



Technical Report on Financing and Ownership of BIPV Buildings

WP 4 / Task 4.1

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1 Introduction

The Work Package 4 (WP4) “Management Aspects of PV Exploitation” of the PV Nord project consists of two task:

WP 4.1 “Financing and Ownership” (lead by KanEnergi AS of Norway)

WP 4.2 “Management and ICT “ (lead by Solpros of Finland)

The results from each task are reported in two separate technical task reports. This report deals with task WP 4.1 “Financing and Ownership”, and should be read in light of the corresponding “Assessment report from task 4.1”, from the initial stages of the PV Nord project.

The objective for this report is to describe how the participants behind each of the PV Nord demonstration buildings (Tasks 5-12) have played their roles as investors in, and owners of the PV systems. It also points out some practical “lessons learned” that hopefully can be of value for future owners of BIPV systems.

BIPV systems are basically not very complex themselves. But when being integrated into a façade, and into the electrical and IT based maintenance systems of buildings, the picture changes. Through careful planning and use of experienced suppliers, one can avoid costly surprises e.g. tied to tendering processes or installation work.

2 Why equip a building with a PV system?

There may be a number of motives behind integration of PV systems in buildings. As described in our assessment report, we believe the following motives are most relevant:

2.1 Energy (power) production.

The energy aspect of a BIPV system consist of at least three elements, namely electricity to cover internal needs and sale to the grid, and as back up in case of break down in the regular power supply. This gives the power generated three corresponding values.

- A value for PV-power that substitutes power otherwise purchased from the grid.
- A value for excess power production sold to the grid
- A value tied to emergency power capacity

2.2 Security of energy supply

Emergency power may have rather special rates, according to what requirements that are defined. In some cases emergency power is only needed to operate special types of equipment for short periods of time. This may for example be computers, telecom equipment or lighting. If a PV installation, including a battery bank of some size, can replace a diesel generator, PV technology may be a cost efficient alternative.

2.3 Aesthetics, architecture

In recent history, the various eras are characterised in architecture and building design. Architecture using materials like steel, aluminium and glass in exterior walls have become quite common during the last decades. PV panels and integrated PV solutions offer new possibilities for designers. A building design that points towards future development trends, and at the same time is acknowledged by design critics as giving buildings a character unique to BIPV, may offer substantial benefits for the owner. In such a context, PV may be seen purely as a design element adding to achieve the expression desired by the architect.

2.4 Environmental concerns, interest

Among the renewable energy technologies, PV is perhaps the most user friendly one. Firstly, the product is electricity, the most desired of all energy products. Secondly, PV may be integrated in numerous varieties in buildings or other structures. PV will seldom displace other desired materials or functions in a building. And thirdly, PV does not have negative environmental effects as noise, smell or emissions.

2.5 Shaping image (carrying out corporate policy, strategy)

A significant portion of the façade covered with PV-cells, will be the defining aesthetic element of a building. The PV-cells will send a signal to a large portion of the environmentally concerned public; “Here is somebody that cares about our future!” In that way, PV installations contribute to the shaping of corporate or organisational image and identity. On this arena PV does not need to compete against other energy technologies, but rather with market activities like media campaigns, etc.

Some years ago, British Petroleum, BP, gave its initials the new meaning Beyond Petroleum. The change points at renewables as main sources of future energy supply. BP’s environmental strategy includes PV, both as manufacturer and supplier, as well as being an active PV user.

2.6 A measure to be among “front-runners” in the energy business

Since the development of PV started in the aeronautical industry, the unit costs have been significantly reduced. In an intermediate time frame, some actors believe that costs of PV will meet the costs of comparable energy sources. With this background, PV projects are performed in order to gain experience and to prepare for the day where PV power can compete in the general electricity market. This might be the case for instance for energy suppliers, utilities etc. One example is the utility in Helsingborg in southern Sweden, where a large PV installation dominates the company’s office building.

2.7 Environmental design criteria’s

In some urban development areas, certain environmental requirements are laid on the developers. Along with themes like sewage and waste treatment, requirements tied to energy may be present. Selecting PV / BIPV may be the most adequate solution in order to comply with such requirements. PV costs may in this context be viewed like other extraordinary costs such as installing sound proof windows, difficult foundation conditions etc. For example, in PV-NORD; buildings A and B (Holmen/Grynnan and Lysande) are built in Hammarby Sjöstad, which is an urban area with exactly these features.

3 Ownership; Motives / driving forces behind the PV Nord demonstration projects:

Least important:

Based on information from the demonstration projects, it seems quite clear that power

generation tied to BIPV (energy production and security of supply) are among the least important aspects. In other words, it is not the power production itself that motivates the BIPV systems. This observation corresponds to the nature of PV-technology, namely that the cost of power production by PV in most cases are way above the value in the energy market. Security of supply seems definitely to be of least importance, perhaps not an aspect at all.

Most important:

Combined with architectural design, the image BIPV is creating seems to be of largest importance. The nature of this image may include several different elements such as:

- “High tech”- says something about the nature of the activity the building owner or –user is doing
- Elegance, modern appearance

Which of these elements that is of most or least importance is unknown. Perhaps this observation implies that PV-cells primarily should be looked upon as an alternative to other façade materials such as rock materials (granite, marble, etc.), metals (aluminium, steel, copper), wood, glass etc. And if this is true, the cost of energy production should only be tied to investments in wiring, rectifiers, grid connection and other electro technical installations.

BIPV as a signal of environmental awareness seems to be of second greatest importance. The public in general might not have the knowledge in order to recognize or identify a PV-installation, especially if it's integrated in building facades. On the other hand, the part of the public that do know about PV are also the one who attach importance to such technology, and is able associate it as an environmentally friendly measure.

In cases where property developers must meet certain external requirements, such as maximum level for net specific energy consumption, PV-systems offer important possibilities. Investments in PV as a response to certain environment related requirements laid on the developer is, however, only of relevance in certain instances, e.g. Hammarby Sjöstad

If the PV-system costs are viewed in light of the total building/construction cost (project cost), it seem to be less than 1%. Only one demo-project reports that these cost lie in the interval 1-5% of total construction costs.

4 PV technology, system costs

When discussing costs of PV-systems, it's important to specify what exactly a cost figure is related to. It's a common definition that a grid connected PV system consists of PV modules (or larger PV arrays) mounted in structures (mounting structures), connected to the grid via an inverter(s).

4.1 System costs - general

The costs of PV systems vary with a number of factors such as system size, technical specifications, grid connection, etc. solar system is directly proportional to the energy required. Small cabin systems start roughly at € 1,000 or a little more. A typical household system could cost anywhere from € 9,000 to €36,000.

For commercial- and other large buildings, thumb rule cost figures are not common, mainly due to the fact that in such buildings, the PV integration largely is a part of the building design. For relatively simple installations, the cost figures may, however, be a little less than those that apply for household (unit costs).

The cost of installing a photovoltaic system having a power of one kilowatt (1 kW) ranges typically from € 5 000 to € 7 000. About half of this investment will cover the PV modules, and the other half the inverter, PV array support structures, electrical cabling, equipment and installation.

Based on the present market prices for photovoltaic electricity compared to electricity produced by traditional fossil fuels, installing a grid-connected photovoltaic system (even with a significant subsidy) will not provide a commercial return. Although this is possible in Japan, and to some extent in Germany, there are few signs that this situation will change in the PV Nord countries in the near future. In most cases a significant subsidy or other financial contribution is necessary in order to make PV systems profitable.

4.2 System costs for PV Nord demonstration buildings

The costs for PV-installations in the demonstration buildings are reported as follows:

	Lowest	Mean	Highest
€/kW _p (without subsidies)	7 550	10 000	12 170
€/kW _p (including subsidies)	3 000	6 000	9 800

The unit costs varies with the size of the PV installation, which means that the highest numbers in the table above corresponds to the installation with lowest capacity, and vice versa.

The degree of subsidy varies somewhat in the way that some of the projects have received additional subsidies or grants from other sources than the EU. In order to receive subsidies, most of the PV-installations have had their own separate budgets.

Among the PV Nord projects, there are few signs showing that favourable feed-in tariffs etc. constitute elements with similar effects on investment profitability as subsidies.

When comparing the cost figures, there is a risk of comparing projects with different cost structures. For instance, costs for project management for PV-installations might be included in the overall building costs (for the building) or kept isolated in separate PV-project accounts. The PV Pergola at the Shell Rijswijk office, a 60% share of the total installation costs were part of the PV Nord project. This is another example showing the difficulty of drawing lines between BIPV-relevant costs and other construction costs. Different cost structures make direct comparisons between the demonstration projects to some extent imprecise.

5 How finance BIPV systems?

Viewed in the eyes of financial officers, PV systems may be evaluated in at least two different ways;

- As an additional cost included the total construction budget of a building. This additional cost will later generate income through energy production etc. This way, the PV-system increases total investment budget, but, in practise, helps to reduce operational costs due to reduced purchases of electricity.
- As a separate investment object, with defined requirements regarding profitability.

5.1 Financing included in a building construction budget.

The BIPV systems in the PV Nord demonstration buildings are all more or less seen as elements in a total construction budgets. The relatively high cost of the power production from the systems makes it natural *not* to see them as financial objects. Consequently, no dedicated financial solutions are made.

Although the energy output from the PV systems in the demonstration buildings are monitored, there are few signs saying anything about evaluation of the economic performance of them after some years of operation.

5.2 PV systems as separate investment objects.

Unlike other building elements, PV systems create values throughout a large portion of buildings lifetime. One could for instance imagine that investors or power companies purchase façade space in order to install PV capacity. Viewed on such a background, it seems natural to have separate financing for the PV system.

Suppliers of heat based on bioenergy, have both in Denmark and Norway, tried to finance mobile boiler houses attached to the customers heating systems. The idea is that the suppliers take care of everything from fuel transport and handling, operation of furnaces, etc. and that customers only pay for a delivered energy volume (kilowatthours). Legal barriers have proved difficult to finance such schemes, however. The reason is that boiler houses, no matter how easy they are to remove, are seen as integrated parts of heating systems, and therefore belong to the buildings. If an owner of a building, for instance go bankrupt, the mobile boiler would automatically be included in the bankrupt estate. Such equipment may therefore not be mortgaged, and consequently close to impossible to finance within reasonable lending terms.

Although integrated in a façade, BIPV-installations may be done in such a fashion that they are relatively easy to remove. Some of the wiring, inverters and other equipment may also relatively easy bring out of a building. But as indicated above, there are few reasons to believe that PV is more bankable than bioenergy schemes. The legal limitations we see here restrict obvious possibilities to generate renewable energy “next door” to the consumer. Changes in legal practise, or creating guarantee schemes, (perhaps with involvement from the public authorities), may loosen up this deadlock.

6 Financial support for project developers

The possibility of receiving investment support etc. from governments, utilities and other sources, vary according to where the project is located.

According to IEA / PVPS (“Trends in photovoltaic applications, Survey report of selected IEA countries between 1992 and 2003”) public budgets for demonstration / field trials and market stimulation in 2003, were as follows (figures in thousand USD):

Country	Demonstration / field trials	Market stimulation
Denmark	759	-
Finland	-	5
The Netherlands	169	84 746

Norway	14	-
Sweden	-	-

The table shows that funding from public budgets of demonstration projects etc were limited. An exemption is The Netherlands, which had support measures for PV, ending in 2003.

No public general support measures to PV projects have been available in Sweden and Norway in 2003. Except for the so called SOL 1000 project (with ambitions to create 650 kW of standardized roof top systems) this also applies for Denmark.

During 2003 in Finland, a new communication strategy plan for the enhancement of renewable energy, including PV technologies has been formulated. It is part of the Action Plan for Renewable Energy Sources launched in 1999 by the Ministry of trade and Industry. Investment subsidies are granted for solar energy systems up to 40% of the expenses. The subsidies are given only to companies, organizations, enterprises etc and not to private individuals. Since 2003 subsidies for renovation sites are more focused on energy system of the site, including also change of the energy source towards renewable energies.

In Sweden, a scheme for increased renewable energy production with so called electricity certificates was introduced during 2003. The aim is to increase the production of renewable electric energy by 10 TWh before 2010, a 6 % increase in Swedish power production from today's level. The initiative is based on a market perspective, in which an energy producer that produces 1 MWh of renewable electric energy will receive a certificate, and the energy companies and the consumers will be forced to buy a number of these certificates corresponding to the amount of energy used. Although PV power producers are included among the beneficiaries in this scheme, there is no specific target for PV deployment.

In Norway, a similar certificate scheme, also including PV-based power production, is expected operational in 2006. Both in Sweden and Norway, the certificate schemes are meant to replace various direct subsidies and other measures used to promote or increase power production from renewable energy sources.

Some municipalities and utility companies in the PV Nord countries, for instance the utility company in the Copenhagen area, have resources to offer PV-projects. The general picture, however, is that owners of PV projects, have limited possibilities of receiving financial contributions of various kinds to strengthen project economy.

7 Revenue potential from PV-systems

The power sales may be valued differently:

- According to market tariffs, basically based on Nord Pool spot prices
- Based on a price equal to the tariff(s) at which PV owners purchase of electricity from the grid, that is a substitutional price or – value. This will be the case with a net-net settlement scheme.
- According to tariffs defined in special purchase agreements.
- Generation and sale of “green certificates”.

The value of PV power varies a great deal, and is especially tied to incentive programmes offered by governments. The IEA PVPS programme has mapped such programmes and tariffs in OECD countries. In the most favourable cases, PV power is paid by a rate about 5 times the market value, over a course of 20 years.

The income potential varies between countries as well as between customers and utilities. vary from which country you are in, and who your customer/ utility is. In Germany it is fixed by law at 0,51 EUR per kWh. In other countries like Japan, the Netherlands, France, etc. the payback rate is equivalent to net metering (that is to say a situation where the electric meter would run backwards). The economic return of the PV power system normally depends upon size of the initial investment and the utility's payback unit rate, e.g. € / kWh.

In Norway, the power bill to ordinary consumers consists of four main elements, namely the electricity itself, transportation (grid costs), electricity tax approximately 9% and 24% VAT. The electricity element varies significantly, but constitutes around one third of the total cost. Transport constitutes another third, and taxes one third. By using self produced power, the BIPV owner can value his own production at the same price as with purchased power, including the transportation and tax elements.

When solar power is sold to the grid, the value is largely determined by the market price levels. For Sweden, Finland, Denmark and Norway, this means the spot price at the Nord Pool power exchange. Due to the unpredictable nature of solar energy, the electricity values are kept relatively low. A rule of thumb may then be that a self generated kWh that substitutes purchase of a kWh, is worth three times as much as a kWh sold to the grid, that is without any kind of special sales agreements. Some utilities offer so called net-net settlements, which means that all PV power produced is priced at the same level at which the producer alternatively purchases power in deficit situations.

The value of PV-power produced in grid connected systems is seldom sufficient to pay an acceptable return on the PV investments. Special buy back rates for grid connected PV

installations have received a great deal of interest as they raise a fundamental issue for the cost recovery of the system investment, and may be very important for the short and intermediate diffusion of the technology. More generally, “green pricing” schemes which apply for PV as well as for other renewable energies have been introduced by a number of utilities in different countries. The buy back rates can be ranked by the level of the rate applied for independent producers of PV power fed into the grid compared to the cost of conventional electricity purchased from the grid. In Germany and Switzerland, PV-producers have received payments as high as 5 times the value of conventional power. These relatively high payments are also guaranteed over a long period of time, between 10 and 20 years.

7.1 Value of power generated from the PV-systems.

The PV generated power in the demonstration buildings is used domestically or (at least partially) transferred to the grid. In some cases, the entire production is actually transferred to the grid, but is priced at the same levels as electricity purchased from the grid (Ekoviikki).

The unit income from the PV power may therefore have two values; one value corresponding to the price per kWh purchased from the grid and one value corresponding to the feed in tariff. These two values will then vary as function of time,- that is as function of the general electricity market. On this background, it is not an easy task to maintain a clear picture of the unit income, nor the economic yield from the PV systems.

Based on the information gathered, none of the demonstration projects could document unit income rates, that is the value or values of a kWh produced. A few projects reported, however, some general grid based levels. This stands somewhat in contrast to the relatively close follow-up on production (monitoring) that takes place. The reasons might have to do with:

- An unclear price picture, described above.
- Unit income levels (“price tags”) that are not very well communicated among participants within each building project.
- A lack of attention due to the fact that the PV systems are not looked upon as investment objects producing financial results.

8 Conclusions.

PV generated electricity in large building integrated systems represents unit costs that are substantially higher than its market value of electricity from the grid. This fact is reflected in many of the conclusions that can be drawn with respect to financing and ownership.

Based on the “lessons learned”, the following conclusions can be drawn:

- PV generated power is generally far more expensive to produce than electricity from the grid.
- In practise, the PV systems constitute additional costs to building projects, - they do not lead to reduced investment needs for example in electrical systems in the buildings.
- The motives behind purchasing the PV-systems seem to be tied to desired building appearance, technology trials, gaining experience and perhaps image-building. Consequently, the PV-systems are not viewed as energy projects with the objective to produce investment return.
- BIPV systems are only to a limited extent viewed as “bankable” objects, seeking dedicated financing solutions.
- There are few signs indicating that building developers, nor third party investors for that matter, will see new building projects as potential “PV-power stations”.
- In order to achieve relatively low costs, careful planning of the PV system as an integrated construction element is necessary.
- Precise communication between the PV-supplier on one hand, and the architects, electricians and project management on the other, proves to be essential.

Appendix: Questionnaire on experiences on financing and ownership of the PV Nord buildings (Task 4.1)

PV Nord WP 4.1, Financing and ownership.

Information from each of the demonstration projects:

Part I: Reasons and motivation for selecting BIPV.

Please mark the appropriate box.

1. Energy production:

How important was it to avoid purchase of electricity from the grid, or to obtain profit from power deliveries through favourable “green” electricity tariffs?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1	2	3	4	5	
not important				important	

2. Security of supply:

Was it was important to obtain redundant power supply as an alternative to an emergency power supply unit?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1	2	3	4	5	
not important				important	

3. Architectural design:

BIPV was important to achieve certain design expressions, alternative to other costly façade materials.

1 2 3 4 5
 not important important

4. Environmental awareness:

BIPV was chosen to express environmental concern or reduce environmental impact of the building.

1 2 3 4 5
 not important important

5. Creating image:

BIPV plays an important role for the user/owner of the building in expressing their brand as future and high tech oriented.

1 2 3 4 5
 not important important

6. Compliance with external requirements:

Living up to certain planning regulations.

1 2 3 4 5
 not important important

Please rank the reasons/motivations according to their importance for choosing BIPV in your project. Set 1 for the most important reason, and 6 for least important.

Energy production:

Security of supply:
Architectural design:
Environmental awareness:
Creating image:
Compliance with external requirements:

Other:
 Please describe other reasons why your BIPV demonstration building came about.

Part II: Profitability and financing of BIPV in demonstration buildings:

1. What was the investment cost for the PV-installation relatively to the total investment costs for the building?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
< 1%	1-5%	5-10%	>10%

2. What was the investment cost of the PV-installation pr kW_p installed capacity?

Without subsidies:€/kW_p
 Including subsidies:€/kW_p

3. Did you have a separate investment budget for the PV-installation, or was the PV-installation part of the buildings total budget?

Yes No

4. What is the price for electricity sold to the grid?

5. Do you have a long term contract guaranteeing this price?

6. What is the cost for electricity bought form the grid?

7. What is the (estimated) energy production per year?

8. What kind of subsidies did the project get?

- Grant
- Reduced interest rates on loans
- Surplus on electricity tariff
- Other

Please specify the received subsidies and their importance for the project: