Should we continue to subsidize solar energy?

Reflections initiated by an extensive dialogue with Hazel Henderson

A treatise on why a new war of currents is imminent
if we want renewable energies to have a chance.

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When I produced the cartoon video "The Blue Economy" known as the SimpleShow, I received an overwhelming praise for offering a fresh look at sustainability. How could we expect that green products that are expensive, and renewable energy that continues to rely on heavy subsidies ever become mainstream worldwide. Green costs more and whatever is good for our health and the environment is expensive. Time has come to do much better - and propose sustainable production systems and renewable energy sources that outcompete the standard on the market. The reality is that we cannot burden our bankrupt governments any further with demands for subsidies and bail-outs that one day must be paid back with tax payers' income. After having presented over 50 concrete innovations that have been converted to sustainable business models, I felt I had a clear view expressed in a 3 minute clip and read with satisfaction a flow of positive reactions.

This initial success is perhaps the reason why I was so sensitive and attentive to the harsh critique from a very dear and much respected friend who I have known since 1979: Hazel Henderson. She forcefully argued that I was trashing solar energy and torpedoing decades of pioneering efforts by hundreds of green movements. While my short video only stated that it is time to do better than we have ever imagined, her fury over Christmas 2010 and the arrival of the Year of the Iron Rabbit urged me to undertake a deeper reflection and question: "Can we justify asking tax payers to continue paying more for green energy?" To be honest - I did not like the idea of pushing me on the subject much beyond the observations in the paragraph above. However, at the insistence of Hazel I dug deeper into the prevailing logic and listened extensively to her arguments. I believe in dialogue and even if we continue to disagree, we had the opportunity to clarify our positions and reach a higher level of understanding.

Hazel is a trendsetter and a self-declared sun-lover. Her pioneering work on ethical financial markets rivals the best. Her views are well published, her action on the ground is pervasive and widely followed around the world. When we met for the first time at the Club of Rome meeting in Salzburg back in 1979 on the occasion of the launch of the Report "No Limits to Learning", we spent hours reviewing what we could all learn - and unlearn thanks to those dialogues with people prepared to listen to each other. I remember from way back then her passion for solar, which had barely been around as a breakthrough technology for putting man on the moon. Indeed, we were reminded that photovoltaic (PV) cells were designed to provide electricity in outer space. At its origin PV was not aimed at substituting fossil fuels or nuclear power, rather it was a part of this race to bring spaceships in orbit and permit life on the moon.

Decades of Subsidies

Hazel built up a passionate stream of arguments and the one that was very much to the point is that fossil fuel, coal and nuclear have all been widely (even wildly) subsidized for decades. She is right! However, does that provide a reason for subsidizing solar as well - forever? The German government, the largest market for photovoltaics added 7 gigawatt (GW) in a record breaking year 2010 to 17 gigawatt, equivalent to 17 large power stations generating a total of 130,000 jobs at a subsidy costs of 9 billion dollars, nearly 1.3 billion dollars for each giga! The incentives agreed in the year 2000 by the German Renewable Energy Act guaranteed above market feed-in tariffs for solar installations for 20 years from the point of installation! This generous support has helped drive down the cost of photovoltaic (PV) systems. The silicon module prices dropped 38 percent in 2009 over the previous year, and 14 percent in 2010. As demand in Asia and North America expands, factory prices are expected over the next five years to drop another 50 percent below the 2010 level. Unfortunately, even with petroleum above $100 in early 2011, PV is still more expensive than a barrel of petroleum. How come?

Of course Hazel is right again, coal has been receiving subsidies since 1965, and solar had just started to receive a strong fiscal support for about one decade. The fossil fuel industry - according to Greenpeace - received that year an estimated $100 billion in government hand-outs in the G-20 member states. However the annual subsidy for coal in Germany was limited in 2010 to €2 billion ($2.8 billion) and the government has passed a law phasing out all subsidies for coal by 2018. The German share for renewables (wind, solar, biogas, etc) got $17.9 billion - meaning that renewables are slowly but steadily getting a major share of government hand-outs. However - does that make these energy sources competitive?

I need to stress that I am not against renewables, neither that I am out to trash the genuine efforts by thousands of pioneers to get us on a path of sustainable development! I want renewables to outcompete and become the standard not because it gets as much or more government support that fossil fuels or nuclear, rather because these energy sources *are* much better on all counts. This requires more that fighting for subsidies, and accusing fossil fuel lobbies to stand in the way of progress. I am sure

that vested interests will do whatever in their power to secure the livelihood of their non-renewable energy source. Now that renewable energies do get a major share of state support, and do get solid risk financing with a 10 billion dollar capital injection in 2010 alone, it is advancing faster than many of us could imagine. Still let us imagine how solar (and renewables) could emerge as a competitive industry to the point that this and other renewables outperform fossil fuels even without subsidies. Would that not be the ideal situation?

Externalization of Costs

Hazel is quick to respond and to insist that this is not viable. Why not? Because the fossil fuels and nuclear on top of unjust subsidies have externalized so many costs that no one makes them accountable for. Again, she is right. It is clear that nuclear industry would never be a viable industry unless the government offered its blank guarantee that in case there is a major disaster as happened in Japan, the company is not responsible. TEPCO, the owners of the defunct Fukushima nuclear power station will end up in a government supported receivership. This is the most pervasive externalization of costs ever seen: a one hundred percent guarantee that the tax payer foots the bill in case of an major meltdown or accident. There is no insurance premium that needs to be paid to have this warranty. It is decided by parliament. This absolute cover is offered to energy plants built in earthquake zones (Japan), war zones (Korea) and terrorist zones (everywhere lately). Few citizens are aware of the implications of this excessively generous approach. The recent disaster in Japan demonstrates that even the worst case scenarios not only happen, reality can be much worse.

The externalization of these costs has been debated for coal and fossil fuels in the light of climate change. The commitment of numerous nations to tax emissions is a first step in the right direction and billions are now slapped on top of operational costs. Who pays this extra? The consumers (!) since the energy companies simply pass on the carbon tax, while they maintain their profit margins. The strategy to tax carbon emissions had the unintended consequence that nuclear gained in popularity amongst the energy planners. Even though nuclear is not at all carbon neutral, as Fritjof Capra eloquently points out, the impression that it does reduce emissions forces us to ask more fundamental questions and design a more effective strategy to make renewables succeed. We have to go beyond arguing in favor of renewables based on (1) the externalization of costs; and, (2) the over-dependence on subsidies. I come back to my favorite theme within The Blue Economy - let us innovate and outperform by changing the business model. How?

The Next Generation of Solar

Fortunately the first examples of companies doing better than the traditional solar companies that sometimes seem too entrenched are appearing on the horizon. Stefan Larsson originally wanted solar energy to work in extreme conditions like the arctic and antarctic. He and his team concentrated sunlight 3.5 times using reflectors that follow the movement of the sun throughout the year without the need for expensive heliostats, instead of using thin film optics. The geometry of the reflector is designed in such a way

that all light hits the heat absorbing tube or the bottom of the PV wafer. His designs generate heat and electricity in the coldest corners of the world. Lars went on to adjust the reflector so that it gives the highest efficiency when the sun is the lowest in the sky. This innovative approach provides consistent energy output across a wide range of temperatures which together with its modular approach makes it suitable for hot water, district heating, solar cooling, water sanitation, desalination and ... the generation of electricity, all at the same time.

Mr. Larsson went on the create Solarus AB, and while he and his team perfected the technology combining multiple functions into one panel. He also spent considerable time securing a supply chain of core materials by recycling carbon fiber from the aerospace industry and accessing silicon ribbon manufacturing technologies. It is the combination of the multifunctional solar cells and the use of recycled carbon fibers that allows Solarus to offer solar energy to the market cheaper than fossil fuel based energy supply without requiring subsidies. On top of that, Solarus has developed a business model that foresees dozens - and over time - hundreds of local manufacturing plants generating local jobs. The combination of ingenious geometrical designs, the recycling of discarded high tech materials, a decentralized production model, that competes on the market without the need for subsidies (while still welcoming any assistance) makes this a prototype of The Blue Economy.

This is not theory anymore, it has been demonstrated. Sweden is a world leader in district heating, where water is centrally heated and distributed through pipe networks. This system is less capital intensive and more energy efficient than the individual water heating systems that today consume about 30 percent of all electricity for home use. Solarus undertook to power a district heating system with 2,400 square meters of solar and thermal collectors reaching a cost price of only $0.025/kWh, based on a 10 year payback time with government subsidies. Without the subsidies, the district heating would still only cost $0.07/kWhr. If the full lifespan of the solar and thermal collectors were considered, then the price of energy without subsidies goes as low as $0.02/kWhr, at par or even better that subsidized nuclear, coal of diesel fuels. This is the type of breakthroughs in the business model that is needed to really give solar a chance.

The market potential for Stefan Larsson and his team at Solarus AB is tremendous. Each panel generates 300W of power and 880W of heat which converts in a sun deprived nation like Sweden into 264 kWh of electricity and 660kWhr of heat for each panel. This multifunctional system provides electricity, hot water, heating and cooling through a heat exchange system. This turns houses energy neutral. A home would become energy independent (in Sweden) with 8 to 12 panels. The low weight, easy installation, weather proof and ability to operate under diffuse sunlight combined with the use of recycled composite materials have reduced the traditional payback from the usual 3 to 5 years to solely 6 months. Now we are talking business.

The low cost of the Solarus system, its high efficiency and low heat loss opens the opportunity to utilize the solar humidification-dehumidification (HDH) process. While this

was the standard desalination and water purification system decades ago, it was very energy intensive and replaced by reverse osmosis. Now it seems that HDH based on solar technologies from Solarus can provide a constant heat in excess of 100°C required to speed up the evaporation and condensation. Whereas the construction cost would equal any existing facility, the operating and maintenance costs of a desalination plant are cut down by factor ten, proving that innovations in solar outcompete fossil and nuclear even in the absence of subsidies. Fortunately, subsidies will still be the rule of the game, tipping the benefits even faster in favor of Solarus-like solutions. Now, knowing that it can be manufactured locally from recycled materials should have the entrepreneurs in the world sitting on the edge of their chairs, while governments could still provide some support without having to go all the way the German authorities did.

The Need to Change the Business Model

We have to address the need to create a level playing field first and foremost from a technical point of view. It is this point - the technical one - that is unfortunately seldom questioned. When I state that we have to do better - then I refer in the first place that we have to change the business model. Solarus demonstrates how to succeed through multi-functionality, generating multiple revenues. While innovations are always welcome, the latest promises on breakthroughs in solar are once again announcing that its newest twist in production will raise efficiency to new records. I do not pay much more attention to these twists in technology, because even if solar (and wind) were cheaper, this power source will still not have a great chance on the market if it competes according to the technical rules. Let us go back in history and remind us that David beat Goliath not because he built up muscles and engaged in a wrestle as we are asking solar to do against fossil and nuclear. David beat Goliath because he changed the rules of the game, throwing stones with a sling instead of using brute force. Time has come for renewables to change the rules of the game and then really get into the market as the main source of energy.

Some point in history Thomas Edison lost against George Westinghouse and Alternate Current (AC) became the standard for the transmission of electricity. AC permitted back in the 1880's to transport electricity over hundreds of miles without a major loss of power. Edison had to admit that the direct current (DC) generated would lose power already a mile from its point of generation. All major power producing systems from coal, to fuel and nuclear generate AC electricity. However, nearly all renewable energy is generated in DC and then has to be inverted from 12 or 24 Volts DC to 120 or 220 Volts AC to become part of this global grid. While this technical standard of AC made sense a century ago, we realize that a majority of electricity consumed by modern households and offices is in DC. Electronic and mobile equipment operates in DC only, LED lights also function with DC and even transport equipment like trains require DC.

This implies that when the current arrives in AC, there is a need for a rectifier to reverse one of the directions of the current into DC. On the other hand, when solar energy is generated, it first has to be inverted to AC. The cycle of DC to AC and then AC to DC leads to a loss of energy, worse it costs more to produce AC from DC due to the need to

invest in inverters, than it costs to directly produce AC. Solar and renewables have the great advantage that these can produce locally, respond to the immediate needs and when a portfolio of renewables is chosen, then there will always be DC electricity available. Wind and solar are only two major sources, and a third one is likely increase in prominence: the power of gravity.

Continuous Supply of Base Load Electricity

We often neglect the fact that when there is no wind, there is no electricity. A windmill that generates one third electricity over time is a commercial success. The sun only shines on half of the world for half of the day. And when there is a cloud cover, the efficiency drops. A solar panel that can capture on average 5 hours of sunlight a day all year is a success, many have the settle with 2 hours and a half on average. And while there is this theoretical world record of a gallium indium phosphide and gallium indium arsenide PV solar cell capable of converting more than 40 percent of these hours of sunshine into electricity, it costs $10,000 per square centimeter. This is the key reason why renewables have such a hard time competing with non-renewables: a nuclear power station can run non-stop for 6 weeks, a fuel or gas-fired power station can be switched on and off at will, and all run on AC. Renewables are not capable of stabilizing the grid with a guaranteed continuous supply.

The response to the unpredictability of supply of energy from renewables like wind and solar has been compensated with an investment in storage batteries. This increases the consumption of batteries made from chemicals like sodium sulphur, or lithium potassium. The largest battery pack in the world is capable of storing 34 MWhr at a premium cost. The best batteries in the world - not surprisingly the most expensive ones - can indeed stabilize the grid and offer a back-up. However, the additional expense puts renewables outside the competitive game, and once again leads to calls for subsidies - while increasing the pressure on mining and smelting of rare earth metals? While we want to reverse climate change, and we do not wish to rely on petroleum that soils our oceans, and nuclear that leaves us with unwanted waste, while no one has a solution for radiation that is impossible to control at times of crisis, we do realize that the present state of affairs where at best (1) renewables operate one third of the time, (2) have to invert, and (3) can only stabilize the grid with back-up batteries, is not an investment strategy that is likely to have a chance were it not for massive subsidies.

Strengths and Weaknesses

The question is then again: "How will renewables outcompete non-renewables?" What are the changes in the rules of the game needed to make renewables mainstream, and that fossil fuels do not make sense anymore. I am submitting that time has come for a new "War of Currents", like the one that was fought in the late 19th century between Westinghouse and Edison which lead to the famous winning of Westinghouse and its AC-based system. The key to the AC system is a massive central production with a determined search for economies of scale at the point of generation of electricity, a huge grid for distribution over long distances with often electricity masts transporting power over communities void of energy. Unfortunately today, million dollar investments

The Weaknesses of Renewables.

First most renewables produce electricity without predictability. No one can guarantee power each hour of the day. The only way to have continuity is to (1) add batteries and (2) blend the technologies, that is to say have wind, solar and biogas combined with hydro. This is expensive.

Second renewables only produce DC and the grid is AC. This imposes the need to invert the DC to AC and that cannot be achieved without a loss of power and an additional expense.

aim to create huge solar parks and feed that same grid. There is no way that solar or wind will ever compete, not even with the wildest subsidies. That is not because the technology is wrong or bad, that is because the grid system as designed and the way the business is regulated it cannot never compete!

While the weaknesses are clear, the potential strength is equally powerful. The growth in demand for electricity is in DC. We often forget that light systems are DC or AC indifferent, but LED lighting systems benefit tremendously from a direct sourcing of power and since so little is needed to generate a bright illumination, only minute sources of energy can continuously provide clarity into the building. All electronic computing equipment runs on DC only and the occasional print that is required - exceptional since digital is increasingly the standard - can be made at a central point, doing away with the status symbol of one printer per work station that only contributes to worsening indoor health. Elevators can also operate on DC!

The weakness of the non-renewables and nuclear has been overlooked by most of the people committed to sustainability: the grid is made for AC, but the demand is for DC, and non-renewables all produce AC, and most renewables generate DC. So why do we want DC from renewables to compete with AC from non-renewable forcing it to flow over a grid made for AC? I repeat, not even the most generous subsidy scheme, not even the greatest breakthrough in solar technologies can ever make this work. So what would work?

On the Grid or not on the Grid

The answer is right before us all the time: change the rules of the game. How? Stop using the grid! The best innovative competitive strategy is to eliminate the dependency on the grid. Where does solar energy work? In the developing world, where there is no grid! Why? Provide the direct link between the point of consumption and the point of production without ever having to invert DC to AC and rectify AC back to DC. The only one making money on this AC dominance is the supplier of the inverters and rectifiers, Did we ever realize that forcing renewables into the grid is the ultimate strategy of the non-renewable energy providers to remain in charge? Force the renewable onto the grid. Can you imagine that each cell phone and each computer in the world would be able to plug directly into its local supply of energy, instead of having to carry the bulky

and expensive chargers (which is a rectifier plus a charger) tapping into power generated a thousand miles away? Can you imagine all the copper and metals that could be saved if this were not necessary anymore? Do you realize the reduction in risks of fire through short circuits caused in faulty switches of 120 or 220 Volts, and that there are no risks of fire with 12 or 24 Volts?

A Portfolio of Renewable Energies

This is exactly what The Blue Economy is proposing. Time has come to use all the minute forms of energy that are in abundance around us. We somehow have limited our spectrum of renewables to wind, solar, biogas, tidal and wave, geothermal and hydro. That is it. We have blocked creativity from the process of finding truly sustainable and renewable sources. Have we ever wondered how a whale pumps 1,000 liters of blood through 175 million kilometers of veins generating electricity from sodium, potassium and calcium? Have we ever wondered how the apple that falls from the tree first harnessed energy from several sources to go against the force of gravity? Do we realize that the fluttering of a cord, made of different materials generates enough electricity to light up your house? Have we ever realized that the mere pressure on a crystal generates enough energy to power LEDs, and whenever there is a difference in temperature, it leads to the generation of currents? What about the differences in pH, that powers cells to the order of 70 millivolts. And what about the pressure of our voice that sends sound waves that could already power the spy microphones during the cold war? We watch this happen before our eyes in James Bond movies, and then simply forget about it.

All these energy sources are considered irrelevant and unreliable by any electric engineer today. Correct! When the grid is based on AC and the engineers would have to contemplate inverting 70 millivolts to 240V then it is a costly affair. The obvious solution has been the battery. Do we realize that over the years perfectly functioning applications of piezo-electricity (created by crystals under pressure) have been substituted by batteries even though the first remote controls, phonograms and microphones solely worked with these abundant energies without ever failing? This invasion of the battery into everything and the submission to the AC engineered power grid is what made and makes renewables uninteresting, and therefore all the innovations listed in the previous paragraph remain largely to be discovered and undeveloped. That is why solar and wind have been the only prominent ones since these can generate enough voltage to make the inversion technically viable, even though most of the times (when there is a grid) it is commercially unviable for the reasons explained.

If on the other hand we create an portfolio of renewable energy generation that is totally local - by this I mean very local with cables on average less than 4-5 meters between point of generation and point of consumption - then we could operate everything in DC, with a base load supplied through a core backbone. The standard unit would be a house, a floor or a building. The higher the structure, the more energy it will generate - and with dozens of energy sources constantly available, there will be a stability in the power supply that outcompetes in price and efficiency AC. This is the end of the days of

continental interconnectivity. I am convinced that the backbone of all energy supply has to become the most stable source of power, one that works 24 hours per day, all year around without any variations or uncertainties: the first one is gravity, the second one is biogas produced from organic municipal solid waste blended with slurry from waste water treatment. Supply of both gravity and waste is guaranteed.

Gravity and Biogas as Base Load

Any secure and stable building has a tremendous potential generating energy from gravity in numerous forms. Whereas the weight of the building could generate at each floor, at each compression point enough electricity to power indoor and outdoor light 24 hours a day - so it could even work in the Arctic Circle in the winter time! A building of ten floors generates more than one of five floors, since it is heavier but also since buildings that are taller swing slightly more with the turning movement of the earth around its axis which makes all buildings move just enough to exert mechanical pressure on crystals now carefully placed throughout the structure, generating electricity. This technique is very well known, and while that has been considered too little to be of any interest, the energy efficiency of electronic equipment, thanks to the reduction of the chip sizes and energy requirements, makes this an attractive new option. This will drive the energy efficiency of the electronics industry and over time energy guzzlers like bluetooth - the Hummer of Electronics - will be replaced by truly energy efficient devices.

The same force of gravity has been harvested for decades from any flow of water, but once again we were looking for economies scale, and went on to build huge dams. Cities have the same collective potential as dams, only it is very well distributed. Whereas water may need to be pumped up the roof when the municipal supply does not have sufficient pressure, once it is on the roof (and complemented with collected storm water) it represents a tremendous energy potential. If the building houses one thousand persons over ten floors, then there will always be a minimal flow for sanitation. All pipes should be equipped with electricity generators from the flow and while this may seem once more too little to be of any value, it is sufficient to provide additional sources for equipment that already has an internal battery back-up - like laptop computers, iPads, cellphones, cameras. The irregular flow of water over the day may not keep the batteries full all the time - and will never continue charging for electricity while trying to charge an already full battery (as is the case in 90 percent of the charging equipment). I am always amazed how quick these options are dismissed basically due to the fact that no one has really been exposed to these opportunities, or to the mind bloc that has been created with the AC powered grid that only pushes for high power and economies of scale. And then there is biogas - impossible to simply send black water off through the sewage system to be treated, biogas will become the standard and more can be read about this in other articles of mine.

Bundling

Over the years I have collected dozens of these energy sources. Once I realized the power of the bundling all these opportunities around a shift in the grid to DC only, then I

saw the light. Inventions and breakthroughs in renewable from Solarus to ITRI and Scandinavian Biogas and Wind-it, will now have a real chance on the market but instead of trying to force the governments to change the grid standard and force a decision, we simply show how buildings from private homes, to radiating hotels and office buildings can generate 40 percent more energy than they ever require, and that fire safety improves thanks to the shift to DC - and even children can now put their fingers into the plug - without any risk of electrocution. Once we start seeing that we can change one building at the time, we will also realize that the future for renewables is bright and the governments should only offer "a license to operate", and from there on common sense will prevail faster than we ever imagined. It seems that the first such building is under construction in Berlin! The Germans - again.

I wonder if my dear Hazel would agree with this?

This next article will be entitled "Nuclear's Exit based on Consensus and Cash".