

The sustainable energy revolution gaining momentum

On May 29, 1975, the construction of the world's largest wind power plant, Tvindkraft, started through the combined action of about a hundred comrades. Three years later, the windmill started producing electricity, and now, 40 years later, it is still producing.

Few people in the world of renewable energy know about the huge importance this had for the breakthrough of wind energy and the inspiration this gave for a renewable energy revolution. But we know and can be very proud of it.

Sooner or later some company would have started the development of modern wind power plants, but it is safe to say that Tvindkraft accelerated this by a decade or more.

We are today seeing the effects of the sustainable energy revolution that we were part of starting up – here in the way of some good news in from the recent weeks, but just as much in the overall trend, where hardly a week goes by without the announcement of a new large-scale power plant using wind or sun as its energy source or some other climate-friendly initiatives.

News from the last two months about an increasing momentum

- The billionaire, Warren Buffet has announced he is ready to invest US\$ 30 billion in renewable energy, and his company has just placed an order of 200 mega wind power turbines at the Danish producer Vestas for a project in Nebraska, USA.
- The US producer of electric vehicles, Tesla has just launched its home battery storage system that fits on a wall in a garage or home. This "Powerwall" can be combined with solar panels and can greatly reduce the monthly electricity bill, because it is programmed to supply power when the electricity from the public grid is most expensive.
- A new record has been set in the small desert country of Dubai in the form of the lowest price ever agreed for electricity from a solar photovoltaic plant – at 5 US cents per kWh. This is below the price of electricity produced by burning coal, oil or gas.
- The company Google has invested US\$ 700 million together with Solar City to finance that US home owners can get solar electricity and simply pay as they would have done anyway to the power company. Such initiatives makes it much more easy for people to switch to solar.

- The Norwegian Government Pension Fund Global has recently sold its 100 US\$ million stakes in 15 large Indian coal and power companies as part of divesting from polluting coal.

Such good news supplement new data on how a renewable energy revolution is gaining momentum:

- In 2014, the amount of wind and solar power installed around the world grew by 15% and 32% respectively. Solar electricity is now cheaper than the grid average in Spain, Italy, Australia, Chile, Germany, Brazil and at least 10 US states.
- Renewable energy systems (without including large hydropower) made up nearly half of all the power capacity added worldwide in 2014. Much of this renewable power is produced in developing countries.
- Japan has since the Fukushima nuclear disaster in 2011 installed more than ten gigawatts of solar power capacity, meaning enough to replace the electricity that was previously produced by ten nuclear reactors. The plan is to double this by 2020.
- 7.7 million people around the world are now employed in the renewable energy business.
- Norway has seen the purchase of electric vehicle number 50,000 and during the first months of 2015, one of every four new cars purchased is electric.
- During the first quarter of 2015, Costa Rica did not burn one drop of oil or any coal or natural gas to generate electricity. They have for years promoted renewable energy and have at the same time been able to lower the electricity rates by 12%. Not only the few and rich have access to this clean energy. 98% of the population have electricity. (An example of what can come out of scrapping the military, as the country decided to do in 1949).

An energy revolution in the making

This is not about a revolution from one day to another. Neither is there one invention or element that makes these changes run ahead. It is rather the combination of rapidly decreasing prices for solar electricity, large amounts of funds from private investors and government going into clean energy, the pressure from many people to take out investments in fossil fuels, and new systems on the horizon that make it possible to substitute central power plants with decentralized electricity production.

It is possible to compare the present situation with some previous, very rapid changes in use of technology.

In the 1970s, the leading computer company, IBM, earned money on huge mainframe computers for large businesses. They estimated the

market for personal computers to be minuscule, and therefore made a deal with Microsoft to pay a fee for every computer using the operating system that Microsoft had developed. This cost IBM billions of dollars and the company was soon bypassed completely.

Up to the 1990s, all large telephone companies relied on land lines. In many parts of the world, however, mobile telephones became the new norm, and landlines are also rapidly declining in the rich part of the world.

There is still some way to go before we will see a similar shift in the world of energy, but there is no doubt about the tendency.

Why an energy revolution?

The need for an energy revolution switching our energy supply from burning fossil fuels to renewable energy sources is by now well known. By burning the fossil fuels on the huge scale done today, planet Earth is steadily on the way to recreate the much warmer climate of millions of years ago, when the carbon from the atmosphere was transformed into the coal, oil and gas reserves.

At the climate summit in Copenhagen in 2009, the governments agreed in principle to keep our planet from heating more than 2 °C since the start of industrialization. Scientist cannot know for sure how much of these fossil fuels can be burnt to keep this limit. This depends on how big a part of the carbon stays in the atmosphere, as opposed to getting soaked up by oceans and plants. But the latest scientific study finds that over 80% of coal, 50% of gas and 30% of oil reserves are "unburnable" under the goal to limit global warming to no more than two degrees.

Even the International Energy Agency, which can be considered a quite conservative source, writes in its 2014 Energy Outlook that the world cannot emit more than around 1,000 gigatonnes of CO₂ from 2014 onwards. With business as usual, this will be reached already in 2040, meaning that no fossil fuel should be burned after that date.

In order to prevent the world from heating catastrophically, it is thus crucial on a global scale to accelerate the shift to carbon-neutral energy such as wind, solar and in some cases hydropower, when done so huge areas are not submerged.

Germany showing it is possible to go renewable

The country that has made the greatest shift in energy systems is probably Germany. In 2010, the country set ambitious goals for cutting greenhouse gases by 80% before 2050, and it seems this "Energiewende" (energy transition) is moving ahead. The power produced by renewables has increased from 6% in 2000 to about 30% in 2014.

Germany has, after Fukushima, decided to close the last nuclear power plants in 2022 and this has made it more difficult to keep their planned reductions of emissions (the nuclear process emits no greenhouse gases). The result has been increased production from power plant burning brown coal – the most polluting kind of coal – and the country's greenhouse gas emissions have actually increased over the last years. More power, however, is now produced from wind, biogas, and solar combined than from brown coal, and the increasingly better economy of solar will make it possible to largely replace coal. Solar energy has become cheaper much more quickly than most experts had predicted and will continue to do so.

The cost of power from large-scale solar installations in Germany fell from over 40 US cents/kWh in 2005 to 9 cents/kWh in 2014. By comparison, electricity from new coal and gas-fired plants costs between 5 and 10 cents per kilowatt hour and from nuclear plants as much as 11 cents – without these prices included the costs to the environment, health systems and all kinds of subsidies.

A thing the German government has done to support roof-top solar systems is to streamline the permitting process so that the costs of these are just half as much as in USA.

The transition has been good for employment in Germany. Since 2004, the number of people employed in the renewable energy sector has more than doubled to 370,000 people.

Other examples from around the world

China is the world leader within renewable energy. Its investments in solar and wind energy grew explosively from US\$ 3 billion in 2004 to \$ 83 billion in 2014.

Especially for solar panels, this Chinese investment has resulted in a huge drop in prices. It has also resulted in 3.4 million Chinese working in the renewable energy sector.

India is another developing country going for solar energy, with investments in 2014 of US\$ 7.4 billion.

The Deutsche Bank finds that rooftop solar will be as cheap as traditional power by 2016 in all 50 US states. California is in the front among the US states, because it has introduced attractive tax credits for home solar systems. The state has also required that the three large power companies must get one third of their electricity from renewable sources (besides the electricity produced from home solar systems). This has forced them to invest in large solar projects that are already producing electricity on the scale of nuclear power plants.

It pays economically for the US states to support renewable energy. The state of North Carolina has, for example, gained 4,300 jobs in the solar industry, which are worth economically much more than the subsidies the state has spent.

South Africa was, together with Indonesia, Chile, Mexico, Kenya and Turkey, in the billion-dollar-plus club in 2014 in terms of investment in renewables.

South Africa relies on coal-fired power plants for 70% of its electricity. It has for years been plagued by power cuts and is now building two large coal power plants. But when they at some stage start to deliver electricity, this will be more expensive than what South Africa can get from its new solar and wind power plants.

Just within the last few years a number of large-scale solar and wind energy plants have started to produce energy, already providing energy corresponding to the consumption of hundreds of thousands of homes. One of these is Africa's largest photovoltaic plant, the 96 MW Jasper Plant supplying power to more than 80,000 South African homes. Many other large solar and wind projects are under construction using the country's excellent possibilities for renewable energy.

The issue of storing energy

South Africa has Africa's first solar concentrated power (CSP) plant (50 MW) and several larger ones are under construction. These systems produce electricity in generators that run on steam produced from very hot oil heated by the sun. Some of this heat is stored in the form of molten salt, which can then be used to create steam when this is needed. The problem of energy storage is often used as an argument against renewables. What to do when there is no wind or at night time when no sun is shining?

Large solar power plants that produce steam can use the system of molten salt or other ways to store heat.

New types of batteries, however, are becoming cheaper and more efficient – just like solar panels. The US company Tesla produces electric vehicles, and since the batteries make up a large part of the cost, the company has, in partnership with Panasonic Corporation, started building a gigantic, US\$ 5 billion factory in Nevada that by 2020 will produce batteries for half a million cars annually. They expect this investment to result in a substantial reduction in the price.

Tesla does not aim only at electric vehicles. The newly launched "Powerwall" can store the electricity from solar panels so that this can be used during the hours when the power companies charge most. This 10

kWh home battery costs US\$ 3,500, and the investment is paid back quite fast, because it can reduce the bill considerably.

Tesla has also started selling a much larger power storage system for businesses. This "Powerpack" similarly reduces the electricity bill and is being used for example by the giant Wal-Mart supermarket chain in California.

Of course, the power companies are not at all happy about this since they can see their profits plunge. This is already leading to conflicts with people wanting to install rooftop solar. The question is whether the large companies can find ways to stop this development. It will not be easy, as homes become more and more independent of the large electric grid.

This will be even more obvious as more people acquire electric vehicles.

Electric vehicles on the road ahead

The Swiss UBS bank predicts that by 2025 electric vehicles charged from solar energy will be cheaper to run than fuel driven cars.

No car manufacturer wants to be left behind, and nearly all the major companies have developed their models of electric vehicles or hybrid cars that can run on both batteries and fuel.

The Chinese BYD (Build Your dream), into which one of the world's richest men, Warren Buffet has invested, expects to reach the same number of batteries as Tesla also in 2020 with their production of lithium-ion batteries in China and Brazil. More electric vehicles are now sold in China than in the US. BYD is also producing electric buses in the US. They can drive 24 hours on a single charge, and have a charging time of 2-4 hours.

Norway is leading in relation to electric vehicles, because the government has decided to support this development through various measures:

- The vehicles are exempt of duties, VAT and other taxes – a huge part of the car price in West European countries
- Free parking and recharging in many of the cities
- No road fee on the roads where this is charged
- Allowed to drive in the lanes reserved for busses and taxis

The US government set a target of having 1 million electric or hybrid vehicles by 2015, and Germany has a similar goal for 2020 (up from 21,000 electric cars now). But this will not happen unless incentives like the Norwegian ones are offered.

Combining electric vehicles with the grid

One reason for promoting electric vehicles is the possibility their batteries give of storing electricity in numerous places – electricity that can then be

used when there is peak demand (such as late afternoon when many people prepare dinner). Later, when there is less demand, the battery can then be recharged.

The state of California has set the goal that the three large power companies must be able to store energy with the capacity of gigawatts by 2020.

There will thus be a demand for car batteries to store energy and the city of San Diego in California has recently decreed that all new homes must be built so they are ready for solar panels and electric cars.

Germany is once again proving to be a pioneer by establishing systems that not only combine electricity from sun and wind, with electric vehicles and home storage systems. They show how to take the next step – the establishment of a huge network of independent, mini grids, that can work together and thus replace the giant, centralized nuclear or fossil-fueled power stations.

The system is being developed by the German carmaker Volkswagen (VW), with support from the government and with the aim of showing that large central power plants are not essential for providing electricity 24/7.

VW has started selling their Lichtblick system to apartments or businesses.

What they sell is a system that coordinates the electricity and heating from renewable energy sources, stores it when necessary, charges batteries when possible, and provides electricity to neighboring systems, if this is necessary.

As back-up for periods with little wind or sun, a gas-fired generator is installed to provide heat and power. Such generators could in the future also run on carbon-neutral biogas or plant oil.

100,000 such units make up a virtual power plant corresponding to the output of heat and electricity from two nuclear reactors.

The systems are coordinated so the generators only need to start up when there is a lack of electricity in an area. This means that they are greatly more flexible and economical than the existing system of huge power plants.

The waste heat from burning the gas is used locally to heat the buildings, and the efficiency is therefore much higher compared to the large plants. So far, several thousand systems have been installed and VW says the investment of installing this in a small hotel is paid back after three years. One can easily imagine a network of such systems, combined with the much cheaper batteries and electric cars that will soon be on the market.

Decentralized electricity in India

An example from India shows how independent mini-grids can be established to provide electricity for rural communities. The energy source is here the sun combined with a special kind of large batteries (vanadium-flow batteries) that are used to provide power to a large number of telecommunication towers spread out over the country. The company has developed a business model, so that 5,000 villages eventually will be connected through small grid systems to the solar energy and storage at these towers. Their goal is to bring electricity to 10 million people in rural India by 2020.

Another example is the Indian company producing and installing gasification plants that run on agricultural waste such as rice husk and selling electricity to 25,000 households in 80 communities.

The neighboring Bangladesh shows that it is possible to make roof-top solar become significant. The Grameen Shakti Bank had by 2012 installed solar systems at one million homes and expects to reach the second million in 2016 – systems that are paid back through their microfinance system. In addition to these, the country has another 2 million homes with roof-top solar, and it has created 115,000 jobs in this business.

With the gradually cheaper storage systems that will come to the market over the next decade, there will be even more possibilities of setting up local carbon-neutral electricity production and completely avoid the extensive grid. Calculations show that if just 3 km of grid lines need to be installed, then the price of delivering a kWh of electricity is much cheaper through solar mini-grids than from a central coal-fired power station.

India has the potential to be a pioneer within the area of producing cars that do not pollute the cities and that can be run on renewable energy. India has 13 of the world's 20 most polluted cities in relation to air. Some of this pollution comes from burning coal, but a large part is the result of burning diesel and petrol in vehicles. Electric vehicles are not just around the corner for most vehicle owners in India, but maybe the small Airpod, expected to be launched by Tata Motors in late 2015, can lead to less pollution. It runs 200 km on a tankful of compressed air and only air comes out as exhaust. This could, if getting the needed support, mean a drastic reduction in pollution in the Indian cities. Energy is of course needed to compress the air at "filling" stations. An advantage is that this energy can be taken when there is little other demand (for example during the night). But the great potential is that this energy can be carbon-neutral. Imagine a number of "filling" stations producing their own power

from solar panels or small windmills and using this to compress air for these cars.

How to accelerate the energy revolution?

The examples mentioned so far show that the technologies are there to sustain the energy revolution. Much is happening, and much more will happen. There are, however, also forces working against this development – just think of the large companies earning their profits from fossil fuels which will do what they can to place obstacles in the way. As always, progress will depend on the many people. Many people just setting up their own systems, such as solar panels and Tesla's Powerwall home battery. Or many people pressing for better policies – for example to end the billions and billions in subsidies to fossil fuels.

The importance of pressure and energy from below

Germany provides some good examples of how to influence energy policies. Two thirds of the country's renewable energy capacity is community-owned, for example by 700 renewable energy cooperatives, and about 20 million Germans live in areas with short-term goals to become 100% renewable energy regions.

Many Germans have seen that they need to regain control over their energy supply and distribution. Much of the energy business was privatized in the 1990s, but there is a popular movement to "deprivatize". In the city of Hamburg, people recently voted to not only take back the city's energy grids, but also that Hamburg should have as its goal to achieve "a socially just, democratically controlled and climate-friendly energy supply from renewable sources".

Forty other German cities have similarly retaken control over their power supply, after these had been privatized and sold to energy giants such as the German E.On and the Swedish Vattenfalls.

The divestment campaign

Divestment is about getting large investors, such as university endowments, pension funds, churches, foundations and rich persons, to sell off assets they have in companies that contribute to global warming. One of the inspirations for divestment has come from the Anti-Apartheid movement and its boycott South Africa campaign, which contributed greatly to the fall of Apartheid.

Over the last years the divestment campaign has been quite successful and pressure to divest is growing to a degree that even conservative financial institutions are beginning to notice.

The governor of the Bank of England has thus warned that the “vast majority of reserves are unburnable” and the bank is investigating the risk of keeping fossil fuel assets that could turn out to lose value.

The Norwegian parliament will at the start of June probably decide that the Government Pension Fund Global, should divest from all companies that derive 30% or more of their business from coal. This will result in a divestment of about US\$ 6 billion. The fund is the largest of its kind in the world, US\$ 950 billion, and consists of money Norway has earned from its oil.

The Rockefeller Brothers Fund, which has all its wealth from oil profits, has committed to sell off worth US\$ 50 million of fossil fuel related assets.

Students are in many places succeeding in getting their colleges and universities to divest, and there are many more examples.

The divestment campaign will not make the share prices of the energy giants drop just like that. There are still too many conservative investors believing all the projections about the huge role these companies will still have decades from now.

It will be up to the many people to show that these were bad investments and that they should have invested in Google, SolarCity, VW, BYD, Tesla or any of the other numerous companies that can be part of building up a different energy scenario.

And besides supporting such campaigns, the many of us need to continue building up the desperately needed alternatives – in the ways of living, ways of transport, ways of working and getting totally independent of the grid of the energy giants.