Integrated Resource Planning (IRP)

Part 1: Recent practice for the power sector

Prepared by

Antonette D'Sa
The International Energy Initiative, (Bangalore) India

Funded by

The Regulatory Assistance Project, USA, as a part of the
India Power Sector Best Practice Network - Integrated Resource Planning Initiative

March 2011

The International Energy Initiative IEI),
Asian Regional Energy Initiative,
80-B Spencer Road, 2nd Cross,
Fraser Town, Bangalore 560 005
India
Telephones: 91 80 2555 3375 /3563
E-mail: ieiblr@vsnl.com
Web-site: www.iei-asia.org

Contents:

Abstract:

Integrated resource planning (IRP) is a planning method in which the requirement of a resource is met through combinations of supply increases and conservation of demand, while minimising the costs to the firm and to society. Countries around the world have programmes devoted to promoting renewable sources of electricity and/or improving the efficiency with which it is used. But, there are relatively few cases where the comparison of both supply- and demand-side options, and their externalities, is an integral part of the evaluation process.

This document briefly describes the concept of IRP and then focuses on how IRP is being carried out for the power sector in various parts of the world. Cases included are those where IRP has actually been carried out, or at least where the IRP-approach can be discerned in some form – through portfolio optimisation or with an inclusion of demand side measures for meeting requirements, or where IRP has recently been recommended. Finally, pertinent questions on integrated planning for the power sector are considered.

1. **What is Integrated Resource Planning?**

Integrated resource planning (IRP) as applied to the power sector, can be described[1] as an approach through which the estimated requirement[2] 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[3], environmental protection, reliability[4], and other country-specific goals (D'Sa, 2005). The purpose of IRP is therefore to minimise the present and future costs of meeting electricity requirement, while considering not only the costs to the utility but to society[5].

Traditionally, when planning for investments, utility planners projected future demand and selected from the options of increasing supply to meet their projections. With the applicable regulations, if any, they considered types of fuels, power plants, and power purchases.

However the power sector has been beset with several problems. Investment in the establishment and maintenance of generating, transmission, and distribution systems have been inadequate; consequently, energy demand has not been met reliably, particularly during peak load periods. In developing countries, the potential requirement is much higher, with a large proportion of households (for example, 48% of rural Indian homes) not yet electrified, even in grid-connected areas. Future shortages could be higher, with increasing population and the corresponding consumptive and productive needs, unless adequate system expansion and improvements are effected, but the projected costs appear greater than that the utilities and/or governments can meet.

Meanwhile, expansion of generation capacity has had detrimental impacts on air and water quality, so much so that an inclusion of such indirect costs in the reckoning is becoming essential.

---

[1] The concept of IRP and its practice for the power sector till the early 2000s' were discussed earlier by the author ["Integrated Resource Planning and Power Sector Reform in Developing Countries", *Energy Policy*, 33(10), pp. 1271-1285]; this Section is based on that paper.

[2]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.

[3] This concern is particularly important in countries where some do not have access to electricity; equity, in this context, refers to fair access to electricity for all.

[4] Reliability refers to the ability of the electric system to meet the demand for power and energy, taking into account scheduled and reasonably expected unscheduled outages of system elements.

[5] For other definitions of IRP, refer to Munasinghe, 1990; Bauer and Eto, 1992; RAP, 1994; Reddy and Sumithra, 1997.

Further, problems even in market economies have suggested that both regulation and a wider range of options are needed for the effective functioning of the electricity system. All these necessitate the approach that integrated resource planning (IRP) provides.

First, through IRP, one can identify a series of the most cost-effective options, from the array of available generation technologies and transmission upgrades, as well as end-use efficiency improvements and other demand-side management (DSM)[6] measures. This is because the costs of delivering and saving a kWh of electricity – from improved lighting retrofits or centralised thermal generation plants or decentralised biomass generation facilities – are compared on a "level playing field". IRP is therefore technologically-neutral, treating deferred or avoided end-use demand as equivalent to "delivered supply"[7] of electricity. By considering a range of options in increasing order of unit-cost, IRP can enable lowering/avoidance of investment in new generation, and "stranded" (or "strandable"[8]) costs. Further, where generators are dispatched in order of increasing bids, the pool price paid to all the generators is set by the bid of the last most expensive generator dispatched; hence, reducing the load to be served (through efficiency measures) displaces the need for the next higher bidder(s), and thereby lowers the price payable to all. Thus, the implementation of IRP optimises resource use and minimises the costs of meeting demand.

Second, IRP includes costs to all stakeholders (rather than only the costs incurred by the utility). Environmental/societal impacts can be included either as constraints in the optimisation process, or as costs – such as the actual cost of pollution controls or proxy values imputed for negative impacts, resulting in cleaner options appearing earlier in the least-cost-supply schedule. IRP can thus ensure that environmental factors are incorporated in the resource selection process, even where explicit structures to internalize those costs (e.g., through taxes, fees, control requirements, or emissions cap and trading systems) are not in place.

Third, by enabling the selection of a diverse set of options, IRP reduces unreliability/risks of supply (such as plant breakdowns and maintenance margins, irregular supply and volatile prices of fuels).

The availability of several alternatives necessitates choices; analytical tools are therefore needed to evaluate the alternatives. IRP consists of such tools. Plans are drawn up for period of 10-20 years, but intermediate monitoring and updating enable mid-

[6] 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.

[7] 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 x [1 ÷ (1-T&D losses incurred)].

[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.

course correction. The IRP process is summarised in Annexe 1 with a schematic description in Figure 1.

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. While in industrialised regions, IRP has helped to improve overall system reliability, moderate loads, and even reduce electricity use, in developing regions, IRP also holds the promise of helping to spread energy services to under-served areas and thereby achieve developmental goals.

2. **IRP in practice**

In this section, IRP[9] used for power sector planning in various countries will be described, distinguishing between (1) developing countries, and (2) industrialised countries. The emphasis will be on the planning programmes of government departments and utilities (state-sponsored and otherwise), rather than the efforts of individual researchers[10], and the information included will be from published reports/papers.

We will also distinguish between an integrated assessment of both demand and supply options and focused programmes -- devoted to DSM measures, and/or renewable sources of electricity – that are being carried out in many countries or groups of countries[11]. Similarly, planning packages have been used to estimate the environmental impacts (in particular, CO_2 emissions) for generation-capacity additions during the planning period[12]. There were some elements of integrated planning, but IRP *per se* was not carried out.

---

[9] While IRP is the acronym for "integrated resource *planning*" (which is a planning approach that involves a procedure), the same term IRP is also used to describe a *plan* so drawn up.

[10] For example, in Vietnam, individual researchers have used IRP for power sector projections, but there is no evidence of power sector authorities considering it. This was for projections on meeting the demand-supply gaps (IEI, 1994) and more recently, for the potential for renewable sources, and for CO_2 mitigation (Nhan and Minh, 2009).

[11] For example, a project "Caribbean Renewable Energy Development Programme" for the promotion of renewable energy sources was carried out in the Caribbean region (1999-2003), funded by UNDP/GEF. The countries include Antigua and Barbuda, the Bahamas, Barbados, Belize, British Virgin Islands, Cuba, Dominica, Grenada, Guyana, Jamaica, Montserrat, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, Trinidad and Tobago, and Turks and Caicos. There were two major agencies involved on a full-time basis in the collection and dissemination of information on renewable energy -- the Caribbean Energy Information System and the Caribbean Electric Utility Services Corporation.

[12] The Long-range Energy Alternatives Planning (LEAP) program and other planning packages have been used to assess resource requirements and emission. For example, LEAP was used for short-term (1994-2005) and long-term (2005-40) planning for the state-monopoly electricity sector of Lebanon. Electricite Du Liban (EDL) has been entrusted with electricity generation, transmission and distribution; it is responsible to the Ministry of Hydraulic and Electric Resources (GoL, 1999). Carbon emissions were estimated for alternative scenarios.

2.1 Developing countries

African countries (as a group of 53 Member states of the ECA[13])

As part of the United Nations Energy Africa (UNEA) programmes, the Economic Commission for Africa (ECA) and UNEP jointly implemented a project on "Making African Power Sector Sustainable", which aimed to facilitate the integration of socio-economic and environmental concerns into the power sector reforms in Sub-Saharan Africa. UNEA is said to have scheduled training activities on Integrated Power Resource Planning (IRP) to raise the awareness of African energy planners on the need to introduce IRP as a means for the least-cost development of their power sector (ECA, 2005).

While there is no evidence that IRP has actually being carried out by the concerned governments/utilities, there have been studies of African regions by researchers[14] that used an integrated approach.

Brazil

Brazil's utilities are not obliged to conduct IRP. However, (as in other countries described below), there is special emphasis on efficiency. The national regulatory agency Agência Nacional de Energia Elétrica (ANEEL) has allocated 1% of the utilities' net annual operational revenue to energy efficiency and R&D[15]. As part of its concession contract, the distribution company presents to ANEEL, a set of programs as an Annual Program against Electrical Energy Waste[16].

It might be pertinent to note that a "Sustainable Power Sector Vision 2020" was drawn up for Brazil by a research team (WWF-PowerSwitch, 2006)[17]. A complete assessment of costs was not carried out, but an IRP approach was used to draw up BAU and improved ("powerswitch") scenarios, and national programmes were suggested for implementation.

Chile

[13] South Africa is the only one of these with legally mandated IRP for several years; it is therefore being discussed separately.

[14] For example, an estimation of the magnitudes of the savings from a regional integration approach for the South African Power Pool (SAPP) was conducted by Purdue University's State Utility Forecasting Group (SUFG) (Sparrow *et al*., 2001).

[15] http://www.aneel.gov.br/area.cfm?idArea=262&idPerfil=11

[16] This plan includes both goals in terms of specific actions taken and financial commitments toward energy efficiency programs. The broad guidelines for these filings are defined in Law 9991, of July 24, 2000, and are contained in specific ANEEL resolutions on energy efficiency (http://www.aneel.gov.br/cedoc/LEI20009991.pdf).

[17] WWF Brazil commissioned the University of Campinas and the International Energy Initiative to investigate a scenario – called PowerSwitch – for meeting Brazil's electric energy needs by 2020 in sustainable way.

Strictly, IRP is not being carried out, but several energy efficiency programmes are in progress. The Energy Efficiency Country Programme (Programa País de Eficiencia Energética) was established in 2005, initially under the Ministry of Economy but since 2008 incorporated within the National Energy Commission (Comision Nacional de Energia) to implement a series of programmes. A detailed action plan for the years 2010 to 2020 has also been drawn up, with objectives, lines of action, programs, financing options and evaluation tools (Karakosta and Askounis, 2010).

China (PRC)

IRP was introduced in China during the early 1990s', with a pre-feasibility study of Hainan province beginning in 1992 and symposia with international teams held in 1994[18]. These were followed by strides in the use of renewable sources as well as efficiency improvements, alongside the increase of conventional generation capacity, but without an integrated assessment[19] of all these.

Laws had been passed pertaining to efficiency (Energy Conservation Law, 1998)[20], cleaner processes (the Cleaner Production Promotion Law, 2003), and renewable sources (-- the Renewable Energy Law in effect since January 2006, updated with effect from April, 2010). The updated renewable energy law requires more detailed planning, including co-ordination of renewables with overall electric power sector development and transmission planning, and co-ordination of local/provincial development with national development plans (Martinot and Li, 2010). In April 2005, China's National Development and Reform Commission (NDRC) and four ministries issued a joint announcement—the *China Water Conservation Technology Policy* that embraces many components constituting an integrated resource planning (IRP) process.

Even so, China's planning process for the power sector had been assessed to be inconsistent with "Scientific Energy Planning" in many important respects (RAP, 2006) – not treating efficiency options as alternatives to generation, not adequately considering environmental and social costs (e.g. coal mine injuries and fatalities), and with its planning disconnected from investment and regulatory decisions. China was assessed to need more and better planning, better markets, where competition could achieve those objectives most efficiently, and better integration of energy and environmental policies and regulation. The State Electricity Regulatory Commission (SERC) was set up in

[18] In January, an international Integrated Resource Planning (IRP) symposium was held, with experts from the UNESCO, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, and utilities from Europe and the USA; Chinese participants introduced the results of China's first IRP/DSM pilot project in the Shenzhen Power Network. In May, a training workshop was conducted jointly by the China Council for International Co-operation on Environment and Development, the International Energy Initiative (Bangalore, India) and the Institute for Techno-Economic and Energy System Analysis (Tsinghua University).

[19] The recent (November 2010) *DSM Implementation Measures* have changed the approach to IRP.

[20] There were also the national Power Conservation Regulations, 2000, that were promulgated jointly by the State Economic and Trade Commission and the State Development Planning Commission in 2000.

March 2003 with a range of responsibilities (He Gang, 2010), but it reportedly did not enjoy the independence of other national regulators (Gee *et al*., 2007).

While the focus of this study is on state and utility plans, it may be relevant to refer to some of the research where IRP-principles have been used. These include drawing up demand and supply estimates[21] for China's power sector (Sparrow *et al*., 2001), for evaluating alternative options to coal plants, such as coal gasification with carbon capture and storage, electricity from combined CHP systems and renewable sources, and DSM[22] options (Finamore *et al*., 2003), for sustainable development of the electricity sector in order to meet its requirements (RAP, 2005), and for the transparent implementation of policies and regulatory procedures for all grid and power company investments (Zhi *et al*., 2006). Appreciable benefits for China were also estimated through efficiency improvements brought about by "Integrated Resource Strategic Planning" (IRSP), which is what IRP was termed (Hu *et al*., 2010) when conducted at the national level in a deregulated power sector.

However, on November 4, 2010, China's central government enacted new demand-side management regulations, called *DSM Implementation Measures*, coming into effect on January 1, 2011. These regulations were jointly issued under the auspices of the State Council by six commissions and ministries, led by China's most powerful government agency, the National Development and Reform Commission (NDRC). For the first time, regulations call for integrated resource planning i.e. considering both supply side and demand side options (China-NDRC, 2010). However, the regulations specify that demand side measures should be considered and given priority in meeting demand growth. Local authorities are required to incorporate these energy efficiency savings into their power industry and local development plans. The power grid companies are required to use a portion of their electricity revenues to develop large-scale programs to help China's factories, businesses and homes invest in energy efficiency, thereby achieving specific savings targets (similar to the Energy Efficiency Resource Standards passed in 19 states in the U.S). The regulations authorize three sources of DSM funding: public utility surcharges beyond the electricity rate, revenue from differentiated electricity prices, and/or other government budget allocations. In addition, legitimate expenses on DSM implementation by power grid companies may be incorporated into power supply cost. Finally, the regulations encourage – though do not go so far as to require – verification of energy savings through independent third parties.

[21] Purdue University's State Utility Forecasting Group (SUFG) created an integrated electricity modelling system (used for each electric utility in the state of Indiana), that was supposed to be used by a joint research team for China.

[22] In 2005, utility experts from Jiangsu Province, Shanghai, Beijing, and elsewhere, began creating an inventory of DSM opportunities - such as high-efficiency lighting, industrial motors, and appliances - that could be brought "online" more rapidly and cheaply than coal plants. The Natural Resources Defense Council (USA) and the China-U.S. Energy Efficiency Alliance helped broker and implement an agreement on DSM cooperation between the California Public Utilities Commission, the California Energy Commission, and the Jiangsu Economic and Trade Commission; the study resulted in opportunities for what are technically referred to as "Efficiency Power Plants" (EPPs).

Egypt

The Egyptian electricity industry had been going through a gradual transitional process from a strongly regulated (exclusively state owned) captive/subsidized electricity market to a liberalized competitive electricity market where both state owned and private sector service providers are supposed to compete under a developing/maturing regulatory system[23]. But, thus far, there have been no Government and/or utility efforts[24] at IRP.

India

Several years ago, training workshops on IRP/least-cost planning were conducted for officials of state utilities and the energy departments by a non-governmental research organisation (IEI, 1994). "Least-cost" plans were drawn up for some of the states; of these, the electricity utility of the state of West Bengal went ahead with finalising an integrated electricity plan (WBSEB and IEI, 1998)[25] and also an efficiency-implementation package (WBSEB and IEI, 1999) that led to implementation of lighting efficiency improvements.

Thereafter, there have been legislative and policy achievements.

The *Electricity Act, 2003*, amended in 2007, requires the Central Electricity Authority (CEA), Ministry of Power, Government of India, to "advise the Central Government" on "matters relating to the national electricity policy, formulate short-term and perspective plans for development of the electricity system and co-ordinate the activities of the planning agencies for the optimal utilisation of resources - - - and to provide reliable and affordable electricity for all consumers" (clause 73a, GoI, 2003). Perhaps due to the advisory role specified in the Act, an IRP division with designated staff was recently created within the CEA (MoP-GoI, 2009). This has been the first attempt to establish IRP in the central Government's planning process. Nevertheless, thus far, the IRP division appears to be involved with the assessment of only supply options to meet projected electricity demand, as evidenced by official estimates (IRP-CEA-GoI, 2010) and presentations from this division[26].

[23] Information has not been obtained after the changes in February 2011.
[24] An individual researcher has worked on an IRP/DSM formulation (Elsobki, 2009) to be used by electric distribution utilities to achieve their goals for meeting the customers needs while competing within new gradually developing liberalized electricity markets.
[25] Detailed demand scenarios for the five main electricity distribution agencies (public and private) in the state were drawn up to estimate the aggregate demand till 2006-07. These estimates were compared with the Central Electricity Authority's Annual Electricity Plans. The costs of the available generation/conservation/increased capacity utilisation options to bridge the state demand-supply gap were then estimated, to derive a least-cost-supply staircase. The likelihood of surplus capacity in this state, if all the proposals were actually implemented, was also considered.
[26] Presentation of the Chief Engineer, IRP Division, at the National Power Conference, 4th December '09.

Meanwhile, a national policy and plan for the electricity sector have also been spelt out for the first time – the *National Electricity Policy, 2005*, and a *National Electricity Plan, 2007*. These were formulated jointly by the power/energy ministries of the central and state governments, and will be periodically updated. However, both display a supply-side bias. The National Electricity Policy, 2005 specified " - - development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or materials, hydro and renewable sources of energy" (MoP-GoI, 2005, Section 1.7); further, the "aims and objectives" (Section 2) emphasize the electricity use per person and per household, rather than the magnitude of energy-services delivered. Likewise, the National Electricity Plan 2007 has estimates of capacity additions during successive Five-Year Plans, broadly based on projected gross domestic product (GDP) growth rates, but the emphasis is on the supply side – generation, transmission, and distribution. Energy conservation and environmental issues have been touched on, but there has been no mention of comparison between generation and conservation options.

In contrast to all these policies/plans, the *Integrated Energy Policy 2006* has specifically recommended an IRP-approach. Among the medium/long-term initiatives is included "Adoption of a least-cost planning and policy approach that ensures that energy efficiency and DSM have a level playing field with supply options - -" (PC-GoI, 2006)[27].

Apart from this policy, an "Energy Coordination Committee", has also been set up under the Chairmanship of the Prime Minister, to review and approve policies for the energy sector as a whole, and a National Clean Energy Fund[28] is being set up for R&D funding. These could be used to facilitate IRP in the future.

It may also be useful to note that, as in other countries, there have been considerable efforts to promote energy efficiency[29] and renewable sources of electricity[30], but without integrating these in the plans to meet electricity service requirements.

Malaysia

[27] "- - The regulatory commissions should invite bids for DSM while approving new capacity additions. Thus, if a state requires an additional peak demand of 1,000 MW over the next five years, the utility can ask for bids from Independent Power Producers (IPPs) as well as Energy Service Companies (ESCOs)", *Chapter VI: Policy for Energy Efficiency and Demand Side Management* (point 11), *Integrated Energy Policy*, 2006.

[28] This is being funded by a cess on coal use (Budget, Ministry of Finance, 2010).

[29] Efforts to foster efficiency improvements include the establishment of the Energy Management Centre, 1989, the passing of the Energy Conservation Act, 2001, the establishment of the Bureau of Energy Efficiency (BEE), 2002, and adoption of the National Mission for Energy Efficiency as a part of the National Action Plan for Climate Change, 2008.

[30] Promotion of investment in and generation from renewable sources of electricity -- particularly wind power, mini/micro hydro-systems, solar photo-voltaics, and biomass gasification – have been taking place through a dedicated Ministry, and the Indian Renewable Development Agency (IREDA) at the centre and corresponding agencies in the states, with fiscal and financial incentives.

An IRP project[31] has been implemented in conjunction with the National Energy Policy; it attempts to take a comprehensive approach towards energy planning. Three modelling tools - Comparative Techno-Economic Assessment of Energy Supply, Energy Demand and Demand Side Management Options (COMPEED), Long Range Energy Alternatives Planning (LEAP), and Computable General Equilibrium (GCE) were introduced. Energy planners and regulators were to evaluate the total costs and benefits of both the supply-side and demand-side options in energy planning, to select an optimal mix, which would provide energy at the least financial, social, and environmental cost. However, it is not clear whether or not these assessments were actually carried out.

Earlier (in 2000), the Four Fuel (oil, gas, hydropower, and coal) Policy, that had been drawn up to meet the supply objective was amended to become the Fifth Fuel Policy (Eighth Malaysia Plan 2001-2005), where renewable energy was the "fifth fuel" in the energy supply mix. Energy efficiency was also encouraged to prevent Malaysia from becoming a net energy importer (Jalal and Bodger, 2009).

South Africa

South Africa appears to be the only country to legally require integrated resource plans for the electricity sector at the *national* level, hence its IRP activities are being described in some detail.

South Africa's 1998 White Paper on Energy Policy first recommended IRP (SA-DME, 1998). However, in the early years, least-cost *supply* schedules were constructed (rather than integrated supply and efficiency plans) by and for the main utility (Eskom). The National Electricity Regulator (NER) then introduced the development of a National Integrated Resource Plan (NIRP) as an independent information source. The first National IRP (NIRP1) was completed and published in March 2002, by Eskom's Strategic Planning Division, under the guidance of the NER (SA-NER, 2002b). The Energy Bill 2002 drafted by the Department of Mines and Energy also included integrated energy and resource planning. At the beginning of 2003, the NER established the National IRP (NIRP) Advisory and Review Committee (ARC) with the function to provide wide stakeholders' guidance and contribution to the NIRP development process.

The NIRP 2003-04 (NIRP2), an improvement on its predecessor, was generated with the guidance of the NER's NIRP Advisory and Review Committee by an NIRP team comprising Eskom Resources and Strategy Group, the Energy Research Institute of UCT and the NER (SA-NER, 2004).

The Electricity Regulatory Act, 2006 (SA-No.1243) was passed on the 31st December 2006. It included IRP and has gives the responsibility for electricity planning to the Energy Minister. She in turn has published regulations, devolving responsibility for electricity planning to Eskom's System Operations and Planning Division, but with

[31] The project was conducted in 2005 with the co-funding from the Danish International Development Agency (DANIDA).

the supervision of the Department of Energy (DoE), which should also consult the National Energy Regulator of South Africa (NERSA).

A 20-year IRP was drawn up by Eskom and the DoE, along with an interim 5-year plan, in September 2009 (SA-DoE, 2009a). Civil society groups were critical that this draft – although referenced elsewhere – was not discussed publicly within the country and was only "leaked to the media" (Nakhooda, 2010, quoting Mail and Guardian, 2010) and that industry voices were given more say in the drafting process. The draft was said to have acknowledged the risks of reliance on renewables, but not the problems[32] associated with coal (SA-DoE, 2009a). In addition, the expected electricity conservation (for example, through efficient motors) was greatly under-estimated (Totten, 2010). According to the Free Market Foundation of Southern Africa, the problem was not technical -- not the lack of planning processes -- but the lack of a regulatory system (Free Market, 2010).

However, for development/revision of IRP-2010, several committees were involved: the Inter-Ministerial Committee on energy (IMC) -- a sub-committee made up of cabinet members to assess progress made on the IRP as well as other electricity–related matters (GoSA, 2010), the Inter-Departmental Task Team, that reports to the IMC on a regular basis, Work Group 2 (an IMC working group) on the IRP, and the IRP Technical Task Team (IRP TTT), whose role is to advise the DoE on technical IRP matters (Eskom, 2010). There were also stakeholder–consultations both on the input parameters to the modelling and the scenarios (IDASA, 2010a; 2010b). Significant changes were made between earlier and subsequent versions, with respect to some parameters (IDASA, 2010c).

The most recent version of IRP 2010 – Revision 2, published in October '10, aims to estimate the electricity demand until the year 2030, and how this demand should be met in terms of generating capacity, type, timing, and cost. It also serves as an input to other departments that focus on job creation, energy security, climate change, and financing considerations. It is being regularly reviewed (with Version 8 currently available) and is considered indicative rather than "cast in concrete". While the Base Case Scenario indicates the least-cost alternative, these costs do not include the inherent externalities. Scenarios were developed around the targets for greenhouse gas (GHG) emissions, as well as policy objectives relating to regional development and increasing demand-side interventions. The scenarios were assessed in terms of cost, emissions, water consumption, and regional development objectives, as well as additional risk to the system (Eskom, 2010). However, comparison with demand-side options has not really been integrated into the planning process; rather, some DSM/EE options have been forced into the schedule (Eberhard, 2010).

While IRP has been instituted by legislation and regulation, it is also desperately needed to inform new investments, as South Africa had experienced blackouts between

[32] The problems with coal-based generation include rising prices (Eskom, 2009), water requirement, unreliable supply due to weather, (Nakhooda, 2010, quoting Reuters, 2008) and cleaning/restoring water systems (Liefferink, 2009).

2005 and 2008 and is likely to experience shortages again[33]. Further, the regulator can only licence those plants that are included in the IRP, unless the Minster decides to include other generators; hence, the plans that have been drawn up are likely to be implemented (Eberhard, 2010). In addition, the process of drawing up an IRP for *energy* (rather than only electricity) has begun, and the plan is due in 2011.

Thailand

The national utility, Electricity Generating Authority of Thailand (EGAT) had drawn up a Power Development Plan (99-02) which stated 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). Thereafter (since 1993), DSM programmes were actively implemented by EGAT's Demand-Side Management Office. The Director of EGAT's DSM and Planning division has justified DSM activities by the generating utility because of deferred investment, peak reduction, and suitability for a single country/utility (Napaporn, 2008), and estimates of conservation through efficiency programmes continue to be made[34]. Even so, integrated planning has not been carried out by EGAT[35].

The Thai government now considers "Strategic Environmental Assessments" (SEA), taking a holistic approach to planning for sectors. For external input into policy-making, there exists a National Economic and Social Advisory Council, and a Senate Extraordinary Committee on State Enterprise Reform that conducts public hearings. In addition, an Interim Regulator for the electricity sector was established, although a more effective regulatory system[36] could be needed (Chuenchom Greacen, quoted in WRI, NIPFP & Prayas, 2006).

2.2 **Industrialised countries**

While IRP had been used for years in some regions of the world (for example, in most states of the USA), its importance lessened with the restructuring and deregulation of the power industry, when the introduction of customer choice and other features fundamentally altered the shape of the industry.

However, the energy crisis of 2000-01 highlighted the dangers of assuming that energy markets would provide adequate, low-cost resources. With the subsequent re-

[33] The economic recession lowered demand during 2008-10.
[34] Lighting efficiency measures was estimated in terms of energy, power and CO_2 emissions reduction; its costs were less than 50% of generation costs in 2008.
[35] Individual researchers have drawn up IRP estimates and planning structure for the country, for example, Tanatvanit, *et al*., 2004; T. Foran, 2009.
[36] The lack of an independent regulator in the Thai electricity sector remains a significant barrier to balancing the interests of EGAT (which is run on a for-profit basis) against the needs of Thai citizens and consumers.

regulation, integrated planning[37] came to be considered useful again. As an alternative, a variant of IRP called "portfolio management"[38] came to be adopted in some states. Portfolio management puts emphasis on uncertainty and risk, and evaluates conventional and renewable energy sources on the basis of their risk contribution to a portfolio of generating assets. While conceptually similar to IRP, it differs from the latter in that it assumes that the distribution function will be performed by an entity that could be buying rather than building a large part of its power supply and is therefore managing a portfolio of different supply and demand options.

Further, advances in automation and information technologies have made multi-dimensional resource decisions and Demand Response programs (and consequently IRP implementation) effective (Tram and Elliott, 2004; Black, 2005; NAPP-Utilities, 2010).

Australia

There is no IRP requirement for the power sector at the national level. However, the National Water Commission, perhaps due to the severe water shortage, has recommended IRP for sustainable urban water planning (NWC-GoA, 2009).

More pertinently, a Code of Practice *Demand Management for Electricity Distributors* was recommended for the power sector of the state of New South Wales (in SE Australia). This Code is an example of a mandatory planning process (though treated as voluntary by utilities). Its purpose was to prescribe a methodology for the market-based development of options for electricity system support (including demand management, embedded generation, and storage options) and their evaluation (through a competitive process), at the same time and in the same manner as network investments (EF-Australia, 2002). Mechanisms – control, funding, support, and markets – that affect demand-side management measures were discussed. However, the extent to which the Code has been followed has not been established.

IRP has also been used to justify hydrogen-energy futures, for example, for a case study of Tasmania, where the major generator has proposed a wind-hydrogen pathway (Pignieri, 2006).

Canada

The province of British Columbia (one of the ten provinces in the country) has drafted its Clean Energy Act (Bill 17 – 2010) through the Ministry of Energy, Mines, and Petroleum (GoBC-C, 2010). This Bill sets out British Columbia's energy objectives, requires the British Columbia Hydro and Power Authority to submit an integrated resource plan describing what it plans to do in response to those objectives, and requires the authority to achieve electricity self-sufficiency by the year 2016. However, rather than emerging through a comparative assessment process, achievements through DSM

[37] Versions of IRP are referred to as Least-Cost Planning, Long-Term (Resource) Procurement Planning, Integrated Resource Strategic Planning, and Scientific Energy Planning.
[38] For further information, see RAP, 2005, Awerbuch, 2006, Steinhurst, 2008.

(@ 66% by the year 2020) and generation through clean or renewable sources (@ 93%) have been specified in the Act.

European Union countries:

The European Commission's Draft Directive, 1995, 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[39] in electricity supply.

However, while most European countries do not have an IRP obligation, they do have obligations regarding renewable sources of energy and efficiency improvements.

Several countries have energy efficiency targets: the UK has had an "Energy Efficiency Commitment" since 2001[40], for efficiency in the residential sector, Italy has an obligation for distribution companies to achieve specific energy saving targets[41], being implemented since January 2005, France has a new energy law since 2005, with 3-year efficiency targets, and the Flemish region of Belgium has imposed energy saving obligations on electricity distributors (Nadel, 2006). But none of these required IRP-like comparisons between alternatives.

Recently, the European Renewable Energy Council (EREC), in its new report *RE-thinking 2050*, outlined a pathway indicating how the European Union can switch to a 100% renewable energy supply for electricity, (as well as heating and cooling, and transport), examining the effects on Europe's energy supply system and on CO_2 emissions (EREC, 2010). However, this was not derived from a comparison with efficiency improvements or other generation options.

While utilities/state energy departments have not considered IRP, consultants have used IRP, for example, to study the extent of demand response (DR) to curb peak load requirements and overall load consumption in the European Union's EU-15 (Capgemini, VaasaETT and Enerdata, 2008)[42]. Another study identifies externalities

[39] The restructuring process in the EU was, in most countries, driven by the IEM Directive on the Common Rules of the Internal Electricity Market. However, as the former electricity market structures were very different, restructuring also took very different paths, within the rules defined by the IEM Directive. For example, the UK started restructuring in the 1980's (well before the IEM Directive) while France started the process for introducing the minimum changes only to comply with the directive.

[40] This was passed by parliament, and is administered by the Office of Gas and Electric Markets (OFGEM), through decisions of the Department for Environment, Food, and Rural Affairs (DEFRA).

[41] Established by the Ministry of Industry in 2001, the implementation details were worked out by the Regulatory Authority for Electricity and Gas (AEEG).

[42] In their dynamic scenario, DR alone achieves 25-50% of the EU's 2020 targets concerning energy savings and CO_2 emission reductions, as well as pre-empting the need for the equivalent of 150 medium size thermal plants in EU-15. However, they estimated that the results were

associated with energy production and use, barriers to increased societal implementation of demand management and an evaluation of options for encouraging increased demand management in several European countries (EF-Australia, 2002).

The few European countries with reported IRP activities are listed below.

Denmark: In Denmark, IRP was carried out in 1995 and 1997 (for 1997-2030). The traditional "macro-IRP" was replaced by a more limited "micro-IRP", or integrated assessment of supply and demand options performed by the distribution companies. Cost/benefit analyses were standardized, and utilities' common organizations compiled the energy companies' contributions and reported these to the Ministry. After 2000, implementation of the Internal Electricity Market (IEM) Directive resulted in the obligation to perform IRP being replaced with an obligation to implement DSM (Lopes *et al*., 2000).

Luxembourg*:* With the creation of the National Research Fund (1999), the announcement of the National Plan for Innovation in 2005, and the provisional Implementation Plan of 2006, there appears to be scope for IRP. Luxembourg's policy instruments to encourage R&D included (among others) environmental initiatives for renewable resources and energy efficiency (Alexander, 2006), but again, there does not appear to have been actual integrated planning.

Portugal: Long-term planning of the generation system, based on IRP, came to be required in 1995; it was to be performed by the Ministry, when proposed by the independent system operator and with advice from the regulatory entity. However, implementation is not evident (Lopes *et al*., 2000).

Some attempts at IRP were made in the 1990s' in Poland and other East European countries, (Chandler *et al*., 1993), but reports of any recent efforts are not available. Several researchers have used IRP for their studies, but as these have not been for a country as a whole[43], they are not being discussed here.

The USA

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 state Public Utility Commissions for approval. IRP showed that DSM could produce large economic and environmental benefits and could avoid the need to build unpopular and

---

unlikely to be achieved with the current level of commitment by the member states and the energy industry.

[43] IRP was used for a case study of Sardinia, Italy, where the production of hydrogen from wind power and via gasification of domestic coals and refinery residuals was compared (Pignieri, 2006).

polluting generating plants. The adoption of IRP was thus driven chiefly by the increasing costs of electricity generation and the consequent need for greater efficiency in the use of energy, as well as environmental concerns.

In contrast, restructuring of electricity markets and the transition to retail access weakened the ability to carry out "integrated" planning (for the generation, transmission, and distribution sectors)[44] and also the perceived need for IRP, because the latter was traditionally thought of as a centralised planning approach.

However, the problems that occurred (in particular, the Californian energy crisis) led to some states suspending power sector de-regulation[45]. Pertinent to this study, a renewed interest in IRP emerged, emphasized by the need for regulation at the point when resource acquisition decisions are made[46]. Some Western states (California, Montana, and New Mexico) have re-introduced an IRP requirement, while other states have developed new rules to strengthen their existing processes, for example, Connecticut, Delaware, Illinois, and New Hampshire have each legislated some form of IRP (Kaye Scholer *et al*., 2008). California and Delaware have mandated a return to deliberate resource planning for procurement of standard service offer (SSO) supply (RI&SEE, 2006). Connecticut's Office of Consumer Council has suggested using IRP methods to evaluate the utility's alternatives -- either "repowering" (replacing old plants with new ones) or new-fuelled plants such as natural gas CC (Rosenthal and Sobolewski, 2010). Maryland's IRP process had largely lapsed since de-regulation, but the need for IRP has been felt to harmonize the sometimes discordant State objectives (Kaye Scholer *et al*., 2008). Missouri is returning to IRP after several years of allowing utilities to file a waiver from existing IRP rules (RAP, 2010).

---

[44] By divesting their generation, utilities relinquished control over generation investment decisions that were thereafter left entirely to merchant generators. By ceding transmission planning authority to an independent system operator, utilities further diminished their IRP role – and, by extension, the State's role as well. Because states could no longer direct their utilities to build system facilities, their planning capabilities and authority atrophied, although the statutory requirements for IRPs often remained on the books. Consequently, planning for generation, transmission, demand response, and environmental protection was fragmented among multiple governmental, quasi-governmental, and private players, with little conscious integration.

[45] Currently (US-EIA, 2010, 1st November 2010), power sector de-regulation activities are not active in 28 states, were suspended in 7, and continue to be active in 15.

[46] "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).

States can be classified on the basis of their power sector planning activities:- those with IRP legally required, those where IRP is carried out by some utilities even without a formal requirement, and those with partial IRP, portfolio management and DSM/EE requirements.

IRP legally required – Currently (November 2010), 23 states[47] have laws requiring that integrated resource plans or Long-Term (Resource) Procurement/Strategic Plans be drawn up, although IRP is practised by some utilities in a total of 31 states[48].

Utilities have to periodically draw up estimates of demand and action-plans on how they intend meeting the goals, in order to provide reliable reasonable-cost service, with manageable risk, to their customers. The plans include short-term strategies for acquiring resources and long-term (10 – 20 year) expectations for resource needs (with specified reserve margins), and preferred portfolios of demand-side and supply-side options. These are submitted to the relevant State Utilities Commissions[49] and, after assessment and approval, determine each utility's activities. The plans are presented regularly, and are re-visited (even annually)[50]. Groups of states (for example, the Pacific Northwest[51]), and utilities that serve several states (for example, PacifiCorp[52]), have also been preparing IRPs in the 20-year range.

Many states require that utilities include various types of risk analyses (e.g. fuel price risk) within their IRP. Consideration of GHG emissions in IRPs is also required by several states; most of the major Western utilities that prepare IRPs incorporated future CO_2 regulations in their analyses of alternative resource strategies in their most recent resource plans. State public utility commissions can set quantifiable annual minimum efficiency and renewable energy goals for utilities; California developed its own "Energy Action Plan" incorporating a priority for energy efficiency followed by renewable energy in meeting the state's future needs. Some states (e.g., in California, New Mexico, and Oregon) have even specified CO_2 emission allowance prices and other requirements related to how utilities undertake their analysis of carbon regulation risk. The impact of IRP on renewable energy development is most apparent in states without a Renewable

[47] These are California, Connecticut, Delaware, Georgia, Hawaii, Idaho, Indiana, Kentucky, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, Utah, Vermont, Virginia, and Washington.
[48] This is from another assessment (RAP, 2010).
[49] Programs of PG&E, SCE, SDG&E, PacifiCorp, and Sierra Pacific Power Co. are submitted to the PUC of the state of California (CA-PUC, 2009). (PacifiCorp is a multi-jurisdictional utility and serves customers in other states too.
[50] Consider, for example, the IRPs of Portland General Electric (for regions in Oregon) (PGE, 2010), Nebraska Public Power District's least cost plan for the period 2008 – 2027 (NPPD, 2008), and Avista Utilities' IRP for 2009-29 (Avista, 2009).
[51] This region consists of the states of Idaho, Montana, Oregon and Washington who have together formed the Northwest Power and Conservation Council (NPCC).
[52] It serves areas in California, Oregon, Utah, Idaho, Wyoming, and Washington, (PacifiCorp, 2009) and submits IRPs for the regions it serves to the Public Utilities Commissions of those states.

Portfolio Standard, for example, Idaho. State policies requiring Utility-IRP in several states (particularly in the west) are credited with increasing the investment on and generation from renewables (Barbose *et al*., 2008).

IRP even without requirement: In some other states – for example, Ohio[53] and Wyoming -- IRP is carried out by some utilities, although there is no formal requirement. In Montana, one vertically integrated utility practises traditional integrated resource planning under the state's IRP guidelines, while the other, a restructured utility, practises portfolio planning, management, and resource procurement for electricity supply for default customers under the guidelines for restructured entities.

Partial IRP, portfolio management and DSM/EE requirement: Other states have portfolio planning procedures, for example, Arkansas, Colorado, Illinois, Iowa, Maine, Maryland, Massachusetts, Minnesota, New Jersey, Rhode Island, Wisconsin, and the District of Columbia (RI&SEE, 2006; RAP, 2010).

Apart from the IRP/portfolio planning requirements, several states have Renewable Portfolio Standards (RPS) and/or Energy Efficiency Resource Standards (EERS) that encourage renewables or efficiency improvement, respectively, through the imposition of targets to be achieved by the utilities and/or guidelines requiring procurement/ conservation plans, but these are not being dealt with in this study.

3. Summary of reported power sector planning activities

The country-wise activities with regard to integrated resource planning for the power sector, reported above, can be summarised with the series of questions:

- ***What*** is the planning approach? Is it really an integration of demand and supply options being evaluated to minimise economic costs (including externalities), or else, *which aspects of IRP are practised*?
    - ***Integrated evaluation of the real costs (including externalities) of supply- and demand-side options within the process*** – This is the ideal; it may have been reached at some/all utilities of those states the USA (e.g. Oregon, Montana), where IRP is mandated. (British Columbia in Canada, and Malaysia have such requirements drawn up, but the planning process may not as yet be taking place).
    - ***Integrated evaluation of the utility-costs (with some externalities) of supply- and demand-side options within the process*** – This is taking place at some/all utilities of other states in the USA where IRP is mandated.

[53] Electric utilities are required to file Long-Term Forecast reports which must specifically address EE and its impact on resources and may include an IRP. Utilities must also file Electric Security Plans and if those include provisions for CWIP or a Non-Bypassable Surcharge, an included IRP must discuss and analyze EE.

- ***"Integrated" evaluation of utility-costs (without externalities) of mainly supply- and a few demand-side options, with some provisions for or portfolios of EE/DSM forced into the plans*** – This is taking place in South Africa, and in some states of the USA.
- ***Strategic evaluation of utility-costs (without externalities) of supply-options, and specified provision (outside the main planning exercise) for renewable sources, and/or DSM/efficiency*** – This is done in Brazil, China, India, and Thailand.

- ***Why*** is this (IRP or partial IRP) planning approach being undertaken, i.e. *what are the drivers for undertaking such planning*?

  - ***Mandatory requirement:***
    - ***Existing laws/regulations*** *of the (central/state) Government/Regulatory authority (indicating that the need was perceived much earlier)* – These exist in several states of the USA and South Africa (since 1998); other countries earlier with the requirement no longer have it, e.g. Denmark.
    - ***New (or re-imposed) regulations****, indicating that the need was recently perceived by authorities* – Some states of the USA have re-introduced IRP requirements (e.g. California, with "Long Term Procurement Plans", Montana, New Mexico), while others have enacted legislation recently (e.g. Connecticut, Delaware, Illinois, New Hampshire). British Columbia (Canada) has recently imposed a requirement.

  - ***Policy directive:***
    - *Existing/recent policies (favourable approach, but not mandated)* India has an Integrated Energy Policy since 2006.

  - ***Perceived need of the utility*** – EGAT of Thailand perceives the need for DSM (but not IRP per se)

  - Also pertinent here:

  Likelihood of plan implementation – This would be dependent on whether or not the utility (or energy department) is answerable (to the government or regulator or even to the public) for implementation of the options selected from the IRP exercise.

- ***By whom*** are the plans constructed?
  - ***Government ministries/departments*** - China, India,
  - ***Government-owned utilities****,* ***supervised*** *by Government-appointed* ***regulator*** – South Africa, (likewise Brazil for EE/DSM)
  - ***Investor-owned utilities submitting plans*** *to the Govt.-appointed* ***regulators/commissions*** – states of the USA
  - ***Utility, even without a strong regulator*** – Thailand

Also relevant here:
- ***Public participation*** *(feedback) allowed* – only where civil society is active, (e.g. states of the USA, India)

- ***Where*** is such planning (IRP/partial) IRP taking place?
  - ***Central (federal)*** *level* – South Africa, Thailand (where the utilities Eskom and EGAT serve their respective countries);
  - ***State/regional*** *levels* - US utilities (that serve a state or parts of one/more state)
  - ***Both central and state*** *involvement* – India (where electricity is a concurrent subject in the Constitution)

- ***When*** (and how often) are plans drawn up? Integrated resource plans, as well as strategic, scientific, and long-range plans, are usually for 15-20 years; however there are also milestones indicated within these, with the accompanying short-term (≤ 5 year) plans and periodic updating every few years (or even annually).

- ***How much*** do the imputed costs include? *What does the costing procedure consist of?*
  - ***"Economic" costs imputed through rigorous analysis, with "monetising" of environmental/societal impacts*** – This is the ideal: it would reflect an equity- and environment-conscious society. (It's not evident that all externalities are counted anywhere).
  - ***Current/expected prices plus charges/taxes and costs for compensatory measures (for environmental/societal impacts)*** – This depends on the extent of prevailing regulations, in turn depending on society's perceptions; it happens at some utilities of the USA.
  - ***Current/expected prices*** (only direct payments that are/have to be incurred) – This happens in India (where charges for water use, polluting effluents, etc. are inadequate).

- ***For whom*** is the planning? Who are the beneficiaries? (This is pertinent in regions of low electrification, because those without electricity are not beneficiaries unless plans include electrification of the currently un-served).
  - ***The energy sector as a whole (all energy carriers/users)*** – Thus far, IRP has not been carried out for the energy sector as a whole (although it is mentioned in India's Integrated Energy Policy 2006).
  - ***The power sector as a whole*** – This has been done in South Africa (where Eskom serves the country), but not elsewhere.
  - ***The utility territory*** - Each utility has carried out IRP for its own service areas in the USA and in Denmark.

Annexe 1: Summary of the IRP process for the power sector (adapted from D'Sa, 2005)

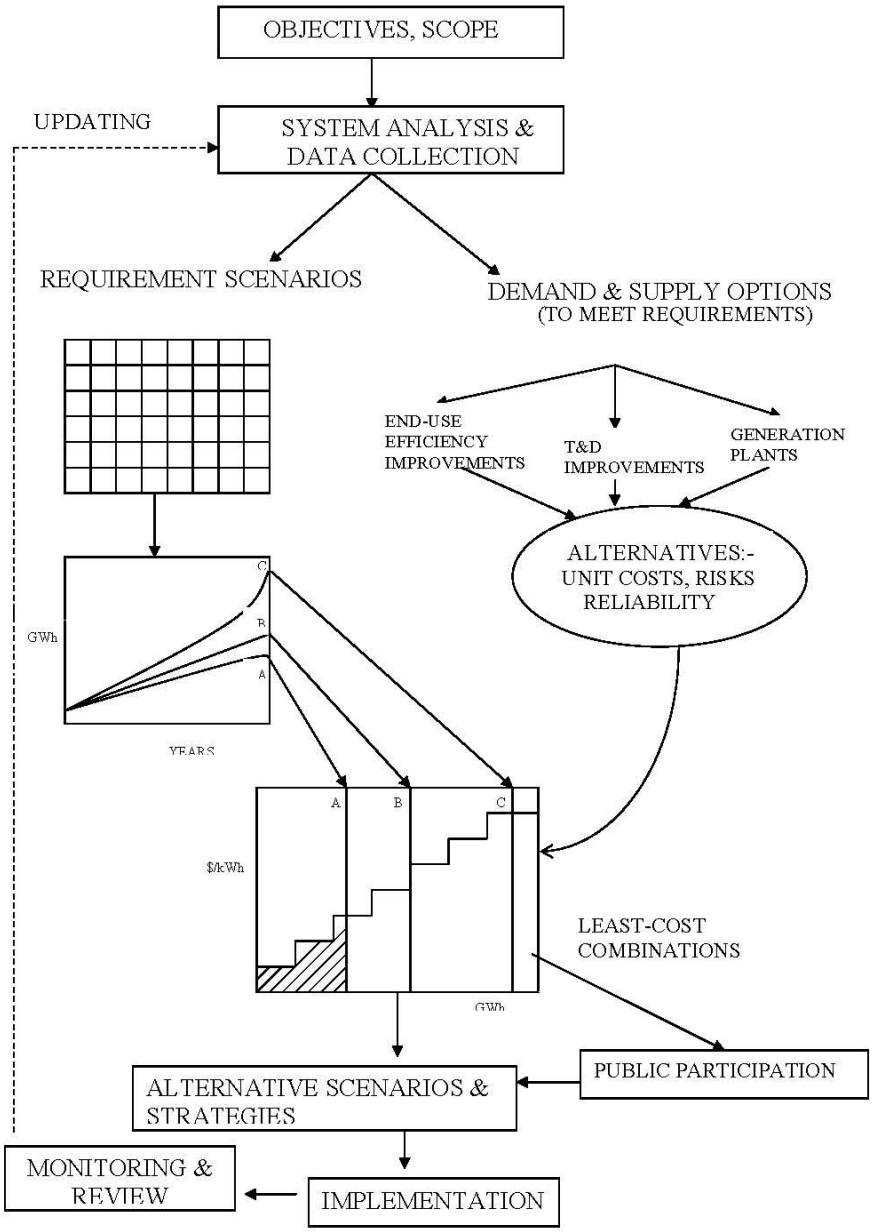
- ***Definition of the objectives and scope of the plans*** – The goals (for example, electrifying all homes), optimisation-objectives (such as minimising economic costs or risks, and their trade-offs), planning period, and regional extent, have to be specified (as these affect the constraints within which the plans must be formulated).
- ***Data collection on base-year (baseline) requirement*** – For a bottom-up (end-use) approach, data on current requirements (based on population and production-levels), and the specific energy-use per energy service (or user category), must be collected.
- ***Estimation of future requirement*** – Forecasting of electricity requirement and time-of-the-day load should be carried out, using acceptable methods. Alternative scenarios (reflecting changes in growth rates, prices, etc.) may be considered.
- ***Identification of options of servicing these requirements*** – The generation- and efficiency-improvement technologies for meeting the estimated requirements have to be identified, so that they can compete for inclusion in the least-cost mix.
- ***Estimation of costs of delivering/saving electricity through these options*** – The costs per unit (usually the annualised life cycle cost)[a] of electricity either delivered or saved, through each technologically-feasible option must be calculated, considering social/environmental costs[b], if any, of delivering electricity, and potential risks (such as price-rises, and variability of fuel supply and hydro conditions), transmission and distribution costs (of supply options) and implementation costs (of DSM measures).
- ***Drawing up plans that optimise resources*** – The available options can then be ranked in order of costs, so that alternative plans can be drawn up with a "mix" of options, subject to (e.g. fuel availability) risks and constraints.
- ***Publication of plans for stakeholder feedback*** – Indicative plans should be publicized, inviting the views of those concerned.
- ***Appropriate strategies*** – Incorporating feedback, decision-makers can formulate appropriate implementation strategies.
- ***Monitoring and periodic repetition*** – Implementation of the plans must be monitored; as importantly, the process must be repeated periodically, incorporating new information (e.g. regulatory changes, technological developments, changes in costs and availability of inputs), so that mid-course alteration can be effected.

Please note:

[a] **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, i.e. ($/kWh) = $[\{\Sigma C_k(1+i)^{k-1}\}x(CRF) + A] \div [kWh/year]$,
where ΣC_k are the capital costs, incurred during the k years of construction, A is the average annual recurring cost = the sum of fuel and operation & maintenance costs, and CRF = capital recovery factor = $i \div [1-(1+i)^{-n}]$, with i = interest rate/year and n = operating life of the plant or equipment (in years).

[b] 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.

Figure 1: Schematic depiction of the IRP procedure (adapted from D'Sa, 2005)



References:

1. ACEEE, 2008; 2009. State Energy Efficiency Policy Database – 2009, 2008, available at http://www.aceee.org/energy/state/index.htm
2. Alexander, S., (Minerva), 2006. *Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments: The "Policy Mix" project*, Country study: Luxembourg A study funded by the European Commission – DG Research, October, available at http://193.192.38.79/PolicyMix/UserFiles/File/UploadedDocs/Policy-Mix_CountryReview_LU.pdf
3. Avista, 2009. *2009 Electric Integrated Resource Plan*, (for customers in the US-North-west) August 31st, available at http://www.avistautilities.com/inside/resources/irp/electric/Documents/Avista%202009%20IRP.pdf
4. Awerbuch, S., 2006. *Portfolio-Based Electricity Generation Planning: Policy Implications For Renewables And Energy Security* available at http://www.springerlink.com/content/443152701738622t/fulltext.pdf and also the Report (with the same title) prepared for REEEP Environment Policy Department, Foreign and Commonwealth Office, London, and Division of Technology, Industry, and Economics, UNEP, Paris, (with examples of the EU, the US, and Mexico) May 2004, available at http://www.awerbuch.com/shimonpages/shimondocs/unepfco_portfolio.pdf
5. Barbose, G., Wiser, R., and Bolinger, M., (LBNL) 2008. "State Policies Provide Critical Support for Renewable Electricity", 15th July, available at http://www.osti.gov/bridge/servlets/purl/962956-woGqMu/962956.pdf
6. Bauer, D.C., and 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.
7. Bhattacharya, S. and Patel, U. R., 2007. *The Power Sector in India: An Inquiry into the Efficacy of the Reform Process*, prepared for Presentation at tbe Brookings-NCAER India Policy Forum 2007, New Delhi, July 17-18, 2007 available at www.ncaer.org/downloads/IPF2007/bhattacharya-patel.pdf
8. Bijoor, Sheila, Greacen Chris, and Greacen, Chuenchom, 2007. "Citizen-oriented power sector reform in Thailand", presented at the Blue Moon Foundation Workshop *Integrated Environmental Policy Packages in the GMS*, July 11-13, Bangkok.
9. Black, C., 2005 "Current Utility Industry Practices in Integrated Resource Planning", presentation to Stakeholder Group for Seattle City Light 2006 IRP, 27th October, available at http://www.seattle.gov/light/news/issues/irp/Docs/Current_Practices_ppt_10_25_05.pdf
10. Bolinger, M. and Wiser, R., 2005. "Utility integrated resource planning: An emerging driver of new renewable generation in the western United States", available at http://escholarship.org/uc/item/1sf3k4xv.pdf and *Refocus*, Vol.6, No.6.
11. CA-PUC, 2009. *Decision conditionally accepting the 2009 Renewables Portfolio Standard Procurement Plans and Integrated Resource Plan*, (Southern California Edison Company (SCE), Pacific Gas and Electric Company (PG&E), and San Diego Gas & Electric Company (SDG&E) must each prepare an RPS procurement plan) 8th June, available at http://docs.cpuc.ca.gov/published/Final_decision/102099.htm
12. Capgemini, VaasaETT & Enerdata, 2008. Demand Response: a decisive breakthrough for Europe – How Europe could save Gigawatts, Billions of Euros, and Millions of tonnes of CO_2, available at http://www.vaasaett.com/wp-content/uploads/2010/01/0805_Demand-Response_PoV_Final.pdf

13. CEA-MoP-GoI, 2007. *National Electricity Plan* - Volume-I (Generation & Related Aspects) & Volume-II (Transmission & Related Aspects), notified in Gazette of India Extraordinary – Part II of 3rd August, 2007, vide Gazette No. 159, Government of India.
14. Chandler, W. U., Ledbetter, M. R., Bashmakov, I. and Hamburger, J., 1993. *Energy efficiency: New approaches to technology transfer* available at http://www.unu.edu/unupress/unupbooks/uu17ee/uu17ee0g.htm
15. China - NDRC, 2010. DSM Implementation Measures, jointly issued by six commissions and ministries, led by the National Development and Reform Commission (NDRC), 4th November, details available at http://www.greenlaw.org.cn/blog/wp-content/uploads/2010/11/2010-DSM-Measures_EN.pdf
16. CREDP, 1999. Caribbean Renewable Energy Development Programme available at www.caricom.org/jsp/projects/CREDP_Project_Document.pdf
17. Davidson, P., 2007. *Demand Side Management (DSM) within the IEA*, available at www.iea.org/work/2007/neet_brasilia/Davidson.pdf and www.ieadsm.org
18. DoE-SA, 2010. Integrated Resource Plan For Electricity 2010, Department of Energy, Government of South Africa, available at http://www.doe-irp.co.za/content/IRP_for_Electricity.pdf
19. 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 Electricity Planning*, Bangalore, November 13th-22nd.
20. 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, 10-30th April.
21. 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, 24-25th August.
22. D'Sa, A., 2005. "Integrated Resource Planning and Power Sector Reform in Developing Countries", *Energy Policy*, 33(10), pp. 1271-1285.
23. D'Sa, A. and K.V. Narasimha Murthy, 2006. "Environmental Reform in the Power Sector: a study of China and India", *Journal of Environment and Development*, Volume 15, Number 2, June, pp.158 –183.
24. 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.
25. Eberhard, A., 2010. Chairman of the NER Advisory and Review Committee of NIRP2 - Personal communication, November.
26. ECA, 2005. Economic Commission for Africa – Support to NEPAD (Report for the period Aug.'04 to June'05), available at http://www.un.org/africa/osaa/2005%20UN%20System%20support%20for%20NEPAD/ECA.pdf
27. EF-Australia, 2002. *Mechanisms for Promoting Societal Demand Management*, prepared by Energy Futures Australia, for Independent Pricing and Regulatory Tribunal (IPART), 13 February, available at http://efa.solsticetrial.com/Library/David/Published%20Reports/2002/MechsforPromotingSocietalDemandMgt.pdf
28. EGAT, Demand Side Management (relevant pages from Annual Report), available at www.pr.egat.co.th/ann_eng/Eng%2034-35.pdf
29. 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.

30. ECEP-BC-Canada, early 2000s. *The BC Energy Plan, A Vision for Clean Energy Leadership*, Energy Conservation and Efficiency Policies, British Columbia, Canada, available at http://www.energyplan.gov.bc.ca/PDF/BC_Energy_Plan_Conservation.pdf
31. Elsobki (Jr.), M.S., 2009. "An Optimal-based IRP/DSM Formulation for Electric Utilities in Transition to a Liberalized Electricity Market" (Paper 0389), presented at the *20th International Conference on Electricity Distribution*, CIRED, Prague, 8-11 June, available at http://www.cired.be/CIRED09/pdfs/CIRED2009_0389_Paper.pdf
32. EREC, 2010. *RE-thinking 2050,* EREC, April, available at http://www.erec.org/fileadmin/erec_docs/Documents/Publications/ReThinking2050_full%20version_final.pdf
33. Eskom, 2009. Proposed Revenue Application Multi-Year Price Determination 2010/11 to 2012-13, September, available at http://www.nersa.org.za/documents/electricity/TransnetPriceIncrease09-MYPD2%20OCT%2009.aspx
34. Eskom, 2010. *Integrated Resource Plan For Electricity*, Revision 2, Version 8, 8th October, available at Http://Www.Doe-Irp.Co.Za/Content/INTEGRATED_RESOURCE_PLAN_ELECTRICITY_2010_V8.Pdf
35. Eto, J., Goldman, C., and 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
36. Finamore, B., *et al*., 2003. *Demand-Side Management in China: Benefits, Barriers, and Policy Recommendations*, Natural Resources Defense Council (USA), State Power Economic Research Center (China), and Energy Research Institute of State Development and Reform Commission (Chnia), October, available at www.nrdc.org/air/energy/chinadocs/dsm.pdf
37. Foran, T., (Unit for Social and Environmental Research, Chiang Mai University) 2009. "Integrated electricity planning: introduction and demonstration", presented at *Mekong Energy and Environment Network Workshop*, 14th May, available at www.probeinternational.org/.../**power**points/Tira_MEE%20Net%20**IRP**%20final.ppt
38. Free Market, 2010. Integrated Resource Planning 2010 (IRP2), Submission by the Free Market Foundation of Southern Africa, 11 June.
39. Gee, R.W., Zhu, S., Li,X., 2007. "China's Power Sector: Global Economic And Environmental Implications", *Energy Law Journal*, Vol. 28, 421-441 available at http://www.geestrategies.com/docs/Chinas_Power_Sector.pdf
40. Georgia Energy Review, 2005. The Georgia Integrated Resource Planning Act, available at http://www.gefa.org/Modules/ShowDocument.aspx?documentid=10
41. GJU, 2008. Gallup Joint Utilities Integrated Resource Plan, available at http://www.ci.gallup.nm.us/GJU/GJU_IRP_2007%20FINAL%202_12_08.pdf
42. GoBC-C, 2010. Clean Energy Act, Bill 17 – 2010, Ministry of Energy Mines and Petroleum Resources, British Columbia, Canada, available at http://www.leg.bc.ca/39th2nd/1st_read/gov17-1.htm
43. GoI, 2003. *The Electricity Act, 2003*, published in the Gazette of India, 2nd June 2003, Government of India, and the Electricity (Amendment) Act, 2007, published in the Gazette of India, 29th May 2007.
44. GoL, 1999. *Climate Change* (A1: The Electricity Supply Sector), Govt. of Lebanon, available at www.moe.gov.lb/ClimateChange/Climate2/part_a/electricity.pdf
45. GoSA, 2010. South African Government's Response to Questions on the Eskom loan application to the World Bank, available at http://www.eskom.co.za/content/SA_GovResponseQuestions~2.pdf
46. Grant, W. (IWLA), 2003. *Resource Planning and Energy Efficiency: The Minnesota Experience*, presentation on 12th June at ACEEE National Conference on Energy Efficiency as a Resource, available at www.**aceee**.org/conf/03ee/grant-8w.pdf

47. He Gang, (SERC), 2010. "Accelerate Market Reform, Strengthen Regulation To Enhance Sustainable Development In China's Power Sector" presented at UNCTAD's *Multi-Year Expert Meeting On Services, Development And Trade: The Regulatory And Institutional Dimension* in Geneva, 17-19 March, available at http://www.unctad.org/sections/wcmu/docs/cImem3_2nd_CHINA_en.pdf
48. 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, U.S. Department of Energy) Oak Ridge National Laboratory, December.
49. Hogan, B., (GoSA), 2010. Government statement on Eskom's World Bank loan and South Africa's long term energy objectives by Public Enterprise Minister, Government of South Africa, 12th March, available at http://www.info.gov.za/speeches/2010/10031509451003.htm
50. Hu, Z., Moskovitz, D., and Zhao, J., 2005. *Demand-side Management in China's Restructured Power Industry, How Regulation and Policy Can Deliver Demand Side Management Benefits to a Growing Economy and a Changing Power System*, ESMAP, December.
51. Hu, Z., Wen, Q., Wang, J., Tan, X., Nezhad, H., Shan, B., and Han**, X.,** 2010. **"**Integrated resource strategic planning in China", *Energy Policy*, Volume 38, Issue 8, August, pages 4635-4642.
52. ICF International, 2010. *Integrated Resource Planning and Implementation Services*, available at http://www.icfi.com/markets/energy/doc_files/irp.pdf
53. IDASA, 2010a. *Revised Eskom MYPD-2 application*, Presentation to NERSA, 28th January, available at http://www.ansa-africa.net/uploads/documents/publications/Idasa_Presentation_to_NERSA_20100128.pps#1
54. IDASA, 2010b, Integrated Resource Plan stake holder consultation process http://www.energy.gov.za/files/media/presentations/20100416IRP_Stakeholder_IDASA_PRESENTATION_16_April_2010.ppt
55. IDASA, 2010c. Revised assumptions for IRP2, compiled by Abigail Knox, 4th October, available at http://www.idasa.org.za/index.asp
56. IEA, 2010. *The Economics of Transition in the Power Sector*, W. Blyth, Oxford Energy Associates, January, available at http://www.oecd-ilibrary.org/the-economics-of-transition-in-the-power-sector_5kmh3njfk8vf.pdf;jsessionid=o7j3dgklhm9u.delta?contentType=/ns/WorkingPaper&itemId=/content/workingpaper/5kmh3njfk8vf-en&containerItemId=/content/workingpaperseries/20792581&accessItemIds=&mimeType=application/pdf
57. IEI, 1994. *IEI-APENPLAN Workshop on Integrated Electricity Planning*, Bangalore, November 13th-22nd.
58. IIE and USAID, 2003. "Regulatory Implementation of IRP/DSM" USAID/ World bank funded consultancy work in association with Institute of International Education (IIE) for identifying policy barriers and implementation strategies for DSM programs in Indian utilities (prepared by S.Vashishtha, P. Gupta (IIE), R. Chatterjee (IIE), S. Ramar (Chief Engineer, Central Electricity Authority); presented at the "Integrated Resource Planning and Demand Side Management", training course organized by Institute of International Education (IIE) and funded by USAID, 9-13 June, Jaipur.
59. IRP-CEA-GoI, 2010. "Likely Capacity Addition during the 11th Five Year Plan", Integrated Resource Planning Division, Central Electricity Authority, Government of India, 24th August, available at http://www.cea.nic.in/planning/Feasible%20capacity%20addition%20during%2011th%20Plan.pdf
60. Jalal, T. S. and Bodger, P., 2009. "National Energy Policies and the Electricity Sector in Malaysia", *Proceedings of ICEE 2009 3rd International Conference on Energy and*

Environment, 7-8 December , Malacca, Malaysia, available at http://ir.canterbury.ac.nz/bitstream/10092/4162/1/12621660_C81.pdf

61. Jiangsu and NRDC, 2006. "DSM Strategic Plan For Jiangsu Province: Economic, Electric and Environmental Returns from an End-Use Efficiency Investment Portfolio in the Jiangsu Power Sector", Joint Report Prepared in accordance with the Memorandum of Understanding Between the Jiangsu Provincial Economic and Trade Commission and the Natural Resources Defense Council (USA) on Cooperation in DSM Strategic Planning, Optimal Energy, Inc., Green Energy Economics Group, and the State Grid Corporation DSM Instruction Center. Updated Report, 20th January.
62. Jiusto, S. and McCauley, S., 2009. *Theorizing a Sustainability Transition in the U.S. Electrical Power System*, GPMI Working Papers No.2009-01, George Perkins Marsh Institute, April, available at http://www.clarku.edu/departments/marsh/news/WP2009-01.pdf and "Assessing Sustainability Transition in the US Electrical Power System", *Sustainability*, 2010, 2, pp.551-575, available at http://www.mdpi.com/2071-1050/2/2/551/pdf
63. Kalra, P.K., Bichpuria, Y.K., and Singh, V.P., "Integrated Resource Planning and Supply Side Management in Power Systems" available at www.3inetwork.org/workshop/**power**/Papers/PapKalraVFM**IRP**.pdf
64. Karakosta, C. and Askounis, D., 2010. Challenges for energy efficiency under programmatic CDM:case study of a CFL project in Chile, *International Journal of Energy And Environment*, Volume 1, Issue 1, pp.149-160
65. Kaye Scholer *et al*., 2008. *State Analysis And Survey on Restructuring and Re-regulation*, Kaye Scholer LLP, Levitan and Associates Inc., and Semcas Consulting Associates, for Maryland Public Service Commission, December 1, available at http://webapp.psc.state.md.us/Intranet/sitesearch/whats_new/Kaye%20Scholer_Final%20Report_State%20Analysis%20and%20Survey%20on%20Restructuring%20and%20Reregulation%20for%20the%20MD%20PSC.pdf
66. Koszalka, M., (PacifiCorp) 2003. *DSM Resource Planning*, presented at the ACEEE National Conference on Energy Efficiency as a Resource, Berkeley, June, available at www.**aceee**.org/conf/03ee/Koszalka-8w.pdf
67. Krause, F. and Eto, J., 1988. *Least-Cost Utility Planning Handbook for Public Utility Commissioners, Volume 2: The Demand Side: Conceptual and Methodological Issues*, National Association of Regulatory Utility Commissioners (NARUC), Washington, DC, December.
68. Kushler, M., York, D., and Witte, P., 2006. *Aligning Utility Interests with Energy-efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Incentives*, Report No. U061, ACEEE, Washington DC, October, available at www.**aceee**.org/pubs/u061.pdf
69. LADWP, 2010. *LADWP Draft 2010 Integrated Resource Plan*, City of Los Angeles Department of Water and Power, July, available at www.lapowerplan.org/documents/Final_IRP_Fact_Sheet_July_10.pdf
70. Lopes, C., Nilsson, L.J., Thomas, S.K., Verbruggen, A., 2000. *Linking reforms and energy efficiency to explore the possibilities for IRP and DSM in the liberalized Internal European Electricity Market* available at www-cep.ensmp.fr/francais/themes/mde/pdf/39.pdf
71. Mail and Guardian, 2010. "Eskom's Secret Tariff Plan Revealed", 8th January, available at http://www.mg.co.za/article/2010-01-08-eskoms-secret-tariff-plan-revealed
72. Martinot, E. and Li, J., 2010. "Renewable Energy Policy Update for China", *Renewable Energy World*, Volume 13 Issue 4, July-August 2010 available at http://www.renewableenergyworld.com/rea/news/article/2010/07/renewable-energy-policy-update-for-china
73. MoP – GoI, 2005. *National Electricity Policy*, Ministry of Power, Government of India, published in the Gazette of India, 12th February 2005, available at

http://www.powermin.nic.in/indian_electricity_scenario/national_electricity_policy.htm and http://www.cea.nic.in/planning/national_Electricity_policy.htm

74. MoP-GoI, 2009. Order regarding Central Public Information Officers (CPIOs)/Appellate Authority in respect of Central Electricity Authority, Ministry of Power, Government of India, dated 29th Dec '09.
75. MWD, 2010. *2010 Integrated Water Resource Plan Update*, (Section 6, Findings and Conclusions) MWD, Southern California, available at http://www.mwdh2o.com/mwdh2o/pages/yourwater/irp/draft_irp/Section6.pdf
76. Nadel, S., Yang, Z., and Shi, Y. *Integrated Resources Planning and Demand-Side Management Manual for China and Other Developing Countries* available at http://drumindia.org/UserFiles/File/DSM/9-Emerging%20Developments/DSM%209-3%20Integrated%20Resources%20Planning%20and%20Demand%20Side%20Management.doc and http://www.aceee.org/pubs/i953.htm
77. Nadel. S., 2006. *Energy Efficiency Resource Standards: Experience and Recommendations*, ACEEE Report E063, March, available at www.**aceee**.org/pubs/e063.pdf
78. Nakhooda, S., 2010. The World Bank Eskom Support Program: "South Africa's plans for a new coal plant bring up difficult decisions for the World Bank", 8th March, available at http://www.wri.org/stories/2010/03/world-bank-eskom-support-program
79. NAPP-Utilities, 2010. North America Power Partners – Utilities – Information on Demand Response, available at http://www.nappartners.com/demand-response-for-utilities/
80. Nhan, T.N., and Minh, H-D., 2009. "Economic Potential of Renewable Energy in Vietnam's Power Sector", *Energy Policy*, Vol. 37, pp. 1601-13, and "The potential for mitigation of CO_2 emissions in Vietnam's power sector", author manuscript available at http://hal.archives-ouvertes.fr/docs/00/44/10/85/PDF/CO2_mitigation_potential_Vietnam_power-20091214.pdf
81. NPPC, 1998. Chapter 8: The Future Role of the Northwest Power Planning Council in *Revised Fourth Northwest Conservation and Electric Power Plan*, Northwest Power Planning Council, available at www.nwcouncil.org/library/1998/98-22/chapter8.htm#E20E19
82. NPPD, 2008. *2008 Integrated Resource Plan, Nebraska Public Power District*, available at http://www.nppd.com/irp/additional_files/irp_final.pdf
83. NWC-GoA, 2009. *Australian integrated resource planning framework and manual* – progress, July 2009, National Water Commission, Government of Australia, available at http://www.nwc.gov.au/www/html/1041-integrated-resource-planning---progress.asp
84. PacifiCorp, 2009. 2008 Integrated Resource Plan, Vol. I, (revisited and refreshed annually and submitted to the State Commissions) PacifiCorp (A Mid-American Holdings Company), 28th May, available at http://www.pacificorp.com/content/dam/pacificorp/doc/Environment/Environmental_Concerns/Integrated_Resource_Planning_3.pdf and Vol.II, available at http://www.pacificpower.net/content/dam/pacificorp/doc/Environment/Environmental_Concerns/Integrated_Resource_Planning_6.pdf
85. PC–GoI, 2005. *Draft Report of the Expert Committee on Integrated Energy Policy*, Planning Commission – Government of India, December 2005.
86. PC–GoI, 2006. *Integrated Energy Policy – Report of the Expert Committee*, Planning Commission – Government of India, August, available at www.planningcommission.nic.in/reports/genrep/rep_intengy.pdf
87. PGE, 2010. *Integrated Resource Plan – Laying the groundwork for Oregon's energy future*, Portland General Electric, filed with the Oregon Public Utilities Commission, April, available at http://www.portlandgeneral.com/our_company/news_issues/current_issues/energy_strategy/docs/irp_issues_in_perspective.pdf
88. Phumaraphand, Napaporn, 2008. "Thailand DSM Programs: Financial Mechanism and Program Design the Key to Success", presented at the *ADB Asia Clean Energy Forum*,

Manila, 4th June, available at www.adb.org/Documents/events/2008/ACEF/Session12-Napaporn.pdf
89. Pigneri, A., 2006. H2-IRP – "Integrated resource planning for the development of hydrogen-energy infrastructures", *WHEC*, 13-16 June, Lyons, France, available at http://hydrogen.its.ucdavis.edu/publications/pubpres/2006pub/pignieri
90. Planning Commission – GoI, 2006. Integrated Energy Policy – Report of the Expert Committee, August, available at planningcommission.nic.in/reports/genrep/rep_intengy.pdf
91. RAP, 2005. "Integrated Resource Planning in the Context of China's Electricity Situation", prepared for the *China Sustainable Energy Program* and for the *China Development Forum*, June, available at www.raponline.org
92. RAP, 2006. "Scientific Energy Planning in China", 19th April, available at www.raponline.org
93. RAP, 2008. "Electricity Markets: The Roles of Integrated Resource Planning and Competition in Meeting China's Power Needs", October, available at www.raponline.org
94. RAP, 2010. "IRP United States and Selected Country Profiles", Draft April, available at www.raponline.org
95. RCG/Hagler Bailly. 1993. "Demand-side management in Poland: Assessment and pilot program." Draft report, US Agency for International Development, Washington, D.C., June.
96. Reddy, A.K.N., and Sumithra, G.D., 1997. "Integrated resource planning", *Energy for Sustainable Development*, Special issue on electric power reforms, Vol. III (6), pp. 14-16.
97. Reuter, 2008. "Anglo closes three South-African coal mines due to rain", March.
98. RI & SEE, 2006. *Integrated Portfolio Management in a Restructured Supply Market*, – A Report to the Office of the Ohio Consumers' Council, Resource Insight Inc. (P. Chernick and J.Wallach) and Synapse Energy Economics Inc. (W. Steinhurst, T. Woolf, A. Sommers, K. Takahashi), 30th June, available at http://www.resourceinsight.com/work/oh_irp_06.pdf
99. Rosenthal, J., and Sobolewski, R., 2010. *OCC Electricity Ideas for Consideration*, Connecticut Office of Consumer Council (OCC), February 1st, available at http://www.housedems.ct.gov/RateRelief/pubs/OCC_Electricity_Ideas_for_Consideration.pdf
100. SA-DME (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, available at www.dme.gov.za/publications/wp_ene/whitepaper1998.htm.
101. SA-DoE (Department of Energy, Government of South Africa), 2009a. *Draft Integrated Resource Plan for Electricity in South Africa*, (for illustrative purposes only), Department of Energy, Government of South Africa, 23rd September, available at http://www.mg.co.za/article/2010-01-08-eskoms-secret-tariff-plan-revealed
102. SA-DoE (Department of Energy, Government of South Africa), 2009b. No.1243, Electricity Regulatory Act, 2006: Determination regarding the Integrated Resource Plan and the new Generation Capacity, DoE, South Africa, 31st December.
103. SA-NER (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
104. SA-NER (National Electricity Regulator, South Africa), 2002b. *An Integrated Electricity Outlook for South Africa*, available at www.ner.org.za.irp/2001nirp-1.pdf
105. SA-NER, 2004. *National Integrated Resource Plan 2*, ISEP Eskom (Resources and Strategy), Energy Research Institute (University of Cape Town) and the National Electricity Regulator, South Africa, available at http://www.pbmr-eia.co.za/documents/NIRP2%20compiled%202004.pdf
106. Schwartz, L. 2010. "Western Renewable Energy Zones Initiative – Phase 3", presented at *Western Resource Planners Forum*, 22 June, available at www.raponline.org

107. Seifried, D. (SEPCO), 2002. "Energy Efficiency in Germany: Experiences and Lessons Learnt", Sustainable Energy Policy Concepts, available at http://www.ises.org/ProjectDocs/seifried.pdf
108. Shirley, W., 2010. "Characteristics of Effective Resource Planning", presented at *Asia-Pacific Dialogue on Clean Energy Governance and Regulation*, 21-22 June, ADB Headquarters, Manila, available at www.raponline.org
109. 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
110. Sparrow, F. T., Yu, Z. and Bowen, B. H., 2001. "Alternative Structures for China's Electricity Market - Policy & Investment Priorities - 2002 to 2012" (Draft), Purdue University, available at http://www.purdue.edu/discoverypark/energy/pdfs/ChinaProp-Draft12-01.pdf
111. Steinhurst, W., 2008. *The Electric Industry at a Glance*, National Regulatory Research Institute, November, available at http://nrri.org/pubs/electricity/electricity_at_a_glance.pdf
112. Tanatvanit, S., Limmeechokchai, B., and Shrestha, R.M., 2004. *Integrated Resource Planning with Demand-Side-Management Programs and CO_2 Limitations in Thailand* available at www.thaiscience.info/.../Ts-3%20interated%20resource%20planning%20w.demand-side-management%20programs%20&%20co2%20limitation.pdf; also "CO_2 mitigation and power generation implications of clean supply-side and demand-side technologies in Thailand", *Energy Policy*, Vol.32, Issue, 1, January, pp.83-90.
113. Tellus Institute, 2002. *Best Practices Guide: Integrated Resource Planning for Electricity*, prepared by the Tellus Institute, Boston, for Energy and Environment Training Program, Office of Energy, Environment and Technology Global Bureau, Center for the Environment, USAID, available at pdf.usaid.gov/pdf_docs/PNACQ960.pdf
114. TID, 2008. IRP details of Turlock Irrigation District (TID) submitted to WAPA, 15th August, available at http://www.wapa.gov/es/irp/CustIRPs/snr/TurlockIRP.pdf
115. Totten, M., 2010, on 26th March, available at http://www.wri.org/stories/2010/03/world-bank-eskom-support-program
116. Tram and Elliott, 2004. "Integrated Resource Planning for Multi-Utility Services", available at http://www.gisdevelopment.net/proceedings/gita/2004/papers/084.pdf
117. US-EIA, 2010. *Status of Electricity Restructuring by State*, accessed on 1st October '10, from http://www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html
118. Wang Y. (Tsinghua University), 2006. "Energy Efficiency Policy and CO_2 in China's Industry: Tapping the potential" as part of *Expert Group Seminar in Conjunction with the OECD Global Forum on Sustainable Development* available at http://www.oecd.org/dataoecd/58/28/36321399.pdf
119. WBSEB and IEI, 1998. *DEFENDUS Electricity Planning for West Bengal*, Report by the West Bengal State Electricity Board, Calcutta (N.N. Ghosh and S.K. Mukherjee), and the International Energy Initiative, Bangalore (Antonette D'Sa), January.
120. WBSEB and IEI, 1998. *Report of the Study on the Feasibility of Implementation of the Least-cost Electricity Plan for West Bengal*, West Bengal State Electricity Board, Calcutta (N.N. Ghosh), and the International Energy Initiative, Bangalore (Antonette D'Sa), August.
121. Weston, F. (RAP), 2009. "Integrated Resource Planning: History and Principles", presented at the 27th National Regulatory Conference, Williamsburg, Virginia, 20th May, available at www.raponline.org
122. Williams, J. H. and Kahrl, F., 2008. "Electricity reform and sustainable development in China", *Environ. Res. Lett*. 3 (2008) 044009 (14pp) available at http://iopscience.iop.org/1748-9326/3/4/044009/pdf/1748-9326_3_4_044009.pdf

123. Wood, Carl, 2001. Prepared Witness Testimony before the Committee on Energy and Commerce, Washington. California Public Utilities Commission, 15th February, accessed at www.energycommerce.house.gov/107/hearings/02152001Hearing40/Wood36print.htm

124. WRI, NIPFP, and Prayas, 2006. *The Electricity Governance Initiative, Benchmarking best practice and promoting accountability in governance of the electricity sector: Summary Report*, The Forum on Electricity Governance (World Resources Institute, the National Institute of Public Finance and Policy, India, and Prayas Energy Group, India), available at http://electricitygovernance.wri.org/files/egi/Benchmarking%20best%20practice%20and%20promoting%20accountability%20in%20governance%20of%20the%20electricity%20sector.pdf

125. 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.

126. WWF-PowerSwitch, 2006. *Brazil's Sustainable Power Sector Vision 2020*, WWF Brazil, available at http://assets.panda.org/downloads/wwf_powerswitch__scenario_brazil.pdf

127. Yeh, Emily T., and Lewis, Joanna I., 2004. "State Power and the Logic of Reform in China's Electricity Sector", *Pacific Affairs*, Vol. 77, No.3., available at www.spot.colorado.edu/~yehe/PA77.3_China.pdf

128. York, D., and Kushler, M., 2002. *State Scorecard on Utility and Public Benefits Energy Efficiency Programs: An Update* Report No. U023, ACEEE, Washington DC, October, available at www.**aceee**.org/pubs/u023full.pdf

129. Zhi, L., Totten, M., and Chou, P., 2006. "Spurring Innovations for Clean Energy and Water Protection in China: An Opportunity to Advance Security and Harmonious Development", Feature Article, *China Environment Series 2006*, Woodrow Wilson International Center for Scholars.