they claim, has helped to more than double the size of the US economy. They also emphasise that coal is a secure energy source. Whereas the USA imports 59% of its oil and 16% of its natural gas, virtually no coal needs to be imported. Hence the USA has control over this resource and is not subject to embargo or cartel-driven price increases. Furthermore the USA has, on current rates of consumption, sufficient reserves for nearly 500 years. They claim that though the prices of other fossil fuels have increased over the past two decades, the price of coal has decreased by 20%. Moreover the cost of coal per unit of energy generated has been lower and less volatile over recent decades than other fossil fuels. They state that more than half the electricity generated in the USA currently is from coal, and it will remain the primary fuel source for energy production in the foreseeable future. They claim that since the implementation of the 1970 Clean Air Act, though coal use has doubled, the emissions of six major pollutants, namely carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter and sulphur dioxide, as measured by the EPA have decreased by more than 35%. They claim that over the past three decades the US coal industry has invested over \$50 billion in new clean coal and environmental technologies and this has succeeded in reducing the rate of emissions per tonne of coal use by 70%. They mention the Vision 21 partnership with the US DOE to reduce emissions to near zero by 2020. There have been specific achievements over the last decade in that sulphur dioxide emissions have decreased by 28%, NO<sub>x</sub> emissions by 15% and particulate matter by 13%. They also state how important coal is to produce the electricity required to drive future US economic growth (National Coal Council, 2001, 2002a,b). Similar information is contained in the National Mining Association's publication entitled *Clean Coal Technology – current progress, future promise* (www.nma.org).

The National Coal Council have also considered issues relating to greenhouse gas reduction in the USA in a report entitled *Coal-related greenhouse gas management issues* (National Coal Council, 2003). In this report they describe the Bush Administration's plans to meet the goal of reducing gas emissions by 18% by 2012 by the means of various private-public programmes. They describe how the federal government has established or announced programmes to address the technical, environmental and societal challenges to widespread adoption of GHG management technologies by private industry, both domestically and internationally such as the Climate VISION programme. They considered that improvement in electricity generation was a very important near-term option for reducing greenhouse gas emissions from coal-based power plants. Considering the existing fleet, they suggest that 75% were candidates for retrofit technologies to increase boiler or steam turbine efficiency and 25% could be retrofitted with a CCT. Having considered CO<sub>2</sub> capture technologies, they suggest that such technologies could account for 40% of global CO<sub>2</sub> reductions but this would require an extraordinary acceleration of current research as presently there are no suitable technologies for capturing CO<sub>2</sub> from large sources such as power plants or for storing CO<sub>2</sub> in geologic or ocean sinks. They suggest that coal could play a major role in the production of hydrogen for a future 'hydrogen' economy and that the cost of CO<sub>2</sub> capture and storage will be significantly lower for hydrogen production than electricity production. In the absence of commercially-available CO<sub>2</sub> capture and sequestration technologies, substantial near-term CO<sub>2</sub> emission reduction requirements would force many coal-fired plants to be retired prematurely. Finally they consider that the current levels of funding are not adequate to develop and commercialise technologies that the USA will need to deploy for a new fleet of advanced coal-based power generation plants.

Another organisation which fosters the long-term viability of coal-fired electricity generation in the USA is CEED (Center for Energy and Economic Development). It is a non-profit, national organisation which aims to attain its goal through research, information gathering and advocacy programmes. Their main priority is to inform regional, state and local decision makers as they develop environmental and energy policies to ensure that coal remains a viable fuel source for the USA. They recognise that coal-based electricity generation has faced ever-increasing attacks in recent years. They claim that as few Americans understand the complexities of the electric power industry, coal has become the primary target for those who ignore the improving air quality in the USA. Their main contention to promote coal as a fuel for power generation is that coal-fired generation is essential in that it provides more than half the nation's power. They also claim that it is affordable and that 22 of the 25 US power plants with the lowest operating costs use coal. Moreover since 1979, the cost of electricity from coal, in real terms, has increased by 4% whereas cost for oil has increased by over 50% and cost of gas-fired generation has increased by 200%. They also state that due to over \$50 billion investment in new technology, emissions of pollutants from coal-based generation have decreased by 33% in the period 1970 to 2000 (Miller, 2001).

CEED have made some effort to refute some claims made against coal-fired generation. For instance considering health claims, CEED state that the regulatory standards established under the 1970 Clean Air Act have been carefully phased in to allow sufficient time for the development and deployment of new technologies. This commonsense approach has helped to keep electricity costs low while dramatic improvements in air quality have taken place. They consider some CATF reports and suggest that the titles of these reports were designed to attract media attention and alarm the public but that experts have found several flaws in the methodology of these studies. For example, when considering the link between the presence of fine particle matter (PM<sub>2.5</sub>) and lung disease, an example of flawed methodology is that it is common for results to be based solely on statistical analyses, with no consideration of clinical studies. These statistical studies often do not adequately consider personal health risk factors such as smoking and alcohol. Furthermore, the term PM<sub>2.5</sub> groups together particles according to their size, whereas in reality they can differ in form, surface characteristics, chemical composition and their ability to dissolve and stay in the lungs. Because of the variations in these factors, different types of PM<sub>2.5</sub> could have a variety of effects on human health, possibly including no effect at all. Environmental groups wrongly assume that particulate matter from power plant have the same effect on human health as tyre particles, vehicle exhausts and bacteria. Some advocates also claim that power plant emissions cause childhood asthma. If this is true why have childhood asthma cases increased in recent years whereas power plant emissions have decreased. These studies appear to have failed to distinguish between outdoor and indoor air. Evidence from the American Lung Association is that indoor air quality is 2 to 100 times worse than outdoor air.

On the subject of mercury, CEED claim that The National Academy of Sciences, the US Environmental Protection Agency and the US Food and Drugs Administration all agree that the risk to most Americans from mercury is very low. As mercury is released from both natural and man-made sources, US utilities are responsible for only about 1% of mercury emitted into the air. The only groups who could conceivably be at risk are children of mothers who ate large amounts of contaminated fish during pregnancy and people who consume fish as a primary staple in their diets. They quote the EPA as saying that it could not be certain that a reduction in utility mercury emissions would lead to any discernable drop in methylmercury found in fish in American waters. Uncertainties notwithstanding, emission control technologies at many US power plants can reduce mercury emissions by up to 40%. As to global warming, CEED claim that emissions of greenhouse gases came from both natural and man-made sources and that there is continuing debate on whether we are experiencing natural variations or if something else is taking place. They say that, though some scientists believe that the one degree warming that has taken place over the past hundred years may lead to potentially catastrophic change, other equally qualified experts are not so sure. They point out that most of the warming in the 20th century occurred prior to 1920s, that is before man-made emissions began a rapid increase. They claim that regulating CO<sub>2</sub> emissions in the USA would be ineffective as most of

the future growth in emissions will be in China and India. They quote information produced by the Energy Information Administration stating that regulating CO<sub>2</sub> emissions in the USA would cost the US economy more than \$350 billion per year. The pathway they recommend for CO<sub>2</sub> removal is sequestration, which is the process by which carbon is captured and stored once it is emitted to the atmosphere. They claim that independent research has shown that assisting natural carbon reservoirs such as plants, forests and soils to more productively capture and store carbon can effectively help reduce CO<sub>2</sub> concentrations and improve soil quality and plant yields without the high cost of regulation ([www.ceednet.org](http://www.ceednet.org)).

CEED have been instrumental in launching, on behalf of the coal industry, an organisation Americans for Balanced Energy Choices (ABEC) which claims to be a non-profit, non-partisan citizen group that advocates energy policies that balance meeting America's growing demand for electricity with the need to protect the environment. Because of coal's prominence in US electricity production, issues relating to coal are a major focus of their activities. ABEC claims to have more than 75,000 members nationwide, consisting mainly of community leaders, small business owners, local elected officials as well as individuals with a particular interest in keeping electricity prices affordable. The organisation is funded by coal-based stakeholders such as utilities, railroads and mining companies. ABEC utilises the paid media to communicate its message to its target audience. Through television, radio, print and the internet, ABEC has explained the USA's coal-based electricity industry to the general public. They suggest that for many years opponents of coal-fired generation in the USA have been successful in working with the traditional news media. Since 2000, the ABEC programme has worked to develop relationships with key reporters across the country. They consider that these efforts have achieved a positive shift in media coverage of coal-based generation and rebutting the misconceptions being marketed by opponents of coal to a largely uninformed audience. ABEC claim that since 1970, coal-fired plants have invested tens of billions of dollars in technology and on average are about 70% cleaner based on emissions per unit of electricity generated. Mercury emissions alone have decreased by 38% between 1995 and 1999. They consider that the EPA's new Clean Air Interstate Rule (CAIR) which has been designed to reduce SO<sub>2</sub> and NO<sub>x</sub> emissions will also reduce mercury emissions by almost 30% and the Clean Air Mercury Rule (CAMR) will further reduce mercury emissions by 70%. They agree with the EPA that Maximum Achievable Control Technology (MACT) should have been rejected as this would have only reduced mercury emissions by 29% but would have incurred considerable costs to the consumer (ABEC, 2005).

ABEC are also campaigning to reform the New Source Review (NSR) requirements of the Clean Air Act. These rules were designed to protect air quality when new factories or power plants are built or when existing facilities undergo major modifications. Under the NSR provisions, new facilities must install either best available control technology (BACT) or lowest achievable emission rate technology (LAER). According to ABEC, existing facilities are subject to

these requirements if they undergo major modifications that lead to a significant increase in emissions. The NSR requirements were never meant to apply to routine maintenance, repair or replacement. ABEC claim that since the inception of these rules, their implementation has been ambiguous at best, but in 1999 the EPA announced that it would retroactively apply a dramatically more stringent interpretation of NSR rules. This has led the EPA to issue sanctions against several electric utilities for conducting routine maintenance, repair and replacement work that had previously been understood as not incurring NSR requirements. ABEC considers that the current interpretation of NSR rules can act as an impediment to power plant operators making improvements to boost efficiency and reduce emissions. ABEC suggest that reform of the NSR rules is necessary to ensure the reliability of America's electricity supply and to protect the safety of workers (ABEC, 2004).

### 2.1.4 US summary

In summary, over half of electricity generated in the USA comes from domestic coal and there has been a renewed interest in coal-fired projects in the new century, largely due to the spiralling cost of natural gas and reasons relating to the security of supply. The available opinion poll data suggest that the environment is not a major priority for the US public and global warming has not been a major concern for those concerned about the environment in the recent past. However, this may change in the future following Hurricane Katrina and the devastation of New Orleans. The latest poll data confirm that global warming is being viewed with greater concern by the American public. There is considerable support for research into new energy sources but very little for cleaner burning for coal. There is considerable concern among the public about the US dependence on imported oil. According to poll data, there was substantially more support for a solution involving the automotive industry manufacturing more fuel efficient cars than building more coal-fired power stations. The US public are not fully aware that the majority of their electricity is produced from coal as a recent poll showed that only a third of the population knew that coal was an important source of electricity. However, there are increasing levels of support for the use of coal to generate electricity and even in California, the level of opposition to the construction of new coal-fired plant is less now than in the 1970s and 80s. The renewed interest in coal-fired plant has inevitably met some public opposition. The opposition is mainly on health and environmental grounds. The opponents also cite the superior environmental performance and potential climate friendliness of gas-fired power plant and IGCC technology. The construction of a greenfield power plant in the USA is subject to New Source Review and if the plant is located in an attainment area, it will require Prevention of Significant Deterioration permitting. As part of this, the applicant has to undertake adequate public participation. It has been suggested that important steps which can help to ensure that public meetings present the relevant information about the new project without stalling progress on the project, include ensuring that the regulatory agency has no reservations regarding the

permit application and educating the public beforehand about the positive aspects of the plant.

The organisations in the USA which campaign against coal-fired plant concentrate mainly on health and environmental issues. They claim that asthma attacks, respiratory disease, heart attacks and premature deaths are among the serious health problems caused by air pollution from the electric power sector. They further claim that the sector causes damage to water as both large users and polluters. In particular areas they claim that landfilling power plant waste has polluted aquifers. They claim that US power plants are the largest source of mercury in the USA and several hundred thousand new born babies have unsafe levels of mercury in their blood. The organisations campaigning in favour of coal emphasise that it is a secure source of energy in that it is available domestically and should last several hundred years. It is used to generate more than half the electricity produced in the USA. They state that since the 1970s considerable sums have been invested in emission control technologies, and that though coal use has doubled emissions of major pollutants have decreased by over a third. They also refute some of the health concerns by saying that in recent years dramatic improvements in air quality have taken place and that US utilities are responsible for only 1% of mercury emitted into the air. As to global warming they claim that there is still debate as to which increasing levels of CO<sub>2</sub> are due to natural variations or man-made. They suggest that sequestration is the answer and that natural carbon reservoirs can be used to store carbon effectively.

## 2.2 European attitudes

Europe's proven coal reserves total 39 Gt which is about 4% of the world total. About 40% of these reserves are brown coal. In most cases, the hard coal reserves are expensive to mine. The estimates of European coal reserves have been downgraded by more than 60% since 1999 following a more realistic definition of viability. Coal production in European countries has declined significantly since 1990 from about 1036 Mt to 647 Mt in 2002. The largest falls in output have been in Germany, UK, Poland and the Czech Republic. This fall in production has exceeded the parallel slump in demand for coal hence imports have risen. This trend is likely to continue, with imports projected to grow from 223 Mt in 2002 to over 300 Mt by 2020. European electricity use is projected to increase at an average annual rate of 1.3% between 2002 and 2030. It is expected that there will be a pronounced increase in the use of natural gas and renewables. Currently nuclear power is the largest source of electricity in the region, supplying nearly a third of demand. A quarter of electricity generated in the EU (European Union) comes from coal, 16% from gas and 6% from oil. More than three-quarters of the existing nuclear capacity will be retired by 2030 because many reactors will reach the end of their life and some countries have policies to phase out nuclear power. The share of nuclear power may fall to 13%. Many of the region's coal-fired power plants are also expected to be retired but in the longer term new coal plants are expected to be built as gas prices rise. It is hoped that generation from renewables will see a substantial increase with a doubling of

its share from the current 13% to 26% by 2030 (International Energy Agency, 2004).

The European Commission has undertaken a major survey to analyse the attitudes of the citizens of the 15 countries then in the European Union towards energy and energy technology issues, at the request of the European Commission's Director-General for Research (The Directorate-General for Research European Commission, 2003). The survey covers the following issues:

- general perception of energy in the EU;
- structure and trends of energy use;
- sources of information on energy;
- perceptions of energy in the future;
- priorities in the energy sector;
- individual behaviour and energy policy.

The survey was conducted in 2002 and a representative sample of at least 1000 people in each Member State were questioned. When asked to what extent each of the following was used to produce energy in their country, the following answers were given (Table 7). The average answers given by Europeans was in reasonable agreement with the actual situation. The respondents correctly stated that oil was the main source of energy in the EU, then gas and lastly coal. However, 28% of Europeans thought that nuclear energy was 'much' used, whereas in reality it accounts for only 10% of overall energy production. In countries like Germany and Denmark, which are traditionally big users of coal, over a quarter of respondents said that coal was 'much' used in their country. In countries where gas is intensively used, large proportions answered 'much' for example UK (66%) and Netherlands (79%). Considering nuclear energy, in countries which have chosen not to use this source, with the exception of Denmark, only a minority of respondents gave the correct answer 'nil', though admittedly this answer was not explicitly listed by the interviewer. Conversely, in countries where nuclear energy plays an important role in energy production, a reasonable proportion of the population was aware of the fact. For example, in France 64% gave the answer 'much'; this answer was also given by 62% of Swedes, 42% of Belgians and 38% of Finns. Europeans tended to overestimate the use of renewable energy, particularly in the Netherlands where 23% gave the answer much. However, the perception of the use of hydroelectric energy was accurate in some countries, for example, France where 27% answered much, Italy (21%), Austria (53%) and Sweden (57%). Overall, except in cases where a very significant amount of energy came from a particular source, there was a lack of awareness of the sources of energy in that country.

The respondents were then shown the following statements and asked to state whether they were true or not (Table 8):

- more than half the electricity used in the EU comes from coal?
- more than one quarter of the electricity used in the EU comes from nuclear power?
- more than one quarter of electricity used in the EU comes from renewables?
- compared to 5 years ago, gas has become more important as a means of producing electricity in the EU?

- it is important for me to know approximately how much electricity in kWh is used in my home per year?
- I know roughly how much was paid in total for electricity in my home last year?

Nearly half of people sampled (49%) knew that the statement 'More than half the electricity used in the EU comes from coal' was false. This was considerably higher than the proportion who thought it was true (21%) but nearly a third did not know. In two countries, Sweden and Denmark, the proportion who thought this statement was true was considerably higher at over 40%. Over half the respondents (55%) knew correctly that more than quarter of electricity produced in the Europe comes from nuclear power but the percentage of don't knows was also high at 29%. The answer 'no' to this statement was given most often by countries such as Denmark and the Netherlands which have few or no nuclear stations. 43% of those questioned knew correctly that the statement that more than a quarter of the electricity produced in the EU comes from renewables was false, though in Portugal and Austria a majority thought it did. The statement concerning the increased use of natural gas was considered true by nearly 57% of those sampled. The last two statements concern attitudes to electricity consumption and about two-thirds of Europeans agreed with the proposition. It is apparent that the majority of Europeans attach importance to knowing how much electricity they use at home.

The respondents were then questioned on their views on global warming. They were asked whether they agreed or disagreed with the following six statements:

- global warming and climate change are serious issues which need immediate attention?
- the use of fossil fuels contributed significantly to global warming?
- nuclear power contributes significantly to global warming and climate change?
- transport is largely responsible for global warming and climate change?
- the use of fossil fuels adversely affects air quality?
- the use of natural gas contributes to environmental problems, but less than oil?

The results are given in Table 9. It is immediately apparent that Europeans agree by a wide margin (88% to 5%) that global warming is a serious issue. They also accept by almost as wide a margin (75% to 9%) that the use of fossil fuels contributes significantly to global warming, though the number of don't knows was over 20% in Spain, Portugal and Ireland. A surprisingly high proportion of respondents (47%) thought that nuclear power contributes significantly to global warming. In Greece 79% agreed with the statement and in Spain 64% agreed. It is not obvious whether those agreeing mistakenly thought that the nuclear power stations themselves release CO<sub>2</sub> or they were referring to the CO<sub>2</sub> that is released during the extraction of uranium. Almost three-quarters of those sampled (74%) agreed that transport contributed to global warming and about the same proportion (75%) agreed that the use of fossil fuels adversely affects air quality. Just under two-thirds of respondents considered that the use of natural gas contributed to environmental problems less than oil. There was a significant proportion of don't

**Table 7 Public's perception of the extent of use of energy sources in their country** (Directorate-General for Research

	Coal					Oil					Gas			
	1	2	3	4	5	1	2	3	4	5	1	2	3	4
Belgium	64	22	6	3	5	13	31	52	0	5	2	30	63	0
Denmark	38	30	29	0	3	6	25	68	0	1	13	43	41	1
E Germany	39	38	17	2	5	4	26	66	0	4	8	35	52	0
Germany <sub>av</sub>	37	38	19	2	5	5	27	64	0	4	8	35	52	0
W Germany	29	39	26	1	6	7	31	57	0	5	7	35	52	0
Greece	30	24	12	5	28	2	8	89	0	2	48	28	10	7
Spain	64	17	4	4	12	4	26	65	0	5	5	41	49	0
France	65	21	4	7	4	6	18	73	1	3	5	37	54	1
Ireland	25	37	29	2	8	5	27	59	2	8	11	42	39	1
Italy	7	16	56	7	14	81	11	2	0	6	59	30	5	0
Luxembourg	62	11	4	14	10	12	26	51	5	6	6	34	53	2
Netherlands	48	16	10	17	9	13	30	48	4	5	5	11	79	1
Austria	41	38	11	2	8	9	28	54	2	7	13	36	40	2
Portugal	55	18	7	6	15	20	18	47	6	9	11	23	56	3
Finland	49	37	6	2	6	4	29	64	0	3	40	44	10	0
Sweden	79	13	2	3	3	10	36	51	0	2	64	28	3	1
UK	43	33	14	1	9	10	29	52	0	9	5	22	66	0
EU <sub>av</sub>	43	26	18	4	9	18	23	53	1	5	18	32	45	1
1	Little													
2	Medium													
3	Much													
4	Nil													
5	Don't know													

knows for these questions as well, particularly from Spain and Portugal. Overall there is a good understanding of the issues affecting global warming amongst Europeans and a serious concern about the problem.

The issue of energy dependency produced the following results. The respondents were asked their attitude to the following statements: 50% of the energy used in the EU comes from outside the EU. This dependency is expected to increase in the future. With which of the following statements, if any, do you agree? The average results obtained for all the EU countries are given in parentheses below:

- it is an urgent issue? (37%);
- energy imports from outside the EU should be reduced? (25%);
- more energy sources should be developed within the EU? (52%);
- more should be done to encourage energy saving in the EU? (51%);
- there are issues which are more urgent? (12%);
- none of these (1%);
- don't know? (7%).

These data show that a significant proportion of Europeans

European Commission, 2003)

	Nuclear					Hydroelectric					Other renewables				
5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
5	13	32	42	1	12	46	30	10	2	12	65	21	4	2	8
2	39	4	2	49	5	60	10	4	21	5	45	41	12	1	1
5	12	40	37	1	10	64	22	6	1	8	70	17	4	2	7
5	13	40	35	1	11	63	22	7	1	8	69	19	4	2	7
6	18	40	30	0	12	59	25	8	1	7	66	23	4	1	7
7	26	6	2	36	30	27	20	19	9	24	42	31	10	6	11
5	29	29	16	1	26	17	35	34	1	13	61	17	5	3	14
3	4	26	64	1	5	20	41	27	2	11	64	18	5	8	5
8	20	12	6	37	26	25	28	16	6	26	59	14	4	6	18
6	7	17	35	19	22	21	28	35	3	13	3	11	60	12	14
5	27	16	20	20	17	33	28	22	3	15	61	21	6	2	10
4	35	28	21	8	7	35	24	21	13	7	39	34	23	1	4
9	27	16	6	37	14	9	30	53	1	8	46	34	10	1	9
7	23	8	5	30	34	18	21	45	2	14	48	22	10	2	18
6	11	45	38	0	6	38	41	16	0	5	74	19	4	0	4
4	5	31	62	0	2	11	31	57	0	1	78	16	3	0	3
7	23	33	20	1	23	40	22	11	3	24	66	13	3	4	14
5	16	28	32	8	16	34	28	22	3	13	53	18	14	5	10

thought that energy dependency is an urgent issue though the proportion thinking that energy imports from outside the EU should be reduced is lower. A majority of the population thought that more energy sources should be developed within the EU and more should be done to encourage energy saving in the EU. On closer examination of the data it was apparent that the proportion of people who considered the situation to be urgent was fairly evenly distributed throughout Europe. However, the proportions favouring the development of more energy sources and those favouring energy saving varied from country to country. Countries in southern Europe (Greece, Spain and Italy) and Finland favoured development

whereas countries predominantly in northern Europe (Denmark, Netherlands, Austria and UK) favoured energy saving.

The respondents were questioned on their priorities in respect of energy. Given the following options, they were asked which should be the Government's first two priorities. The options given were:

- low prices for consumers (62%);
- ensuring uninterrupted supply (30%);
- protection of the environment and public health (72%);
- other (1%);

**Table 8 EU public awareness of fuels for power generation** (Directorate-General for Research European Commission,

	1			2			3		
	Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know
Belgium	15	60	25	70	10	20	25	53	22
Denmark	46	39	16	56	31	14	29	61	10
E Germany	26	48	26	66	12	22	18	59	23
Germany <sub>av</sub>	28	46	27	65	12	23	20	57	23
W. Germany	33	39	28	59	14	27	26	48	26
Greece	32	16	52	38	12	51	44	16	41
Spain	15	46	39	37	17	46	33	31	36
France	9	72	19	76	11	13	41	41	18
Ireland	31	26	43	40	16	44	32	28	40
Italy	10	53	38	39	22	40	32	33	35
Luxembourg	20	55	25	73	11	16	32	51	17
Netherlands	26	55	19	52	29	19	32	54	14
Austria	21	48	31	62	15	24	54	25	21
Portugal	16	45	39	32	22	46	57	13	31
Finland	36	48	17	79	11	11	30	55	15
Sweden	45	42	13	81	11	8	24	66	10
UK	29	34	37	48	16	35	24	42	34
EU <sub>av</sub>	21	49	31	55	16	29	30	43	27

1 More than half the electricity used in the EU comes from coal

2 More than quarter of the electricity used in the EU comes from nuclear power

3 More than quarter of electricity produced in the EU comes from renewable sources

4 Compared to 5 years ago, gas has become more important as a means of producing electricity in the EU

5 It is important for me to know how much electricity is used in my home per year

6 I know roughly how much was paid in total for electricity in my home last year

- don't know (3%).

It is apparent that the protection of the environment was the most important, followed by low prices and ensuring the security of supply was least important. These proportions varied between countries in the EU. In some countries both in northern and southern Europe, higher priority was given to low prices, for example, Belgium (80%), Greece (77%) and France (70%). In some countries there was greater concern about the security of supply, for example, Finland (63%), Netherlands

(60%) and Denmark (55%). Italy (83%) and Sweden (88%) were particularly keen on protecting the environment.

When asked which energy sources in 50 years from now would provide the greatest amount of useful energy, the following average results were obtained:

- solid fuels (4%);
- oil (14%);
- natural gas (20%);
- nuclear fission (17%);

2003)

4			5			6		
Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know
67	10	23	67	25	8	63	27	10
63	20	18	71	27	2	76	20	3
65	12	22	71	19	10	72	19	9
66	12	22	73	18	10	72	18	10
68	10	23	78	13	9	74	15	11
67	5	28	77	12	10	71	19	10
52	11	37	55	27	18	60	23	17
64	15	20	65	28	8	73	20	7
61	7	32	39	41	20	50	31	18
40	20	40	61	26	13	64	20	16
70	10	21	61	29	11	53	36	11
57	21	23	58	37	5	59	35	6
52	14	34	62	24	15	69	16	15
69	6	25	55	31	14	58	30	12
60	23	17	58	35	7	73	23	5
52	24	24	63	34	4	73	24	4
52	12	36	43	42	14	69	20	11
57	14	29	61	28	11	68	21	11

- nuclear fusion (22%);
- hydroelectric (17%);
- other renewables (27%);
- none of these (1%);
- don't know (19%).

There is less certainty about the future and 19% stated that they did not know. The proportion of respondents considering that the combined types of renewable energy would be the most predominant was 44%. Nuclear fission, nuclear fusion

and natural gas came next at about 20%. Only a small proportion at 4% thought that solid fuels would be an important source of energy.

When asked which of these energy sources would be best for the environment, the following average scores were obtained:

- solid fuels (3%);
- oil (2%);
- natural gas (10%);
- nuclear fission (4%);

**Table 9 EU public awareness on global warming** (Directorate-General for Research European Commission, 2003)

	1			2			3		
	Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know
Belgium	85	7	8	66	16	18	48	27	25
Denmark	83	11	6	79	9	12	24	58	18
E Germany	89	4	8	73	11	16	40	35	26
Germany <sub>av</sub>	88	4	8	73	10	17	39	35	26
W Germany	85	4	11	71	9	20	36	35	29
Greece	91	2	7	85	3	11	79	6	16
Spain	89	2	9	74	6	20	64	9	27
France	89	8	3	73	15	12	57	26	17
Ireland	87	3	10	79	4	17	61	11	28
Italy	92	3	5	79	6	15	42	22	36
Luxembourg	91	3	6	80	9	11	57	27	16
Netherlands	88	8	5	79	10	11	35	46	20
Austria	83	6	11	74	10	16	41	32	27
Portugal	84	4	13	64	8	28	59	10	31
Finland	89	7	4	83	8	10	28	54	18
Sweden	86	8	6	85	7	9	20	67	13
UK	88	6	6	76	9	16	45	27	28
EU <sub>av</sub>	88	5	7	75	9	16	47	27	26

1 Global warming and climate change are serious issues that need immediate action

2 The use of fossil fuels contributes significantly to global warming

3 Nuclear power contributes significantly to global warming

4 Transport is largely responsible to global warming

5 The use of fossil fuels adversely affects air quality

6 The use of natural gas contributes to environmental problems, but less than oil

- nuclear fusion (5%);
- hydroelectric (38%);
- other renewables (67%);
- none (2%);
- don't know (12%).

When considering the protection of the environment, Europeans clearly give high priority to renewable energy. Very few (3%) chose solid fuels. Regarding price, Europeans backed renewable energy with 40% considering that solar

power, wind power and biomass would be the cheapest form of energy and 24% choosing hydroelectric power. Another 21% chose natural gas and nuclear fusion was the choice of 14%. 11% chose solid fuels.

The respondents were also asked to state their views on energy-related research. When asked the question, 'In which of the following areas would you like to see more energy-related research in the EU?', the following responses were obtained:

4			5			6		
Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know	Yes, it is the case	No, it is not the case	Don't know
72	13	15	72	11	17	61	22	17
79	12	9	88	4	8	74	14	12
73	14	13	77	10	14	59	15	26
73	14	14	76	10	14	57	16	27
72	11	17	74	11	15	49	17	34
84	8	9	86	4	10	78	6	16
78	6	16	70	5	25	68	6	26
75	15	10	71	13	16	70	12	18
62	17	21	76	3	21	65	10	25
75	13	12	77	7	16	68	11	22
67	23	10	87	5	9	79	8	13
56	32	13	84	8	8	73	13	14
78	10	12	75	9	16	65	11	24
70	13	17	69	6	26	69	9	22
60	29	11	82	8	10	74	10	16
81	11	8	86	5	9	79	7	13
73	13	15	76	7	18	61	12	27
74	14	13	76	8	16	65	12	23

- coal (5%);
- oil (6%);
- gas (13%);
- renewable energy sources (69%);
- nuclear fission (10%);
- nuclear fusion (21%);
- cleaner means of transport (51%);
- other (1%);
- no further research (2%);
- don't know (10%).

There was overwhelming support for more energy-related research though a significant minority (10%) did not know which area should be supported. The two areas that Europeans most liked to support were renewable energy sources (69%) and cleaner means of transport (51%). Research into nuclear fusion had a modest level of support (21%) but support for research into conventional fossil fuels was low. There was obviously little awareness for the potential for clean coal technologies. On examining results from individual countries, it was apparent that research into new

energy sources and clean transport had widespread support throughout Europe but especially in Sweden, Denmark and the Netherlands. By contrast, the support of research into nuclear fission and fusion was more marked in countries in northern Europe (Sweden, Finland, The Netherlands) and less so in Austria, Spain and Portugal (The Directorate-General for Research European Commission, 2003).

Greenpeace have included the Eurobarometer data in an assessment of the EU's energy support programme (Froggatt, 2004). They claim that in spite of the public's desire for research and development into renewable energy, much of the existing support is directed at the nuclear and fossil fuel industries. They claim that the nuclear industry benefits from huge subsidies under the provisions of the Euratom Treaty. They suggest that over the past 30 years, about €60 billion in R&D funding has been awarded to nuclear technology which is considerably more than to any other energy source. They also say that the nuclear industry has additional subsidies to finance nuclear waste liabilities. They claim that the fossil fuel industry also receives considerable amounts of state aid. From 1994 to 2001, over €60 billion went to the coal sector in the Member States. In Germany alone, the coal industry received €120 billion between 1970 and 2003. In addition, they claim that both these industries benefit from indirect subsidies. The public financial support through the structural

funds for the extension of both the gas and electricity networks is expected to reach €4 billion between 1994 and 2006. This compares with only €650 million for renewable energy over the same period. They also claim that the true costs of fossil fuel and nuclear power are not given due consideration when assessing energy sources. These industries are not required to internalise external costs, such as the impact of human-induced climate change or the long-term management of nuclear waste. This, they say, penalises renewable energy. Greenpeace suggest that the following proposals be adopted:

- a change in funding levels by the European Investment Bank to increase renewable generation and energy efficiency;
- a shift in R&D priorities from nuclear to sustainable generating options;
- the abolition of the Euratom treaty;
- the end of EU endorsed state aid to fossil fuel and nuclear generation;
- changes in structural funding to remove emphasis on large-scale energy generation;
- the internalisation of the external costs of electricity generation to reflect the damage done by fossil fuel and nuclear generation in comparison with renewables.

The umbrella organisation representing the European coal

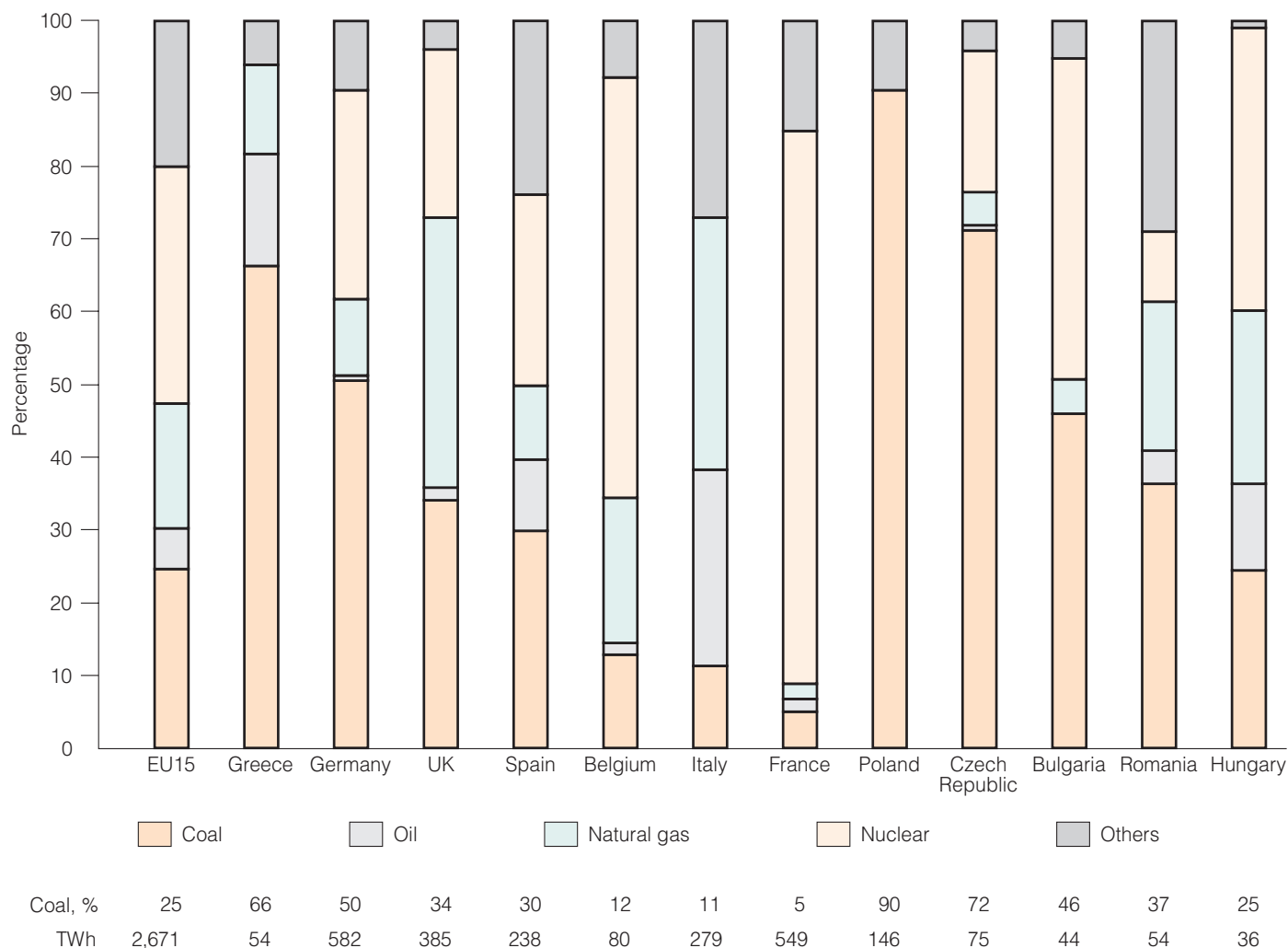


Figure 7 Power generating structure of selected European countries in 2001 (EUROCOAL, 2003)

industry is EURACOAL (European Association for Coal and Lignite). It contains individual associations and companies representing the coal industries in Belgium, France, Germany, UK, Greece, Spain and the new member states of the EU. EURACOAL's role is to highlight the importance of coal's contribution to the security of energy supply within the enlarged EU, to price stability, to added value and to environmental protection. They stress that an energy mix without coal is unimaginable in the EU as coal accounts for 25% of the EU's electricity supplies. It is also indispensable for steel production and other energy-intensive industries. As coal is the only significant indigenous energy source in the EU, it guarantees a degree of independence in energy policy and ensures the security of supply. Coal does not require a strategic reserve as a safeguard against political risks as has been proposed for oil and gas. The production and consumption of coal also provide added value by generating employment in many parts of the EU. Following EU enlargement, coal and lignite play an even more important role in the energy supply sector (Mills, 2004). The proportions of fuels used in power generation in several EU countries are shown in Figure 7. Sufficient quantities of coal are available on the world market and the fuel can be shipped and stored without any problems. Although the construction of coal-fired power plants is a capital intensive process, subsequent operating costs are relatively low. Oil and gas-based power generation may require lower initial costs but the subsequent high and fluctuating fuel costs bring considerable risks. They claim that switching from coal to gas makes no environmental sense. This arises as when one considers the efficiencies of firing domestic coal with gas transported from a distant region, when allowance is made for losses incurred during extraction and shipment and the effect of methane on the environment, the overall efficiencies of the two fuels are similar. New materials and improved technical processes result in higher efficiency levels from more advanced coal-fired power plant. Plant efficiencies of coal-fired plant approaching 45% are feasible today. They claim that if all the coal-fired plants worldwide were to be refurbished to meet current EU standards, this would save half the CO<sub>2</sub> emitted by the EU. This, they suggest, means that the construction of new-coal fired plant is a cost-effective way of reducing CO<sub>2</sub> emissions as the cost and potential for renewables is an expensive alternative. In the longer term there is considerable potential in the capture and sequestration of CO<sub>2</sub> (EURACOAL, 2003).

## 2.3 United Kingdom

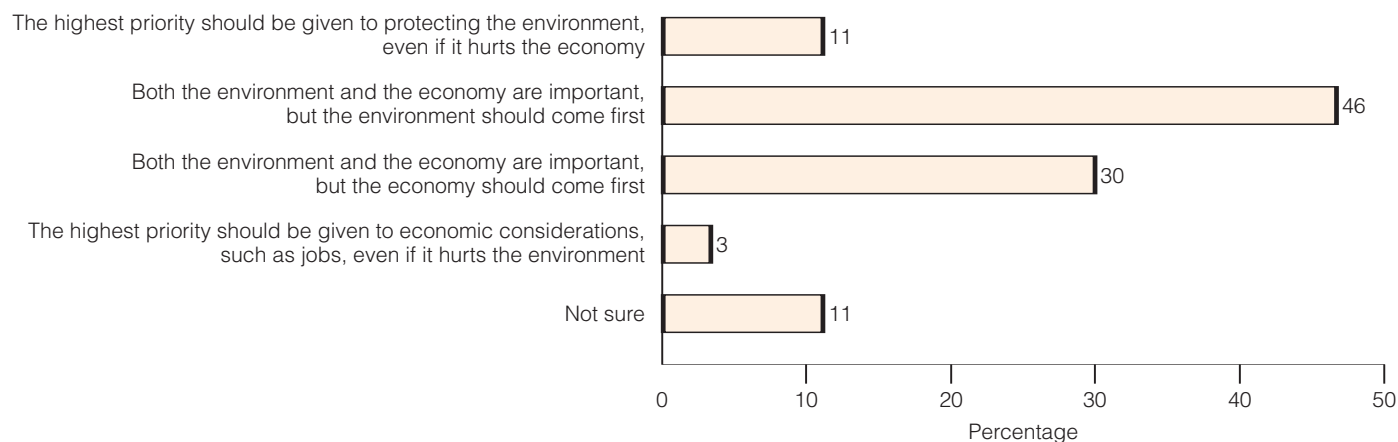
In the United Kingdom, there has been a considerable increase in the use of natural gas for power generation since the late 1990s, though recently this trend has been reversed. In 2003, natural gas generated 37% of UK's electricity, followed by coal (36%), nuclear (23%), biomass (1.6%), oil (1.5%) and hydro (1.2%). The UK has ratified the Kyoto Protocol and will easily meet the Kyoto target of a 12.5% reduction in greenhouse gas emissions of 1990 levels in 2008-12, though it is unlikely to meet the Government's own target of a 20% reduction by 2010.

### 2.3.1 Public attitudes

In September 2004, the Laboratory for Energy and the Environment (LFEE) at the Massachusetts Institute of Technology (MIT) in conjunction with the Judge Institute of Management at the University of Cambridge, conducted a survey of attitudes towards energy and the environment in the UK. The British survey was conducted by YouGov and involved 1056 participants. The respondents were asked to choose the three most important issues facing the UK from a list of 25% and 13% chose the environment as one of their three top concerns. The overall top three concerns were asylum seekers (42%), terrorism (39%) and crime (31%) and environment was the eighth top concern. The survey then asked respondents to name the top two environmental concerns facing the UK. The results which include both the first and second responses are shown in Table 10. Global warming was by far the most important concern with nearly half the respondents listing it as one of their top two choices. Twenty per cent more people thought it was more important than the second most important concern which was overpopulation. Concern about global warming was related to political preference – 58% of Labour supporters ranked global warming as one of their two top priorities whereas 34% of Conservatives and 54% of Liberal democrats did so. When asked to choose their preference for protecting the environment or maintaining the economy, the results in Figure 8 were obtained. The largest percentage thought both were important but that the environment should take precedence. The respondents were asked to choose the priorities for the UK Department of Trade and Industry (DTI) and the results are shown in Table 11. Over half the respondents considered that research into new energy sources was a top priority for the DTI. The proportions prioritising research into other energy sources namely, nuclear, oil and gas and clean coal technologies were low. Of the respondents

**Table 10 Most important environmental concerns in the UK (Curry and others, 2005)**

Concern	Listed first or second, %
Global warming	49
Overpopulation	29
Resource depletion	24
Urban sprawl	22
Destruction of ecosystems	18
Ozone depletion	16
Toxic waste	14
GM crops	11
Water pollution	9
Endangered species	6
Smog	2
Acid rain	0



**Figure 8 UK public attitudes to trade-off between the environment and the economy (Curry and others, 2005)**

**Table 11 Priorities for the Department of Trade and Industry (Curry and others, 2005)**

Priority	Listed first or second, %
New energy sources	52
Public transport	24
Energy conservation	23
Anti-terrorism and security	22
Energy efficient transport	18
Nuclear power	9
Energy efficient buildings	8
Managing toxic waste	8
Clean drinking water	7
Nuclear waste disposal	7
Atmospheric carbon removal	7
New oil and gas reserves	6
Hydropower	6
Cleaner burning of coal	2

who chose global warming as one of their two most important environmental concerns, the survey investigated how much they understood about the sources of carbon dioxide. The results are shown in Tables 12 and 13. Only few of the respondents answered incorrectly about automobiles, factories, coal-fired power plant, home heating, breathing, windmills and trees. However, the respondents were less sure and less correct about nuclear power, farming and oceans.

One goal of the survey was to determine the public's understanding of carbon sequestration or carbon capture and storage. The respondents were asked to say whether they have heard or read about several technologies relating to greenhouse gas reduction and the results obtained are given in Table 14. It is apparent that very few people had either

heard or read about either carbon capture or storage or carbon sequestration. When asked which environmental problems given in Figure 9 does carbon capture and storage (CCS) address, the results were not impressive. Given that so few people had heard about CCS, it is not surprising that there were so many people who were not sure as to what problem it addressed. The highest number of 'can reduce' responses were for global warming but this figure was only 40%. There was a significant minority who thought that CCS addressed other atmospheric concerns such as ozone depletion, acid rain and smog. When the same question was asked about those who had heard about CCS, over 80% knew that it addressed global warming. When the respondents were asked which technologies they would use to address global warming, the answers in Figure 10 were obtained. Respondents strongly supported the use of bioenergy/biomass, carbon sequestration (defined in this case as the use of trees to absorb CO<sub>2</sub>), solar energy, wind energy and energy efficient appliances and cars. Only a minority voiced any opposition to these technologies. The public were more evenly divided over nuclear energy, CCS and iron fertilisation. Carbon capture and storage, which was defined in this case as storage in underground reservoirs, received a net slightly favourable response.

The survey then asked respondents to choose from seven different approaches to address global warming in relation to the generation of electricity. Half the respondents were given information about the current patterns of electricity generation and the expected costs of the different approaches and half were not. The seven suggested approaches were:

- 1 Do nothing. We can live with global warming.
- 2 Invest in research and technology. New technologies will solve the problem.
- 3 Continue using fossil fuels but with capture and storage of carbon dioxide.
- 4 Expand nuclear power.
- 5 Expand renewables.
- 6 Reduce electricity consumption even if it means lower economic growth.
- 7 Do nothing. There is no threat of global warming.
- 8 Don't know.

The results are shown in Figure 11. This shows that, with and without the additional information, expanding renewable

**Table 12 Understanding the sources of carbon dioxide** (Curry and others, 2005)

Technology or practice	Increases carbon dioxide, %	Decreases carbon dioxide, %	No impact, %	Not sure, %
Automobiles	84	1	2	13
Factories	80	1	1	17
Coal-fired power plant	81	2	1	16
Home heating	66	2	6	26
Breathing	56	3	21	21
Nuclear power plants	24	12	28	36
Farming	8	27	25	39
Trees	3	76	6	15
Oceans	1	33	30	36
Windmills	1	25	53	22

**Table 13 Correct responses** (Curry and others, 2005)

Technology or practice	Increases carbon dioxide	Decreases carbon dioxide	No impact
Automobiles	✓		
Factories	✓		
Coal-fired power plant	✓		
Home heating	✓		✓
Breathing	✓		✓
Nuclear power plants		✓	✓
Farming	✓		✓
Trees		✓	
Oceans		✓	
Windmills		✓	✓

energy receives the greatest support. However, when the respondents were given the additional information, support for expanding nuclear energy and using fossil fuels with CCS increased considerably. Support for nuclear energy doubled from 9% to 18% and support for fossil energy with CCS increased from 1% to 10%.

The survey suggested that whilst the environment was not a pressing concern to the majority of the public in the UK, a large proportion believed that action should be taken to address global warming. The public strongly supported the use of renewable energy. When the relevant information was given, there was increased support for nuclear energy and fossil fuel generation with CCS. When asked to rank environmental concerns, global warming was by far the most serious environmental concern with over 70% thinking that action needed to be taken and over 40% thinking that immediate action was necessary. Over half the respondents

thought that the environment was more important than the economy. Very few people in the UK had heard of CCS but when information about it was given, support for it increased markedly (Curry and others, 2005). The Tyndall Centre for Climate Change Research has also investigated public perceptions of carbon capture and storage. A series of meetings of two 'Citizen Panels' were held to explore public perceptions of off-shore CCS. They found that on first hearing about CCS in the absence of on any information on its purpose, the majority of those interviewed either had no opinion or had a somewhat sceptical perspective. However, when even limited information was provided on CCS, opinion shifted towards slight support for the concept (Shackley and others, 2005).

Another opinion survey conducted in the UK was by MORI for the Nuclear Industry Association in November 2005. It addressed UK attitudes to nuclear energy by questioning

**Table 14 Knowledge of technologies** (Curry and others, 2005)

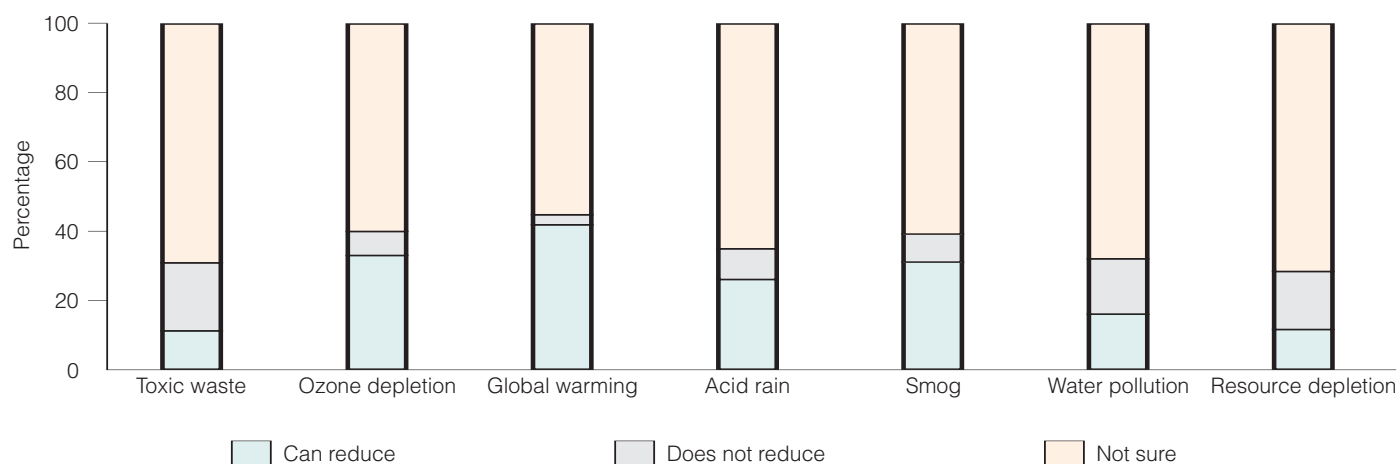
Technology	%
Wind energy	69
Solar energy	55
More efficient cars	53
More efficient appliances	40
Nuclear energy	39
Hydrogen cars	26
Bioenergy	10
Carbon capture and storage	5
Carbon sequestration	2
Iron fertilisation	1
None of these	21

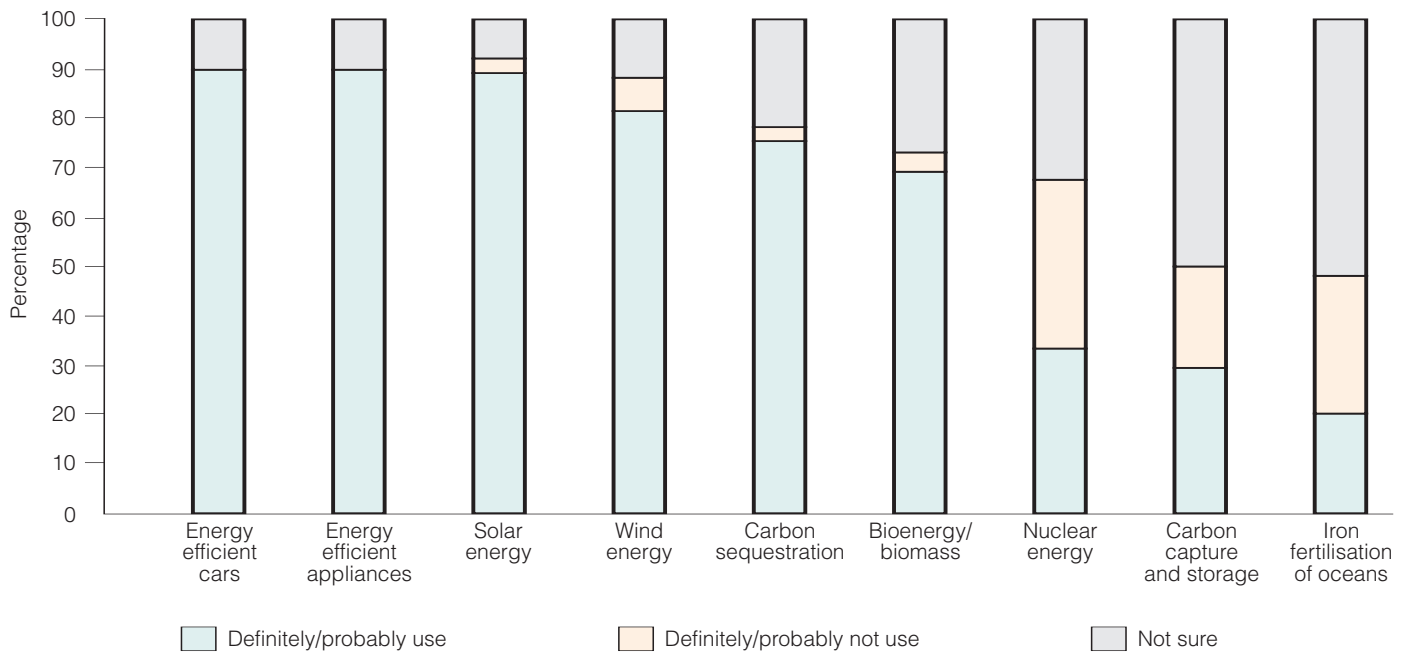
2035 adults about issues relating to the environment but other sources of energy were also considered. When asked what issues concerned the respondents, 12% mentioned the greenhouse effect and another 8% mentioned the protection of the environment. The issues of most concern were law and order (28%) and education (16%). However, when asked which issue relating to the environment was of most concern, the greenhouse effect was by far the most important with 34% of respondents mentioning it and this was a 19% increase since 2004. When asked which energy source would be a major contributor in the future, only 24% agreed that coal would be whereas 52% thought it would not. When asked which three factors should be taken into account when deciding methods of power generation in the future, the top three were effect on the environment (52%), effect on global warming (48%) and need for renewable forms of energy (32%) and 59% of respondents were personally willing to pay more to address these issues. Only 8% of respondents thought that coal would do most to ensure that we have reliable and secure energy supplies in the future (MORI, 2005).

### 2.3.2 UK organisations opposing coal-fired plant

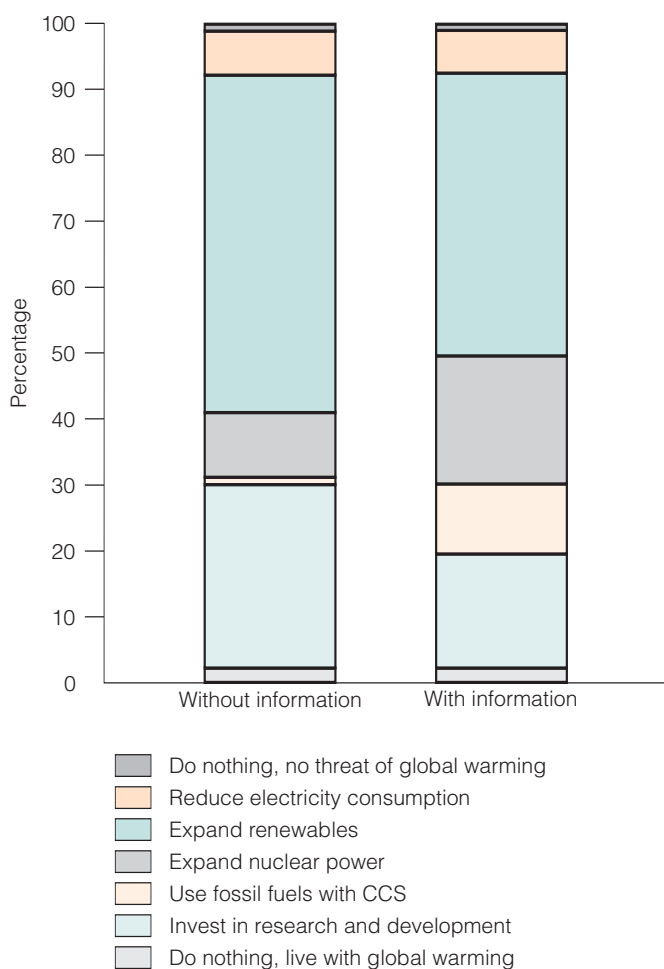
An organisation in the UK which campaigns for the environment and frequently criticises the operation of existing coal-fired power plants is Friends of the Earth. In a recent report entitled Carbon Dinosaurs they claim that coal-fired power plants in the UK are responsible for 27% of UK CO<sub>2</sub> emissions and are the single biggest source of CO<sub>2</sub>. They claim that coal-fired power stations emit up to three times as much CO<sub>2</sub> per unit of output as modern gas plant and that there is no way of extracting this CO<sub>2</sub> and the only way to reduce emissions is to burn less coal. All but one of the remaining coal-fired power plants are over 30 years old. The technology they use is out-of-date and they should be replaced by more efficient designs. They state that these coal plants also emit other pollutants such as SO<sub>2</sub> and NO<sub>x</sub> which cause acid rain and 9 out of these 16 plants are unlikely to be fitted with control technologies to reduce these emissions as it would be too expensive. At least half these plants do not meet efficiency standards set by the EU. They suggest that closing these stations need not have a damaging impact on the UK coal industry. Half the fuel burnt in these plant is imported from overseas and the percentage is rising. Newer cleaner coal-fired plant could reinvigorate the UK coal market if, for example, they utilise coal gasification technologies which enable dirtier UK coal to be burnt more cleanly especially if they are situated on or close to deep mines.

They propose that the government should introduce a tough cap on emissions of carbon dioxide from all point sources when it implements the EU Directive on Greenhouse Gas Emissions Trading and furthermore the cap should be set in line with the UK's domestic emissions target to reduce CO<sub>2</sub> emissions by 20% by 2010. The cap should take into account increases in emissions since 1999 so that credits are not unnecessarily handed out. The Large Combustion Plant Directive should also be implemented fully and industry's calls for relaxing the cofiring rules in the Renewables Obligation should be resisted. They claim that renewable power has the potential to more than meet UK's energy needs. Though the Government has a target of generating

**Figure 9 UK knowledge of problems addressed by carbon capture and storage** (Curry and others, 2005)



**Figure 10 Technological preferences to address global warming (Curry and others, 2005)**



**Figure 11 Preferences regarding electricity production (Curry and others, 2005)**

10% of our electricity from renewables by 2010, they suggest that a more challenging longer term target of 25% renewables by 2020 should be set. They suggest that there is considerable

scope for reducing energy demand by having smaller power plants distributed more widely in the country. Homes and businesses can also reduce demand by preventing energy losses and purchasing more efficient appliances. They also propose increased use of combined heat and power (CHP). They are in favour of the introduction of coal gasification which reduces emissions of local pollutants and also decreases CO<sub>2</sub> emissions due to increased efficiency. As for the UK coal industry, they claim that UK coal deposits are relatively expensive and many fields have high levels of sulphur. As the majority of UK power plant do not have FGD, SO<sub>2</sub> emission limits have been met largely by importing low sulphur coal, which now accounts for over half the UK coal burn. They suggest that the closure of the unabated plant could increase the market for UK coal. Friends of the Earth support the development of a limited number of coal gasification plants close to deep mine coal-fields provided that emissions can be shown to be as low as from existing gas-fired plant (Friends of the Earth, 2003).

The actions of UK authorities overseas have incurred the criticism of Greenpeace. They claim that the UK is continuing to fund the export of dirty coal technologies to the developing world through the Export Credit Guarantee Department (ECGD). The ECGD exists primarily to help UK firms conduct business overseas. Through the ECGD, the UK has funded fossil and nuclear generation projects worth £1.76 billion every year since the UN Framework Convention on Climate Change was signed in 1992. They estimate that since 1997, these additional plants have resulted in 13.3 Mt of carbon per year. This is equivalent to a third of annual emissions from UK's own power generation sector. This means that even if the UK meets its Kyoto commitments in full, half of those gains will be cancelled by emissions overseas directly attributable to the ECGD. Stations constructed with ECGD support since 1997 include Shandong in China, Manjung in Malaysia and Alfin-Elbistan

in Turkey. They claim that the UK has not funded a single renewable energy project overseas and encouraged the UK authorities to do so (Greenpeace, 2002).

### 2.3.3 UK organisations favouring coal-fired plant

An international organisation based in the UK which campaigns on behalf of the coal industry worldwide is the World Coal Institute (WCI). It is a non-profit, non-governmental association of coal enterprises and associations which has the objective to provide a voice for coal in international energy and environment policy and research discussions. They also aim to improve public awareness about the merits and importance through their outreach activities. In a recent report entitled *Coal: Secure Energy* they emphasise that coal has long been, and will remain, one of society's most secure forms of energy offering many advantages. Coal reserves are large and will be available for the foreseeable future without raising geopolitical or safety issues. Coal reserves are significantly more abundant and more widely and evenly dispersed than other fossil fuels. Both developed and developing nations have indigenous coal reserves and in developing nations these reserves provide the energy needed for economic development. Coal is readily available from a wide variety of sources in a well-supplied international market. It is an affordable fuel and coal prices have been lower and more stable than oil or gas. Coal is a safe and stable product to transport. Coal does not require high pressure pipelines or dedicated supply routes and these routes do not need to be protected at enormous expense. Coal can easily be stockpiled at power stations and these stocks can be drawn to meet demand without depending on primary supply. Almost 40% of global electricity is generated from coal and coal-based power is well-established and reliable (World Coal Institute, 2005).

The environmental issues which are raised by the utilisation of coal are addressed in their report entitled *Clean Coal-Building a future through technology*. This report describes various clean coal technology options and provides case studies where they have been put to practical use in both developing and developed countries. They suggest that clean coal technologies represent a developing range of options to meet coal's environmental challenges. There are options available to improve the environmental performance of coal-fired power plant for countries at every stage of economic development. The options which are discussed in the report include:

- the enhanced installation of existing technologies such as coal cleaning, ESPs, FGD and NO<sub>x</sub> reduction;
- improving efficiency levels at power plant. A 1% increase in efficiency can reduce emissions by about 2%. Hence upgrading or replacing older plant can yield significant CO<sub>2</sub> reductions;
- the deployment of advanced technologies. Technologies such as supercritical, ultrasupercritical and IGCC can achieve much higher plant efficiencies;
- exploiting synergies with renewables can improve the environmental performance of coal-fired plant while supporting the growth of the use of renewable energy;

- the development and commercialisation of next generation technologies. In the longer term, technologies such as carbon capture and storage have the potential to dramatically reduce carbon emissions and also enable coal to form the basis of a future hydrogen economy.

The report claims that through the continued deployment of existing technologies and research and development of new technologies, further major improvements in the environmental performance of coal can be achieved (World Coal Institute, 2004).

The IEA Clean Coal Centre is another international organisation based in the UK. Its website ([www.iea-coal.org.uk](http://www.iea-coal.org.uk)) contains a considerable amount of information on clean coal technologies which reduce emissions from coal-fired plant. The cleaner coal technologies site describes various technologies which are undergoing development in order to provide an environmentally satisfactory method for using coal for power generation. Some of these technologies are commercially available and in widespread use whereas others are at the demonstration stage. The technologies considered are supercritical PCC plant, fluidised bed combustion, integrated gasification combined cycle, combined heat and power and carbon sequestration. For each of these systems, the overall economics and the flexibility of the process, the ease with which the process can meet new environmental requirements, the efficiency and the state of development of the technology are discussed. The site also contains the UK DTI guide to cleaner coal technology related websites. This is a guide to information related to cleaner coal technologies that can be found on the Internet. It contains a list of over 70 sites produced by associations and research centres with activities related to cleaner coal technologies.

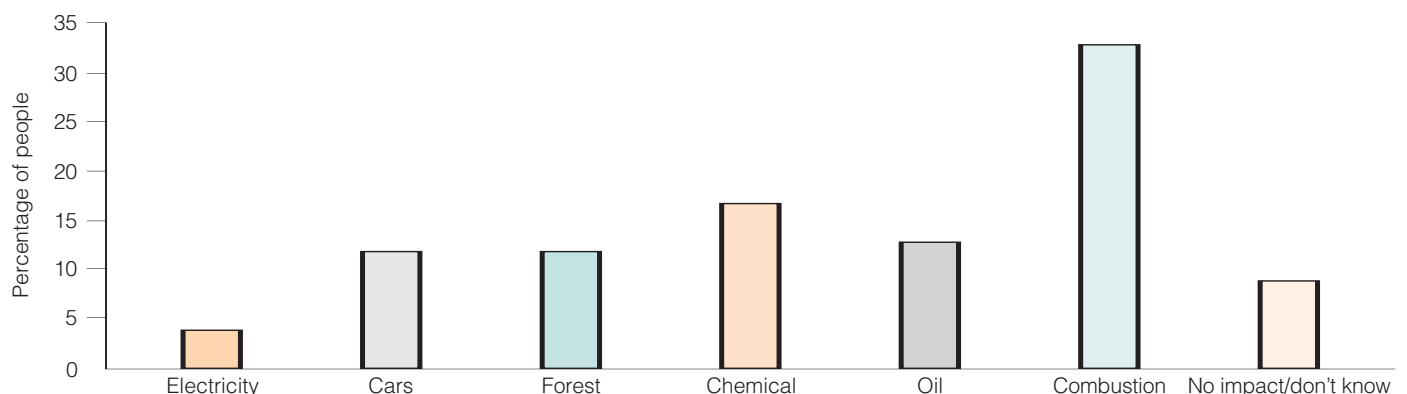
UK power plants have also in recent years made considerable efforts to involve the local community. For example, the 2000 MWe Didcot 'A' power plant is one of RWEpower's three coal-fired stations. In recent years the plant has cofired biomass. The station supports a wide range of community groups and charities through their charitable giving programme and their employee volunteer schemes. They offer guided tours of the station to interested parties to foster a greater understanding of power generation and their care for the environment. The tour lasts about two hours and begins with an introductory talk on power generation at Didcot. A short video *Welcome to Didcot* is shown, followed by a site tour which includes visits to the coal plant, boiler house, turbine hall and control room. Schools can combine a visit to the power station with a half day outing to the adjoining Sutton Courtenay Environment and Education centre. Upon entering the environmentally-friendly building, the children become eco-warrior detectives, searching out clues as to how they can act in a sustainable way in their everyday lives. The site contains five acres of woodland, wetland and grassland. In addition to the power station tours, RWEpower aims to reach at least 9000 pupils through their educational programmes such as the *Energy to live, energy to learn programme*. This includes a free education power pack for use by schools and community groups. The company also encourages employees to help the community. In 2004,

800 employee volunteers were involved with local community projects. This is intended to strengthen relationships with the local community and affords employees team building opportunities (www.npower.com ).

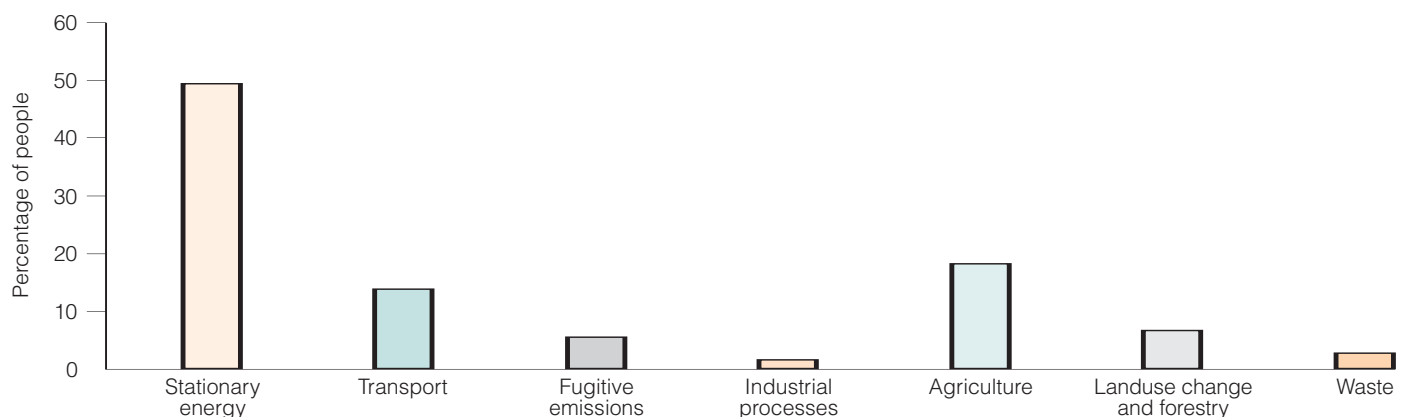
## 2.4 Australia

Australia has some of the most extensive coal reserves in the world. These reserves include both lignite and bituminous coal that are located mainly in the east and south-east corner of the country near to major population centres. In 2003, coal accounted for 43% of Australia's total primary energy supply and 77% of electricity generation. Australia has signed the Kyoto protocol but not ratified it. The Australian branch of the World Wildlife Fund (WWF) and Greenpeace are amongst the organisations campaigning against the use of coal in Australia. In a report entitled *Australia's polluting power*, WWF claims that the 24 coal-fired power stations in Australia are the largest source of greenhouse gases in the country amounting to one-third of Australia's greenhouse emissions. In 2000, the use of coal was responsible for the emission of 186 Mt of CO<sub>2</sub>. These 24 stations produce more CO<sub>2</sub> emissions than many entire countries such as Argentina, Belgium and Greece. They state that there are no legal requirements on coal-fired stations to reduce greenhouse emissions and there are no disincentives against the building of such plant. They claim that Australia is one of the biggest polluters of greenhouse gases in the world. According to

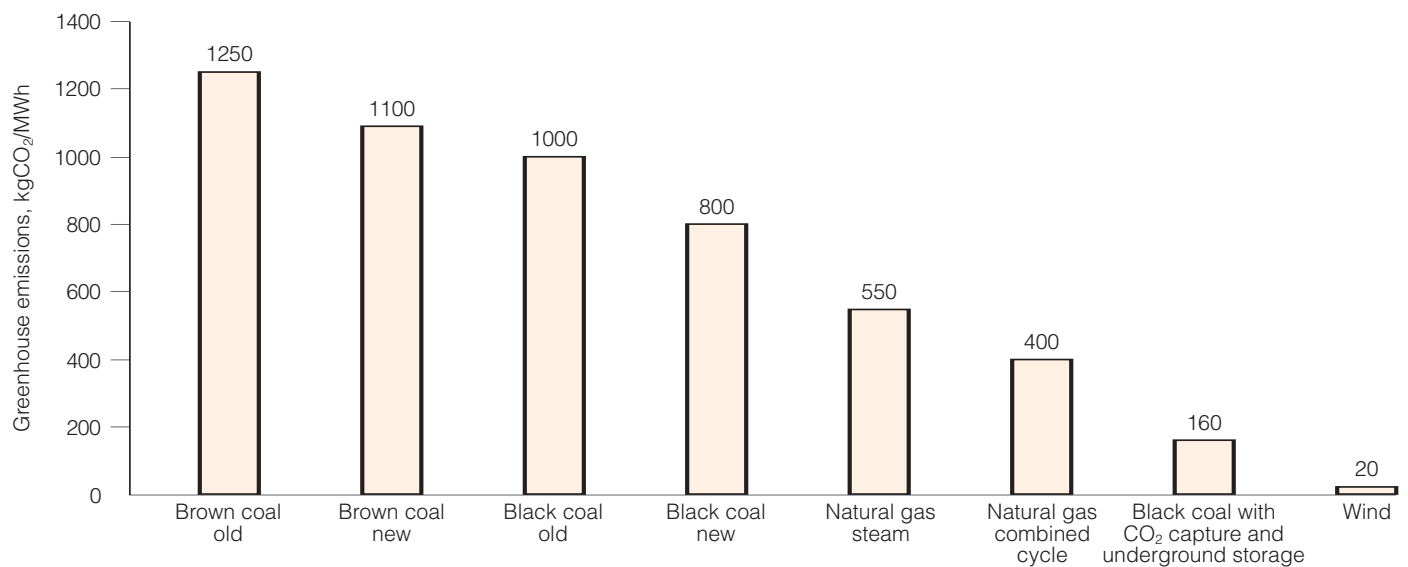
WWF, most Australians are unaware of the central role of coal in generating Australia's electricity and its major role in causing global warming. They quote a recent survey by the Sustainable Energy Development Authority which found that only 33% of people surveyed knew that coal was the main fuel for producing electricity. The source most nominated was hydropower. Another survey showed that only 4% of respondents thought that the electricity sector was primarily responsible for causing long term changes to the earth's climate. Figures 12 and 13 are presented as showing the large gap between the Australian public's perception of the impact of power generation and the reality of the contribution it actually makes to Australia's greenhouse gas emissions. They state that power plant built in the 1990s for lignite coals are only about 29–30% efficient whereas those firing bituminous coals are 35–36% efficient thus making lignite plants the most polluting type of power plant. A comparison of CO<sub>2</sub> emissions from different types of power plant is shown in Figure 14. Though coal is an important source of electricity for both industrialised and developing nations, Australia is exceptionally dependent on coal as shown in Table 15. Countries that are not so dependent on coal include UK and Thailand where there is significant use of gas-fired generation. In Denmark, 18% of electricity is generated from wind power and there is also significant use of biomass. Some countries such as Belgium, France and Sweden produce a high proportion of energy from nuclear power. They further claim that in the period 1990-99, both coal consumption and greenhouse gas emissions have increased in



**Figure 12 Australian public perception of the responsibility of industrial sectors towards global warming (Diesendorf, 2003)**



**Figure 13 Actual responsibility for global warming (Diesendorf, 2003)**



**Figure 14 Comparison of greenhouse gas emissions form different plant (Diesendorf, 2003)**

**Table 15 Proportion of electricity generated from coal in selected countries (Diesendorf, 2003)**

Country	Year	% from coal	Trend since 1990
Poland	2000	96	steady at saturation
South Africa	2000	92	rising slightly towards saturation
Australia	2000	78	steady
China	1999	75	small increase over the decade
India	1999	75	small increase
Czech Republic	2000	73	steady
Germany	2000	53	fallen slightly
USA	2000	52	steady
Denmark	2000	47	big decline as gas and wind increase
Korea	2000	42	big increase
UK	2001	37	big decline since 1986
Japan	2000	22	big increase
Thailand	1999	18	small decrease
Vietnam	1999	12	big decrease

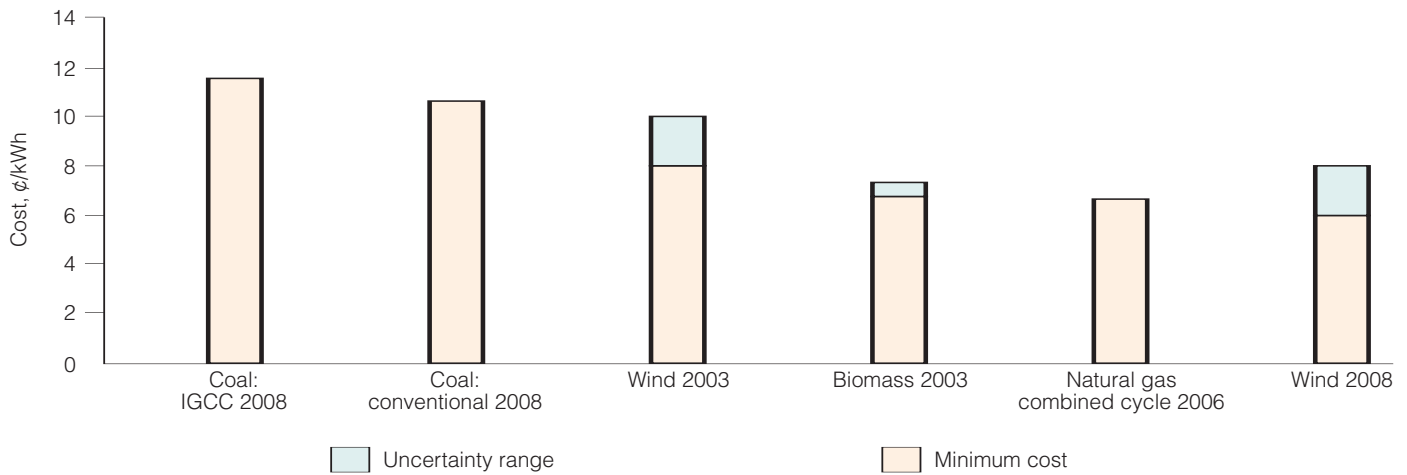
Australia at a rate faster than in other OECD (Organisation for Economic Cooperation and Development) countries, even more so than in the USA.

WWF suggest several practical methods to reduce CO<sub>2</sub> emissions from coal combustion. These include:

- improving coal quality;
- utilising more efficient technologies such as FBC, IGCC and supercritical boilers;
- carbon capture and storage.

They claim that the currently available clean coal technologies yield only a modest reduction in CO<sub>2</sub>. The two

proposed methods which are not yet commercially available but could produce much greater reductions are the use of 'ultra-clean' coal and carbon capture and storage. Ultra-clean coal is a solid fuel made from coal containing very little ash (1%), which can be directly fired in gas turbines. This technology is not a substitute for firing coal in conventional power stations. Even if the technology works it would be used as an alternative for heavy fuel oil and gas in gas turbines. Hence promoting ultra-clean coal as a means of improving conventional coal-fired plant is misleading. There are two methods of eliminating CO<sub>2</sub>, either collecting CO<sub>2</sub> after burning the coal or removing the CO<sub>2</sub> beforehand. The former method involves scrubbing flue gas and then reheating



**Figure 15 Cost of generating renewable electricity from different plant (Diesendorf, 2003)**

to produce high-purity CO<sub>2</sub>. Large energy requirements are required and, they claim, this technology is not commercial for power plant. Coal can be gasified to form pure CO<sub>2</sub>, which can be removed, and hydrogen. The hydrogen can be used in a fuel cell to generate electricity or to fuel a gas turbine. They claim that the method of generating hydrogen is not a clean process and that the methods of converting hydrogen to electricity are not commercial. As to the storage of CO<sub>2</sub>, three methods are feasible:

- 1 Underground storage – the injection of CO<sub>2</sub> into underground geological formations such as depleted oil and gas wells;
- 2 Ocean sequestration – the injection of CO<sub>2</sub> into deep and intermediate ocean waters;
- 3 Conversion and reuse – the conversion of CO<sub>2</sub> into another chemical compound. This option does not look promising as there is no market for such compounds.

The WWF report considers that of these options, underground storage will be technically possible within the next decade because of the existing geological and technical knowledge from the oil and gas industry. However, there are still unanswered questions over the volumes of CO<sub>2</sub> that can be safely stored, whether the storage will be secure, the gaps in scientific knowledge about the potential storage sites and the economic cost and the environmental impact of the storage sites. If old oil and gas fields are used, the security of CO<sub>2</sub> storage will depend on whether these fields have been damaged by the number of wells drilled into it and by the structural changes resulting from the extraction of the oil or gas. The main danger of storage is the danger of a large volume of CO<sub>2</sub> escaping into the atmosphere. This could not only affect the global and local environment, but the sudden presence of a large volume of CO<sub>2</sub>, which is heavier than air, could result in the asphyxiation of the local population. In Australia, itself, they suggest that the potential for CO<sub>2</sub> storage in deep unminable coal seams is very limited. Furthermore, the storage potential in Australian oil and gas fields is limited as these fields are not sufficiently depleted. This suggests that only saline aquifers are feasible in the next 30–40 years but these are not well understood scientifically. The report also quotes data from an International Energy

Agency study which compares the cost of CO<sub>2</sub>-free electricity from several sources. These data are shown in Figure 15. The costs quoted for coal-fired plant refer to new plant. It is expected that the costs of windpower will decrease in the near term. It is apparent that costs of renewable energy are cheaper than clean electricity from coal. They suggest that CO<sub>2</sub> storage will not be competitive with renewables unless it receives an economic benefit from enhanced oil or gas recovery or large economic subsidies. WWF considers that it would be a mistake for governments to continue to approve coal-fired power stations or to slow efforts to reduce their emissions in the hope that these emissions can be eliminated easily and quickly (Diesendorf, 2003).

In a report entitled *Towards Victoria's Clean Energy Future* for the Clean Energy Future Group in collaboration with Environment Victoria, the author suggests a plan to cut the state of Victoria's greenhouse gas emissions from electricity by 2010. The report claims that at present there are proposals to expand existing coal-fired generation by, for example, extending the life of the 1600 MWe Hazelwood plant, develop gas-fired generation such as Origin Energy's proposed plant at Mortlake and to develop renewable energy projects such as Pacific Hydro's Portland wind project. It is suggested that any decision to continue supporting coal-fired generation would lock the state into CO<sub>2</sub> emissions that would dwarf any proposed methods of reducing them. The report claims that cleaner energy sources could substitute coal-fired generation by a combination of realistic supply-side and demand-side initiatives by 2010. They claim that these measures would reduce Victoria's CO<sub>2</sub> emissions by 13.8 Mt/y. The proposed supply-side measures include wind power, bioenergy and either natural gas combined-cycle plant or reductions of coal generated electricity exports to other states. The policy measures required from the state government include:

- a greenhouse intensity limit on all new power plant and major refurbishment and life-extensions of old plant;
- either a carbon levy or a system of tradeable emission permits;
- the requirement that energy retailers submit renewable energy certificates as a licence condition.

The suggested demand-side measures include the extension of energy performance standards for new buildings, the substantial expansion of solar energy, the wide dissemination of 'smart' meters and peak load pricing and the provision of low-cost energy efficiency packages for householders. It is suggested that though the supply-side measures will increase the price of electricity, the demand-side measures will reduce usage thus keeping bills approximately constant (Diesendorf, 2005).

The Queensland Mining Council, the Australian Coal Association and the New South Wales Minerals Council have produced a report in the *Introduction to Australia's Minerals* series entitled *Coal in a Sustainable Future*. The report describes technical issues relating to coal extraction and use. The report acknowledges that burning fossil fuels, including coal, releases greenhouse gases into the atmosphere. However, the report states that the use of low-cost coal for the generation of electricity has brought many economic and social benefits. It has underpinned economic development since the industrial revolution and is now bringing social progress and raising living standards in the developing world where nearly two billion people have no access to electricity. They suggest that the challenge is to maintain the benefits society gains from coal-based electricity while significantly reducing greenhouse gas emissions. Examples of clean coal technologies which reduce greenhouse gas emissions include:

- reducing greenhouse emissions during mining by capturing methane and using it to provide power for the mine or transmitting it to the grid. Not only does this provide an additional source of energy but it also reduces safety risks associated with methane build-up;
- using advanced preparation and cleaning techniques to eliminate impurities from coal;
- employing new technologies to improve thermal efficiency. The use of supercritical and ultra-supercritical plant can increase the efficiency to 45% compared to an average efficiency of 38% for conventional plant. They claim that newer advanced materials could increase the efficiency to 55% in the future;
- incorporating pollution control devices in power stations to capture SO<sub>2</sub> and NO<sub>x</sub>;
- gasification of coal in commercial IGCC systems can achieve efficiencies close to 45%. With recent advances in gas turbine technologies it may be possible to achieve efficiencies over 50%. Another advantage of IGCC is that a concentrated stream of CO<sub>2</sub> can be produced which can be removed. In addition, hydrogen from coal gasification can be used to generate clean power in fuel cells or to run hydrogen-powered vehicles;
- capturing the CO<sub>2</sub> and permanently storing it underground (carbon sequestration) (Cook, 2003).

## 2.5 India

India has approximately 9% of world, proven, recoverable coal reserves. Coal provides about one-third of India's primary energy demand and 85% of fossil fuel consumed for electricity generation. Indian coal is generally low in sulphur but has a high ash content and low calorific value. The generation capacity in India is unable to meet demand and there is a peak

demand shortage of about 14%. Consumers even in major cities can be subjected to long power cuts. Hence, the major priority for both the government and the public is to increase capacity and though India is a vibrant democracy with many organisations strongly committed to the environment, there is little public concern about the increasing use of coal for power generation (Gopalakrishnan, 2005). A nationwide poll of 1452 Indians was conducted in November 2005 by the Indian polling organisation C-voter. The survey showed that 85% of those polled thought that global warming was an important threat, with 45% saying it was extremely important. Only 10% thought it was unimportant. Those polled rejected the view, expressed by the Indian government, that developing nations do not have a responsibility to limit their greenhouse gas emissions. Only 26% were of this opinion whereas 69% endorsed the position that all countries have a responsibility to make some efforts to limit emissions. Those with higher than average educational levels and income were somewhat keener to see India take steps to limit emissions ([www.worldpublicopinion.org](http://www.worldpublicopinion.org)).

Another survey has been conducted of the opinion of scientists and engineers (Pruthi and others, 1999). Over a thousand members of the Indian Science Congress Association were questioned. The questions first determined their awareness and understanding of issues relation to global climate change, sources of greenhouse gases (GHGs) and environmental consequences. Then the respondents were questioned on the environment and economic development and finally on local, national and international policies and strategies. The understanding of scientific terms by the respondents was determined by asking them to explain various scientific terms with three options. Over 75% gave correct descriptions to the terms 'global warming', 'greenhouse gases' and 'ozone hole'. These were followed by alternative energy sources (72%), El Niño (65.7%), acid rain (56.6%) and sustainable development (51%). The least understood terms were desertification (35%), eco-friendly technology (31.9%) and biodiversity (31%). To assess the knowledge of the respondents regarding the significance of different sources of greenhouse gases, a list of natural and man-made sources was supplied and the respondents were asked to name the two most probable sources of greenhouse gases. Regarding natural sources, more than 65% thought that forest fires were the most probable source followed by volcanoes (51.7%). Regarding man-made sources, the respondents perceptions of the order of importance was in the following descending order: automobiles (55.6%), fossil fuel burning (54%), coolants (27%), rice fields (14%), atomic power reactors (17.5%), oil spills (13%) and mining (9.7%). When asked what constitutes a greenhouse gas, 71% identified CO<sub>2</sub> as the most important gas. The other prominent sources which were identified were chlorofluorocarbons (59%), methane (49%), nitrous oxide (35%) and nitrogen dioxide (29%). To assess their understanding of the consequences of global warming, the respondents were asked to choose three from a list of eleven. Sea level rise was chosen as the most significant phenomenon by 62% of respondents. This was followed by melting of glaciers (52%), sinking of coastal areas (46%), climate changes (46%), loss of biodiversity (35%) and change in agricultural patterns (26%).

When asked whether they were willing to change their lifestyle to reduce climate change, 36.2% of respondents were willing to adopt a more frugal lifestyle, 24.7% had already adopted it, 22.8% were willing to try it out, 11.8% felt they could adopt with difficulty and 2.1% were not willing to change. When assessing the relative merits of protecting the environment and economic development, 87% of the respondents agreed with the statement 'Environmental protection and economic development can go side by side by selecting the appropriate technology'. A substantial percentage of 70% disagreed with the statement 'Priority should be given to economic development even if the environment is affected'; 63% disagreed with the statement 'Environment protection measures adopted by industry are generally effective in protecting the environment'; 57% disagreed with the statement 'Existing guidelines are adequate for industry to protect the environment'; and 55% disagreed with the statement 'Priority should be given to protecting the environment even at the cost of economic growth'. Regarding policies to reduce climate change, 79.5% of respondents agreed that industrial corporations should voluntarily take steps to reduce GHGs. A similar proportion (77%) felt that the thrust of national policy should be to promote international cooperation but 75% felt that India should take its own steps to protect the environment without waiting for the adoption of international codes. The specific proposals which had substantial support included encouraging R&D activities, adopting the 'polluter pays principle' and adopting domestic legislation for abatement of environmental pollution. The survey demonstrated that these respondents with a scientific background were quite familiar with various environmental terms. They correctly identified the main GHGs and singled out CO<sub>2</sub> as the major player. The respondents were overwhelmingly concerned about the environment and were personally prepared to adopt a frugal lifestyle. They were most concerned about the rise in sea levels and were of the view that Indian authorities should adopt the polluter pays to reduce emissions (Pruthi and others, 1999).

An alternative approach is advocated by the World Wildlife Fund-India Climate Change & Energy Programme. They are campaigning for Demand Side Management (DSM) to reduce power shortages in Delhi. They are asking regulators to direct utilities, as facilitated in the Electricity Act 2003, to implement DSM schemes. They suggest that by achieving efficiency improvements and strengthening transmission and distribution networks, it should be possible to save electricity and this is cheaper than building new plant. They voice the benefits of conserving electricity by, for example, residential light saving and the use of energy efficient appliances. Such optimal use of resources, they say, will help to reduce harmful impacts on fragile ecosystems and the environment (Rao, 2004)

## 2.6 Sri Lanka

The Sri Lankan power sector has faced considerable difficulties over many years. The daily demand is about 1600 MWe. Nearly half of this demand is met by hydro power (785 MWe) and the remainder by thermal, mainly

diesel. About 550 MWe of the thermal component is purchased by the Ceylon Electricity Board (CEB) from the private sector's emergency power supplies at high prices. Because of this, Sri Lanka has one of the highest power tariffs in the world but in spite of this, the CEB loses Sri Lankan Rs 30 M (\$0.3 million) per day. Sri Lankan consumers currently pay an average of 3.7 Rs/MWh (37 \$/MWh) whereas the cost of generating and delivering the energy is approximately 10.7 Rs/MWh (107 \$/MWh) (Power in Asia, 2005; Ladduwahetty, 2005). Severe problems can also arise under drought conditions when there is insufficient water in reservoirs supplying the hydro plants. There were severe power cuts in 2001 and 2002 for this reason. There have been on and off plans for over 20 years to construct a coal-fired power station both to increase generation capacity and to reduce the cost of generation. Sri Lanka does not contain any indigenous coal reserves hence coal for any coal-fired plant would have to be imported. The original plans were to construct the plant in Trincomalee, in the north-east of the country, which has Sri Lanka's most economically viable deep-water harbour. These plans met considerable environmental objections and hence were not realised. The plant was not to contain FGD but would have limited SO<sub>2</sub> emissions by firing low sulphur coal. These plans received severe criticisms from the environmental lobby as being insufficient to contain acid rain which could easily damage the tea estates in the central region and the archaeological sites located in the north-east. There were also concerns that the effluent cooling water would raise the temperature of the waters in the bay, on the shore of which the plant was located, by an unacceptable amount and decrease fish stocks (De Silva and Fernando, 1988).

More recently plans to build a 900 MWe coal-fired facility in Norochcholai in the Puttalam district in the north-west of the island have been proposed. These proposals too were subject to severe criticisms in the period 1998-2001 and the plan was halted by the President in 2001. Since then the plans have once more been revived. The objections were mainly environmental. The original plan was for a 4.2 km jetty to transport the coal from the ships to the shore. There were concerns that the pillars of the jetty would increase sea erosion and would increase the threat to the Holy Shrine at Talavila. These protest were lead by the Catholic Bishop of Chilaw. There were also fears that dust from the coal stockpile would cover a large acreage and would be harmful to devotees in open camps and to the shrine itself. Following these protests, the option of the jetty has been rejected and the present plan is to either use barges or to unload the coal at Trincomalee and transport it by road or rail. There are also concerns that the effluent cooling water would increase sea temperatures and affect marine life. Nearly 5000 families engage in fishing in the local area. The landfilling of fly ash and bottom ash and the possible seepage of pollutants into the water table could also have affected local agriculture. In spite of the ESPs, local farmers, who cultivate chilli, onion and other vegetables locally were concerned about the effect of fugitive fly ash emissions. However, the advantages of building a coal-fired plant are recognised. Coal remains one of the cheapest forms of energy. Other countries in the region, such as Malaysia and Thailand, which have built coal-fired plants have been able to achieve much higher

growth figures. Coal is always available and the price is much more stable than other fossil fuels. In spite of the objections the Government has once again given the go-ahead for this project. This is the result of the periodic power cuts affecting the general public and the high price of electricity making Sri Lankan exports less competitive. The project will be built with assistance of Chinese export credit support from the China National Machinery Import Export Corporation. The 300 MWe first phase of the project is estimate to cost \$460 million and is due to commence in 2006 and be completed in four years (Tissera, 2005; Ladduwahetty, 2005; Power in Asia, 2005).

## 2.7 Southeast Asia

Since the late 1990s, several countries in Southeast Asia have decided to increase the use of coal for power production as part of plans to develop balanced energy programmes using low-cost fuels. While most of these countries have some coal reserves, only Indonesia and Vietnam have sufficient reserves to supply export markets. Malaysia and the Philippines have small reserves but already import the bulk of their requirements. Thailand has had plans to implement a major coal-fired power construction programme, having already developed their indigenous lignite reserves in the 1980s. Over 80% of the coal consumed in this region is for power generation. The cement industry is the second largest consumer. In some countries, small quantities are used in briquette form for cooking (Hayes, 2004). Polling data for this region show that there is considerable concern about climate change. A poll conducted by GlobalScan Incorporated in late 2005/06 showed that the proportion of the population considering global warming to be a serious problem was 94% in South Korea, 86% in the Philippines, 81% in Indonesia and 80% in China. The proportions who did not consider it to be a serious problem were 4% in South Korea, 13% in the Philippines, 16% in Indonesia and 17% in China ([www.worldpublicopinion.org](http://www.worldpublicopinion.org)).

Those favouring the use of coal in this region stress that coal is not only a national commodity but also a transglobal commodity which provides low-cost electricity to a significant proportion of the world's energy consumers. The combination of established utilisation technologies, safety of use, abundance and availability from a range of reliable, low-cost suppliers such as Australia, mean that coal will continue to be an attractive option for power generation in this region for the foreseeable future (Bryant, 1998). However, it is recognised that coal can only play this key role if the environmental issues relating to coal are addressed and that it provides cost-effective energy while doing so. The types of clean coal technologies which will need to be incorporated include:

- coal beneficiation – the production of low ash coal through washing;
- coal blending – this can result in improved boiler performance and reduced emissions utilising a coal which is better tailored to the individual boiler;
- combustion – environmental emissions from coal combustion can be largely eliminated by FGD, NOx control and particulate control;

- use of new technologies – emerging new technologies such as IGCC can achieve greater efficiencies and reduce emissions;
- value added activities – activities such as the extraction of coal seam methane can add value and eliminate a by-product which is also a greenhouse gas.
- retrofitting existing plant – existing plant, particularly in developing nations can be dated and by updating these it is possible to improve performance and reduce emissions.

The author claims that Australia is well placed to facilitate CCT uptake in Asia as Australia has considerable experience in coal production and utilisation. Australia's involvement with organisations such as APEC (Asia-Pacific Economic Cooperation) has enabled it to share this expertise with other Asian countries. The Australian government has also employed a range of strategies to promote the uptake of CCT in Asia. These include funding of infrastructure studies, skills transfer through training, sponsoring visits by key decision makers. It is recognised, however, that there are a number of perceptions throughout the region which pose a threat to coal market developments. There are regional concerns which are prevalent across a number of countries on issues such as climate change and ash disposal. Local issues can also arise for example in Thailand, coal was seen very negatively following environmental incidents at the lignite-fuelled Mae Moh plant (Bryant 1998).

Greenpeace are campaigning against the use of coal for power generation in Asia (Baker and Horsman, 2005). They claim that as most of the world's developed economies rush to exploit renewable energy sources, coal-fired power generation is rapidly expanding in Asia. They claim that companies, mostly based in OECD countries which no longer have domestic markets for such dirty technologies, are exploiting the developing world. They state that the use of coal brings with it a host of environmental, human health and social costs which can be seen most clearly through the impact on poor communities in and around mines and coal-fired power plants. Coal mining has a direct impact on the environment, affecting the land, causing subsidence and producing mine wastes. Coal combustion, in addition to CO<sub>2</sub>, releases SO<sub>2</sub>, NOx, particulates and toxics. Though emissions of SO<sub>2</sub>, NOx, particulates and toxics have been decreasing in developed countries in recent years, many developing countries are experiencing rapid growth of energy-related pollution. Of the ten most polluted cities in the world, seven are found in China. SO<sub>2</sub> and soot emissions result in the formation of acid rain. Greenpeace claim that samples taken from the ash fields on the coal-fired power plants of Mirant-Toledo and Salcon-Naga in the Philippines indicated the presence of mercury and arsenic thus showing further evidence of serious toxic threats posed by coal power to communities and the environment. They suggest that the coal industry causes severe social impacts of displaced and disintegrated communities as well as losses in traditional livelihoods, local employment and way of life, such as small-scale agriculture and harvesting.

They claim that the notion of 'Clean Coal' is a myth. Though technologies exist to reduce SO<sub>2</sub> and NOx pollution, they are

unable to reduce CO<sub>2</sub> or mercury sufficiently. Furthermore even FGD technologies produce large amounts of wastewater and sludge that require disposal. Clean coal technologies only transfer pollutants from one waste stream to another; they are eventually all emitted into the environment. The money that is spent on clean coal research risks diverting funding from renewable energy research. The fact that clean coal technologies have failed to be a financially viable alternative to CCGT plant is demonstrated by the fact that the USA, Japan and Australia are increasingly turning to CCGTs while simultaneously promoting coal-fired plant in Asia. They report that the chief exporters of coal in Asia are Australia and China. Greenpeace suggests that Australia has rejected the Kyoto protocol to protect the vested interests of its coal industry exports to Asia. Indeed in 2002-03, 80% of Australian coal exports went to Asia. They suggest that transfer of coal technologies is funded through government backed financial institutions which provide the loans, insurance and guarantees which are needed to promote coal use in the developing world. These organisations include the World Bank, the Asian Development Bank (ADB) and Export Credit Agencies (ECAs). They acknowledge that the coal industry is spending considerable funds on geosequestration of CO<sub>2</sub> either on land or offshore. However, they claim that geosequestration involves a range of environmental, technological, social and economic risks. Regarding certainty and efficiency, it is far better to respond to climate change by not producing the CO<sub>2</sub> in the first place. Geosequestration is unlikely to be commercially available till 2030 and it will be prohibitively expensive to install on existing plant. Hence all the new coal-fired plants coming on stream over the next few decades will still be huge sources of CO<sub>2</sub>. They also doubt the efficacy of planting trees to reduce CO<sub>2</sub>. Though this will take up CO<sub>2</sub> in the short term, eventually it will be released into the atmosphere. Hence this option, at best, only postpones the problem, while making it worse in the long term. They conclude that only way to provide the necessary energy without further destabilising the climate or destroying the health, welfare and livelihoods of communities is by the rapid expansion of renewable energy sources such as wind, solar, micro-hydro, wave and biomass coupled with increasing energy efficiency and conservation (Baker and Horsman, 2005).

## 2.8 Thailand

Thailand's long-term power development programme calls for the construction of several IPP (Independent Power Producer) coal-fired plants to increase the nation's baseload capacity, having mainly relied on gas-fired plant to expand electricity production since the early 1980s. Gas-fired plants constitute about 75% of installed capacity. Hydroelectric schemes account for 12.6% and 10.6% is coal-fired generation from the 2400 MWe Mae Moh lignite-fired plant in Lampang province which fires lignite from the nearby Mae Moh mine. The Electricity Generating Authority of Thailand (EGAT) has plans to increase coal-fired generation substantially by the construction of three IPP plants with a total installed capacity of 3485 MWe. The first of the new coal-fired plants to start operation will be the 1346 MWe Map Ta Phut in Rayong province. The first 673 MWe unit is

due to commence in October 2006 and the second in February 2007 (Hayes, 2004, 2005). There have been public concerns in Thailand about coal-fired power generation. At the Mae Moh plant there have been concerns regarding SO<sub>2</sub> emissions, ambient air quality standards and the monitoring of ambient air quality. After two months of operation half the surrounding rice fields were damaged by acid rain. This resulted in the installation of FGD technology (Bitrakul, 2000).

The Map Ta Phut plant is being developed by BLC Power which is jointly owned by Banpu Power Limited and CLP (China Light and Power) Asia Limited. The plant will use coal imported from Indonesia and Australia. Greenpeace claim that this plant is a clear example of how public and private finance colludes with governments and transnational coal and power companies that operate with scant regard for the health of communities or the local or global environment. They suggest that the Coaltrans Thailand Conference was organised specifically to deepen the carbon addiction of the developing world and at the same time lobby governments, being unaware of the industry's agenda, by packaging the Map Ta Phut plant project as state-of-art, clean coal technology. The Coaltrans meeting became the scene of protests organised by People Against Coal, which is a national network of affected communities, local activists and environmental groups in Thailand who are demanding that the government and coal industry should stop expanding coal usage and switch to renewable energy (Greenpeace, 2005). BLCP claim that their policy is to live harmoniously with the surrounding community and offer a win-win solution to all members of the community. The Environmental Impact Assessment (EIA) was approved subject to public consultation requirement and the setting up of a Tripartite and EIA monitoring committee. Hence, in 2002, BLCP conducted a public opinion survey and in the same year set up a EIA monitoring committee. They claim to have made considerable efforts to encourage the local community to have a more positive perception and acceptance of coal-fired plant. They have organised over 100 visits for nearly 2000 people to a nearby power plant to help them understand more about the operation of the power plant and the benefits it brings to society. The Tripartite Committee has held 11 meetings involving 455 participants. The Monitoring Committee has held 11 meetings involving 276 participants and the EIA Audit Committee has held 11 meetings involving 139 participants. BLCP has implemented a project through which fly ash has been utilised to produce over 300,000 environmentally-friendly cement blocks. BLCP is also investigating whether bottom ash has agricultural uses locally. Marine cultivation is also a priority and has involved the cultivation of one million small shrimps, one million small blue crabs and 20,000 small fish. BLCP actively sponsors educational, religious and cultural events in the region (Tantitham, 2005).

The other two IPP projects that were proposed were the 734 MWe Bor Nok plant and the 1400 MWe Hin Krut plant. Both were to be located on coastal sites on Thailand's southern seaboard in the Prachuab Kiri Khan province. The Bor Nok scheme was to be developed by Gulf Power Generation Co and the Hin Krut by Union Power

Development Co. Both proposals met with considerable local opposition. The public concerns about Bor Nok included the impacts on fishing due to the construction of the jetty, the reduction of young aquatic organisms and plankton due to the intake of seawater and the discharge of heated cooling water and concerns regarding air pollution. The discharged water could also affect whales, dolphins and rare water birds. There were additional concerns relating to coal storage and ash disposal. The plant would emit massive amounts of greenhouse gases. There were complaints that there was insufficient public participation on the impact on the local community. It was said that public hearings were held without the attendance of protesting villagers or the Bor Nok Sub-District Administration Organisation (SAO). The great majority of the SAO were against the project. There were concerns that the plant would damage the local communities' means of livelihood, in particular fishing and agriculture. There were complaints that the Environmental Impact Assessment (EIA) only made a brief mention of the nearby Sam Roi National Park. It had not sufficiently researched bird species or the intricate ecology of the wetland. The EIA even claimed that acid rain would not have been a problem as it would have been neutralised by the alkali-rich wetland water. Measurements showed, however, that the wetland was, in fact, slightly acidic. Furthermore the EIA did not consider whales and dolphins and underestimated the effect on local fishing activities. In January 2002, thousands of people gathered at the village to protest when the Thai Prime Minister visited the village (Bitrakul, 2000; ECA Watch, 2002). The complaints at Hin Krut were similar namely, effects on fishery, air pollution, acid rain, cooling water discharges, coal storage, ash disposal, social impacts and community conflicts. Flaws were identified in the EIA such as the underestimation of the number of fish species and fishing households affected and the lack of public participation. These public protests coincided with an economic downturn in Thailand hence the Thai government decided to mothball the project. But both projects have been revived more recently and Bor Nok is due for completion in 2007 and Hin Krut in 2008 (Hayes, 2005).

## 2.9 Philippines

The majority of the coal produced in the Philippines is subbituminous coal mined from Semirara Coal Corporation's open-mining operations on the island of Semirara. About 90% of this is used for power generation and the rest for cement production. Coal presently accounts for 28.6% of electricity generation followed by gas (25.8%), geothermal (19.1%), hydroelectric (15.3%) and oil (11.2%). Currently a 232 MWe plant is being developed on the island of Mindanao. This is due to be in commercial operation at the end of 2006. There has been controversy about the viability of the plant and the means by which it was approved (Modern Power Systems, 2002). There are a number of other medium-sized coal-fired plants due for construction in the next five years. Three with a combined capacity of 500 MWe were to be minemouth plants on Semirama island. Two plants totalling 240 MWe were to be built in northern Luzon burning low quality coal and two at Isabella in Luzon burning local lignite with a further 120 MWe plant at Surigoya. The

construction of many of these projects has been slowed or halted by intense environmental opposition (Ewart, 2004; Hayes, 2005).

The World Wildlife Fund (WWF) has mounted a major campaign named PowerSwitch against the use of coal to generate electricity in the Philippines. They claim that the use of coal pollutes air, aggravates asthma, causes children to have smaller and less efficient lungs, causes lesions and scars in lungs resulting in lung cancer, contributes to acid rain, produces mountains of ash which poisons aquatic life and produces by-products which contain radioactive materials. They claim that 50% of global mercury emissions come from fossil power plants in Asia. They state that following severe power shortages in the 1990s, the Philippines government invited foreign-owned IPPs to develop fossil-fuelled power plants. However, when the Asian business crisis hit in 1997, the government's energy forecast turned out to be exaggerated and the country's reserve capacity, at over 50%, is excessive. However, the consumer still has to pay for these unused plants resulting in excessively high bills. Comparing the country's energy mix from 1991 to 2001, the share of dirty energy (coal and oil) increased from 57.5% to 62.7% and the share of clean energy has decreased from 42.5% to 37.3%. According to the Philippines Department of Energy's current forecasts, coal's share of electricity generation will increase from the current 34% to 50% by 2012. PowerSwitch suggest that there is considerable scope to increase the use of renewable energy. Though the current capacity of geothermal power is 1931 MWe, a further 1200 MWe remains untapped. An analysis of small-scale (5–10 MWe) schemes has shown the potential for 236 further sites with the possible installed capacity of 2308 MWe. Philippines has considerable natural gas reserves. WWF views natural gas as a transitional fuel. While it is not renewable, it is significantly cleaner than coal. Considering wind power, according to an analysis by the National Renewable Energy Laboratory, there are 1038 sites with a power density of at least 500 W/m<sup>2</sup> with a potential capacity of 7404 MWe. The PowerSwitch campaign suggests that by fully utilising these renewable options and having realistic economic growth forecasts, it should be possible to increase the renewable share of energy from 37% to 41%, to increase the natural gas share from 24% to 31% and decrease the coal share from 37% to 26% by 2012.

During the recent Clean Fossil Energy seminar of APEC (Asia Pacific Economic Cooperation) in Cebu, thousands of Filipinos and local environmental groups demanded the end of the promotion of coal and a switch to renewable energy. Coal power was perceived as major threat to the environment, people's health and their livelihood. The preferred alternatives were renewable sources, such as wind power, solar energy and biomass. Local protests lead to the rejection of plans to build a 100 MWe, coal-fired power plant in the province of Iloilo in Panay island. The objectors claimed that the proposed plant risked polluting Benate Bay in the Visayan Sea, which contains one of the biggest and most productive fishing grounds in the country. The project was also rejected because the developer and the local government failed to consult stakeholders during the process leading to the signing of the memorandum of understanding (World Wildlife Fund, 2003, 2004 and 2005).

### 3 Conclusions

The global use of coal for power generation continues to increase and nearly 40% of electrical power worldwide is supplied by coal-fired plant. Public attitudes to coal-fired power plants or indeed any source of energy are important in shaping government policies. Such attitudes are also important in determining whether new coal-fired projects can go ahead. Concerns about acid rain in the 1970s and 80s compelled many governments to legislate to limit SO<sub>2</sub> and NO<sub>x</sub> emissions from power plant. The rapid reduction in the growth of nuclear power in the 1980s and 90s was due to public concerns regarding accidental leaks of radiation from nuclear plant and issues relating to disposal of nuclear waste. Coal remains the world's most abundant, safe and secure form of energy but the public's perception of coal-fired plant is not always favourable. Many of the environmental concerns regarding coal-fired plant focus on emissions such as SO<sub>2</sub> and NO<sub>x</sub> emissions, mercury emissions, particulates and ash disposal. However, the greatest concerns are those relating to CO<sub>2</sub> emissions leading to the greenhouse effect. Opposition to coal-fired plant is generally on these factors rather than on the design or layout of the plant. To gain full public acceptance, in the longer term, it will be necessary to install coal-fired plants with very low levels of environmental emissions as well as ongoing education about role of coal in energy production.

In the USA, over half of electricity generated comes from domestic coal and there has been a renewed interest in building new coal-fired projects in the new century, largely due to the spiralling cost of natural gas and reasons relating to the security of supply. The available opinion poll data suggest that the environment is not a major priority for the US public and global warming has not been a major concern for those concerned about the environment in the recent past. However, this may change in the future following Hurricane Katrina and the devastation of New Orleans and the latest poll data confirm that global warming is being viewed with greater concern by the American public. There is considerable support for research into new energy sources but very little for cleaner burning of coal. There is considerable concern among the public about the US dependence on imported oil. According to poll data, there was substantially more support for a solution involving the automotive industry manufacturing more fuel efficient cars than building more coal-fired power stations.

The US public are not fully aware that the majority of their electricity is produced from coal as a recent poll showed that only a third of the population knew that coal was an important source of electricity. However, there are increasing levels of support for the use of coal to generate electricity and even in California, the level of opposition to the construction of new coal-fired plant is less now than in the 1970s and 80s. The renewed interest in coal-fired plant has inevitably met some public opposition. The opposition is mainly on health and environmental grounds. The opponents also cite the superior environmental performance and potential climate friendliness of gas-fired power plant and

IGCC technology. The construction of a greenfield power plant in the USA is subject to New Source Review and if the plant is located in an attainment area, it will require Prevention of Significant Deterioration permitting. As part of this, the applicant has to undertake adequate public participation. It has been suggested that among the steps which can help to ensure that public meetings present the relevant information about the new project without stalling progress on the project, include ensuring that the regulatory agency has no reservations regarding the permit application and educating the public beforehand about the positive aspects of the plant.

The organisations in the USA which campaign against coal-fired plant concentrate mainly on health and environmental issues. They claim that asthma attacks, respiratory disease, heart attacks and premature deaths are among the serious health problems caused by air pollution from the electric power sector. They further claim that the sector causes damage to water both as large users and polluters. In particular areas they claim that landfilling power plant waste has polluted aquifers. They claim that US power plants are the largest source of mercury in the USA and several hundred thousand new born babies have unsafe levels of mercury in their blood. The organisations campaigning in favour of coal emphasise that it is a secure source of energy in that it is available domestically and should last several hundred years. It is used to generate more than half the electricity produced in the States. They state that since the 1970s considerable sums have been invested in emission control technologies and that though coal use has doubled, emissions of major pollutants have decreased by over a third. They also refute some of the health concerns by saying that in recent years dramatic improvements in air quality have taken place and that US utilities are responsible for only 1% of mercury emitted into the air. As to global warming they claim that there is still debate as to which increasing levels of CO<sub>2</sub> are due to natural variations or man-made. They suggest that sequestration is the answer and that natural carbon reservoirs can be used to store carbon effectively.

Currently in Europe, nuclear power is the largest source of electricity in the region, supplying nearly a third of demand. A quarter of electricity generated comes from coal, 16% from gas and 6% from oil. The European Commission has undertaken a major survey to analyse the attitudes of the citizens of the European Union towards energy and energy technology issues. When asked to what extent fuels were used to produce energy in their country, the average answers given by Europeans was in reasonable agreement with the actual situation. However, except in cases where a very significant amount of energy came from a particular source, there was a lack of awareness of the sources of energy in that country. Nearly half of people sampled knew that the statement 'More than half the electricity used in the EU comes from coal' was false. Over half the respondents knew correctly that more than quarter of electricity produced in the Europe comes from nuclear power. The results demonstrated

that Europeans agreed by a wide margin that global warming was a serious issue. They also accept by almost as wide a margin that the use of fossil fuels contributed significantly to global warming. This was very different from the situation in the USA. These data show that a significant proportion of Europeans thought that energy dependency was an urgent issue though the proportion thinking that energy imports from outside the EU should be reduced was lower. When asked about their priorities regarding energy, it was apparent that the protection of the environment was the most important, followed by low prices and ensuring the security of supply was least important. This was again different from the priorities in the USA. Europeans gave high priority to renewable energy and there was overwhelming support for energy-related research. However, Greenpeace claim that in spite of the public's desire for research and development of renewable energy, much of the existing support is directed at the nuclear and fossil fuel industries. The umbrella organisation representing the European coal industry is EURACOAL. They stress that an energy mix without coal is unimaginable in the EU as coal accounts for 25% of the EU's electricity supplies. It is also indispensable for steel production and other energy-intensive industries. As coal is the only significant indigenous energy source in the EU, it guarantees a degree of independence in energy policy and ensures the security of supply. Coal does not require a strategic reserve as a safeguard against political risks as has been proposed for oil and gas. The production and consumption of coal also provide added value by generating employment in many parts of the EU. New materials and improved technical processes result in higher efficiency levels from more advanced coal-fired power plant and plant efficiencies of coal-fired plant approaching 45% are feasible today. They claim that if all the coal-fired plants worldwide were to be refurbished to meet current EU standards, this would save half the CO<sub>2</sub> emitted by the EU. In the longer term there is considerable potential in the capture and sequestration of CO<sub>2</sub>. These arguments are similar to those made in favour of coal in the USA.

In the UK, there has been a considerable increase in the use of natural gas for power generation since the late 1990s and, in 2003, natural gas generated 37% of UK's electricity, followed by coal (36%), nuclear (23%), biomass (1.6%), oil (1.5%) and hydro (1.2%). The UK has ratified the Kyoto Protocol. When in an opinion survey UK respondents were asked to choose the three most important issues facing the UK from a list of 25, 13% chose the environment as one of their three top concerns which was the eighth top concern. The survey then asked respondents to name the top two environmental concerns facing the UK and global warming was, by far, the most important concern with nearly half the respondents listing it as one of their top two choices. When asked to choose their preference to protecting the environment or maintaining the economy, the largest percentage thought both were important but that the environment should take precedence. Over half the respondents considered that research into new energy sources was a top priority for the DTI. In a separate survey to determine the public's understanding of carbon sequestration or carbon capture and storage, it was apparent that very few people had either heard or read about either carbon capture or storage or carbon

sequestration. When the respondents were asked which technologies they would use to address global warming the respondents strongly supported the use of bioenergy/biomass, carbon sequestration (defined in this case as the use of trees to absorb CO<sub>2</sub>), solar energy, wind energy and energy efficient appliances and cars. These views are more in line with those expressed in Europe than those in the USA.

Organisations in the UK which campaign for the environment frequently criticise the operation of existing coal-fired power plants. Friends of the Earth claim that coal-fired power plants in the UK are responsible for 27% of UK CO<sub>2</sub> emissions and are the single biggest source of CO<sub>2</sub>. They claim that coal-fired power plants emit up to three times as much CO<sub>2</sub> per unit of output as modern gas plant, that there is no way of extracting this CO<sub>2</sub> and the only way to reduce emissions is to burn less coal. They suggest that there is considerable scope for reducing energy demand by having smaller power plants distributed more widely in the country. Homes and businesses can also reduce demand by preventing energy losses and purchasing more efficient appliances. They also propose increased use of combined heat and power. Friends of the Earth support the development of a limited number of coal gasification plants close to deep mine coal-fields provided that emissions can be shown to be as low as from existing gas-fired plant. Organisations based in the UK which campaign on behalf of the coal industry emphasise that coal has long been and will remain one of society's most secure forms of energy offering many advantages. Coal reserves worldwide are large and will be available for the foreseeable future without raising geopolitical or safety issues. Coal reserves are significantly more abundant and more widely and evenly dispersed than other fossil fuels. It is an affordable fuel and coal prices have been lower and more stable than oil or gas. Coal is a safe and stable product to transport. Coal can easily be stockpiled at power stations and these stocks can be drawn to meet demand without depending on primary supply. Almost 40% of global electricity is generated from coal and coal-based power is well-established and reliable. They suggest that clean coal technologies represent a developing range of options to meet coal's environmental challenges. These arguments are similar to those made in the USA and elsewhere. UK power plants have in recent years made considerable efforts to involve the local community. The activities include supporting a wide range of community groups and charities through their charitable giving programme and their employee volunteer schemes. They also offer guided tours of power plant for interested parties to foster a greater understanding of power generation and their care for the environment.

Australia has some of the most extensive coal reserves in the world. In 2003, coal accounted for 43% of Australia's total primary energy supply and 77% of electricity generation. Australia has signed the Kyoto protocol but has not ratified it. The Australian branch of the World Wildlife Fund and Greenpeace are amongst the organisations campaigning against the use of coal in Australia. WWF claims that the 24 coal-fired power stations in Australia are the largest source of greenhouse gases in the country amounting to one-third of Australia's greenhouse emissions. According to WWF, most Australians are unaware of the central role of coal in

generating Australia's electricity and its major role in causing global warming. They quote a recent survey which found that only 33% of people surveyed knew that coal was the main fuel for producing electricity. Another survey showed that only 4% of respondents thought that the electricity sector was primarily responsible for causing long term changes to the earth's climate. They further claim that in the period 1990-99, both coal consumption and greenhouse gas emissions have increased in Australia at a rate faster than in other OECD countries, even more so than in the USA. Amongst the practical methods suggested by WWF to reduce CO<sub>2</sub> emissions from coal combustion include improving coal quality, utilising more efficient technologies such as FBC, IGCC and supercritical boilers and carbon capture and storage. However, considering underground storage, there are still many unanswered questions. Environmental groups also oppose proposals to expand existing coal-fired generation, for example, extending the life of the 1600 MWe Hazelwood plant. It is suggested that any decision to continue supporting coal-fired generation would lock the state of Victoria into CO<sub>2</sub> emissions that would dwarf any proposed methods of reducing them. They claim that cleaner energy sources could substitute coal-fired generation by a combination of realistic supply-side and demand-side initiatives by 2010.

Organisations representing the coal industry acknowledge that burning fossil fuels, including coal, releases greenhouse gases into the atmosphere. However, they suggest that the use of low-cost coal for the generation of electricity has brought many economic and social benefits. It has underpinned economic development since the industrial revolution and is now bringing social progress and raising living standards in the developing world where nearly two billion people have no access to electricity. They suggest that the challenge is to maintain the benefits society gains from coal-based electricity while significantly reducing greenhouse gas emissions. This can be accomplished by clean coal technologies.

India has approximately 9% of world, proven, recoverable coal reserves. Coal provides about one-third of India's primary energy demand and 85% of fossil fuel consumed for electricity generation. The generation capacity in India is unable to meet demand and there is a peak demand shortage of about 14%. Consumers even in major cities can be subjected to long power cuts. Hence, the major priority for both the government and the public is to increase capacity and though India is a vibrant democracy with many organisations strongly committed to the environment, there is little public concern about the increasing use of coal for power generation. A nationwide poll conducted in 2005 showed that 85% of those polled thought that global warming was an important threat and only 10% thought it was unimportant. Those polled rejected the view, expressed by the Indian government, that developing nations do not have a responsibility to limit their greenhouse gas emissions. A survey of Indian scientists and engineers demonstrated that those respondents with a scientific background were quite familiar with various environmental terms. They correctly identified the main GHGs and singled out CO<sub>2</sub> as the major player. The respondents were overwhelmingly concerned about the environment and were personally prepared to adopt a frugal lifestyle. They were most concerned about the rise in

sea levels and were of the view that Indian authorities should adopt the polluter pays principle to reduce emissions.

The Sri Lankan power sector has faced considerable difficulties over many years. The daily demand is about 1600 MWe. Nearly half of this demand is met by hydro power and the remainder by thermal, mainly diesel. About 550 MWe of the thermal component is purchased by the Ceylon Electricity Board (CEB) from the private sector's emergency power supplies at high prices. Because of this Sri Lanka has one of the highest power tariffs in the world. Severe problems can also arise under drought conditions when there is insufficient water in reservoirs supplying the hydro plants. There were severe power cuts in 2001 and 2002 for this reason. There have been on and off plans for over 20 years to construct a coal-fired power station both to increase generation capacity and to reduce the cost of generation. The original plans were to construct the plant in Trincomalee, in the north-east of the country, which has Sri Lanka's most economically viable deep-water harbour. These plans met considerable environmental objections and were hence not realised. More recently plans to build a 900 MWe coal-fired facility in Norochcholai in the north-west of the island have been proposed. These proposals too were subject to severe criticisms in the period 1998-2001 and the plan was halted by the President in 2001. Since then the plans have once more been revived. The objections were mainly environmental. There were concerns regarding the building of a jetty to transport the coal from the ships to the shore. There were also fears about dust from the coal stockpile and that the effluent cooling water would increase sea temperatures and affect marine life. The landfilling of fly ash and bottom ash and the possible seepage of pollutants into the water table could also have affected local agriculture. In spite of the objections, the Government has once again given the go-ahead for this project. This is the result of the periodic power cuts affecting the general public and the high price of electricity making Sri Lankan exports less competitive.

Thailand's long-term power development programme calls for the construction of several IPP coal-fired plants to increase the nation's baseload capacity, having mainly relied on gas-fired plants to expand electricity production since the early 1980s. The first of the new coal-fired plants to start operation will be the 1346 MWe Map Ta Phut plant in Rayong province. Organisations opposing this plant claim that this plant is a clear example of how public and private finance colludes with governments and transnational coal and power companies that operate with scant regard for the health of communities or the local or global environment. They further demand that the government and coal industry should stop expanding coal usage and switch to renewable energy. The plant operators claim to have made considerable efforts to encourage the local community to have a more positive perception and acceptance of coal-fired plant such as conducting a public opinion survey and setting up a EIA monitoring committee. The other two IPP projects that were proposed were the 734 MWe Bor Nok plant and the 1400 MWe Hin Krut plant. There were complaints at both plants regarding the effects on fishery, air pollution, acid rain, cooling water discharges, coal storage, ash disposal, social impacts and community conflicts. These public protests

coincided with an economic downturn in Thailand hence the Thai government decided to mothball the project. But both projects have been revived more recently and Bor Nok is due for completion in 2007 and Hin Krut in 2008.

The majority of the coal produced in the Philippines is subbituminous coal mined in open-mining operations on the island of Semirara. About 90% of this coal is used for power generation and the rest for cement production. Currently a 232 MWe coal-fired plant is being developed on the island of Mindanao. This is due to be in commercial operation at the end of 2006. There are a number of other medium-sized coal-fired plant due for construction in the next five years. However, the construction of many of these projects has been slowed or halted by intense environmental opposition. Those opposing coal-fired plant claim that the use of coal pollutes air, harms human health, contributes to acid rain, produces mountains of ash which poisons aquatic life and produces by-products which contain radioactive materials. The World Wildlife Fund claim that 50% of global mercury emissions come from fossil power plants in Asia. They suggest that, when the Asian business crisis hit in 1997, the government's energy forecast turned out to be exaggerated and the country's reserve capacity at over 50% is excessive. However, the consumer still has to pay for these unused plants resulting in excessively high bills. They claim that there is considerable scope to increase the use of renewable energy, as the current capacity of geothermal power is 1931 MWe but a further 1200 MWe remains untapped. There have been demonstrations in which thousands of Filipinos and local environmental groups have demanded the end of the promotion of coal and a switch to renewable energy.

The available poll data indicate that the public's knowledge of the importance of coal for power generation varies considerably from country to country. Opposition in some countries to coal-fired plant is due to concerns on human health whereas in others it is due to environmental concerns, particularly global warming. Even organisations opposing conventional coal-fired plant are sometimes supportive of coal gasification technologies. In developing nations having severe power shortages such as India and Sri Lanka, even though there are concerns regarding coal-fired plant, there is little outright opposition. In those countries which have reasonably adequate power supply, such as Thailand and the Philippines, there can be more vociferous opposition to further plant construction. Even though the proponents of coal-fired plant emphasise issues such as availability, security of supply, cost and reductions in major pollutants in recent years, the concerns regarding global warming are so overwhelming, that widespread public acceptance is unlikely to be achieved till technologies are available to enable a large-scale, economically-viable, coal plant to operate with low CO<sub>2</sub> emissions. More efforts are required to make the general public more aware of the vital role coal plays in generating electricity globally, the dramatic reductions in some environmental emissions from coal-fired plant in recent years and the potential to reduce CO<sub>2</sub> emissions considerably in the future. Currently such information is presented in journals, conferences etc. but it would be very useful if this information was also conveyed in newspapers, news broadcasts, the internet and documentaries on television

which are more likely to be seen directly by the general public.

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