Inspirational paper 2

The Flexibility Makers

"The biggest challenge to transition to a zero-carbon world is not the total amount of clean energy available, it is to make sure there is clean electricity available at all times, 24/7 – all days of the year".
Patrik Möller, Cor Power Ocean

We have previously written about the exceptionally strong growth sector we are seeing within electrification in the Nordics in general and in Sweden in particular, with companies such as autonomous truck maker Einride, electric bike maker Cake and electric boat makers Candela and X-shore, to mention only the tip of the iceberg. Now we want to highlight a group of technologies quickly emerging out of the Nordics that are of crucial importance to understand for anyone involved with our energy system in one way or the other - the technologies making sure your tea kettle keeps boiling even as everyone else is putting theirs on, the one that can bring the price of charging your EV down, the true heroes of our electricity cables – The Flexibility Makers.

These companies are providing flexibility to the grid in one way or the other, by counteracting the variability of energy production which tends to be higher in renewables such as wind and solar. They are typically under-seen in relation to their potential impact on our society and in the long run our ecosystem. Allow us to introduce you to the companies enabling an electricity grid with an abundance of renewable electricity.

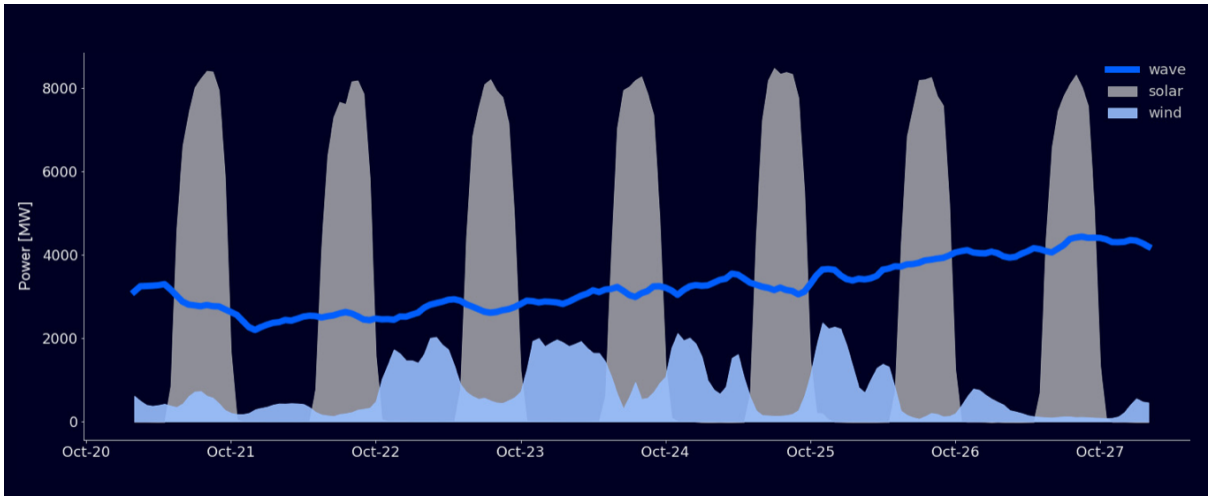
Power plants that add flexibility without adding CO2 to the atmosphere

C-Green uses a process called hydrothermal carbonization, which in more simple terms is the treatment of wet or dry organic matter at elevated temperatures in oxygen-free conditions. C-Green has managed to turn this into a robust industrial process that can transform a variety of different biomass, such as the wet sludge left overs from waste water treatment plants, into Hydrochar, a solid, high energy density fuel with properties similar to coal. However, with the distinct advantage to coal, oil and natural gas, that it is produced from renewable biomass sources, meaning a much lower carbon footprint. It is ideal for use in biofuel and waste incinerator power plants, and yep you might have already guessed it, one of the main advantages of these plants are that they can typically provide both base-load and highly flexible peak-load power.

Wave power has an energy generation profile that complements solar and wind

Waves are fetched over long distances, over multiple days from various weather systems, giving wave power a very consistent power flow at any time of the day and any time of the year, independent on local weather conditions, making it an excellent complement to stabilize the clean energy mix.

Wave power has been long in the making but with recent development the technology seems to be finally coming out of testing and into the real world. CorPower Ocean converts the mechanical energy of the waves into electrical energy for utility-scale energy generation. The solution is inspired by the pumping principles of the human heart. Advanced control technology forces the wave energy converters to oscillate in optimal timing with incoming waves, strongly amplifying energy absorption and power output. Size, weight and cost ratios of the plants therefore becomes much more beneficial. Harnessing electricity from waves on open waters has proven notoriously difficult due to the harsh conditions and costs associated with it, but in the same way the technology of CorPower Ocean can amplify the wave energy, it can also be used to dampen the effect of storm waves. CorPower Ocean has been testing and proving the technology over a long time and are just about to put their first full scale version into the Atlantic Ocean outside of Portugal.



Source: CorPower Ocean

(Very) distributed power production

Distributed power production has taken a huge leap forward with the accelerating roll-out of rooftop solar. Something that has proven to be sometimes more scalable compared to building traditional centralized power production. Now some companies have even taken this one step further.

Exeger is in full swing already producing Powerfoyle, a customizable, thin, bendable solar cell that integrates into products such as headphones. I am writing this with my own pair of Urbanista Bluetooth headphones lying on the desk in front of me. They are charged and powered by the integrated solar cell that doesn't even look like a solar cell, and I have not had to charge them once since I bought them a year ago.

Epishine has created a similarly thin, flexible and portable organic solar cell that can be used for harvesting energy for indoor applications. It is manufactured through a printing process and requires significantly less materials than typical solar cells used today.

These solutions have a positive impact on our ecosystems from reducing the battery need. Removing the need for charging products increases comfort and lowers maintenance cost making them suitable to be integrated into many more products. Removing small appliance charging from the grid won´t create any large impact on the grid in the near future but give this technology some years to scale and ride the cost curve and we might see these solar cells on surfaces we have not yet even been thinking of. Maybe we won´t even see an EVs without integrated solar being sold, and then we'll start to see a big impact on easing the burden on the grid.

Baseload Capital focus on enabling "the nuclear of renewables"

Not the one with harmful waste and the risk of catastrophic radiation leakage, but the one that is naturally created within the core of our planet. Geothermic heat power is a form of renewable energy that can be harnessed from pre-existing heat sources. This includes not only geothermal heat but also industrial waste heat. Unlike wind and solar power, heat power can provide a constant stream of electricity, regardless of the weather or the time of day, also known as baseload power, which is today mostly produced using nuclear energy, or fossil fuels, mainly in the form of coal. Swedish company Baseload Capital is focusing on investing in these types of projects by forming power companies to develop and operate geothermal power plants in Iceland, Taiwan, Japan and the U.S.

Emission free heat and steam from electricity surplus hours

Generating steam or hot water is a common use of energy in the industrial sector, particularly in industries such as food processing, chemical production, and paper manufacturing. The need for heated steam or water is however strongly tied to the production intensity, causing energy prices to rise at those time of the day when most production occur as well as requiring a high flexibility in choosing when and how much steam or hot water to produce.
Elstor instead utilizes the electricity market's cheapest hours, when electricity demand is low, and stores this electricity as thermal energy. The stored energy is then used to produce heat and steam when it's needed during peak hours. Operating costs are stated to be lower than creating this type of flexibility with fossil fuels and the grid is utilized more efficiently during low demand hours. Steam is critical in industrial processes such as food production, where it is used for things such as heating cooking pots, heat treatment and sterilization. Food company Herkkumaa has been a pioneering customer who replaced their current system for steam and heat production, which used approximately 264,000 litres of light fuel oil per year, with an Elstor system fuelled by fossil free electricity. This made their process emission-free and reduced the carbon footprint of Herkkumaa's production to zero (the emissions created by the manufacturing of the Elstor system were compensated for in only half a year).

Batteries, Batteries and even more Batteries

Batteries for large scale energy storage is the obvious way to provide demand flexibility and decrease pressure on the grid and get the most out of renewable energy installations. Swedish fast growing solar company Alight recently installed 2 MW of storage alongside a recent solar park and have stated they see battery storage becoming a natural part of solar power parks being built in the future, adding both emission free electricity and being able to provide some grid power flexibility at the same time.

Swedish Northvolt is the undisputed heavyweight champion of Nordic battery factory development, and that is astonishing considering that the company didn't exist 10 years ago. Their target for annual cell output by 2030 is 150 GWh, and when considering the current carbon impact of batteries, Northvolt predicts that the production of these cells will emit 80% less CO2 compared to cells made using coal power. At that point 50% of the raw material that goes into their cells will come from old batteries recycled by Northvolt themselves…

In similar fashion, Norwegian Morrow is leveraging low emission battery production through the abundant Norwegian renewable hydropower electricity and aim to develop and manufacture the world's most sustainable batteries in their Giga factory being built in the south of Norway, using Lithium-Sulphur-technology.

Equally important, a bunch of Nordic companies are developing different anode and cathode materials to improve economy, performance and price of batteries.

Cenate is a Norwegian company developing and producing silicon-containing anode materials with nano technology to be directly used in today´s lithium-ion batteries. This is a new anode material for Lithium batteries that will make it possible for battery producers to both lower battery cost and increase energy storage density.

Swedish Altris has developed a new way of producing a sodium-ion cathode material – with the potential of eliminating the use of rare, poisonous, or hard to find raw materials and replacing them with abundant and recyclable natural materials such as iron and sodium (available in sea-salt).

Zinc-ion batteries are not yet being commercialized in scale but come with great promise as they are potentially safer, longer lasting and significantly cheaper than lithium-ion batteries. Current global Zinc production is 130x higher compared to the production of Lithium. Swedish Enerpoly is developing batteries using zinc metal as anode and manganese dioxide as cathode with a water-based electrolyte. These batteries lend themselves particularly well for grid flexibility applications, shifting energy load from peak to off-peak hours, due to their charging and discharging properties.

Ligna Energy is taking a totally different route developing batteries from forest materials, making use of lignin taken from the forest industry waste stream. They use a water-based electrolyte and organic polymers. Their first product, batteries for IoT devices, is already on the market and as only natural materials are used in the design the batteries can be disposed of and incinerated without any CO2 impact.

The local market in the Nordics is clearly benefitting from each other. Both through complementing competences but also through co-operations along the value chains. Swedish fast growing energy storage company Polarium, specializing in supplying battery storage to the Telco industry, have initiated a long-term partnership with Northvolt who will supply Polarium with lithium-ion battery cells, replacing a lot of the diesel generators still in use for backup power in telecom installations all around the world.

Energy - a service that includes the battery?

Finnish Cactos has built their business idea on the fact that businesses only need their electricity during working hours. Their battery Cactos One automatically charges when electricity is cheap and provide the cheap electricity when the businesses need it most during the expensive hours, lowering the electricity bills whilst stabilizing the national electricity grid at the same time.

Ferroamp sell microgrids based on a DC power backbone. This decreases costs and minimizes conversion losses between solar panels, storage batteries and EV charging.

The EnergyHub from Ferroamp connects solar cells and batteries in a DC grid instead of using the normal 230V grid AC lines. The system is modular and can be used in a house just as well as an apartment block or corporate setting, meaning that multiple buildings can cost-efficiently share energy, storage and power resources. Why DC you might ask? Well, since solar, battery and EVs already uses DC power natively it is more efficient to move the power between these devices directly by using a DC grid instead of having huge losses by being forced to go back and forth between AC and DC several times.

Software and connectivity creating flexibility from existing power use

We haven´t even touched upon solutions to add flexibility by controlling and optimizing the demand side. Tibber is a Swedish company offering energy efficiency services and energy insights. Through their systems its possible to adapt your energy use and lower consumption during peak hours. Some things are even managed automatically by Tibbers system, such as adaptive EV charging where the system can make sure you only charge your car during cheap off-peak hours. Several EV charging companies such as Danish Monta, Swedish Chargeamps and Finnish Virta provide cloud-based charging platforms capable of moving EV charging load from peak hours to low price and low demand hours.

Similar software-based flexibility can be achieved through a variety of applications and user cases, such as heating buildings or running industrial processes. Swedish Ngenic, as an example, already today provides grid flexibility by connecting and aggregating heat pumps in use. The flexibility created by being able to regulate or shut down a large amount of heat pumps in a coordinated way makes them able to provide this as a commercial service.

This topic could go on forever… it has for instance been beyond the scope to look at how the more mature energy related companies work with flexibility services, and despite all these fascinating developments we are only seeing the beginning. An interesting data point: In Germany, one of the leading storage markets worldwide, the cumulative battery energy of about 72 GWh is already nearly twice the 39 GWh of nationally installed pumped hydro storage, demonstrating the enormous flexibility potential of battery storage for the energy system...

With increasing roll-out of battery storage, heat-pumps, emission free electricity generation and smart software to tie it all together we may see a landscape that will change more in the coming years than most believe today. At the very center of this development is the capability of the grid to transmit, for lack of better words, high quality electricity to users.

The flexibility makers are enablers of exactly that.

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