

TESLA TECHNOLOGIES

BRIDGE **T** **T** HE FUTURE

Innovative Cascading Hydro Power Plants on the Ural River in Kazakhstan



2019

Construction of the cascading HPP on the Ural River



- River Ural is 2,428 km long,
- Covering the basin area of 231,000 km²,
- It is generally not navigable because it has large fluctuations in water flow throughout the year,
- Building cascading hydroelectric power plants would be regulated and leveled for the vessels navigability, from the Caspian Lake to the place above the city of Orsk in Russia,
- The river would enrich with a constant amount of water in the riverbed, which is suitable for the development of ecology, and as well as for the regional tourism potential.



- Near the town of Orenburg, the Ural river is at 149m height, where the annual average flow rate is 104 m³/s, and where the periodic water leveling varies from 3 to 4m,
- Near the city of Oral the level of the river Ural is at 35m height, where the average annual flow rate is 390 m³/s, and where the periodic leveling of water varies from 9 to 10 m,
- Near the city of Atiraja, the Ural river level is at -20m, where the average annual flow rate is 410 m³/s, and where periodic water leveling varies up to a 3m difference.



- The Caspian lake is at - 28m below sea level, where flooding waters from the river Ural periodically reach 14,000 m³/s,
- In the described Ural region basin, the annual rainfall is 530 mm/m²,
- Water flows in the river delta achieves 65% with the melting snow in the spring, 30% during the summer and autumn from the rainfall, and 5% in the winter period when there is a minimum flow in the Ural river.



- The Ural River fall, from the town of Orenburg to the delta is approximately 177 m,
- In this section of the Ural River, 59 cascading hydroelectric power plants could be installed,
- The height of the cascade is 3 m, which enables the individual installation of 3 MW to 12 MW generators,
- Total, 59 cascades x 8 MW = 472 MW of cascading hydroelectric power plants.



The 600 kW CHPP with two installed generators of 300 kW and two separate hydro turbines



- A cascading HPP fits into the existing infrastructure, connects to the city electrical grid,
- Uses the existing traffic access roads,
- It has two modes of operation at different water levels of the Ural river,
- The first mode is with a cascading height of 4m, max. 23 m³/s of water flow throughout two turbines,
- The other mode is with a cascading height of 3m, max. 30m³/s of water flow throughout two turbines.

The CHPP operation mode depends on the period of the year



- The Chagan River flow has already been regulated with the dam/lock, which is the advantage for the first installation of a 600 kW cascading hydropower plant



- With the use of the already existing lock, water goes further in the Ural river direction in a safe a controlled way.



- The lock has a reinforced concrete structure of considerable dimensions, and it is a safe place for the CHPP installation,
- A water level difference of up to 4m is achieved at this location.



- A single discharge outlet will be used for the 600 kW CHPP installation, with an additional concrete wall.



- In the high water period, the CHPP will work with a 3m water column.
- Installation of cascading hydropower plants does not present any danger to humans or the natural environment
- the investor obtains documentation and connection to the local electrical network
- the construction period is 4 to 6 months from obtaining the necessary approvals for the execution of the works

- a cascading hydropower plant is a mounting/dismantling type
- a machine room with control systems is built, and protection against freezing and ice
- managing work processes are semi-automatic, with one necessary local worker for monitoring and supervising
- In the future, a possibility to install the software for automatic control of hydroelectric power processes
- The generator operation has software management, connected by the monitoring application to the computer or a mobile phone
- Education and supervision of workers to adjust the barrier level and water flow rate, monitoring the operations
- Electricity production is mostly in the daily mode of operation and consumption heights.

Cascading hydropower plants with an installed power of 1,600 kW

- The total installed power of three cascading hydropower plants is 1,600 kW (2 x 200 kW and 4 x 300 kW)
- Construction of three cascading hydroelectric plants is worth in the region of 2,000,000 euros
- Building permit and the connection of three cascade hydropower plants to the local network is an additional cost
- The project can be conducted as an upgrade or repair of existing hydro facilities.

Operation of three cascading hydroelectric power plants:

- They are synchronized with one another, and the water accumulates upstream above the first hydropower plant
- Two skilled workers are needed to supervise and manage the operation of three hydroelectric power plants
- One to two vehicles are needed, for the purpose of the employee's terrain work

Innovative cascading hydropower plants, future references for construction:

- The existing riverbed is used where there are no legal barriers to construction, 100% state ownership of the land
- Fabricated modules are being built, which are then placed in the riverbed, a standardized construction of cascading hydroelectric power plants
 - Can be placed on all sorts and types of river banks, and also on the swamp lands
- The by-product of CHPP construction is the amelioration of the coastal land along the river, for the new agricultural possibilities with planned irrigation
- A stable riverbed is obtained without the possibility of meandering of the riverbed, useful for the urban developments along the river
- An example of future larger cascading hydroelectric power plants building, a 10 MW rapid construction within six months
- By the CHPP setting, the river has a constant flow throughout the year, regardless of the amount of rainfall
 - Existing reservoir lakes can completely stop the water flow during the night so that the CHPP operates in day-time mode and power consumption heights,
- Such operation regime suits the existing hydroelectric power plants with dams and reservoir lakes, the production is usually daily or as needed
- By water overflow through the artificial waterfalls, the water can be transported daily to a distance of over 1,000 km, thus preventing the water concentration and flooding in the affected area,
- The river ecology is fully respected, and the automatic water management regulates the level in the centimeter, while the fish hatching places are always provided with freshwater with water leveling as ideally needed by nature