Renewable Energy: Is That Where Salvation Lies?

By Roger Blanchard

A number of prominent American environmentalists, as well as individuals not necessarily noted as environmentalists, have stated that the best way to avoid catastrophic global warming is to switch, as quickly as possible, from fossil fuels to renewable energy sources. The list of noted individuals seeing salvation in renewable energy includes Bill McKibbon (350.org), Michael Brune (Sierra Club), Paul Krugman (economist), and Joe Romm (Climate Progress).

According to Paul Krugman, not only can renewable energy sources replace fossil fuels, presumably totally, but they can do it cheaply, rapidly and with economic advantages to those countries that move in that direction. Michael Brune has written that the U.S. can be essentially free of fossil fuels by 2030, 15 years from now. Easy, cheap and fast - that's what I call optimism.

It's common to read on blogs dealing with global warming that the only thing preventing renewable energy from replacing fossil fuels in short order within the U.S. is the political muscle of the fossil fuel industries.

Germany is offered as a template for how governments can encourage a move to renewable energy. Germany has had a fairly long legislative framework for promoting renewable energy starting in 1990 with the Electricity Feed Law and moved further along with the Renewable Energy Law of 2000. These laws set goals for electrical generation from renewable energy sources and offer substantial subsides to achieve those goals. Thus, Germany has had a fairly aggressive effort in renewable energy for 25 years.

Table I has energy consumption and CO_2 emissions data for Germany in 1990, 2000, 2010 and 2012.

Energy Consumption and CO_2 Emissions for Germany

Year	Oil	Natural Gas	Coal	Total Fossil Fuels	Total Energy	% Fossil Fuels	CO_2 Emissions (million metric tons)
1990*	5.523	2.192	5.394	13.109	14.857	88.2	990.6
2000	5.720	3.042	3.448	12.210	14.261	85.6	854.7
2010	5.093	3.422	3.155	11.670	14.021	83.2	797.0
2012**	4.947	3.094	3.210	11.251	13.466	83.6	788.3

Table I: Energy consumption values are in quadrillion BTU and data is from the U.S. DOE/EIA

*1990 data is the sum for East and West Germany

**This is the most recent complete data from the U.S. DOE/EIA

Between 1990 and 2012, Germany's energy obtained from fossil fuels declined 14.2% and CO_2 emissions dropped 20.4%. Carbon dioxide emissions dropped 13.7% from 1990 to 2000 and 6.8% from 2000 to 2010. The higher percentage decline for CO_2 emissions from 1990 to 2000 can be attributed largely to easier to eliminate coal uses within Germany (see Figure 1).

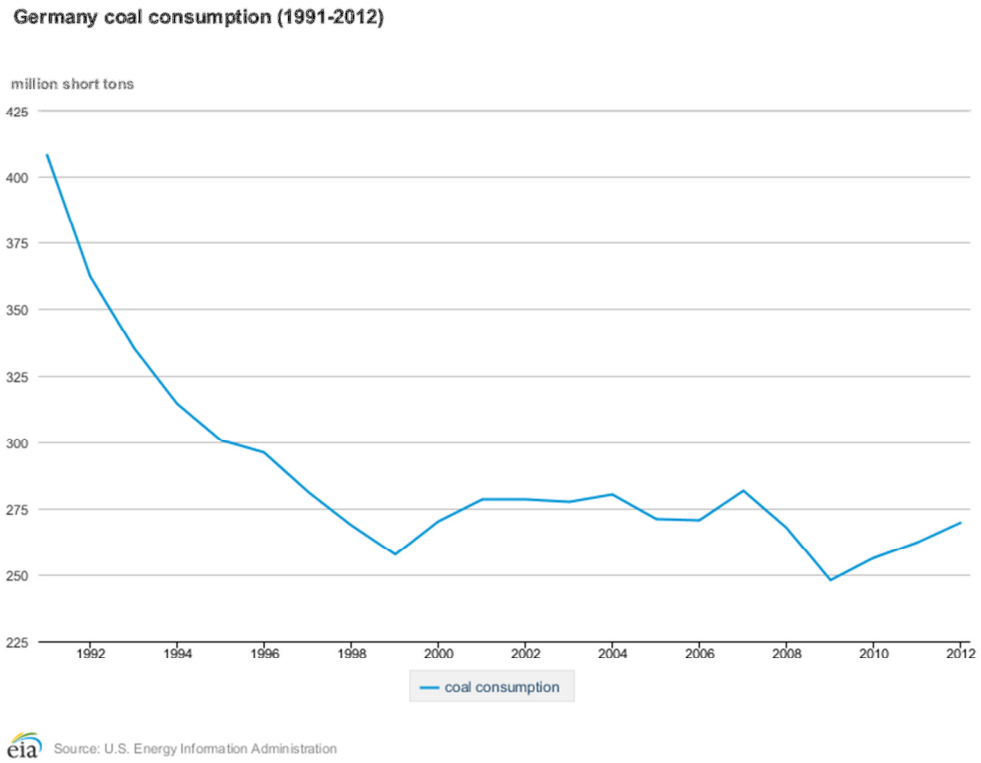

Figure 1- Coal consumption in Germany since 1990

I occasionally read that a high percentage of daily **electrical** energy generation within Germany is due to renewable energy sources, namely wind and solar. That can be the case on good days when the wind is blowing strongly and/or the sun is shining brightly. There are also many days when little electrical energy comes from renewable energy sources. That is particularly the case during winter because of limited sunlight hours, low incoming radiant flux angles and the attenuation of incoming solar radiation by clouds (see Figure 2).

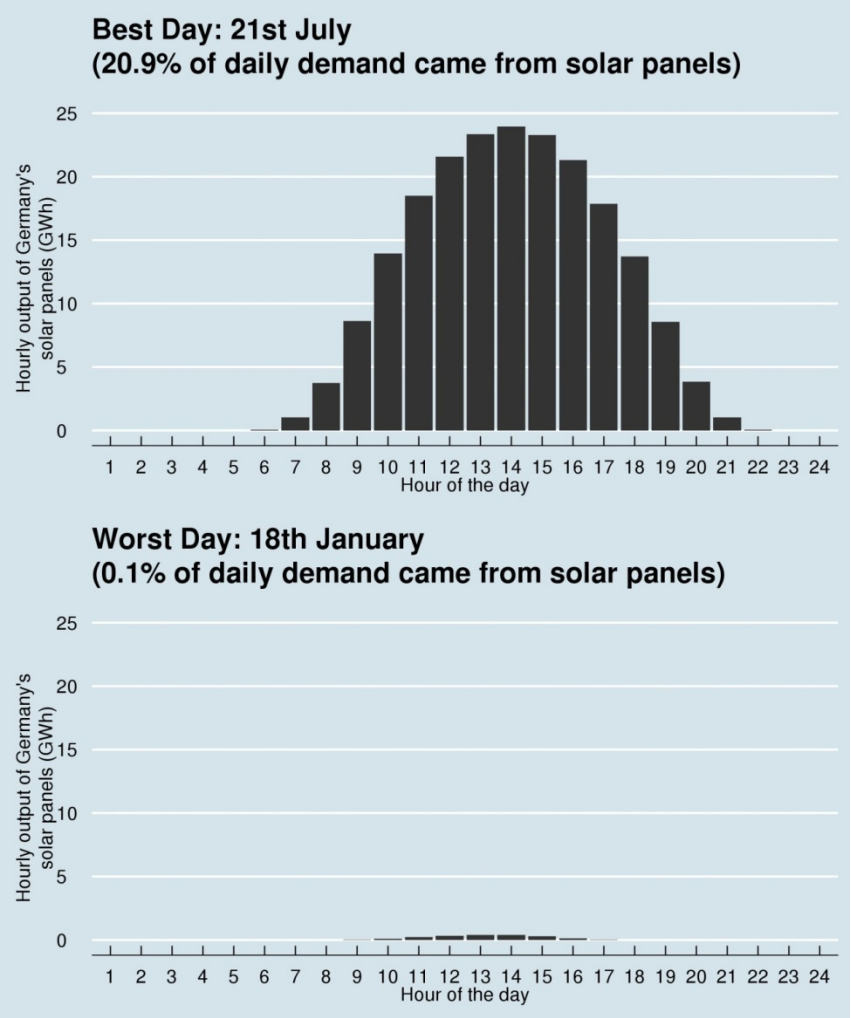

Figure 2 – The best and worst days for solar electrical generation in Germany during 2013

There can be a large gap between the generating capacity of wind and solar, the maximum amount of electrical power they can produce, and how much those sources actually produce. That is because the wind isn't always blowing strongly and the sun isn't always shining brightly. Installing more solar and wind generating capacity will not change that fundamental limitation of renewable energy generation in Germany.

There isn't the storage capacity in Germany to store electrical energy for prolonged periods when wind and solar produce little energy. It's unlikely that the necessary storage capacity will be built anytime soon because of the high cost of building such capacity.

Averaged over the course of a year, renewable energy (wind, solar, geothermal, biomass, and hydro) provided ~24% of Germany's **electrical generation** in 2012 (see Figure 3) and a reported ~30% in 2014.

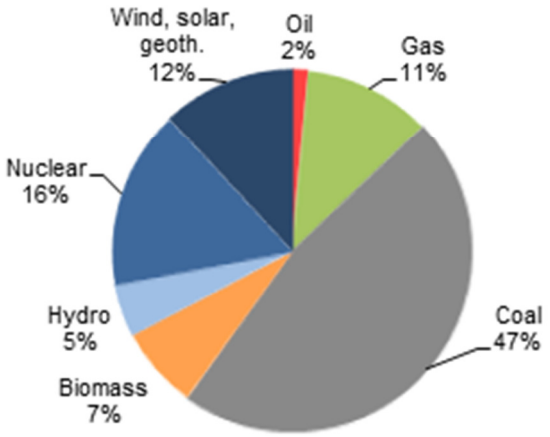

Figure 3-Germany's electric power generation by source in 2012

At the end of 2013, there were 36 gigawatts of installed solar capacity in Germany which produced 28.3 terrawatt-hours of energy. For the period 2011 through 2015 Germany plans on installing 19.7 gigawatts of new coal-burning power plant capacity with an average annual output of 75 terawatts hours of energy. Coal provides considerably more energy from its installed capacity than solar or wind do. In the case of wind, Germany's capacity factor, the percent of produced power relative to its maximum potential, has generally been under 20% each year over the last 20 years.

In recent years nuclear power has supplied approximately 16% of Germany's electrical energy. It's German government policy to phase out nuclear power by 2022 so that either fossil fuels or renewable energy will have to fill the gap that phasing out nuclear power will create. The expectation by authorities is that in 2023, coal and natural gas will be relied upon as much, if not more, than in 2013 to generate electrical energy as nuclear is phased out.

Figure 4 is a bar graph showing how much **primary energy**; which includes **electrical** as well as **non-electrical** energy such as non-electrical energy used in transportation, heating, industry, etc.; that has come from renewable energy sources in recent years for Germany.

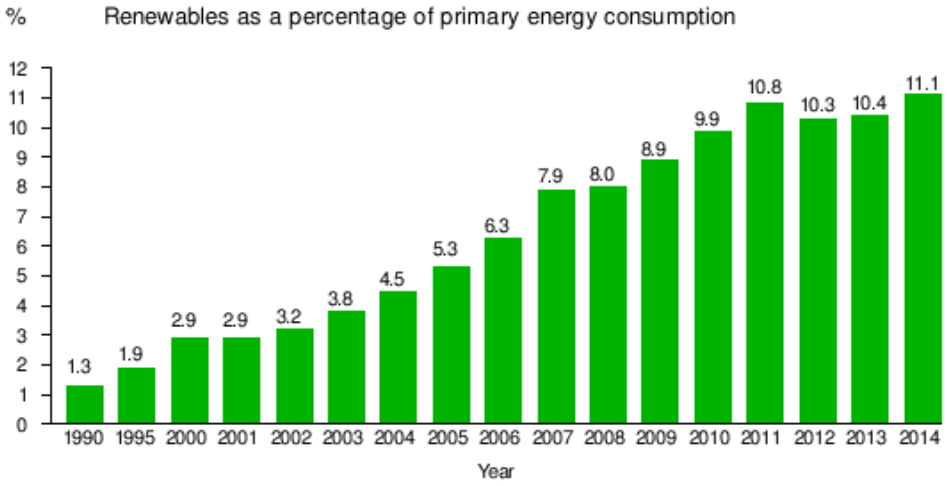

Figure 4-Renewable energy as a percentage of primary consumption in Germany

There are sectors of the German economy that remain heavily dependent on fossil fuels and will remain so for the foreseeable future. Those sectors include aviation, surface transportation, mineral extraction, agriculture, heavy construction, etc. so no one should expect renewable energy to provide most or all of Germany's energy anytime soon.

Since I have been taking Germany as an example of a country that is doing far more than most to transition from fossil fuels to renewable energy sources, imagine for a moment what it would mean if we took Germany as the standard for how much per capita CO_2 emissions people around the world should be allowed to generate.

If that were the case, people in the U.S. would have to dramatically cut their CO_2 emissions from ~17 metric tons/person/year to ~10 metric tons/person/year. That wouldn't go over well in the U.S.

On the flip side, people in developing countries would be able to dramatically increase their CO_2 emissions. As an example, per capita CO_2 emissions in India could increase from ~1.7 metric tons/person/year to ~10 metric tons/person/year.

Globally, if all countries had the per capita CO_2 emissions of Germany, CO_2 emissions would rise from the present ~35 Gtonnes/year to ~72 Gtonnes/year. That's not so good if the objective is to reduce global CO_2 emissions in order to avoid catastrophic global warming.

If there is one country that should want to move in the direction of renewable energy, it's Japan. Japan has no indigenous coal production and next to no oil and natural gas production so they have to import almost all of the fossil fuel energy they use.

Japan has attempted to rely heavily upon nuclear power as a means of reducing imports of fossil fuels as much as possible. The Fukushima Daiichi Power Plant disaster in 2011 has led to a

substantially increased reliance upon fossil fuel energy in Japan as can be seen in the data of Table II.

Japanese Energy Consumption and CO_2 Emissions

Year	Oil	Natural Gas	Coal	Total Fossil Fuels	Total Energy	% Fossil Fuels	CO_2 Emissions (million metric tons)
1990	10.807	2.142	2.739	15.688	18.768	83.6	1047
2000	11.131	3.077	3.939	18.147	22.408	81.0	1201
2010	**8.920**	**4.078**	**4.827**	**17.825**	21.793	**81.8**	1177
2012*	**9.520**	**4.722**	**4.725**	**18.967**	20.306	**93.4**	1259

Table II: Energy consumption values are in quadrillion BTU and data is from the U.S. DOE/EIA

*This is the most recent complete data from the U.S. DOE/EIA

There are efforts in Japan to increase the use of renewable energy but Japan will rely heavily upon fossil fuels for the foreseeable future. I assume there isn't a large fossil fuel lobby in Japan that is preventing a move to renewable energy as some claim is the case in the U.S.

Despite the desires of many American environmentalists to see the U.S. become largely or totally free of fossil fuels, that certainly won't happen in the next 20 years, if ever.

Why won't the U.S. move beyond its great dependence on fossil fuels in the next 20 years, or even in the next 50? Because fossil fuels have major advantages in terms of energy density, energy on demand, and relatively high energy return on energy invested values.

It's appealing to think that these advantages aren't important, but they are. And because they are, the U.S., and other developed countries, will continue to rely heavily upon fossil fuels in the foreseeable future no matter how much they may want to transition to renewable energy sources.

A problem with expecting renewable energy to be the solution for global warming is that it gives people the impression that it's not necessary to actually cut back on energy use. That is because the energy will come from renewable sources at some point in the near future, or at least that is the promise. So in the view of many and perhaps most people today, if renewable energy use doesn't grow rapidly, it's due to backward politicians and the power of the fossil fuels lobby, not to the practical limitations of renewable energy sources.

There will of course be a transition to renewable energy as fossil fuels are depleted as there is no alternative, but what we will end up with is far, far less energy consumption than we have today, and far, far less than most people believe we will have in the future.

If the ultimate results associated with the continued burning of large amounts of fossil fuels are nasty, that will be unfortunate but people today have lifestyles to maintain or to strive for and they can't be bothered with the long-term consequences of those lifestyles. That is for people

in the future to deal with. Although most people today have no appreciation or even understanding for the implications of physical phenomena such as thermal inertia or positive feedback, people in the future will get to experience the results of those phenomena.