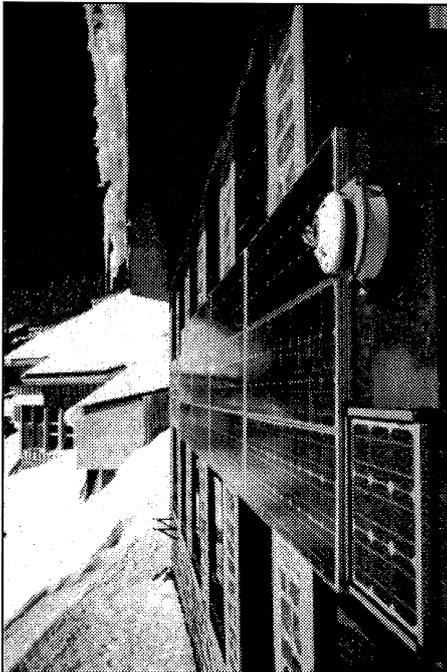


# Operating Results of ISB's Grid Connected 1.1kWp PV Plant at Jungfrauojoch (3454m)

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## Introduction

The **highest grid connected PV plant in the world** at Jungfrauojoch (3454 meters above sea level) was planned and realised by ISB during summer and fall 1993. It has operated successfully with a 100% availability of energy production and monitoring data since Oct. 27, 1993.

24 modules Siemens M75 (48Wp) are mounted vertically to the outer walls of the international research station at Jungfrauojoch. Energy produced by the modules is injected into grid by means of an inverter Top Class 1800.

## Purpose and Goals of the project:

- **Test of PV components:** Operation in high altitudes is a very hard stress for all components due to **extremely high irradiance peaks** of more than 1.5kW/m<sup>2</sup>, **heavy storms and thunderstorms**, and **large temperature differences** (solar cell temperature: -30..+60°C). PV components surviving in such a harsh environment should per-

form more reliably under normal operating conditions.

- **Experimental finding of the energy yield** of a high alpine grid connected PV plant.
- **Analytical monitoring.**
- **Maximum availability of energy production and monitoring data (AMD = 100%).**

## Test of PV Components:

During the first year of operation the plant survived several heavy storms (wind speed above 200km/h), thunderstorms, irradiance peaks (up to 1660W/m<sup>2</sup>) and temperature differences without any damages. The only problem was the very large snow quantity, which resulted in a complete covering of one of the two PV generators and therefore a loss of energy for a few days. The data acquisition system worked without major problems.

## Energy production 1994:

Referred to nominal PV generator power (1152Wp), energy production

was 1247kWh/kWp, referred to effective power (1130Wp) even **1272 kWh/kWp**. Winter energy fraction was **48.0%**, about as high as expected.

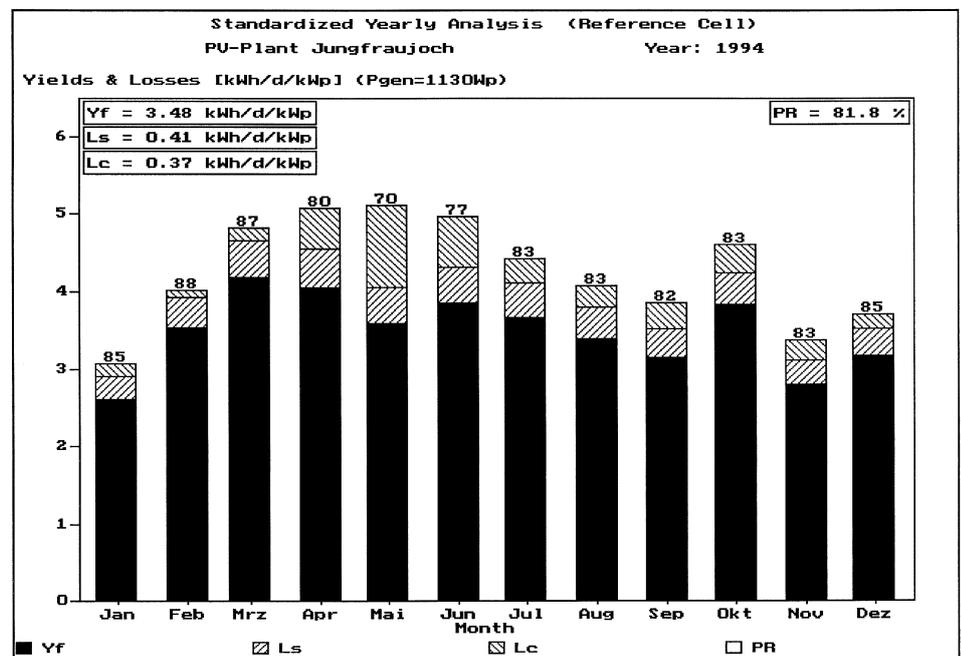
Referred to effective power mean value of **performance ratio** was **81.8%**.

## Comparison of different PV plants in the Canton of Berne:

1994 Jungfrauojoch produced an **additional yield of 46%** referred to a plant in the lower part of Switzerland in Burgdorf (3.18kWp/ 530m)! Referred to the plant at Mont Soleil (560kWp/1270m), the additional yield was 35%.

## References:

- [1] H. Haeberlin, C. Beutler and S. Oberli: "Yield and Reliability of Grid connected PV Systems at different Locations in the Canton of Berne (Switzerland)", *Proc. 12th EU PV Conference, Amsterdam 1994.*



Standardized yearly analysis with monthly values of Yf, Ls, Lc and PR (referred to effective solar generator power). Irradiance is measured with a reference cell. Partial snow covering of the solar generator in spring causes higher Lc and lower PR-values. Monthly performance ratio is between 70 and 88%, annual average is 81.8%!