A NEW SYSTEM TO HARNESS ENERGY FROM OCEAN

Invented by
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PRESENTING WORLD'S FIRST EVER 100 MW WAVE ENERGY HARNESSING SYSTEM PRODUCING OVER 80% OF INSTALLAED CAPACITY

Presenting to the WORLD the most Eco-friendly, Modular, non polluting Wave Energy Harnessing system capable of generating 100 MW or more of Grid interactive Electricity continuously at over 80% of installed capacity, and costing almost as conventional Coal based Thermal power plant.

I, a scientist inventor and a Environmentalist, with about 30 years of experience in advocating Alternate Energy and author of highly popular web site on Solar cookers (adopted by SCI and UNESCO http://www.solcooker.net, http://www.eolss.net/E6-106-toc.aspx, https://solarcooking.wikia.com/wiki/Compendium_of_solar_cooker_designs, which has won me an acclaim as International Solar Cooker Expert, now take pleasure in presenting first ever 100 MW Wave Energy Harnessing system to the World.

But what made me detour from Solar Cookers to Wave ? To make the long story short, having studied and experienced impacts of Coal Based Thermal power plants, burning of fossil fuels and consequent Green House effects on the Planet, I had been exploring Alternate Energy Sources, and zeroed on Wave Energy. I have tried to share some information on my search through an E-magazine - (http://www.d-sector.com/article-det.asp?id=868)

Why Wave Energy? Because, it has a regular and predictable periodicity besides being the most concentrated form of free energy available on this planet, (Power of Sun, Moon, wind and Earth's rotation), while Solar energy is available only during day time and Wind energy is intermittent.

Attempts have been made for the past several centuries to harness Ocean Wave Energy. Some of the following drawbacks rendered the earlier systems not very successful :-

1. They were rather costly in comparison with existing conventional energy systems like Coal, Nuclear or Hydro Electric.
2. The energy produced by Wave power units had variable outputs resulting in a need for costly systems to synergize and upgrade the produced energy to link it with the grid.
3. There was no provision to store the wave energy or propose such a thing to ensure uniform output during lean wave periods.
4. Inventors who thought of storing energy by storing water, could not push it to the right level to gain any advantage.
5. Most of these systems were not suitable for Tropical seas, where the wave pattern is not only low but highly intermittent.
6. Some of the low cost harnessing systems, like TAPCHAN, required huge areas to 'store' sea water and one off system that had functioned successfully for a long time, got virtually washed away in a gale.
7. No one felt the urgency to switchover to wave power because it was assumed that fossil fuels were unlimited and cheep.

8. Some of the systems like OWC, popular with Indian researchers, would occupy lot of coastal area interfering with activities of other stakeholders. Besides its output was rather low, especially in tropical seas.

9. Largest system now installed is designed to produce ONLY 2 to 2.5 MW of power per unit, Bhagiratha proposes to produce 100 MW, a modular design meaning can produce 1 to over 1000000 MW depending on space available at the site.

10. Many of these systems, like Pelamis, use Generators in the systems and hence long under water cables to transmit energy, which are subject to corrosion and shorter life of the system.

In the recent past however, there is resurgence in harnessing alternate Energy, wave in particular, on account of various concerns, major one being the realization that fossil fuels have peaked and also that coal burning is contributing actively to Global Warming, resulting in series of setbacks, including health hazards causing loss of billions of Dollars worth of Man hours.

Some of the countries like Portugal which have very limited access to fossil fuels, have treaded ahead experimenting extensively, though costly, with available wave energy systems, although such systems are inundated with some of the drawbacks listed above.

1. The largest installation at present is, the PELAMIS off the coast of Portugal. They have installed two such units which in total produce about 2.5 MW at a cost of 4.5 Million Euros. PELAMIS (Figure 1 – i) is an ingenious device consisting of a series of interlinked large cylinders resulting in a sausage like assembly. On open sea, the cylinders oscillate with waves, this causes hydraulic fluid in closed system inside the system circulates with pressure, turning a Generator in the process.

Other promising designs are :

2. ANACONDA – is a long fluid filled tube of a durable polymer in which fluid moves like blob from one end to other as the tube zig-zags on waves. The blob of fluid moves along the length of the tube and turns a generator at one of the ends. The device is supposed to be low cost as the entire tube is made up of a durable polymer. Largest unit being designed now envisages to generate about 2 MW (Figure 1 – ii)

3. SEARASER (UK) and SEADOG (USA) – Which consists of basically buoy type devices, which bob up & down on the waves, these moving buoys then operate a pump to push water into a reservoir on the shore, from where the water is drained to or forced through an Alternator to generate electricity. At present the reservoirs in these cases are at a low level, not high as proposed in Bhaghiratha, thus my design has better advantage. (Figure 1 – iii & iv)

4. CETO – model is comparable to two designs mentioned above, but the buoys are under water. (Figure 1 – v). Recently, however, they have launched surface buoy type device as well.

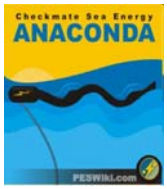
5. OYSTER – is another upcoming design where huge flaps made up of vertically assembled hollow cylinders are anchored to sea floor near coast. The assembly move

forwards and backwards due wave action to pump water with a force into a generator on the coast. (Figure 1 – vi)

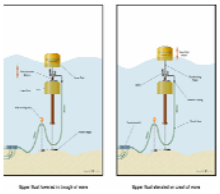
6. Archimedes Wave Swing (AWS) system is a submerged system comprising of 2 large cylinders. The central one is fixed and houses part of power generating part, while the air filled larger cylinder moves up-n-down, the units weigh about 700 tons. (Fifure 1-vii

7. WAVE ROLLER – has the moving flaps on the floor of the sea, near coast of course, which move as the water flows back and forth along sea floor, the movements pumps pressurized water into small under water generators adjacent to the assembly. (Figure 1 –viii)

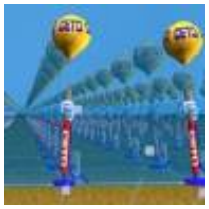

i – Pelamis

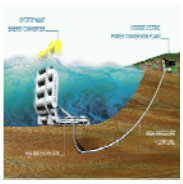


ii - Anaconda


iii- Searaser


iv- Sea Dog


v–CETO design


vi- Oyster


vii – Archemides

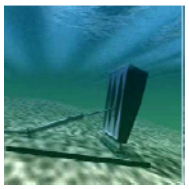

Viii – Wave Roller

Figure 1

There are many more designs, like OWC (also called LIMPET), Tidal, others using underwater currents, or those using temperature difference like OTEC, some of which are at advanced of development. But none of these designs are commercially viable so far, due of course, on account of one or more reasons listed above.

Not even a single design proposed so far aims at producing more than 5 MW per unit uniformly. Study of these and other designs and the problems associated with them prompted me to think about a new designs to overcome, if possible, all the drawbacks listed above.

The endeavor to invent a good system has resulted in a very promising design dubbed as ‘Bhagiratha’ named after the great legendry Sage who had strived to get the sacred Ganga flow down from its abode in heaven. In the present design, however, water flows in reverse direction and produces energy in the process.

Salient features of Bhagiratha are:

1. It is specially designed for tropical seas where the wave height and periodicity are low. So the design incorporates adequate storage to generate electricity uniformly and continuously.
2. Sea receded over 200 to 300 meters during low tide in some parts of west coast - this design has taken cognizance of it.
3. Design enables augmentation of intermittent wave energy which is rather low in Tropical seas, and store it at a suitable height to gain maximum advantage.
4. The electricity generated can be easily connected to the grid, as it is produced by a conventional hydroelectric generator.
5. It would be possible to generate large quantity of power, like say 100 MW or more at a single site, without the adding series of boosters, converters or storage devices.
6. It is one of the most Eco-friendly designs ever proposed so far to generate electric energy for it makes least demand on Environment, space on land to store water just for 3 to 6 hrs, and the water used is circulated, it does not emit any pollutants, or dangerous residues.

Bhagiratha was basically designed for regions where there is a small hillock adjacent to coast.(Figure 2, A & B) Experience gained so far indicates that it is possible to adopt this design for other non-hillocky areas as well. The system can generate any quantity of power 10 kWs to 1000000 MWs or more of power depending on space available.

This unique system Bhagiratha system, has two reservoirs, one at the base of the hillock and another at the top at, say at 100 mts. height(Figure 2 - C). Water, (fresh water is recommended to prevent any damage to habitat in the event of accidental breach in reservoirs if they were to store sea water). Water is 'pumped' from lower reservoir to upper reservoir using ONLY the power of waves, with the help of newly invented **Plurality of Composite Hydraulic Pumps** (Figure 2 - D).

The very first design of pump was to operate by sheer weight of water. A prototype of this design was made,(with the help of a small grant from DSIR, under TEPP) but as it did not work as envisaged, a new pump design based on Hydraulic principles was evolved, for which Patent is pending. This new design has better mechanical advantages, and reliability as it is based on proven Hydraulic Technology. As the buoys which operate the pump are under waster, they do not clutter the coast or interfere with stakeholders like Fishermen or Sports lovers.


A : Aerial view area


B : A Cliffy coast

C : Schematic View

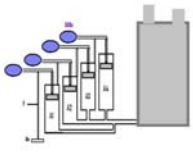

D : Composite Pump

Figure 2 (D : Patent on Application No. CHE/1779/2010)

Following Table compares Bhagiratha with other designs.

Features	**Other Designs**	**ADVANTAGE of Bhagiratha**	
Off shore/ Onshore	Off shore	Partially offshore	Easy maintenance
Harnessing power of low waves	Not much	MAXIMUM	Big plus point
Suitable for tropical Seas	NO	YES	Mega plus point
Multiplier effect	Almost nil	MAXIMUM	Another Plus point
Direct Grid connectivity	Not possible	POSSIBLE	Major advantage
Power output	Variable	STEADY	Very good feature
Inverters and other devices	Required	NOT REQUIRED	Lower cost
Anchoring	Very Heavy	Not Heavy	Lower cost
Cost of anchoring	High	Lower	Lower cost
Ease of installation and maintenance	High & Costly	Low & Easy	Low cost
Technology	Everything is new	**Proved technology**	Very reliable
Cable net work under Sea	Required	NOT REQUIRED	Lower cost
Ease of manufacture	Complicated	Fairly Complicated	Higher output
Vulnerability to Gale/Hurricanes	YES	Not so vulnerable	Because underwater
Durability	Not so durable, subject to corrosion	Very durable, materials Corrosion resistant	Units mostly out of water, so longer life
Under water Cables etc	Yes	No	Very safe, less problems
Vulnerable to Tsunami	YES	Partially protected	But no
COST	High	Fairly LOW	**Economically Viable**

Bhagiratha has the Ability to produce power on a uniform and CONTINUOUS basis day and night,, even during low tide, Grid parity, a feature which is not possible with any other models invented so far. Besides, for the **first time in the history of Wave Power** Harnessing, Bhagiratha presents a system capable of **generating 100 MW or more of Grid interactive power** at one installation at over 80% of installed capacity. The design is modular and depending on the availability of space, even a 1000 MW or more power can be generated at one installation. That is, if there are many or large hillocks adjacent to coast, big enough to accommodate reservoir to hold adequate amount of water.

The newly invented Plurality of Composite Hydraulic Pump, composed of three tires (Fig.2-D) has several advantages. It takes the advantage of proven Hydraulic Technology. Part one, first tire, of the system, is placed under water and thus will not interfere with any stakeholders, be it fishermen with boats or water sports enthusiasts. This part harnesses wave energy and energizes the 2nd tire of he system. The 2nd and 3rd tires are coupled, and they are placed on the shore, but under a large roof, capable of accommodating and rendering protection and comfort to stakeholders as well. As the entire pumping system will be under water near shore, it will not interfere with navigation of small boats, while the large boats will not come so close to the shore. Besides, being under water means maximum protection for the pumping system during High Seas and Gales. Mathematical analysis of new design has been undertaken which is indicative of its success. A small scale prototype has also been tested at Honey Beach, Ankola. However it would be essential to build a full scale model to stabilize the dimensions of the system.

The Optimum ratio between small to large Cylinder(Actuator) has been reset after the trials with the small scale model. A wave can operate series of smaller pumps and energize the Actuator which in turn, pushes water to the upper reservoir. Thus enough and more amount of water can be stored, with minimum number of these Composite Hydraulic pumps, to run the Generator during high as well as low tide.

The system is primarily designed for Coasts (like in North Kanara) with adjacent Hillocks. These hillock range from to 60 to 100 m in height, and at present are uninhabited, and devoid of vegetation as well, on account of exposed hard Latterite stones. After gaining some more experience, the system can be adapted to coastal areas without any such hillocks, through construction of suitable tall buildings for housing reservoirs.

The project has been approved and supported by experts of Dept. of Science and Industrial Research (DSIR) of India. The whole exercise, up to completion of simulation activities, and beyond till fabrication of prototype, would also be supported by Govt. of India, but it will still be my project, meaning - I will have the full rights over it. Govt. would also support prototype construction activity. But present proposal envisages to beat the inherent delays in Govt. funding to launch the system at a faster pace.

Economic Feasibility :

It is well known fact that the return on capital investment on Coal based power plant takes more than 25 to 30 years. While the returns on Bhagirata, would take much less time although the initial investment would be a bit higher. This is because no fuel is burnt as in a coal plant and no pollutants to control.

Cost of a 100 MW Bhagiratha.

	Description	Rs/Crores
1	100 MW Hydroelectric Generator (Ref KPCL, Karnataka quote)	150
2	Reservoirs, (Big enough to store water for 3 hrs) including excavation into hard lattrite stone top, Total space required 250 m^3/s x 3600 sec = 900,000 m^3 /hr x 3hrs = 27,00,000 m3 Cost of Excavation and Water proofing at Rs 525/m3 So 27,00,000 x 525 = Rs. 141,75,00,000, Taken as Rs 150 crores So for 2 tanks x 150 = Rs.300 crores	300
3	Composite pumps at Rs 50,000 each unit x 6000 units	30
4	Anchoring Maze underwater	20
5	Pipes, Pressure Hose, Building for Generator etc.	75
6	Work and other	75
	Total	**650**

Thus the profit ratio would be much higher and return on capital investment will be much sooner as well.

The unit will not occupy large land area. Therefore, the cost of land and R&R costs will be very low. No pollution mitigation cost or compensation related to the same. There's absolutely no question of Wave Energy running out, like for example with coal or other fossil fuels, until and unless the Sun and Moon stop shining.

Materials for pump will be selected on the basis of experience gained from Shipping and other Marine Industries, and thus its life is expected to be more than 20 to 25 years, with minimum maintenance and man power. The unit will not add any GHG or any other

pollutants like SOx, NOx to the atmosphere. No Fly ash or other such nagging pollutants to bother about, no heavy metal residues like Mercury or lead, hence no mitigation cost. Further there will not be any demand for daily intake of fresh water – **ONLY PURE ENERGY till Sun n Moon shine.**

Business plan :

Attempts are on to linkup with a Big player of India with international presence, without sacrificing our independence, interests and rights, but to ensure smooth sailing.

International standards demand that a 2 MW commercial prototype (cost about Rs 4 million - US$ 65,000/) plant should work successfully at least for two years, and its working scrutinized and validated by a certified agency. As our system is based on proven Technology, we are confident of passing this test with flying colors. After this we expect at least order for 3000 MWs within one year. This is because, as of now, our system is the only one which can claim production grind interactive power of over 80% of installed capacity.

Cost of which would be Rs. 2,400 to 2,700 Crores. (about $ 530 million), which should not be difficult sum to raise by virtue of our linking up with a reputed company, from standard sources including Banks and Public.

Bhagiraha will operate till **Sun and Moon** last and supply pollution free energy for the ever power hungry world on a **continuous basis Day & Night, thus making it most useful and most viable Alternate Energy Device, ever invented, as it will have a PLF of over 80%, almost three times than that of any other Alternate Energy harnessing systems.**

Our logical step would be to launch a full fledged Industry through participation of tie up partner so as to be able to manufacture all the proprietary components and along with construction of 100 MW or bigger units on a BOOM (Build-Own -Operate-Maintain) basis and step into a highly profitable realm.

We promise excellent returns on funds invested with us (up to 18 to 20% per year) offer excellent exit options as well, which could be return on investment at best market value or any other plan the Investor proposes. Big investors would also get position on the Management.

(Detailed Business Plan is ready and can be presented at the time of further discussions)

THE TEAM

Small team now formed comprises of the following :

1. Dr. Ashok Kundapur, M.Sc., Ph.D., Inventor & Promoter.
2. Mrs Prameela Kundapur, Partner, (Designs)

3. Mr. M J Thomas, BE., Partner & Technical Advisor Eelectronics,(Formerly with Kasturbaia Medical College, (KMC), Manipal, served in Medical Instrument Maintenance of KMC, well versed with control systems and components)
4. Mr. Prabhakar D H., BE., First Financial Partner, (Engineer in an Oil Company, Highly experienced in various aspects Marine structural).
5. Prof. H K V Rao, Retd. Prof of Mechanical Engineering, Manipal Institute of Technology, (MIT) Manipal, Advisor on Engineering aspects.

Others experts being consulted on technical and other issues are :

1. Sri Balasburamanyam B.E., Guidance on Hydraulic pump design and fabrication, (Consulting Hydraulic Engineer, Sai Creations, Bangalore),
2. Dr S Shenoy, M.Tech., Ph.D., Consultations on Mechanical aspects (Working as Prof. of Mechanical Engineering, in one of the Colleges),
3. Dr B V Bhat, M.Sc., Ph.D., Consultation on Physical aspects, Energy Transactions and Complex calculations. (Retd. Professor of Physics, but now working a Prof and Head of Department of Physics, at J C Engineering College, Mangalore
4. Sri Bharatish Ballal, Chartered Accountant (CEO, Ballal Associates, is the Auditor of several big Firms of the region, he is also assisting us in financial matters)
5. Mr Nawaz Ahmed, Business consultant, Expert on Excel sheets, Based at Bangalore.
6. Mr Sudhakar Naik, M.E., General Consultations on designs and strategies. Based at Mumbai.

Dr Ashok Kundapur

Digitally signed by Dr Ashok Kundapur
DN: cn=Dr Ashok Kundapur, c=IN, o=Kapali Shakti, ou=Founder Inventor, email=arkundapur@yahoo.com
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