

Solar Fact Finding Mission to Germany for Utility Decision Makers *Summary Report*

June 9 – 13, 2008



Presented by:

NORTHWEST SOLAR CENTER



Utility Fact Finding Mission to Germany

Summary Report

June 2008

Executive Summary

From June 9 to June 13, 2008, thirty-one utility executives and managers travelled to Germany to learn about the country's success and experience integrating significant amounts of solar energy into the electricity grid. Throughout the five-day fact finding mission, the delegation met with numerous players in the German electricity marketplace, visited multiple solar installations, and toured the largest solar tradeshow in Europe. This report presents the key findings and provides links to more information.

Utility Market

The group discovered that there are many differences between the structure of utility markets in German and the US. Some of the major differences include:

- Germany has full retail competition, applicable to both publicly owned and privately owned utilities. Both types of companies continue to own generation and buy from wholesale markets.
- Wholesale and retail prices are both high by US standards – 15-20 US cents/kWh for wholesale and 25-40 US cents/kWh at retail.
- In Germany there are 4 transmission organizations and over 900 distribution organizations, but approximately 4 distribution utilities sell to 80% of the German market.
- The vast majority of distribution (and some transmission) lines are buried – there very few overhead wires.
- In Germany residential meters are only read once a year (or when a customer begins or ends service) but customers pay a fixed bill each month based on an initial year estimate. Bills are then trued up for under- or over-payment once annually.

Renewable Energy Feed-in Tariff

Germany's justification for the feed-in tariff (referred to as the EEG) is fundamentally based on the emergence of the solar and wind industry as an economic development tool for providing high tech goods and services to the future energy sector. The country has more annual revenue from exports than any other country, including China and Japan. Traditional industries – e.g. steel, chemicals, and automobiles – are relocating to lower cost regions, growing slowly, or not growing at all. The notion is that a feed-in tariff for renewables helps meet carbon targets and electricity demand while building industrial capacity in a key export industry that does not require cheap labor, land, or materials to grow.

With the structure of the feed-in tariff in Germany, solar electricity is exclusively fed into the grid on the utility side of the meter rather than in a net metering arrangement.

Throughout the week in Germany, the delegation heard varying reports on the cost of the feed-in tariff to each customer:

- According to Craig Morris, author of *Energy Switch: Proven Solutions for a Renewable Future*, the feed-in rate adds .06€ to the retail rate of around .19€. In Craig's words, the extra cost for renewable electricity is equivalent to a cup of coffee for month/family.

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- According to Badenova, the municipal utility in Freiburg, in 2007 the feed-in tariff cost 52 USD for the average three-person household, representing 4.7% of electricity costs.
- According to Solar Fabrik (which presented numbers from BSW Solar, the German solar industry trade group), in Germany photovoltaics adds €.24cent to the average retail price of just below €20cent per kilowatt hour under FITs, equivalent to an increase of 1.2%.

Upon returning to the US, the organizers of the fact finding mission conducted further research into the costs of the feed-in tariff. A summary of what was found is provided in the “Follow-up Information” section at the end of this report.

Based on what the delegation heard from representatives of German utilities and solar companies, the greatest values provided by the feed-in tariff structure seem to be long term stability for investors and clarity for utilities and PV system generators.

One question frequently asked by members of the delegation remains unanswered: What happens at the end of the 20-year term of the feed-in tariff? Will customers continue to sell all of the power back into the grid or will they want to go to a net metering model? Most likely net metering will offer greater economic value to building sited systems, while ground-mounted more remote systems will need to analyze the wholesale market structure and their O&M costs to determine the viability of continued operations versus deconstruction and reselling the parts.

Grid Integration

One of the primary goals of the fact finding mission was to examine what grid integration issues utilities faced with the interconnection of large volumes of photovoltaics to the grid. Meetings with investor owned and municipal utilities as well as a major research institute revealed that even with high solar penetration (commonly 20%, and as high as 30%), grid integration issues have not been a problem for utilities in Germany. In addition, there are very clear rules in place about what is required of the utilities, thus eliminating many of the “utility barriers” put up in the US (such as complex interconnection agreements, interconnection fees, external disconnect switches, etc).

In fact, the German utilities have realized that solar electricity can provide grid stability and therefore there is movement toward PV providing grid stabilization services during grid events (VAR support, ride-through, delayed trip, etc) – similar to the evolution that has happened with wind energy in the US.

Solar Costs and Barriers

Pre-trip, many members of the delegation had heard secondhand and through various media sources that the costs of PV are expected to decline significantly in the coming years. While in Germany, this notion was reinforced by PV manufacturers and integrators who are all confident that costs for modules and systems will continue to decline, potentially significantly over the next 2-3 years.

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Module costs will decline due to the emergence of cheaper thin-film technology, rapid expansion of manufacturing capacity in both module and silicon production, and rising efficiency. Integrators pointed to major opportunities for cutting balance of system costs, perhaps in half (e.g., from about \$2/watt to \$1/watt for thin film installations).

When asked by the delegation about interest and plans to do business in the United States, some solar integrators cited long standing US electrical rules as an area that needs improvement and currently makes it cost prohibitive for them to work in the US market. For example, in the US buried electrical cable must be less than 600 volts and sheathed in conduit, while in Europe 1000 volt cables can be buried and marked without conduit, decreasing losses and system costs.



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Summaries of Individuals Meetings/Tours

June 9

1. Craig Morris – Guest Speaker

Craig Morris, author of *Energy Switch: Proven Solutions for a Renewable Future*, provided the group with a presentation introducing them to the German feed-in tariff (referred to in Germany as the EEG).

Key findings from the presentation and conversations with Craig:

- The solar resource in all parts of the US (with the exception of Alaska) is far better than the solar resource in German. The average solar capacity factor in Germany is 11 percent versus 20% for the best locations in the US.
- Germans have a very different mindset from Americans. They ask “where will we get our energy?” We ask “can renewable ever meet our energy needs?”
- Based on the actions of US policymakers, Germans perceive that the US has made a conscious decision not to compete in the worldwide solar manufacturing marketplace.
- Renewable portfolio standards are goals. Feed-in tariffs are mechanisms.

More information:

[Craig's presentation](#)
[EEG Brochure](#)

2. Solar Estate – Presentation by Rolf Disch, Architect and Designer

The delegation visited the “Solar Estate” and met with Rolf Disch, architect and designer. The Solar Estate is a mixed commercial and residential use development in the City of Freiburg. The cumulative system size on all buildings in the development is 445 kW.

Key findings:

- Innovative whole building design significantly reduces the building’s thermal and electrical needs, including innovative components such as vacuum insulation panels, building ventilation, and daylighting (which is very common in many of the buildings visited).
- Modular building components, including specific mechanical/electrical modules, can provide innovative, but standardized design that can be packaged in vertical or horizontal designs at lower costs than custom designs.
- Roof mounted systems do not offset load in the home/business – they are connected on the utility side of the meter and are independent business propositions that the building owner or investors assess, not on-site energy management tools.

More information:

[Case study](#)
[Technical presentation on distribution grid impacts prepared by the Fraunhofer Institute](#)



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3. Wind Turbines – Meeting with Andreas Markowsky, Ökostromgruppe Freiburg

The delegation visited two wind turbines on City of Freiburg property. The turbines are owned by a group of individual and commercial investors and operated by project developer Ökostromgruppe Freiburg. Andreas Markowsky, CEO, met with group to discuss the project. The turbines were manufactured by a company which does not do business in the United States at this time.

Key findings:

- With the German feed-in tariff, it is cost effective to install 1-3 wind turbines without having to install a wind farm with a large number of turbines. Feed-in tariffs have various categories by technology (wind, solar, etc), but also location (off-shore, on-shore) and size (in megawatts).
- Most wind projects in Germany are less than 70 MW each and are funded by groups of investors, including general citizens, when open calls for investment are formed.
- The wind turbine tower was poured concrete, due to shipping size limitations at the time on the local roads, which have been resolved by tower design changes.
- The renewable plant owner is required to pay for costs up to the point of connection to the utility distribution network.
- Renewable electricity output has priority in grid management – the system operator manages non-renewable units around the integration of renewable electricity, which has priority in the system integration.

More information:

None available

4. Badenova – Presentation and Discussion

The delegation met with Maik Wassmer, chief financial officer at Badenova which is the municipal utility for the City of Freiburg. Freiburg ranks third in German solar cities, having installed 49.2 watts per person of solar electricity and .071 m² per person of solar thermal heat. In addition to the solar power fed into its grid, Badenova has a green power type program with approximately 10,000 – 12,000 participating residential customers out of 80,000, a utility investment program which paid for the installation on the Freiburg soccer stadium, and a “innovations fund” that the utility puts €1.8 million of profits into each year to fund customer projects throughout its territory.

Key findings:

- All German utilities are deregulated, including municipalities. Because of the competitive marketplace, customer satisfaction is important and “customers want them to embrace renewables, not just accept them.”
- Utilities in Germany only read residential meters once a year (or for new or terminated service), but customers make fixed monthly payments to the utility based on estimated bills.

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- PV makes up 3 percent of Badenova's total power mix and they have had no grid integration issues.
- What Badenova likes most about the feed-in tariff is the clarity and transparency – there are no surprises or uncertainty and therefore they can plan accordingly.
- German utilities must interconnect all renewables to the grid and the rules are very clear. Therefore, external disconnects and system inspections are not necessary. Some of the ease of integration is inherent to the less litigious nature of Germany and the assignment of no-fault as long as the specific rules were followed.
- Though the national true-up for the FIT rate impact makes a utility whole for its payout of the FIT, administrative costs and interconnections costs must be recovered through a regulatory filing.

More Information:

[Badenova Presentation](#)

5. World Future Council – Presentation by Bianca Barth

Bianca Barth provided the group with a presentation about the differences between the German and Spanish feed-in tariffs.

Key findings:

- In Spain, there are two Feed-in Tariff options: fixed and premium (except for PV).
 - **Fixed:** German-style gross FIT, pays fixed rate for 20 years
 - **Premium:** sell electricity on wholesale market – receive market price plus a premium on top, which covers the difference between fixed and market prices. Sets a 'ceiling' and 'floor' – making a price 'corridor' – if ceiling hit, no more €, if price at floor, guarantees minimum: premium increases to cover gap

More Information:

[Presentation: FITs in Europe – the Spanish Case](#)

6. Freiburg First Mayor – Reception at Town Hall

The First Mayor of Freiburg hosted the delegation for a reception at the town hall.

Key findings:

- Local leadership is very proud of their solar accomplishments, founded in early opposition during the 1970's to nuclear developments in the region.

More information:

<http://www.solarregion.freiburg.de/solarregion/forum.php?lang=en>

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7. Solar Fabrik – Presentation and Tour of Manufacturing Plant

The CEO of Solar Fabrik met with the delegation to talk to them about the company and the German market.

Key findings:

- Many of the energy/labor intensive parts of the solar value chain are being outsourced to countries in Asia. Generally speaking, silicon and solar cell manufacturing are migrating to Asia, which are then shipped to panel manufacturing plants, which are more evenly distributed globally (lighter to ship cells only vs. panels).
- Some manufacturing plants and/or steps are highly automated; others still rely heavily on manual labor.
- In Germany, the PV market is 10% large ground mounted field systems, 40% residential, and 50% commercial.
- The average upfront cost of a residential system in Germany is 4,500€ (US\$6,500).
- 40,000 people were employed in PV manufacturing in Germany in 2007.

More information:

[Solar Fabrik Corporate Presentation](#)

[German Market Presentation](#)

8. Fraunhofer Institute – Presentations and Discussion

The delegation met with a number of individuals from the Fraunhofer Institute for Solar Energy Systems. Two presentations were given: one about the institute's activities and another about a study done on the distribution grid impacts of the Solar Estate which was visited the previous day.

Key findings:

- Two percent of all of Bavaria's energy (a region within Germany) comes from photovoltaics and on a sunny day as much as twenty percent of all power is coming from PV. The utilities have not had any problems resulting from this high short-term penetration.
- German utilities used to require external disconnect switches but do not any longer. Since there are so many PV systems on their grid, it would be a burden to the utility to utilize and manage them all.
- While the German utility industry is deregulated, only about 2 percent of customers switch power companies each year.
- German utilities want PV to stay on the grid during disturbances to provide grid support, rather than trip-off and exacerbate the situation (similar transition that the wind energy industry made in the US in the past).
- Studies at the Solar Estate of the grid impacts of 400+ kW of PV indicate that only voltage levels are affected within power quality but it is within certified tolerances.

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Harmonics were thought to be a problem, but they discovered the harmonic distortion was caused by the electronic loads rather than the invertors.

More information:

[Fraunhofer Activities Presentation](#)

[Presentation on distribution grid impacts](#)

[Presentation on utilities' experience and perception of PV distributed generation](#)

9. EnBW Energie Baden-Württemberg AG – Presentation and Discussion

The delegation met with a representative from EnBW, the third largest investor owned utility in Germany. EnBW has 15 GW of generation, 15 percent of the German transmission and distribution grid, and 6 million customers.

Key findings:

- EnBW's primary renewables growth areas are expected to be off-shore wind in Germany and hydro in Turkey.
- EnBW has found a way to integrate itself into the solar value chain by creating a solar business unit that provides 2 products:
 - Consulting to municipalities and investors, project development, O&M, insurance
 - Turn key installation with O&M and insurance
- Germany has 900 distribution system operators and 4 transmission system operators

More information:

[EnBW Presentation](#)

June 11

10. 1.8 MW Rooftop Installation – Tour with Plant Manager

The delegation visited a 1.8 MW installation utilizing First Solar thin film panels on the roof of a tire distribution center. The tour was given by Achim Jung, head of operational plant management for Juwi Solar, the company that installed, operates, and maintains the system.

Key findings:

- As long as the roof space is available, there is no reason rooftop PV systems cannot be multi-megawatt in size.
- It is not always necessary to penetrate the roof to install a PV system – this system was held down by concrete blocks.
- In order to have a PV system installed, integrators require that roofs are less than 5 years old.
- Inverters are configured as “master” and “slave” to better utilize the higher efficiencies at higher inverter capacity by sub-blocks of panels.

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- Several other PV systems of considerable size were located in the warehouse district, but no mention of local distribution problems were brought up.

More information:

[Fact Sheet for 1.8 MW Installation](#)

[Juwi Group Company Presentation](#)

11. 432 kW Ground Mount Landfill Installation – Tour with Municipal Utility

The delegation visited a municipal landfill that serves as a site for a 432 kW ground mounted PV system utilizing First Solar thin film modules, three wind turbines (one 1.5 MW turbine and two 750 kW turbines), and a landfill gas plant. Juwi Solar was also the system integrator for this PV project. The delegation was also joined at the site by a representative of the municipal utility that owns the landfill.

Key findings:

- Most PV installations on municipal land in Germany are owned by multiple investors (combination of individuals and companies) rather than by the municipality. The feed-in tariff payments are split amongst the investors.
- Rather than mowing the grass around and underneath ground mounted PV systems, sheep are brought in to graze.
- Rain is frequent enough that no cleaning is necessary and grit does not affect generation substantially.

More information:

Link to monitoring info: www.karlsruher-sonnendaecher.de/ (unfortunately not in English)

12. Remote Monitoring Facility - Phoenix Solar Presentations

The group visited Phoenix Solar's Remote Monitoring Facility where they monitor systems that are installed throughout Europe. Two presentations were given: one was an explanation of the typical process a system integrator must go through to complete a project from start to finish and the second was a demonstration of how they remotely monitor systems and how they respond to maintenance and security issues.

Key findings:

- Theft of panels has become a problem in Europe. All new large ground mounted systems require the installation of cameras, security systems, and local on-call security personnel options by the insuring agents.
- System monitoring can be done from anywhere as long as the relationships are in place to have local resources that can handle on-site issues.
- Outside utility property, in the U.S. buried electrical cable must be less than 600 volts and sheathed in steel pipe, while in Europe 1000 volt cables can be buried and marked, decreasing losses and system costs. This difference is considered a major barrier by European companies who would like to do business in the U.S.

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- Systems are monitored at the string level to isolate problems. Infrared cameras can also pinpoint hotspots before problems emerge.
- Preplanning installation and minimizing onsite installation time is key to reducing costs.

More information:

[Phoenix Solar Large Power Plant Development Presentation](#)

13. Phoenix Solar Headquarters - Presentations and Q&A with Management

Following the presentations at Phoenix Solar's Remote Monitoring Facility, the delegation travelled to the company's headquarters for meetings with its executive management team.

Key findings:

- Phoenix Solar is likely to become a player in the US market in the future, although specific plans were not shared.
- Even though thin film has lower efficiency, which results in higher balance of system costs, there are significant opportunities to reduce these costs at a faster rate than silicon technology cost reductions.

More information:

[Phoenix Solar Corporate Presentation](#)

[Phoenix Solar Monitoring & Maintenance Presentation](#)

June 12

14. Intersolar tradeshow

Intersolar is the largest solar tradeshow in the world, with more than 1,000 exhibitors. The delegation spent a day walking the show floor and getting a better understanding of the worldwide solar industry.

Key findings:

- The solar industry is real! It is not a niche market, but rather a multi-billion dollar industry with many major corporations as players.

More information:

[Intersolar TV](#)

June 13

15. 6.3 MW SunPower installation – visit with plant manager

Approximately two-thirds of the delegation visited the 6.3 MW ground mounted installation that is part of the larger Bavaria Solarpark 10 MW project (separated into 3 sites). The group was joined by SunPower employees who are responsible for the plant.

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Key findings:

- Large ground mount systems are a relatively small and decreasing part of the overall German solar market.
- The system utilizes single-axis N-S tracking at zero degree tilt and single motors that move large blocks of panels to increase yields at minimal costs.
- Involvement by the local community is key to acceptance of a large project – local shepherders mow the grass, a local construction firm helped in the project, walking paths were built in the area, etc.
- The system is not washed and only receives spot cleaning as necessary to remove bird droppings, etc.

More information:

[Bavaria Solar One Case Study](#)

16. First Solar meeting

Approximately two thirds of the delegation met with numerous executives from First Solar to discuss the company's technology and its perception on the future of the solar industry.

Key findings:

- First Solar panels are almost never used with tracking systems as the increased output does not justify the increased cost.
- Targets for 2012 include 12% efficiency (currently 10%), which is approaching lower end silicon panels, and 10-15 Cents/kWh USD for large utility and commercial markets, which is their niche.

Follow-Up Information

Upon returning from Germany, trip organizers reviewed a March 2008 report, *Electricity from Renewable Energy Resources: What Does it Cost Us*, from the Federal Ministry for Environment, Nature Conservation, and Nuclear Safety. Below is a summary of the key points. The full report can be accessed [here](#).

According to this report the average cost of resources acquired through feed-in tariffs was 11.4 Euro cents/kWh. The predominant resource acquired is wind, which earns a much lower feed-in tariff than photovoltaics. For tariffed customers, the average monthly bill is 60.3 Euros/month of which 2.9 Euros (roughly 6 percent) cover the cost of feed-in tariffs. It is estimated that the feed-in tariff may rise to a maximum of 4 Euros/month, declining to 0.6 Euros/month by 2030.

About one quarter of the bill (15.6 Euros/month) cover taxes (both an electricity tax and value added tax). Non-tariffed customers (+10,000 kWh/year - about 75% of load) pay negotiated electricity prices, usually under confidential contracts; the ability of the utility to pass along some or all costs of feed-in tariffs to these customers will vary substantially.

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In 2007, renewables represented about 14 percent of national electric supply, up from 6 percent in 2000.

The analysis of the costs and benefits of the feed-in tariff is complex. The tariff itself does not include integration and administrative costs, which are generally incurred by the grid operator and passed along to the local utilities. Integration and administrative costs are estimated at 300-600 million Euros annually. The existence of fed-in resources lowered wholesale market clearing prices, by about 0.8 cents/kWh in 2007. It is important to add that German wholesale market prices for 2008 are 230% higher than for 2003, so the net value of the fed-in resources can vary substantially by hour and year.

The Ministry also concludes that consideration of external costs, particularly for coal and lignite, also affects net benefits. The external benefits of the existing renewables are estimated at 4.3 billion Euros annually; roughly equal to the total cost of the program.



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