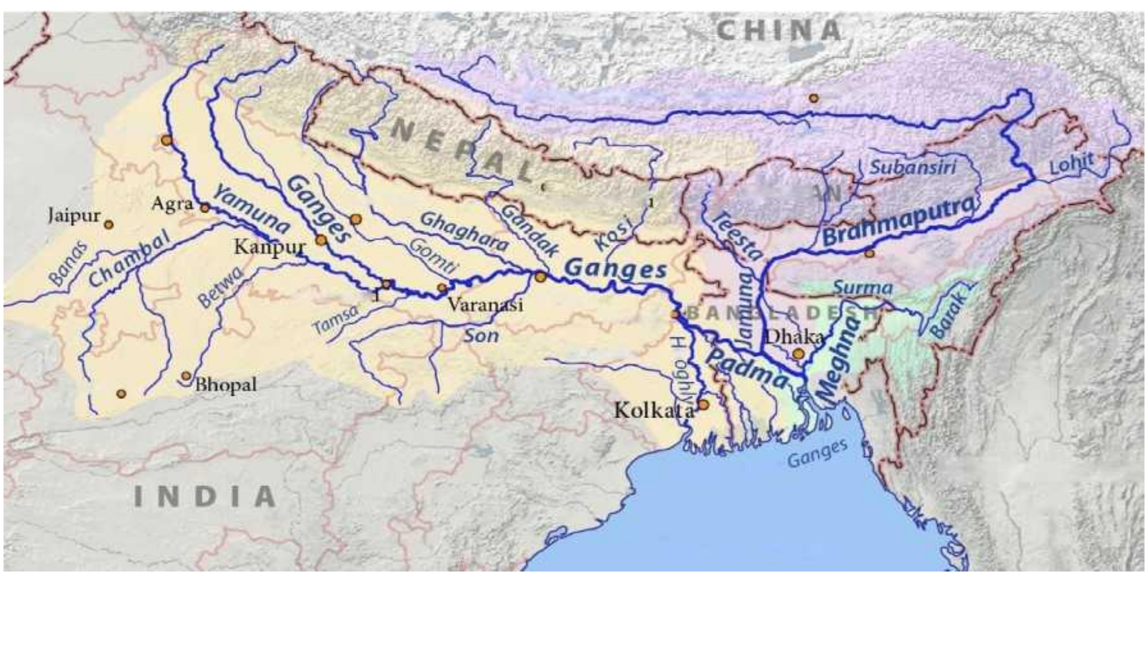
CASCADING HYDRO POWER PLANTS IN INDIA AND BANGLADESH



2021

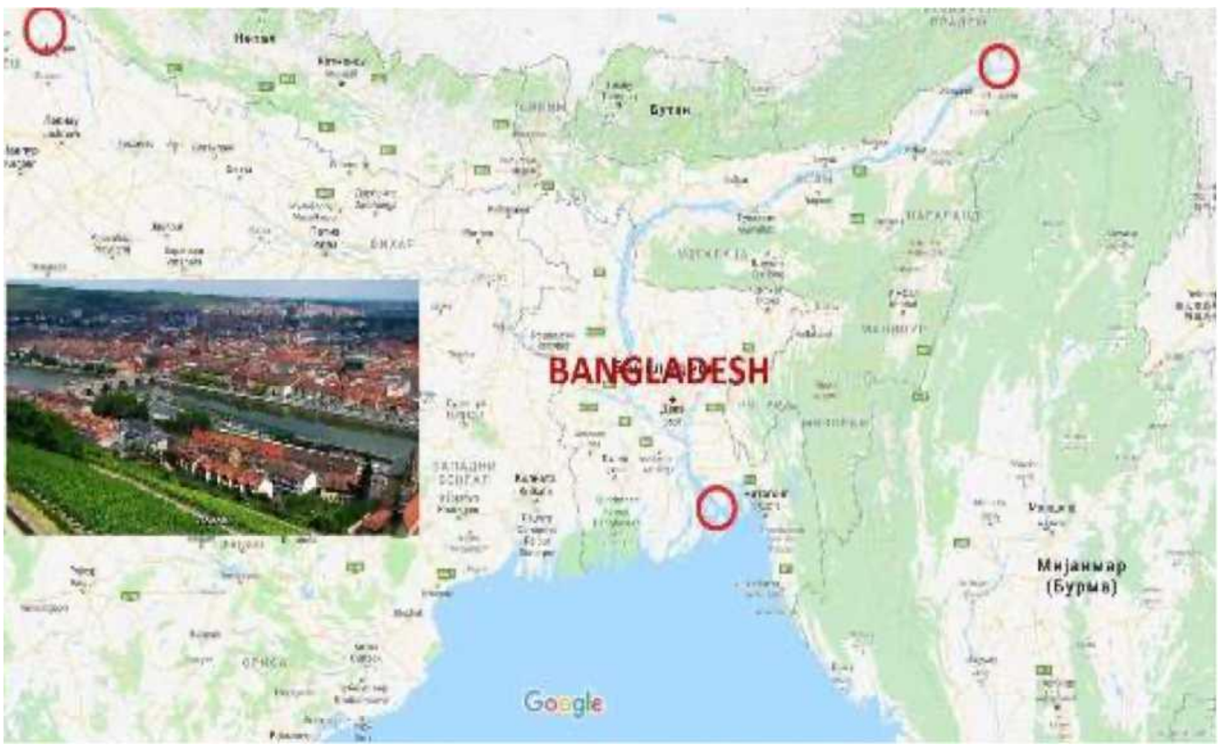
India together with Bangladesh has significant and unused potential of the lowland rivers for the power production

India and Bangladesh territory is located significantly above the sea level on which spreads a fertile land with many canals and large rivers and their deltas to the sea.

India with Bangladesh has a huge territory with enormous unused low-land river potential for possible integration of approximately 30 GW of TTT cascading hydro power plants

With limited space for a functional and decent development, it is necessary to have a comprehensive territory arrangement with the use of innovative technologies, which primarily relates to the construction of cascading hydroelectric power plants for a huge power generation, flawless river transportation and flood prevention.

The Padma river basin in the territory of Bangladesh is taken as an example of a possible arrangement with the innovative cascading HPP settings for electricity production and a number of additional benefits in the hospitality industry, sports and tourist facilities, sustainable waterways with year-long navigability, water supply, land melioration, flood management, advanced fishing and some other prosperities for the people and governments.



The positions of the last ports in the India and Bangladesh river basins are marked, a network of arranged rivers and channels will serve as a regulated waterway from the ocean ports to the foothills of the Himalayas.


With a central seaport that will serve a number of river ports 365 days a year, along the Brahmaputra and Ganges rivers with their smaller and larger tributaries, smaller and larger ports, and docklands in north and central India. Then the regulated and mapped waterway is automatically managed and controlled for the daily transportation needs of more than 500.000.000 people living around the Brahmaputra and Ganges basin regardless of the monsoon rains or the dry season. A new type of light and fast ships will be developed that will easily transport passengers and goods on the reclaimed waters that are constantly calm. Trade will take place much easier, agricultural products, life groceries and other supplies will be distributed and overall safet and stability will be much improved.

At the border of India and Bangladesh, the Brahmaputra river has an averageannual flow of 20,000 m3/s

At the border of India and Bangladesh, the Ganges river has an average annualflow of 12,000 m3/s

The Padma River has an average annual flow of 35,000 m3/s, in a dry season of15,000 m3/s

The rivers beneath the Himalayas flow through the larger living settlements, which can be urbanized for a versatile purpose

Construction does not impair fertile land around the river, the soil is being developed and improved for greenhouse production and standard agriculture

Electric power beneficiary will be the local population and economy, which now does not have a significant local support from any built power plant

Climate data for Dhubri (1971–2000)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	29.9 (85.8)	33.2 (91.8)	38.3 (100.9)	41.1 (106.0)	41.4 (106.5)	39.1 (102.4)	37.8 (100.0)	37.0 (98.6)	38.8 (101.8)	34.3 (93.7)	32.1 (89.8)	27.8 (82.0)	41.4 (106.5)
Average high °C (°F)	23.7 (74.7)	26.2 (79.2)	31.1 (88.0)	31.6 (88.9)	30.7 (87.3)	31.5 (88.7)	31.0 (87.8)	32.0 (89.6)	30.9 (87.6)	30.1 (86.2)	27.7 (81.9)	24.5 (76.1)	29.3 (84.7)
Average low °C (°F)	8.6 (47.5)	10.5 (50.9)	15.2 (59.4)	20.2 (68.4)	22.2 (72.0)	24.4 (75.9)	25.1 (77.2)	25.2 (77.4)	24.2 (75.6)	21.1 (70.0)	15.5 (59.9)	10.6 (51.1)	18.5 (65.3)
Record low °C (°F)	2.4 (36.3)	2.8 (37.0)	7.4 (45.3)	6.4 (43.5)	15.9 (60.6)	13.9 (57.0)	20.8 (69.4)	21.7 (71.1)	19.4 (66.9)	17.2 (63.0)	9.4 (48.9)	7.8 (46.0)	2.4 (36.3)
Average precipitation mm (inches)	6.9 (0.27)	18.1 (0.71)	42.6 (1.68)	177.7 (7.00)	410.9 (16.18)	607.4 (23.91)	652.8 (25.70)	467.0 (18.39)	443.0 (17.44)	167.8 (6.61)	14.3 (0.56)	8.0 (0.31)	3,016.6 (118.76)
Average rainy days	0.6	1.5	2.8	9.3	15.7	16.6	19.1	13.1	13.5	5.6	1.0	0.6	99.3

Source: India Meteorological Department (record high and low up to 2010)[26]

Annual rainfall in the territory of India and Bangladesh divides into a period of monsoon rains, which lasts around six months, and a season with less precipitation, all shown in a chart above

The project of constructing thousands of cascading hydroelectric power plants below the Himalayas is the future benefit for the watercourses regulation through India's and Bangladesh's territory and a stable and decentralized electric power production

At the merger of the river Brahmaputra with the Ganges river, a cascading hydroelectric power plant is installed that creates a 3m water slowdown

The coastline of the river is solved with the bank from a stainless steel net filled with locally sourced stones

The future cascading hydroelectric power plant can connect the already constructed road network on both sides of the river with a bridge over the power plant

Cascading hydroelectric power plant at this site has an installed capacity of 1,400 MW with a fast-lock for the vessels passage
Maximal power drives generators from the 70,000 m3/s water flow rate The excess water from the monsoon rains overflows the waterfall

In the period since the year 1966, only on the section of the Padma river basin, 70,000 hectares of fertile land were lost

Losses continue due to the river meandering and erosion during seasonal floods from monsoon rains

No future land erosions due to the river meandering with the construction of a segmented number of cascading hydroelectric power plants along the river

Then floods will become a thing of a past, fertile land will be preserved, soil reclamation will take place and agricultural production will be improved, while easier access to the river will be facilitated

On such formed cascades (one shown on the picture), our innovative technology for fish farms can be applied, a new technology for additional fish feeding and selective and calibrated fish catch will greatly benefit local economy

When the water level is raised by 3m, the river biodiversity will be regulated and improved

The ecology of the river will be fully respected, and with the automatic water level control the height will be precise in the centimeter, the fish meadows are always provided with a fresh flowing water with loads of oxygen which is all very important for an environmentally clean and transparent water management

The wetland area will be given to the nature until a height of up to 5m above the sea level, a position where the first cascading hydropower plant is built that creates a water slowdown of 3m, marked at 8m above the sea level

The water level of the Brahmaputra River at the border with India is at an altitude of 35m
The difference in the level drop of the Brahmaputra river in the territory of Bangladesh is 30m, which is enough potential for the construction of ten cascading hydropower plants that would permanently regulate the flood issues on that territory

Simple, easy and precise power plant and cleansing management

The management of all processes of the described operation of the cascading hydroelectric power plant is from the monitoring room, from where everything is managed including automatic cleansing of the surface waste from the river, which deposits on an anchored barge and is then easily taken away

Rivers can have watercourses designed for recreational and tourism purposes

Cascading hydroelectric power plants have the possibility of building additional recreational content on the river, like the small boats, jet skis etc., and additional arrangement for year-long river navigability and different tourist content! Artificial paths with fast water currents for rafting and kayaking can be made on each cascade, with water parks and entertainment facilities, with hospitality facilities with terraces coming out over the splashing overflow on the plant's waterfall! If necessary, artificial water flow can be used for water skiing, water slides etc. Periodic release of water for recreational purposes annually does not exceed 0.1% of the river flow potential, which is almost nothing for the future process of electricity generation through innovative cascading hydroelectric power plants The position of the cascading turbine itself is safe, the water flows at the bottom of the riverbed. A swimmer, if found at the site of the hydroelectric power plant, slides over the barrier, without any consequences. The turbines are fish friendly, and the water outlet below the turbine is secured with a structure that does not allow the formation of whirlpools

Benefits of using cascading hydropower plants

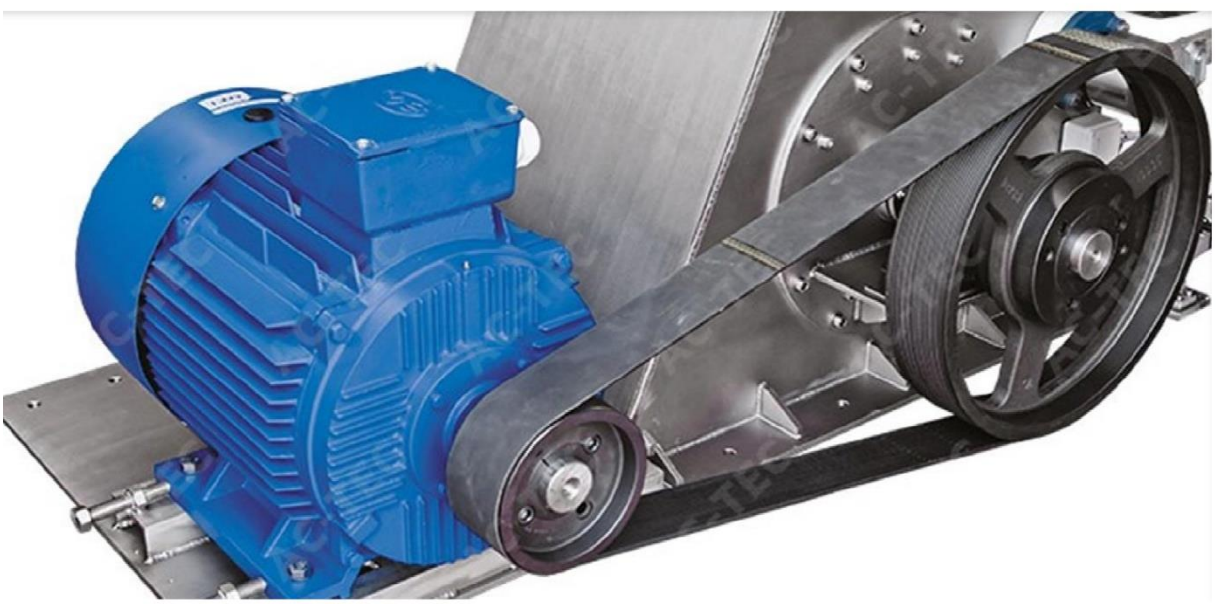
- The state is the owner of the riverbed, there is no additional land or real estate purchase! Building permits are obtained quickly because there are no legal obstacles to coownership of the property!
- No coastal land is disturbed, cascading hydropower plants are located in the riverbed! The built infrastructure on the river bank is not affected or disturbed!
- An already well-known water resource is being used, which is very suitable for the reason of the possible energy amount prediction that we have at our disposal, from the expected water flow across the river basin including many tributaries and rainfall!
- Many individual positions of the setting in the river bed, the construction is several times faster considering the construction of classical hydroelectric power plants!
- We utilize until now unused resource of the lowland rivers!
- A favorable maintenance type, the part is changed serially within 24 hours per location!
- By comparing the HPPs technology with the wind farms technology, the new hydroelectric power plant has the same or lower construction cost per MW, but it can achieve up to twice the amount of annual electricity production!
- Energy from the new hydroelectric power plants can be produced at a time when it is the most necessary for us, and not like wind and solar which depends on the circumstances!
- The river sediment is not stopped (very important for the flora and fauna and extensive biodiversity), as in the case of classic hydroelectric power plants! Investing in this concept of green energy is sustainable, and in the long run, it has the potential of the planned development of the river with surrounding areas and industrial zones!
- Financing is easier and stable, faster return on investment (ROI) quicker construction, while the finished section of the project can finance the next segment of building the hydroelectric power plants along the river.

Expensive construction of classical hydroelectric power plants

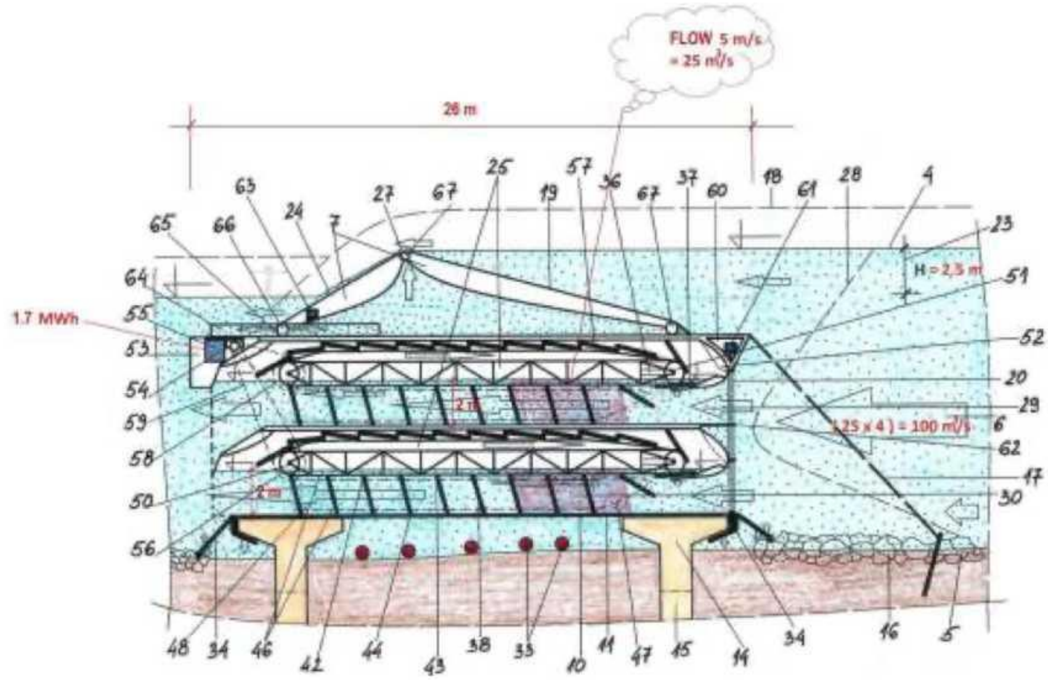
Large-scale preparatory works are needed, such as the partial restructuring of the river, land acquisition, relocation of built roads, melioration of coastal land etc.! For all of these, it takes a lot of time and investment, thus, it creates an enormous carbon footprint!

Then, on the formed construction site, extensive and expensive reinforced concrete construction works are performed!

Every classical hydroelectric power plant is different while cascading hydropower plants are standardized!



Part of the patent, the mode of operation of the cascading HPP



In this solution, the hydropower plant can operate as a local generator connected to a local power grid.

Production of electrical energy from cascading hydropower plant is realized in this way: Pylons (15) are fixed to the riverbed (5), on them are laid stripe foundations (14). Two cascading turbines are interconnected (10) and laid on stripe foundations. (14).

Achieved water height difference "H" (23) creates pressure to cascading power plant. Regulators (20), gradually leak water (6) towards pipes (29) of the turbine with rate of inflowing water (6)

Water (6) inpipes (29) accelerates, paddles (38) of the turbine utilize it to convert to mechanical energy. A pressure of trapped air (25) prevents water penetration (6).This way, flowing water (6) is directed through a turbine pipe (29) where it is utilized on turbine paddles (38). The turbine paddles (38) on return path are moving through the air almost without any undesirable resistance.

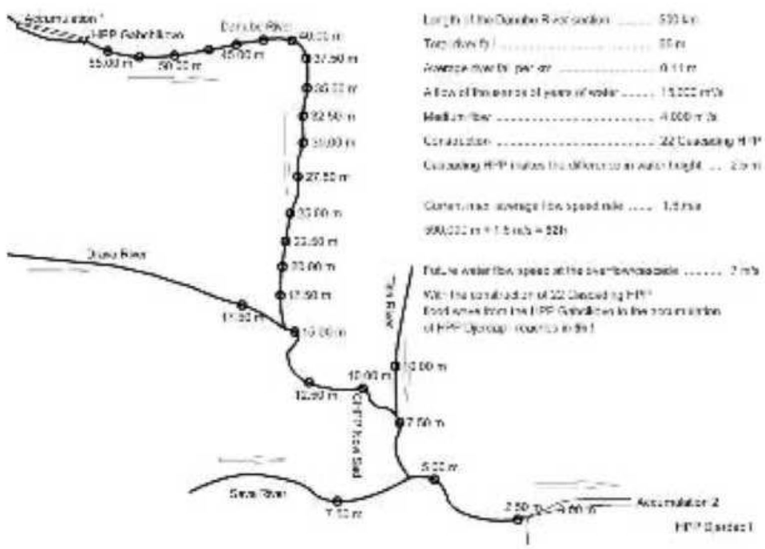
A direction of the movement of a turbine paddles (38) is achieved by "U" profiles (46) and guides (47).Such a relation is balanced and stabilized with overflowing (27) water over the barrier (19). In this way, we accomplish stable RPM on electric energy generator (55).

In total, pipes (29) have several times bigger volume than planned utilization of water flow (6) per second in the river. This enables that water flow potential (6) is maximally utilized almost to the turbine standstill by using software control. When a cascading plant is in operation, one can observe overflow of a small amount of water like a waterfall, while the majority of water is directed through the turbine. The cascades are regulated by the building of an embankment made of metal net filled with locally sourced stone. A reduction is not necessary; energy is transferred directly to a generator shaft.

Chart showing the water flow ratio and HPP's installed power

In proportion to the water flow in the observed river (m^3/s) !

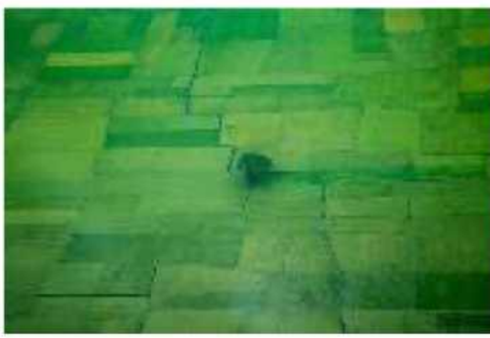
River water flow	Cascade height	1.5 m	2 m	2.5 m	3 m	3.5 m	4 m
5 (m^3/s)			70 kWh	87 kWh	105 kWh	122 kWh	140 kWh
10 (m^3/s)		105 kWh	140 kWh	175 kWh	210 kWh	245 kWh	280 kWh
20 (m^3/s)		210 kWh	280 kWh	350 kWh	420 kWh	490 kWh	560 kWh
30 (m^3/s)		315 kWh	420 kWh	525 kWh	630 kWh	735 kWh	840 kWh
40 (m^3/s)		420 kWh	560 kWh	700 kWh	840 kWh	980 kWh	1.420 kWh
50 (m^3/s)		525 kWh	700 kWh	875 kWh	1.050 kWh	1.225 kWh	1.400 kWh
60 (m^3/s)		630 kWh	840 kWh	1.050 kWh	1.260 kWh	1.470 kWh	1.680 kWh
70 (m^3/s)		735 kWh	980 kWh	1.225 kWh	1.470 kWh	1.715 kWh	1.960 kWh
80 (m^3/s)		840 kWh	1.120 kWh	1.400 kWh	1.680 kWh	1.960 kWh	2.240 kWh
90 (m^3/s)		945 kWh	1.260 kWh	1.575 kWh	1.890 kWh	2.205 kWh	2.520 kWh
100 (m^3/s)		1.050 kWh	1.400 kWh	1.750 kWh	2.100 kWh	2.450 kWh	2.800 kWh
150 (m^3/s)		1.575 kWh	2.100 kWh	2.625 kWh	3.150 kWh	3.675 kWh	4.200 kWh
200 (m^3/s)		2.100 kWh	2.800 kWh	3.500 kWh	4.200 kWh	4.900 kWh	5.600 kWh
250 (m^3/s)		2.625 kWh	3.500 kWh	4.375 kWh	5.250 kWh	6.125 kWh	7.000 kWh
300 (m^3/s)		3.150 kWh	4.200 kWh	5.250 kWh	6.300 kWh	7.350 kWh	8.400 kWh
400 (m^3/s)		4.20 MWh	5.60 MWh	7.00 MWh	8.40 MWh	9.80 MWh	11.20 MWh
500 (m^3/s)		5.25 MWh	7.00 MWh	8.75 MWh	10.50 MWh	12.25 MWh	14.00 MWh
600 (m^3/s)		6.30 MWh	8.40 MWh	10.50 MWh	12.60 MWh	14.70 MWh	16.80 MWh
700 (m^3/s)		7.35 MWh	9.80 MWh	12.25 MWh	14.70 MWh	17.15 MWh	19.60 MWh



Picture 6. A view from the top of the Danube River Basin, a possible location for the construction of 22 cascading HPPs in the existing river bed, all per the invention. By building 22 artificial waterfalls in the riverbed, the water would be quickly shifted down the river where the use of technology would prevent the formation of a flood wave. The cascading HPP Novi Sad is highlighted, whit the detailed description. Such arranged riverbed does not have quick water flow, the eroding of the shoreline and the riverbed meandering is protected. The HPP Grabickovo is now working with a 17.5 m water column, due to future regulation of river beds, the water level further decreases by 1.5 m below the dam. This way Grabickovo HPP would use the existing technology with a water drop of 19 m, where production would increase by 8% or an additional 200 GWh per year. The same is with the HPP Djerdap II, where the increase in electricity generation would be even more significant. The waterway is regulated, land melioration is done, the possibility of channel irrigation and drainage, water stops overnight without the necessary biological minimum flow.An example of heavy rains in Austria, the Danube River collects water in the reservoir of the Grabickovo HPP. The flood wave is now traveling towards the delta with the max. a speed of 1.5 m/s. On the river length of the 2,000 km, it is approximately 370 hours. By constructing the described 34 cascading hydropower plants, controlling the discharge into three existing reservoirs, the water would immediately be transferred from the cascade waterfalls to the other cascading waterfalls. The flood wave from Austria through the existing river bed in the length of 2,000 km travels to the Danube Black Sea delta in less than 24 hours.

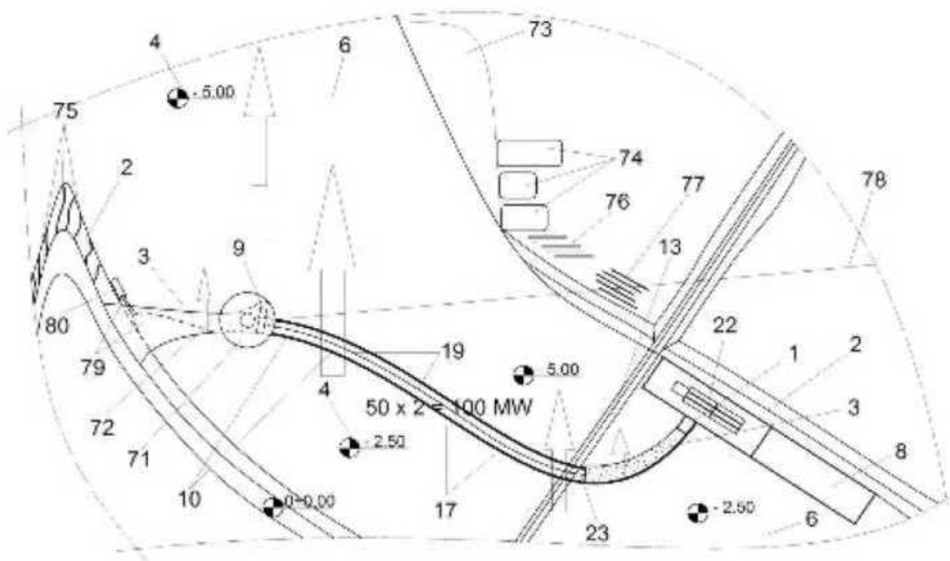
 

The annual rainfall is disproportionate in the territory of India and Bangladesh, the monsoons cause uncontrolled periodic flooding, which is affecting the local population and the economy!

All this is resolved with the construction of a series of cascading hydropower plants when the river is fully controlled, with water leveling for irrigation purposes without the need for the additional energy.

Then the water systematically goes out of the agricultural area, the melioration. The effort of people is not wasted, and then regular harvesting of agricultural crops takes place, among others, and from rice fields.



Picture 7. A top view of the possible setting of the cascading HPP "Novi Sad" on the Danube River in the urban settlement, with a demonstrated overall arrangement of the ambient on the lowland river and the banks of the river, all in accordance with the invention. The venture is the construction of the first classical hydroelectric power plant with an installed capacity of 37 MW, built on Niagara Falls under the design of Nikola Tesla. It had a river flow potential of 6,000 m3/s and a water drop of 52 m. While cascading HPP "Novi Sad" has a river flow rate of 3,500 m3/s and a drop of 0.11 m per kilometer of the river flow. In such a modest energy potential, with the installation of 200 reinforced concrete cascades, 50 generators have been installed. HPP "Novi Sad" has a total power of 100 MW, with an annual production of 335 GWh mainly electricity in the daily regime. With a daily flow concentration of 5,700 m3/s, it would generate 100 MWh periodically.The river is narrowed in the urban area at 350 m, where it extends to 650 m downstream. The architectural setting of the cascading hydroelectric power plant is such that it allows a 650 m overflow to control the flow of thousands of years of water. The conically positioned cascading hydroelectric plant with the help of water flow concentrates the surface waste at the point of the outlet 79. The funnel transports the periodically collected waste at the outlet 79 to the downstream barge 80 where the waste is collected through the flowing water and then transported to the recycling or incineration.

Center of the Novi Sad is 7 m below the level of the quay, which is a problem with abundant precipitation when the surface waters paralyze the city. It represents the problem also with the three sewage drains on the quay, which, due to the high water level of the Danube, return the water to the city. During the summer months, due to the fall of the river level, an unbearable smell is felt. This is all resolved by the cascading HPP "Novi Sad", where the water level of the river permanently levels and three collectors connects into one, which transports the wastewater downstream of the hydroelectric power plant. Then aesthetically shaped ambient is created along the river with the permanent water leveling, the parks with separate resting benches can be built, under which the enjoyable burble sound of purified water is heard. Dozens of streams 75 with shaped rock paths and bridges can be built. There is free access for the pedestrians on the embankment over the quay, over which the platform with the terrace 72 is built. The observation point 71 can be on several levels, independent with a pillar in the river and a high platform above the river level. The observation point 71 that is rotating, where is the ideal place for cafes and restaurants. In this case, the cable car 78 connects the observation point 71 with a fort on the other side of the river.

On the coastline below the cascading HPP with a 2.5 m difference in the water level, sports, and recreational activities can be organized. Kayaking and skiing paths 76, a series of water slides 77 with a large amount of running water. Pools 74 are filling with naturally filtered water, which is passing under pressure and is cleansed through the barrier. Downstream is a clean beach 73, with no unpredictable water flows or vortex. Vessel lock 8 is in this case along the coast, upstream of the existing bridge, with two levels of overflow. Over the vessel lock 8, the elegant pedestrian path construction can span, which further continues along the pedestrian path above the waterfall on the barrier, and further to the terrace and another riverbank.

Project parameters for construction of a 1.400 MW cascading hydropower plant

- The location, Padma River at the mouth of the Brahmaputra River and the Ganges River • The future installed useful water flow of the cascading hydropower plant is 70,000 m^3/s
- The average installed power of cascading hydropower plants per 1m of the river fall is 467 MW
- The installed cascading HPP capacity is 1,400 MW
- The expected annual production of 1,400 MW HPP is 3,800 to 4,400 GWh of electricity
- Cascading hydroelectric power plants have a mutual difference of the useful height of the 3m water drop
- The cascading hydropower plant will contain 560 turbines
- The cascade hydropower plant will contain 280 generators, installed below the water surface
- The output water speed at the turbine bottom is automatically controlled at 7m/s
- The cascading hydroelectric power plant has two machine rooms, located on the bank of the river
- The cascading hydroelectric power plant has several small vessel locks and two large vessel locks
- The height of the waterfall, the cascading overflow is up to 3m, where the water flow speed is approximately 8 m/s. The cascading hydropower plants can stop the water flow of the river during the night, then the flow in the is 0 m^3/s
- Mostly, only the daily water flow is used for electricity generation or depending on the demand^ The generators are asynchronous with a linear 400 V voltage
- The torque of the generator is 750 rpm
- A direct transmission of mechanical energy to the generator, without a reducer
- The ratio of the mechanical energy transfer from the turbine to the generator is via the shaft, the transmission ratio is 1: 3
- The parameters are controlled and adjusted using the automation with a number of technical solutions
- The height of the turbine setting is with a water column slowdown of minus 2m to plus 3m, the adjustment oscillation is 5m
- Electricity production is delivered directly to the local electrical network and consumers The cascading turbine is made of stainless steel, which is predominantly processed by pressing, puncturing and welding (it does not require additional painting), the material is solid and stable in order for the turbines to be used for a long number of years

The arrangement of the northwestern part of India is the beginning of a possible megaproject in the Indian subcontinent

Himachal Pradesh area, as well as adjacent areas, have considerable untapped water potential, characterized by the large drops of the rivers

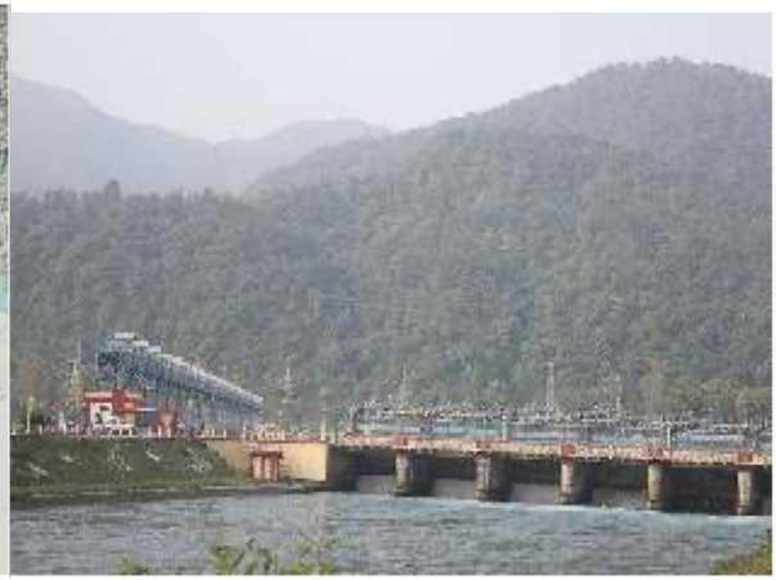
Potential useful for the described electricity production, land reclamation, easy waterway navigability, etc...

The flow of the river should be concentrated together with smaller rivers, arranged for the installation of large cascading hydropower plants

Also we can take advantage of the many smaller rivers, for the simple setting up of a local hydroelectric power plant with an installed capacity of 100 Kw

The river level rises by several meters, then the river bed is constantly nder the water Suitable for gravel and sand extraction, easy waterway maintenance, advanced fisheries, tourismdevelopment, etc.

There are more reservoir lakes with conventional hydroelectric power plants in the North- East of India, with the construction of future reservoirs, it will give even bigger benefit for systematic use of the cascading hydroelectric power plants Already existing, Bhakra Dam with 12.2 billion m3 water storage, Koldam Dam with 12 million m3 of water, Tehri Dam with 3.2 billion m3 of water, Koteshwar Dam with 35 million m3 of water Dakpathar Barrage (pictured below), is a lock that controls the downstream flow of the Yamuna River for irrigation purposes and the future generation of electricity from the CHPP until the river Ganges



From the mentioned lock until the New Delhi, the river drop of the Yamuna River can be utilized with an altitude difference of 250 meters, that is sufficient fall of the river bed to build 100 CHPP with an average cascade height of 2.5 m 50% of the Yamuna River is already used in the irrigation process, while the other 50% would be used for the construction of the CHPP

The project provides urban development for the Indian subcontinent, human satisfaction in harmony with the natural environment

Rivers in the Indian subcontinent will often be bridged with easy pedestrian bridges, new traffic routes, river, road, and rail traffic will all be established across the newly built CHPP Nature will be enhanced with rivers full of water, where nature will have the potential to develop

Only 2 m/s of continuous flow is required in smaller rivers to install 100 kW CHPP

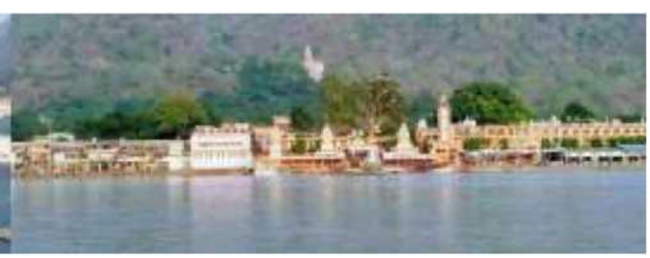
Then at night, we stop the water flow in the river for 12 hours Electricity is produced during the day, when it is a highest need, for 12 hours period with a water flow of 4 m^3/s

The river is periodically automatically cleaned at the intended technical position with the water flow. The local population will have a benefits of a safe pools for recreation and relaxation in the water and around the water

There are numerous unused rivers in this part of India, as well as in much of the Indian subcontinent



Rivers are now widely used for irrigation of fertile lowlands, the construction of cascading hydroelectric power plants will, among other things, contribute to land reclamation and preventing meandering of rivers due to heavy rainfall

CHPPs regulate river banks in accordance with existing urban solutions of settlements and cities


Temples next to the rivers will be protected from torrential flows and floods

On the river, traffic and transportation of passengers and cargo will take place and a nice water recreation will be possible


The cities will receive new developments, and there will be more electricity for any needs produced and supplied from a local manufacturer


The settlements will have flood protection and full regulation of the river flow with the applied cascading technology

All rivers with a water flow of more than 2 m^3/s are suitable for the construction of CHPP regardless of the type of riverbank

The Madhya Pradesh region is rich in water (waterfall pictured), used mainly for irrigation

With the construction of the CHPP, an additional advanced irrigation system is going to be available; then the existing river bed is a storage of water used in the irrigation process

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Nature is endangered, mammals are retreating!

Let's make a huge leap forward in the technology of today's, building the future together in harmony with nature!

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