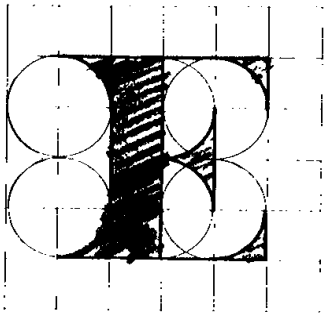

ENERGY, GROWTH & THE ENVIRONMENT

Toward a framework for a sustainable energy strategy

(Extracts)

From the 1991 EcoPlan report: *Choosing Europe's Energy Future*
Commissioned by: DG XVII, the European Commission

Comments on this contribution and discussion are invited either via the Forum or directly to the authors at:

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Toward a Framework for a Sustainable Energy Strategy

Commissioned by: DG XVII, Commission of the European Communities

Background: Prepared as an independent thinkpiece to supplement the Commission's own work and reflections in the area of longer range energy policy. Follow-on of a major report and techno-economic database prepared by EcoPlan for the Commission over 1990/91, *Choosing Europe's Energy Future*. The authors were asked to draw not only on their past work and databases, but also the findings and views of a wide range of leading thinkers, institutions and adversarial sources. A summary of their findings and recommendations follows.

SYNOPSIS

The paper opens with a reflection on current concerns within the Commission with the threat of climate modification in the face of rapidly increasing emissions from fossil fuel combustion. At present European and other OECD governments at various levels are coming under pressure to implement measures which promise to reduce, or at least stabilize, such emissions over the next decade. Despite the fact that the expert community shows considerable misgivings about their chances, many governments are announcing and even legislating short term measures. The authors maintain that this approach makes at best only limited sense, and needs to be set within a coherent longer term strategic frame. They contend that effective policies are being held back, above all, because the wrong questions are being addressed.

The authors chart the broad outlines of a reference structure which they call the *deep future energy system*, claiming that we must be prepared to look fifty years or more into the future in order to develop a competent strategic frame for the sector. Their analysis suggests a surprising conclusion, namely that two energy currencies, hydrogen and electricity, can be expected to have a major, possibly even dominant role in the production of energy services in the latter 21st Century, albeit with a great variety of resource and technology routes for getting there. The report looks at these various routes and combinations in an attempt to identify better and worse policy paths. One conclusion of their analysis is that the *transport sector* emerges as the major target for public policy and remedial action in the years immediately ahead.

The paper suggests that this conceptual framework could, with further work and refinement, serve as an "invisible target" for orienting the Commission's reflections, work and actions in this important policy area. As a second cornerstone in this revised policy structure, they suggest that those concerned with these issues in Europe must expand their horizons and take an active leadership role in resolving these problems in the Third World and the formerly Communist countries. This will require an entirely different approach, qualitatively and quantitatively. To attain these objectives, it is going to be necessary to develop and put in place a new energy regime which offers technologies, performance and prices that will both (a) achieve the necessary environmental targets and (b) be so much better than those currently in place that both the OECD and the developing countries will switch over on pure efficiency grounds. The authors stress that this opens up major leadership opportunities, including for farsighted groups in the private sector. The report concludes with a set of conclusions and ten recommendations to the Commission.

Toward a Framework for a Sustainable Energy Strategy

Contents of Summary:

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Selected extracts from Chapter 1 of EcoPlan report for European Commission:

The Bottom Line

1. Introduction

Greenhouse gases and global warming may prove to be a legitimate and grave problem which could eventually menace life on earth. Then again, it may not. And if there is indeed a climate change in process, it may be due primarily to anthropogenic activity. And then again, perhaps not.

Inconclusive as the evidence is till now, though, there are at least two things can be said concretely and with some certainty about the global warming debate today from the vantage of public policy. The first is that the evidence is not only ambiguous to the point of being genuinely confusing, but also -- and this is what makes things really disorienting -- is subject to rapid and continuous reinterpretation and qualification as new and often quite contradictory findings roll in.

But that is only half the story. The second marking factor that needs to be taken into extremely careful consideration is the enormity of the stakes, no more or less than the well-being of our planet and possibly even the survival of future generations. Thus, whatever the details of the evidence and the varying interpretations given to it, the threat of climate modification is one that needs to be taken very seriously; the implications are great enough to warrant serious attention, a great deal more study and, at the very least, intelligent and responsible defensive action.

Given the considerable uncertainties involved, then, and bearing in mind further how all this is compounded by the enormous time lags associated with any eventual "course correction" that might be made once the scientific community is able to come up with its more conclusive picture, energy policy makers over the decade ahead may be forced to adapt the following wisdom: "One does not have to be absolutely certain that the barn is going to burn down for fire insurance to make sense." (That may not sound very scientific, but at least it has a certain amount of horse sense -- and that is an important policy attribute).

This paper is thus about insurance policies. And we would point to the plural of the word since global warming is only one grounds why a longer term and genuinely strategic framework is required in support of energy policy and the choices which we need to make in the years immediately ahead. A series of insurance policies are what is needed, not just one.

2. Objectives and Overview of the Report

This report was initiated to provide a wide-ranging, free-wheeling thinkpiece in the face of what we saw as an urgent need for a much broader, much more far-sighted and generally much more strategic approach to energy policy making in Europe. Not intended as an esoteric study or academic report, this piece takes as its objective to set out a thoughtful, objective, informed and -- not least -- provocative assessment of the main issues involved and policy approaches which are or could be made available. The intent is to provoke discussion about these matters within the Commission and elsewhere, if possible along far broader lines than has been the case to now.

The paper takes as its point of departure current concerns within the Commission and elsewhere in Europe with the threat of climate modification in the face of rapidly increasing emissions from fossil fuel combustion. At present European governments at various levels are coming under pressure to implement measures which promise to reduce, or at least stabilize, such emissions over the next decade. Despite the fact that the expert community shows considerable misgivings about their chances, many governments are announcing and even legislating a number of such short term measures. The authors maintain that this approach (to which they refer as "tactics without strategy") makes at best only limited sense, and needs to be set within a coherent longer term strategic frame. The authors contend that effective policies are being held back, above all, because the wrong basic questions are being addressed.

Claiming that we must be prepared to try to look at least fifty years into the future in order to develop a competent strategic frame for the sector, the paper sets out to chart the broad outlines of a "reference structure" which the authors refer to as the deep future energy system (Chapter II). Their analysis suggests a surprising conclusion: namely that two energy currencies, hydrogen and electricity, can be expected to have a major and possibly even dominant role in the production of energy services in the latter 21st Century, albeit with a potentially very great variety of resource and technology routes for getting there.

The report then looks at these various routes and combinations (Chapter III) in an attempt to identify better and worse technology and policy paths. One conclusion of the analysis is that greatly increased reliance on natural gas as a "bridging" technology over the decades immediately ahead would seem to be a prudent path. The paper suggests that this conceptual framework could, with further work and refinement, serve as a beacon or "invisible target" for orienting the Commission's reflections, work and actions in this important policy area. As a second cornerstone in this revised policy structure, the authors suggest that those concerned with these issues in Europe must now expand their horizons and take an active leadership role in resolving these problems in the Third World and the formerly Communist countries. This will require an entirely different approach, qualitatively and quantitatively.

To attain these objectives, it is going to be necessary to develop and put in place a totally new energy regime which offers technologies, performance and prices that will (a) in due course combine to achieve the necessary environmental targets and (b) be so much better than those currently available in terms of their performance and economics that both the OECD nations and the developing countries will switch over on pure efficiency grounds. The authors stress that this opens up major leadership opportunities,

including for farsighted groups in the private sector. The report concludes with a set of conclusions and recommendations to the Commission.

Based on a considerable amount of original research in long term planning and policy considerations in the energy sector internationally, this paper has taken its present shape in good part as a result of a series of exchanges of views and materials that have taken place over the last half year with a number of colleagues and critics, based on earlier drafts of what follows. The report is however an entirely independent assessment of the situation and trade-offs, and as such represents the views of the authors only, and not those of either the Commission or any of those who are cited in the *Acknowledgments* that will be found in the closing pages of this document.

3. Why a Strategic Approach?

There are many reasons why energy policy needs to be plotted in a fully strategic manner against a sensible and well developed long term time horizon. Some of these relate to the environmental issues which currently are the subject of so much public discussion and some political action. But there are other compelling reasons as well:

- Decisions have to be made on a continuing basis concerning public investment in and/or regulatory stance concerning the development of such on-going matters as new gas contracts, power station construction, regional development commitments, etc. -- all of which are long term concerns which bring us to time horizons that quickly get up to 2050 and beyond.

- The need for a proper foundation against which to make funding and support decisions concerning energy R&D (by definition a long term process) -- bearing in mind that strong decisions in these matters can have a major impact on the search for solutions to the problems lie ahead. 1

- The CO2 and greenhouse gas issues that are currently receiving so much attention in the global warming debate (but which may or may not stay the longer course).

- Stretching well beyond these climate issues the much broader concept of sustainability which, though being given many meanings in different contexts, boils down in this setting to three main underpinnings of equally great importance to policy makers (and which interact closely, to the point that they cannot be separated from one other):

    1. Ecological or environmental sustainability

    2. Social sustainability

    3. Economic sustainability

- The precise configuration of the future energy system is going to be shaped in large part by broad and powerful trends that have their root in basic human needs (for shelter, comfort, mobility, etc.) which, though evolving in many matters of detail, are long term considerations which lie at the very heart of our civilization and well-being.

- And one step beyond all the above, the pressure of continuing world population growth and the specter of ten billion-plus people on the planet within the next two generations -- with all that implies for the drain on resources, pollution, etc.

[1] Bearing in mind that the budgets for some sources (nuclear and coal coming immediately to mind) are quite large, while others which may in the long run be much more important (such as various forms of solar) are currently getting only small change.

So, the bottom line here is that global warming -- even taking into consideration the continuing elements of uncertainty in the debate -- is an important consideration that is indeed worthy of the attention of policy makers; but it is not the only important issue on the horizon and a wise energy policy must take this into account.

Ideally, then, policy makers will be able to take out an insurance policy which covers not only global warming (just in case it turns out to be a real threat) but these other critical considerations as well.[2] This paper is given over to describing how such a multi-point insurance policy might be defined, starting with the CO2 issues and global warming as the point of departure but then stretching considerably beyond that debate to see if a broader policy framework can be specified and eventually put into effect.

The Conclusions and Recommendations that close this report reflect this search.

[2] The analogy might be that of the responsible home owner and parent who takes out insurance not only against the risk of fire but also theft, natural catastrophes, illness, death, etc. As will be seen, the purpose of this paper is to describe how a series of such policies can now be identified and put in place.

4. Energy, the Threat of Climate Modification and Public Policy

According to most global studies of long-term energy demand and supply perspectives, fossil fuels will continue to dominate the primary energy mix well into the foreseeable future. Thus, even if world energy demand and supply mixes were to stay at present levels, some 20 to 21 billion additional tons of CO2 would be poured into the earth's atmosphere annually. This dominance among the energy related greenhouse gas emissions makes CO2 the main issue within the general debate of climatic change and energy system evolution.

Moreover, with the possible exception of CH4, a restructuring of the energy system towards lower CO2 emissions will also lead to a reduction in the generation and release of all other energy related greenhouse gases. Needless to say, a full account of all greenhouse gas emissions must become an integral part of all scenarios enveloping the route forward to low-carbon or no-carbon energy futures.

While not the only source, the energy system is certainly the most important, currently accounting for fully half of all greenhouse emissions. While the precise percentage figures cited vary from source to source depending on the base of calculation, the following chart fairly reflects the approximate shares of energy and the other major emissions sources at the world level as of this date.

[global warming figure here]

Not only the heaviest polluter of the atmosphere, the energy sector is also the fastest growing. Fortunately, it also turns out quite possibly to be the source that is most amenable to policy, giving us an interesting combination of bad -- and eventually, if we prove ourselves to be up to the challenge -- good news.

When we say "amenable" to policy in this context it should not be taken to suggest that we believe that any eventual changes or improvements are going to be easy to attain. The issues involved are many in number, often terribly complex in their substance, close to inextricably inter-related, fraught with uncertainty, and not about to yield to facile policy or superficial massaging of institutions or behavioral patterns.

There are at least four main sets of reasons that help to explain why it is proving so difficult to organize a firm political consensus around these issues. Let us review these quickly.

- Although scientific evidence linking unrestricted fossil fuel use to potential climatic change is increasingly gaining credibility, there is still disagreement not only with respect to the basic issues of greenhouse gas build-up and their impact on climate, but also as to the effects of global climatic change.

- There is the fact that while many environmental issues at the local level are materially palpable (i.e., you can see it, smell it, feel it) and therefore not subject to great debate concerning their very existence and the menaces they pose -- for example, urban air pollution is no longer subject to

scientific uncertainty -- this is not the case for greenhouse gas accumulation and their likely effect, global climate change.

- There is the question of "winners and losers" in the event that climate change does actually take place -- a topic that somehow combines issues of ignorance, selfishness and ethics in a most disturbing way.

- And perhaps more important than all of the rest from a pure policy perspective, is the fact that the threat of global climate change is not proximate. Since it involves an eventual chain of events that are going to take decades to play themselves out, it is not being given much importance by the political process. The whole concept of climate change appears to have for most of us the present day importance of a remote event, lacking the urgency of other shorter term considerations.

In a political world where conspicuous fire-fighting has become the behavioral norm, it seems difficult to mobilize a consensus behind something as long term as fire prevention, particularly for issues that stretch out to a generational horizon. As Eduard DeBono put it years ago, the conflict here is between the urgent and the important -- with the urgent (but somehow not so important) somehow always carrying the day.

Taking all the issues involved in their full complexity presents us with two sets of major challenges in citizen responsibility and collective decision-making: the first a challenge of brains, the second one of will.

- The first challenge lies in our intellectual ability (or in this case our inability) to put our finger on the exact nature of the problems or on the kinds of possible solutions we should be looking at. The sad truth is that we as a society are not yet accustomed to looking at and making collective decisions about things at this level of system complexity. The causalities and feedback loops of the environmental and energy systems are so many, so complex and so often only partially understood and filled with elements of uncertainty, making it difficult for us not only to sort out what we should be doing next but even to maintain our concentration on the issues at hand. Our first challenge, then, is to develop the intellectual and social habits of first facing, then understanding and finally making decisions in front of matters of such complexity.

- The second challenge before us has to do with our ability to mobilize the collective will to do what is needed in the face of these challenges, once we figure out what they are. If the biggest immediate barrier to change is ignorance, just after that comes our inertia. Of course it needs to be taken into account that the sources of resistance are numerous, considerable and can be expected often to be fierce in their opposition to change. But it is our inability to mobilize a consensus even to address the issues in an adequate way that is proving to be the real quandary.

Changing our ways of looking at and doing things, either on an individual or collective basis, is not among the natural fortes of mankind. However, that is exactly what we are going to have to do if we are deal successfully with the challenges of creating a sustainable energy system.

5. Tactics to Reduce Greenhouse Gases

There is more than a little confusion clouding the debate concerning these issues of greenhouse gas emissions and global climatic change. Considerable pressure is accumulating through the media and the political establishment in many parts of Europe to find ways to stabilize or reduce emissions levels. Depending on the time and place, the word "significant" is being interpreted as 10%, 20% and even as high as 50% reductions in present emissions levels, and most often from a time horizon of ten or fifteen years.

This call for action is putting heavy pressure on the political establishment to react in an explicit, visible and immediate way. As a result the Commission, along with many national governments, is being pressed hard to come up with policies which show promise of being able to address and resolve these issues -- and invariably on a very condensed timetable.

In order to put some order into the discussions, it will be useful to distinguish between the kinds of questions which are presently being posed in most places concerning these issues, and those which perhaps should be asked. Typically, there are only two basic policy questions that are being vented in the media and concerned political circles in most places today. These boil down to asking...

1. What can be done in the immediate future in order to reduce emissions from the energy system within a specific country or region by the year 2000 or thereabouts? Or...

2. If that is not possible, what if anything can be done at least to stabilize them?

Tackling the issues from such a narrow perspective -- narrow in time, narrow in geography and narrow in policy reach -- does not provide an adequate base for energy policy in the broader strategic sense which is so imperative to the sector. It represents a start and a necessary first stage of awareness, but only that; and there is the danger that if we rely only on this approach it may lead us to focus all attention and resources on a limited range of what we call eco-energy tactics (of the sort that are set out in the following table).

The policy measures being considered in most places today range from energy price manipulations ("green taxes"), standards, regulated emission levels and tradeable permits to prescribed energy supply technologies. The focus is on achieving immediate impacts on emission levels, and not on providing the market with guidelines and incentives for a transition toward an environmentally sustainable energy system.

A summary of measures being considered or taken in fourteen leading countries which are trying to address problems of climate modification at the national level is reproduced below.

National Climate Policies, Proposed or Enacted

(As per October 1990)

Nation	*Goal*
Australia	Reduce greenhouse gas emissions 20 percent from 1988 level by 2005
Austria	Reduce CO2 emissions 20 percent by 2005
Canada	Freeze CO2 emissions at 1990 level by 2000
Denmark	Reduce CO2 emissions 20 percent by 2005, 50 percent by 2020-2040
France	Freeze CO2 emissions near 1990 per capita level
Germany	Reduce CO2 emissions 25 percent from 1987 level by 2005
Japan	Freeze CO2 emissions at 1990 level by 2000
Netherlands	Freeze CO2 emissions at 1990 level by 1995, followed by reduction
New Zealand	Reduce CO2 emissions 20 percent by 2005
Norway	Freeze CO2 emissions at 1989 level by 2000
Sweden	Freeze CO2 emissions at 1988 level by 2000
Switzerland	Reduce CO2 emissions 10 percent by 2000
UK	Freeze CO2 emissions at 1990 level by 2005

* * *

6. Beyond Eco-Tactics

In contrast to "eco-tactics" -- which we see as useful first steps, but only that -- there are at least four sets of fundamental underlying issues which are not receiving attention in most of these cases but which deserve full and careful consideration. These include:

1. What are the full range of objectives that remedial policies in these areas should be addressing?

2. How do they link to other priority concerns (such as the state of the economy, growth, international competitivity, politics, ethics and the environment more broadly), and how can these eventually complex issues be factored into the analysis?

3. What are the specific geographic and political areas that need to be addressed in order to achieve truly meaningful results.?

4. What is the timetable that will be realistic for any eventual changes or improvements?

Asking questions with this much broader sweep brings us to an entirely different sort of agenda, contrasting sharply with the sort of hasty issue framing that is currently being practiced in most places. Getting meaningful answers to such fundamental questions demands no little reflection and work. But such a process is absolutely essential to strong policy decisions.

But for the man in a hurry the utility of probing such broader considerations may not be so evident -- until, that is, the results are in and it is too late to do anything about it. Given the stakes, this could work out to be a most costly omission.

Here listed in some sort of rising crescendo of ill-advised incompetence are three broad alternative policy outcomes which could conceivably result from the policy actions (all of which basically CO2-oriented) currently being discussed and/or being taken in various places today:

1. Remedial actions which fail to meet the various emissions targets -- and which also undermine the economy and growth.

2. Policies or programs which more or less well achieve the short term emissions targets -- but which later undermine the economy and growth.

3. Policies which make some inroads on emissions in the next few years -- but which move along a path which it proves impossible to sustain after, say, the turn of the century.

This does not exhaust the list of ways in which targetless policies ("tactics without strategy") can go badly wrong, but it should serve to give a first taste of the pitfalls that one should be on the lookout for.

> *There was much planning, but no plan. The needs of the moment are met sometimes exceedingly well but without reference to the whole... It is at that low stage of animal development in which the brain is rudimentary and ganglia scattered throughout the organism stimulate such activity as serves to keep the creature alive.*
>
> - Frank Pick commenting on planning in London in 1927

7. The Need for Establishing a Target Energy System

In response to pressures for action exerted by growing public concern, policy makers in Europe and elsewhere need to be able to identify and enact remedial measures that hold out promise of being able to make at least some inroads into the greenhouse gas problem over the coming decade. Such tactical responses will not be framed and implemented in a policy vacuum. Issues such as resource availabilities, international competitiveness, domestic employment effects, sunk capital cost, supply security, lack of international convention or socio-political acceptance will need to be brought into the calculations in order to guide and determine the degree and the extent of these tactical choices.

Tactics guided solely by the need for being able to demonstrate short term successes run the risk, however, of failing to serve the more meaningful and important longer term objectives and performance. In fact, poorly thought out fix-it tactics identified and implemented without reference to an adequate strategic framework may well, in the longer term, not only jeopardize and reverse whatever short run progress they may manage to achieve, but even work against the underlying interests of society and the environment.

In the face of this challenge, what is needed is a viable long term policy frame in order to ensure that today's energy/environment tactics line up with society's longer term priorities and possibilities. Such a policy structure does not at present exist.

As a step in this direction, we outline below a certain number of ideas concerning what we call a long term reference or target energy system for the deep future. *Properly constructed and presented, such long-term reference system can play the role of a beacon for energy policy, for public investment in infrastructure changes beyond the capability of free market forces, for publicly funded research and development activities as well as for private sector investments.*

8. The Mid 21st Century Energy System (A First Look)

The precise configuration of the future energy system is going to be shaped in good part by extensions of patterns of historical energy systems evolution. These are broad and powerful trends that have their root in basic human needs (for shelter, comfort, mobility, etc.), social and economic structures, technology, resource availabilities, prices, costs, infrastructure availability, institutions, habits and preferences. But, in addition to these, the future energy system is also in part going to be determined by the forces which render the current system obsolete -- including the unacceptable burdens that the present energy structure places on the environment.

To understand something about this future is above all an exercise in pattern recognition. Now, pattern recognition is neither forecasting (or, as some have it, "bean counting"), nor prediction, and certainly not a matter of a fastidious search for fine grained detail This distinction is important for the policy maker. Decision making can be hugely improved through careful analysis and anticipation of patterns, despite the uncertainties that make detailed predictions impossible. (For example, Ravetz observes that "In projecting our future we never know everything. But we seldom know nothing" (1986) -- and then goes on to describe the patterns one can anticipate based on existing (if skimpy) knowledge.)

Our attention in these pages is given over to a search for broad tidal flows that are going to shape the deep future energy system in a profound and continuing sense, not surface ripples that will have little or no bearing in the long run. Throughout it all we are on the lookout not for the future as if it could take the form of some sort of detailed blueprint, but rather for a future combinations or patterns of uses, resources, technologies and structures which (a) will have a significant role to play in the long term horizon under just about any conceivable set of circumstances and (b) can be achieved (i.e., got to) by an extremely broad range of alternative paths.

It is our belief that it is possible to discern the broad outlines of such a future. Despite the enormous uncertainties involved, it is possible to make a certain number of general statements about the likely shape of the world energy system in the second half of the 21st Century. Here are some of the characteristics that we believe can be reasonably anticipated:

- The deep future energy system will be above all needs-driven -- and not shaped by supply sources (resources) or technology.
- The future will see much larger than present variations in the mix of resources and technologies that are used from place to place -- depending on the specific resource endowment, climate, technology past, traditions, economic level, etc. of the region or country.
- Energy systems will in general be much more decentralized
- Energy efficiencies will be substantially enhanced
- One way of another there will be a lot less carbon in the system
- A general move away from today's open-cycle technologies to more closed cycle systems.
- Greatly reduced waste of resources
- A move in general away from the operational complexity of today's system, toward greater operational simplicity.

It can further be anticipated that the fundamental shifts that do occur are going to take effect gradually, given the enormous size and profoundly inertial nature of the system. This does not rule out rapid innovation and improvement on the margin, but rather reflects the time it takes to replicate whatever results are achieved at the leading edge to the rest of the world.

9. Policy, Not Planning

To close this first chapter, a final word on policy and planning, since there is some potential for ambiguity on this score. This paper sets forth a number of ideas for a strategic policy framework which we believe is needed both to ensure informed long term decisions in the sectors under study, and to permit shorter term tactical measures to be identified and implemented which do not work against the longer run interests of society.

The background to this initiative is the call for a new set of ground rules in order to ensure the appropriate development of the sector in the future. If there is as yet little agreement as to what these new ground rules should be, there is by contrast broad and growing dissatisfaction with the practices and structures that are currently in place.

The emphasis is here is, thus, firmly on policy, and not planning. We have now buried centralized, bureaucratic, specific, highly detailed, technocratic planning -- once and for all. This has been a long and costly learning experience, and we should not allow legitimate concern for problems of the environment to blind us of the limitations which are, by definition, inevitable concomitants of the old authoritarian central planning approaches.

Our objective must therefore be entirely different -- namely, not to try to create a set plan to achieve some technically "optimal" course and solution set, but rather to use policy to create a reactive process and a vigorous climate for innovation and adaptation which is profoundly participatory and profoundly shared.

10. Attributes of a Winning Energy Strategy (A First Summary)

Prior to delving into the main thrust of this paper -- namely, the challenge of charting the broad outlines of the deep future energy system that is the topic of the following chapters -- in order to get a better feel for the kinds of things that will characterize a winning energy strategy for the long term, let us begin by simply listing a certain number of abstract qualities or characteristics which in our view constitute some of the essential preconditions of such a strategy.

Profiting from the experience of past accomplishments and of past errors of energy policy (some of the more adventuristic of which have been quite flagrant), it is our view that the right path at this time of considerable uncertainty about the future will be the one which offers the best and broadest "insurance policy" to both public policy makers and the private sector (the main actors in this piece).... an insurance policy which

- Can achieve the necessary inroads in terms of emissions reductions -- without undermining well-being (there can be no sustainability without economic and socio-political sustainability)
- Addresses not only those challenges and problems that relate to greenhouse gases and the threat of climate modification, but also the full range of energy issues that link to both environmental and economic (growth) considerations as set out above.
- Will work to increase the diversity and the flexibility of the energy system
- Avoids putting all the energy eggs into one technology basket
- Encourages multiple energy sources (geological, political) to stay in contention -- while keeping the maximum number of technology horses in the energy race
- Is implemented in a way which generally increases the degree of freedom of those concerned in the public and private sectors as events unfold (and does not cut them down)
- Places the public sector above all in a stewardship role, with responsibility for ensuring that no less than three specific kinds of broader public interest are fully represented and built strongly into the incentive system that will create the future energy system:
    1. Awareness that the main sources of innovation and adaptation lie in the enterprise system and the market;
    2. Those socio-environmental considerations generally left out of today's incentive system:
    3. The interests of future generations (which at present are badly served by the existing incentive system).
- Provides a "level playing field" for <u>all</u> resource and technology candidates which means specifically...

a) No hidden subsidies to any of the existing players (with the implications that all such existing subsidies need to be ferreted out and either removed or at the very least be made explicit and brought into full public view); and

b) Each resource and technology must be priced according to its full costs (including its socio-environmental impact).

- Avoids any huge immediate commitments of public funds or resources to any given source or technology
- Does not depend for success on any specific technological or resource breakthrough ("revolutions") -- and certainly not anything which might depend on some tight schedule
- Does not embark on any irreversible (or very costly to reverse) investment of public moneys or policy commitment options which may foreclose future options
- Keeps the public sector firmly out of the business either of selecting and of paying for resource or technology development
- Provides clear and firm (i.e., steady) ground rules for those in the energy business and related technology areas, so as to decrease the considerable level of hesitation and uncertainty which is presently working to hold back the needed longer term commitments and investments -- and in this way to ensure maximum creative input of the entrepreneurial powers of the private sector and participation of existing sources of expertise and capital
- Provides a strong incentive structure for the sources of innovation and entrepreneurship to respond vigorously to the new challenges and opportunities of an energy system which much change radically
- When in doubt "tilts" in favor of existing infrastructure and institutions
- Sets in motion a framework of programs, incentives, activities, etc. that can be monitored, extended, upgraded and modified as circumstances evolve.

This list, simple as it may seem at first glance, actually turns out to be quite a demanding set of constraints. While not at all sufficient as the base for a strategy per se, they nonetheless provide a useful first step in the process of developing one. Even in their present unfinished state, though, they already have their uses. For instance, if we compare the above to government policies of the past, it can be seen that many of these last have failed to meet one or more of these simply stated but far from trivial criteria -- with the implication that had such a "philosophic framework" actually been worked out and applied, some very costly errors might have been avoided.

* * *

Against this background, let us now proceed to a consideration of the deep future energy system, which we propose as an "invisible target" for orienting discussions and eventually policy decisions and work in this important area.

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11. Looking Back From The Year 2052

(A Reverse Scenario)

The following is a reverse-scenario or "backcast" which purports to look back at the situation we face today from the perspective of a commentator writing in the middle of the next century. The idea is to get across in a few hopefully readable pages some of the main concepts which are developed in the main body of the report. An earlier working title for this piece, "How You Make an Elephant Turn on a Dime", had the advantage of setting out the "problematique" in somewhat more colorful terms.

The basic thesis is that history would seem to suggest that, whenever society is faced with a challenge of the dimensions of that which concerns us here, the only conceivable way that things ever work out positively is in the wake of some larger and completely unanticipated surprise event or catastrophe. We suggest one such remote possibility in the following, but each reader will certainly have his or her favorite candidates (for example, a rapid fire succession of Chernobyls across the newly freed countries to the east of the Community, a major heat wave which panics politicians into action, a major and enduring Middle East war....). The scenario ends with an "Epilogue" which has been compiled in an attempt to make a link between the obviously fictional account of the scenario and the main topic of this analysis. Its validity and eventual usefulness we leave you to judge.

Dateline Brussels, 1 January 2052

Our Sustainable Energy System (And How We Got Here From There)

The energy system we enjoy today as we get ready to enter the second half of the 21st Century, is the result of more than just blind luck or historic accident. The fact that we managed to negotiate the transition from a nature-threatening energy system based on costly and polluting fossil fuels from an insecure and limited supply base to our present arrangements which allow for ample, convenient, clean and affordable energy, not only in what used to be called then the "developed countries" but world wide, has been among the major technological and social achievements of the last century. The process of transition traces to an enormous medley of circumstances, habits, flukes and decisions, but above all it was shaped by a cycle of events which first began to get underway some sixty years ago.

Seen from today's vantage, the energy system as it existed in the closing years of the 20th century appears anachronistic indeed. The supply of energy currencies and services back then centered primarily around the oxidation of the carbon atom. The fossil fuel cycle was highly inefficient and open to the atmosphere. Consequently, as the century drew to a close, large areas of the planet were increasingly assaulted by air pollution in a variety of forms. The menace of a lasting and irreversible impact on global climate became a common item in the daily newslines of the period.

Because prices back then reflected only part of the real cost of energy to the system -- that is, consumers at the time paid only those costs related to fuel supply and nothing at all for the costs imposed on others -- prices were kept low, demand was high and, not surprisingly, efficiencies were low. Under these circumstances of artificially low prices, the use of polluting fossil fuels continued to grow unabated, despite the increasingly high costs they were imposing on society as a whole. Energy policy at the time was hardly concerned with these matters, but rather was preoccupied with issues of supply security (meaning international oil politics) and economics (meaning "cheap" energy), occasionally interrupted by a stop-and-start public debate on the suitability of nuclear power.

But just before the turn of the century, a fundamental shift took place, a change not just of degree but of kind. In response to mounting public and political awareness of the environmental threats posed by the old system, a nucleus of representatives of the scientific community got together with a handful of the more far-sighted political leaders, responsible institutions and other centers of concern in an attempt to forge a way out. It all began in a small and tentative way, but gradually the movement gained in force and began to take root.

Not just one but a whole range of policies and approaches eventually resulted from this emerging international consensus. The tactical policy measures at first studied and later enacted in various places around the world included, with a huge number of variations and degrees of success, such things as emission taxes of various sorts, higher performance standards for energy conversion equipment, tradeable emission permits, mandatory application of least-cost energy planning methods for utilities, accelerated depreciation for investments in efficiency improvements and R&D expenditures, and yet others.

But though the tactics differed considerably between countries and regions, the basic underlying strategic approach was eventually the same. As a result of the path-breaking work of a core group of concerned people and institutions who prepared themselves to be ready to move when the time was right, progress was made which eventually permitted the alignment of energy prices with their full social and environmental costs. With full cost pricing in effect, market forces eventually proved to be sufficient to move the energy system in the direction of least-cost energy supplies, with no sacrifice in either life quality or economic well-being.

The main technical vehicle for this successful transition was efficiency improvements through technological innovation under the incentive of revised energy prices. The main transitional energy source was, to the surprise of many, natural gas. The main instrument for implementing this changeover was the market itself (working under full energy prices), and not the command-and-control measures which turned out in the final analysis to have only a supplemental role.

In each country and each region, the energy system evolved in a way which was consistent with the resource, financial and other advantages and constraints of that place. One of the principal hallmarks of the new energy system as it emerged was its diversity.

Still, simple as it may appear in retrospect, initiating the transition to a sustainable energy system did not prove to be an easy undertaking. The barriers were many and the pessimism was deeply felt. At first, the environmental objectives were condemned as being at variance with many deeply-held economic and social objectives. Unilateral increases in relative prices were feared as likely to prove counterproductive and result in loss of international competitiveness. The burgeoning growth in the energy requirements of the less developed countries developed into an almost insurmountable obstacle. And as there existed no

model of international cooperation for resolving such dilemma, muddling through was the common practice in the early years of the transition.

Strange as it may seem to us today, probably the biggest challenge of the time was in convincing voters and politicians that their societies had the intellectual, cultural and material resources needed to manage the process of conversion to what we now call, almost without blinking, a "sustainable energy system". There was a huge amount of self doubt, and in most places a stubbornly held belief that no policy was going to be the best policy. It was, we can see with all the wisdom of hindsight, a strange time.

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The first largely unanticipated surprise took place in 1989 when the state legislature in California decided to require that any motor vehicle manufacturers who wished to market cars in the state by the end of the century had to sell a steadily growing proportion of "zero-emission vehicles". This turned out to be an extraordinarily far-sighted decision. The law required that the manufacturers not just put "clean" cars on the market, but that they make sure they actually got into the hands of Californian drivers. Not only did this extraordinary decision galvanize the American, Japanese and European car builders into action, but it also mobilized the resources of the petroleum and electrical industries on a scale that could not have been anticipated at the time.

The Events in Ireland were, if anything, even less anticipatable. When, after the catastrophic Events which eventually and to the world's surprise brought on Reunification, Irish political leaders of all stripes got together to form a multi-party consensus and sign a long term commitment to line up domestic energy prices with their full social costs (the Irish Clean Air Conversion Program), most observers were too preoccupied by other considerations in the wake of the general political turbulence of that troubled time to give much attention to this particular "administrative detail". But when exactly one year to the day after Reunification, petrol, fuel oil and coal prices all were in fact increased by the agreed additional twenty percent tax (a "carbon tax", it was then called), a number of governments began to reflect on what this experiment might in time lead to.

What struck most of them was the all-party convention to make the necessary price increases to realign the system over a ten year period -- together with the high degree of public and media support for a no-turnback policy. Some governments also took note of the fact that a number of American, Japanese and other European technology companies had decided to expand their business activities in the new and expanded republic as, in their words, "part of our watching brief on the future".

What happened next was, however, anticipated by no one and is now part of history. When in Year 2 of the Irish Clean Air Conversion Program, energy prices were further realigned right on schedule in that small wet country, most of the world had all but ceased to take note. Outside of Ireland, it was at best page 5 news; even within the country, it was considered just one more step, tough but do-able, in the direction that was needed to guarantee the quality of life in the new country they were all working so hard to build.

Unexpectedly and within only months, the wave began to spread. The state legislatures in California, Oregon and New York independently and without any known consultation met and passed bills authorizing broadly similar programs of their own at the state level (with that in California being unanimous), beating out by days the decision by the German government backed by an all-party agreement in the wake of a referendum which expressed overwhelming public support for such a program. Denmark, Sweden, Italy and the states of Washington, Maine and Vermont followed before the end of the year. In the eighteen months that followed more than half of the nations of Europe and even the first of the developing countries followed suit.

As the nineties wore on, a number of the more farsighted industrialized nations provided seed incentives and R&D support for industries concentrating on the design and development of clean energy technologies such as fuel cells, photovoltaic cells, magneto-caloric refrigeration or "inherently safe" modular nuclear power plants. Some of these investments soon turned into large scale economic benefits. The technological leadership role opened considerable new export markets for those who were sufficiently foresighted to take the lead.

It took the better part of a decade for the rest of the world to convert, and it was surprising to few that the United States, along with Libya and Albania, was among the last holdouts. When, however, the American Congress finally signed the act, it hardly mattered since forty two of the fifty one states had already passed measures on their own which substantially exceeded the belated national commitment.

It surprised some that the private sector turned out to be fully up to the task. In fact it worked out that many businesses were actually saved by the wave of innovation that followed. Ironically, of the companies that ultimately did best were several who at first had been among those who fought hardest to block the original initiative. The joint development program, initiated at the last minute and almost in despair by the French and Italian motor vehicle manufacturers, working in direct collaboration with their respective governments, was a case in point. Their concerted effort led them to be among the most active and successful early suppliers of electric vehicles on the international market, and was certainly among the main reasons for their survival at a time when many other car companies failed.
Thus it was that a series of events, some planned, others almost accidental combined to initiate the transition from a nature-threatening to a sustainable energy system such as we know it today. Certainly the additional income collected from polluters cushioned the hardships of restructuring the smoke-stack industries, helped finance re-education and R&D in no-carbon energy technologies and, most importantly, became the instrument to facilitate transfer payments and finance (clean and efficient) technology transfer to the Developing Countries.

Meanwhile, the carbon compounds that were at the base of the problems of the last century have progressively disappeared from the mix of energy sources and currencies that we use. The heat engine that was the major source of motive power of the period today can be found only in museums. The decade-long debate that raged in the nineties as to whether the greenhouse effect is real or not has long ceased. Still inconclusive, the question has now become irrelevant.

The mid 21st Century energy system we live with today centers around the twin currencies of hydrogen and electricity. Hydrogen supplied fuel cells and turbines have over the years captured a large part of the transport market. Hydrogen and electricity production, during the transition period based on natural gas, are now increasingly generated by solar energy and nuclear power.

Natural gas, still the dominant fossil fuel, is being used in combination with heat pumps and other efficient technologies to provide space and process heat services to residential and industrial consumers. But the days of natural gas are clearly numbered, and the future is clearly to renewable fuels. The transition is proving to be a smooth one.

Environmentally harmful emissions from the energy system have today reached significantly lower levels than previously thought possible. Although not yet a truly sustainable energy system, the course towards this goal is well underway.

And was it just a question of luck? Certainly not! We have our grandfathers and grandmothers to thank for this; their foresight and willingness to concern themselves with our future has given us the world in which we live. They gave us back the purity of our natural environment which had almost slipped from their hands, and a level of well being that they could not have imagined. And now we must do the same for the future generations that follow us. After all, that is what responsibility is all about.

12. Epilogue

Is this scenario pure fantasy? Has it no conceivable usefulness or application at this time? That we have to leave to you to decide. From a policy point of view, though, this little story does in fact identify a few strands, including several notable steppingstones and prerequisites which will have to be taken into consideration if the transition to a sustainable energy system is ever to be made. Among these we would note in particular:

1. The potential of the market system, when supplemented by the right prices, to achieve virtually all of the objectives that need to be targeted.
2. To accomplish this, the inescapable need for full internalization of external costs of all energy sources.
3. The importance of being able to move toward an environmentally adequate energy end-use structure, without which a sustainable energy system is going to be impossible to attain.
4. The need for developing mechanisms to re-distribute some portion of these emission taxes in the transition period for such purposes as easing social hardship, further stimulating technological innovation, encouraging technology transfer to the developing countries, etc.
5. The importance within Europe of securing for the transition period (starting now!) gas supplies from within and outside Europe, and especially from Siberia. The latter may well be part of a comprehensive package to assist the Soviet Union in her struggle for new political and national identity and economic reform efforts. Similar strategies may apply to gas from Africa, Middle East or South-East Asia.
6. The requirement to develop the expertise to be able to adapt, when the time comes, the gas transport and distribution infrastructure to hydrogen.
7. The usefulness of developing policy mechanisms to accelerate the rate of innovation in order: a) to achieve greater efficiencies of energy service technologies across the board; b) to advance in particular low-carbon and no-carbon energy service technologies; and c) to stimulate the development of no-carbon energy sources.
8. The need for a strategic conversion program, preferably backed by solid long term commitments, implementable programs, multi-party consensus, international agreements and conventions.

Two final points emerge from the scenario which are possibly worth bearing in mind. The first is the suggestion that an early decision on the nature of no-carbon energy sources is <u>not needed</u>. This is important since it considerably lessens the burden of those responsible for energy policy (and spares them the need for perfect foresight).

The second is the implication that the only way in which the needed transition is likely to be attained is not through some sort of narrowly prescribed technical adjustment or legerdemain slipped into a generally receptive system -- but by some combination of acute individuals and responsible groups who have done their homework and are prepared to move on this challenging agenda when the opportunity presents itself. Whenever and wherever that might be!