ECO CULTURE : HIGH-PERFORMING CULTURAL ECO-BUILDINGS WITH PV

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ABSTRACT: This project addresses demonstration of energy efficient technologies integrated into three high-performing cultural ECO-buildings. All the buildings will be designed using a "Whole Building Design Approach" in order to ensure the largest energy saving potential possible. The buildings are now in the design phase and the façades will be equipped with a building integrated PV system. These highly visible PV systems will contribute significantly to raising the awareness of new Eco-concept with building integrated PV among the wider public.
As well as PV systems heat pumps (sea water, ground water), energy storage and efficient climate controls will be demonstrated. The use of PV in combination with other renewable energy techniques has an enormous potential for future buildings in Europe.
Keywords: Building integration; Façade; Grid-connected

1 INTRODUCTON

The Eco-Culture project is a 6th framework demonstration project funded by the European Commission. The objective is to realize three high-performing cultural Eco-buildings in Amsterdam, Copenhagen and Oslo based on the eco-building principle. The Eco-concepts will be demonstrated in three high-profile cultural buildings:

- The Danish Royal Theatre (DK)
- The Amsterdam Library, Amsterdam (NL)
- The New Opera House, Oslo (NO)

This project addresses demonstration of energy efficient technologies integrated into these buildings and two of them, the Library in Amsterdam and the New Opera House in Oslo, will be equipped with a highly visible and attractive PV façade. The Danish Royal Theatre in Copenhagen will also have a PV system installed on the stage tower. The PV systems are part of several renewable techniques that will be demonstrated in these buildings.

All three projects will be built in the period 2004-2006. The project is now in its final design phase.

2 ECO-BUILDINGS

2.1 Eco-buildings

Eco-buildings are buildings that are designed to have a low energy use and are using renewable energy. The concept builds on two main steps: 1) reducing the demand for electricity consumption, heating and cooling, and 2) supplying the necessary heating, cooling and electricity consumption in the most efficient ways using renewable energy. The application of building integrated photovoltaics (BIPV) is one of the most visible renewable energy techniques and the produced power contributes directly to the electricity demand of the buildings. This concept will lead to a reduction of CO_2 emissions.

2.2 Whole building design approach

The first phase is the Eco-design of the buildings. All the buildings are designed using a "Whole Building Design Approach" in order to ensure the largest energy saving potential possible. The methodology of the Whole Building Design Approach is to

1. Reduce the demand for heating, cooling, electricity and ventilation, and
2. Supply the necessary heating, cooling, electricity and ventilation in the most efficient way using renewables.
3. Always consider the impact on a whole building level.

The PV design will be an important part of the design because it will be one of the techniques that is visible for the visitors.

2.3 Demonstrated techniques

Focus will be on demonstrating and testing of the following technologies, which have been selected out of the integrated Eco-concepts as being especially innovative and contributing to further development. Besides the building integrated PV systems these are:

- Energy Storage (thermoactive slabs and double aquifer)
- Heat Pump (sea water and ground water)
- Demand controlled hybrid ventilation
- Building Energy Management Systems (BEMS)
- Use of Environmental Friendly Concrete for thermal storage in thermo-active slabs

3 PRESENT STATUS

3.1 Design phase

The overall design is based on innovative architecture aiming at low-energy demand buildings and renewable energy such as BIPV. The use of passive solar energy and daylight is a natural design parameter for all the involved

buildings. The architects together with the consultants are designing the PV facades with special see-through PV modules. Special interest is paid to:

- Maximum producible dimensions of the glass modules
- % of daylight transmittance
- Use of amorphous silicon modules

3.2 Dual function PV

The façade comprises a large surface of glass and transmits a lot of warmth from the sunlight and some form of shading is necessary to prevent overheating. The use of see-through modules can very helpful to realize an optimal indoor climate without the use of additional sun shading. Building integrated PV has thus the advantage that besides the generation of electricity it also has the function of

- Building element
- Sun-shading and prevention of overheating

These dual functions make it more attractive to use PV in the facades.

3.3 Public Library, Amsterdam

The architect of the library is Jo Coenen Architects & Co from Maastricht. The design is now focusing on a 200 m^2 PV façade with see-through modules. The use of amorphous silicon modules is investigated.
A roof installation of approximately 50 kWp is also foreseen.

Figure 1: Artist impression of the Amsterdam Library

3.4 New Opera house, Oslo

For the opera house in Oslo a 400 m^2 PV façade installation is under investigation. Several designs are now made.

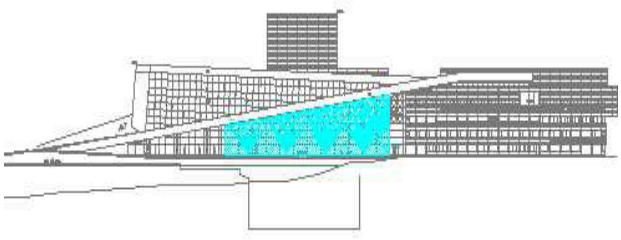

Figure 2: Draft design of PV façade New Opera House

Figure 3: Artist impression of the New Opera House, Oslo

4 POTENTIAL IMPACT

The scientific and technological objectives of the Eco-culture project are to demonstrate innovative integrated energy concepts in European cultural buildings. It will be shown that PV is part of an innovative integrated design of the whole building and this will show the necessity of PV for this type of energy concept. The use of PV in combination with other renewable techniques has a high potential in future European buildings because the energy concept is not only valid for cultural buildings but also for office buildings.

The main objective of the project is to influence the establishing of tomorrow's standards and concepts for "Whole Building Design Approach" of cultural and other buildings.
It is expected that the demonstration and documentation of the ECO-concepts will contribute significantly to the further adoption of the solutions in cultural buildings all over Europe such as building integrated PV. In a European context, the potential impacts of the presented project are significant: Energy savings and implementation of renewable energies in buildings.

5 RESULTS

The Eco-Culture project itself has started in January 2004 and will run until 2007. All of the three buildings included in this project have a carefully prepared integrated approach, when it comes to the conceptual design, and their visible location in the cities of Copenhagen, Oslo, and Amsterdam ensures that the buildings will become landmarks of the cities. It will result in buildings with innovative building integrated PV systems. About 2,400,000 people will visit the cultural buildings every year. faces. Thus, the project will contribute significantly to increasing the awareness of new Eco-solutions with building integrated PV.

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