

CHAPTER – III

Capacity Utilization and Electricity Generation

3.1 Capacity utilisation

3.1.1 Installed capacity of a power station is the maximum output of electricity which can be produced under specific conditions. The primary factors, in the case of hydro station, that determine capacity utilisation are ‘water flow’ and ‘reservoir storage characteristics’. However, power stations are not operated at their full capacity at all times, and output varies according to the conditions at power stations and /or as per instructions given by the grid operator keeping in view the power supply and demand position. Capacity Utilisation Factor (CUF⁷) of power stations selected for performance audit for the five years ended 31 March 2014 can be seen in Table 3.1.

Table 3.1
Design, annual and average CUF of selected power stations during 2009-2014

(per cent)

Power Station	Design CUF ⁸	Annual CUF					Average CUF from 2009-10 to 2013-14	Shortfall in average CUF w.r.t. design CUF in percentage points
		2009-10	2010-11	2011-12	2012-13	2013-14		
NHPC								
Bairasiul	49.40	39.51	45.09	46.36	45.79	40.46	43.44	5.96
Tanakpur	54.78	57.08	56.35	59.14	58.29	46.53	55.48	No shortfall
Chamera I	35.20	43.65	50.90	56.23	51.62	49.49	50.38	No shortfall
Uri I	61.52	64.28	72.30	64.31	70.56	59.96	66.28	No shortfall
Dhauliganga	46.27	46.23	46.23	47.17	46.31	54.50*	48.09	No shortfall
Teesta-V	57.59	58.15	58.73	57.48	50.77	51.48	55.32	2.27
Chamera III	53.67	-	-	-	47.19#	46.35	46.77	6.9
Chutak	55.26	-	-	-	12.39#	8.82	10.61	44.65
SJVN								
Nathpa-Jhakri	50.32	53.42	54.34	57.91	51.58	54.74	54.40	No shortfall
THDC								
Tehri Hydro	31.93	24.17	35.57	45.48	35.41	46.35	37.40	No shortfall
NHDC								
Indira Sagar	20.91 ⁹	24.18	25.09	37.52	33.06	46.56	33.28	No shortfall

*Worked out up to date of flooding of DGPS (i.e. 16 June 2013)

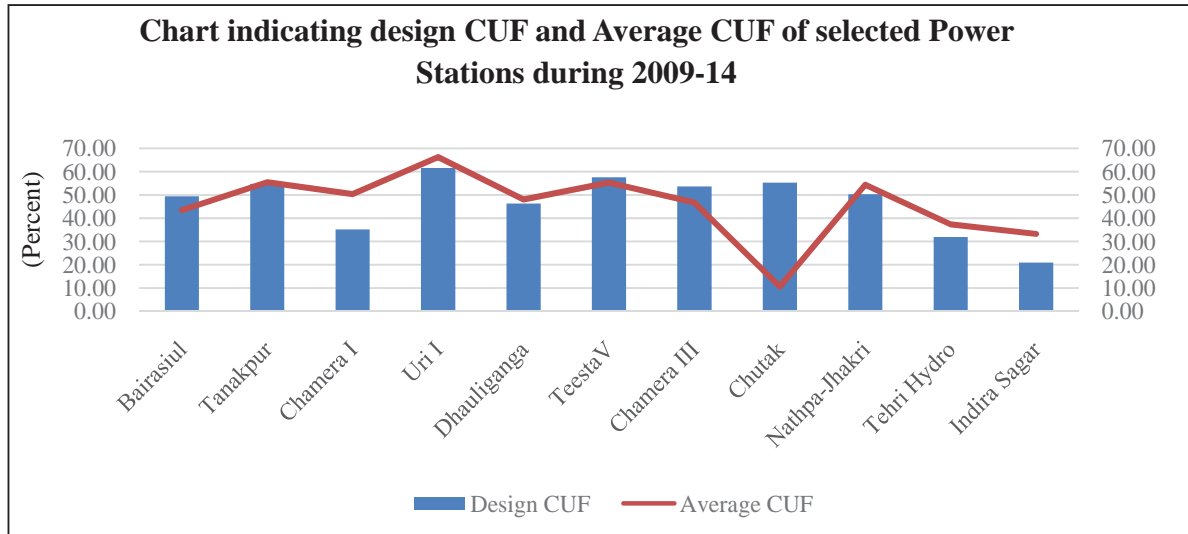
Worked out from the commercial operation date (COD) i.e. June 2012 and July 2012 for Chamera III power station and November and February 2013 for Chutak power station.

⁷ It is the ratio of actual energy generated by a power station to the equivalent energy output at the rated capacity over a period.

⁸ Design energy/ energy output at rated capacity x 100

⁹ Worked out on the basis of average of Design Energies for the years 2009-10 to 2013-14 (i.e. 1979 MU, 1901 MU, 1846 MU, 1715 MU and 1715 MU)

The chart below depicts the average CUF of power stations selected for performance audit during 2009-14:



It may be observed from the above table that average CUF of Bairasiul, Teesta-V, Chamera-III and Chutak power stations of NHPC were below their respective design CUFs by 2.27 to 44.65 percentage points.

While agreeing to the audit observation NHPC stated (February/August 2015) that all power stations have been advised to avoid any shortfall in average CUF with reference to design CUF. However, NHPC further explained that

- (i) During 2009-14, Plant Availability Factors (PAF) of Bairasiul and Teesta power stations were 94.5 per cent and 87.8 per cent against the Normative Annual Plant Availability Factors (NAPAF) of 85 per cent fixed by CERC.
- (ii) Less CUF in Chamera-III during 2013-14 was mainly due to shutdown of power station for rectification of water conductor system during its first year of operation and less water inflow.
- (iii) Lower CUF in respect of Bairasiul was on account of less water inflow/poor hydrology.
- (iv) At Chutak Power Station CUF was very low because it was not connected to the Grid. It runs on isolated load of Kargil area. Because of load constraints, its capacity utilization was low. Repeated breakdown of the units in Chutak power station were as a consequence of its prolonged part-load operation and associated high vibration, etc.

The reply is to be viewed against the facts that

- (i) NAPAF is the plant availability factor fixed by CERC for tariff regulation, while capacity utilisation is being compared with the initial design CUF. NAPAF is based on location, type of plant (*i.e.* pondage, RoR and reservoir), silt condition and is

fixed generally below the PAF. Therefore, comparison of CUF with NAPAF is not appropriate.

- (ii) In Chamera-III, during three months of 2013-14, water inflow was more than design inflow. In six months water inflow was less than design inflow, but reduction in actual generation w.r.t. design energy was in greater proportion. Only in three months reduction in generation was in the same proportion as reduction in water inflow. In fact there was 1387 hours of forced outages in 2013-14 itself which resulted in lesser capacity utilisation in Chamera-III.
- (iii) Water inflow in Bairasiul was also more than design inflow during 37 out of 60 months.
- (iv) Regarding Chutak it was enquired by Audit during the Exit Conference whether the demand factor and need for providing connectivity to National Grid was considered while preparing DPR. On this MoP asked NHPC to furnish a write up on this to Audit, which was awaited.

MoP stated (August 2015) that NHPC may instruct project teams to ensure avoidance of under utilisation of design capacity.

3.1.2 Utilisation of installed capacity in Tehri Hydro Power Station (THPS) of THDC

THPS, was designed as a multipurpose project¹⁰ for Full Reservoir Level (FRL) of EL¹¹ 830m., with Maximum Reservoir Level (MRL) of EL 835m. As per the direction of Government of India (GOI), the State Government was responsible for entire rehabilitation task. The funds for rehabilitation were to be made available by THDC. Accordingly, rehabilitation of families upto MRL of EL 835 m level was done by State Government with funds provided by THDC. However, THDC has not so far been permitted to fill the reservoir beyond EL 825m. This was in spite of the fact that THDC had so far (January 2015) made payments of ₹972.97 crore required for rehabilitation of families upto EL 835 m (Maximum Reservoir Level).

MoP stated (August 2015) that State Govt. decision appears to be based on the socio-economic situation of the region and the issue was required to be taken up with Govt. of Uttarakhand through Ministry of Water Resources since the main loss was to irrigation in U.P. and cleaning of Ganga. Further, the MoP agreed (August 2015) in the Exit Conference that it would intervene in the matter on behalf of THDC.

3.1.3 Review of design energy

CERC orders dated 8 December 2000 *inter alia* provided that review of design energy of power stations might be undertaken by CEA as and when any specific information about change in consumptive use of water upstream or in runoff was brought to the notice of CEA.

¹⁰ Apart from the power generation, its objective is to supply drinking water to Delhi as well as water for irrigation to Uttar Pradesh.

¹¹ The elevation of a geographic location is its height above or below a fixed reference point.

Guidelines of CEA for submission of proposal for revision of design energy of hydro power stations also provided that review of design energy be undertaken after every five years as per CERC orders. Fixation of realistic design energy of a hydro power station is therefore, essential because it forms the basis for determination of tariff and recovery of costs by the hydro power station. As per CERC Regulations, total annual charges of a power station are recovered through tariff by generation of power up to the level of design energy. Any secondary energy¹² generated over and above design energy is an additional income to the power station. In case design energy is not reviewed and remains fixed at a level below the actual generating capacity of the power station, this would result in generation of more secondary energy. Consequently, the consumer is burdened as the secondary energy would be otherwise covered under annual charges if design energy is revised.

Audit examination revealed that during 20 years since commissioning in 1994-95, actual generation of Chamera-I had exceeded the design energy by 13 to 60 *per cent*. Despite significant and consistent variations in the actual generation *vis a vis* design energy consistently over the last 20 years, the design energy of Chamera –I power station was not got reviewed by NHPC in terms of above CERC orders and CEA guidelines. Therefore, Chamera-I power station earned ₹274.98 crore¹³ during the period 2009-2014 through sale of 3592 MUs secondary energy. The end users were consequently burdened¹⁴ to the extent of ₹274.98 crore, thereby defeating the purpose of National Electricity Policy of balancing the interest of consumers and reasonable recovery of cost by the generators and investors.

CEA stated (August 2015) that the guidelines had been formulated by them in order to give guidance for submission of proposal for design energy review. Any reduction/ increase in design energy would be known only after a review is carried out.

MoP stated (August 2015) that as informed by CPSEs, secondary energy was sold at a much lower rate of 90 paise/ unit which was actually only the reimbursement of cost of secondary energy. MoP also agreed in the Exit Conference (August 2015) that if CPSEs were earning more money they should pass on the same because they cannot be permitted to make undue profit. However, MoP felt that this was a regulatory issue and reference from the regulator could be made to CEA.

MoP's reply is to be viewed against the facts that

- (i) all costs involved in generation of electricity were considered while calculating capacity charges and energy charges up to design energy. As such, any recovery by sale of secondary energy was in the form of undue profit, especially when in case

¹² Energy generated beyond Design Energy.

¹³ Worked out by multiplying secondary energy generated in the years 2009-10 to 2013-14, multiplied by energy charge rate of the respective financial year subject to ceiling of ₹0.80 per unit.

¹⁴ Because in case of higher Design Energy, there would have been lesser or no secondary energy and energy charge rate would have been lesser. As per CERC notification applicable for the period 2009-14, Energy Charge Rate = Annual Fixed Charges x 0.5 x 10 / { Design Energy x (100 – Auxiliary consumption in per cent) x (100 – Free Energy to Home State in per cent) }

of deficiency of generation with reference to design energy in any year, the same was made good by beneficiaries in subsequent year.

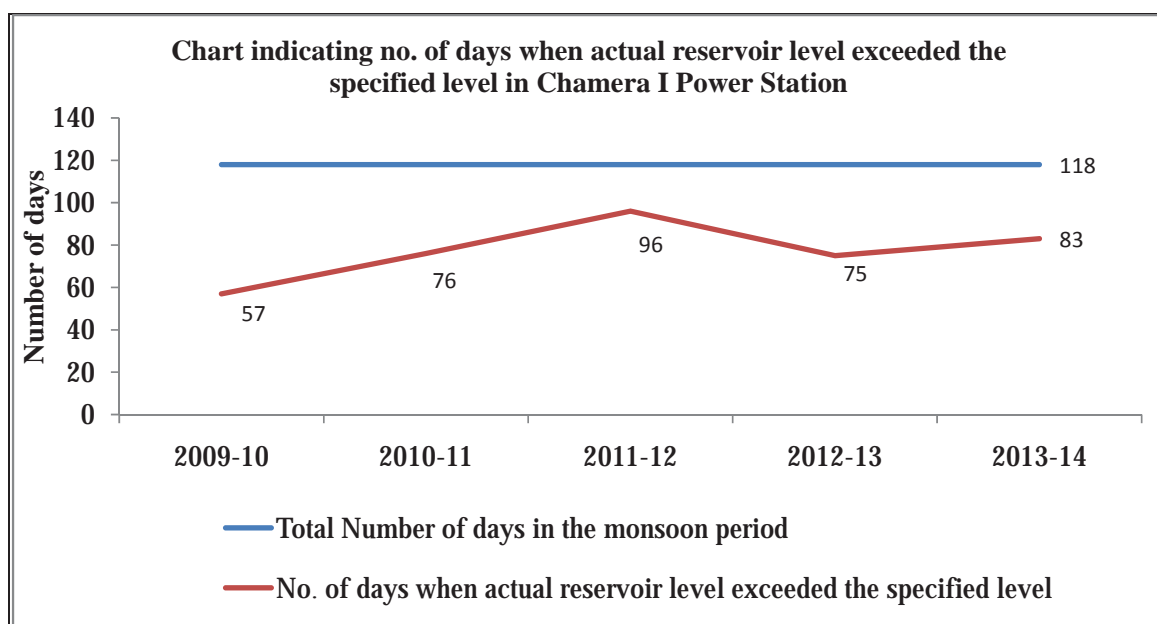
- (ii) Further, National Electricity Policy provides for “balancing the interest of consumers and reasonable recovery of cost by the generators and investors”. Therefore, in the larger public interest it was desirable for the MoP to coordinate with other agencies including the regulator to ensure desired action.

3.1.4 Inadequate reservoir flushing and resultant reduction in reservoir capacity

The best and most economical way to prevent silt from entering into the intake gates is to avoid silt deposition in reservoir. This can be achieved by (i) keeping water in reservoir at specified level during monsoon and/or (ii) carrying out regular flushing operations as per specified norms depending on type of reservoir. Non-adherence to the above conditions not only reduces the useful life of reservoir and power station but also makes flood management difficult.

Reservoir Operation Manuals (ROMs) of Chamera-I and Uri-I power stations of NHPC, and Tehri hydro power station of THDC provided for maintaining reservoir levels as a mechanism to avoid silt deposition. ROMs of other hydro power stations provided for specific requirements for flushing operations apart from maintaining reservoir levels during monsoon season to avoid silt deposition.

Audit noticed that Chamera-I power station did not maintain the specified reservoir level¹⁵ during monsoon seasons 2009-14 as detailed in Chart below:



Non-maintenance of prescribed reservoir level resulted in reduction in gross and live reservoir

¹⁵ 15 to 30 June -757 metres, 1 July to 15 September-750 metres, 16 to 30 September -755 metres and 1 to 10 October – 757 metres.

capacity of the Chamera-I by 15 per cent and 13 per cent respectively, during post monsoon 2008 to post monsoon 2013.

MoP/NHPC did not offer any comment on this.

Further, flushing operations were also not carried out as per specified norms. Table 3.2 indicates actual number of flushing operations performed by selected power stations of NHPC vis a vis those prescribed in their respective ROMs.

Table 3.2
Flushing operations prescribed in ROM and as actually undertaken
by power stations of NHPC

Power Station	Number of flushing operations prescribed in ROM	Number of flushing operation actually undertaken				
		2009-10	2010-11	2011-12	2012-13	2013-14
Bairasiul	5	2	7	9	9	11
Tanakpur	4	4	2	3	4	4
Dhauliganga	8	6	6	6	3	0
Teesta-V	5	5	5	7	7	6
Chamera III	4	-	-	-	2	1
Chutak	5	-	-	-	0	0

3.1.5 Flushing operations in NHPC power stations

- (i) In DGPS apart from inadequate flushing operations as indicated above, maximum water level in the reservoir during monsoon season (137 days each year) was kept between 1340 and 1345 meters as against prescribed level of 1340 metres on 4, 27, 22 and 49 days respectively during 2009-13 due to which gross and live storage capacity of reservoir declined by 5.9 and 3.9 per cent respectively during 2009-13.
- (ii) In the first year (2012-13) of operation of Chamera-III power station, gross and live capacities of reservoir reduced by 18 per cent and 7 per cent with reference to gross and live capacities envisaged in its DPR.
- (iii) Reservoir capacity of remaining power stations (Teesta V, Chutak and Tanakpur) was not assessed regularly during the period 2009-14. Accordingly, Audit was unable to assess the impact of flushing operations on the reservoir capacity of these power stations.

NHPC stated (February 2015) that flushing of Chamera III Power Station was done in tandem with Chamera-II power station for which permission was to be obtained by both power stations from Northern Region Load Dispatch Centre (NRLDC) and State authorities.

The reply is to be viewed against the fact that documents in support of disallowance of flushing operations by NRLDC in Chamera-III were not furnished despite specific request in this regard.

3.1.6 Flushing operations in Nathpa Jhakri Power station of SJVN

In Nathpa Jhakri Power station (NJHPS) of SJVN neither the frequency of flushing was prescribed in ROM nor was any system of assessment of post monsoon reservoir capacity put in place. In the absence of appropriate systems in place, Audit was unable to assess the adequacy of flushing operations carried out by NJHPS and consequent impact, if any, on the reservoir capacity.

SJVN stated (June 2015) that 100 per cent silt was flushed out during reservoir flushing.

However, no documentary evidence was provided in support of reply and sedimentation assessment study was not carried out after the monsoon without which it was not possible to assess the effectiveness of such operations.

CEA stated (August 2015) that concerned utilities need to follow specified norms to take care of this aspect.

MoP, stated (August 2015) that SJVN had been advised to streamline flushing of reservoir and incorporate in its ROM.

3.2 Auxiliary energy consumption in power stations

CERC order of December 2000 prescribed the norms of auxiliary energy consumption¹⁶ and transformation losses in case of underground hydro power station with static excitation¹⁷ and for surface power stations with static excitation as 1.2 per cent and 1.0 per cent of energy generation respectively. Out of the 11 hydro power stations selected for performance audit, eight power stations are underground and three power stations (*i.e.* Bairasiul, Tanakpur and Indira Sagar) are surface power stations.

In Bairasiul and Tanakpur power stations auxiliary energy consumption consistently exceeded the normative auxiliary energy consumption and actual auxiliary energy consumption exceeded norms by 23.43 Million Units (MUs) and 6.31 MUs respectively during last five years ended 31 March 2014.

NHPC stated (October 2014) that Tanakpur power station was commissioned in 1992, *i.e.* 22 years back. As such the efficiency of old electromechanical equipment like transformers, motors, pumps and other electrical equipment have its impact on auxiliary energy consumption. NHPC further stated (February 2015) that power stations with higher auxiliary energy

¹⁶ Auxiliary energy consumption means the quantum of energy consumed by auxiliary equipment of the generating station, such as the equipment being used for operating plant and machinery including switchyard of the generating station and transformation losses within the generating station.

¹⁷ The process of generating a magnetic field by means of an electric current is called excitation.

consumption are going to be addressed through Renovation & Modernization programme one by one, after the power station had run its initial useful life.

Reply is to be viewed against the fact that NHPC had not made any long term plan (February 2015) to take up Renovation & Modernisation of its power stations in phased manner.