ELSEVIER

Energy Policy ▮ (▮▮▮▮) ▮▮▮–▮▮▮

ENERGY POLICY

www.elsevier.com/locate/enpol

Integrated resource planning (IRP) and power sector reform in developing countries

Antonette D'Sa*

International Energy Initiative, 25/5 Borebank Road, Benson Town, Bangalore 560 046, India

Abstract

The integrated resource planning (IRP) approach is one that considers both supply and demand-side options to meet the need for a resource, while minimising the costs accruing to the firm and to society. This paper focuses on IRP as a tool for the power sector in the light of the existing problems and the ongoing reforms in developing countries. It looks at the advantages that IRP would afford, juxtaposing these with the barriers to such a planning process—those encountered in the past as well as the possibilities in view of structural changes. It then discusses the policies that would enable the IRP approach to be usefully employed to mitigate the problems of the power sector. Although IRP has receded in importance in some areas of the world, there are perceptible benefits for developing countries; these could adopt such planning methods through the agents and the instruments suggested.

Keywords: IRP; Power-sector reform; Development

1. Introduction

When power sector reforms were initiated in developing[1] countries during the last decade, they were driven chiefly by the shortage of generating capacity, coupled with inadequate funds for new investment. Attention to social and environmental welfare, or what may be termed public benefits, had been far less important. With such benefits inadequately provided for even when the power sector was controlled by the state (via the main utilities), it could be suspected that commercialised and privatised utilities would be even more likely to ignore them. An approach that integrates equitable access to and judicious use of resources would therefore be called for.

Furthermore, problems that have been experienced even in some developed market economies[2] have suggested that regulation is needed for the effective functioning of the electricity system. Hence, integrated planning and appropriate intervention are required not only to achieve the developmental goals of the region but also to ensure supply security and reliability.

The power sectors of developing countries have been beset with several problems. However, with some form of power sector reform currently taking place, there appears to be scope for new institutions and remedies, including planning processes, thereby affecting improvement in performance. It is in this context that this paper discusses integrated resource planning (IRP). A brief explanation of integrated resource planning (IRP) in Section 2, leads in Section 3 to the advantages of using IRP as an aid to appropriate investment decisions and, more importantly, for addressing the existing problems of the power sector. Section 4 looks at whether or not IRP had been in use before reforms were initiated and if reforms are affecting changes in the planning processes. This analysis leads to a list of likely barriers to IRP. As reform is still in progress, an assessment is then made of the possibilities with IRP at each stage of restructuring, focusing on conditions that would necessitate IRP. Section 5 then discusses through whom and how—the policy agents and instruments, respectively, a form of IRP appropriate to the region could be implemented.

2. What is integrated resource planning (IRP)?

Energy services can be enhanced in the power sector either through increases in the use of electricity, which necessitate supply increases, or through improvements

*Tel./fax: +91-80-353-8426.

E-mail address: ieiblr@vsnl.com (A. D'Sa).

[1] The term "developing countries" is usually used for lower income countries that are members of the G-77, and China.

[2] The Californian electricity crisis of 2001 provides a striking example of such problems.

0301-4215/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2003.12.003

in efficiency. Improvement in the efficiency with which electricity is delivered and employed can result in the *same or more* energy services being provided with a *lower use of electricity*. Supply increases include both enhanced generating capacity and improved utilisation of the existing capacity, can be obtained from a variety of sources, and either through transmission from centralised generation stations or at local sites. The maturity time also varies with the particular option and furthermore, the costs of each option include those incurred by the firm as well as those accruing to society. The availability of several alternatives necessitates choices; analytical tools are therefore needed to evaluate the alternatives and select an appropriate "mix" from among these. Integrated resource planning (IRP) consists of such tools.

Numerous definitions of IRP, or, as applied to the energy sector, integrated energy planning (IEP), are available in the literature on the subject (Munasinghe, 1990; Bauer and Eto, 1992; RAP, 1994; Reddy and Sumithra, 1997) and in the policy documents of those states that required integrated resource plans to be submitted (Appendix A). As applied to the power sector, *IRP can be described as an approach through which the estimated requirement*[3] *for electricity services during the planning period is met with a least-cost combination of supply and end-use efficiency measures, while incorporating concerns such as equity, environmental protection, reliability and other country-specific goals.*

The IRP approach differs from strategic supply planning because it includes not only the costs incurred by the individual/organisation, but also societal costs, such as environmental impact mitigation necessitated by some resource choices. Secondly, IRP is technologically neutral, treating demand-side options—end-use efficiency improvements and demand-side management (DSM)[4]—with the same weight as supply side resources, so that deferred or avoided end-use demand is equivalent to "delivered supply"[5] of electricity. IRP is thus intended to make an integrated assessment of supply and demand-side options of increasing energy services, attempting to minimise all costs, and creating a flexible plan that allows for uncertainty and adjustment in response to changing circumstances (Fig. 1). The process—described earlier in detail (Krause and Eto, 1988; Bauer and Eto, 1992; Eberhard, 1992; Hirst, 1992)—is summarised in Appendix B.

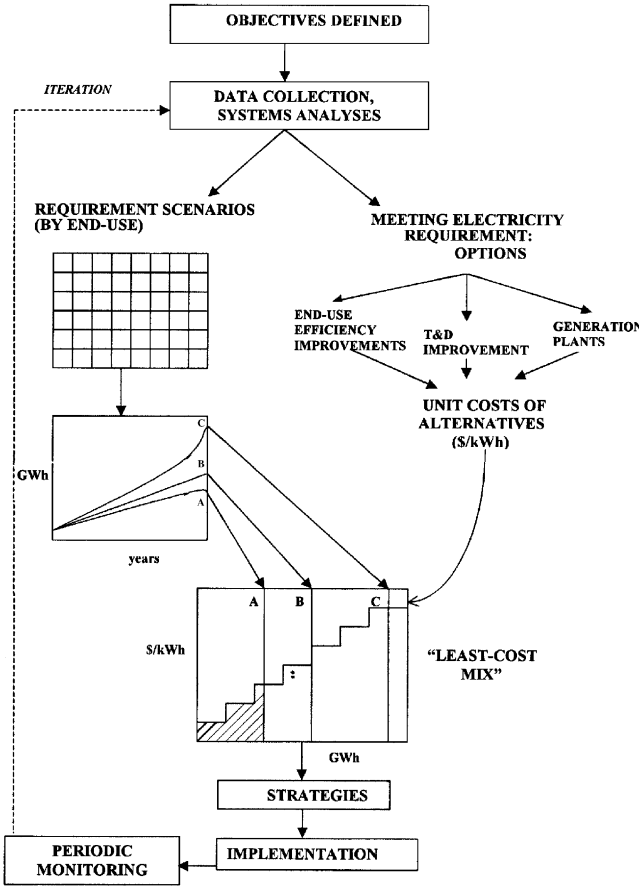

Fig. 1. Steps in the IRP procedure. This figure is based on the author's earlier presentations (D'Sa, 1994, 1996, 2001).

3. Benefits from IRP

IRP assists planners by indicating appropriate investment decisions. More importantly, IRP could be used to address the main crises of the power sectors in developing countries. These crises have been found to be (IEI, 1993): poor access (i.e., numerous un-electrified homes even in grid-connected areas, with families too poor to afford market prices), insufficient financial resources for investment in such non-lucrative sectors, inefficient transmission and distribution systems, and inadequate environmental protection. It can be shown that these problems can be mitigated through the implementation of integrated resource plans.

[3] The term "requirement" has been used rather than "demand" to distinguish it from the neo-classical economic term denoting quantity varying with the price of the commodity. Such demand would not represent the *true requirement* of energy services if poverty (lack of purchasing power) prevents purchase; millions of people go without adequate water, food, housing and other basic needs that must reasonably be considered "requirements", but would not constitute "demand" at the prevailing price. Obviously this requirement must also be an estimate because individuals' perceived requirements vary with behavioural patterns.

[4] DSM refers to all those activities—end-use efficiency, as well as fuel switching and load shifting—that alter the consumers' (demand) load profile. Hence, a differentiated time-of-the-day tariff-structure that encourages consumers to shift their use outside periods of high demand would be a DSM measure although there has been no improvement of end-use-efficiency.

[5] Apart from the capital cost of the transmission and distribution (T&D) facilities, the costs of "delivering" electricity to the consumer must account for T&D losses so that the total cost of delivery = generation cost × [1/(1−T&D losses incurred)].

3.1. Meeting the energy services efficiently

Planners have to make decisions regarding the best ways to bridge the gap between supply and demand. Developing countries are confronted with power scarcity, even with the present level of home electrification, with about 801 million people in the Indian subcontinent and 509 million in Africa living in unelectrified homes (IEA, 2002b). Adding to their problems is the projected capital requirement, far greater than that their utilities and/or governments can meet. In fact, the financial scarcity was identified as one of the chief problems of the power sector in the cases of Brazil, Ghana, India, and Indonesia, from a study of six countries (IEI, 2003).

However, a fixed capital requirement is derived from fixed coefficients—for the technological requirement of energy per unit of output or per energy service, and for the cost per unit of energy. With IRP, both these coefficients can be lowered: the same services can be obtained with devices that require less energy per unit of output, and the cost per unit of energy can be lowered with alternative technologies (Reddy et al., 1991, 1995; Reddy and D'Sa, 1995). This implies that, if IRP were implemented, the supply–demand gap itself could be reduced and the cost of bridging that reduced gap could also be lower.

Further, in cases where a new restructured power pool system is being established—where generators are dispatched in order of increasing bids—the pool price paid to all the generators will be set by the bid of the last most expensive generator dispatched. Hence, lowering the load to be served through efficiency measures will displace the need for the next higher bidder(s) and thereby lower the price payable to all (Eto et al., 1998).

3.2. Providing for future requirements effectively

Even if there is surplus generating capacity with respect to the present requirements, the long lead time before commissioning makes early decisions essential to prevent future shortages. The need for planning for future requirements has been reiterated even in the USA,[6] where California's "retreat from integrated resource planning"[7] and the consequent absence of "warning signals" have been cited among the reasons for the recent inadequacy of the supply system. Conversely, if supply requirements are appropriately matched with estimates of demand, those options beyond acceptable limits can be avoided and "stranded" (or "strandable")[8] costs can be eliminated.

3.3. Contributing to social and environmental welfare

The provision of sustainable energy services requires that energy be produced and used in ways that "support human development in all its social, economic and environmental dimensions" (UNDP, 2000). By indicating the lowest costs of energy services, IRP facilitates the extension of these services to those without them, particularly the economically disadvantaged, and thereby makes this provision more equitable. And, in so far as energy is essential for basic needs such as water supply, lighting, education, and health-care, IRP assists in social development. In this context, there is a rationale not just for utility- or national-level IRP, but also for an area comprising several independent countries, such as the South African Development Community (SADC) region; here, it has been argued that the regional optimum solution would be superior to the sum of country optima (Graeber and Spalding-Fecher, 2000).

IRP's association with environmental development is well known. One of its original purposes was to include the costs of environmental protection, as "most rate-setting and economic practices fail to account for the long-term costs of environmental degradation and/or environmental clean-up, as well as the health risks associated with energy production and consumption" (USEA, 1992). Inclusion of either actual costs (such as the cost of pollution controls) or proxy values (such as charges imputed for negative impacts) in the comparison of costs results in cleaner options being relatively less expensive and therefore appearing earlier along the least-cost-supply schedule.

Secondly, a reduction in generation requirement—brought about through efficiency/DSM options featuring earlier on the cost-supply staircase—leads to less fuel

[6] The 2001 National Energy Policy states "A fundamental imbalance between supply and demand defines our nation's energy crisis" (quoted in Cowart, 2001).

[7] "Throughout the 1980s and 1990s, the California Energy Commission and the Public Utilities Commission (PUC) conducted a joint integrated resource planning process. Future resource needs were forecast and a mix of demand side management, generation, and spot purchases identified to meet those needs". However, after a particular auction process for additional capacity was found to be flawed, "the PUC determined not to incorporate a state planning component into the adopted deregulation experiment. This retreat from integrated resource planning in California aggravated the problems that stemmed from market uncertainty. The state ignored its energy efficiency building standards during the building boom of the mid-1990s and discouraged the construction of cost-of-service power plants, all in the hope that unregulated investors would build sufficient new generation capacity for predicted future needs. No warning signals were built into the deregulation experiment which provided policy makers with adequate warning that the market was not providing sufficient new capacity" (Wood, 2001).

[8] Stranded costs are higher than present capital costs that have been incurred already and are difficult to recover; "strandable" costs are present costs that may be stranded if future costs fall.

being burned and less harmful emissions.[9] While environmental taxes can theoretically be imposed, they might not be considered politically feasible, but by integrating impact mitigation through environmental "adders" (Bushnell and Oren, 1994) into the costing, IRP can insert environmental protection into the selection procedure itself. And, although IRP affects marginal investment, this is not negligible in the rapidly growing sectors of developing countries.

3.4. Making rational choices from among alternatives

Through IRP one can identify the most cost-effective of the array of DSM/efficiency improvement measures and renewables, because the costs of delivering and saving a kWh of electricity—from improved lighting retrofits to centralised thermal generation plants to decentralised biomass generation facilities—are compared on a "level playing field". An option is then recommended only if its cost is less than/equal to other competing alternatives. At particular times, for example, to meet additional peak demand, efficiency options not always cheaper may be preferable to conventional generating plants, thereby indicating specific niches for such peak-saving DSM options.

In addition, the choice of cost-effective efficiency improvement and/or resource diversity options has been considered a risk-reduction or reliability-improvement strategy (RAP, 1994; Cowart, 2001).[10] For instance, with the replacement (or postponement) of a new generation plant by some DSM options, the volatility of demand could decrease, so that there would be lower reserve requirements, fewer dollars at risk (from unwanted construction), and a lower risk of outages. Moreover, by selecting options on the basis of levelised costs[11] per unit, those with shorter lead times would be chosen and this means that utilities and customers benefit from quicker answers to changes in requirements. Developing countries already suffering from unreliable and inadequate supply can aim at reducing such problems through IRP-induced measures such as additional (back-up) capacity from less expensive end-use efficiency improvements.

To deliver electricity to a particular region, local sources could often be more appropriate, because of the avoided transmission and distribution (T&D) costs from the existing generation plants to the consumers. It is pertinent that one of the issues emerging in the course of power sector reform has been the difficulty of extending and maintaining basic access to electricity for commercially unattractive rural areas (WRI, 2002). Hence, integrating all costs into the comparison enables the selection of cost-effective decentralised or distributed supply options.

3.5. Prioritising programmes and policies

In so far as there is a rationale for regulation/government intervention (Golove and Eto, 1996) either to overcome market failures (such as reducing environmental damage) or to lower transactions costs (such as acquisition of information), there is also a need for tools to address these regulatory issues. IRP exercises indicate preferable options; these can influence policies if the results of such exercises are translated to fiscal and/or financial measures. For example, if an IRP exercise indicates that biomass-fuelled generators are the best option for providing rural energy services, policy-makers could use this to levy lower taxes on such generators or provide softer-term loans for their purchase.

While the precursor to IRP—utility/system planning—appeared to exclude some resource choices (particularly efficiency measures) and stakeholder perspectives (such as environmentally benign options), IRP provides a larger menu of options, thereby expanding consumer and utility choices (NARUC, 1988). National and state-level IRP exercises could thereby help to prioritise government policies and programmes.

Thus, because of the emphasis on: selection of the least costly of the array of available options, reduction in the required investment, consideration of decentralised generation and efficiency-improvement measures that would reduce system loads, and inclusion of the costs of environmental damage, the main problems of the power sector in developing countries could be addressed.

4. Experience of IRP in the power sector

While countries have their own variants of power sector restructuring, one could also distinguish between them on the basis of their motives for reform. Common drivers for change have been the need to improve the efficiency of the sector and the view that competition could increase this efficiency. The hoped-for reduction in subsidies also contributed; in Chile, one of the reasons for privatisation was the need to reduce government subsidies to the utilities (Rosenzweig and Voll, 1997; Bacon, 1995) while in the UK, privatisation allowed the government to stop coal subsidies which were then

[9] This would be essential with the Framework Convention on Climate Change (FCCC) commitments to stabilise or reduce carbon emissions.

[10] The US utility regulators have by resolution urged state regulators, power pools and Congress to "encourage and support programs for cost-effective energy efficiency and load management investments as both a short-term and long-term strategy for enhancing the reliability of the nation's electric system …" [quoted in Cowart, 2001, p. iv].

[11] For plants of the same capital cost, the longer the construction time of a plant, the greater the value of its cost at the commissioning date.

channelled through favourable long-term contracts with the electricity system (Bacon, 1995; Littlechild, 2000). There have also been ideological shifts towards private ownership as part of a broader framework of macro-economic restructuring in the UK and Chile (Rosenzweig and Voll, 1997; Bacon, 1995; Patterson, 1999).

However, while most industrialised countries had adequate if not surplus generating capacity, developing countries suffered from capacity shortages coupled with inadequate funds for additional investment. The financing need forced countries to apply for multinational funds and, in turn, lenders such as the World Bank[12] encouraged power sector restructuring. Further, in industrialised countries, the evolution from monopoly utilities to deregulation was to a great extent technology-driven,[13] but for developing countries, non-technical problems at debt-ridden utilities were more urgent (Reddy, 2001).

As the process of power sector reform is currently still in progress in many countries, one cannot compare pre- and post-reform periods. However, one could verify whether or not IRP was in use in the power sector before reforms were initiated, and if the situation has been changing as reforms have progressed; one could also theoretically assess possible scenarios in various stages of restructuring. Factors that hinder the use of IRP can then be identified.

4.1. Before power sector reforms

4.1.1. Developing countries

Before power sector reforms were initiated in developing countries, IRP had not been in practice, nor had national and state energy/power plans/policies[14] included IRP or any form of comparison between supply and demand-side options. Utilities had projected least-cost plans, but these had been least-cost *supply* schedules rather than integrated supply and efficiency plans, and had been for the utilities rather than for the country as a whole, for example, the "integrated strategic electricity planning" of South Africa's Eskom. Specific DSM or conservation programmes had been run aside from their activities, as in the case of the Demand-Side Management Office of Thailand's national utility, Electricity Generating Authority of Thailand (EGAT, 2000). There had also been a few cases of IRP exercises carried out by academics or research organisations for the power sectors of a state of a country, for example, the Indian states of Karnataka (Reddy et al., 1991, 1995) and West Bengal (WBSEB and IEI, 1998, 1999), or for efficiency measures, for example, the conservation supply curve for Brazil (Geller, 1991).

4.1.2. Industrialised countries

In the USA, the Clean Air Act Amendments of 1990 had contained provisions designed to motivate state commissions to adopt standards requiring utility participation in IRP. This was followed by the US Energy Policy Act of 1992 with a mandatory requirement that all electric utilities carry out IRP and submit plans before their Public Utility Commissions for approval. The adoption of IRP was thus driven chiefly by the need for greater efficiency in the use of energy and concern for the environment. In 1992, the USA had 32 states with IRP regulatory frameworks; nine others were just beginning to explore the implementation of IRP regulatory frameworks (Mitchell, 1992). In general, the broad adoption of IRP by state public utility commissions created a regulated public process whereby a variety of generation and demand-side resources could compete for inclusion in utilities' resource plans (RAP, 1996).

Among European countries, only Denmark's 1994 Electricity Act had an effective IRP obligation. Distribution/supply companies were required to prepare DSM plans, generation and transmission companies and the Independent Systems Operator drew up scenarios for generation and transmission, and the Ministry gave guidelines and co-ordinated an overall 20-year plan. Few experiences with IRP have been reported in other European Union (EU) countries (Wuppertal Institute et al., 2000). At the local level, the case of Hanover, Germany, was the most comprehensive and successful, resulting in a range of DSM programmes (Stadtwerke Hannover AG, 1995).

4.2. With power sector reforms in progress

4.2.1. Developing countries

The components of reform that have been introduced so far in developing countries have hardly touched the planning process, even if the existing planning boards of the ministries/state utilities have been replaced by new "policy" planning entities. Most countries have legislation and organisational support for conservation and energy efficiency, but these have not been integrated into the main planning procedure. Even elaborate new

[12] The World Bank had indicated, even in 1989, an "unbridgeable gap" between capital demand and supply at the level of the whole developing world (Churchill and Saunders, 1989).

[13] The technologies of generation at smaller scales (e.g., through gas turbines) led to smaller scale independent power producers (IPPs). Consequently, opening access of IPPs to the grid led to the separation of generation from transmission, and to the break-up of distribution into bulk and smaller entities. Meanwhile, computerised dispatch on a merit-order basis enabled consumers to choose their generators. This led to restructuring the market for competition and also introduced a regulator to prescribe the rules for the generation to distribution process.

[14] In this section, the experiences of six developing countries, namely, Brazil, Ghana, India, Indonesia, South Africa and Thailand (IEI, 2003), have been used to extract information on IRP, supplemented wherever necessary with relevant information from other countries.

Electricity Acts such as India's Electricity Act (notified by the Government on 10th June 2003) have not focused on planning. And, while there is funding for planning (from National/State budget allocations), this is not earmarked for integrated planning exercises. The Power Development Plan (99-02) of Thailand's main utility mentions that "an analytical framework and a procedure for integration of DSM into the system planning process are expected to be established in the near future" (EGAT, 2000, Section 6), but DSM has not yet been integrated into its planning process.

A noteworthy exception is South Africa's 1998 White Paper on Energy Policy that has clearly recommended integrated resource planning: "In the electricity sector's case, the National Electricity Regulator (NER) will only license new facilities upon the satisfactory completion of an integrated resource plan" (DME-SA, 1998). The first National IRP was developed in 2002 with the co-operation and resources of the main utility Eskom's Strategic Planning Division, under the guidance of the NER (NER-SA, 2002b). At a later date, local qualifying regional electricity distributors (REDs) will be required to submit local integrated resource plans (LIRPs). The new Energy Bill (2002) drafted by the Department of Mines and Energy also includes integrated energy and resource planning.

4.2.2. *Industrialised countries*

In contrast, restructuring of electricity markets and the transition to retail access in the USA seem to have weakened the perceived need for long-term region-wide planning and broad public involvement (Northwest Power Planning Council, 1998), perhaps because IRP was traditionally thought of as a centralised planning approach while deregulation was supposed to allow individual decision-making. Among the states that have restructured,[15] some have suspended the IRP obligation, while in other cases the Public Utilities Commissions have shifted from mandatory to optional IRP, or to mere compliance with a defined level of investments[16] in DSM and/or renewables. Moreover, IRPs have at times been presented by utilities for information and to meet prescribed requirements, rather than for review and approval (Slater Consulting, 2000). At the same time, some IRP issues such as "information requirements for assessing power supply adequacy and reliability, sustaining economically efficient investment in efficiency, ... and an adequate efficient, economic and reliable power system" continue to be mentioned (Northwest Power Planning Council, 2002).

Similarly, the European Commission's 1995 Draft Directive had required Member States to undertake "Rational Planning Techniques" (RPT)—essentially IRP or integrated assessment of supply and demand options—for their internal electricity and natural gas markets. The European Commission and the European Parliament saw the RPT Directive as a necessary complement to the Internal Electricity Market (IEM) Directive that required competition in electricity supply. The Member States were required by European Union (EU) directives to introduce wholesale competition and a minimum of retail competition (equivalent to approximately 27% of the total electricity consumption) by 1999/2000 (Wuppertal Institute et al., 2000). Although it did not become a binding obligation, the issue still draws attention in the European Union[17] and a draft directive on energy demand management is due to be presented by the European Commission.

In several other countries, power sector restructuring has brought in an independent national system controller/operator who prepares an outlook on supply adequacy to enable customers and investors to evaluate future opportunities. Such is the situation in the UK, where the National Grid Company prepares an annual 7-year Statement of Opportunities and in Australia, where the National Electricity Market Management Company, by the National Electricity Code, prepares a 10-year Statement of Opportunity.

4.3. *Barriers to IRP*

From the experiences noted, particularly in the countries studied, one can identify factors that have hampered integrated resource planning for the power sector.

4.3.1. *Supply bias*

The most important of these appears to be the supply bias—the belief that augmenting generation capacity is the only effective way of meeting (projected increases in) the demand for electricity. Forecasting exercises estimate how much more capacity is required, usually without considering demand reduction through increased efficiency. The opinion that any power is better than none has been so strong that it has been translated into a pressing need for private investment in

[15] As of February 2003, retail access is legally available to some/all customers in 17 states; of the other 33, 27 are not actively pursuing restructuring, 5 have delayed the restructuring process/implementation of retail access and 1 has actually suspended direct retail access (EIA, 2003).

[16] There has actually been a noticeable decline in utility spending on energy-efficiency programmes in the 1990s (Eto et al., 1998). This has led to the creation of a Public Benefits Fund to provide matching funds to states for public purpose programmes formerly funded by electricity customers as part of utility rates (US-DOE, 1998).

[17] In Denmark, implementation of the IEM resulted in the obligation to perform IRP replaced with an obligation to perform DSM. However, the basis for the decision on which DSM to select remains the integrated assessment of supply and demand options, the fundamental principle of IRP.

generation, so that power sector reform has been almost synonymous with the introduction of independent power producers (IPPs). These IPPs, including foreign investors, have been lured by hitherto unmatched rates of return on investment in generation (Reddy and D'Sa, 1995a; Sant et al., 1995). With such profitable opportunities in generation, efficiency/conservation options were unlikely to be considered.

The emphasis on supply options is also because of the barriers to and consequent limited contribution from energy efficiency measures. For example, high-efficiency devices are often difficult to find, and/or do not live up to performance claims due to manufacturing flaws, installation problems, or improper use (Geller, 2003). This hurts their reputation and thereby creates a vicious circle where low demand leads to low production and supply, and this limited availability in turn restricts use.

Furthermore, there is usually inadequate information available on indicators such as the potential for energy conservation and the extent of environmental damage caused by some generation technologies. This lack of awareness of such issues translates to their importance being underestimated. Being considered peripheral to the main system, they are not integrated into plans that continue to concentrate on supply increases.

Due to the bias in favour of capacity addition, there has seemed to be no need for considering efficiency improvements, in conditions of current excess generating capacity. Furthermore, most price-setting mechanisms discourage investment in demand-side options, viewing such measures as causing reduction in sales and revenue unless rates could be raised correspondingly. Although demand is not a limiting constraint in highly populated developing countries, the tariffs applicable to lower income households are lower than those paid by the industrial, commercial and higher-income household categories where efficiency improvement is taking place; hence, conservation in these categories lowers the average earning per kWh.

4.3.2. Institutional arrangements

The prevailing institutional arrangements also inhibit integrated planning. Related subjects are treated as different sectors and the controlling departments (Ministries, Departments of a Ministry, or Agencies) are separate entities. For example, in India, the Ministry of Power is distinct from the Ministry of Non-Conventional Sources of Energy and these do not draw up integrated plans. Here, and in other countries too, the Environmental Ministry has its own domain. Hence, programmes are planned and implemented, to whatever extent, independently of each other.

Moreover, there is little co-ordination between the energy demand and supply programmes, an essential for IRP. For example, the Rural Development and Agriculture Departments in India hardly include energy requirements in their programmes, and then too, on an ad hoc basis without systematic assessment (Rao et al., 1996). Without adequate co-ordination, subjects are considered in isolation, with each entity more concerned about fulfilling its own targets than integration for overall development.

Similarly, there is hardly any coordination between state agencies/utilities and voluntary action groups/non-governmental organisations (NGOs). As a result, the work of NGOs is restricted to sporadic demonstration projects and the main state plans do not benefit from association with them.

In addition, there is often a lack of trained manpower in the main energy departments. The required expertise in the use of the required analytical tools is available in research/academic institutions, but without adequate collaboration between these and the state departments/utilities, the lack of technical expertise hinders elaborate planning exercises.

4.3.3. Financial difficulties

In many cases, utilities are faced by severe financial difficulties and therefore have no surplus for planning and research, particularly elaborate processes such as IRP. Beset as they are with day-to-day problems, debt-ridden utilities have resorted to stopgap measures rather than long-term planning.

4.3.4. Preoccupation with other problems

In cases where the situation is in flux—restructuring is in progress and changes are expected in the position and jurisdiction of utilities—the long-term forecasts traditionally used for IRP do not seem practical. Moreover, current restructuring problems (such as ownership transfers and objections from labour unions particularly about workforce reduction) tend to preoccupy those in authority, to the exclusion of longer-term issues.

Thus, the main bias towards supply options coupled with institutional, technical, financial and administrative problems have obscured the advantages of integrated resource planning.

4.4. Possibilities during restructuring

In the face of the barriers shown, one would need to identify the conditions in which IRP implementation would be beneficial, more so because with restructuring—commercialisation, privatisation and competition—it has been considered that "electricity businesses would be focused on delivering profits through electricity sales and IRP would be seen as a distraction" (IEA, 2000, p. 76). Since many developing countries are still in the process of reforming their power sectors, it may be useful to assess the likely possibilities for IRP at various stages of institutional and structural reform.

Following the categorisation used for classifying stages of restructuring (USAID, 1998; Kozloff, 1998; Dubash, 2001), one can consider commercialisation and corporatisation[18] of utilities, vertical and horizontal unbundling (of integrated utilities), privatisation (of the utilities' ownership) and introduction of competition between the resulting utilities (in the generation and supply segments).

- *Commercialisation and corporatisation* of utilities would appear to lessen the need for IRP, as their strategic plans would not have to coincide with the developmental goals of the region. Hence, if utilities had no compulsion to extend energy services, it is conceivable that they would serve only the remunerative categories and ignore the others, thereby obviating the need for an integrated approach.

  On the other hand, for commercial/corporate entities, costs of supply have to be recovered through tariffs (rather than government subsidies). This would encourage the search for least-cost options that emerge from IRP, in particular, if governmental/regulatory mandate required a certain level of services to be provided. Estimates have been made of the energy required to meet specified service or activity levels (Goldemberg et al., 1985). Through these, one/two bulbs of a prescribed wattage per dwelling are provided and electricity is fed for a specific number of hours per day. If such state-run utility programmes, were required to be continued even by commercial enterprises, then utilities would need IRP to indicate the least expensive ways of complying with such requirements.
- *Unbundling* or fragmenting of integrated utilities would also appear to negate integrated planning, because there could be no major player perceiving both the potentially high costs of new supplies and the benefits from investments in efficiency (Swisher, 1994). Horizontal unbundling could limit concern to specific regions of operation and customers, while vertical unbundling could focus operations on specific tasks.

  Nevertheless, IRP would continue to be required if energy services had to be provided on a least-cost basis. For example, an IRP exercise would indicate if it would be more economical for a generator to purchase electricity from a neighbouring utility instead of constructing a new plant itself. Generators and distributors would also be jointly interested in alternative sources of electricity and/or DSM among the distributors' customers, if costs could be curtailed for both. As noted in a study of the European Union (Wuppertal et al., 2000), IRP principles could assist energy supply companies in assessing the cost-effectiveness of various services. Obviously, indicative resource plans for the region as a whole would continue to be useful.
- *Privatisation* may lessen the need for IRP, as private utilities are unlikely to consider externalities that do not impinge on them. However, if emissions charges or environmental "adders" were imposed, then the environmental cost would be added to the unit cost, thereby affecting the dispatch order. The need for minimising the emissions costs would necessitate the integrated approach.

  Further, instead of restricting itself to the resources available to it, the utility could turn to cheaper options elsewhere, as indicated by regional IRP. Here, regional has been used in both senses—to contiguous units within a country and to adjacent countries. An example of the former is the WAPA (Western Area Power Administration), that deals with a group of states in the USA (WAPA, 2000) and of the latter, is the South African Power Pool (SAPP), consisting of 12 independent countries from the southern part of the African continent (NER-SA, 2002b).

  More importantly, IRP would continue to be needed by those requiring a larger perspective, in particular, the regulator or systems operator.
- *Competition* in the retail segment, when introduced, would make IRP seem the least likely to be useful, as electricity-retail businesses need to be concerned only with supplying electricity profitably.

  But again, IRP methods would be required if energy companies were expected to analyse the most cost-effective options to provide eligible customers the energy services they need at least cost, and with a minimised environmental impact (Nilsson et al., 2001). And, if vertically integrated, even competitive private utilities would choose an IRP exercise where capacity investment costs can be postponed or avoided through less expensive efficiency improvement/DSM (Lopes et al., 2000). From the regional point of view, integrated planning would help ensure that the mix of resources would meet projected requirements.

  From the foregoing discussion, one can conclude that IRP would be necessitated in conditions of "action-forcing circumstances" (Bauer and Eto, 1992), in particular if:

  - governmental/regulatory mandate *necessitated a certain level of services* to be provided,
  - these energy services had to be provided on a *least-cost basis*,

[18] "Commercialisation" of a utility refers to the adoption of commercial accounting practices (which implies a change in behaviour rather than organisational form or ownership) whereas "corporatisation" involves the State's legal relinquishing of management, though possibly still having some control through setting overall objectives.

[19] For example, India has home lighting schemes such as *kutir jyoti* (home light), *lok deep* (people's lamp), and so on, for economically weak households.

- *environmental impact* and emissions mitigation costs had to be *minimised*,
- additional capacity *investment costs could be postponed or avoided* through less expensive efficiency improvement/DSM.

5. Policy mechanisms to encourage an integrated planning approach

The earlier section has derived the conditions necessitating IRP, at different stages of power sector restructuring and in the face of barriers to its acceptance. However, even with appropriate conditions, one must suggest *who* could carry out IRP and *how*: the *policy agents* and *the roles* they could play, and the *policy instruments* that would be required to accomplish those tasks.

5.1. Policy agents and their roles

5.1.1. The government

- *Policy formulation*: Effective national resource planning needs commitment at the highest level, preferably that of the central government. Although it has been felt that the power sector requires freedom from government intrusiveness, reform could be viewed as a step in designing and implementing a more intelligent regulatory setting; in fact there is need for "re-regulation" (Teplitz-Sembitzky, 1990). It has also been concluded that the existence of market barriers provides ample justification for government intervention in energy service markets (Golove and Eto, 1996). Further, societies have become increasingly aware of the negative impacts of energy production on health and the environment, so that governments have to intervene to prevent unregulated markets from producing more of the externality-causing services than are socially desirable (UNDP, 2002).

  Therefore, even if the government is no longer an active player in the reformed power sector, it should continue to use its authority to establish coherent policies. As was done in South Africa with the 1998 White Paper (DME-SA, 1998), Governments would need to formulate some guidelines for resource planning (Appendix C). These guidelines are applicable elsewhere, but may need to be tailored to the specific needs of the country. The 2001 National Integrated Resource Plan (published in mid 2002) is supposed to have been drawn up in accordance with the guidelines. However, the emphasis thus far has been on supply; the plan drawn up (NER-SA, 2002b) assumes a single cost per kWh of saved electricity for all DSM options, avoiding the comparison of individual costs and corresponding selection of specific measures.
- *Legislation/directives*: It has been argued that there should be conditions—such as the obligation to provide sufficient and economic energy services in an environmentally sensitive way—for planning processes like IRP to take place. Hence, if the Government chose to exert stricter control to translate policies into practice, suitable legislation/directives would be required.

5.1.2. The independent public authority

Reform has usually brought a new authority to the power sector in the form of a regulatory commission that is supposed to be independent of government departments/utilities and accessible to the public. If not already in existence, such a responsible and impartial authority would need to be established. The authority should be responsible for the planning framework, for imposing the need for least-cost energy services, for monitoring the implementation and renewal of plans, for facilitating data accumulation, and to serve as an acceptable conduit for timely two-way communication between stakeholders.

- *Responsibility*—The independent regulatory commission/authority should undertake the responsibility of arranging for an integrated assessment of demand and supply and the indication of least-cost options. As seen in California, three major consumer advocacy groups, in their plan to "fix" the electricity crisis in 2001, suggested the creation of a "public power authority" that would "institute 'Integrated Resource Planning' to project demand and identify the appropriate actions needed to meet that demand" (Consumers Union, 2001). However, the actual task of drawing up plans could be assigned to the regional systems operator (who would co-ordinate between generators and distributors) or to the regional utilities.[20] For example, in South Africa, the National Electricity Regulator has developed IRP procedures and utilities' performance criteria and has mandated that the national utility Eskom utilise its capabilities to produce a National IRP (NER-SA, 2002a).
- *Monitoring/evaluation*—Periodic re-evaluation of IRP plans is required to ensure that unforeseen changes are suitably incorporated. Similarly, monitoring of implementation is also essential to ensure that the increases in electricity requirements (notwithstanding efficiency improvement), whether due to economic activity or population needs, are

[20] In the USA, investor-owned utilities have been submitting their IRP estimates to the State Public Service (Utilities) Commissions and the state-owned utilities to the State Energy Office; with deregulation, the PSC and Energy Office could jointly conduct a State IRP exercise (Slater Consulting, 2000).

matched by scheduled supply increases. Regulators should also check service commitments (including energy service levels and reliability), and tariffs actually imposed. Utilities have to be provided with the incentives and autonomy to choose among different ways of achieving desirable performance goals, but should also be held accountable through appropriate regulatory reviews.

- *Data repository*—The regulatory commission should be the repository for information from electricity generators (suppliers) and distributors (service providers) so that an adequate database for the purpose of analysis is available at an impartial location.

5.1.3. Research organisations

Research and academic organisations could be involved in the new régime either directly for their technical expertise or indirectly for training personnel in planning methods. IRP needs to be carried out by those capable of technical and economic analysis; such skilled personnel may not be available at the existing utilities or energy departments. These skills and appropriate training could be sourced from academic and research institutions. The alternative of consultants could also be considered.

5.1.4. Electricity service providers

If IRP were to be undertaken by electricity utilities and service companies, it would require a strong commitment by the senior management and also the ability to design and implement effective programmes and/or acquire resources.

Even if the independent regulator were designing indicative plans for the national/state, electricity distributing utilities and electricity service companies (ESCOs) could be involved in the implementation of local plans. It has been noted in Europe (Nilsson et al., 2001), that the participation of electricity providers in programmes can reduce transaction costs, both because—on the "Polluter pays" principle—the abatement costs of environmental damage can be included in the tariffs to the end-users who could otherwise (through higher electricity use) worsen the situation, and because the contact that they have with their customers can facilitate information dissemination, as well as installation and billing.

5.1.5. Involvement of other stakeholders

Regional planning would also benefit from the involvement of other stakeholders, such as consumer groups and other non-governmental organisations (NGOs). For example, the particular knowledge of local rural-based NGOs would ensure that the needs and priorities of rural people are considered.

5.2. Policy instruments

The policy instruments through which IRP could be implemented would include pricing mechanisms, capacity building activities, information propagation, funding, setting of standards and interlinking of related departments.

5.2.1. Pricing mechanisms

Most price-setting mechanisms discourage investments in demand-side measures; hence, an important policy instrument is moving to tariff-setting systems that include such investments in a rate base. The integrated perspective at the planning phase would not be effective if prices did not communicate accurate signals of the value of the resources being consumed (Fernando et al., 1994), hence the costs of saved or un-served energy must also enter the reckoning.

5.2.2. Capacity building

Capacity building is required both at the national/regional and local levels, and for technical as well as other activities.

- *Appropriate technical training*—Personnel would have to acquire the technical competence for the preparation of energy and demand forecasts; this would include estimation of demand requirements, assessment of supply technologies, resource integration, treatment of uncertainty and effective evaluation.
- *Facilitating institutions*—The selection of non-traditional options through the IRP process would require suitable support organisations. For instance, if there is increased demand for efficiency-improved devices, it should be possible to increase their supply. There would also be increased activity for energy service companies (ESCOs); these are "one-stop" firms that provide financing, technology, installation and performance guarantees for efficiency measures. They have just begun to operate in developing countries (Sathaye and Ravindranath, 1998), but increasing resort to renewables and efficiency options would require corresponding ESCO support.

5.2.3. Information collection

IRP necessitates the analyses of detailed information that is not readily available. This must be collected from a variety of sources and would be facilitated with public awareness.

- *Data accumulation*—The database on information provided by electricity generators (suppliers) and distributors (service providers) to the regulator or any other appointed organisation would provide a basis for future estimates. Regular additions to the database would enable pertinent information (such

as the falling costs of some technologies) to be incorporated.

- *Public awareness promotion*—Public awareness of the advantages of IRP, particularly cheaper energy services, would spur utilities to consider them. Some measures may not be profitable for utilities due to the transaction costs involved in catering for a large number of small consumers (for example, efficiency retrofits in the residential sector) but may be undertaken to improve customer relations. For example, the results from surveys on the supply and demand for energy efficiency services in Sweden (Bergmasth et al., 2000) conclude that profitability is low but this is tolerated to support energy sales. Hence, information should be easily available to the public to enable them to make choices and thereby influence decision makers.

5.2.4. Funding

The activities involved in the preparation of integrated plans would require adequate funding. There are several ways in which IRP could be funded, chiefly through "cost recovery" or "earmarked" taxes from electricity sales, but also from other resources of the government.

- *Charges on electricity sales*—Public interest programmes have often been funded from a surcharge on electricity sales, i.e., from ratepayers. For example, the UK has the non-fossil fuel obligation (NFFO) according to which a levy is imposed on fossil fuel based power generation and the funds thus collected are used to promote renewable sources of energy. In the USA, the public benefits charge (PBC) of the Federal Government, collected at 1/10 of one US cent per kWh, funds low-income assistance, energy efficiency programmes, renewable energy and public interest energy R&D (Eto et al., 1998). Such PBCs have been levied in 18 states of the USA and also in a number of European countries (Kushler, 2000). Thailand has funded its DSM programmes partly through a surcharge on electricity prices (EGAT, 2000). Brazil's regulatory agency Agência Nacional de Energia Elétrica (ANEEL) has allocated 1% of the utilities' net annual operational revenue to energy efficiency and R&D. The cost of conducting IRP (i.e., the costs of data collection, analyses, forecasts and so on) could be funded in the same manner.

  Another alternative is a "systems benefits charge" on the distribution system. It would be "non-bypassable" because the distribution system is needed to deliver electricity to all types of consumers,[21] and would be competitively neutral because shifting to another supplier (generator) would not change the payment (RAP, 1996). Such collection could also be used to help fund planning for the sector.
- *Community service obligations of the government*—Some aspects of IRP—such as extending electricity services to un-provided homes—could be viewed "as a community service obligation which should be clearly costed and funded by government" (IEA, 2000, p. 78)[22] in the same way other services to the economically disadvantaged are.

5.2.5. Standards

System operators have traditionally focused on supply side resources to meet reliability requirements for electricity systems, but demand-side resources could possibly fulfil the requirements at lower cost if standards were adopted as a screening tool on investment decisions, for example, the "Efficient Reliability Standard" suggested in the USA. This states that before "socializing" the costs of a proposed reliability-enhancing investment, through tariffs or other cost-sharing requirements, the regulatory authority concerned should check "(1) that the relevant market is fully open to demand-side as well as supply side resources; (2) that the proposed investment or standard is the lowest cost, reasonably available means to correct a remaining failure; and (3) that benefits from the investment or standard will be widespread, and thus appropriate for support through broad-based funding" (Cowart, 2001, p. 52). Such standards would be potent instruments to ensure the judicious use of resources.

5.2.6. Interlinking of departments/programmes

Countries have separate departments/ministries for power, mining, petroleum, non-conventional energy sources, and so on; they also have specific programmes for energy conservation and environmental protection. If these entities were to integrate their plans for energy, instead of making projections independently, they would be more cost-effective and likely bottlenecks would be avoided. The International Energy Agency in its assessment of the Indian power sector recommended "integration of political accountability into a single energy ministry … Only an integrated authority can exploit economies of scale through co-operation and integration at the Union level" (IEA, 2002a).

IRP can take a variety of forms: at one end there is government-initiated "mandatory-IRP", where the government exerts significant control, while at the other,

[21] Even consumers who have captive (self-generation) facilities need back-up power that in most cases means that they too will remain connected to the distribution system.

[22] Development Mechanism No. C3—*Integrated Resource Planning*, Section 5, p. 78.

there is the utilities' "business-related IRP" for strategic planning purposes (IEA, 2000). Hence, the main policy mechanisms suggested would have to be adapted to the specific *institutional and market structure* and the range of *barriers* to IRP prevailing in a particular locale, as well as the *purpose of the IRP*, and with appropriate combinations of measures, both institutional and technical.

6. Conclusions

Power sectors are being restructured and new organisations formed, but the pressing problems in developing countries—extending access to the economically disadvantaged, improving operational efficiency and reliability of supply, and curtailing environmental damage—have not been addressed adequately. These problems, in turn, force decision-makers to make choices—between types of generation and of fuel, between technologies of transformation of these fuels, and from among end-use technologies. IRP assists in making these choices systematically and transparently. Furthermore, social and environmental benefits had earlier been (intended to be) provided by the monopoly utility serving as an extended arm of the government. With reduced state involvement today, the need for planning and policy intervention is even more acute.

The main objective of IRP—to minimise the long-run costs of energy services—would be reason enough for using such a planning approach. But with commercialisation of utilities and the reduction or removal of state subsidies, tariffs have increased in several developing countries. This is adversely affecting affordability. Since one of the main drivers for power sector reform/restructuring in developing countries was financial difficulty, that had led to inadequate expenditure on capacity and maintenance and thereby to poor performance, the least-cost options obtained through the IRP approach constitute an important answer to the problem.

In particular, IRP would be essential if:

- governmental/regulatory mandate necessitated a certain level of services to be provided,
- these energy services had to be provided on a least-cost basis,
- environmental impact or emissions mitigation costs had to be minimised, and
- additional capacity investment costs can be postponed or avoided through less expensive efficiency improvement/DSM.

In this regard, reform and restructuring could afford the sector new opportunities for adopting better planning practice through the institution of new mechanisms. These mechanisms include the development of enabling government policy (possibly through new legislation), the commitment of an independent regulator/system operator vested with adequate authority, co-ordination between organisations for the building of appropriate technical expertise, tariff-setting that includes DSM opportunities in a rate base, facilities for information sharing, and adequate funding for the planning processes.

Modifications may be adopted to suit regional situations. However, the key characteristics of IRP would need to be retained: explicit and fair treatment of both demand and supply options, inclusion of both economic and social costs of providing energy services, and analysis of the uncertainties associated with external social factors and resource options, thereby ensuring the deployment of cost-effective sources and technologies and the provision of energy services on a sustainable basis.

Acknowledgements

The author would like to thank in particular, Anton Eberhard, Gilberto de M. Jannuzzi, K.V. Narasimha Murthy, Lars Nilsson, and Amulya K.N. Reddy for their comments and/or suggestions. The International Energy Initiative (IEI) was financially supported by the Ministry of Foreign Affairs of the Netherlands and the Norwegian Agency for Development Cooperation (Norad) at the time this research was undertaken.

Appendix A. Definitions of IRP

"IRP is the process for integrating supply and demand-side resources to provide energy services at a cost that balances the interests of all stakeholders… The goals of IRP have evolved from least cost planning and encouragement of demand-side management to broader, more complex issues including core competitive business activity, risk management and sharing, accounting for externalities, and fuel switching between gas and electricity" (Bauer and Eto, 1992, p. 8.1).

"IRP describes an economic planning process which, if implemented correctly, locates the lowest practical cost at which a utility can deliver reliable energy services to its customers. The ultimate intent of this planning process is to acquire a mix of energy resources that minimise the total dollars spent and maximise the energy service benefits gained" (RAP, 1994, p. 7).

"Integrated resource planning is an energy planning approach to identify the mix of 'clean' centralised, decentralised renewables and efficiency improvements that will meet the demand for increasing energy services for instance at least cost or least environmental impact" (Reddy and Sumithra, 1997, p. 14).

Several states of the USA have had descriptions of the IRP they required. For example, the state of South Carolina in the USA defines an integrated resource plan as one that "contains the demand and energy forecast for at least a 15-year period, contains the supplier's or producer's program for meeting the requirements shown in its forecast in an economic and reliable manner, including both demand-side and supply side options, with a brief description and summary cost-benefit analysis, if available, of each option which was considered, including those not selected, sets forth the supplier's or producer's assumptions and conclusions with respect to the effect of the plan on the cost and reliability of energy service, and describes the external environmental and economic consequences of the plan to the extent practicable" (South Carolina Law Section 58-37-10 quoted in Slater, 2000).

Appendix B. Summary of the IRP process for the power sector

- *Definition of the objectives and scope of the plans*—The goals (for example, electrifying all homes), planning period and regional scope have to be specified as these affect the constraints within which the plans must be formulated.
- *Data collection on base-year requirement*—Information on the requirement of electricity services in the initial year must be collected based on energy-service or by user category.
- *Estimation of future requirement*—The future requirement of electricity services can then be estimated, from the base-year information and changes expected in different scenarios.
- *Identification of options of servicing these requirements*—Generation and efficiency-improvement options of meeting the requirement of energy services have to be identified, so that they can compete for inclusion in the least-cost mix.
- *Estimation of costs of delivering or saving electricity*—The costs per unit (usually the annualised life cycle cost)[23] of electricity either delivered or saved, through each technologically feasible option must be calculated, considering social/environmental costs,[24] if any, of delivering electricity, and potential uncertainties such as the likely range of fuel costs.
- *Optimisation of the mix of resources*—The costs so computed can then be ranked so that a "least-cost mix" of options can be indicated.
- *Appropriate policies and strategies*—Given the least-cost mix, decision-makers can formulate appropriate policies and implementation strategies.
- *Implementation*—Plans must be implemented according to schedule.
- *Monitoring and iteration*—Implementation must be monitored, with requirements and costs periodically re-evaluated.

Appendix C. Summary of the Guidelines for integrated energy planning in South Africa

Apart from the technical requirements of integrated energy planning (IEP) listed, the energy sector is expected to:

- Establish the appropriate structures and systems to carry out IEP functions;
- establish and maintain the necessary resources to operate these structures and systems;
- link IEP technical functions into policy-making processes;
- facilitate the development of a least-cost energy system, including environmental costs;
- ensure an appropriate balance between demand and supply side actions and the use of primary energy resources;
- link electricity into municipalities' infrastructure investment plan. Therefore at local government level, the IEP forms a component of the integrated development plan (IDP).

Source: Section 1 of Part 4 (Cross-Cutting issues) of the *White Paper on the Energy Policy of the Republic of South Africa*, December 1998, (available at www.dme.gov.za/publications/wp_ene/whitepaper1998.htm).

[23] Annualised life-cycle cost = the annual equivalent value of the total costs incurred (initially and during the working life of the plant or equipment) divided by the electricity generated per year ($/kWh) = $[\{\Sigma C_k(1+i)^{k-1}\}(\mathrm{CRF}) + \mathrm{A}]/[\mathrm{kWh/year}]$, where ΣC_k are the capital costs, incurred during the k years of construction, as evaluated at the start of operation (in $), A is the average annual recurring cost = the sum of fuel and operation & maintenance costs (in $), and CRF = capital recovery factor = $i/[1-(1+i)^{-n}]$, with i the interest rate/year and n the operating life of the plant or equipment (in years).

[24] Social/environmental costs are difficult to quantify; comprehensive assessments would include the costs of mitigating the negative impacts of the production and delivery of electricity from a particular source on the air, water, land and wildlife habitat.

References

Bacon, R.W., 1995. Privatisation and reform in the global electricity supply industry. Annual Review of Energy and Environment 20, 119–143.

Bauer, D.C., Eto, J.H., 1992. Future directions: integrated resource planning. In: Proceedings from the ACEEE 1992 Summer Study on Energy Efficiency in Buildings, Panel 8: Integrated Resource Planning. American Council for an Energy-Efficient Economy, Washington, DC, pp. 8.1–8.16.

Bergmasth, M., Lewald, A., Nilsson, L.J., Strid, M., 2000. The role of energy efficiency in the deregulated Swedish electricity market. In: Proceedings from the ACEEE 2000 Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy, Washington, DC.

Bushnell, J.B., Oren, S.S., 1994. Incentive effects of environmental adders in electric power auctions. The Energy Journal, International Association for Energy Economics 15 (3), 55–73.

Churchill, A.A., Saunders, R.J., 1989. Financing of the energy sector in developing countries. Presented at the 14th World Energy Conference, Montreal, 14–22 September.

Consumers Union, 2001. Consumer groups united on plan to protect California consumers and fix energy crisis. Sacramento, 9th January, available at www.consumersunion.org/telecom/consumerwe101.htm.

Cowart, R., 2001. Efficient reliability: the critical role of demand-side resources in power systems and markets. Prepared for The National Association of Regulatory Utility Commissioners (NARUC), Regulatory Assistance Project, June.

DME-SA (Department of Minerals and Energy, Government of South Africa), 1998. White Paper on the Energy Policy of the Republic of South Africa, Part 4, 2nd December.

D'Sa, A., 1994. Construction of electricity demand scenarios and introduction to comparative costing and least-cost electricity scenarios. Presented at the IEI-APENPLAN Workshop on Integrated Energy Planning, Bangalore, 13–22 November.

D'Sa, A., 1996. Integrated energy planning—methodology and integrated energy planning—a case study of Karnataka state. Presented at the Workshop on Sustainable Energy organised by the Energy and Atmosphere Program, UNDP, New York, 10–30 April.

D'Sa, A., 2001. Least-cost planning for the power sector. Presented at the IEI-Prayas Workshop on Power Sector Reforms and Public Participation, Bangalore, 24–25 August.

Dubash, N., 2001. The public benefits agenda in power sector reform. Energy for Sustainable Development 2, 5–14.

Eberhard, A., 1992. Integrated energy planning for widening access to basic energy services in South Africa: a methodology for policy analysis and research. South African Energy Policy Research and Training Project, Paper No. 2, Energy for Development Research Centre, University of Cape Town, South Africa.

EGAT (Electricity Generating Authority of Thailand), 2000. EGAT Power Development Plan (PDP) 99-02 (Update Schedule of Committed Projects). Generation System Development Planning Department, System Planning Division, May.

EIA (Energy Information Administration), 2003. Status of State Electric Industry Restructuring Activity, February, available at www.eia.doe.gov/cneaf/electricity/chg_str/regmap.html.

Eto, J., Goldman, C., Nadel, S., 1998. Ratepayer-funded energy-efficiency programs in a restructured electricity industry: issues and options for regulators and legislators. LBNL-41479, May, available at www.eetd.lbl.gov/EA/EMP.

Fernando, C.S., Kleindorfer, P.R., Munasinghe, M., 1994. Integrated resource planning with environmental costs in developing countries. The Energy Journal, International Association for Energy Economics 15 (3), 93–121.

Geller, H., 1991. Efficient electricity use: a development strategy for Brazil. American Council for an Energy-Efficient Economy, Washington, DC, and Berkeley, CA.

Geller, H., 2003. Energy Revolution—Policies for a Sustainable Future. Island Press, Washington, DC.

Goldemberg, J., Johansson, T.B., Reddy, A.K.N., Williams, R.H., 1985. Basic needs and much more with 1 kW per capita. Ambio—A Journal of the Human Environment 14 (4–5), 190–200.

Golove, W.H., Eto, J.H., 1996. Market barriers to energy efficiency: a critical reappraisal of the rationale for public policies to promote energy efficiency. Lawrence Berkeley National Laboratory (LBL-8059), Berkeley, CA, March.

Graeber, B., Spalding-Fecher, D.R., 2000. Regional integrated resource planning and its role in regional electricity co-operation and development in Southern Africa. Energy for Sustainable Development IV (2), 32–37.

Hirst, E., 1992. A good integrated resource plan: guidelines for electric utilities and regulators. ORNL/CON-354 (prepared for the Office of Conservation and Renewable Energy, US Department of Energy) Oak Ridge National Laboratory, December.

IEA (International Energy Agency), 2000. Research Report No.3, Task VI of the IEA DSM programme: developing mechanisms for promoting demand side management and energy efficiency in changing electricity businesses. International Energy Agency, Paris, August.

IEA (International Energy Agency), 2002a. India, Part B: Regional Outlooks to 2030. In: World Energy Outlook: 2002. International Energy Agency, September, available at www.worldenergyoutlook.com/weo/pubs/weo2002/weo2002.asp (Chapter 9).

IEA (International Energy Agency), 2002b. Energy and Poverty, Part C: Special Issues Arising from the Outlook. In: World Energy Outlook: 2002. International Energy Agency, September, available at www.worldenergyoutlook.com/weo/pubs/weo2002/weo2002.asp (Chapter 13).

IEI (International Energy Initiative), 1993. Problems arising from the current approach to electricity planning. Presented at the Workshop on Integrated Electricity Planning, Bangalore, 8–12 March.

IEI (International Energy Initiative), 2003. The expanded provision of public benefits as power sectors in developing countries are reformed. Project of the International Energy Initiative (in progress).

Kozloff, K., 1998. Electricity sector reform in developing countries: implications for renewable energy. Renewable Energy Policy Project, No. 2, April.

Krause, F., Eto, J., 1988. Least-Cost Utility Planning Handbook for Public Utility Commissioners, Vol. 2: The Demand Side: Conceptual and Methodological Issues. National Association of Regulatory Utility Commissioners (NARUC), Washington, DC, December.

Kushler, M., 2000. Summary Tables of Public Benefit Programs and Electric Utility Restructuring. American Council for an Energy-Efficient Economy, Washington DC, May.

Littlechild, S., 2000. Privatisation, Competition and Regulation in the British Electricity Industry, with Implications for Developing Countries. World Bank, Washington, DC.

Lopes, C., Nilsson, L.J., Thomas, S., Verbruggen, A., 2000. Linking reforms and energy efficiency to explore the possibilities for IRP and DSM in the liberalised internal European electricity market. In: Proceedings of the ACEEE 2000 Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy, Washington, DC.

Mitchell, C., 1992. Integrated resource planning: where the states stand. The Electricity Journal 5 (4), 10–15.

Munasinghe, M., 1990. Energy Analysis and Policy—Selected Works. Butterworth, London.

NARUC (National Association of Regulatory Utility Commissioners), 1988. Least-Cost Utility Planning Handbook for Public Utility Commissioners. NARUC, Washington, DC.

NER-SA (National Electricity Regulator-South Africa), 2002a. National Electricity Regulator Policy Framework NER 01-2002-IRP: Framework for Integrated Resource Planning in the Electricity Supply Industry (Draft 3), available at www.dme.gov.za/publications/wp_ene/whitepaper1998.htm.

NER-SA (National Electricity Regulator-South Africa), 2002b. An integrated electricity outlook for South Africa, available at www.ner.org.za.irp/2001nirp-1.pdf.

Nilsson, L.J., Thomas, S., Lopes, C., Pagliano, L., 2001. Energy efficiency policy restructuring European Electricity Markets. ECEEE Proceedings, Paper No. 5110.

Northwest Power Planning Council, 1998. The Future Role of the Northwest Power Planning Council in Revised Fourth Northwest

Conservation and Electric Power Plan, available at www.nwcouncil.org/library/1998/98-22/chapter8.htm#E20E19 (Chapter 8).

Patterson, W., 1999. Transforming Electricity—The Coming Generation of Change, The Royal Institute of International Affairs. Earthscan Publications Ltd., London.

Rao, N.S.M., Kuldeep, K.K., Muralidhar, K., 1996. Integrated energy planning for India using the Energy and Power Evaluation Programme (ENPEP). Presented during an IAEA-RCA Regional Training Course on Integrated Energy and Electricity Planning, Thailand, June–July, available at www.npcil.org/docs/article4_1n.htm.

RAP (Regulatory Assistance Project), 1994. Integrated Resource Planning for State Utility Regulators—A compilation of papers prepared by C. Harrington, D. Moskovitz, T. Austin, C. Weinberg and E. Holt from workshop presentations of The Regulatory Assistance Project, June.

RAP (Regulatory Assistance Project), 1996. Perspectives in Electric Utility Restructuring (Ed. Ellen Baum)—A compilation of papers prepared by T. Austin, P. Bradford, C. Harrington, E. Holt, D. Moskovitz, C. Weinberg of The Regulatory Assistance Project, February.

Reddy, A.K.N., 2001. Indian public sector reform for sustainable development: the public benefits imperative. Energy for Sustainable Development 2, 74–81.

Reddy, A.K.N., D'Sa, A., 1995. The Enron and other similar deals vs the new energy paradigm. Economic and Political Weekly XXX (24), 1441–1448.

Reddy, A.K.N., Sumithra, G.D., 1997. Integrated resource planning. Energy for Sustainable Development (Special issue on electric power reforms) III (6), 14–16.

Reddy, A.K.N., Sumithra, G.D., Balachandra, P., D'Sa, A., 1991. A development-focused end-use oriented service-directed electricity scenario for Karnataka. Economic and Political Weekly XXVI (14&15), 891–910, 983–1001.

Reddy, A.K.N., D'Sa, A., Sumithra, G.D., Balachandra, P., 1995. Integrated energy planning: part I—the DEFENDUS methodology. Energy for Sustainable Development II(3), 15–26. Integrated energy planning: part II—examples of DEFENDUS scenarios. Energy for Sustainable Development II(4), 12–26.

Rosenzweig, M.B., Voll, S.P., 1997. Sequencing Power Sector Privatisation. National Economic Research Associates, Washington, DC.

Sant, G., Dixit, S., Wagle, S., 1995. Dabhol project PPA: structure and techno-economic implications. Economic and Political Weekly XXX (24), 1449–1456.

Sathaye, J.A., Ravindranath, N.H., 1998. Climate change mitigation in the energy and forestry sectors of developing countries. In: Annual Review of Energy and the Environment, Vol. 23, pp. 387–438.

Slater Consulting, 2000. Analysis and evaluation of the integrated resource plans of the investor-owned and state-owned electric utilities in South Carolina. Prepared for the South Carolina Energy Office, available at www.state.sc.us/energy/irppage.htm.

Stadtwerke Hannover AG (Eds.), 1995. Integrated resource planning, The Hanover LCP case study. Final Report, Öko-Institute/Wuppertal Institute, Hannover/Freiburg/Wuppertal.

Swisher, J.N., 1994. Barriers and incentives for utility energy efficiency programmes in de-regulated markets. Proceedings of the ACEEE 1994 Summer Study on Energy Efficient Buildings, American Council for an Energy-Efficient Economy.

Teplitz-Sembitzky, W., 1990. Regulation, deregulation, or reregulation—what is needed in the LDCs power sector? Industry and Energy Department Working Paper, Energy Series Paper No. 30, The World Bank, July.

UNDP, 2000. World Energy Assessment—Energy and the challenge of sustainability. Goldemberg, J. (Chairman, Editorial Board), The United Nations Development Programme. United Nations Department of Economic and Social Affairs and World Energy Council, New York.

UNDP, 2002. Energy for sustainable development—a policy agenda. In: Johansson, T.B., Goldemberg, J. (Eds.), The United Nations Development Programme. The International Institute for Industrial Environmental Economics and The International Energy Initiative, New York.

USAID (United States Agency for International Development), 1998. The Environmental Implications of Power Sector Reform in Developing Countries. Washington, DC.

US-DOE (United States Department of Energy), 1998. Comprehensive Electricity Competition Plan. Department of Energy, Washington DC.

USEA (United State Energy Association) Energy Efficiency Committee, 1992. Strategic Planning for Energy and the Environment, 12(1), "Part 1: Getting Down to Business: Foundation for an Energy Efficiency Strategy", pp. 7–16.

WAPA (Western Area Power Administration), USA, 2000. Integrated resource planning criteria, available at www.es.wapa.gov.

WBSEB & IEI (West Bengal State Electricity Board, Kolkata, and International Energy Initiative, Bangalore), 1998. Least-cost electricity planning for West Bengal. Report prepared for the West Bengal State Electricity Board, January.

WBSEB & IEI (West Bengal State Electricity Board, Kolkata, and International Energy Initiative, Bangalore), 1999. Feasibility study on the implementation of the DEFENDUS electricity plan for West Bengal. Report to the West Bengal State Electricity Board, August.

Wood, C., 2001. Prepared witness testimony before the Committee on Energy and Commerce, Washington. California Public Utilities Commission, 15th February, available at www.energycommerce.house.gov/107/hearings/02152001Hearing40/Wood36print.htm.

WRI (World Resources Institute), 2002. Power politics—equity and environment. In: Dubash, N.K. (Ed.), Electricity Reform. WRI, Washington, DC.

Wuppertal Institute, ACE, ADEME, ARMINES, CCE, DEA, energy piano, EEE, EST, InterRegies, Lund University, and Politecnico di Milano, 2000. Completing the market for least-cost energy services, strengthening energy efficiency in the changing European electricity and gas markets. Project Final Report—September, Wuppertal Institute, Wuppertal, Germany.