**I do a lot of talking on this channel about the amazing breakthroughs in laboratories and test centres all over the world that are aimed towards decarbonising human activity and energy use.**

**The vast majority of them are focussed on providing renewable power and energy storage to our electricity grids.**

**But there are still almost a billion people in the world who don’t have access to a national or regional grid, and although the mass migration into cities, especially in many developing nations, has brought that number down significantly over the past decade, there are still an awful lot of remote locations that will most likely never receive the infrastructure for a grid connection.**

**So, for the hundreds of millions of folks living in those areas the options are horrible, dangerous kerosine lamps to provide light during the evenings, and noisy generators running on diesel, which is an increasingly expensive fuel that pollutes the air and dumps huge amounts of carbon dioxide into the atmosphere.**

**In recent years solar PV panels on individual homes have played a significant role in improving the lives of many of those folks, but solar does have that inherent, and inconvenient intermittency factor, which, even with battery storage, can never be completely overcome.**

**So, more recently a group of visionary entrepreneurs had a bit of a rethink and decided to see if there were any other more reliable ways in which nature could provide energy to those difficult to reach communities. And in most cases the glaringly** **obvious answer was the water flowing nearby in rivers and canals.**

**But surely Dave, you’re not advocating yet more dams on yet more rivers causing yet more damage to the local environment and wildlife, are you?**

**No, I’m not!**

**Hello and welcome to Just Have a Think.**

**Now, I don’t think anyone would seriously suggest that harnessing the power of water was exactly a new concept. The Greeks were using water wheels for grinding wheat into flour more than 2,000 years ago, and that exact same technology was still in widespread use right up until the dawn of the industrial revolution, not just for making flour but also for sawing timber, pulping paper and running looms to make textiles.**

**During the twentieth century that constantly flowing resource was harnessed at breath-taking scale to drive hydropower turbines and generators producing reliable, baseload electricity in many parts of the world.**

**Hydropower doesn’t emit any carbon dioxide in operation, so on the face of it, it looks like a great option for any region that has a major river with a decent gradient. The trouble is though, that most governments are fixated on extremely large centralised infrastructure projects that can supply enormous quantities of electricity into national grids. And they’re getting bigger. You think the Hoover dam was impressive at a power generation capacity of 2000MW? Well check out the Three Gorges Dam in China, completed in 2012, capable of more than ten times that power output. Enough for tens of millions of homes, offices and factories. There’s lots of good logical reasons for this approach, of course. Large infrastructure projects tend to get higher levels of investment from commerce and industry. Building large in one location is often logistically easier than building small in lots of different locations. And once they’re up and running, those grand, centralised power generators can be easily controlled by power companies and regulated by the state, essentially providing a nice neat and tidy monopoly on a commodity that has become essential to our modern way of life.**

**But the environmental impact of grid scale hydropower is a big concern. Building a dam on a river means blocking, diverting or completely changing the natural course of the water. That often screws up the migration routes for species of fish that rely on them to get to their annual breeding grounds. The consequence of that is a drastic reduction in fish populations, with big negative effects on the ecosystem, including food stocks for indigenous human beings.**

**Water-borne sediment flow is also massively reduced which** **means far fewer nutrients for all forms of wildlife further along the river system, not to mention the obvious consequence of water scarcity or even drought for the folks downstream. And damming a river also causes upstream flooding. The Three Gorges Dam caused a flood area of a thousand square kilometres, which is about 80% of the entire area of Los Angeles, displacing 1.3 million people as a result. And several recent studies have shown that organic matter like dead plants that get trapped in the reservoirs break down and release carbon dioxide and methane into the reservoir water.**

**So, you know…not ideal!**

**Here’s the ideal shopping list then, for several hundred million people living in remote areas of the world...**

1. **Small scale, locally controlled power generation.**
2. **Reliable, affordable electricity available 24 hours a day, 7 days a week.**
3. **Minimal, or even zero, environmental impact.**
4. **The ability to hook up to a grid system if it’s available or run completely off grid if necessary.**

**All of those criteria are met by a micro-hydropower system developed by a Belgian start-up company called Turbulent, founded in 2015.**

**I recently spoke with the guys at Turbulent to gain a better understanding of how their system works.**

**Essentially they’ve designed what they describe as a vortex turbine that can work in river systems with a head of water of less than five metres and as little as a metre and a half from the top of the system inlet to the bottom of the outlet.**

**A channel gets dug to divert a small portion of the river or canal flow to one side. A sluice gate and mesh filter are installed at the very start of the channel to regulate the flow of water and to stop any large debris getting in.**

**Once the sluice gate is opened water flows down into a circular well where the Turbulent turbine is installed and as the water passes across the turbine it creates a low-pressure vortex.**

**The low rotation turbine blades have soft rounded edges allowing aquatic life to pass straight through the entire system, possibly somewhat invigorated and keen to have another go, but not harmed in anyway at all.**

**All the water and fish are then returned straight back into the main flow of the river system to continue on their journey, entirely unaffected.**

**So, now you’ve got a spinning turbine driving a generator producing electricity in exactly the same way as its larger-scale hydroelectric cousins. That supply can either be hooked up to a grid, if there’s one available, or simply run through a stand-alone electrical consumer unit to provide power for the building or community that it’s been specifically designed for.**

**The whole thing is controlled autonomously by electronic wizardry in the electrical cabinets that Turbulent’s engineer’s install on site, and of course there’s an app for it, so that all the performance parameters can be monitored remotely by the Turbulent team and the owners of the system.**

**The smallest installation has a capacity of 5kW, which in remote areas of developing nations is enough to supply 50 rural households, plus water treatment at night and businesses during the day. Larger installations can be up to 200kW per turbine, and those turbines can be linked up into a network, generating multiple megawatts of power.**

**Off grid communities get the benefit of effectively free electricity, 24 hours a days 365 days a year for the entire lifetime of the turbine, which is rated at 30 years. If they do decide to get hooked up to the grid, then they may even generate a small income through grid feed-in payments.**

**Which brings us nicely to cost.**

**Well, the guys at Turbulent pointed out that these are very much bespoke systems, constructed to fit precisely into each selected and carefully surveyed site, so that means that every project will have its own cost structure, but as a rough rule of thumb, a 15kW grid-tied installation would come in at around €75,000 and a similar off-grid connected system would be about €90,000. If that was installed in Europe it would be enough constant baseload power to run 30 typical European homes, which equates to a cost of €3,000 each. Compare that to a typical solar panel installation that could cost as much as €10,000 and which would only provide intermittent power, and the numbers start to look pretty favourable. And the larger 50 or 70kW systems have even better economies of scale than that.**

**And it really becomes very enticing indeed if you compare it to the cost of diesel, which is the fuel source that Turbulent will be competing against on most of their projects.**

**A 15kW system will be generating 360kWh of energy every day. That’s 131,400 kWh every year for 30 years, which is very nearly 4 million kWh of energy over the lifetime of the turbine. If you divide that into the off-grid installation cost of €90,000 you get a unit cost of less than 2.3 Eurocents per kWh, compared to a typical diesel fuel cost of more like 50 Eurocents per kWh.**

**That’s a pretty compelling business model.**

**Turbulent now have 10 fully installed or in-progress projects at various sites around the world.**

**This installation, in Bali, Indonesia was commissioned by the Green School, one of the most eco-friendly schools in the world and a pioneer of sustainable education. The turbine sits on the Ayung river, famous for its white-water rafting. The system provides the school with about 80% of all its energy requirements, with the rest coming from a small existing solar installation. The school spent 11 years trying to develop their own micro hydropower system by trial and error. Their most recent construction was destroyed by a flood that carried debris downstream, so one of the main design objectives for the Turbulent team was to create mechanical components that were capable of withstanding whatever our changing climate could throw at them, including severe flooding.**

**The turbines are all fitted with a fully submersible gearbox and induction generator with mechanical face seals, plus a secondary sealing system with multiple layers of protection against fresh and brackish water debris and sand, designed specifically for use in continuous heavy-duty, harsh environments.**

**All the components for the Green School were boxed separately and taken to site on the back of a relatively small flatbed vehicle and because the water diversion channel and the circular vortex well already existed, installation only took a day to complete, without the need for any heavy machinery . The system sits within a nice, small, neat footprint just outside the school. A solar installation generating a similar output would have taken up the space of four tennis courts.**

**One of the benefits of the constant baseload supply of these vortex systems is that they can run essential services like hospitals and other public buildings that absolutely must guarantee permanent uninterrupted power. Those institutions currently spend a large amount of their budgets on diesel generators to ensure the lights and life support machines never switch off.**

**And then there are commercial businesses like nature parks, eco-resorts, and agricultural centres that are often located far from the standard power grids but typically very close to a source of running water, making them ideal candidates for these sorts of stand-alone power generators.**

**Micro-hydropower can be an attractive option for governments as well. Rural electrification and development programs are a key priority of the United Nations Sustainable Development Goals, and grants are available for these sorts of initiatives, both from the European Union and the World Bank.**

**The grand-scale hydropower dam projects that I talked about earlier are horrendously expensive and many are currently on hold in developing nations as a result of increased project costs.**

**Turbulent turbine projects can be built in phases, to decrease initial investment and risk, and part of the energy can be directly used in the areas immediately adjoining the site, which helps to gain the support of local communities. Developing and constructing a large-scale hydropower plant can take up to 10 years, while multiple linked up micro-hydropower installations can be completed within months, and could well have paid for themselves entirely in less than the time it takes to build and commission a dam.**

**Regular viewers of this channel will know I’m a big fan of these sorts of lateral thinking approaches to solving some of our planet’s trickier problems, and I for one would love to see many more of these brilliant devices installed in remote areas around the world. In fact, if do ever retire and realise my own little pipe dream of a timber framed Passive house next to a river in the middle of the woods somewhere, then I’d be very tempted to invest in one of these things myself.**

**Jump down to the comments section below to share your thoughts, but that’s it for this week.**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.
See you next week**