ENERGY & SUSTAINABLE DEVELOPMENT

BY ROBERT PRIDDLE

Finding an environmentally sustainable way of producing and using energy is the only way in which we can count on a secure energy future. Failure to respond to society's concerns about energy and the natural environment would put at risk the continued, reliable supply of energy on which our economies depend.

To speak of energy in the context of sustainable development introduces the social dimension. Not only must energy production and use be compatible with society's environmental priorities, it must also be organized in such a way as to support the social consensus which binds us together.

Sustainable development is an over-arching theme today of the work of the Organization of Economic Co-operation and Development (OECD), to which the International Energy Agency (IEA) is affiliated. *(See box, next page.)* It finds concrete expression in work on climate change — both the OECD and the IEA contributed to the conference in November 1998 of the Parties to the UN Framework Convention on Climate Change in Buenos Aires — on sustainability indicators, on technological development and on the environmental impact of subsidies. A major report on these and other aspects of sustainable development will be delivered to OECD Ministers in the year 2001.

It is worth pausing for a moment to consider what is meant by sustainable development. If you consult the founding articles of the OECD, you will find that even then, in 1960, there was reference to the pursuit of economic development on a sustainable basis. But the use of words evolves over time. What the founding fathers of the OECD had in mind was economic development which could be sustained indefinitely without over-heating the economy, avoiding a cyclical pattern of boom and bust. Sustainable development today means more than that: such sustained development, certainly, but also development which does not unacceptably draw down our environmental or social capital, or impose disproportionate burdens on future generaions.

That is an enriched definition. It captures, for example, the sense of our responsibility, today, to take prudent action to diminish the risk of future climate change, which found political expression in the Kyoto protocol last year. But in our enthusiasm to capture these new nuances, let us not forget one thing. Continued economic development is an essential part of the equation. And a secure, economic supply of energy is essential to economic growth.

CLIMATE CHANGE IN LIBERALIZED MARKETS

At their summit, the G-8 leaders issued a statement expressing their commitment "to encourage the development of energy markets". They also declared that "the greatest environmental threat to our future prosperity remains climate change [and] we confirm our determination to address it".

The first of those commitments reflects concern with efficiency in energy supply in a globalized economy, to underpin vigorous economic activity. The second reflects the growing perception of the menace of climate change. There are clearly potential tensions between these concerns. Let us consider how they might work out in practice.

Governments' perceptions as to how best to secure energy supplies at acceptable prices have been transformed in

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recent years. Whereas the strategic importance of energy was once assumed to lead naturally to public ownership and state monopoly, energy is now widely regarded as a service best delivered in a competitive market. There is less government intervention, whether through regulation or ownership.

Private sector investors from all over the world are being encouraged to participate in energy infrastructure projects and competition is being introduced into projects previously regarded as natural monopolies. For example, sixteen countries in the OECD now have systems which provide effective third party access to the electricity grid and a wholesale electricity pool system — the hallmarks of a competitive market.

If expectations are fulfilled — and, so far, the signs are good — competition will stimulate innovation, increase productivity, improve resource allocation and encourage more efficient fuel conversion in the energy supply system. In short, there will be efficiency improvements; and greater efficiency should mean lower prices to end users.

Clearly, greater efficiency in fuel use in the energy supply system is in the interest both of the economy and the environment.

Lower prices however, may discourage efficiency in end-use. Wasteful use of energy is clearly not compatible with environmental objectives. If fossil fuel is the primary fuel in question, there is a particular conflict with the objective of curtailing greenhouse gas emissions.

THE INTERNATIONAL ENERGY AGENCY

Not to be confused with the Vienna-based International *Atomic Energy* Agency (IAEA), the Paris-based International Energy Agency (IEA) was set up in 1974 to focus on issues of energy security, especially oil security. Today, the organization is equally concerned with the question of how production and use of energy can be satisfactorily reconciled with the preservation of our natural environment. This transition represents an evolution in the expression of its objectives, but not a fundamental change. The IEA prepares and publishes a wide range of reports, studies, and publications on energy issues of importance to its member countries.

The IEA is part of the Organization for Economic Cooperation and Development, also based in Paris. More information about the IEA is available over its Internet site at http://www.iea.org. The mailing address is 9, rue de la Fédération, 75739 Paris Cedex 15, France. Telephone: +33-1-4057-6554. Facsimile: +33-1-4057-6559.

What this illustrates is that, though free and open markets do some things very well, one thing they do not do well is deliver benefits which are not valued in the market. Economists call these externalities. Climate change is one such externality. The benefits of avoiding global warming, though large, come largely in the form of *problems avoided*, rather than *marketable commodities created.*

That is why governments have had to step in, in Kyoto, to make political commitments, which they now have to realize through policy instruments. In liberalized markets, the instruments available to governments are more limited than before. They cannot, for example, direct company fuel choice as, in many cases, they could when those companies were state-owned. A range of market-compatible instruments nonetheless remains available, such as tradeable permits or taxes; and direct regulation is still an option too, provided it is applied uniformly across the market, e.g. in setting insulation standards for new buildings.

CARBON-FREE FUELS

One of the options open for tackling the greenhouse gas problem is to encourage substitution of carbon-free fuels for conventional fossil fuels. I shall consider two such forms of fossil-free energy, which have sharply contrasting environmental reputations, renewable energy and nuclear energy. There is a tendency to over-simplify, regarding renewables as always "good" and nuclear energy as always "bad". The reality is more complex.

Renewables. Let us consider renewable energy first. The first thing to say about this form of energy is that we know a lot about renewable energy -—more than you might think — simply because it is already so widely used. Of the world's primary energy requirement for electricity

production, over 20% comes in the form of renewables. If biomass is included, 18% of total world energy demand is met by renewables. Globally, final consumption of biomass is roughly equivalent to consumption of coal or gas. Many governments have high expectations of the sector — Italy, for example, promotes the use and development of renewables in support of the central policy objectives of developing indigenous resources and protecting the environment. Most IEA governments support renewables in one way or another — through research and development, subsidies, tax exemptions, premium prices, purchase obligations on utilities, and so on.

The present contribution of renewables to electricity supply comes mainly from hydro-electric plants; but the new renewables are growing fast, faster than any other method of electricity generation.

The global installed capacity of wind turbines doubled between 1990 and 1995; the annual production of photovoltaics is doubling every five years. The World Energy Council has a scenario in which 45% of electricity is produced from renewables in the year 2020. Shell (Oil Company) has a scenario in which renewable energy predominates worldwide, not just in electricity production but in alternative fuel forms too, by the middle of the 21st century.

Many environmental benefits are foreseen from such an energy future. By displacing fossil fuels, renewables already save 1500 million tons of carbon dioxide emissions every year, some 7% of energy-related $C0_2$ emissions. By 2020, one World Energy Council scenario raises this figure to 9000 million tons, 40% of the present level of all energy-related $C0_2$ emissions. There are advantages, too, in reduced emissions of sulphur dioxide and nitrogen oxides.

And it doesn't stop there. Renewables can also bring benefits in terms of improved water supply, land reclamation and employment opportunities in rural areas. It is no surprise that the European Commission has called for adoption of a target of doubling the share of renewables in total energy consumption in EU member states in 2010, from 6% to 12%.

The title of a recent International Energy Agency publication, *Benign Energy? The Environmental Implications of Renewables*, appears to echo this high expectation. But our title has a subtle difference. There is a question mark after the words "Benign Energy?". What is it that we are questioning?

We are questioning the glib assumption that renewables are all good for the environment and fossil fuels all bad. Not denying the benefits, but taking a cool look at the picture in the round. For renewables are not without their environmental disadvantages. One needs to look at the life-cycle impact, not just the environmental effects of annual operations. This means looking at renewables — and other energy forms — in terms of the impact at all stages, from resource extraction, transportation, materials processing, component manufacture and so on, right through to plant decommissioning and product disposal.

For renewables, gaseous emissions from all stages other than operation are equivalent to, or greater than, those arising from the same stages of the life-cycle of conventional generating technologies. This is because renewables convert "dilute" sources of energy compared to the concentrated fossil fuels and uranium used in conventional generating systems. The collection of these dilute sources and their conversion to useful energy generally requires more machinery and larger structures per unit of electricity produced. These, in turn, require more energy in their manufacture and construction.

Nonetheless, after taking account of all these factors, gaseous emissions from renewables are small compared to those from the fossil-fuelled plant they displace. The ratio is, typically, 1:10. It can be 1:100. But it can also be much less. The life-cycle advantage of solar photovoltaics over a gas-fired, combined cycle gas turbine, in terms of $C0_2$ emitted per kilowatt-hour of electricity produced, is of the order of 3:1.

There are other hazards in making comparisons. Electric vehicles have zero gaseous emissions at the point of use, which is certainly good news for urban air quality. But if the electric power required was originally generated from a conventional mix of fossil fuels, the overall CO_2 emissions from electrically powered vehicles are

approximately the same as those from petrol vehicles, while sulphur dioxide emissions may well be higher.

And there are significant environmental impacts beyond gaseous emisisons. We are all familiar with the controversy which surrounds any large-scale hydro-electric project, in terms of population displacement, loss of habitat, change to the water table and so on. Some of the materials used in the production of photovoltaic cells are toxic and hazardous. Geothermal operations can release heavy metals which may leach into groundwater. To produce electricity from energy crops requires well over 100 times the land area required to produce the same electricity from coal. Wind farms have an undesirable visual impact in the eyes of some, can generate irritating noise, and interfere with electromagnetic communications.

I do not make these points in order to discredit renewables. The IEA, like others, has high hopes of renewables. Rather, my purpose is to caution against over-simplistic environmental assumptions. All energy forms require careful site selection, a thorough environmental impact assessment, application of the best available technology, and proper engagement of the local community in the evaluation. Renewables are no exception.

Nuclear Power. Let me now turn to another energy source, but one with a very different environmental image: nuclear power. Though free of carbon emissions at the operational stage, nuclear power awakens grave environmental concerns. These stem from the possibility of the release of radioactive emissions, as a result of an accident or in the course of transport or storage of high-level waste. There is also the fear that the civil nuclear programme might contribute, indirectly, to the proliferation of nuclear weapons.

These public concerns have found expression here, in Italy, after a referendum, in a moratorium on nuclear production. And, as you know, the new German government has decided, in principle, to phase out nuclear operations.

The Chernobyl accident, understandably, lies behind these grave concerns. That plant was not operated safely, nor designed to fail-safe. By contrast, the accident at Three Mile Island in the USA did demonstrate that properly engineered safety systems can prevent the release of radioactivity to the environment, even when badly operated.

And in other respects, civil nuclear power has some significant advantages to a society troubled by the prospect of climate change triggered by carbon emissions. In operation, nuclear plants are carbon free. Fuel supply to civil nuclear plants is, potentially, indefinitely sustainable. Uranium resources are globally widespread. At current rates of usage, known uranium resources would last 60 years — longer than the known reserves of oil and gas and, like them, likely to grow as demand and price increase. Moreover, technological options are known though not yet commercial, for increasing the energy extracted from natural uranium, permitting us to extend the estimated availability of this energy source, even on the basis of present knowledge, to a period of 8000 years.

Eight thousand years, in this context, can be equated with indefinite sustainability. But this consideration alone is not enough. The timescale which has been adopted as a design criterion for safe isolation for repositories of high-level nuclear wastes is 10,000 years. No government, or even civilization, can be counted on actively to safeguard a waste site over that period. A solution must be found for nuclear waste disposal which is passively safe, i.e. which requires no active human intervention to ensure continuing safety.

ENERGY & ECONOMICS

I started by discussing sustained economic activity; and I want to conclude by referring again to economics.

The security of energy supply and the costs of energy supply are no longer issues in the public eye. Accordingly, the need for nuclear energy seems less imperative to many today than it did during the period of oil shocks in the 1970s.

But concern about climate change could change this. Putting a cap on carbon emissions necessarily means that energy prices will rise to reflect an emerging "carbon value" — the value of not emitting carbon. The public attitudes towards carbon-free nuclear power could then change as the balance is perceived to shift between the

ENERGY RESOURCES

Two recent publications of the International Energy Agency examine policy and environmental issues related to the use of nuclear power and renewable energy technologies, respectively. The reports were issued in October 1998 and are available for purchase from the IEA *(see box, page 3)*.

■ ***Nuclear Power: Sustainability, Climate Change and Competition*** examines the future of nuclear power in the context of three policy issues: the sustainability of energy supplies and energy use, concern about the effects of energy use on the earth's environment, and the advent of competitive electricity markets. It concludes that nuclear power has the potential to compete in electricity markets, on an environmentally sustainable basis, provided that key issues are resolved.

The report makes the following points:

Public acceptance of new nuclear facilities, or even an extension of lifetimes for current plants, is a key issue. Second, real, complete programmes and facilities for disposal of high-level radioactive waste and processing of used fuel have to be put into place. Third, in the global context, an important issue is ensuring that any expansion of civilian nuclear power does not lead to proliferation of nuclear weapons.

If emissions of carbon dioxide are to be curbed, the report states there must be some recognition of the value of producing less carbon dioxide from energy use. Nuclear's ability to produce electricity with no carbon dioxide emissions will not lead to its increased use unless some of the non-economic impediments to nuclear power are overcome.

The report states that nuclear power will not be immune from the changes brought about by market liberalization in the electricity sector. Competition brings a focus on reducing generating costs that will reinforce the trend towards improved economic performance in nuclear plants.

■ ***Benign Energy? The Environmental Implications of Renewables*** outlines the environmental benefits of renewable energy sources and describes the best practices and mitigation measures to reduce their undesirable environmental impact. The report addresses the use of biomass (including agricultural, forestry, and municipal waste), hydropower, geothermal energy, photovoltaics, solar thermal electric systems, and wind power.

It points out that renewables are projected for use on a larger scale over the next ten to fifteen years, as global efforts accelerate to achieve greater reductions in energy-related gaseous emissions. A big part of this growth is expected to come from "new" forms of renewable energy not yet established in the marketplace. The report addresses a number of environmental burdens associated with renewables, and examines methods to reduce them. They cover aspects related to land use, visual intrusion, noise, and

risks and rewards of nuclear power.

Cost-effectiveness is a necessary condition of sustainable development. Both renewable and nuclear energy are currently at a disadvantage in this respect. A recent IEA publication, *Nuclear Power: Sustainability, Climate Change, Competition,* discusses what would be necessary to make these energy sources economically competitive. On the assumptions discussed there, a carbon value of as little as US $25-$35 per tonne would make nuclear competitive, while $65-$100 per tonne would achieve the same for many renewables. These figures are well within the range being quoted for the carbon value implicit in the Kyoto commitments.

What I have sought to do is to explore what constitutes sustainability in energy supply. One vital feature is sensitivity to environmental concerns. Security of supply and economy in supply are no less important. When it comes to evaluating environmental acceptability, renewal is a great virtue; but it is necessary to go well beyond that in order to draw up the full balance sheet. Some renewables have environmental drawbacks. Some other forms of energy, though anathema to certain groups, have characteristics whose value will become increasingly clear as we come to grips with the realities of acting to combat climate change. ❐