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FEED IN TARIFFS AND BUILDING INTEGRATED PV (BIPV) CAN WE MAKE IT A WINNING TEAM?

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ABSTRACT : Photovoltaic in building integration is seen as the main target application area for grid-connected PV systems in Europe. The very high potential of such an application seems to be suitable for private investors at the point of sale for the utility, where the electric power has the highest market value. However; even in the booming German PV market the fraction of real building integrated PV in facades in 2004 only reached 1%. There is a much larger fraction of roof top PV installations. But the ground mounted market is the fastest growing market segment today in Germany. This paper evaluates the reasons for the phenomen and proposes some possible improvement to be made by the PV community to overcome this barrier and to open this important market segment for grid-connected PV applications in Europe.
Keywords: Grid-Connected, Marketing, Roof-top Systems

1 PV GRID-CONNECTED MARKET IN EUROPE

1.1 The Situation in Germany 2004 as a front-runner

In the developed world, where there is an existing power grid infrastructure, PV in buildings is regarded as a major application area for photovoltaics. In Germany for example the market ist the pacemaker for the European PV industry as well as for the worldwide PV community besides Japan. Between 2003 and 2004 the German market has grown again from 153 to 360 MWp (Fig. 1).

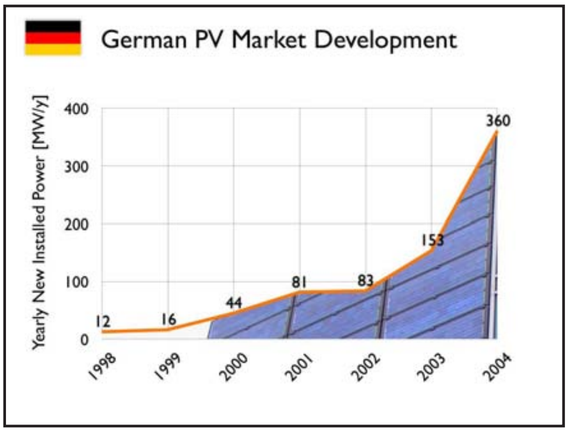

Figure 1: The German PV Market Development 2004 [Ref. 1] and its performance 1998 - 2004. The mathematical average capacity of the total 40'000 installed new installations reaches 9kWp.

In Germany the PV grid-connected market for 2004 shows dramatic development (Table 1), with a growth rate between 2003 and 2004 of nearly 135%. The bad news is that the real market share of PV integrated in facades only reaches 3MW or 1% .

A deeper analysis of the split between the three major market segments (BIPV, roof mounted PV and ground mounted PV) shows a real imbalance in market development (Figure 2).

New PV installations 2004	360 MWp
Total installed capacity end 2004	758 MWp
Number of new installations 2004	40,000
Average capacity 2004	9 kWp
Market value 2004	1.7 billion
Number of jobs in sector	20,000
New roof mounted installations 2004	253 MWp (70%)
New ground mounted installations 2004	104 MWp (29%)
New BIPV installations 2004	3 MWp (1%)

Table 1: German PV market development

Roof-mounted PV is still taking the lead with 70% of the market. With several multi-MW installations, ground-mounted PV is taking a big part of the fast-growing market, occupying 20–29% in 2004 and new plants constructed or announced for 2005 suggest that this proportion will have increased significantly by the end of 2005. BIPV on facades, in which the photovoltaic elements actually form part of the building envelop, lags far behind with a market share in the region of just 1%.

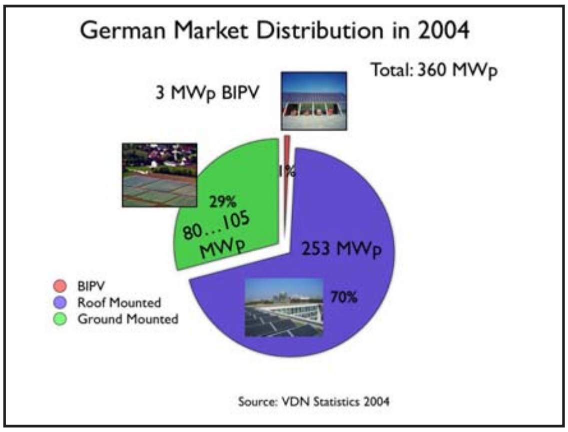

Figure 2: German Market Distribution of grid-connected PV installations 2004. The distribution between roof mounted and ground mounted is not fully approved by the statistics at the time of publishing. Some sources give ground mounted a fraction of 20% not 30%. The author's calculation has been done using the cost elements from the VDN statistics as shown in [Ref. 2].

1.2 The large undeveloped market segment BIPV

BIPV can deliver much more. The potential for PV in buildings in selected International Energy Agency (IEA) member countries was evaluated by members of IEA PVPS Task 7 [Ref. 3]. Figure 3 shows the fraction of total national electricity use that could technically be covered by BIPV. That fraction is calculated as over 55% in the case of the United States, but the average fraction across all the countries examined is 30%. This represents a very high application target.

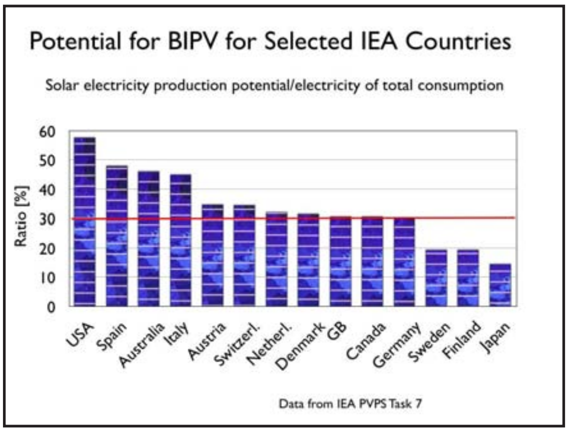

Figure 3: Technical market potential for BIPV for selected IEA countries as a fraction of the total electric energy consumption 2002 as discribed in [Ref. 3].

The application of BIPV today is still very low (Figure 4); in 13 central European countries (Austria, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden Switzerland and UK), only 0.02 m2/capita of PV is integrated into buildings, in sharp contrast with the 18.5 m2/capita for PV mounted on roofs and 6.5 m2/capita mounted facades.

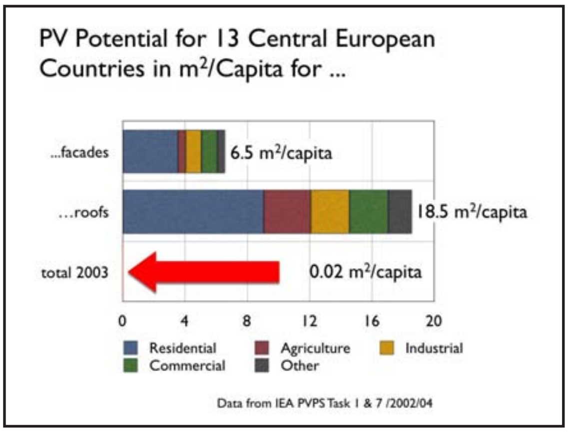

Figure 4: [Ref. 4] gives a detailed analyses of the technical grid-connected PV potential application for 13 Central European Countries. Facades and roofs in comparison in the actual use 2003.

2. THE VIEW OF PV EXPERTS

2.1 The Survey

Why do we see such an unbalanced market development, even under ideal economical conditions as available in Germany today? To help answer this question, the author carried out a survey among a small number of key experts in the European PV community, half of whom are PV-dedicated architects.

The participated persons were:

- Cincia Abbate-Gardner, Architect, PVPS Task 7, Italy
- Harm Boomsma, Consulting/Innovator, Netherlands
- Walter Mikisch, Colt International, Switzerland
- Reto Miloni, PV-Architect, Switzerland
- Brigitte Schneider-Gmelch, PV Specialist, Germany

The survey addressed the market segments of BIPV, roof mounted PV and ground mounted PV with respect to cost and economics, technology, market and value indicators. The survey examined a number of different parameters (Table 2). Its findings are summarized in Figure 5. On a scale from 1 (bad) to 10 (excellent) the ratings are given for each of the three market segments.

Topic	Parameters considered
Cost and economics	• Cell and module • Inverter • Balance of systems (BOS) • Project development • Financial engineering
Technology	• Best possible orientation/yield • Best possible plant size • Best cell/module technology and size • Best size of inverter • Best availability BOS solutions
Market	• Highest added value for PV • Highest market potential for PV • Best image for client • Highest relevance for PV industry • Best market development incentives
Values	• Lowest construction costs • Lowest market price for investor • Highest payback price for PV owner • Highest PV added value • Least know-how and training needed

Table 2: Issues considered in a survey of key European experts

In figures 6-8 there are graphic layout of the score level of the three market segments. Figure 9 shows the overview in comparison of all three market segments . It is obvious that real BIPV on facades has the lowest score in comparison to roof top and roof mounted PV installations. The reaction of the PV market for the different segments seems to be the result of different parameters effecting the market behaviour.

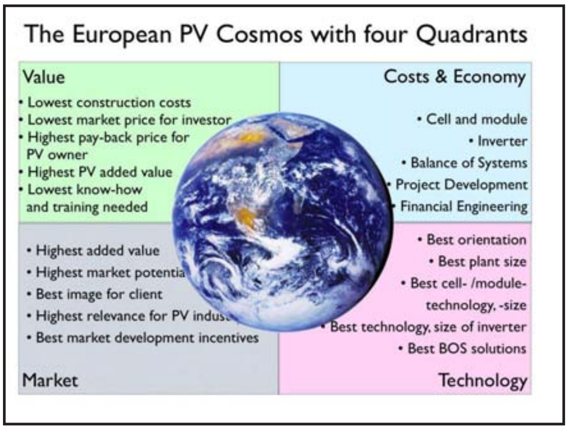

Figure 5: The European PV Cosmos discribed in four Quadrants. In a growing PV market the development of the PV sector is no longer depending only on technical and cost parameters. The question of value und market parameters have a more important impact. The result of market development is the combination of all these factors in total.

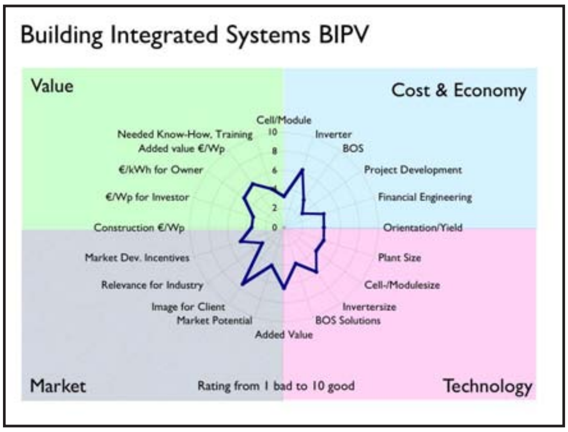

Figure 6: Weak spots by building integrated PV. Facades are especially problems with the project development, the alignment of the project to to cell and module size and in consequence the relevance for the industry

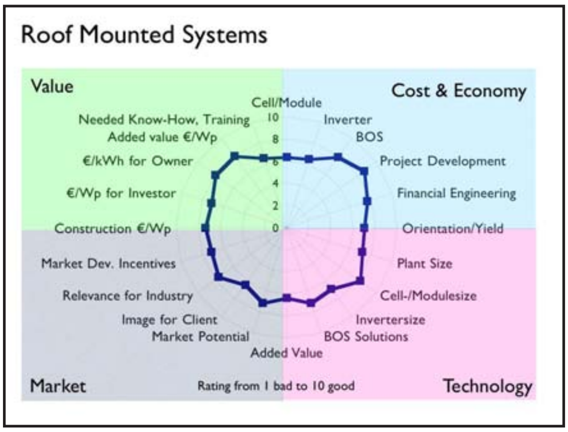

Figure 7: This concept, especially the approach of roof top installations, is well established. Minor disadventages are questions around the plan size and the orientation yield question. The only value lower than BIPV facade is image for some clients because the roof top installations are not visible from outside.

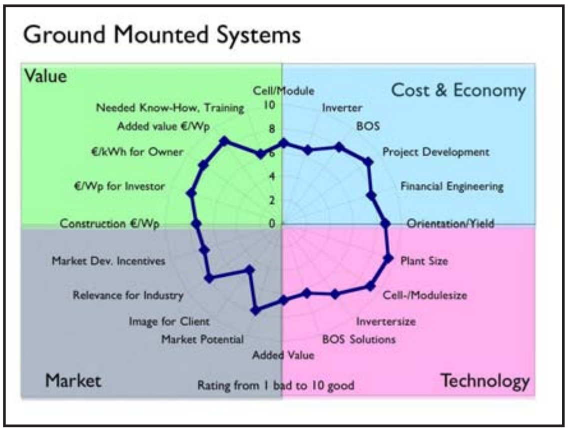

Figure 8: The overall score is here the best of all three. With the disadventage of image for client (why should we use land?) and some disadventages by BOS solutions. Do we really need fences?

2.2 The Comparison of the three market segments

The unbalanced situation between BIPV and the other major applications of PV cannot be blamed on one single cause. Comparison of the rating lines (Figure 9) of the three market segments highlights those areas in which there are major differences. BIPV falls far short of roof-mounted and ground-mounted applications with respect to a number of criteria. Three critical cases are discussed below.

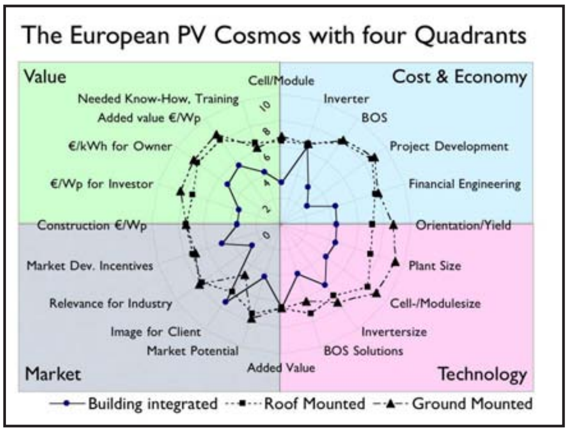

Figure 9: The graphical score list of the three market segments of the European PV cosmos. The side-by-side comparison of the different market segments allows a better understanding of the market behaviour.

3 THREE CRITICAL CASES DISCUSSED IN MORE DETAILS

3.1 Case 1: Does BIPV share construction costs?

The question highlighted here is the impact of investment costs on the BIPV project development. Compared with an ordinary roof mounted installation, which is placed on top of conventional roof. The basic concept of a true BIPV installation is to share the cost of the building envelope because the installation has a double function.

But can these these double functions actually work in practice? The main potential of double function in the area of balance of systems (BOS) is in the area of module costs and installation costs, where it should be 30% of the total system cost (Figure 10). While this overlap of cost can be described theoretically, in practical terms it cannot be achieved in an actual project development.

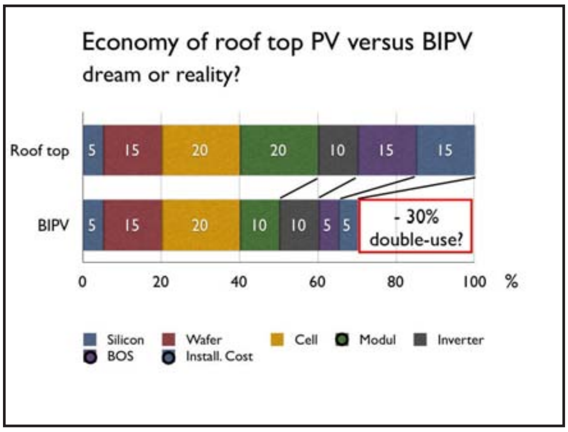

Figure 10: Economy of roof top PV versus BIPV. The question is: Can the double-use function be realised by sharing the investment cost for the elements module, BOS and installation costs?

3.2 Case 2: The dilemma of 'closed' PV systems

The module design evolution we have done we will go from the cell to the frame. We are going from the inside to the outside and the cells get bigger and than we put them into a frame and we have a module.

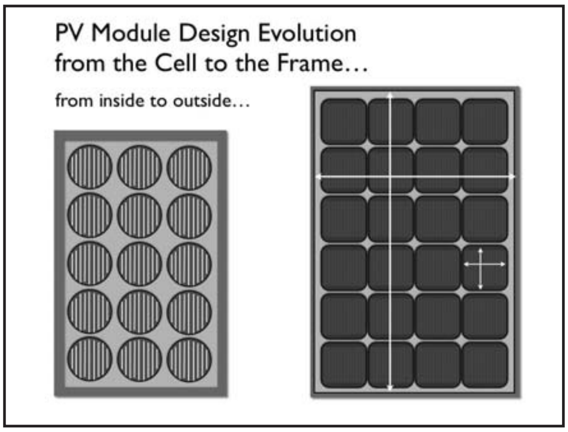

Figure 11: PV Module Design Evolution from the Cell to the Frame .....
from inside to outside

The different suppliers in the PV industry produce and market their modules in individual, non-standard sizes. Each company has its own layout depending on the cell type and technology it uses. They all optimize the physical sizes of the modules to achieve the best 'fill factor' (Figure 11).

Direct comparison of similarly rated modules shows that their physical layout differs by a few centimetres – the modules are almost the same, but not exactly the same size (Table 3).

The PV 'tower of Babel' – non-standard sizing examples

Brand	Type	Power (Wp)	Length (mm)	Width (mm)	Height (mm)
Sharp	NT 175 EI	175	1575	826	46
BP Solar	BP 7175	175	1593	790	50
Shell Solar	Power Max Ultra 175	175	1613	814	56
Sanyo	HIP-180BE3	180	1319	894	35
RWE Schott Solar	ASE-190 GT-FT	190	1600	800	50

Table 3: Comparison of different types of modules

We can not permit "Locked PV Systems" for BIPV. We have to look at the dilemma of the PV industry in the building, planning process. This lack of consistency contrasts strongly with the approach of today's construction industry, in which building components are available in standardized dimensions. It demonstrates the immaturity of today's fledgling PV industry.

The approach across most of the building industry is for many elements to be specified by size, then becoming part of the tendering process. Unfortunately, the PV industry does allow this procedure to be followed, leading to the dilemma of what I call the dilemma of 'locked PV systems' in the building planning process (Figure 12).

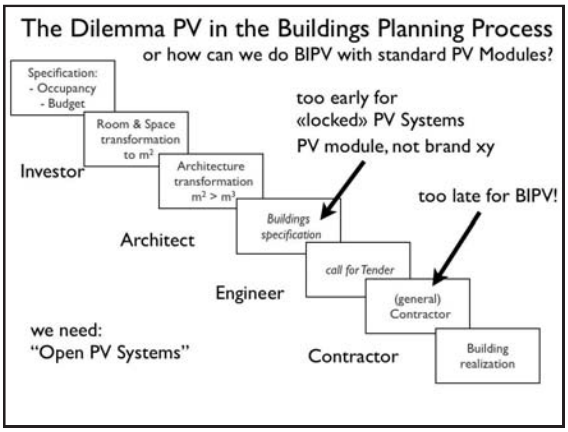

Figure 12: The dilemma PV in the building planning process. The PV industry has to respect the well established approach of building development and realisation. The PV industry has to offer an interface on the level of building specification and still allow an open tendering process.

The main players, the investor, gives specification, budget and a plan for space and room. The architect transorm this form m2 into m3. This is the art of architectial work to make an attractive building.

The engineer develops the buildings specification in the call for tender. In many case big projects are taken by a general contractor, who is realising in the whole building. This means that PV tends not to be taken into account by the planning team for the tendering process. Because each PV brand has its individual size for modules, the planning team is forced to design its application in favour of a certain product, before the call for tender. (Non-standard sizing also makes it difficult to replace broken modules during their operating life if their supplier has gone out of business or has changed the sizes again.) This is also the experience of the author as an PV engineer. The PV group is always too early or too late but never on time. So we need open PV systems. Not standard modules but standard sized modules.

3.3 Case 3: The sky is tolerant' – solar radiation on inclined roof versus facades

In a BIPV application, how effective is a vertical wall facade installation compared with an inclined roof? Maximum available irradiation is received by a roof inclined at the optimum angle for its latitude. Assuming this number is 100%, the amount of radiation received, for example, by a vertical wall facing south would be just 70% (Figure 13).

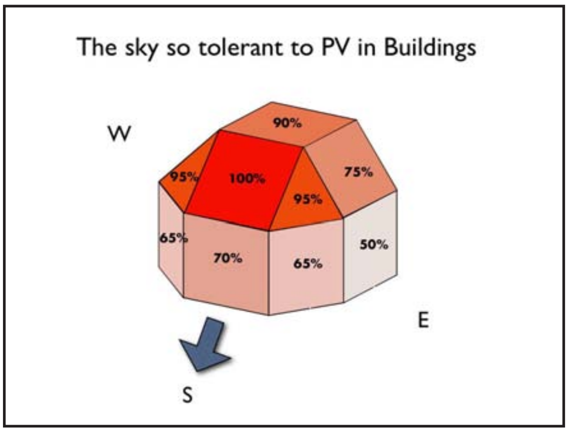

Figure 13: The radiation. A given building envelop receives the highest radiation on the tilted roof towards south (100%). The vertical wall towards south still receives 70% of the local radiation. So the sky is tolerant for PV in buidings (radiation data for typical European location).

However, Germany's EEG law does not make a full compensation for this. For, although the difference in radiation – and thus performance – between a roof installation and a facade is 30%, the difference in feed-in tariff changed from 'rate-based compensation' between tilted roof (Eurocents 57.4) and facades (Eurocents 62.4) is only 9% (Figure 14). So although facade installations receive a higher rate, it does not compensate well enough to encourage facade installations.

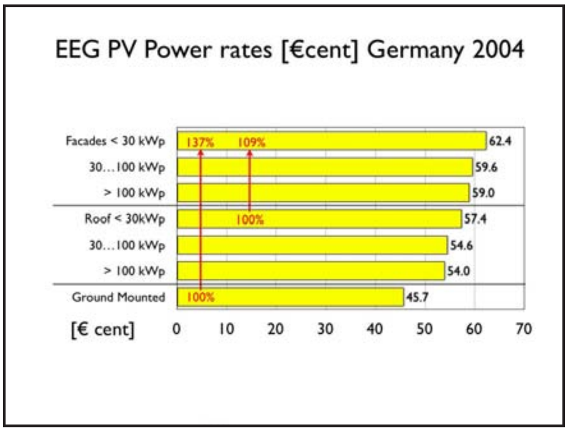

Figure 14: The German EEG law is cost-wise in favour of BIPV facades but the higher power rate of 92.4 €cent/kWh in comparison to a roof top with 57.4 €cent/kWh is only partly compensating the loss of solar radiation of -30%.

Cash flow for 3 investors in Germany 2004

Freiburg 30kWp	Rates €c/kWh	Yield kWh/kWp a	Cash in €/a kWp	German market share [%]
Roof	57.4	850	488	70
Ground mounted >30kWp	45.7	900	411	29
BIPV	62.4	595	371	1

Table 4: Cash flow comparison. It compares three investment options for PV plants of less than 30 kWp in Freiburg, southern Germany in 2004 – for roof mounted PV, ground mounted PV and BIPV installations.

4. CONCLUSIONS

- Roof mounted, Ground mounted and BIPV: We need all 3 of this market fast economical and technology progress. We have to be careful with ground mounted installations.
- The PV community thinks in kWp. The building industry is thinking and planning in m2. We are not talking the same language.
- Today the PV industry is offering ‘Locked PV systems’. Tomorrow we need ‘Open PV systems’. Standard size modules not standard modules as they are used for the building industry by dishwashers etc.
- We are on the way and we work hard to make PV the perfect companion for a low or cero energy house. This will be in the near future a new value for our society maybe even better than a second or a third car.
- If the market is overheating we have to be careful with quality and performance. A sustainable energy source needs a sustainable product and solution. And that’s the reason I believe our work at Task 2 as a long-term survey looking back and ahead is important. That’s the reason I also invite you to take part at our global survey “Cost over time”. We have to understand, what we are doing.
- The German rate-based compensation for facades is not considering irradiation with respect to orientation. There is room for improvements.
- With ongoing economical progress roof mounted PV and BIPV installations are the next hot “multi GW” targets. In the next 5-7 years, if we proceed also economical, these installations will become cost effective in the European Sunbelt. For many private electrical users on the one by one rate-based, even without rate-based incentives!

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