IMPACT OF PV SOLAR FEED-IN-TARIFFS IN GERMANY, by Willem Post; 27 December, 2010
http://www.coalitionforenergysolutions.org/

INTRODUCTION

The purpose of this study is to show the impact of the http://1bog.org/top-10-countries-using-solar-power/ ">PV Solar feed-in-tariffs, FITs, in Germany. It has the largest installed base of grid-connected PV solar systems in the world, and much data is available about it.

Prior to 2000 PV solar FITs did not exist and there were almost no PV solar systems in Germany, because Germany's annual PV solar capacity factor, CF, for true-south-facing, fixed-tilt, correctly-angled systems is about 0.115, which makes it a very poor candidate for unsubsidized PV solar power.

By 31 August, 2010, German households and businesses had installed about 700,000 grid-connected PV solar systems with a total capacity of 14,680 MW due to the subsidies and generous FITs in effect starting in 2000.

The FITs are lucrative for the households and businesses with grid-connected PV solar systems. They get to sell all of their PV solar power to the utilities at generous, but declining FIT rates for 20 years from date of installation. The average FIT rate was $0.54/kWh in 2009. For comparison: In 2009, the average wholesale rates at which German utilities buy and sell were about $0.058/kWh for base load power and about $0.075/kWh for peaking power.

Households with solar systems buy power for their own consumption from the utilities at about $0.28/kWh, for a gain of $0.26/kWh. Businesses buy power for their own consumption at about $0.20/kWh, for a gain of $0.34/kWh. Note: US dollar is about 0.725 euro.

http://www.energy.eu/

German utilities are allowed to include the additional costs of the FIT regime into their rate base. In effect, the few more wealthy households and businesses are being subsidized by the many less wealthy households and businesses. In 2009, renewables FITs added $0.029/kWh to household rates and are likely to add $0.05/kWh in 2011, mostly due to the added PV solar systems in 2009 and 2010. Businesses are complaining about higher electric bills making them less competitive.

STUDY SUMMARY

The main results of the subsidies and generous FITs have been huge investments in PV solar systems and huge FIT subsidies paid to the owners of PV solar systems that produce just a very small quantity of variable, intermittent and expensive power and avoid the emission of a miniscule quantity of CO2 per installed MW.

Capital Investments

During the 2000-2009 period that FITs were in effect, Germany installed 9,830 MW of PV solar systems by the end of 2009 at a cost of about 9,830,000 kW x $6,000/kW (2000-2009 average) = $59 billion. The 2000 PV systems were about $9,000/kW, the 2009 PV systems were about $5,000/kW, and the 2010 PV systems are about 4,300-5,200 $/kW, depending on the type of installation.

http://www.solarplaza.com/article/booming-german-pv-market-could-cost-ratepayers-70
http://www.gtai.com/fileadmin/user_upload/Downloads/Industries/Renewable_Energies/Photovoltaics/1_Englisch/IndustryOverview_Photovoltaics_August2010_GTAI.pdf

Solar Power Production

Germany's installed power plant capacity is about 135,000 MW and its peak power demand is about 100,000 MW. Its power production was 594,100 GWh in 2009, of which PV solar power was 6,578 GWh, or about 1.1% of Germany's production.

If we assume PV solar power is produced from 7 AM to 5 PM, then the average level during these ten hours was 6,578 GWh/yr x 1,000 MW/GW x 1 yr/(10 hr x 365 days) = 1,802 MW, insignificant compared to Germany's peak demand of about 100,000 MW.

FIT payments

For the systems installed during the 2000-2009 period, the FIT amount that has been paid by utilities for the PV solar power fed into the grid from the start of 2000 and that will be paid until the end of 2029 http://repec.rwi-essen.de/files/REP_09_156.pdf ">has been estimated at $73.2 billion.

In 2009, German utilities paid 2.48 billion euros, or $3.54 billion, for the 6,578 GWh PV solar power produced by an effective installed capacity of 5,950 MW (start 2009) + 1/2 x 3,880 MW (added in 2009) = 7,890 MW. The 2009 average FIT was about $3.54 billion/6,578 GWh = $0.54/kWh.

http://www.slideshare.net/solarplaza/the-solar-future-de-karl-kuhlman-can-solar-pv-compete-with-grid-energy-in-germany-by-2013
http://rwecom.online-report.eu/2009/ir/3/reviewofoperations/environment/germanelectricityprices.html

The German government had budgeted a certain amount for PV solar subsidies for 2010. Because of the rapid rate of installation of PV solar systems to beat FIT reduction deadlines, this amount is depleted.

The German government, already under budget pressures, is finding it politically difficult to rein in the inefficient PV solar sector which will become more harmful to the stability of the grid and overall efficiency of the economy as it gets bigger.

The German government, over much opposition, has decreased the FITs at a faster pace than originally planned, and is planning still faster FIT decreases, to slow the growth of the sector to a more sustainable rate. There were FIT reductions of 9-11% on 1 January, 2010, 8-13% on 1 July, 2010, and 3% on 1 October, 2010. Additional reductions are planned for 2011. These reductions are on top of the scheduled reductions. These FIT reductions caused spikes of 1,461 MW and 1,700 MW installed in December 2009 and June 2010, respectively, to beat the deadlines.

http://repec.rwi-essen.de/files/REP_09_156.pdf
http://uvdiv.blogspot.com/2010/02/german-solar-industry-protesting.html
http://www.renewableenergyworld.com/era/news/article/2010/05/germanys-solar-pv-industry-a-victim-of-its-own-success
http://www.solarplaza.com/article/booming-german-pv-market-could-cost-ratepayers-70

Capacity Factors

In 2009, Germany's PV solar CF was 6,578 GWh/(7,890 MW x 8,760 hr/yr) = 0.095. The low CF may indicate the PV solar panels are aging, dusty, partially shaded by trees, partially snow-covered, etc., and, as about 80% of the PV solar systems are roof-mounted, many roofs may not be true-south-facing and the panels may not be correctly angled. Germany could raise its average, if it installed more suntracking systems that would have CFs of about 0.16

http://theenergycollective.com/willem-post/46142/impact-solar-pv-feed-tariffs-germany

STUDY ANALYSIS

PV Solar FIT Cost, Production and Capacity Factors

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Variation of PV Solar Power and Grid Stability

The sma.de website displays a graph of the real-time PV solar power production in Germany during each day of the year. The methodology of determining the display is explained in the website.

The website shows 14,680 MW of PV solar was installed as of 31 August 2010, which means 14,680 MW - 9,830 MW (end of 2009) = 4,850 MW was installed during the first 8 months of 2010, or about 606 MW/month.

http://www.sma.de/en/news-information/pv-electricity-produced-in-germany.html
http://www.allianceforrenewableenergy.org/2010/10/germany-adds-nearly-1-of-electricity-supply-with-solar-in-eight-months.html

This rate of installation is more than twice as high as in 2009, because the FITs will be significantly reduced in 2011 making it less lucrative to own a PV solar system. Installations planned for 2011 are being shifted to 2010 to beat the FIT reduction deadline. For comparison: US total installed PV solar was 1,256 MW pus 397 MW of concentrated solar power, CSP, at the end of 2009.

The website shows the PV solar power production from the 14,680 MW of PV solar systems reached a maximum level of about 5.3 MW (36% of installed PV solar capacity), 3.6 MW (24%) and 7.0 MW (48%) at about 12 noon on October 6, 7 and 8, respectively.

The website shows that maximum outputs at 12 noon vary from about 20% (2,936 MW) to about 60% (8,808 MW) of installed capacity during the summer and from about 10% (1,468 MW) to about 30% (4,400 MW) of installed capacity during the winter.

The rapid build-up of PV solar power capacity will have an increasing effect on grid stability.

http://www.upi.com/Science_News/Resource-Wars/2010/10/19/German-grid-aching-under-solar-power/UPI-13471287518368/

Daily Power Demand

The Tagesgang website displays a typical power demand curve for Germany. This curve will vary somewhat during the year, but, to simplify the analysis, we will assume the curve is valid for all days of the year, which will not affect the conclusions of the study.

http://en.wikipedia.org/wiki/File:Tagesgang_engl.png

The website shows peaking unit operation from about 10 AM to about 2 PM which coincides with high levels of PV solar production. This means German utilities have less need for peaking units.

PV Solar Power Impact on Peaking Unit Operation

Peaking units usually are gas-fired, simple-cycle, gas-turbine generators. Their efficiency at full load is about 35%, or about 9,750 Btu/kWh, and at 50% load about 30%, or about 11,375 Btu/kWh. Peaking units usually operate at about 50% load otherwise they cannot modulate as needed by demand.

For this study, utility long-term gas contract prices are assumed at $4/million Btus.

As we know the total FIT subsidy paid in 2009, we can allocate a part of it to the 10 AM to 2 PM period and the rest to all other hours of of PV solar power production.

If we assume the average PV power output during the 10 AM and 2 PM period of each day of 2009 at about 2,500 MW and all of it is fed into the grid, then German utilities save about 2,500 MW x 1,000 kW/MW x 4 hrs/day x 13,375 Btu/kWh x $4/million Btu = $0.54 million/day in fuel expenses. The savings are somewhat less due to spinning reserves kept in operation in case PV solar power lessens due to weather events (clouds, snow, rain, etc.)

There are very little additional savings, because the peaking units are in service during other peak periods of the day (see Tagesgang website) when PV solar power is much less. The operating personnel are present whether the peaking units are operating or not.

In 2009, German utilities credited, as required by the FIT scheme, the monthly bills of the owners of PV solar systems on average about 2,500 MW x 1,000 kW/MW x 4 hrs/day x $0.54/kWh = $5.4 million/day for this 10 AM to 2 PM power, or 365 days/yr x $5.4 million/day = $1.97 billion for all of 2009.

The FIT amount credited for all other hours of PV solar power production was about $3.54 billion - $1.97 billion = $1.57 billion.

German utilities could have bought the PV solar part of the 10 PM to 2 PM peaking power for $0.075/$0.54 x $5.4 million = $0.75 million/day from the grid, instead of buying it from PV solar system owners for $5.4 million/day.

A drawback of the PV solar power during the 10 AM to 2 PM period is that it is variable from day to day due to cloud cover changes, which means the peaking power purchases by utilities will vary from day to day more so than if the peaking power had been bought only from the grid.

This average level of PV solar power will increase as more PV solar systems are installed. It will have an increasing effect on the costs of owning and operating spinning reserve power plants and on the costs of standby power plants and transmission and distribution systems.

PV Solar Job Creation

By the end of 2009, the German PV solar sector employed, directly and indirectly, about 65,000 people and the thermal solar sector about 15,000 people in production, distribution, installation and maintenance. Employment is higher in 2010, because the rate of installing PV solar systems has increased to beat FIT reduction deadlines. The sector would employ even more people, but because China is the low-cost PV solar panel producer in the world, most of the panels, at least 50% of the systems' cost, are imported which creates jobs in China, not in Germany.

There are several German studies and at least one Vermont study that conclude jobs created in the PV solar sector reduce about an equal number of jobs in other sectors, because resources, due to subsidies, are shifted to the PV solar sector away from other sectors; i.e., there is no free lunch.

According the Vermont Department of Public Service, VT-DPS, report "The Economic Impacts of Vermont Feed in Tariffs", about $228.5 million will be required to implement 50 MW of FIT subsidized renewables and that 35% of that amount would be supplied by Vermont sources, the rest, mostly equipment, by non-Vermont sources. For example: PV panels from China and inverters from Germany are about 70% of a PV system's materials cost.

The VT-DPS report states: "There would be a spike of about 550 short-term jobs during the 1-3 year construction stage which would flatten to a permanent net gain of 13 long-term full-time jobs during the operation and maintenance stage. In essence jobs are created in one sector (renewables) of the Vermont economy at the expense other sectors".

It appears using scarce ratepayer/taxpayer funds for a government-subsidized, capital-intensive renewables program that produces just a little of expensive power and reduces CO2 at a high cost per dollar invested is NOT the jobs creation panacea so much talked about by proponents of renewables. If the legislature were to bless Vermont with more such ineffective programs Vermont would be in even deeper financial trouble than it is now. See below website.

http://publicservice.vermont.gov/planning/DPS%20White%20Paper%20Feed%20in%20Tariff.pdf
http://www.coalitionforenergysolutions.org/renewables_are_expensive_an.pdf
http://www.germany.info/Vertretung/usa/en/09__Press__InFocus__Interviews/03__Infocus/03__ClimateBridge/Studies__Pubs/BMU__Gross__employment__from__RE__in__Germany__2009__DD,property=Daten.pdf

CONCLUSIONS

The study indicates the political decision of "going solar" in Germany in 2000 is beyond reason with regard to economics, air pollution and global warming. It is an extremely expensive way to subsidize an industrial sector, create jobs and reduce CO2.

Because of the large gap between the FIT rates and utility electric rates, it is an easy decision for German households and businesses to "go solar", much to the delight of PV solar vendors, financiers and developers who call this (for them) a success. Spain is having a similar disastrous experience with its solar FITs. See website.

http://www.bloomberg.com/news/2010-10-18/spanish-solar-projects-on-brink-of-bankruptcy-as-subsidy-policies-founder.html

If we are to slow down climate change at a reasonable cost, we must use technologies that provide the greatest reduction in CO2 per dollar invested, such as energy efficiency (CF about 1.0) and nuclear (CF about 0.90). As a renewable, PV solar is among the highest in capital cost per installed kW and the lowest in power production and CO2 reduction per dollar invested.

Those advocating PV solar for creating new industries and jobs, etc., completely miss the point; those are, at best, side issues. We NEED to do energy efficiency, nuclear and renewables to avoid/minimize global warming. Therefore, we need to have a structure of priorities.

For example: It is much better to first deal with the urgent issue of global warming and later work on viable solutions for decommissioning, waste processing and storage.

Capital-intensive investments in inefficient PV solar systems that, without subsidies, have simple paybacks of 20-40 years divert resources from less capital-intensive measures, such as energy efficiency that, without subsidies, has simple paybacks of 1-5 years, AND reduces CO2 more effectively, AND requires no changes to the grid, AND is quiet, AND is INVISIBLE.

Doing energy efficiency first and renewables later is an easy choice to make. There may be money in Germany, but not in the US and other nations, to do both at the same time.

Supplementary Websites

http://en.wikipedia.org/wiki/Solar_power
http://en.wikipedia.org/wiki/Solar_power_in_Germany
http://www.coalitionforenergysolutions.org/power_capacity_and_producti.pdf