

Chapter IV

Diversification and Innovation

4.1 Need for diversification and innovation

Recognising that utility power plant business was plagued by sector specific issues like lack of adequate coal linkages, mounting losses of state utilities, land issues and financing, BHEL fixed Strategic Plan targets for the period 2012-17 with focus on diversification and innovation. Thus, challenge before BHEL was not only to safeguard its core business, but also to focus on diversified areas like defence, solar, wind and water businesses and also involve R&D to attempt breakthrough developments. As such, BHEL Board approved (November 2011) the following strategies:

- Adopt strategies aimed at bridging technology gaps especially in Circulating Fluidized Bed Combustion (CFBC) area, leverage Engineering, Procurement and Construction (EPC) capability, attempt new areas like coal washery reject based power plants etc.
- Adopt Strategic Business Unit (SBU) structure and forging alliances in Renovation and Modernisation (R&M) business with focus to target BHEL supplied sets included in the CEA plan for XII plan period.
- Pursue both development and strategic tie-ups routes for maximising share in transmission business which was identified as a potential area of growth.
- Pursue proposed factories by Indian Railways at Dankuni, Kanchrapara, Marhowra and Madhepura either on PSU model or in association with a lead bidder, considering “Transportation” as a potential area to become second largest contributor in company’s top line in future.
- Pursue opportunities in Solar and Wind areas by expanding Photovoltaic (PV) capacities as well as leveraging on tie-ups already in place.
- Implement in set timeframe Enterprise Resource Planning (ERP)/ “ONE BHEL” in view of need to manage mammoth size of company’s business volume.

BHEL’s efforts for diversification and innovation during 2011-16 are discussed in succeeding paragraphs.

4.2 Inadequacy of efforts for diversification

4.2.1 Failure to bridge technology gap

(i) **Circulating Fluidized Bed Combustion (CFBC):** CFBC constituted 70 per cent of Captive Power Plant (CPP) business. Despite the decision (May 2013) to offer cost effective CFBC solutions in 150 MW and below sets, BHEL has not been able to bridge technology gaps in this business area. In 2015-16¹⁵, BHEL lost a tender in this area valuing ₹170 crore (L1 price) due to higher weight of BHEL’s boiler package, higher auxiliary consumption of BHEL equipment and longer commissioning period.

¹⁵ As per departmental procedure of Industry Sector of BHEL, lost tender files were required to be maintained for one year. As such, records relating to lost tenders for the year 2015-16 could only be reviewed in audit

(ii) **Gas Turbine package:** Efficiency of Frame 6 (Fr6) model of Gas Turbine offered by BHEL was 5 to 6 *per cent* lower than Siemens and Hitachi models, attracting substantial technical loading¹⁶ on BHEL. In case of supply of 2x25 MW Gas Turbine Generator (GTG) and Heat Recovery Steam Generator (HRSG) against an EPC tender issued by M/s Rashtriya Chemical and Fertilizers Limited, BHEL offered Fr6B GT model with output of 43 MW owing to non-availability of GT model having output of 25 MW. Due to lower efficiency of Fr6B GTG offered by BHEL, there was substantial technical loading (₹114.64 crore) on BHEL, which rendered BHEL's offer uncompetitive.

(iii) **Photovoltaic (PV) modules:** Efficiency of BHEL's Photovoltaic (PV) modules (15.20 *per cent*) was lower in comparison to that of its competitors (15.90 *per cent*). On account of this, BHEL lost (2013-14 and 2015-16) two orders for solar PV project, Belarus.

(iv) **Current Transformers (CT) up to 220 kV:** BHEL-Jhansi unit has the capacity to manufacture dead tank type CTs, which are costlier compared to live tank CTs. BHEL participated in 63 orders for supply of up to 220 kV CTs during 2012-16 and lost nearly all of them (60 orders) valuing ₹87.15 crore.

(v) **Dry Type Transformers (DTT):** BHEL manufactures Cast Resin Type Transformers which are costlier compared to Resin Impregnated DTTs. During 2012-16, BHEL lost all the ten tenders for supply of DTT, valuing ₹7.36 crore.

(vi) **765 kV GIS based substations:** In order to reduce Right of Way requirement for transmission lines and overcome constraints in availability of land for substations, 765 kV Gas Insulated Switchyard (GIS) is being increasingly adopted. However, BHEL has not been able to develop 765 kV GIS technology.

(vii) **500 MVA Inter Connecting Transformers (ICTs):** 500 MVA Inter Connecting Transformers (ICTs) of BHEL did not qualify for substation projects as these were not Dynamic Short Circuit tested. Out of total 139 tenders for sub-stations of capacity 220 kV and above (new and extension) finalized during 2012-13 to 2015-16, BHEL participated in only 31 (22.3 *per cent*) tenders and secured 19 (61.29 *per cent*) orders.

Management stated (February 2017) that discussion for technology collaboration for CFBC Boilers was under progress with prospective collaborators. BHEL was making efforts along with its technological partner to explore ways to offer higher efficiencies of GTs to address the market requirements. BHEL has since attained a higher level of efficiency of PV modules and 132 kV Live Tank CT has been designed, manufactured and tested in-house successfully. BHEL plans to take up development of 765 kV GIS after present efforts once 420 kV GIS are completed successfully and efforts were on for clearing the Dynamic Short Circuit test for BHEL make 500 MVA ICTs. Ministry added (May 2017) that several attempts were made to diversify the company's product offerings and these efforts were still going on, which were likely to bring positive outcomes in times ahead.

The reply indicates that efforts are ongoing in BHEL for correction of identified technology gaps. However, technological tie-ups and product developments in these areas were expected to be achieved in initial period of Strategic Plan (2012-17) so that decrease in turnover of core power sector could have been supplemented.

¹⁶ Technical loading is the process of assigning higher cost at a pre-determined rate due to inferior technical parameters offered at the time of evaluation of bids to bring at par the bids of different parties

4.2.2 Non-finalization of business tie-up for R&M business

Renovation and modernization (R&M) was seen as a cost-effective option for additional generation from the existing thermal power stations due to its lower cost and shorter gestation period. Management Committee (MC) in June 2012 had raised concerns about BHEL's inability to execute R&M projects, mainly due to lack of service engineering set-up. MC specifically instructed (2012) Management to expedite business tie-up for service cooperation with a suitable partner for R&M business which is yet to be finalised. Audit noticed that BHEL completed R&M of six units during 2011-12 to 2015-16 with time overruns ranging from 13 to 61 months.

Management stated (December 2016) that during 2011-2015, only two comprehensive R&M projects, viz., 210 MW Unit 5 of Bandel thermal power station (TPS) and 210 MW unit 6 of Koradi TPS, were finalised in the country and BHEL secured (May 2013) one of them (R&M of Koradi TPS). For Bandel TPS, BHEL did not participate as boiler was non-BHEL make. Management further stated (February 2017) that due to depleting R&M business in India and development of in-house capability for taking up comprehensive R&M, actions initiated for the business tie-up for service cooperation was not continued. Further, the Government of India, in line with focus on the cleaner efficient plants, was encouraging replacement of inefficient older power plants, which BHEL plans to address. Ministry added (May 2017) that the reasons for delay in completing R&M works were not totally attributable to BHEL.

Audit noticed that non-compliance of delivery schedule by BHEL for shutdown requirement was a major concern identified in customer perception survey. It is important to note that BHEL's inability to timely execute R&M projects had been raised as a concern by the MC as early as 2012 which was not effectively addressed by BHEL.

4.2.3 Non-participation in Indian Railways projects

As per the Strategic Plan 2012-17, BHEL was to participate in tenders for setting up JV for manufacture, supply and maintenance of locomotives/rail coach factories at Dankuni, Kanchrapara, Marhowra and Madhepura, either on PSU model or in association with a lead bidder, considering "Transportation" as a future potential area.

4.2.3.1 For Diesel Loco Manufacturing Facility at Marhowra-Bihar, BHEL decided (March 2012) to supply equipment from its existing facilities to GE (India) which in turn would supply to the JVC of Indian Railways. This decision, was not in line with the vision of the Strategic Plan which envisaged technology partnership. Audit noticed that GE was keen to include BHEL as consortium partner initially. Subsequently, GE secured (November 2015) the contract. Agreement between BHEL and GE regarding sourcing equipment from BHEL's existing facilities was not on record.

Ministry stated (May 2017) that GE quoted on its own during the initial Request for Qualification (RFQ) stage of the tender and stated that BHEL would be included during Request for Proposal (RFP) stage. Indian Railways, however, did not allow inclusion of BHEL during RFP stage.

The reply does not consider the fact that BHEL (in the 442nd meeting of BHEL Board) decided against setting up of JV with GE, much before the RFP stage. Thus, BHEL's decision of not becoming consortium partner was irrespective of the decision of Indian Railways in this regard.

4.2.3.2 For Electric Loco manufacturing factory at Madhepura, Bihar, BHEL did not participate as it could not meet “Technical Capacity” qualification criteria of RFQ document. Setting up of factory at Madhepura was awarded to M/s Alstom (November 2015). Similarly, BHEL could not meet the “Technical Capacity” qualification criteria of RFQ for the Kanchrapara Rail Coach Factory project.

Management stated (February 2017) that BHEL could not participate in the Madhepura project as it did not meet the qualification criteria for the RFQ. Ministry added (May 2017) that BHEL made efforts from 2013 to forge global tie-up/JV through letters of cooperation.

Audit noticed that efforts made by BHEL for appropriate global tie-ups were inadequate. Against the tender floated in May 2013 by Indian Railways for Madhepura project, BHEL made efforts to contact global players in this field only on 04 October 2013 and requested responses by 15 October 2013 which proved unsuccessful. In case of Kanchrapara project, BHEL issued EOI for tie-ups in August 2016 against the RFQ issued by Indian Railways in October 2015.

4.2.3.3 The Strategic Plan 2012-17 envisaged participation in metro projects on consortium basis, and forging global tie-up/JV for EMU/MEMU/Distributed power trains/High speed locos/Metro projects. However, no tie-ups have yet (May 2017) been achieved in this business area. Though BHEL participated in 2013-14 in the tender for supply of metro coaches to Delhi Metro in consortium with M/s Hitachi, it could not succeed due to higher price.

Ministry stated (May 2017) that BHEL started making efforts for coach manufacturing by forging global tie-ups through EOI floated in March 2012. Though it participated in consortium with M/s Hitachi in Delhi Metro tender, no breakthrough could be achieved because of higher price of BHEL-Hitachi consortium. BHEL had discussions with M/s Hitachi to lower the costs to attempt future projects. However, no results materialised. Thereafter, global EOI for long term tie-ups were re-floated in December 2015.

The efforts made by BHEL in this regard have not been consistent. One EOI was issued in March 2012, followed by another in December 2015. During this period, a number of metro projects have been under development in India and BHEL lost the opportunity to participate in them.

4.2.4 Ineffective tie-ups in solar energy area

To supplement its expertise in Concentrated Solar Power (CSP) plants, BHEL signed an MoU with M/s Abengoa (January 2011) having a validity of two years (up to 13 January 2013) for identifying business opportunities in CSP and submit joint EPC bids. The MOU was extended thrice, up to 13 January 2016. As per the MOU, if any party decided not to participate in a certain joint offer, it could do so by communicating in writing to other party; and the said party, thus, would be free to submit that offer by itself or with a third party without taking prior consent from the party not interested in quoting the opportunity. The MoU, therefore, did not bind M/s Abengoa to submit joint bids with BHEL. Audit observed that during validity of the MOU, BHEL and M/s Abengoa quoted independently for two tenders (100 MW) and BHEL’s offer was not accepted due to lack of reference. Thus, BHEL could not convert tie-up with M/s Abengoa into orders.

Ministry stated (May 2017) that BHEL quoted independently in terms of CSP to explore the possibilities of increasing the business in this sector.

The reply, however, has to be viewed against the fact that BHEL entered into an MoU owing to its lack of expertise in CSP and therefore, quoting independently negated the purpose of entering into

MOU. Besides, the MoU provisions allowing independent bid submission by BHEL and M/s Abengoa were counter-productive.

4.2.5 Municipal solid waste-based power plants

In the 48th Product Committee meeting (25 September 2013), Industry Sector presented the outlook on emerging market for Municipal Solid Waste (MSW) based power plants. Based on available data for 2010-11, the power generation potential from MSW was estimated at 370 MW which was expected to over 500 MW by 2016-17. Most of the equipment for this business segment were in BHEL's manufacturing range except the firing system, for which technology needed to be tied up. Toward this end, Expression of Interest was proposed to be floated before December 2013. However, BHEL did not take any steps on the matter till date (May 2017).

Management stated (February 2017) that competing technologies, viz., enviro-friendly plasma pyrolysis vis-à-vis pollution intensive conventional incineration process has been a matter of concern in making the right choice for municipal bodies and equipment manufacturers alike, which contributed to the slowdown/delay.

The existence of competing technologies in the area does not explain inaction on part of BHEL to assess their suitability and adopt appropriately.

4.2.6 Late response to emerging opportunities

Jawaharlal Nehru National Solar Mission (JNNSM) was launched by GoI in January 2010, setting a target of 20000 MW solar power capacity by 2021-22. This target was enhanced to 100000 MW in June 2015. Though BHEL had been in the renewable energy sector since 1983, its production capacity (8 MW for PV cells and 26 MW for PV modules) was insignificant compared to these ambitious targets. The Strategic Plan 2012-17 envisaged (November 2011) enhancing Photovoltaic (PV) module production capability progressively to 100 MW by 2014-15 at its Electronic Division (EDN), Bengaluru which could be completed only by January 2017. Due to delayed expansion of production capacity, BHEL could not participate actively in the first phase of the mission. Ministry of New and Renewable Energy also observed (December 2012) that while a large number of big and small organisations had participated in first phase of the mission, BHEL had contributed only marginally. Up to May 2016, the country added a solar capacity of 7564.86 MW under JNNSM, while BHEL commissioned only 105.5 MW (1.39 per cent) during this period.

Management stated (February 2017) that most of the capacity addition out of the 7564.86 MW happened through tenders in developer mode, which entail sourcing of land, signing of PPA with utilities etc., where BHEL does not directly participate. BHEL participated in all tenders where developers brought out EPC tenders. Currently BHEL's market share on EPC tenders was around 15 to 18 per cent. Hence BHEL's contribution cannot be directly compared vis-a-vis the capacity added. Ministry added (May 2017) that capacity of the manufacturing facilities was decided based on the installed manufacturing capacity in the country and to address the projects which require domestically manufactured cells and modules and to reduce dependence on other domestic manufacturers.

The response of the Management does not address steps that would need to be taken by BHEL to bridge the considerable gap the Company faces in solar power.

4.3 Innovation

In the pursuit of Strategic Plan targets, Board desired (November 2011) that:

- Each technology plan developed for realising 15 identified mission projects must also reflect timeframe and investment; and
- Implementation of ERP/‘ONE-BHEL’ be done in set timeframe.

Audit reviewed the initiation and completion of Project Initiation Reports (PIRs) with reference to technology development plan in connection with mission projects. Observations of Audit in this regard are discussed in succeeding paragraphs.

4.3.1 Delay in completion of R&D activities of mission projects

Under the 15 mission projects of BHEL, 517 Research and Development (R&D) projects were initiated. Of these, 492 R&D projects relating to 12 mission projects¹⁷ were completed during 2011-12 to 2016-17 of which 31.17 *per cent* (156 projects) could not be completed within schedule. Out of these 156 projects, three projects were completed after a delay of more than three years, 15 projects were completed with delay of 1 to 3 years and 28 projects were completed with delay between six months and one year. Besides, 25 R&D projects relating to five mission projects were in progress as on 31 March 2017.

Ministry stated (May 2017) that some of the R&D projects were delayed due to extraneous factors, *i.e.*, non-availability of site for field trial, delay in procurement of non-standard items, testing at reputed National/ International laboratories and uncertainties in new technological development.

The contention of the Management that the R&D projects were delayed due to extraneous factors needs to be viewed against the fact that such factors were not brought to the notice of MC which expressed concerns regarding the delays repeatedly.

4.3.2 Delay in development of Advanced Ultra Supercritical Technology

In order to reduce dependence on foreign technology, an MoU was entered (August 2010) into between Indira Gandhi Centre for Atomic Research (IGCAR), NTPC Limited and BHEL for development of Advanced Ultra Supercritical (AUSC) Technology for thermal power plants. This project called ‘Mission 2017 for Thermal Power Plants planned enhancement of plant efficiency to 45-46 *per cent*, and reduction of coal consumption and CO₂ emissions by ~20 *per cent*. As per MoU, IGCAR was to develop the new materials required for the technology, BHEL was to design, manufacture and commission the equipment and NTPC was to implement the project. The design and development was estimated for 2½ years, manufacturing and installation for a further 4½ years from the date of sanction of this project by GoI. BHEL’s Strategic Plan 2012-17 also proposed development of R&D capability for AUSC technology by 2017, so as to meet likely demand from 2017-18 onwards.

Audit noticed that:

- There has been considerable delay in conception and approval of the project. BHEL took three years to conceive the R&D projects which were approved by BHEL Board in December 2013 (estimated cost of ₹1019 crore). Though DHI communicated (October 2014) the approval of Expenditure Finance Committee for this project, the Cabinet approval of the

¹⁷ No R&D project was initiated against Mission Project No. 3, 4 and 13

project involving estimated expenditure of ₹1554 crore (BHEL-₹270 crore, NTPC-₹50 crore, IGCAR-₹234 crore, Department of Science and Technology-₹100 crore and GoI-₹900 crore) was received only in August 2016. The fund required for the project was released from April 2017 onwards.

- The Monitoring Committee for effective coordination and supervision of progress of project execution, such as Over Arching Committee and Project Management Council, is yet to be constituted (December 2016).
- To achieve the objective of the AUSC technology project, timely completion of R&D was essential, especially when the same technology was under development in European Union, United States of America, Japan and China. The delay would defer the development (by seven years as per approved timelines).

Management stated (February 2017) that Government took 3½ years in approving the project. Ministry stated (May 2017) that presently the AUSC technology was under development stage. No commercial plants were operated anywhere in the world with AUSC technology. Government has approved the R&D mission project for development of AUSC technology by the consortium of BHEL, NTPC and IGCAR.

The reply does not address the delay in initiating the project.

4.3.3 Delay in development of 765/ 800 kV technology for Power Transmission Sector

Strategic Plan 2012-17 provided for hastening development of 400 kV Gas Insulated Sub-station (GIS) and in-house development of equipment for 765 kV GIS. Audit noticed that:

- Corporate R&D Division executed five PIRs for development and design of 400/420 kV GIS technology during 2011-12 to 2015-16. Out of these, two¹⁸ PIRs were completed with delays of two and 45 months and three¹⁹ PIRs were in progress (December 2016).
- As these projects were to be developed and tested in series, delay in development of 400 KV GIS Circuit Breaker and Modules resulted in cascading delay in development of 765 kV technology.
- The PIRs for 765/ 800 kV technology were raised in December 2015 but have not yet been approved by BHEL Corporate Office (November 2016). This delay has also adversely impacted the presence of BHEL in 765 kV GIS. As a result, BHEL could participate only in seven out of the 25 tenders (with equipment sourced from OEMs) issued during 2012-13 to 2015-16 for 765 kV GIS.

Ministry stated (May 2017) that development of 420 kV GIS circuit breaker and other modules had been taken up by BHEL and progressively completed by March 2012. No opportunities were lost, but completion got delayed as concept of single break dual circuit breaker was developed for the first time and these was lack of third party certification and non-availability of short circuit testing facility in India.

¹⁸ (i) Development of 400 KV GIS Circuit Breaker and Modules and (ii) Development of Single break Gas Circuit Breaker for 400 kV GIS application using Spring Hydro Drive

¹⁹ (i) Development of Gas insulated surge arrester module for 420 kV GIS, (ii) Development of Gas-to-Cable termination module for 420kV GIS and (iii) Development of 63 kA Single break Gas Circuit Breaker for 420 kV GIS Application

Audit however noticed that development of 420 kV GIS circuit breaker and other modules was completed after a delay of 45 months. Delay in development and commercialisation of 420 kV technology and consequent delay in initiation of R&D projects for development of 765 kV technology affected opportunities for BHEL in the transmission sector, which was identified as one of the potential growth areas in Strategic Plan 2012-17.

4.3.4 Absence of ERP assistance to meet business challenges for sustaining competitiveness

To streamline and standardise business processes and to meet business challenges for sustaining competitiveness, BHEL Board accorded (November 2010) in-principle approval for implementation of Enterprise Resource Planning (ERP) in the Company. ERP was to be implemented within 36 months from Board's approval, i.e., by November 2013. The ERP system is yet to be fully functional (June 2017). Audit noticed the following issues regarding implementation of ERP in BHEL:

- Management took more than two years in appointing (June 2012) a consultant (M/s PricewaterhouseCoopers-PWC) for studying existing systems and platforms, preparation of RFP documents and implementation and supportive hardware. RFP documents could be finalised only in August 2013.
- BHEL introduced a tender condition of 'joint and several' responsibility and consortium agreement between ERP-OEM and Implementation Partner (IP) against the advice of the consultant. Though BHEL invited tenders with these conditions twice (September 2013 and April 2014) and subsequently altered it with additional safeguarding conditions in July 2015, no responses were received.
- During discussions between RFP Committee and OEMs held on 12.5.2016, it emerged that primary concern of bidders was that they were not able to negotiate on the license buying schedule from the ERP-OEM as per BHEL's proposed licenses Procurement Schedule (based on roll outs across units). A revised RFP was yet to be approved (February 2017).

Ministry stated (May 2017) that in order to minimise the risk and cost, BHEL included certain special conditions in tender documents. But due to various market conditions and resistance of vendors, there was no response even after multiple tenders. BHEL was already having SAP-ERP at Hyderabad, Trichy, Bengaluru units, and robust in-house and integrated systems at other major units. While ONE-BHEL tendering process had been underway, many critical and corporate applications²⁰ were developed in-house to address the missing links with respect to applications in Business Sectors, Power Sector Regions and Corporate and to meet the business challenges for sustaining competitiveness in the market. Further, integration was also undertaking and systems were being continuously updated.

Thus, even after seven years of in-principle approval, BHEL could not implement a company-wide ERP system which would have promoted streamlining of business process, better checks and controls and ensured better transparency in operations. Information Technology systems on uniform platform is essential for a large entity like BHEL where real-time and end-to-end visibility of information on multiple dimensions like projects, financials, inventory, customers, vendor database etc. would add value.

²⁰ Site Construction Management System, SAR/CAR/MDR Systems, Corporate Quality System, Order Book Liquidation, Debtors Management System etc.