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SOME ISSUES IN ENERGY POLICY AND PLANNING

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Keywords: Energy planning, energy policy, externalities, Kyoto Protocol, policy assessment.

Contents

Summary

In addition to its conventional meaning of "*preparing for future situations*", energy planning addresses policy making, in particular in situations where self-regulating markets are perceived as inadequate for reaching given policy goals. A general example for such a situation is given by the presence of non-monetary externalities, that is, costs or benefits that are not included in market interactions themselves. In the energy sector, one of the most important externalities is the environmental impact of energy conversion and use. To internalize externalities, policy making can influence energy market prices by taxes and subsidies, among others. These measures are so-called market instruments. Another group of measures is sometimes called "*command and control*". This term refers to rules and regulations such as labeling, building codes, and bans. The choice among several policies and measures aiming at the same outcome depends, among others, on the geographical level (global, national, local) of policy making. While the geographical level refers to the means available to policy makers, policy assessment is an instrument to guide the choice among possible options by evaluating criteria such as effectiveness and side effects. Throughout the energy planning process, uncertainty and its management are important aspects to consider.

1. Introduction

Despite a global trend towards energy market liberalization, there is – and will be – ample room left for energy planning. The natural domain of energy planning begins where markets approach their conceptual limits, that is, whenever non-market (non-price) costs or benefits begin to play a role. Conventionally, non-market costs are termed negative and non-market benefits positive *externalities*. Both kinds of externalities can arise on a global, a national, and a sub-national (regional, local) level. An example of an external global cost of fossil fuel use is the increase of atmospheric concentrations of greenhouse gases (GHG). An example of a possible local external benefit of hydropower generation is flood control. Both of these examples describe environmental externalities, but this need not be so. An example of a non-environmental externality is the generation of knowledge over and above the specific kind of knowledge that is protected by the rules governing intellectual property.

In the existing markets, one important task of energy planning is to address *market failures*. This term is used to describe situations in which a market transaction is not happening despite it being favorable in narrow economic terms, i. e., without considering externalities. The external costs involved in this example are associated with the acquisition of information. These costs are incurred by making a buyer aware of a more favorable opportunity than one actually seized. Although this kind of market failure could be interpreted as just a specific example of the general case, its frequent occurrence warrants separate mention. To the extent that this kind information could not have been provided through more conventional advertising – which usually is an internal cost factor – providing such information would be a suitable task for (public) energy planning.

Another kind of market failure is the non-existence of the theoretical premises that are postulated to assure the functioning of markets. One such premise is competition between the actors – buyers as well as sellers – in a market. This premise is violated in situations of monopoly and oligopoly, which were observed in the energy area. This particular kind of market failure has been addressed by recent efforts to "liberalize" energy markets.

Only theoretically, energy planning can be addressed in isolation. In reality, any energy system is embedded in – and closely interacts with – the overall economic system. Together with the environmental interactions just described, the combination of these three fields is often referred to as "E3". E3 models are therefore tools used for the analysis of energy-economics-environmental systems. They are described in more detail in *Energy Planning Methodologies and Tools*.

2. A Conceptual Frame

While conceptualizing the energy system it is useful to recognize different levels of energy. Natural forms of energy such as coal, natural gas, or eolic (wind) energy are referred to as *primary energy*. *Secondary energy* is usually the result of a first step of conversion, for example refined oil products or electricity at the busbar of a power plant. *Final energy* is the form of energy bought and sold in the market to final consumers, e. g., grid-delivered natural gas or electricity at the point of a wall socket. It is important to note that these distinctions are primarily conceptual. Looking at coal or natural gas for example, there is no essential difference between the physical energy forms on the secondary and that on the final level.

These three energy levels are the basis for the consideration of energy conversion technologies. Aggregating identical or very similar technologies such as all coal-fired power plants or all gasoline-fueled passenger cars and adding all links between them, we can consider the *Reference Energy System* (RES) of an economy. Note that a RES is not uniquely defined, but rather depending on the level of aggregation considered in a particular analysis.

For energy planning purposes, it is important to add the concept of *useful energy*. In contrast to the three energy levels just described, useful energy is not represented by an energy carrier. Rather, it is the kind of energy that delivers an *energy service*, which cannot always be expressed in energy units. Examples of useful energy are the heat radiated from a residential heat source and the motion of a passenger car. These two forms of useful energy correspond to the energy services of a comfortable room temperature and passenger kilometers respectively. The importance of the concept of energy services for energy demand is highlighted by the fact that essentially the same energy service is provided by one car with occupancy of four as by four cars each carrying one passenger over the same distance. Obviously, final-energy consumption is drastically different in the two cases.

3. Means of Energy Planning

Although energy planning can be part of a business plan of a private company, the focus of the discussion in this section will be mostly on public energy planning.

The prime instrument available to policy making to influence the quantities of different energy forms in the market is to influence prices of goods and services via the collection of taxes on their production and/or consumption. Since governments anyway need revenues to function, the question is often asked, why not tax dirty and exhaustible resources such as fossil fuels more and renewable resources such as human labor less. A partial answer to this question is that as any tax change creates a new kind of distortion of the economic "playing field", it is politically difficult and often infeasible to introduce a new tax without compensation for those who suffer new losses. Thinking of a significant carbon dioxide tax, for example, a realistic assumption is that major emitters of carbon dioxide would have to be compensated for their new financial commitments, which in turn would weaken the desired effects of such a tax. Another drawback of many environmental taxes – in particular in comparison to an income tax – is that according to many studies they are *regressive*, that is, consumers with lower disposable income would be taxed a higher share of it than consumers with higher income.

Both of these two reasons against an environmental tax have to do with distributional consequences of the introduction of new taxes. Distributional aspects are important for all kinds of policy measures. They are therefore a prime criterion in the assessment of policy options. This and other assessment criteria will be described in a separately below (see Section 0).

Subsidies are the mirror image of taxes. In the past years, it so happened that subsidies often enhanced the use of "dirty" fuels such as coal for power generation, therefore not always furthered the cause of the environment. Nowadays, subsidies are more and more granted also to renewable energy, often in the form of guaranteed selling prices. Subsidies are a typical instrument of national energy policy making and therefore described in more detail in the following.

Taxes are only one way of internalizing external costs. Another possibility is to issue emission permits, each of which allowing its owner to emit a certain amount of a pollutant. The emission of any amount of this pollutant is then allowed only if an equivalent amount of permits is held. The rules for the allocation of such permits are a separate policy issue, which will be discussed together with the examples described in the following.

In theory, a system of tradable emission permits is equivalent to emission taxes in the sense that a limit on total emission leads to the same effect as an emission tax set at the level of the shadow price of the emission constraint. In less technical terms, this means that an emission tax set equal to the marginal abatement costs – the costs of abating the last unit of emission to stay within the emission limit – generates the same economic costs and the same environmental benefits as a "command and control" emission limit assuming a corresponding number of tradable permits to be issued. In other words, analyzed to this depth, the two policies are equivalent in terms of economic efficiency. Ignoring for a moment that this equivalence does not include the differences between the transaction costs of both strategies, there are also very practical differences between the two. Emission limits aim at precise emissions, but incur uncertain costs whereas taxes incur unambiguous costs, but result in uncertain emission reductions. The circumstances in an actual decision situation will therefore have an influence on the question which of the two policies to select.

In an energy planning situation where the aim is to freeze emissions at a certain level, the so-called "grandfathering" is an often-quoted allocation rule. This rule freezes the status quo for each emitter. Obvious as this rule may seem at first glance, it appears at least questionable if applied to global carbon emission entitlements, because it would "award" the heaviest polluters by granting them the largest emission entitlements, hardly an equitable proposition. On a national level, if emission permits were granted to industries for example, grandfathering permits would have the additional disadvantage of working as an obstacle to new entrants into the market.

As an equitable rule for the allocation of permits, equal emission rights for each person have been proposed. This rule is tantamount to granting equal property rights (to a carbon-free atmosphere, for example) to everyone and therefore highly suggestive, but the re-distributional consequences of its application are so great (it would force the politically most powerful industrialized countries to reduce their emissions the most) that the likelihood of its actual implementation is sure to remain low for a long time.

Anyway, a carbon tax addresses the issue of economic efficiency, and the endowment with emission permits addresses issues of equity. Although it does not necessarily help actual negotiations, it seems worth emphasizing here that the two are separate issues that are largely independent of each other.

Another major class of means for energy planning comprises general organizational or legal measures. An example of a general organizational measure would be the establishment of binding or non-binding standards. An extreme form of standard setting is a product ban, a policy measure that was introduced in the "Montreal Protocol on Substances that deplete the Ozone Layer", which prohibits the import/export of controlled substances from non-members and bans the export of relevant technologies to them.

A legal measure aiming at improving the information base of consumers is the mandatory labeling of energy-consuming goods. Labels on electric appliances, for instance, would inform consumers about the energy consumption and the environmental impact to be expected from the use of the item, thus enabling consumers to make educated decisions about the benefits (in terms of energy savings and a reduced burden on the environment during the lifetime of the item) of a possible higher purchasing price of an environmentally more compatible and less energy consuming alternative. Empirical studies have shown, however, that the discount rates calculated from actual consumer purchasing decisions can be much higher than market discount rates. In other words, higher purchasing prices of energy-consuming equipment must pay back in very short times to make the increased investment attractive to consumers. This observation has been made for individuals as well as for companies. The discrepancy between market discount rates and consumer expectations has been wide enough to encourage private entrepreneurs to establish energy service companies who take care of the energy services required by a company. These energy companies work for part of the discrepancy of the discount rates, thus still reducing total energy expenses of the client firm ("contracting").

Less an object of policy making, but more an example of energy planning, are voluntary action and voluntary agreements, which have become an important means to reduce negative environmental impacts. The propensity to voluntarily invest in environmental protection depends of course on values and beliefs held in a society. To influence value systems is a long-term energy planning task, usually addressed by education on all levels.

The specific kind of policy measure chosen for implementation depends crucially on the geographical scope of energy planning. In the sequel, we shall therefore discuss energy planning according to the geographical scale of externalities that it addresses.

4. Global and International Energy Planning

For lack of a global government and, by and large, of equivalent institutions, no planning in the conventional sense of legislation and execution happens at the global level. Nonetheless, the tasks of energy planning described above are no less important in a global context than they are in the traditional domains of governments. An example of the role played by laws and regulations in a national context is that of multilateral environmental agreements such as the UN Framework Convention on Climate Change (UNFCCC) on a global level. In this example, the according equivalent of a parliament would be the Conference of the Parties (COP) of the UNFCCC. A kind of scientific arm of the UNFCCC is the Intergovernmental Panel on Climate Change (IPCC), jointly established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988.

Other international institutions playing roles in global energy planning include (1) the Global Environmental Facility (GEF), a multilateral fund initially endowed with US$ 1.5 billion. This fund would financially support developing countries to carry out environmental projects including the area of climate change; (2) The Carbon Technology Initiative (CTI), a multilateral initiative of 23 IEA/OECD countries and the European Commission to promote the objectives of the United Nations Framework Convention on Climate Control (UNFCCC). Its goal is to foster international co-operation for accelerated development and diffusion of climate friendly technologies and practices for all activities and greenhouse gases; and (3) the Prototype Carbon Fund (PCF), which was established in July, 1999 by the World Bank. The PCF, with the operational objective of mitigating climate change, aspires to promote sustainable development, to demonstrate the possibilities of public-private partnerships, and to offer a structured "learning-by-doing" in the area of projects that will produce high quality greenhouse gas emission reductions, that could be registered with the United Nations Framework Convention on Climate Change (UNFCCC) for the purposes of the Kyoto Protocol. To increase the likelihood that the reductions will be recognized by the Parties to the UNFCCC, independent experts will follow validation, verification and certification procedures that respond to UNFCCC rules as they develop.

One of the first planning goals the UNFCCC has set is the "Kyoto Protocol", which was established at its third Conference of the Parties (CoP 3, held in Kyoto in 1997). The Kyoto Protocol requires the industrialized (Annex I) countries to reduce the annual emissions of six greenhouse gases by "at least" 5 % – relative to 1990 – during the five-year period 2008–2012. The agreement is a result of the endeavor to set a first quantitative goal and to initiate serious action in pursuit of the overall objective of the UNFCCC. One problem with the "Kyoto limit" is that it is not absolutely necessary and by no means sufficient to avoid dangerous climate change. It therefore reflects the difficult reality of international problem solving, which is further emphasized by its still outstanding ratification (as of May 2003).

Many of the debates surrounding the Kyoto Protocol concern the restrictions applying to the so-called *flexibility mechanisms*. From the theoretical point of view, restrictions may appear as an unnecessary complication, because *international emission trading (IET), Joint Implementation (JI)* and the *Clean Development Mechanism (CDM)* all describe mechanisms that introduce flexibility – thereby enlarging the basis for achieving cost-effectiveness – into the choice of the place and the circumstances under which greenhouse gas emissions are to be reduced. In practice, however, some of the restrictions aim at protecting interests of Parties to the UNFCCC and/or the effectiveness of the Kyoto Protocol. The differences between the three mechanisms seem artificial from a theoretical perspective, but they are extremely important from a practical political point of view. Not surprisingly, the difficulties in implementing projects under the rules of the flexibility mechanisms are of the same kind as the difficulties of allocating an initial endowment of emission permits.

One difficulty with respect to the endowment with emission entitlements has already arisen in the case of the Kyoto Protocol, i. e., the formerly Planned Economies were allocated emission limits that are not likely to be binding. Under a scheme of emission permit trading, countries like Russia and Ukraine would thus be able to sell part of their entitlements without having to reduce any extra emissions at home. The amount of emission entitlements that could be traded without an emission reduction effect is often referred to as "hot air". Buying major amounts such "hot air" can be expected to become a problem of public acceptance in most prospective buyer countries. Should such trade of "hot air" actually occur, it would most likely have to be accompanied by side agreements that make sure that the transferred money serves the goals of the UNFCCC sooner or later.

Recent examples of international voluntary action are those by multinational firms. For example, with the beginning of the year 2000, BP Amoco implemented its global emission-trading program. This program has the goal to reduce the company's emission of greenhouse gases by 10 % from a 1990 baseline over the period to 2010. The program was given preference over a program that would have introduced internal emission "taxes" because it was argued that an emission trading system provides the most economic and most effective route for reducing emissions. An even more ambitious reduction is the goal of Shell's STEP (Shell Tradable Emission Permit System) program, which has already committed 10% reduction in GHGs emissions by 2002 against its 1990 level. The Shell system is based on the company's practice to measure, report and externally verify its greenhouse gas emissions. Compliance measures include internal fines.

Both trading schemes have of course also an experimental character. For example, abatement costs are still unknown, Shell estimating that illustrative values will be in the range of 5 US$ to 40 US$ per tonne of carbon abated.

A prerequisite for successful action in the environmental area is environmental management. This simple observation was the thrust behind the activities by the International Standards Organization (ISO) – and others – to introduce standards for environmental management. Similar to standards assuring quality management (the ISO 9000 series) the ISO 14 000 series of environmental management standards was introduced. Companies can apply for certifications that they abide by these standards, which makes acquiring certification by these standards, an example of voluntary action.

Clearly, certification according to either standard as well as successful voluntary measures have a significant advertising value for the companies that have been awarded an ISO certification or that carry out environmental projects. This may be perceived as an infringement on the voluntary character of these actions, but a major difference between voluntary measures and laws remains.

5. National Energy Planning

Conceptually, the difference between global or international and national energy planning is that the latter refers to decision making within one national economy. (In the sense of this section, energy planning by a political entity such as the European Union belongs to the national rather than to the international part.) As a practical consequence, national energy policies can be formulated and carried out by existing decision-making bodies and within an existing jurisdictional framework, which often makes national planning easier than international planning.

One example for such a policy is the establishment of a market for tradable sulfur allowances in the US in 1995. The purpose of this policy was to drastically reduce SO_2 emissions by the electricity sector and to provide an institutional framework for a genuine market in emission allowances with a minimum of regulatory restrictions or other market interference by the authorities.

The experiences gained from sulfur trading gave rise to the design of a scheme for carbon emission trading that combines the success of and the familiarity with sulfur emission trading with the cost certainty of an emission tax. According to that scheme, the government would offer additional permits at a pre-specified trigger price. Like a carbon tax, this hybrid scheme fails to guarantee a particular emission level but it limits the economic cost of the program.

Technological progress is one of the most important factors influencing the costs and benefits of energy conversion and end-use. This progress can be accelerated by research, development, demonstration, and deployment. All these activities are undertaken also by private companies, but since not all benefits from technological progress accrue to the firms investing in its acceleration (the so-called "spill-over" effect), governments are called upon to take care of this externality by supporting investments in these areas and by protecting the benefits of successful development by law.

In the analysis of technological progress, the experience-curve concept (also: learning-curve concept) has received increasing attention. (The concept is described in *Energy Planning Methodologies and Tools*) According to this concept, technological progress has an element of learning-by-doing, which means that a new technology, which is too expensive to be competitive at a given point in time, can be expected to become cheaper as a consequence of deployment, i, e., the accumulation of experience with that technology. A role of a government could therefore be to support this particular kind of technological progress by procurement of a "learning" technology. If the speed of "learning" and existing price differentials are sufficiently favorable, doing so can therefore lead to overall cost savings in the longer run despite seeming irrational from a myopic economic point of view.

This stratagem seems particularly suited for supporting new and promising technologies, such as fuel cells, solar photovoltaic, and eolic (wind) energy and has indeed been incorporated into a recent case of actual policy making in Germany. In February 2000, the *Deutscher Bundestag* (German Parliament) passed a law on the priority for electricity from renewable energy technology. The new law puts an obligation on the utilities to buy electricity produced from specified kinds of renewable energy at a guaranteed minimum rate. Guaranteed rates are reduced annually. Starting in 2002, the guaranteed rates for new installations are reduced year-by-year by a fixed percentage. For photovoltaic electric conversion (PV), the law sets up a checkpoint at cumulative capacity of 350 MW. When investments in PV reaches this point, the *Deutscher Bundestag* has to take a new decision on guaranteed rate for PV considering the cost reductions that have been achieved since the law was enacted.

In the sense that the German Government attempts to make sure that the longer-term societal optimum is met, it addresses one kind of market failure, one which is characterized by costs and benefits of a particular consumer decision being distributed among different groups of people.

Another opportunity for governments to address this general type of market failure is a situation in which a house or apartments are built by one agent, but then rented by tenants. Any investment costs of energy-saving equipment would then be carried by the constructor when the benefits of reduced conditioning costs would be enjoyed by the tenants. Although it would still be rational to optimize the overall system, the incentives for doing so are of course reduced. This is therefore a typical situation, in which standard setting is a policy that can effectively address this situation.

Another important kind of market failure is the lack of information available to consumers who make purchasing decisions. To address these, governments can introduce labeling rules that inform consumers about the technical and environmental performance of consumer goods. As the programs selling "green" electricity show, demand for electricity that is generated in an environmentally friendly way exists, and consumers are prepared to pay a premium price for it.

6. Regional and Local Energy Planning

The distinction between national and sub-national energy planning is warranted by the different areas of responsibility on the two levels. These are defined differently in different countries, but the importance of the smaller organizational entities must not be underestimated. After all, any planning is carried out eventually by individuals, who act first of all in a local environment. This insight has been highlighted by the well-known slogan "think globally, act locally".

Typical examples of local energy planning are urban transportation, district heating, regional development, addressing local environmental problems such as deforestation (fuel wood), urban air quality, waste management, and others. These fields provide for ample energy planning tasks. In principle, the same set of policies and measures are suited to tackle these tasks, but their applicability depends on how the planning responsibilities in a country are allocated to the different levels of decision-making. The observation that the local level is the one that is closest to the individual suggests that this level is the natural place for initiatives aiming at the information and education of citizens in the widest sense. Education is perhaps one of the "slowest" strategies leading to environmentally compatible energy systems, but its success is a prerequisite for the effectiveness of all policies at higher hierarchical levels. This refers not only to the natural inclination of individuals towards "free-riding" but also to the effectiveness of voluntary action by companies. If such voluntary action would not have the effect of making a company profile attractive to environmentally conscious consumers, the value of the voluntary action to the company would be greatly reduced.

7. Assessment Criteria for Policy Options

Criteria for the assessment of policy instruments can be classified into the following three groups. The first group is effectiveness. Generally defined as effect per unit of effort, this assessment criterion can be used for a comparative assessment of two or more policy options. Perhaps the most important example is cost effectiveness, which calculates the specific costs of achieving a desired effect. In the absence of side effects, cost effectiveness permits the ranking of policy options. Side effects can add to or subtract from a calculated cost effectiveness not only with respect to different policy goals, but also with respect to the same goal, i. e., by indirect effects. An important strategic and methodological aspect of effectiveness is that it can be used to analyze problems that would ideally be solved by optimization, if only the objective function would be known. A prominent example is climate change. Since the future benefits of carbon dioxide emission reductions are highly uncertain, the usefulness of optimization is limited, but the cost effectiveness of any policy option – expressed, for instance, in dollars per ton of carbon abated – is useful as soon as at least some mitigation is being legislated. For addressing abatement costs, the criterion also includes an assessment of the potential of each policy or measure. A full analysis of a set of measures to mitigate pollutant emissions would then result in a "supply curve" (in the form of a step function) of mitigation options – ranked by increasing specific costs – and their potentials. Such a curve would quantify how much benefit can be expected from spending a given amount. In particular, such a curve would also express, for each level of effort, the marginal costs of achieving an additional unit of benefits.

The second group of policy assessment criteria is that of social considerations and wider economic effects. This criterion includes many effects that cannot be readily quantified as in the previous group, for example the consequences of policies and measures on equity (including all aspects of the distribution of costs and benefits), development, technological progress, or employment.

The third group of criteria addresses administrative, institutional and political aspects. This group includes all considerations that address the feasibility and foreseeable effectiveness of policies, for example financial feasibility, public acceptance, capabilities of existing institutions in terms of information collection, monitoring, enforcement of compliance, and general political feasibility.

In particular, in view of the considerable uncertainty often surrounding the environmental effect of policies, an important strategic criterion of policies is flexibility. As we have seen in the case of the climate change problem, the uncertainty with respect to the critical level of atmospheric greenhouse gas concentrations suggests that the most flexible policies will be preferred, i. e., those policies that allow for fast mid-course modifications should future scientific findings re-assess costs and benefits of greenhouse gas mitigation.

Glossary

Energy service:	The ultimate purpose of energy end-use. A particular energy service need not be measurable in energy units (passenger-kilometers, for instance).
Externalities:	Non-monetary costs or benefits of a market interaction.
Final energy:	The form of energy bought and sold in the market to final consumers.
"Grandfathering":	A right based on past facts. Here: a flat-rate reduction of past of emissions.
Market failure:	A situation in which an – environmentally and economically – preferred outcome does not happen.
Primary energy:	Naturally occurring forms of energy
Secondary energy:	the result of a first step of conversion of primary energy
Shadow price:	Here: the costs of abating the last unit of emission to stay within the emission limit.
Useful energy:	The form of energy that delivers an energy service.

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Biographical Sketch

Leo Schrattenholzer has been affiliated with IIASA (International Institute for Applied Systems Analysis) since 1973, after graduating from the Technical University of Vienna. Presently he is Leader of ECS (Environmentally Compatible Energy Strategies) Project at IIASA.

The focus of his present work in the ECS project is in the field of energy technology assessment, including the analysis of the role of research and development in enhancing technological progress.

Dr. Schrattenholzer received his master's degree in mathematics in 1973 and his Ph.D. in energy economics in 1979, both from the Technical University of Vienna. His Ph.D. thesis was on modeling long-term energy supply strategies for Austria. From 1972 to 1974, he was a research and lecture assistant with the Institute of Mathematics I of the Technical University of Vienna. He has worked as a consultant to the Energy Sector Management Assistance Program sponsored by the World Bank and UNDP, for which he conducted a major project assessing personal computer models for energy planning in developing countries. He has also been a consultant to governmental institutions on national strategies to reduce greenhouse gas emissions. Other consultancy work has included the design and implementation of a computerized information system about space heating demand in the city of Vienna. He has represented IIASA-ECS in international teams working for three major projects co-sponsored by the European Commission and has lectured at universities and other educational centers. He is a Lead Author of the IPCC's (Intergovernmental Panel on Climate Change) Second Assessment Report. He is also the member of editorial board of the Pacific and Asian Journal of Energy (PAJE) and the International Journal of Global Energy Issues (IJGEI).

His scientific interests include the development, implementation and application of energy-economy-environment models, energy forecasting, and scenario analysis.

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