Access to Energy

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EDITORIAL

Dr. Akanksha Chaurey
CEO, ITP India

The era of non-conventional old renewable energy

Let me first explain the term – *non-conventional old renewable energy*. Utility scale solar and wind energy available at INR 2.44 per unit constitute conventional renewable energy. Hybrids, energy storage, smart grids, smart mobility solutions, floating PV, and off-shore wind are generally termed as new renewable energy. The forgotten ones and pushed to the fringes by the first two categories, are the non-conventional old renewables. Improved cookstoves, biogas, solar hot water systems, solar lanterns, watermills, micro-hydro, solar dryers and many more fall in this third category. Ironically, the energy access challenge can only be addressed by this third category of renewables if we define energy access as not merely the availability of energy systems but their actual usage for various services and applications.

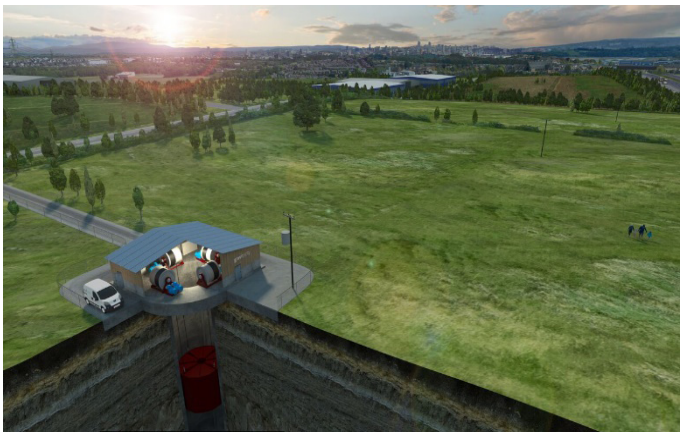
While the government of India schemes such as *Saubhagya* (electricity connection to all households) and *Ujjawala* (LPG connections to all below poverty line families) provide the physical energy access, there is no provision in either the design, delivery, monitoring or reporting of the schemes that ensures that accessible energy is actually being used by the target population. On the other hand, the delivery models typically adopted by social enterprises, NGOs, micro-financiers and local entrepreneurs for non-conventional old renewable energy inherently address usage related challenges. These models are inclusive and stakeholder driven, decentralized and flexible in their design. Further, they integrate elements related to awareness, financing, income opportunities, community development, training for local assembly and O&M etc. to ensure that energy thus provided is used for services that benefit the communities and not merely add to the numbers. However, if one integrates the statistics on installed capacities and delivered energy from these non-conventional old renewables, the numbers would probably surpass the other two categories.

If our understanding on energy access goes beyond reporting the number of household connections with electricity and for LPG, then our actions and efforts would be targeted towards ensuring energy usage. The non-conventional old renewables would no longer be sitting on the fringes then.

Disused Mineshafts Could Get New Lease of Life as Green Energy Power Stores

Mineshafts have always been under scrutiny of the human right activists, environmentalists and once abandoned its hardly of any use. It can even be hazardous if left open without reclamation. Some abandoned mines have been converted into tourism attractions. They include the National Mining Museum Scotland at Newtongrange and the Llechwedd Slate Caverns in north Wales, UK. Other deep holes and tunnel have been turned into attractions for thrill-seeker, offering activities such as caving, abseiling and underground tours.

Former mining communities could find a new lease of life – with old mine shafts turned into hi-tech green energy stores. Gravitricty, an Edinburgh based company aiming to utilise the gravity, abandoned mineshafts and relatively simple engineering mechanisms for power storage, has secured a government grant to develop the technology for the suspension of massive weights in pit workings to generate power for the grid exactly when required.



Conceptual Design of the Gravitricity Technology

The company believes that massive suspensions shall be able to balance the intermittent nature of Renewable energy generation methods. Many companies and institutions are pouring time, money and space into projects to develop large battery systems that would be able to store green energy and release it at times when there is greater demand on the grid. However, Gravitricity has different plans. The company said that the £650,000 grant from Innovate UK, the UK Government's innovation agency, to start building a demonstration of the technology this year.

It is proposing to hang a weight of up to 2,000 tonnes down a mineshaft, held by cables attached to winches on the surface. When the grid or local wind turbines are producing surplus energy, the weight would be lifted up to a height, through the shaft, thus storing energy as gravitational potential energy; when demand outstrips supply, it would be lowered, and the resultant movement of the winches would generate electricity.

Charlie Blair of Gravitricity: "What goes up, must come down."

Charlie Blair, managing director of Gravitricity, said: "when there is excess electricity, for example on a windy day, the weight is winched to the top of the shaft ready to generate power. This weight can then be released when needed, in less than a second, and the winches become generators, producing either a large burst of electricity quickly, or releasing it more slowly depending on what is needed." "As we rely more and more on renewable energy, there is an increasing need to find ways to store that energy – so we can produce quick bursts of power exactly when it is needed"

Mr Blair pointed out that the idea of using gravity to store energy is not new. World has known pumped storage hydro schemes since a long time. However, the Gravitricity concept do not need as much infrastructure as the storage hydro scheme and would be quicker to produce electricity. "The difference is we don't need a mountain with a loch or lake at the top, and we can react much faster," he said.The start-up reckons each 'Gravitricity Energy Storage System' to operate for decades without any degradation in performance and

estimates each to last up to 50 years. Later this year they aim to build and test a part-scale demonstrator. They are now on the look-out for investors, including those who can bring mining experience to the team, and suitable mine shafts for their first full-scale working prototype in 2019-20.

The biggest single cost is the hole, and that is why the start-up is developing their technology utilising existing mine shafts. As the technology advances, the cost of drilling will reduce significantly and will allow them to sink purpose-built shafts wherever they are required. Each shaft, which could be anything from 150m to 1,500 m deep, would provide construction jobs initially and then a small number or operational roles.

There is also the potential to use the technology oversea, and mines in South Africa are being analysed for suitability. They plan to build models from 1 to 20MW and deploy on large-scale. If the plan succeeds, their technology could breathe new life into former mining communities, and with it jobs and economic activity.

Mr. Blair is a shareholder in Gravitricity along with Peter Fraenkel and Martin Wright. His two business partners previously founded Marine Current Turbines, a tidal power generating company that was based in Bristol, before they sold it to Siemens in 2012. Peter Fraenkel is also one of the founders of IT Power.

(Image courtesy- www.gravitricity.com)

Wave Energy – The Untapped Resource

Nidhi Verma
Consulting Engineer
ITP India

Water – The most abundant, geographically diverse, sustainable and unutilised natural resource available on Earth. Around 70% of the globe is covered with oceans, yet most of our energy is derived from land-based sources. Oceans carry a lot of potential to help meet the electricity needs, if harnessed diligently. The limited, or rather scarce, utilisation of the abundant ocean energy resources is a result of the harsh offshore conditions and limited accessibility; both of which provide engineering challenges and high costs. The UK leads the world in ocean energy research and development, and many prototypes have been installed and tested in the UK's waters over the past 3 decades. Recent progress in ocean energy technology development presents an optimistic future for harnessing renewable energy from our oceans.

Ocean energy can be harnessed through the energy carried by ocean waves, ocean temperature differences, salinity and tides. Wave energy is the energy carried by the surface waves and not to be confused with the tides. Waves are created due to the movement of winds; however, tides are caused by the gravitational pull of sun and moon. Kinetic energy, the energy of motion, in waves is tremendous. Waves can be captured to generate electricity near the shore, at mid or far offshore, many miles from the coast. Waves tend to be larger and more powerful in deeper water further out in sea. The global total ocean energy resource has been estimated to be over 2 million TWh/year; wave energy represents a significant opportunity for clean sustainable energy supply, with the total estimated wave resource across the globe of up to 80,000 TWh/year, out of which the IEA estimate that nearly 4,000 TWh/year is economically exploitable. The global resource potential of ocean thermal energy conversion (OTEC) is even greater than wave's; with a theoretical potential of about 44,000 TWh/year. The theoretical tidal energy potential (including both tidal stream

and tidal range) is estimated to be 26,000 TWh/year, of which about 8,800 TWh/year is in shallow coastal basins. Ocean salinity gradients have an estimated technical potential of about 1,650 TWh/year.Wave power generation is a niche renewable energy which has been witnessing slow development although the attempts to use it began in the 1890s. Among renewable energy, the ocean energy sector has suffered relatively high cost thus restricting the speed of development. However, many recent technological developments and improvements, both in design and technology, indicate that economic and environmental costs can be brought down to competitive levels with commercialisation. In lieu of the factors involved in the utilisation of ocean energy, they offer good scope for large-scale power generation.

India, with a long coastline of ~7,500 km, possesses numerous sites with high wave energy potential and the country's total wave energy potential is estimated to be 40-60 GW. India began its development of wave energy in 1980s when the Department of Ocean Development of GoI provided funds to IIT, Madras, for carrying out research. One of the world's first, large-scale, pilot wave energy converters was an Oscillating Water Column device installed at Vizhinjam, Kerala. This pilot project was used to research many different wave energy extraction topics and even desalination from wave energy was trialled. The pilot project was eventually decommissioned in 2011. With the intent to utilise the resource more diligently and foray in the sector, India became a member country of the International Energy Agency – Ocean Energy System (IEA-OES) in January 2016. India's first indigenous wave–powered navigational buoy was inaugurated in November 2017 as part of the workshop 'Harnessing Energy from the Oceans — A Global Scenario'. The buoy, developed by the National Institute of Ocean Technology (NIOT), is used to guide ships into and out of ports. This small-scale application of wave energy is the start of a development and scale upprocess that could, one day, see India generating meaningful, grid-connected power from the waves.

ITPEnergised has been working in wave energy since the early-2000s and has assisted with the development, design and testing of a number of different device concepts. ITPEnergised is currently working for Wave Energy Scotland (WES), undertaking engineering design reviews of a series of promising, novel wave energy converter technologies. The WES programme is providing support and staged funding to assist the successful development of the wave energy sector.

There are thousands of patents registered, however, hundreds of them have been able to reach prototype testing deployment. Over 100 different ocean energy technologies are currently under development in more than 30 countries, with the UK taking the lead.

Ocean Energy requires consistent, insistent and persistent efforts from both the industry and the stakeholders to harness its actual worth!

Solar Landfill – an Australian First

Oliver Bryant
Business Development Consultant
ITP Renewables, Australia

Solar is being installed at an impressive rate all around the world. The utilisation of solar energy is not new anymore and researchers, economists and industrialists are putting in time and efforts to maximise the utilisation of this abundant resource.

With ever growing urbanisation comes the significant increase in amount of municipal solid waste (MSW) generated. According to the World Bank report, global MSW generation levels that were approximately 1.3 billion tonnes per year in 2013 are expected to

nearly double to approximately 2.2 billion tonnes per year by 2025. The oldest form of waste treatment is construction of landfills.

It is quite evident that both, landfill and solar, require a lot of land and what could be better than utilising both on the same land?

ITP Renewable, Australia took the challenge to make the thought practical and working at Wollert landfill site near Melbourne which has 6.6 MW of landfill gas generators operated by LMS Energy. The key stakeholders are LMS Energy, Joule Energy, Hansons and ARENA.

Wollert Solar Lanfill Project 100 kWp

LMS Energy (LMS) is Australia's most experienced landfill gas to energy company with landfill gas projects located around Australia. LMS generates over 370,000 MWh of renewable electricity per year. Joule Energy (ITP Renewables' client) is LMS Energy's solar PV company and the owner of the PV array. Hansons are the site owners. ARENA supported the project with a funding contribution of $100,000, to maximise the knowledge sharing aspects of the project.

ITP staff worked with Hansons, LMS and Joule Energy to develop the concept and the ARENA funding application. ITP designed, installed and commissioned the PV project. Green Earth Electrical was sub contracted to undertake the electrical installation works.

The client sought a 99 kW PV system to be built on this landfill site with the requirement that:

- the integrity of the cap for the gas reservoir must be maintained,
- three different ground-mount systems to be used, so their advantages and disadvantages can be examined, and
- the PV system be designed to cope with the expected ground level movements, the landfill surface subsides considerably over time, 1 to 2 metres is feasible over the next 20 years at the site.

The project aims to increase the uptake of PV at landfill sites by demonstrating the options for overcoming these challenges. ITP held numerous toolbox meetings and training sessions with the clients' staff to facilitate their engagement with the project and to maximise opportunities for knowledge sharing.

LMS staff were given O&M training to prevent gas leaks

Three PV arrays were designed and installed using different foundation mounting systems, hence, meeting the requirements:

- anchors, (shallow earth screw footings),
- pre-cast concrete ballast, and
- gravel rock ballast.

The project involved identification of an opportunity for use of a challenging site as well as an innovative technical design, delivery methodology and risk management plan. The PV project demonstrated the engineering options for managing the challenges of maintaining cap integrity and coping with potential subsidence.

Additional bentonite clay added to the top of micro pile posts

The project has raised the profile of the opportunity for installing ground-mounted PV on landfill sites.

ITP has provided a summary of lessons learnt from the construction and undertaken testing for gas leakage. LMS and Joule Energy are undertaking long-term monitoring of the impacts of any subsidence on the integrity of the cap. They are also monitoring the performance plus O&M requirements of the PV arrays. After sufficient data is collected, an analysis will be undertaken on the optimal approach for significantly larger (MW-scale) installations of ground-mount PV arrays at a range of landfill sites.

With Indians producing ~62 million tonnes of waste annually and much of that going to landfill, a solar farm offers genuine re-use options for such sites and more broadly, will have major economic, environmental and community benefits.

ITPEnergised Offices

Bristol
ITPEnergised
29 Great George Street
Bristol, UK BS1 5QT
T: +44 (0) 117 214 0510
E: info@itpenergised.com

Edinburgh
ITPEnergised
7 Dundas Street
Edinburgh, UK EH3 6QG
T: +44 131 557 8325
E: info@itpenergised.com

Glasgow
ITPEnergised
The Whisky Bond
2 Dawson Road
Glasgow, UK G4 9SS
T: +44 (0) 131 557 8325
E: info@itpenergised.com

London
ITPEnergised
Unit 3.14-15
18 King William Street
London, UK
EC4N 7BP
T: +44 (0)20 3700 6111
E: info@itpenergised.com

Mainland Europe
ITPEnergised
Lisbon, Portugal
T. +351917208573
E: info@itpenergised.com

Latin America
ITPEnergised
Buenos Aires, Argentina
T: +54 11 3750 9853
E: americas@itpowergroup.com

China
IT Power China
Beijing
T: +86 10 6413 6295
E: china@itpowergroup.com

Australia & Pacific
ITP Renewables / ITP Thermal, Canberra
T: +61 2 6257 3511
E: info@itpau.com.au

New Zealand
ITP Renewables
Auckland
T: +64 275 818 989
E: admin@itpau.com.nz

Published by:

IT Power Private Limited
410, Ansal Tower, 38 Nehru Place
New Delhi – 110019, INDIA
Tel: +91 (11) 4600-1191/92
Fax: +91 (11) 4600-1193
Web: www.itpower.co.in
Email: info@itpower.co.in