GLOBAL IMPACT OF SOLAR ENERGY CASE STUDY - GERMANY

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Abstract

Renewable energy *is a socially and politically defined category of energy sources. Renewable energy is generally defined as energy that comes from resources which are continually replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat. About 16% of global final energy consumption comes from renewable resources, with 10% of all energy from traditional biomass, mainly used for heating, and 3.4% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing rapidly.*

This paper seeks is aimed at presenting the impact solar energy could have on a world level given the finitude, reachability and ever increasing prices of fossil fuels. As a case study we will present the solar energy industry in Germany emphasizing the advantages and disadvantages this form of energy has in this country and worldwide.

Solar energy – Global Impact

First we need to ask ourselves if the world needs saving and if the answer is yes then what does it need saving from?

We can address the second question by providing two answers. One would be "from the climate change effects caused mostly by man-driven global warming". The other would be from extensive fossil-fuel dependency, which, by nature is a finite resource.

However we can challenge both of these answers. There are increasing arguments towards the fact that overflowing greenhouse gas emissions, especially carbon dioxide, are impacting the world climate. Still the size of this impact as well as whether to adapt to the change or put it to a stop are still in debate. If we consider the last argument this would require a consolidated effort towards alternative energy, in which solar power would have an important and if not mainstream role. The first one doesn't impose any major changes but staying on the actual course of access to the cheapest energy available which is fossil fuels to stimulate economic growth that will (inter many alia) provide support for adaption to the new altered climate.

Similarly, as the rise of hydraulic fracturing has pointed out, previously inaccessible fossil fuel sources are now exploitable due to advances in technology. Also there are growing signs that yet more untouched resources seem to be present, such as methane secluded in the bottom of the sea in icy structures called clathrates. Given this seemingly abundance of fossil fuels one raises the question why to invest in alternative sources like solar power.

In spite of this solar energy demand is growing at a tremendous rate – 100% rise every 40 years. In other words humanity, without any major change, will consume in the next 40 years as much energy as in its entire history. Humanity and nature, then, are playing a game similar to the wheat-on-the-chessboard game proposed in fable by a cunning subject to a mathematically naive monarch who wanted to reward him. Those who believe the game will end disastrously for mankind suggest anticipating the problem by giving solar technologies their rightful importance and investment – even though without subsidies, at the moment, they are not sustainable – so that when needed they can be deployed rapidly.

As an example we will take Germany and how solar energy is impacting the country with pros and cons.

The main pro argument would be that in Germany conventional energy supplies 25% of the country's energy needs; solar energy is accountable for 5% and almost 40% in the summer period; in addition a third of the world's solar cells are put in place here. Given the arguments above solar cells are very helpful.

The main cons refer to the fact that Germany has one of the most expensive electricity cost in Europe; subsidies for green energy amount to approx €20 billion euros every year; also during colder seasons the country is forced to resort to energy imports from her neighbors. The above are pointing towards an increased risk of energy blackouts in the country.

The main reason for Germany's energy imports is that given its geographical positioning there is not much sun present throughout the year, especially in winter. However countries further south have the sun up most of the

time. Should a suitable intercontinental power grid be put in place, countries in Northern Europe would find it possible to switch to solar energy through imports, rather than generating in on-site.

However there are other foreseeable problems in Europe since many of the sunniest nearby countries have governments of questionable stability and unquestionable noxiousness. On the other hand places such as the US, which have sunny deserts within their territories, might find moving solar energy around in this way more feasible.

This opens the gate to another alternative, the fact that we don't need solar energy to save ourselves but we will use it anyway – simply because of the advantages over other alternatives. The above argument is founded on the fact that sunlight is free, and also the running costs of at least the simplest sort of solar power-station, one made of photovoltaic solar cells, are thus minimal. Should the capital costs of this technology go down (which does seem to be happening) coupled with solving the problem of overnight storage (at first glance a much more harder task, but being tackled by many in the present with ideas ranging from using holes in the ground to store compressed air to building huge batteries from cheap materials), and market economics will do the rest.

The future role of solar energy seems very much possible if not attainable. The debate should be fascinating.

Solar energy – Key facts

Main Pros:

- Solar panels are pollution free, the only pollution produced as a result of solar panels is the manufacturing of these devices in factories, transportation of the goods, and installation.
- The production of energy from the use of fossil and some renewable fuels (e.g. wind turbines) can be noisy, yet solar energy produces electricity very quietly.
- One of the great pros of solar energy is the ability to harness electricity in remote locations that are not linked to a national grid. A prime example of this is in space, where satellites are powered by high efficiency solar cells.
- The installation of solar panels in remote locations is usually much more cost effective than laying the required high voltage wires.
- Solar energy can be very efficient in a large area of the globe, and new technologies allow for a more efficient energy production on overcast/dull days.
- Solar panels can be installed on top of many rooftops, which eliminates the problem of finding the required space for solar panel placement.
- Another great pro of solar energy is the cost. Although the initial investment of solar cells may be high, once installed, they provide a free source of electricity, which will pay off over the coming years.
- The use of solar energy to produce electricity allows the user to become less dependent on the worlds fossil fuel supplies.

Main Cons

- The major con of solar energy is the initial cost of solar cells. Currently, prices of highly efficient solar cells can be above $1000, and some households may need more than one. This makes the initial installation of solar panels very costly.
- Solar energy is only able to generate electricity during daylight hours. This means for around half of each day, solar panels are not producing energy for your home.
- The weather can affect the efficiency of solar cells.
- Pollution can be a con of solar energy, as pollution levels can affect a solar cells efficiency, this would be a major con for businesses or industry wishing to install solar panels in heavily polluted areas, such as cities.

Solar energy – Key to world salvation

Is solar energy the key to world salvation? Alone solar energy cannot achieve this (assuming it does need saving). Although we are hyperbolizing in the sense of dramatic impact the world is, however, in the middle part of an evolution in its energy infrastructure. While we are constantly striving to decrease the pollution damage inherent in our current fossil-fuel-intensive society, there is a wide range of technologies stepping up to contribute. Among these we include solar energy, but also a widespread array of options such as energy-efficiency improvements in building, industry and transport; other renewables such as wind, geothermal and biomass; smart grids that feature demand-side management; distributed and central storage to handle the variability of wind and solar; and improved long-distance power transmission to further smooth this variability. Traditional energy sources are also evolving to keep up with the alternative ones, with the continuing advance of natural gas, displacing coal and its higher emissions, cleaner coal with the possibility of carbon capture and sequestration, and even nuclear with the possibility of new concepts that may greatly reduce cost and risk. These technologies will come together in the market place in

fierce competition. Their impact and importance will be caused by their developers' ability to reduce costs and to a lesser extent by government policies.

As stated above our energy system is going through major changes. It may come as a surprise to most people but within the European Union over the last 3 years, photovoltaic, wind and natural gas contributed nearly all the new installed electric generation capacity. Gigawatts (GW) wise photovoltaic accounted for 17 GW), wind 12GW and natural gas 5GW (net of retirements). Due to plant retirements coal and gas contribution were negative. Germany's case study on solar power can be sought as once again to better understand the current state of change. With a population density 6 times bigger than that of the US and half the solar resource per unit area, it has become the global renewable-energy leader among large countries. Of course there are skeptics who argue that solar and wind cannot provide sufficient energy to run a modern economy. In 2012, renewables were responsible for supplying more than a quarter of Germany's energy consumption. Photovoltaic is responsible for 5%, a consistent rise from zero ten years ago (33% of the world's photovoltaic modules are installed in Germany). Should the weather provide sunny days photovoltaic's share rises to approximately 30-40% of the overall electricity demand. The pitfall between these 2 situations has been dealt with by the national German grid without the significant disruption also predicted by skeptics. Moreover the German government is planning to continue its renewable energy expansion program with a target of 80% electricity production from renewable sources by 2050.

It is thus achievable but at what cost. Since its inception photovoltaic energy has been significantly more expensive than conventional generation; however, recently we have witnessed massive increases in manufacturing scale which have resulted in rapidly decreasing prices. The main cause for this is also related to the large expansion of photovoltaic on the German market. In 2012 we saw history in the making with German residences compensation for their rooftop photovoltaic production at less than the prevailing residential electricity retail rate. Going ahead by June 2013 the residential generation feed-in tariff slumped to €0.15 per kilowatt hour (kWh) while the average retail electricity purchase rate was €0.25/kWh. Although homeowners are being paid less than the retail rate, they still continue to install systems because of the attractive returns generation. Ground-mounted photovoltaic plants of large scale are being paid approximately €0.10/kWh. Should we compare this with coal power we see that by adding externalities (health costs, etc) to the cost of coal generated electricity we are almost even, and similar to what large industries pay for their electricity. If we leave out the externalities a further 40-50% cost reduction is needed for photovoltaic to compete with the coal cost. Given the current growth rate there are few who believe this cannot be achieved in the next 10 years. The following argument is laid down to sustain the above: a 50% drop in system prices over the last five years, with tangible signs of another 50% reduction. Should this be reached, photovoltaic will become the lowest cost option for generating electric energy, even in sun-less countries like Germany. Sunnier parts of the world will enjoy this benefit sooner, or, as in Italy, already do.

One cannot set aside the effort German consumers have put in to support this remarkable story by surcharges on their electric bills. This raises the question of how big of an impact has this had on the German economy. Given the fact it's the strongest in Europe and among top 5 of the world we can conclude that the impact was minimal. Another question that we could raise is given the expansion of photovoltaic and the subsequent reduction of fossil fuel electricity plants was there any rise in unemployment figures? Hardly, since German unemployment rate is about 5%, lower than US or UK for instance. Instead of creating economic downturn or employment these surcharges have created a new, non-polluting and renewable energy source for the world. Thus the entire world is indebted to Germany for shining a bright light on what is possible with renewable energy. Luckily more and more countries are also beginning to take similar paths and we are seeing some breakthroughs in the US, Japan and China. We are on the brink of a renewable revolution.

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