States, Markets and Energy Use Patterns in China and India Holly Sims

During the second half of the 20th century, states and private marketled forces emerged as key players in the production and distribution of energy critical to the economic growth of pivotal developing countries, including China and India. In both countries, major responsibility for energy production and distribution was initially shouldered by states, with rapid industrialization as their overriding objective. The critical test of energy systems? performance was simple. They were to serve instrumental economic purposes and to a much lesser extent, political ones, since a share of scarce amenities was channeled to rural areas, where most people lived.

A new criterion for assessing the systems' performance--efficiency-became increasingly compelling in the 1970s and 1980s, due to global economic developments and domestic policy changes that widened scope for market-led forces. During roughly the same period, a third criterion for assessing energy systems -- environmental responsiveness -- arose from mounting international concern about the health of the planet. This paper discusses the experience of China and India in developing energy systems since the 1950s and compares their recent efforts to improve efficiency and environmental responsiveness. The paper?s argument may be summarized as follows. The political economy of Chinese and Indian energy policy evolved in broadly similar fashion from the 1950s until the 1970s. Thereafter, the two states responded to pressures for energy system efficiency and environmental responsiveness in different ways, reflecting their contrasting political systems. For example, China's authoritarian structure that combines economic liberalization with political control has facilitated official efforts to pursue market-led energy policies that have foundered in democratic India.

Yet India's federal system highlights ambiguities in notions of environmental responsiveness, and conflicts between national and local perspectives in particular.

Despite constraints imposed by political economy and political structures, there is considerable scope in both countries to develop energy systems that could be widely seen as environmentally responsive, particularly in rural areas, which often are poorly served by state-led instrumental or market-driven energy systems. Examples of such promising initiatives are provided in the concluding section.

It is important to emphasize the parallel factors that shap ed the initial design of Chinese and Indian energy policy systems. China and India are among the few major countries whose primary source of energy is coal. The ?ignoble fuel?² blamed for greenhouse gas production, acid rain and serious air pollution and health hazards accounts for almost 70 per cent of industrial energy use in China, and over half of primary energy sources used in India. Coal use helps both countries retain claims to some of the world?s most polluted cities.

The priority of economic development is underwritten by the striking gap between industrialized and even rapidly-growing non-industrialized countries in terms of energy access, and by population pressure. Although the range of high and low temperatures is broadly similar in China and the United States, the average person in China uses only 3 per cent of the energy used by the average American.³ An estimated 100 million Chinese live without electricity.

India's population is three times that of the United States, but the former?s energy use is little more than a tenth of the U.S.A.'s commercial energy consumption.⁴ Population pressure upon shrinking resource bases makes development all the more urgent. By 2025, China and India may represent 3.75 per cent of the projected global population of 8 billion.⁵

Variations in the impact of dissimilar political systems upon energy policy are highlighted by the ?double-edged? perspective of Peter Evans, et

<u>al</u>., that brings both domestic and international reference points and constituencies into focus.⁶ The need to do so becomes particularly important beginning in the 1970s, with widening global economic integration and mounting global environmental concerns. Both trends influenced the roles of states, market forces and international agencies in economic development and energy production. The ensuing discussion explains why states took a leading role in energy policy in China and India. First it is essential to clarify criteria of energy policy systems? performance.

Criteria of Performance

Contemporary Chinese, Indian and also Brazilian energy systems evolved from broadly similar centralized, state-led production and distribution mechanisms that were primarily designed to be instrumental to economic growth via rapid industrialization. Since strategies to achieve that goal in low income countries with vast and dispersed rural populations and limited infrastructure were not entirely clear, policy-makers were concerned more with the goal of development than with specific means to achieve it.⁷ Efficiency, denoting "ability to produce the desired effect with a minimum of effort, expense or waste,"⁸ was not a useful or even applicable test in the 1950s and 1960s. At mid century, risks and costs of investment in the rural areas that predominated in most low-income countries were high and potential returns a distant mirage.

The efficiency of energy production and distribution can be judged only when standards of desirability and plausible relationships between causes and effects are clear and widely recognized. Specific problems and pressures that directed state leaders' attention to efficiency in energy production and distribution are noted in the ensuing section. Yet the pursuit of efficiency proved difficult in countries with elaborate state structures and real or potential political concerns.

The third criterion, environmental responsiveness, is potentially controversial, particularly when both standards of desirability, or goals, and strategies to pursue them are ambiguous or contested. Nuclear power offers a good example. People who broadly agree on the need for environmental responsiveness may disagree whether nuclear power's advantages relative to fossil fuels offset its intractable management risks and waste disposal problems. Instead of proposing a narrow definition of 'environmental responsiveness' based upon an exclusive list of such promising renewable energy sources as solar energy, wind power, biomass and small hydropower projects, the definition of 'environmental responsiveness' will be left broad, in order to focus more on policy change.

One of the most important obstacles to environmental responsiveness is persistent global reliance on coal, earth?s most abundant fuel. Coal generates about 35 per cent of the world?s electricity, and the figure may rise to nearly 40 per cent by 2010. If coal remains the ?fuel of choice for electricity generation in the foreseeable future, ?⁹ new 'clean coal technologies' that limit environmental emissions deserve serious consideration as possible means to advance environmental responsiveness, even if longer-term strategies emphasize alternatives to coal.

In the short term, other practices or technologies also are available to make energy use more efficient and/or environmentally responsive. They include conservation, sometimes called 'demand side management,' and cogeneration, which involves the simultaneous production of electrical or mechanical power and thermal energy from a single fuel source.

In sum, environmental responsiveness may accommodate a range of possible strategies whose absolute merit may be debated. The range of alternatives

allows space for new technologies to become available and clearer standards to crystallize. In the meantime, even when there is broad agreement on objectives and standards of environmental responsiveness, there may be tradeoffs between efficiency and environmental responsiveness and also official instrumental goals.

For example, some might decry rising energy intensity in rural areas of India and China, as subsidized commercial fuels such as kerosene and coal encourage a shift from traditional biomass.¹⁰ Yet the resulting losses in energy efficiency may be offset by gains in environmental responsiveness, since the use of commercial fuels obviates the need to collect biomass and thereby aggravate deforestation. Provision of subsidized fuels may also serve official instrumental goals related to the equitable distribution of critical resources.¹¹ In short, prospects for improving efficiency may be limited by other important considerations. Yet the ensuing discussion of state-led instrumental energy systems suggests that there is broad scope for improving efficiency, in order to use energy with less pollution and waste.

STATE-LED INSTRUMENTAL ENERGY SYSTEMS

The state-led energy production and distribution systems that emerged in China and India mid-way in the 20th century bore the hallmarks of prevailing development theory. Theorists assigned states and their public sectors the leading role in economic growth, which involved rapid industrialization and import substitution through the centrally-planned development of heavy industry in particular. In India, the private sector was too limited in size and scope to orchestrate energy production and distribution on a large scale. The People's Republic of China established by Mao Zedong in 1949 envisaged no role for private participation in such a critical sector.

The priority task of industrialization oriented all three nations' power systems toward large-scale energy production through massive dams, power plants and oil refineries. Coal and oil, the fossil fuels that sparked 18th

century Britain's industrial revolution, were widely seen as 'modern' energy sources, and critical ingredients for advanced large-scale production. China and India were well-endowed in terms of fossil fuel resources and they claimed some of the world's most vibrant and majestic rivers. As a result, giant hydroelectric power plants offered another important energy option. Major dam projects appealed to leaders in many developing countries because they represented symbolic giant steps toward 'modernization.' Indian Prime Minister Jawaharlal Nehru captured such sentiments by alluding to major dams as the temples of modern India. The grandest hydroelectric project was conceived for China. For the Chinese political leadership, the Three Gorges Dam over the Yangtze River represented not only the source of 18,200 megawatts of electricity, equivalent to energy produced by about 50 million tons of coal each year, but also a symbol of national pride and achievement.

If state leaders' ambitions for drastic change were sometimes heroic, their reach into the hinterlands generally was more attenuated. The countryside was often overlooked in urban-based leaders? race for development, whose benefits and opportunities were widely expected to trickle down to widening constituencies over time. Meanwhile, rural people overwhelmingly depended upon traditional biomass fuels, which were not traded in marketplaces but gathered from fields and forests.¹² Estimates of biomass use vary widely, reflecting difficulties of measuring trends beyond the market economy.

The importance of political factors--specifically, rural constituencies and official adherence to equity in China and India--served to extend both commercial energy and new industries and to rural areas, particularly since the 1960s, when agricultural development drew increasing official attention. Economists might criticize 'inefficient' uses of resources, ¹³ but possible compensating advantages deserve note. In China and India, rural investment served to slow the pace of urban migration, thereby mitigating pressures of rapid urbanization. Brazil's rapid but regionally specific industrialization and relative concentration of energy resources in early years of its development reflects state leaders' more narrowly focused priorities and constituencies.

On balance, Chinese and Indian state leaders' achievements merit recognition. Chinese leaders could take pride in mastering the design, manufacture and operation of what became the world?s third largest power system after that of the USA and Japan. In 1950, total annual electricity generation was only 4.6 terawatt-hours (TWh); by 1994, the figure had increased to 928 TWh.¹⁴ During the Ninth Five Year Plan (1996-2000), officials hoped to increase annual electricity capacity by about 20 gigawatts per year, equivalent to adding a major electric power station every two to three weeks.¹⁵ India?s power sector increased from production levels of 2300 megawatts (MW) in 1950 to 69618 MW by 1992. Officials said the country needed to add up to 8,000 megawatts of new capacity each year until 2013.¹⁶

Organization and Management

Mid-century perspectives on the efficiency of centrally-planned and orchestrated development significantly affected the organization of production and distribution of energy resources. In China, provincial and other subnational electricity providers in the country's 23 provinces and five autonomous regions were restrained by a nationally-directed system. Until 1985, the Ministry of Water Resources and Electrical Power was the main official agency overseeing funding and management of power enterprises. Its annual investment and power supply plans were prepared under guidelines of the State Planning Committee's Five-Year Plans.¹⁷

Central direction was harder to maintain under India's democratic federal political system, which gave control of energy to constituent states. In general, India's 25 states and seven union territories are covered by a system of vertically-integrated utilities that spans the administrative unit. Yet states vary substantially in size and population, and their leaders goals and strategies with respect to energy reflected divergent interests and local

socio-economic power configurations. State government officials have considerable influence over the activities and finances of state electricity boards (SEBs). Official reluctance to yield control over SEBs is reflected in the absence of provisions for effective regulation of the SEBs, by either central government or independent authorities.¹⁸

Both the centralized and decentralized energy production and distribution systems had many shortcomings, including faulty distribution, inefficiency, and heavily polluting carbon-intensity. Faulty distribution covers both sufficiency and reliability of supplies. In short, neither country has a power service that provides energy to all who might require it, and the distribution of existing supplies is unreliable.

Faulty Distribution

Even a casual visitor to Beijing or New Delhi would quickly experience a major shortcoming of state-led power systems. Power outages or blackouts, euphemistically called "load-shedding" in India, are a feature of daily or weekly life. Long-time residents of both capitals may attest to a deterioration in power supplies. In the 1960s and early 1970s, India produced more electric power than it could use, but faced growing shortages in the 1990s. During peak hours in 1997, officials reported shortages of 20 per cent.¹⁹

China also faced increasing and widening power shortages and gaps between supply and demand, even in such favored areas as Shanxi province, which has abundant energy resources. National average peak hour power shortages ranged around 20 per cent. Losses in terms of economic output were high, and certain to increase, despite official efforts to dramatically expand supplies.²⁰

In part, the overall unreliability of energy supplies reflects such generic problems of underdevelopment as inadequate infrastructure,

particularly transportation networks. China's coal production is centered in northern and northwestern China, whereas its booming industry is mainly in the southeastern region. The difficulties of transporting supplies from the world's richest coal region to southeastern factories are ironically underscored by China's recent decision to import coal supplies from Australia.²¹ Production and transportation costs have also sobered potential private investors' enthusiasm regarding large oil reserves in China's landlocked Xinjiang region.

Aging energy production facilities also impede reliability of distribution. About 40 per cent of India's power plants are more than 15 years old, and thus prone to repeated breakdowns. As in China, officials sometimes favored investment in new plants instead of allocating adequate resources to plant renovation that could extend plant life and perhaps produce energy at far lower costs than amounts needed to build new plants.²²

Apart from technical problems related to transmission and distribution along power grid networks that are ill-equipped to adjust supplies and demand across regional jurisdictions, unreliable power distribution in India's constituent states also reflects extensive electricity theft. In many rural areas and surrounding towns, a power line is an inviting challenge for entrepreneurs who hijack power resources to the detriment of the financiallystrapped SEBs.

Inefficiency

The efficiency of energy use may be assessed by financial profits or losses to providers, and by energy intensity. Neither measure is entirely satisfactory, but they indicate patterns of production and use that need attention. With respect to financial measures, it bears repeating that Indian and Chinese energy systems were not designed to minimize costs and maximize outputs measurable by profits. Dismaying statistics on financial losses of state-led power systems, which are available for India, should be regarded in that light.

India's SEBs are widely seen as the inefficient Achilles heel of its state-led energy production and distribution system. The SEBS' spiraling annual losses rose to about \$1.7 million by 1995.²³ Such hemorrhages clearly deterred further investment in the power sector and also effective maintenance of existing facilities.

Pricing policy for power is perhaps the major factor in SEB losses. Official policy has often set electricity tariffs at extremely low rates to subsidize use by agriculture, as well as domestic users. Attempts to reduce such subsidies have been countered by state politicians, who can readily mobilize support from agriculturists. Poor management is reflected in deficient metering practices, bill collection and absence of measures to deter power theft.²⁴

China performs poorly in relation to a second measure of the efficiency of energy use, energy intensity, denoting energy consumption per U.S. dollar of Gross Domestic Product (GDP). China's energy intensity is 18 times that of Japan, whose energy intensity is lowest among industrialized countries, while India's is four times that of Japan.²⁵ Economists might offer several explanations, including obsolete facilities and processes, poor energy management and lingering low energy prices that discourage efforts to improve energy efficiency.²⁶ It is important to note that a developing country may use more energy per unit of output precisely because it is developing, rather than using larger proportions of energy to support such economically nonproductive activities as watching television and driving automobiles.²⁷

Deficiencies of state-run energy systems became more compelling with economic growth and population pressure, since both trends increase demand. Global economic, political and technological changes also yielded new criteria of performance, along with new opportunities and constraints.

PRESSURES FOR EFFICIENCY AND MARKET-LED ENERGY SYSTEMS

Fossil-fuel based energy policy systems throughout the world faced a major impetus for change in 1973 and 1979, when international oil prices unexpectedly skyrocketed. Producer nations thereby challenged complacency regarding development goals and strategies in countries that imported oil. Official responses in oil-importing countries reflected actual or perceived vulnerability to external threats to fossil fuel supplies. China's fossil fuel reserves made it relatively invulnerable to international oil prices increases in the 1970s. India's more limited oil resources led officials to try to reduce oil imports and rely more upon indigenous fuel sources. The most convenient alternatives, coal and steam engines, saved foreign exchange but did little to improve either energy efficiency or environmental responsiveness.²⁸ Like their counterparts in many other oil-importing countries, Indian officials considered alternative fuels based on renewable sources. Brazil is one of the few countries where renewable energy programs drew strong official support in the 1970s, largely because its leaders had long been aware of limitations on indigenous fossil fuel resources and thereby supported experimentation with biomass-based fuels such as ethanol or ethyl alcohol, which is produced by the fermentation and distillation of sugar derived from molasses and from agricultural residues.²⁹ Ethanol can be used in vehicles as a premium liquid fuel to supplement petroleum-based fuels.

In China and India, domestic and international economic developments provided stronger impetus for national energy policy change than did the oil price shocks of the 1970s. Variations in the timing and nature of economic change helps to explain dissimilar impacts on national energy policies, which also reflected contrasting political structures in the two countries.

China's major steps toward a market-led economy occurred almost a decade earlier than those of its Indian neighbor, and they reflected deliberate policy measures designed to accelerate economic growth and thereby achieve state leaders' goals of technological modernization. The reforms initiated in 1978 by the late Vice Premier Deng Xiaoping decentralized economic administration; allowed scope for market forces and opened China to the international economy.³⁰ Because Chinese leaders were isolated both from major industrial powers in the international arena and from domestic opinion, economic and political change was controlled to a degree unimaginable in democratic India.

In India, links between domestic and international politics and economics were as exposed and potentially hazardous as a wayward surging power line. In large part, economic reforms were enacted in 1990-91 in response to external crisis, specifically in foreign exchange reserves, which followed a steep rise in world oil prices accompanying war in Kuwait. Subsequent external pressure for economic policy change made state leaders vulnerable to criticism from attentive domestic constituencies who might contend that market-led growth and heightened foreign investment threatened important values of equity and self-reliance. The ?double-edged? perspective that places state leaders upon both a global and domestic stage captures influences of authoritarian and democratic systems on energy policy reforms.

Political Systems and Energy Policy Change

In the 1980s and early 1990s, both Chinese and Indian leaders dramatically reversed energy policies that excluded private sector participation, and expressed support for efficiency as a new criteria of energy system performance. At first sight, state leaders? approach to potential private investors, particularly foreign investors, seemed parallel. Both countries solicited external foreign investment for energy needs made more urgent by global economic integration and increasing competitiveness. The latter trend was buoyed by mounting interest in industrialized countries about market potential in the world's most populous nations.³¹ It met dissimilar conditions in the two types of political systems.

Chinese officials' control vis-a-vis both external and domestic constituencies was reflected on several counts. First, the formal domain of

China's interaction with international agencies is relatively small and restricted in scope. Second, state officials sought to maintain clear priorities for investment, and exercised considerable control over economic actors' activities. As the Minister of Power Industry commented, "Since power supply is of great importance to the national economy, foreign investment in it will proceed under the State's macro-control." ³² Particularly in early years of China's opening to the West, foreign investment was limited to Special Economic Zones on China's eastern seaboard, where its effects could be monitored. Third, in sharp contrast to India, negotiations between Chinese officials and international economic interests could be held behind closed doors. Terms of discussion did not become public issues, let alone political issues.

In India, questions raised in parliament and in the nation's free press thwarted efforts by state officials to keep negotiations with foreign investors within quiet halls of government. Central leaders' attempts to attract foreign investment with 'fast-track' approvals backfired as various projects, most notably a power station proposed by the U.S.-based multinational Enron Development Corporation, were subsequently caught in domestic political maelstroms and widespread criticism by India's attentive public.³³

Experience on the domestic front further illustrates a domestic political system's ability to complicate the quest for efficiency through market-driven policy change. Prices and private ownership are linchpins of market-based activity, but in a democratic political system, both may become public and political issues rather than policy issues addressed in cloistered deliberations by officials and policy experts.

In India, as in the United States, energy prices are inherently political issues; thus proposed price increases justified as means to efficiency or environmental responsiveness are fair game for contending politicians. Indian voters' opposition may be expressed more dramatically than in the United States, since representatives of the former's vast agricultural constituency have mobilized in violent protest of market-led energy prices.³⁴ Subsidies to electricity used in agriculture reflected not only the 65 per cent of the population in various state politicians' constituencies but also an overriding national priority, since agriculture constitutes 34 per cent of India's GDP.³⁵

China's subsidized electricity prices were not substantially changed for 30 years, until central officials undertook price reforms to promote costeffectiveness and energy conservation. Official resolve to wield a key instrument of market-led economic reform apparently was not tempered by the political obstacles that daunted their Indian colleagues.³⁶

Similarly, administrative reform seemed uncomplicated in China but fraught with political difficulties in India. China's once-mighty Ministry of Water Resources and Electrical Power (MWREP) was superseded by new, streamlined organizations including 30 provincial power companies and six power groups from 21 of the 30 provincial power companies. As parastatals only partly owned by government, they were encouraged to follow a popular trend to 'jump into the sea,' a colloquialism suggesting entry into the marketplace.³⁷

By contrast, India's SEBs seemed unready to either jump or be pushed into the sea. External pressure from Bretton Woods agencies to dismantle them angered members of India's sizeable attentive public.³⁸ Many observers expressed skepticism about the World Bank's reform efforts undertaken in Orissa, one of India's poorest states. Its government opted in 1993 to raise electricity tariffs, eliminate its financially-troubled SEB and establish an independent regulatory authority.

While few members of India's attentive public might challenge economists' arguments that investments in dispersed rural communities was inefficient, and subsidized energy distribution in the countryside egregiously so, even fewer Indian political leaders would willingly shoulder repercussions of rising energy prices and limitations on energy distribution, particularly if changes could be linked to external pressure that challenged Indian sovereignty and to financial interests of external utility company shareholders. Domestic political fallout thus reflected back upon national leaders as they faced external economic and political actors.

PRESSURES FOR ENVIRONMENTAL RESPONSIVENESS

The transboundary environmental problems that galvanized concern in the 1970s about the earth?s viability are well-known and need not be discussed here. Patterns discussed in the previous section are also visible in the two political systems? response to global pressure to pursue environmental sustainability, particularly by limiting carbon dioxide emissions that threaten to aggravate global climate change.

In India?s democratic system, political leaders cannot easily address external audiences without drawing attention from domestic constituencies. The latter are particularly prone to monitor policy-makers? statements closely, to watch for signs of capitulation to industrialized countries? pressure that may challenge Indian sovereignty or developmental goals. Such concerns intensified during international discussions on measures to avert global climate change, particularly because many Indians, including vocal environmental non-governmental organizations, argued that the United States showed no signs of accepting responsibility for its disproportionate share of greenhouse gases, but its political leadership instead sought to shift attention to such rapidly-growing low-income countries as China and India. While Chinese leaders might express similar concerns in international negotiations, the important point to note here is that they do not have to simultaneously face criticism from domestic constituencies.

Chinese leaders? relative autonomy from domestic constituencies is even more dramatically apparent with respect to their recent initiatives to

construct large-scale hydroelectric projects. The Chinese leadership?s determination to pursue the Three Gorges Dam project notwithstanding domestic and international misgivings stands in sharp contrast to the limits on power in a democratic political system.

In India, local agitations have challenged national leaders? judgements that large-scale hydropower projects are environmentally responsive. Central authorities may contend that dams are considerably more environmentally responsive than coal-based power projects, but local activists and their supporters among India?s widely-dispersed environmental advocates highlight the importance of local perspectives in ways that are not possible in China. The debate underscores the subjective dimension of environmental responsiveness, and the prospects for competing values that restrain unilateral action in the world?s largest democracy.

Market-led Environmental Responsiveness

Asia provides one of the world's most dynamic markets for energy sources that claim environmental benefits, including clean coal technologies, small hydropower industries and wind and solar power. In both China and India, the 1990s marked increasing use of government incentives to attract industries that could mitigate rising air pollution in both rural and urban areas, and also provide power and employment opportunities. The balance of private industry's attention remains heavily in favor of fossil fuel industries, however, for they serve instrumental purposes of industrial development.

Limiting factors for renewable industries such as solar and wind power include a lack of public information about renewable energy, but perhaps more importantly, the heterogeneity of the renewables sector due to their dissimilar levels of maturity and organization. As a result, it is difficult in many settings to enter markets dominated by fossil fuel industries, which often benefit from government subsidies and research support. The institutional separation between 'conventional' and 'non-conventional' energy sources in India reflects difficulties in inducing SEBs to move away from fossil fuels as their major power source. The Department of Non-conventional Energy Sources was converted into a ministry in 1992. Its elevated status helped to direct attention to India's untapped wealth of renewable resources, but isolation from agencies responsible for 'conventional' fossil fuel energy represented a potential limiting factor, as experience in industrial countries sugggests.

It is important to emphasize that there is nevertheless vast scope for use of renewable energy, including solar and wind power, particularly in rural areas of China and India that have traditionally been served poorly by instrumental systems geared to industrial development, and that may increasingly be short-circuited by private energy systems that promise efficiency based on profitability. Examples of such local initiatives will be provided in the next version of this paper, to illustrate the potential for locally-based initiatives for environmental responsiveness that strengthen local communities and enhance their capacity to bring new skills and perspectives to regional and national arenas. This emerging arena exists in both political systems, and it allows for participation by local men and women, regional and state political leaders, private economic interests and international agencies including the United Nations.

Role of the United Nations in the 21st Century

The United Nations may play a pivotal role in facilitating environmental responsiveness in the coming century by providing information and technical support. It can develop technical capacity in both fledgling environmental agencies and in local communities, in demonstration or pilot projects centered on particular energy technologies. Also, it can promote information exchange among users and potential users, and help governments determine incentives and support for particular renewable energy industries.

Perhaps one of the most critical emerging needs in the wake of energy de-regulation and privatization is assistance in developing mechanisms for accountability, that would make energy producers and distributors answerable to people beyond themselves. Efficiency or profitability is a narrow concern, not an absolute value. In industrialized countries, pricing policy has sparked controversy, particulary when private utilities favor large customers and discourage conservation. Tendencies to prefer fossil fuels over alternative energy sources has also highlighted a need for independent monitoring by representatives of different interests, including environmental protection. Last but not least, there is a need for involvement in monitoring of hazardous power projects, such as nuclear power plants, by people who live in their shadow and unwittingly till their wastes. This may well become a major issue as nuclear power plants claim environmental responsiveness vis-avis fossil-fuel based energy sources.

Summary

At mid century, states sought to develop energy for instrumental purposes, but by the 1970s, their development objectives remained distant goals. As past strategies for achieving development were called into question by uncertain energy supplies such as oil and by technologies increasingly recognized as wasteful and environmentally unsound, two new criteria of energy system performance emerged, efficiency and environmental responsiveness.

Private interests have strong incentives to monitor profitability, which is one aspect of efficiency. States have incentives to measure the overall efficiency of energy use and effectiveness of its distribution. Environmental responsiveness is a shared concern of states, market-led forces and the citizens who use energy in their daily lives. Because of its extensive experience with environmental technology and informal education about its use and effects, the United Nations can and probably will be a catalyst in crystallizing both goals and standards for environmental responsiveness in the 21st century.

NOTES

Unless otherwise indicated, ?systems? refers to energy production and distribution.

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