

BHEL's in-house Development of the largest pumps for World's largest Kaleshwaram Lift Irrigation Scheme in Telangana

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Abstract - World's largest Lift Irrigation Scheme is being executed in the water starved state of Telangana. The features of this multi-purpose irrigation project on Godavari River are described which will meet the irrigation and drinking water needs of 20 of the 31 districts of Telangana. The links, lifts, reservoirs (existing and new) are briefly mentioned in the paper to give an overview. The paper explains the success story of BHEL who has passed successfully the phases of design, model testing and manufacturing of the highest capacity synchronous motor driven pumps with in-house experience and technology.

Keywords: Largest lift irrigation project, largest pump-motors.

I. INTRODUCTION

In 2015, NASA's satellite data revealed that globally speaking, 21 of the 37 large aquifers are severely water-stressed. With growing populations, and increased demands from agriculture and industry, researchers indicated that this crisis is only likely to worsen. In India, at the time of Independence, there were about 15 lakh water bodies spread across rural India. However, now over 12 lakhs have been either encroached or polluted. The impact is being felt now with about 72% of aquifers drying up. The world is heading towards severe disaster and water may emerge as the main cause for the triggering of the World War-III.

India is taking initiatives to manage the need of water by creating the Ministry of Water Resources, River Development and Ganga Rejuvenation for formulation and administration of rules and regulations relating to the development and regulation of the water resources in India [1-2]. The Government of India has launched the **Jal Jeevan Mission** on August 15, 2019, to provide tap water supply to every rural home by 2024. Some initiatives are taken in some states by linking of the rivers within a state or interstate.

The Godavari River flows from Maharashtra into the northern Telangana. As per the award of *Godavari River Disputes Tribunal*, Telangana has an allocation of 900+ TMC of water in the Godavari River. However, Telangana is barely able to use 300 TMC. The reason behind is that inflows into existing major and medium irrigation projects in Telangana from Maharashtra are very poor. This is due to the construction of several dams, barrages and lift irrigation projects on river Godavari in the Maharashtra. Further, Godavari River flows at a lower elevation (+100 m Above sea level) whereas Telangana regions are at a higher elevation (+300 m to +590 m above sea level). Gravity based projects

are not a feasible option and lift based projects remain the only way out. Such a situation compelled Telangana to take-up such a huge lift irrigation project to fulfill water demand of 20 water starved districts.

A great initiative was taken in Telangana where world's largest lift irrigation project is under execution to cater the needs of irrigation and drinking water. Telangana has started harnessing the water at the confluence of two rivers with Godavari by constructing a barrage at Medigadda in Jayashankar Bhupalpally district and reverse pump the water into the main Godavari River and divert it through multi-stage lifts and pumps into a huge and complex system of reservoirs, water tunnels, pipelines and canals.

(a) Unique Records

The project records the world's longest water tunnels, aqueducts, underground surge pools, and largest capacity pumps, all indigenous.

(b) Major project data

Lifts	618 m by 20 nos. lifts powered from 19 pump houses
Links	7 nos.
Power requirement	7152 MW
Incoming grid supply voltage	33 kV to 400 kV (stepped down to suit the motor voltage)
Electricity suppliers	Telangana State Northern Power Distribution Company Limited.
Water flow system	Total length = 1832 km (1531 km gravity canals, 203 km tunnel and 98 km pressure/delivery mains).
Irrigation area	45 Lakh acres
Drinking water/industries	Hyderabad, Secunderabad, several towns, and villages
Project cost	Rs. 80,000 Cr. (Likely escalate to over Rs. 1 Lakh Cr.)

II. LAYOUT OF KALESHWARAM LIS AND ITS MAJOR COMPONENTS

The project comprises of several existing balancing reservoirs, new reservoirs, canals, tunnels and seven links for distribution of water. The overall Scheme of the Kaleshwaram project is shown in Figure 1.

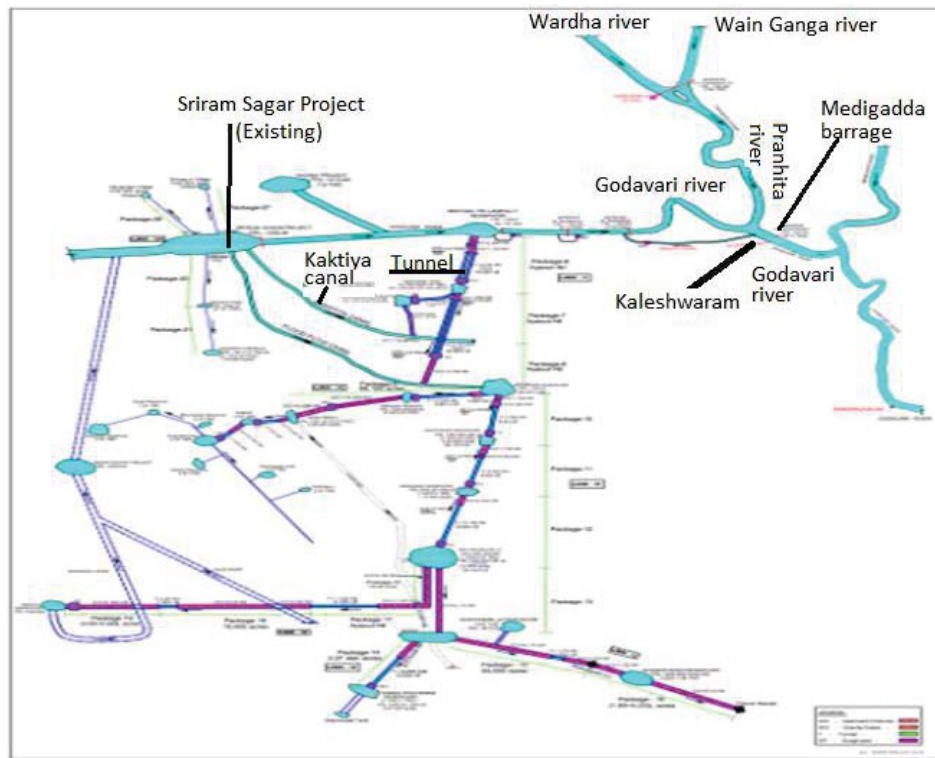


Fig. 1 Layout of Kaleshwaram Lift Irrigation Project [3]

Kaleshwaram Lift Irrigation Project starts at the confluence of rivers *Pranhita* and *Godavari* at Kaleshwaram village in Jayashankar Bhupalipalli district. Pranhita river in itself is a confluence of various other smaller tributaries mainly, Wardha, Penganga, and Wainganga Rivers. It is

estimated that Pranhita river has an annual average flow of 280 TMC. It remains untapped as its course is principally through the dense forests and other ecologically sensitive zones such as wild life sanctuaries. Its layout is shown in Figure 2.

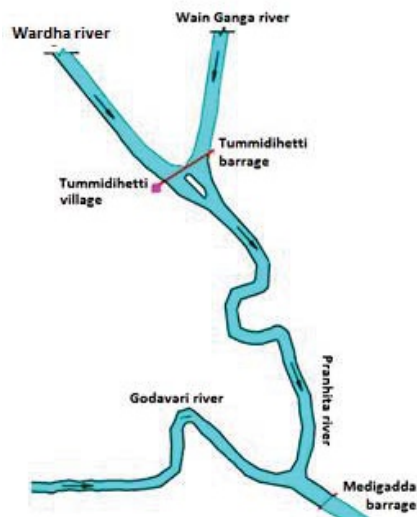


Fig. 2 Rivers Pranhita, its tributaries, and Godavari [3]

In 2016, Telangana and Maharashtra governments signed MoU in which a new barrage at Medigadda and a lift at Kannepalli Village lift water for the project was agreed. The whole project was designed with adequate barrages and reservoirs aided by pumps and lifts at appropriate places under the name "*Kaleshwaram Lift Irrigation Project*".

III. LINKS AND WATER USAGE

Kaleshwaram Project is divided into 7 links and 28 packages covering about 500 kms of 13 districts and a canal network of about 1800 kms. The project aims to utilize a total of **240 TMC** of water from following resources:

Table 1: Planned Break-up of drinking water from Kaleshwaram Project.

Source	Water quantity
Medigadda Barrage	195 TMC
Sripada Yellampalli Project	20 TMC
Groundwater	25 TMC

The break-up of the usage of 240 TMC water is given in Table 2.

Table 2: Planned Break-up of usage of water from Kaleshwaram Project.

Usage	Annual Quantity of water
Irrigation	169 TMC
Water for Hyderabad	30 TMC
Drinking water for villages along the project	10 TMC
Industries	16 TMC

Note: 12 TMC water is estimated evaporation losses

The links for water flow through canal/tunnels and Irrigated Command Area/Ayacut (Acres) are given in Table 3.

Table 3: Links in the Kaleshwaram Project

Link No.	Linking between	Command Area/ Ayacut (Acres)
Link-I	Medigadda Barrage on Godavari River to Sripada Yellampally Project	30,000
Link-II	Sripada Yellampally Project to Mid Manair Dam	
Link-III	Mid Manair Dam to Upper Manair Reservoir	86,150
Link-IV	Mid Manair Dam to Konda Pochamma Reservoir	5,95,754
Link-V	Anicut to Chityala	2,43,500
Link-VI	Sri Komaravelly Mallana Sagar to Singur Dam	2,80,296
Link-VII	SRSP Foreshore to Nizam Sagar Canals and to Dilwapur and Hangarga village for Nirmal and Mudhole Constituency	5,90,000

NOTE: New Ayacut = 18,25,700 Acres, apart from 18,75,000 Acres (Stabilization of existing ayacut)

Gravity Canals & Tunnels for distribution

Gravity Canal	1531 kms
Gravity Tunnel	203 kms
Pressure Mains/ Delivery Mains	98 kms

The water is to be reverse pumped from the confluence point of Godavari and Pranhita Rivers to Sripada Yellampally Project by providing 3 barrages (Medigadda, Annaram and Sundilla) and 3 lifts shown in Figure 3.

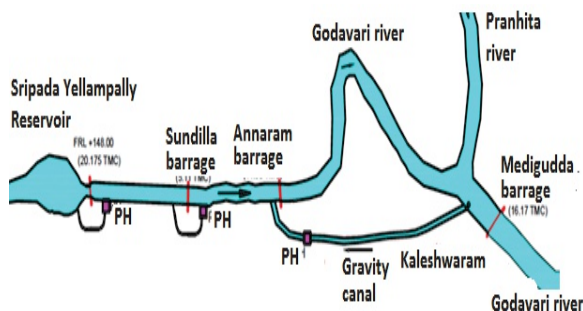


Fig. 3 Layout of Link-I of the Project [3].

At present, lifts are being constructed to lift 2 TMC (56,63,36,93,184 liters) of water per day from Medigadda to the backwaters of Annaram barrage and then to Sundilla barrage. Finally, the water if pumped from Sundilla to Sripada Yellampally Project. The civil works under execution are to lift 3 TMC per day but presently the pumps are being erected to lift only 2 TMC. In future, if need be, only pumps would need to be installed to increase capacity to 3 TMC.

Major civil contractors associated with Kaleshwaram LIS are M/s MEIL (Megha Engineering & Infrastructure Ltd), M/s NEC (Navayuga engineering company Ltd), M/s Prathima Infrastructure Ltd, and M/s KNR Constructions Ltd.



Fig. 4 Overview of the Medigadda pump house [4].



Fig. 5 Delivery Reservoir: Package 6

IV. DEVELOPMENT OF HIGHEST CAPACITY PUMPS IN INDIA

BHEL is the leading public sector Company for the design, manufacturing, supply, installation, commissioning, and subsequent services of the wide range of heavy electrical equipments which include generation, transmission and distribution systems of hydro, thermal and nuclear power projects. It is equipped with the best laboratory in India for testing of the models of hydro machinery. They have supplied and commissioned hydro power projects in India and abroad with generating capacity up to 200 MW. As far as reversible units for pumped storage projects are concerned, BHEL has supplied pumps up to 220 MW but in some foreign collaboration.

The first large capacity pumps quoted by BHEL were 4x18 MW for Srisaillam Lift Irrigation Project. It was challenging to win the customer's confidence for design and manufacturing based on in-house design experience and manufacturing technology. The model testing of the pump impeller was carried out in BHEL's Hydro Machinery

Laboratory in Bhopal which was witnessed by Irrigation Department, Government of Andhra Pradesh and APSEB. The hydraulic design of pump was reviewed by IIT Delhi. Finally, the customer was convinced and placed an order on BHEL. This impeller profile was modified from time to time for other ratings of the pumps using CFD (Computational Fluid Dynamics).

The Pranhita pumping projects in Kaleshwaram LIS are under various stages of supply, installation, commissioning, and operation. BHEL has a major contribution in the prestigious Kaleshwaram Lift Irrigation Scheme. All high rating Pump-Motor sets along with control systems are in the scope of BHEL supply. BHEL scope under these packages are Pump-Motor & its Auxiliaries, bus-bars, discharge valve, Static Frequency Converters for starting the synchronous motor, SCADA & Busducts. BHEL has supplied and commissioned 22 Pump-Motor sets for 4 Pumping stations to match with the site requirement. Another 23 Pump-Motor sets for 5 Pump houses are under supply. The status of pump-motors is given in Table 4.

Table 4: Large capacity Pumps ordered on BHEL

S.No.	Project	Capacity	Speed (RPM)	Head (M)	Discharge (Cumecs)	Remarks
1	Pranhita Package-6	7x116 MW	200	105.45	7x90	7 nos. commissioned
2	Pranhita Package-8	7x139 MW	214.3	119	7x90	7 nos. commissioned
3	Pranhita Package-10	4x106 MW	200	101.2	4x85	4 nos. commissioned
4	Pranhita Package-11	4x134.4 MW	214.3	122	4x85	4 nos. commissioned
5	Link-2 Package-1	5x145 MW	250	148	5x72	Supply under progress
6	Link-2 Package-2	4x138 MW	200	108	4x90	Supply under progress
7	Link-4 Package-1	4x125 MW	200	116	4x84	Supply under progress
8	Link-4 Package-2	6x125 MW	375	168	6x55.5	Supply under progress
9	Link-4 Package-4	4x81.5 MW	176.7	74	4x83.25	Supply under progress

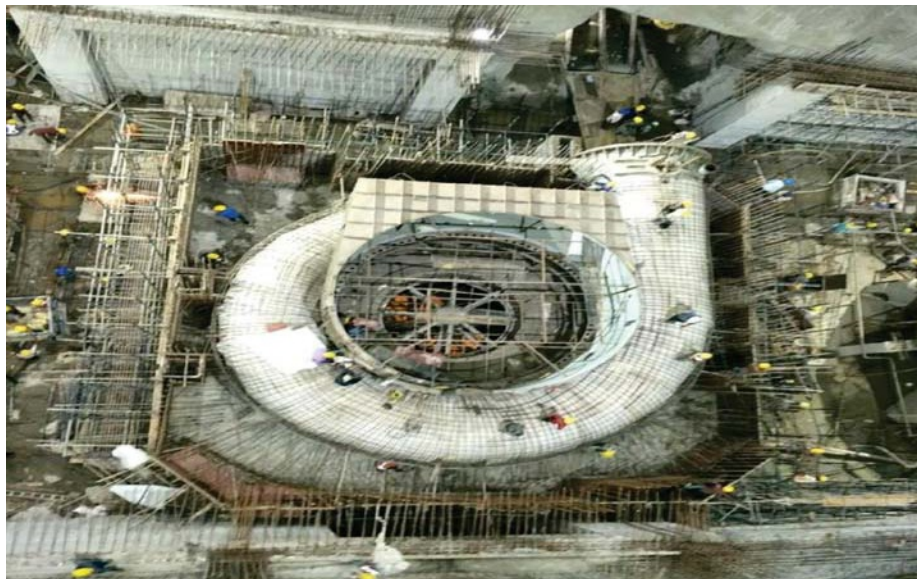


Fig. 6 Spiral Casing of 134.4 MW Pumps under installation

Table 5: Large capacity Motors ordered on BHEL

S.No.	Project	Capacity	Speed (RPM)	Motor Voltage (kV)	Remarks
1	Pranhita Package-6	7x116 MW	200	11	7 nos. commissioned
2	Pranhita Package-8	7x139 MW	214.3	13.8	7 nos. commissioned
3	Pranhita Package-10	4x106 MW	200	11	4 nos. commissioned
4	Pranhita Package-11	4x134.4 MW	214.3	13.8	4 nos. commissioned
5	Link-2 Package-1	5x145 MW	250	11	Supply under progress
6	Link-2 Package-2	4x138 MW	200	11	Supply under progress
7	Link-4 Package-1	4x125 MW	200	11	Supply under progress
8	Link-4 Package-2	6x125 MW	375	11	Supply under progress
9	Link-4 Package-4	4x81.5 MW	176.7	11	Supply under progress



Fig. 7 Lowering of 200 t Stator Assembly of 116 MW Pump



Fig. 8 Lowering of Rotor Assembly of 125 MW Pump



Fig. 9 Pump House equipped with 4x134.4 MW Pumps

Kaleshwaram LIS is the glaring example as what could happen if the customer is not only satisfied but also delighted. BHEL has won the customer’s confidence which has resulted in bulk order for the supply of total pump house equipments to BHEL for Palamaru Ranga Reddi LIS. This project is designed to lift water in five stages from the Srisailam Reservoir near Yellur village in Nagarkurnool district to the proposed KP Laxmi devipally Reservoir (+670.00 M) near

Shadnagar. The project is envisaged to create irrigation potential in upland areas of Nagarkurnool, Mahabubnagar, Vikarabad, Narayanapet, Rangareddy and Nalgonda districts, for an ayacut of 10 lakh acres and drinking watersupply to villages, GHMC and industries. The details of orders for supply of pump-house equipments / machinery are given in Table 6.

Table 6: BHEL to supply for Palamaru Ranga Reddi LIS

Project Stage	Pump-motor capacity
Palamuru Stage-I	4x145 MW
Palamuru Stage-II	5x145 MW
Palamuru Stage-III	5x145 MW
Palamuru Stage-IV	3x145 MW
TOTAL	17x145 = 2465 MW

V. CONCLUSION

The project will enable farmers in Telangana to reap multiple crops with a year-round supply of water wherein earlier they were dependent on rains. Thus, they would get rid of frequent crop failures. Several districts would come out of the sufferings to water scarcity and also the ground water contaminated with fluoride. Apart from irrigation, a major component of the project is the supply of drinking water to several towns and villages and also to twin cities of Hyderabad and Secunderabad. The Kaleshwaram LIS is progressing fast and the farmers have already started cultivating multiple crops and situation on supply of water for drinking and industries is easing down.

It has been a great achievement for the nation that BHEL has successfully emerged and established as the designer, manufacturer and erector and commissioning of the pump houses equipped with largest capacity synchronous motor driven pumps in India. It has resulted with the award of huge order of 17 pump-motors and associated equipments.

Indigenous development of largest capacity synchronous motor driven pumps with in-house efforts is an exemplary step towards ATMANIRBHAR BHARAT which has already saved imports of equipments /machinery worth hundreds of crores of Rupees.

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