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Energy pricing

Pricing is the most effective policy instrument to influence production and consumption behaviour, and public finance instruments are often used to affect prices for changes in the economy. Pricing influences technology development and investment decisions. For example, estimates of oil and gas reserves have changed dramatically over the last four decades as crude oil prices have moved upwards. What were not even considered reserves have now become part of reserves. Exploitation of reserves has moved into more and more remote and expensive locations, as the market prices have gone up and provided enough margins to exploit them. As a result, the problem of energy supply security is not as grim as it was some years ago. It is the impact of using different forms of energy on climate that is the larger security issue.

In the light of growing pressure on energy resources and rising prices, nations with their own energy supplies may use them to dominate those that do not have them. Richer nations might use the offer of finances and technology to dominate poor but energy resource–rich countries. The attempts of Venezuela to dominate Latin America and of Russia to keep many old Soviet bloc countries within their sphere of influence by supplying oil and gas at special low prices are good examples; as is the example of China which has invested in Myanmar, Sudan, and Nigeria, despite government regimes that have received condemnation from much of the world.

Energy pricing is often not considered as a whole but determined differently for different sectors and consumer groups, and varies internationally and regionally. Energy security, however, must consider different micro aspects within the overall macro framework. Thus, it is said that international market prices must determine domestic market prices. But is there a genuine international market price for oil products or are prices a result of cartel influences and military interventions? In that case, should prices from domestic energy sources be determined separately from international prices? Should essential sectors like fertilizers or power generation get energy supplies at lower prices than others? Energy pricing is also complicated by the growing acceptance that energy supplies are a right that all citizens must have access to at affordable prices. This leads to price subsidies for many influential or vulnerable consumer groups, raising issues of targeting and distribution. Also, subsidies impact public resources, and affect the ability of governments to perform in other service sectors such as health, education, and infrastructure, influencing people's attitudes towards their governments. Energy supplies and their prices thus have an effect on internal security because of attendant issues of non-availability, non-affordability, or non-access.

Energy pricing influences relative competitiveness within an economy and between countries. It influences migration of production to places where energy prices are affordable. It affects almost all costs of production and transportation. As such it could have inflationary impacts on the economy, and aggravate income differentials and relative spending power, with the poor being affected the most. These have obvious implications for national security.

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Rising oil prices: resultant incentives for change

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The recent increase in the price of oil has caused serious problems, particularly for a developing country like India, which imports 75% of its oil requirement and where the oil import bill increased by more than 30% in 2007. The prices have registered a phenomenal increase in the last 12 months or so. While the Nymex Light sweet crude oil prices hovered between $55/barrel and $60/barrel throughout 2006 and till the middle of 2007, the price reached $92/barrel in September 2007 and ended at about $100 by the end of the calendar year. In April 2008, it reached the record figure of over $120/barrel.

While there are some expectations of a decline in prices in the summer of 2008, it is very clear that the days of cheap oil are over. According to some theories of 'peak oil', oil production has already reached a peak of about 85 MBPD (million barrels per day) and no substantive increase is possible because of ageing major oil fields and non-discovery of any new fields with substantial resources. The two biggest oil fields at Ghawar (66–150 Gb) in Saudi Arabia and at Burgan (32–75 Gb) in Kuwait were discovered in 1948 and 1938, respectively. Oil production in these two fields, which are now old, is already on declining curves of production. New discoveries have taken place, particularly in the 1960s, but the average size of discoveries has been declining over time. As the increase in oil demand is expected to continue, particularly because of increasing demand from countries like India and China, oil prices, according to this theory, are only expected to harden further. The 'peak oil' theory, however, is firmly rejected by Secretary General, OPEC (Organization of Petroleum Exporting Countries), who goes on to say that 'even your grandchildren will have enough fossil fuels'. However, even if one considers the 'peak oil' prognosis to be too pessimistic, countries, particularly the developing ones, are most likely to face the impact of high prices on their economic growth.

It may be worthwhile to recall the worldwide energy conservation movement initiated in the mid-1970s after the first oil price increases in 1973/74. Japan was in the forefront of this movement and outstanding results were achieved by mid-1980s, on the basis of the direction given by the 'Comprehensive Energy Measures Promotion Cabinet Conference' set up in Japan in 1977. The emphasis on energy efficiency in Japan continues since then. Some results of such efforts in Japan, achieved immediately after initiation of measures in the 1970s are as follows.

- The energy demand declined from 281 kilolitre of oil equivalent for every 100 million Yen of GNP (gross national product) in 1973, to 195 kilolitre in 1983.
- The average mileage of fuel per litre for passenger cars increased from 9.5 in 1973 to 12.8 in 1984.
- The improvement in specific energy consumption for steel, aluminium, cement, pulp and paper, and so on varied between 71% and 99% between 1973 and 1984.

France also took intensive steps in this regard. The emphasis on nuclear energy in France is well known. Apart from diversifying the energy basket, energy intensity also declined drastically as evidenced in the following.

- While the industrial output index went up from 117.5 (base year 1970) in 1973 to 130 in 1983, the industrial energy consumption index came down from 116 in 1973 to 107 in 1983.
- Gas consumption for heating a detached home came down from 2.6 tonnes of oil equivalent per year in 1973 to 1.2 in 1983.
- Today, about 40% of energy requirement in France is met by nuclear energy.

France and Japan are only two examples. In the US, UK, and other European countries too, there was intense activity from the mid-1970s, and the results were for everybody to see. As a result of these developments as also easing of supplies, prices, which increased to very high levels during the Iran–Iraq war in 1979/80, declined continuously from mid–1980s from a peak of $34/barrel in 1982. This decline continued for a number of years reaching the lowest possible level after the first oil crisis to about $10/barrel in 1998. In 2004, the prices were about $36/barrel and then they started going up slowly, ending with steep increases since mid-2007.

If high oil prices are to continue, what are the compulsions or incentives that arise from such price levels? Broadly, the four most important areas of development will include the following.

- Energy efficiency in different sectors aided by new technology
- Greater thrust on oil exploration, particularly in deeper waters, along with a focus on non-conventional oil (oil shale, tar sands, and coal bed methane)
- R&D efforts in renewables because of their increased relative economic attractiveness
- Change in lifestyles

Energy conservation and efficiency

Let us first dwell on the need and prospects for energy conservation. The preceding discussions have brought out the frenzy with which the world plunged into energy conservation measures after the first oil crisis during 1973/74. Though there is no evidence of a similar urgency now in spite of the doubling of oil prices in the last one year as against an increase of a little over a dollar (at current prices) in 1973/74, the need for conservation continues. This is particularly because of bleaker supply prospects. No doubt, energy efficiency efforts have continued, and global energy demand in 2002 had reduced by about 20% as compared to that in 1990. According to one estimate, without energy efficiency improvements, the OECD (Organization for Economic Cooperation and Development) nations would have used approximately 49% more energy than was actually consumed as of 1998. Similarly, the US economy is reported to have grown by 36% between 1973 and 1986 with no increase in energy use. Energy use per purchasing power parity GDP (gross domestic product) in India also declined from 0.25 kg (kilogram) oil equivalent in 1990 to 0.18 kg oil equivalent in 2003.

Notwithstanding all this, prospects for further savings are significant when short to medium periods of payback on investments for this purpose have been identified practically in all countries. A study by the CII (Confederation of Indian Industry) has established that the energy saving potential of 10% exists in iron and steel, aluminium, and refineries sector in India, while such saving potentials are of the order of 20%–25% in textiles, pulp and paper, ferrous foundry, and glass and ceramics. The potential in fertilizers, cement, and petrochemicals is estimated to be at least 15%. It is interesting to note that CII has recently adopted the Mission on Sustainable Growth, which recommends inter-alia that specific consumption of energy for all industrial activities be reduced by 2%–6% every year. If implemented, this will no doubt be a laudable achievement.

Energy savings today are not evenly spread out either across countries or across sectors. Japan leads the world in successful energy saving measures. Also, savings achieved in the residential and transport sectors are considerably less than in the industrial sector. Oil consumption is the maximum in the transport sector and price signals are the most potent for conservation in this sector. Increased gasoline and diesel oil prices are not only expected to curb oil demand, but may also encourage a modal switch. This switch from private to public passenger transport, and from road to rail for goods traffic, should get a new fillip in this regime of high oil prices.

The residential sector similarly provides new opportunities. The concept of 'green buildings' is already catching up. The initial investment cost for such a building will have a shorter payback period if the resultant savings in energy cost are taken into account.

Ensuring sustainability and meeting the goal of stabilizing emissions at 1990 levels have also foregrounded the urgent need to limit the use of carbon-emitting fuels. Climate change concerns, impending supply scarcity, and the identified potential of energy saving should together lead to a less energy intensive world economy than what it is today. As potentialities for energy efficiency have been established at varying levels across countries and sectors, high oil prices will provide new incentives, if not compulsions, for bringing about change.

Oil exploration

Another impact of high oil prices will be a new thrust on hydrocarbon exploration particularly in deep waters and frontier areas. This will be accompanied by a focus on non-conventional oil such as oil shale, tar sands and coal bed methane. Thanks to relatively low oil prices from mid-1980s to late 1990s, investment on new rigs suffered and deep water exploration also slackened in pace. The marginal cost of oil production from some new offshore fields then was $25/barrel or more. The incentives for new exploration and for going deeper in offshore exploration will increase immensely when the oil prices stand at about $100/barrel compared to $50/barrel. The importance of frontier areas can be understood from the renewed interest in exploring Arctic oil. The estimates of oil and gas reserves under the Arctic ice remain varied and uncertain, but figures as high as 25% of world's oil and gas reserves (400 billion barrel of oil equivalent) being under the Arctic ice have been frequently mentioned. This has resulted in a number of countries now taking comprehensive steps for accelerating exploration in Arctic waters. New technology and high oil prices will thus provide incentives for covering such frontier areas as also deepwater areas with water depth much beyond the presently explored level of 6000–8000 feet.

Focus on renewables

The third area, which will get an impetus from high oil prices, will be new R&D and additional investments in renewables. In India, there has already been an emphasis on development of renewables. The total installed electricity generation capacity from renewables in India, as on 31 December 2007, was about 11 500 MW including about 7900 MW from wind power.[1] Renewables include biomass, solar energy, wind power, and small hydro. According to an IEA (International Energy Agency) projection, biomass is potentially capable of providing approximately 20% of primary energy demand by 2030. While such figures are only indicative in nature, there is no doubt that high oil prices will warrant, and stimulate, both R&D and production of energy from renewables.

An experiment at the University of Kassel in Germany led to the installation of a capacity of 50 MW of power, for both base load and peak demand, through a combination of wind power (61%), biogas (25%), and solar photovoltaics (14%). The cost of power so generated is estimated to be double the present conventional cost. Such experiments are bound to get replicated as oil prices remain at high levels. Diversification of the energy basket away from oil will be pushed now more vigorously with particular emphasis on possibilities for greater use of nuclear energy. Liquefaction of coal and biofuels will now be looked into with a different set of financial and economic figures.

Lifestyle changes

Finally, the impact of high oil prices on lifestyles cannot be underestimated. The effect on personal lifestyles has not been too conspicuous as yet, because of the expectation that oil prices will settle down at much lower levels. But a continuation of the present price trends will bring out the unsustainability of current practices. The compulsions of climate change will also add a new dimension, calling for both travel habits and domestic lifestyles to be changed to a less energy intensive level. Gasoline demand in the US, which accounts for 25% of total energy consumption in the world, is reported to have come down after a number of years, by half a per cent.

To sum up, improved energy efficiency, increased hydrocarbon exploration efforts, greater emphasis on renewables, new initiatives for moving away from oil, and changes in

[1] Details available at <www.mnre.gov.in>

lifestyles are most likely to be stimulated by sustained high oil prices. Whether these changes occur or not will depend on a number of factors like maintenance of appropriate price levels and other governance-related factors, cultural acceptance of the need for change and, of course, the all-encompassing 21st century tenets of commerce. High oil prices will certainly induce such changes; only the degree of change will depend upon global and local conditions as they develop.

Towards effective petroleum subsidies

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The Indian petroleum sector has been plagued by a perverse system of subsidies for long now. Under this umbrella of an inefficient subsidy regime, Indian consumers have been using subsidized kerosene and LPG (liquefied petroleum gas) to meet their lighting and cooking needs. Though traditional arguments for provision of subsidy refer to the need to maintain access to essential services for the underprivileged sections of society, in the case of petroleum subsidies in the country this target group is rarely the beneficiary. In this context, this article serves two objectives: a) it aims to examine the efficacy of petroleum subsidies and their impact on the vast sections of poor population in India; b) it suggests options to make subsidies effective in enhancing household energy security.

Need for enhancing modern energy supply

Ninety per cent of rural households in India are still dependent on biomass for cooking their daily meals (Figure 1).[1] Not only are these fuels inefficient sources of useful energy but also have an adverse impact on health, environment, and the safety of users.

Exposure to indoor air pollution from solid fuels has been linked to many diseases, in particular pneumonia among children and chronic respiratory diseases among adults. According to WHO (World Health Organization) estimates, India accounts for 80% of the 600 000 premature deaths due to exposure to indoor air pollution that occur in South-east Asia annually (Sinha 2007). Also, important gender issues are associated with the usage of traditional fuels for cooking in rural households. The health-related effects of indoor air pollution are higher for women and children. This is clearly highlighted by the fact that indoor air pollution resulting from chulhas burning wood, coal and animal dung as fuel, is claiming a shocking 500 000 lives in India every year, most of whom are women and children. Further, a substantial amount of time is spent by the women of the household in collecting biomass. Girls are often pulled out of school so that they can help in the collection. It is expected that the provision of cleaner fuels for these households would mean utilization of the time saved for better economic activities.

The answer to the social and environmental challenges posed by the use of biomass fuels lies

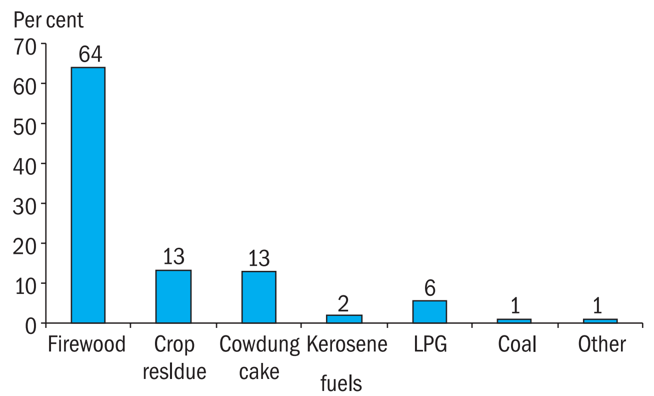

Figure 1 Primary fuel for cooking in rural areas
Source Census of India (2001)

[1] Census of India (2001)

in moving to cleaner sources of cooking energy, and facilitating their penetration in rural areas. Switching from solid fuels such as wood, dung, or charcoal to more efficient modern fuels like kerosene and LPG can bring about the largest reductions in indoor smoke. This is borne out by the results of a study in rural Tamil Nadu, India, which compared the levels of respirable particles between homes where gas or kerosene were used for cooking, and homes that used wood or animal dung. Average pollution levels of 76 $\mu g/m^3$ and 101 $\mu g/m^3$ in kitchens using kerosene and gas, respectively, contrasted with levels of 1500 to 2000 $\mu g/m^3$ in kitchens where biomass fuels were used (WHO 2006).

Kerosene and LPG subsidies in India and their impact on usage

Kerosene is used by all expenditure classes in both urban and rural areas in the country, which in effect makes its description as a poor man's fuel a misnomer. Though kerosene has been subsidized to promote its penetration as a clean cooking fuel in rural areas, only about 2% of the rural households consume kerosene as a cooking fuel (see Figure 1).[2] The major share of this product is consumed as a source of lighting. According to Census 2001, 56% of households in rural areas consume kerosene as the primary fuel for lighting. This reflects a failure of public policy on two counts. First, kerosene is a highly inefficient source of lighting as compared to electricity, and the subsidy on its consumption is not intended to provide the fuel as a light source. Second, its use as a lighting energy source limits its use for meeting cooking energy needs resulting in continued dependence on biomass with all its attendant problems.

Another key concern with kerosene subsidy in India is the existence of a huge parallel market. Under the present system, kerosene subsidies flow from the top of the value chain that is from the oil companies' storage point to the end point that is the fair price shops doling out the product. Hence, there is considerable incentive for the entities along this value chain to siphon off kerosene to the parallel market, where it is utilized to adulterate diesel. This incentive is compounded due to the differential that exists between kerosene and diesel retail prices. According to NCAER (National Council of Applied Economic Research) estimates, nearly 40% of kerosene is siphoned off to black markets (NCAER 2005). Figure 2 shows the price difference between subsidized kerosene and diesel over the last five years. The price of kerosene has remained constant over this entire time period. The price revisions that have taken place have been on account of changes in the sales tax regime in the state. On the other hand, the price of diesel has been increasing over time and hence the price differential and the incentive to siphon off kerosene to the diesel market has been increasing.

The government universally subsidizes LPG sold to the domestic sector. However, there is a huge rural–urban divide in LPG consumption. According to Census 2001, only about 6% of rural households use LPG as the primary source for cooking, whereas in urban households its penetration is close to 50%. Even in urban households, consumption of LPG is concentrated in the upper income (consumption expenditure) classes (Figure 3).[3] According to TERI analysis,

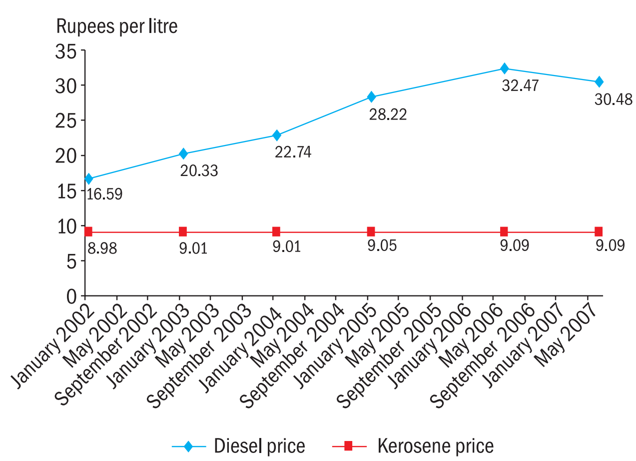

Figure 2 Price movements of diesel and kerosene over last five years (New Delhi)
Source PPAC (2007)

[2] Census of India (2001)

[3] The data is taken from the 50th and 51st Round of household survey undertaken by National Sample Survey Organization. The survey divides the households on the basis of the MPCE (Monthly Per capita Consumption Expenditure) classes, which are represented on the X axis

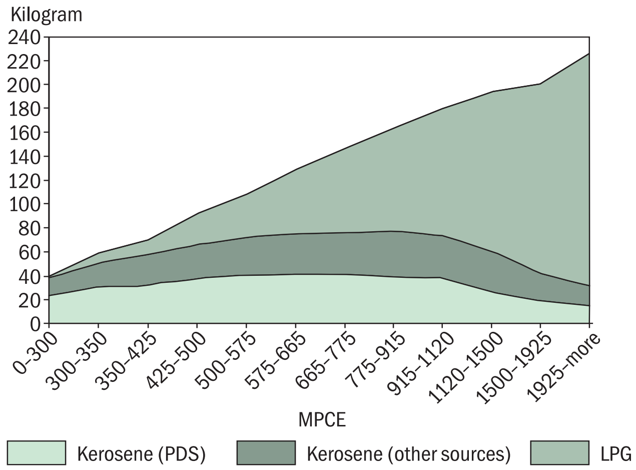

Figure 3 Consumption of cleaner fuels (urban) MPCE by class

based on NSSO (National Sample Survey Organization) data, it has been estimated that 76% of the LPG subsidy goes to urban areas with 25% of the total population, and that 52% of this urban subsidy is enjoyed by the richest 27% of households. In other words, nearly 40% of the LPG subsidy is enjoyed by the richest 6.75% of the population (Misra, Chawla, Srivastava, *et al.* 2006)!

The above discussion brings forth the grim reality that even after providing subsidies on kerosene and LPG for over three decades the Government of India has not been able to bring a meaningful change in the energy consumption patterns of Indian households, especially the poor and rural households. Petroleum subsidies have important implications for sustainable development because of their impact on the level of energy use and the types of fuels that are used. Many households are still dependent on traditional sources of energy and the benefits of subsidized fuels have not reached them. The following section discusses the fiscal implications of subsidies.

Financing subsidies

Subsidies on LPG and kerosene were introduced under the APM (administered pricing mechanism), in an effort to promote consumption of cleaner fuels. Under the APM system, prices of petroleum products were controlled by the government, and the subsidies on kerosene and LPG were partly financed with budgetary support while part of the burden was shared by the oil companies. This system was prevalent up to 1998, when the dismantling of APM was announced in a phased manner, spanning over four years (1998–2002). A phased reduction of LPG and kerosene subsidies was proposed—a proposal which has not been implemented even half a decade after the end date for dismantling.

Although end-use subsidy on kerosene and LPG has not decreased over the years, the share of budgetary support in total subsidies has declined from Rs 6709 crore in 2002/03[4] to only Rs 2535 crore in 2006/07—a decrease of nearly 62% (MoPNG 2007). During this period, there has been no retail price revision of kerosene, while LPG price has been revised by a mere 22%.[5] At the same time, the price of the Indian crude basket has increased by nearly three and half times.[6] The price differential between the actual price and the subsidized price has been

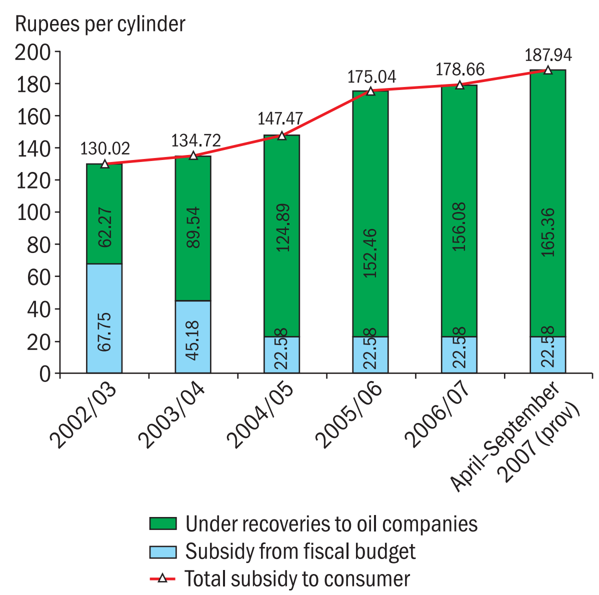

Figure 4 Per unit government subsidy and under recovery oil marketing company per cylinder of LPG sold
Source PPAC (2007)

[4] First year of post-APM period
[5] Analysis based on data available at www.ppac.org.in
[6] http://ppac.org.in/OPM/Indian_basket_crude_jan.pdf and http://www.iocl.com/Products/CrudeOil.aspx, last accessed on 18 March 2008

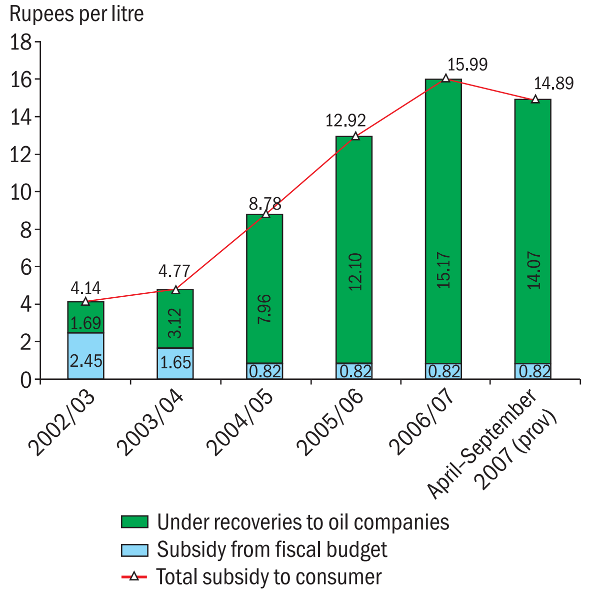

Figure 5 Per unit government subsidy and under recovery oil marketing company per unit of kerosene sold
Source PPAC (2007)

borne by oil marketing companies, and with rising crude oil prices their under-recovery on these fuels has been increasing (Figures 4 and 5).

On an aggregate basis, as a result of this non-revision of prices, the total under-recoveries accruing to the oil marketing companies for kerosene and LPG alone amounted to Rs 28 584 crore in 2006/07 (PPAC 2007). These under-recoveries have had an impact on the profitability of the oil marketing companies.

Making way for targeted subsidies

It is clear that the present system of universal subsidies on kerosene as well as LPG is not fulfilling its purpose. The policymakers must take cognisance of this and focus their efforts on designing mechanisms for delivery of targeted subsidies for the benefit of the poor. Smart cards offer an effective subsidy delivery mechanism for the energy sector, as has now been recognized in the context of food subsidies.[8] These smart cards can be designed to record personal identity as well as benefit-eligibility information for targeted beneficiaries of energy subsidies. The cards can also keep track of the pattern and extent of subsidy-utilization by intended end-users. Apart from providing an insight into the usage of energy subsidies, this would help in tracking any fraudulent use of allocated subsidies. The Planning Commission has also recognized the smart card as a good way of dealing with the challenge of providing targeted subsidies. The Integrated Energy Policy, released in August 2006, mentions smart cards as the most desirable option for provision of targeted subsidy delivery to the needy. However, any pilot schemes for implementation have not taken off. Policy-makers thus need to rise beyond rhetoric and take concrete steps, at both the national and state levels, for designing as well as implementing a more effective subsidy programme. Not only is this paramount for ensuring financial viability and international competitiveness of oil marketing companies but is also critical for enhancing the country's energy security.

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Subsidies and the provisioning of lifeline energy

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Over 50% of India's population lacks access to any form of commercial energy. Ensuring reliable access to modern forms of energy for lifeline support is therefore a critical challenge to India's energy security. One key measure employed to achieve this objective is the provision of subsidy. The IEP (Integrated Energy Policy) of India recognizes the importance of this measure, stating that 'energy security requires that… access to lifeline energy be ensured even if it requires directed subsidies' (Planning Commission 2006). However, the identification of beneficiaries for a subsidy and assessment of its net effect is rarely simple, and subsidies may often result in a transfer of resources from the intended to the unintended.

This article discusses challenges with regard to provision of energy subsidies for the poorest sections of the population in India. It also attempts to identify ways to address these challenges, and illustrates the smart card mechanism for better delivery of subsidy.

Setting the context: subsidy for lifeline energy

In India, 10% of domestic monthly per capita expenditure is attributed to spending on fuel and light, with rural and urban households of India spending Rs 57 and Rs 105 respectively towards meeting their energy needs (NSSO 2007). Seventy per cent of household energy is supplied by biomass, which is often used inefficiently. Forty-five per cent of the unelectrified rural households represent almost 1.2 lakh villages out of the 5.9 lakh inhabited (20.33%) census villages.[1] The share of electricity in domestic sector consumption is only about 10%–12% with per capita electricity consumption of 480 kWh (IEA 2007). This explains the dependence on other inefficient sources of lighting such as kerosene-based wicks that produce light of about 60–70 lumens only (Rajvanshi 2003).

The usage of energy is based on access to resources, financial and physical. The poorest segment of the population is primarily dependent on traditional sources of energy—both inanimate (fuel wood, crop residue, dung) and animate (draft animals and human labour). The better-off sections prefer to use modern energy sources such as electricity, coal, oil and gas (Barnett 2000). Furthermore, the energy-poverty linkage suggests that access of population to poorer (traditional fuels) forms of energy leads to poorer quality of life. The poorer sections of the population spend a great amount of time meeting their basic energy needs—time that could have been alternatively used for other productive purposes (Barnes and Halpern 2000).

The energy value chain is complex: the relationship between the cost of energy generation from various sources and the price that consumers pay is blurred by direct and indirect subsidies, market mechanisms, and transmission and distribution costs. In addition, at times, the costs associated with energy are also obscured by commercial sensitivities and competing claims that make the determination of an energy policy difficult and often imprecise. A classic case of competing claims is that of energy sources such as kerosene, which often have multiple uses—for lighting purposes at the household level, and as an adulterant for diesel in the transport sector (Planning Commission 2006).

Most subsidy programmes are initiated with welfare of the population in mind, and a major intended outcome is improvement in the quality of life of the vulnerable sections of society. Also, subsidy functions as an instrument that facilitates

[1] http://www.powermin.nic.in/, last accessed 27 February 2008.

the provision of services to the rural sector. Businesses find it hard to justify the initial high costs of serving the poor, for instance the high costs involved in providing rural households with LPG (liquefied petroleum gas) due to the scattered nature of habitation in rural areas. For energy businesses with short-term profit goals, the resulting small revenue flows do not justify large up-front investments by private or even public businesses to reach low-income groups. It is critical therefore that subsidy is directly targeted to the intended beneficiaries, and aids in minimizing market distortions.

In practice, however, it is difficult to efficiently achieve subsidy's multiple objectives as there are several associated problems.

- Subsidies may be mis-targeted, thus involving errors of inclusion and exclusion (for instance, in the case of subsidy on kerosene). Indiscriminate policies and operationalization may imply that the well-off sections eventually benefit from the subsidies.
- Subsidies can be overly restrictive with respect to the end use or technology allowed, thus depriving the user of choice.
- In some cases, the state faces problems in withdrawing subsidy due to the self-interest of influential sections, for instance, the case of farmers in Punjab and Andhra Pradesh who have been provided electricity free of cost. This has led to undue exploitation of groundwater resources, and Punjab is now starting to experience water stress (TERI 2005; Demaine and Rajagopalan 1994).

In light of the above mentioned problems in provisioning of subsidy, some of the factors on which subsidies need to be assessed are as follows.

Relative efficiency This would imply that the subsidy reaches those for whom it is intended. As illustrated in IEP (2007), 'A lot of kerosene to be distributed under PDS (public distribution system) system is diverted for the adulteration of high-priced diesel even at the depot level. Based on NSS (National Sample Survey) data, it is estimated that only 56% of kerosene released by states reaches people through PDS.'

Sector efficiency Sector efficiency implies that the subsidy is structured in such a way that it encourages provision of service at least cost. The subsidization of renewable energy options for remote villages is one such example. There are 119 570 unelectrified villages in India (TERI 2007). A majority of them have been identified as remote villages wherein electrification through grid has been found unviable as the costs for extending the line turn out to be very high for the discoms, especially when the villages are located in forest areas (TERI 2006). In this context, instead of extending the grid, a viable option could be the subsidization of renewable energy options such as solar lanterns. A study on the relative performance of a solar lantern indicates that it is an effective source of lighting with light output better than a *chirag* (a small kerosene lamp), hurricane lamp, and 25-W incandescent bulb (Prasad 1995).

Cost-effectiveness Cost effectiveness implies that the subsidy achieves social goals at the lowest programme cost while providing incentives to businesses to serve poor and rural populations.

Well-targeted subsidies: the case of smart cards

The design and implementation of a subsidy should not be viewed as a static process. Sound decisions must be made on the subsidy's target group, on its form and its level, on the eligibility criteria for the subsidy, and its financing. Subsidies for access to different types of energy can be justified only if they are well targeted and if they reduce business costs in a rural service territory.

As proposed by the IEP (Planning Commission 2006), the use of latest technology embodied in smart cards to provide requisite energy support to targeted consumers will have several advantages. These cards would enable the provision of subsidy directly to the end consumer, unlike the present system where the subsidy flows from the top (supplier) up to the retailer and finally to the consumer. As the subsidy is availed at the level of the consumer, the smart card mechanism would ensure full pricing along the supply chain and dramatically reduce the incentives for adulteration. The system of ensuring the delivery of targeted subsidies through smart cards will have the following characteristics.

Target It would ensure that the targeted population receives the benefit of the subsidy scheme, as the eligibility criteria would be strictly based on income level and access to energy services. In order to prevent misuse, the cards can be provided with physiological identification.

Form Smart cards would also ensure welfare through the usage of the correct form—funds transfer. The provision of subsidy in the case of smart cards would be through preloaded funds in the cards, which the bearer can use for fulfilling his/her energy needs in pre-determined locations such as PDS outlets. And as the IEP (Planning Commission 2006) states 'even in case the bearer decides to sell his/her share of entitlement, and not use the subsidy it would be welfare improving'. It would also ensure the transparent movement of subsidies from government to the consumer.

Level The level of subsidy can be determined in accordance with the NEP (National Electricity Policy)[3], or the smart cards could be preloaded with a monetary equivalent of a specific amount of gas and units of power, or an equivalent amount of kerosene.

Smart cards are being used in many countries for a range of different purposes in sectors such as energy, health and telephony. For instance in Malaysia, smart cards are being used to facilitate effective management of collection and disbursement of micro-loans.[4] In Russia, in 2002, the Moscow Social Card was officially launched as the world's first integrated benefits and payment card. Beneficiaries use the card for public transport, health and medical insurance, access to government subsidies, and discounts from participating retail stores. In India itself, several applications of smart cards are underway. These include provision of microfinance by SKS (Swayam Krishi Sangam) in the Medak district of Andhra Pradesh, and Smart Prepaid Cards for electricity in the Sundarbans (Misra, Chawla, Srivastava, *et al*. 2005).

In India, mechanisms such as smart cards would limit kerosene subsidy through better targeting while meeting social objectives. They would reduce the unnecessary burden on oil companies, as these companies would be assured of transparent returns for delivery of subsidized energy options. Such mechanisms would also curb adulteration and associated environmental and health impacts. They would provide the Government of India with the flexibility to expend smart cards not only to include petroleum products but also other energy options such as electricity, transforming it into an Energy Subsidy Smart Card, and eventually promoting clean energy options and phasing out subsidies.

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Electricity tariffs for an energy secure India

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Pricing policies play an important role in producers' and consumers' selection of energy sources. Appropriate price signals not only guide investment and supply decisions but also influence efficiency and conservation. The nature of electricity tariff determination in India, however, provides limited incentive to minimize costs and reward efficiency.[1] The present tariff structure in most states in India reveals the presence of cross-subsidy wherein the domestic and agriculture consumers are cross-subsidized by the industrial and commercial consumers, who pay a much higher price than the cost of the electricity they consume. In addition, many states still depend heavily on subsidy from government. This article focuses on the means by which electricity tariff setting can address energy security concerns. In addition, it also discusses the issue of access, which forms an important dimension of energy security.

In the electricity sector, while determining tariffs, the regulator needs to maintain a balance between social equity and return on investment. As per the Electricity Act (2003), the ERCs (electricity regulatory commissions) have been given the important role of setting tariffs, besides the responsibility of the sector's regulation. Section 61 of the Act specifies that the ERCs shall be guided by MYT[2] (multi-year tariff) principles while fixing tariffs. MYTs not only lead to cost-cutting by providing incentives to improve investment and operational efficiency but also lead

[1] This is because electricity tariffs in India have predominantly been set on cost plus basis. Cost plus basis allows all costs incurred by the utility to be passed on to the consumer (subject to a prudence check by the regulator), in addition to providing for a reasonable return (regulated). This methodology allows recovery of fixed cost components such as interest on debt, and operations and maintenance costs, and assures a fixed return on the investor's equity.

[2] Multi-year tariff offers a system where the tariff determination is done for a number of years in one exercise instead of following an annual tariff determination exercise.

to better risk-allocation and improvement in customer service through reward/penalty provisions that encourage compliance. They also simplify the regulatory process and provide more certainty to the investor. A number of states have issued MYT regulations and some are in the process of issuing MYT tariff orders.

While a move towards MYT tariffs is encouraging, growing environmental concerns, depleting resources, and inadequate access to electricity, necessitate that tariff determination must take these concerns into account, and contribute towards attaining energy security.[3] Both supply and demand side measures are required to ensure energy security. Supply side measures include the use of renewables for production, alternative fuels and environment-friendly technologies. Demand side measures include the use of energy-efficient appliances and energy conservation.

Supply side measures

The electricity generation mix in India is dominated by coal (53% as on November 2007).[4] There are crucial concerns associated with the environmental impact of extensive coal-based generation, and lack of suitable quality and quantity of coal available in the country. The price of imported coal too is witnessing an upward trend due to increased requirement in countries like China and India. To meet the deficits in the electricity sector in an environmentally sustainable manner, there is a need to promote power generation based on alternative energy sources.

Even within conventional sources of energy, there lies potential for diversification of the fuel mix. Natural gas is a cleaner fuel as compared to coal. Presently, it comprises only 10% of the generation mix[5], and according to the Report of the Working Group on Petroleum and Natural Gas Sector for the Eleventh Plan, only 3% of the planned capacity addition is expected to be based on natural gas (MoPNG 2006). One reason for this is the uncertainty in price at which natural gas will be available to the power sector, with natural gas prices rising in light of international price volatility. However, if environmental costs are taken into consideration, natural gas-based generation comes out to be much cheaper. Thus, if merit order scheduling[6] that is undertaken by the regulator in approving the power-purchase cost of the utility, can take this aspect into account, natural gas may become more acceptable. This direction would have to come from the central regulator while notifying the terms and conditions of tariff-fixation. It may be noted that the country will have to depend on imported natural gas, at least until domestic gas is available in adequate quantities for the power sector.

There also needs to be increased focus on renewable sources of energy such as small hydro, wind, and biomass. Though the Electricity Act has provided for a greater focus on renewables, and regulators have been entrusted to specify minimum RPOs (renewable purchase obligations), progress in this regard has been slow, with only 11 states having fixed RPOs (as on May 2007) (Jha 2007). The enforcement of RPOs on utilities has met with some difficulties, raising concerns about arriving at a realistic assessment of availability of resources in the state, and the fixing of RPOs by the regulator. Further, the cost plus approach to tariff determination that most states have adopted, requires detailed cost-related information from developers. The cost of

[3] Energy security here must be seen as a broad and evolving concept. The Integrated Energy Policy, Government of India (GoI) states that *we are energy secure when we can supply lifeline energy to all our citizens irrespective of their ability to pay for it as well as meet their effective demand for safe and convenient energy to satisfy their various needs at competitive prices, at all times and with a prescribed confidence level considering shocks and disruptions that can be reasonably expected* (Planning Commission 2006).

[4] Website of the Ministry of Power, Government of India, http://powermin.nic.in/, last accessed on 14 January 2008

[5] Website of the Ministry of Power, Government of India, http://powermin.nic.in/, last accessed on 14 January 2008

[6] Merit-order scheduling is a principle for power purchase whereby least cost power should be dispatched in preference to more costly power.

generation varies depending on the RET (renewable energy technology) applied, size, configuration, fuel, and so on. Also, considering the diversity in RETs, it would require significant resources by the regulator to scrutinize the proposals and determine tariffs. The states must adopt more effective approaches for tariff determination like benchmarking[7], avoided-cost approach[8], and so on, that do not have large data requirements, and where estimates can be made more accurately (Maurya 2007). The overall objective should be to make renewables more cost-attractive. While governments, both at the central and state levels, have provided incentives like tax holidays, low interest loans, and tax/duty waiver, the regulators should also give preferential treatment to renewable energy sources in the tariff-setting process.

Improving supply side efficiencies is another aspect that should be given adequate attention.[9] For the first time in India, under the UMPP (Ultra Mega Power Project) initiative, a tariff-based competitive bidding route has been adopted that promotes the use of super critical technology.[10] Such policy directions are a welcome step for they promote energy security through resource conservation.

Demand side measures

A key component of efforts to enhance energy security is effective management of power demand. Inappropriate tariff design results in over-consumption of electricity, with limited or no scope for conserving energy and enhancing efficiency of use. This is true for most categories where electricity tariffs are subsidized, for instance for domestic and agricultural use. While capacity addition remains a viable option for bridging the ever-increasing demand–supply gap, it requires large investments in capital and time. Promotion of energy efficiency and DSM (demand side management) are amongst the least cost-intensive options for ensuring energy security.[11]

Pricing can play a significant role in providing signals to consumers to conserve electricity and invest in energy-efficient technologies. Implementation of ToD (time-of-day) is one available means. Under this regime, tariffs are higher during peak hours and lower during the off-peak hours, thus providing an incentive for users to shift their consumption to the off-peak periods. As part of DEEP (Delhi Energy Efficiency Programme) launched by TERI in partnership with the Government of Delhi in January 2007, it was estimated that implementation of ToD tariffs and adoption of basic energy efficiency interventions can result in significant load savings at the system level, and help in reducing the consumers' electricity bill. The regulators need to take proactive steps to establish the feasibility of introducing such measures, estimate their likely impact, and ensure their timely implementation. Other measures such as offering special concessions/ rebates in electricity bills on use of solar water heaters, and amortizing cost of purchasing efficient appliances over monthly bills, can also be taken up. Some states including Karnataka and Gujarat have initiated these measures but they are yet to become common practice.

Conclusion

Clearly, rational pricing is necessary for ensuring energy security. Appropriate pricing systems can provide for increased consistency and predictability in the market, which will not only foster investment in the electricity sector but also promote energy efficiency and R&D

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[7] Benchmarking typically adopts a representative station for determination of tariffs, where all cost elements of the station are considered.

[8] Avoided cost considers the unit cost of energy displaced at the margin by the energy generated through renewable sources at the margin. This cost that is avoided is thus payable for the energy generated by the renewable energy- based power.

[9] Increase in net capacity addition can be achieved at lower costs through energy efficiency than with installing new generation capacity.

[10] The first UMPP, the Sasan Power Project, has been awarded to Reliance Energy Ltd at Rs 1.19/unit

[11] DSM also reliably mitigates global climate change and environmental degradation associated with electricity production and use.

activities. In the case of renewables, besides preferential treatment in costs, it is also important to ensure their availability so that the RPOs set are enforced. On the demand front, if pricing mechanisms are such that they encourage the use of energy-efficient appliances, there will be an increase in the net supply capacity. To encourage DSM, steps have already been taken by many states: DSM centres have been established to showcase and promote energy efficient technologies. Efforts have also been undertaken by some SERCs (state electricity regulatory commissions) to rationalize tariffs and reduce the prevalent degree of cross subsidization. It is important to scale-up these initiatives as they are essential to send the right signals to both industry players and consumers.

Energy security holds no meaning if clean, reliable, quality, and affordable energy is not accessible for the masses. Providing access to all requires provision of electricity at reasonable tariffs to those sections of society who cannot afford these services at the actual cost of supply. This entails provision of subsidies which if effectively targeted can result in significant social benefits. Only when continuous and cautious efforts are made to incorporate energy security concerns in tariff-setting at all levels, will the benefits associated with enhanced security be reaped by all.

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Support schemes for renewable energy: the case for feed-in tariffs

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The promotion of renewable energy is in line with India's objective of achieving energy security in the framework of sustainable development. Renewable energy uptake can contribute to India's security of supply, and ensure long-term competitiveness since renewable energy options are low-cost in the mid and long term. In addition, they contribute substantially to reducing greenhouse gas emissions and mitigating climate change. Appropriate policy interventions are imperative to facilitate technology learning and cost reduction for promising renewable energy technologies.

To increase the uptake of renewable energy technologies for power generation, various mechanisms have been devised. This article focuses on two such mechanisms: feed-in tariff laws, and the quota model, their comparative advantages and disadvantages, and the scope for the mechanisms in India.

India's renewable energy potential

At present, India imports about 71% of its oil requirement, and its overall energy import dependence is likely to increase to over 90% by 2030 (TERI 2006). This situation clearly raises significant concerns for India's competitiveness and the security of its energy supply. As India's energy consumption grows, constraining the availability of fossil fuels, renewable energy sources can occupy an important place in India's energy mix.

India has good potential in the areas of solar energy, wind energy, and biofuels. The country is located in the equatorial sun belt of the earth, thereby receiving abundant radiant energy from the sun. The country receives about 5000 trillion kWh/year equivalent energy through solar radiation. The annual global radiation varies from 1600 to 2200 kWh/m^2, which is much more than most of Europe. At the present, with conversion efficiencies of 11%, solar photovoltaic systems can produce 1 MWh of power per day on 0.118 ha (hectares) of land. Similarly, with a conversion efficiency of 13%, solar thermal power systems can produce 1 MWh of power a day on 0.140 ha of land area. Considering that 17.45% of the country's land area is classified as wasteland, the vast scope for thermal power should be apparent. Further, given present yields of bio-diesel plantations, over 25% of the wastelands can displace 21% of current petroleum based transportation fuels. Surplus crop residues, estimated at 139 MT (million tonnes) per year, almost the same in coal-equivalent, form another significant renewable energy source at the village level.[1]

Wind energy and hydropower are now commercially established. The country's total wind potential is pegged at 45 000 MW (megawatt) in gross terms. Even while only 13 000 MW was considered feasible, these estimates have shown to be conservative. As of 31 March 2008, the country had an installed wind power generation capacity of about 8757 MW. Other renewable sources include fuel wood plantations on wasteland and degraded forestland, and small hydro power.

Barriers to renewable energy

Several barriers have resulted in the slow uptake of renewable energy technologies vis-à-vis fossil fuel based technologies. These include costs, administration, and technical and legal concerns. Policies and government programmes are therefore required to support renewable energy technologies both in the short run as well as in the long run. The large subsidies supplied to the fossil fuel and nuclear industries even after several decades of support, form a barrier to up-take of renewables. Table 1 shows the barriers under the heads of costs, legal and regulatory issues, and market performance.

Renewable energy support schemes

Figure 1 depicts the existing support mechanisms that are available and how they work. The following section provides details on two of the mechanisms—feed-in tariff laws and the quota model.

The feed-in tariffs model

The basic feed-in model can be considered a 'pricing law' under which producers of renewable energy are paid to set rates for their electricity, usually differentiated according to the technology used and size of the installation. The rate should be scientifically calculated to ensure profitable operation. The period for which the payment is made should also be set in law, and should cover a significant proportion of the working life of the installation. Grid operators are obliged to provide priority access to renewable energy installations.

Table 1 Barriers to Renewable Energy

Costs and pricing	*Legal and regulatory issues*	*Market performance*
Subsidies for competing fuels	Lack of legal framework	Lack of access to credit
High initial capital costs	Restriction on sites and construction	Perceived technology performance and risk
Difficulty of fuel price risk assessment	Transmission access	Lack of technical and commercial skills and information
Unfavorable power pricing rules	Utility interconnection requirements	
Transaction cost	Liability insurance and requirements	
Environmental externalities		

[1] The total yield of crop residues each year is 546 million tonnes, but a major proportion gets absorbed in the rural economy.

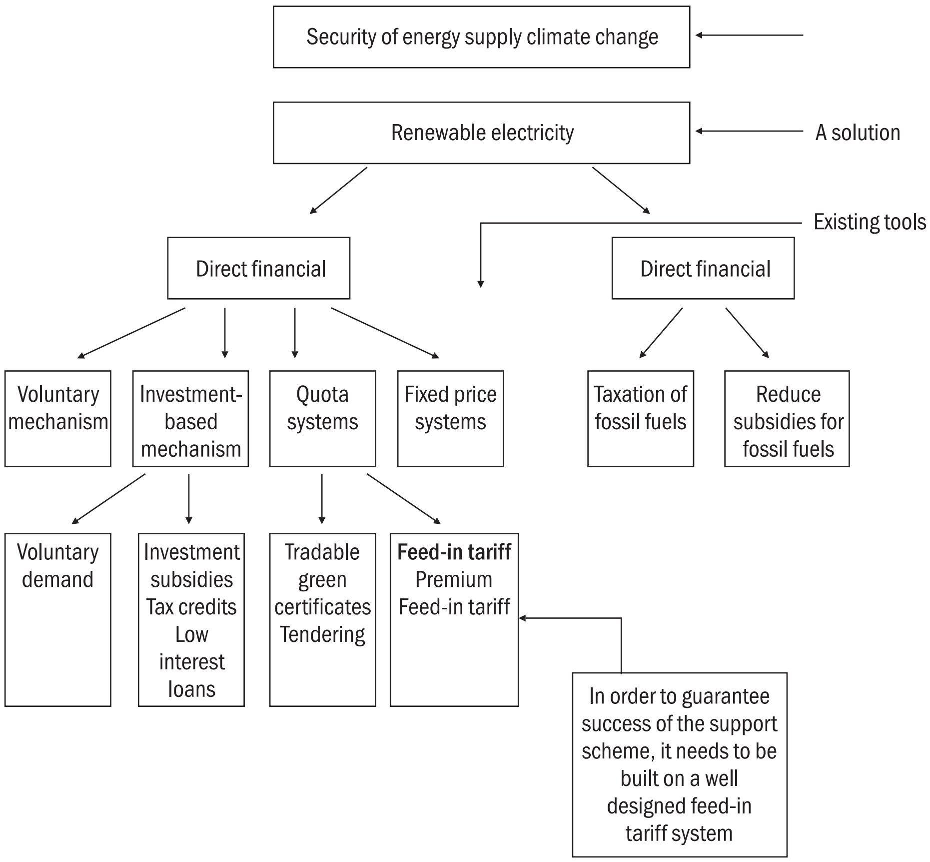

Figure 1 Origin and structure of support mechanisms

The additional costs of these schemes are paid by suppliers in proportion to their sales volume, and are passed to the power consumers by way of a premium on the kilowatt-hour end-user price. In the best designs, the guarantee periods are long, thus providing investment certainty. A variant of the FIT (feed-in tariff) scheme is the fixed premium mechanism currently implemented in Denmark and partially in Spain. Under this system, the government sets a fixed premium or an environmental bonus, paid above the normal or spot price electricity to renewable energy generators.

The quota model

The quota system is used extensively in the US, and to a small extent in Europe primarily in the UK and Sweden. While feed-in laws set the price and let the market determine capacity and generation, quota systems work in the reverse. In general, governments mandate a minimum share of capacity or grid-connected generation of electricity to come from renewable sources. The share often increases over time, with a specific final target and end-date. The mandate can be placed on producers, distributors or consumers.

There are two main types of quota systems used today: obligation/certificate also known as the RPS (Renewable Energy Portfolio Standard), and tendering systems. Under RPS, a target is set for the minimum amount of capacity or generation that must come from renewables, which should increase over time. Investors and generators then determine how they will comply, in terms of the type of technology to be used except in the case where specific targets are established by technology types. They determine the developers to do business with, and the price and contract terms they will accept. At the end of the target period, depending upon the policy design, electricity generators and suppliers must demonstrate (through the ownership of credits that they earn through transactions) that they comply, in order to avoid paying a penalty. Producers receive credit in the form of *green certificates* for the electricity they generate from renewables. Those with surplus of certificates can trade or sell them; and those with too few can build their own renewables capacity, buy electricity from other plants using renewables (which generally includes a bidding process), or buy credits from others. Once the system has been established, the government's role includes the certifying of credits, and compliance monitoring and enforcement (Swain 2004).

The advantages and disadvantages of these mechanisms, along with investment subsidies and voluntary demand, are compiled in Table 2. Many studies that have involved a comparative analysis of the different mechanisms that support renewable energy technologies have concluded that FITs have produced the most quick and low-cost deployment of renewable energy technologies in countries that have implemented them well.

Table 3 shows the feed-in tariffs of select European countries. The most successful cases of implementation of FITs are in Germany and Spain. As of 2006, about 41 countries had adopted FITs. India is the first developing economy to have adopted the mechanism in 2005.

The Indian experience

Along with the adoption of the feed-in tariffs system in India, the central regulatory authority has also announced the adoption of RPS by all states, such that at least 10% of

Table 2 Evaluation of different support mechanisms for RETs

Support mechanism	*Investor security*	*Simplicity*	*Proven success*	*Cost effectiveness*	*Guaranteeing a mix of different technologies*
Feed-in tariff	Very high	Very high	Very high	Very high	Very high
Quota systems	Very low	Very low	Very low	Very low	Very low
Investment subsidies	Good	High	Good	Good	Good
Voluntary demand	Low	High	Low	Very high	Very low

Table 3 Feed-in tariff levels in select European countries as of 2006 (Klein, Held, Ragwitz, *et al.* 2006)

Tariff levels in 2006 (€ cents/kWh and duration of support for different technologies)

Country	*Small hydro*	*Wind onshore*	*Wind offshore*	*Solid biomass*	*Biogas*	*PV*	*Geothermal*
Austria	3.8–6.3	7.8	–	10.2–16.0	3.0–16.5	47.0–60.0	7.0
	13 years	13 years	–	13 years	13 years	13 years	13 years
Cyprus	6.5	9.5	9.5	6.5	6.5	21.2–39.3	–
	no limit	15 years	15 years	no limit	no limit	15 years	–
Denmark	–	7.2	–	8.0	8.0	8.0	6.9
	–	20 years	–	20 years	20 years	20 years	20 years
France	5.5–7.6	8.2	13.0	4.9–6.1	4.5–14.0	30.0–55.0	12.0–15.0
	20 years	15 years	20 years	15 years	15 years	20 years	15 years
Germany	6.7–9.7	8.4	9.1	3.8–21.2[2]	6.5–21.2[2]	40.6–56.8	
	30 years	20 years	20 years	20 years	20 years	20 years	20 years
Spain	–	–	–	–	–	–	–
Fixed	6.1–6.9	6.9	6.9	6.1–6.9	6.1–6.9	23.0–44.0	6.9
	no limit	no limit	no limit	no limit	no limit	no limit	no limit
Premium	8.6–9.4	9.4	9.4	8.6-9.4	9.4	25.5	9.4

[2] The maximum value for Germany is only available if all premiums are cumulated. This combines the enhanced use of innovative technologies, CHP generation, and sustainable biomass use. (Klein, Held, Ragwitz, *et al.* 2006)

power is generated from renewables by 2012. Early this year the Ministry of New and Renewable Energy announced two feed-in laws for (1) grid-connected solar-PV-based power generation and (2) grid-connected solar-thermal-based power generation. In both these cases, the time period is 10 years and the maximum capacity set is 10 MW. The central subsidy per kWh for PV and for solar thermal is Rs 10 and Rs 12 respectively. This will be in addition to the state subsidy. This policy makes renewable power generation an attractive option for renewable energy technology developers and investors. It is to be seen in the coming years how these policies facilitate the uptake of renewable energy technologies.

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Contributions

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The next issue of *Energy Security Insights* will focus on

- ***International energy collaborations***

We welcome contributions for the subsequent issue which will include articles on

- ***Renewable energy and energy efficiency***

Last date for submission, 20 August 2008

Please e-mail the contributions to Deepti Mahajan at *deeptim@teri.res.in*

Centre for Research on Energy Security

CeRES (Centre for Research on Energy Security) was set up on 31 May 2005. The objective of the Centre is to conduct research and provide analysis, information, and direction on issues related to energy security in India. It aims to track global energy demands, supply, prices, and technological research/breakthroughs – both in the present and for the future – and analyse their implications for global as well as India's energy security, and in relation to the energy needs of the poor. Its mission is also to engage in international, regional, and national dialogues on energy security issues, form strategic partnerships with various countries, and take initiatives that would be in India's and the region's long-term energy interest. *Energy Security Insights* is a quarterly bulletin of CeRES that seeks to establish a multistakeholder dialogue on these issues.

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