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Optimising Power Generation

17.1 Our power scenario

There is a perennial power shortage in our country. Low generating (installed) capacity, low plant load factor (PLF), high transmission and distribution (T&D) losses and thefts are the major causes of a far too inadequate generation, afflicting the quality of life and causing industrial sickness. To have a brief idea, the present installed capacity and its level of utilisation (2003-2004) is indicated below:

Table – 17.1

Power generating sources

Means of generation	Installed capacity (MW)	[a]In terms of generation/Year (kWh) (a)	Actually utilised (kWh) (b)	[b]Load factor (b/a %)	PLF=$\frac{LF}{0.79}$%
[c]Thermal (Coal, diesel or gas)	80,500	705.2×10^9	472.1×10^9	66.9	84.7
Hydro-electric (hydel)	29,500	258.4×10^9	$75.2^d\times10^9$	29.1	36.8
Nuclear	2,700	23.65×10^9	17.8×10^9	75.3	95.3
Total	1,12,700	987.25×10^9	565.1×10^9	57.2	72.4

Based on Ministry of Power

a. Generation/year kWh = kW × 24 (hours/day) × 365 (days/year)

b. This accounts for T&D losses of minimum 21%. This is compared to world average of 9% and USA, Germany and Japan average of 6-6.5%.

c. Includes wind, diesel and gas.

d. The low utilisation may be due to major shutdowns or low water level at the catchment area.

- Thermal generation ailing with low PLF at 55% about 5 years ago has since improved remarkably to about 84.7% by 2005. There are considerable efforts by most generating stations, particularly State Electricity Boards (SEBs) to improve it further. But the country still reels under acute power shortage partly due to lack of work culture and partly due to very low installed capacity. But there are still many

SEBs in eastern region, particularly Bihar and NE states that are operating at low to very low PLF of the order of 14-58% and have large scope of improvement to the extent of about 8,000 MW (10% of the present thermal installed capacity). A lot also remains to be done to minimise the T&D losses that still stand at a very high level of 21% and more. These losses at about 10% may be considered reasonable. Some means to minimise T&D losses I have discussed in my Engineering Handbook. If all this can be done we can generate additional about 20,000 MW (11% of 1,12,700 ≅ 12,000 MW and 8,000 MW by improving PLF). This is equivalent to 10 super thermal power plants (STPP's) of 2000 MW capacity each. We shall also be saving about 6.5% energy consumed on plant auxiliaries if we set up a new plant. And this can be achieved in just 3-5 years. If the country can generate additional power equivalent to about 10 STPP's in 3-5 years in addition to new generating stations already in the offing, our major power problems will be addressed. It will also mean saving on land and non-renewable raw material. And then, side by side we shall take up additional generation also, as noted later, to transform the whole power scenario in just a few years.

- Since most losses generate at the distribution level, revamping of distribution systems is imperative to handle more power while the TL's may withstand the additional power as and when created. It may be an easier job to revamp the distribution system in the face of more advanced techniques now available. We intend converting overhead distribution systems (HV or LV) to underground cable system and in principle all new distributions to underground system only and raise the sub-distribution voltage from 11 kV to 33 kV to transport more power at least for large distribution centres. We shall eliminate open distribution hazards and also save scarce land area for wider roads. The existing voltage fluctuations, overloadings, frequent breakdowns and necessity of installing a voltage booster with each household appliance will then be gradually eliminated and become a culture of the past. At present it is clumsy, costly and consumes the already scarce power besides generating excessive heat.[1]

By the time we start the work on **city centres**, the power situation would have eased fairly through revamping of existing plants. For

1. Any amount of1 heat generated contributes to global warming and must be minimised at the source itself. Under Kyoto protocol, of which we are a signatory, it is mandatory on our part to contain these losses to the bare minimum. For more details see my Engineering Handbook.

additional power demand, ***we*** prefer to give more impetus to renewable resources like hydro-electric (hydel) generation and wind power than thermal or others. We possess large water resources as nature's gift to us. Water management will also address many other problems side by side (like scarcity of water, floods, droughts). Setting up of new thermal power plants can wait until the revamping of existing thermal stations and making optimum use of water resources through hydel generation as noted below;

Hydro Electric (hydel) Power : This can be the saviour to provide solution to all our power problems and also tame and conserve water resources.

Table 17.2
Hydro–electric potential

Areas with Hydro Potential	Probable Capacity (MW)
Brahmaputra and Central Indian rivers	54,200
Mahanadi	6,566
East flowing rivers (in south India)	17,885
Ganga	17,858
Indus	33,313
West flowing rivers (Narmada, Tapti etc.)	10,248
Total	1,40,070 MW

[National Hydro Power Corporation (NHPC) has estimated it at 2.5 lac MW, while less than 11% is generated presently (Table 17.1)]

ADVANTAGES

- It is the cheapest source. Generation cost is just 5 paise per unit.
- Saves non-renewable natural resources like coal, oil, diesel and gas.
- No transportation, wagons, railway tracks or power for locomotives required.
- Water management is carried out automatically (controls floods and droughts).
- It can conserve about 75% of surface rain water that presently goes to sea.
- Canal network can be established for irrigation.
- No Pollution.

We have indeed wasted very crucial time to make use of this resource. ***We*** will prefer North-Eastern states to take up hydel power generation in a big way to provide power to the whole nation, means of livelihood to the local people, and boost the industries there and elsewhere. It is

also possible to have small generations through shorter falls at small catchment areas. Himachal Pradesh and Uttar Pradesh (now Uttranchal) started this scheme a few years ago. More thrust can be given to this. Government has already conducted surveys to identify the potential areas.

SARDAR SAROVER PROJECT (A CONTROVERSY)

- There is a severe resistance internally by a few environmentalists (like Medha Patkar, Arundhati Roy and Baba Amte) against large dams. The controversy is not unfounded and reflects the apathy of our system that ignores the people who are directly affected, displaced or whose means of living are lost. It is this basic problem that gives rise to such controversies and retaliatory activities. If we are able to rehabilitate them and arrange for their livelihood there will be no such controversy. *We* are sure people are not averse to dams rather to these adverse effects, which we will prudently take care of by providing them:
  - Proper rehabilitation.
  - Alternative land or means of living and
  - Address environment and water logging with the same fervour.
  - Afforest alternative land more than the forests and arable lands that would be consumed by such large dams.

A study of a number of major dams built so far shows that the population displaced by construction of dams is hardly about 0.5 to 4% of the population benefited by irrigation facilities, power to industries and homes and subsequent development of the area.

Estimated number of persons displaced	
by the Sardar Sarovar	≅ 0.7 lac people
Project can feed up to	≅ 2.025 cr people
Generate employment for	≅ 10 lac people
Provide water to	≅ 3.0 cr people

Besides providing power to industries and homes

The ratio of beneficiaries to affected persons is better than 200 : 1.

The major problems are water logging, marshy lands and increased alkalinity of soil besides submerging of forests and arable lands. Land is already scarce (Table 11.3), we cannot afford to waste it. Emphasis shall be on extensive research to save the submerging forests and arable lands besides overcoming other shortcomings. ***We*** are sure our scientists,

environmentalists and experts on the subject will find out some remedy. Until then, for the prosperity of the nation and its people some sacrifice may have to be done.

- Irrigation facilities – it is noticed that canal network is not adequate to irrigate the local areas. It will become a part of dam construction activity to connect all arable areas through a well-knit canal network. Nothing shall be left incomplete or to chance.
- Seismic effects – It is essential to closely study these effects and undertake a project only when it is found safe. In fact *we* are also in favour of higher dams for better generation. But we can also go in for slightly lower ones if that can be more safe. Experts will study these aspects and work out the most beneficial design, making optimum use of our water resource in the greater interest of all.

17.2 Making optimum use of non-conventional energy sources

The potential of power generation in our country through non-conventional renewable energy sources is enormous, and our endeavour will be to make optimum use of these through continuous and rigorous R&D. Some major resource areas are noted below;

(i) Solar energy : It has potential up to 20 MW/sq km.

a. Photo voltaics (solar cells) – They convert solar radiation directly to electricity, using solid state technology. US has installed single stations up to 1000 MW.

b. Solar thermal electric – through a heat engine that drives a generator. The engine uses concentrated solar radiation to rotate it. US has the technology to supply sets up to 750 MW.

We should explore these possibilities and start rigorous R&D on non-conventional energy sources. We can start with solar energy for heating of water and buildings and solar cookers, in addition to generating electricity.

(ii) Wind energy : Potential in India over 45,000 MW whereas utilised is about 5500 MW. Viable where wind speed is $\geq$18 kmph. Coastal areas (Tamil Nadu, Andhra, Kerala, Karnataka and Gujarat) are ideal locations for wind mills.

Land required : $\cong$ 5 acres/250 kW or 20 acres/MW

- Large land area requirement makes it unviable for large generation. Recommended for remote areas needing small amounts of power and where supplying regular power may be cumbersome and costly.

- It is also possible to install mills in 2 tier formation to save on space, i.e. two mills of different heights at the same place and in form of large mill farms.
- It is seen that average utilisation under optimum conditions is of the order of 35% only because of non-availability of wind speed at all times of the year.
- Main advantages – no pollution, no raw material and small manpower requirement.

(iii) Nuclear power : We do not encourage it although it is economical, because disposal of nuclear waste and eventual plant decommissioning are cumbersome. We are, therefore, not considering this as the future power source at least for the present, irrespective of US and other countries agreeing to supply us uranium (see Section 23.3)

(iv) Bio-mass energy : Present estimate is at more than 19,500 MW, by burning biomass fuel like,

- Wood, agriculture residues from crops, farm lands and forests, wastes from wood processing plants, saw dust, tree bark and left-over wood chips.
- Agriculture waste after harvesting.
- Industrial waste from dairies, distilleries, tanneries, food processing plants and pulp and paper mills.

ADVANTAGES,

- Eco-friendly – It absorbs CO_2 and releases the same while burning. Therefore no contribution to additional CO_2.
- No 'S' is produced therefore causes no acid rains (S with atmospheric moisture and oxygen forms Sulphuric acid $H_2 SO_4$).
- This fuel is a renewable source.
- Some companies even sell biomass in form of pallets and briquettes.

(v) From urban and municipal wastes : It is the cheapest form of fuel. It consumes the municipal solid wastes of an urban area, disposal of which is otherwise a problem. Average garbage generated in urban areas per day is $\cong$ 0.5 kg/person. Cities with a population of 10 lac can generate up to 500 tonnes/day. It can be sorted out and used as fuel for power generation. There are a few pilot plants in our country but they are not successful at present because of quality of garbage. Importing of garbage defeats the purpose. ***We*** shall put more efforts

(like R&D) on this front to make it viable with our own house-hold and municipal wastes. With the present fuel efficiency of about 2 kW/tonne of waste we can generate 10-15 MW power from this source in cities like Delhi and about 1 MW at each **city centre** and consume entire household wastes and solve garbage dumping problem. Smoke shall need to be controlled which may contain vapours of plastic wastes which is hazardous. It may be advisable to combine biomass, urban, municipal and industrial wastes to quadruple the generation and make optimum use of all wastes at one point. With one plant at each **city centre** (total 1000 numbers) we can generate power of over 1,000 to 4000 MW. *We* will conduct extensive research to accomplish this and also improve the fuel efficiency to above 2 kW/tonne of waste.

(vi) Biogas : By-product of sewage treatment and disposal plants. It can be used for cooking or generation of power.