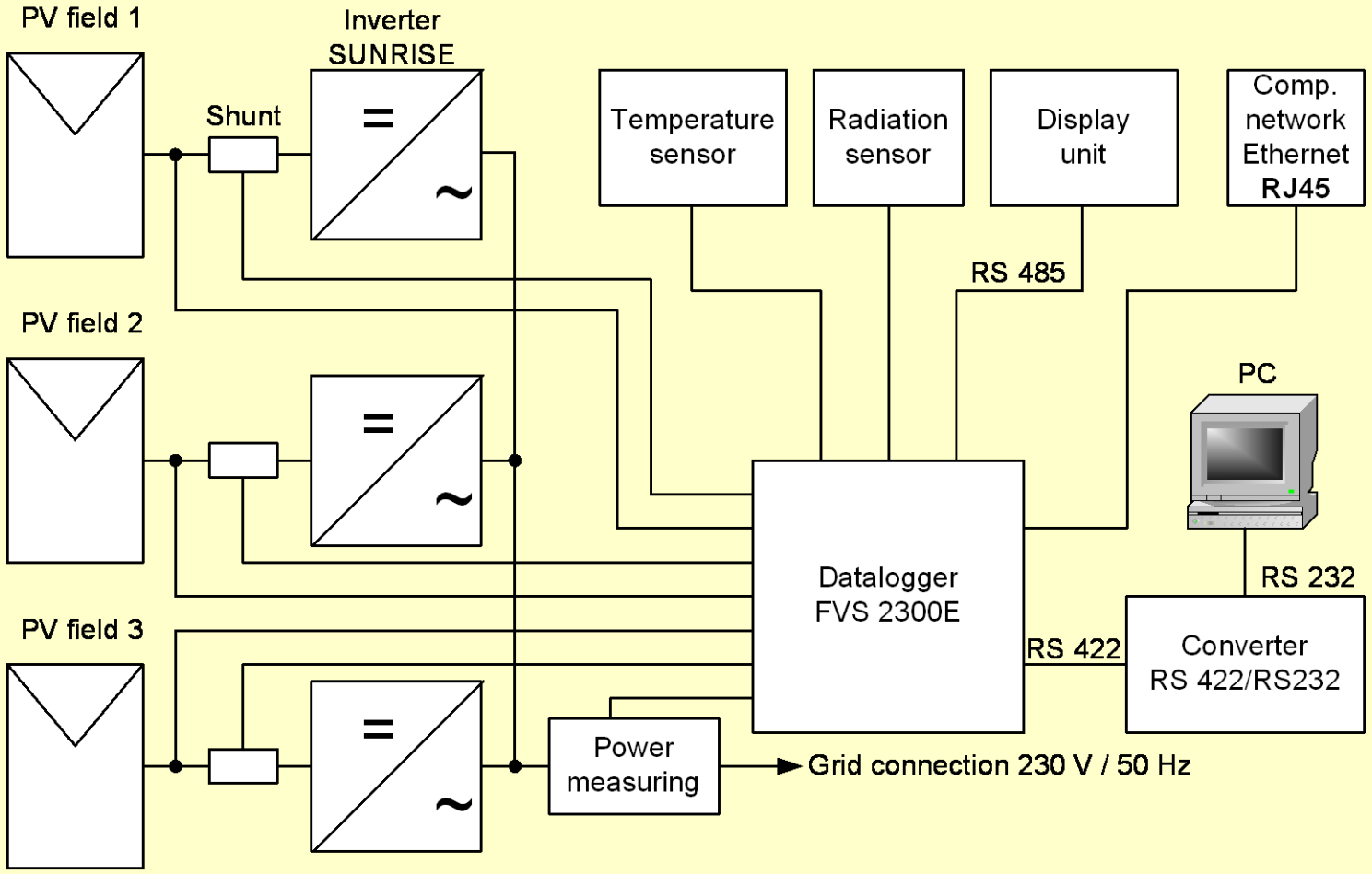
Experience from PV system performence including comparison of on-roof and façade systems

Vitezslav Benda, Zdenek Machacek
CTU Prague, Faculty of Electrical Engineering

KATEDRA ELEKTROTECHNOLOGIE FEL PRAHA

In the year 2001, a 3kW$_p$ demonstration, on-grid connected photovoltaic system has been built at the Czech Technical University in Prague on the roof of the Faculty of Electrical Engineering.



Installed peak power: 3320 W_p
Total module area: 26 m^2
Number of modules: 30 (3 fields of 10)
Latitude: 50.07 °N
Altitude: 205 m

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Module type	P_{max} (W_p)	V_{pm} (V)	I_{pm} (A)	V_{OC} (V)	I_{SC} (A)	η_{cell} (%)	η_{module} (%)
RADIX72-112	111,5	17,4	6,41	21,5	7,04	14,9	12,8
RADIX72-108	107,8	17,1	6,29	21,5	6,98	14,4	12,4

Parameters of PV modules at radiation power 1000W/m2, spectrum AM 1,5 and temperature 25°C

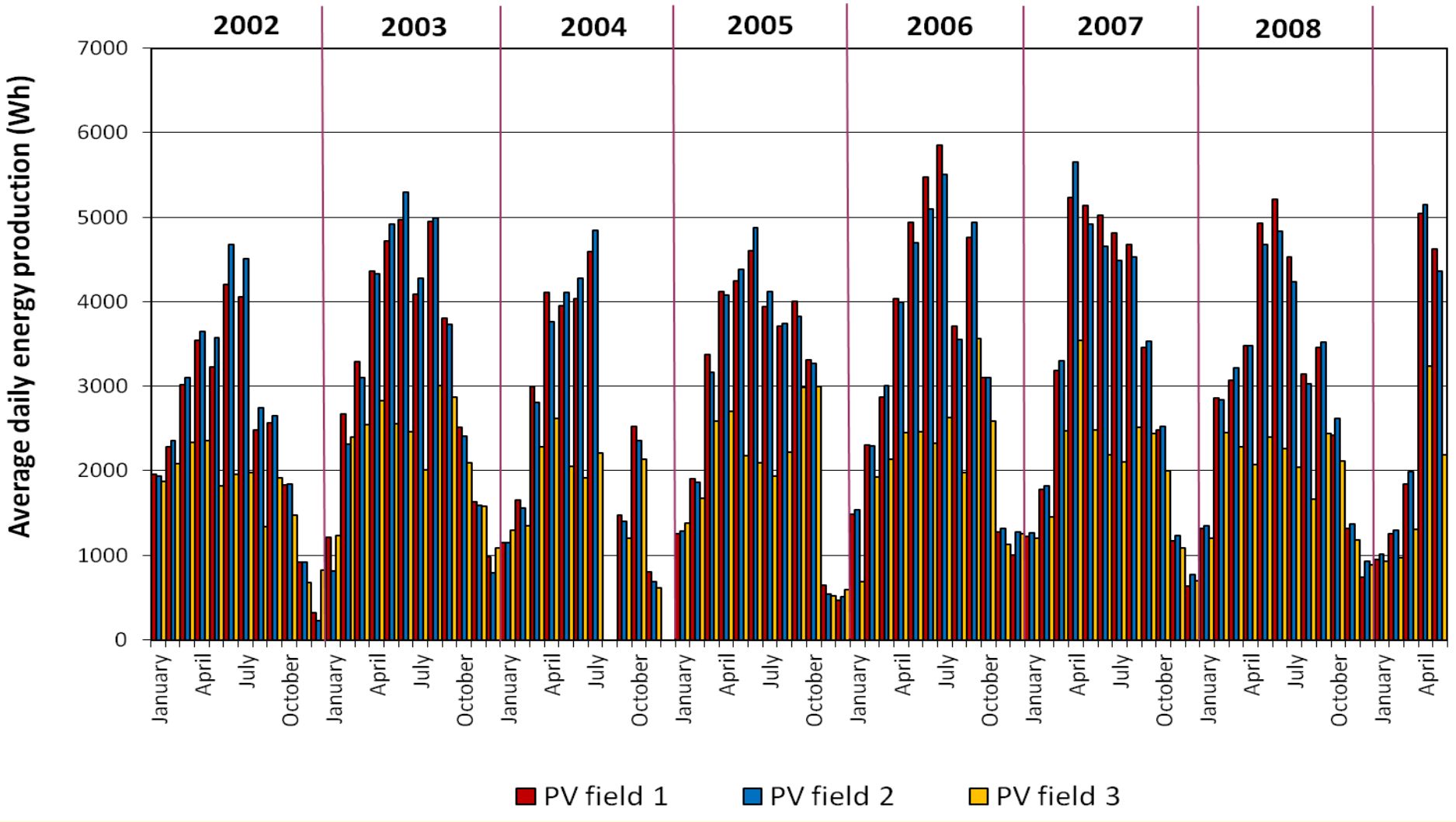
PV field	Tilt angle	Module type	P_m (W_p)
1	45°	RADIX72-112	1120
2	variable	RADIX72-112	1120
3	90°	RADIX72-108	1080

Parameters of individual PV fields

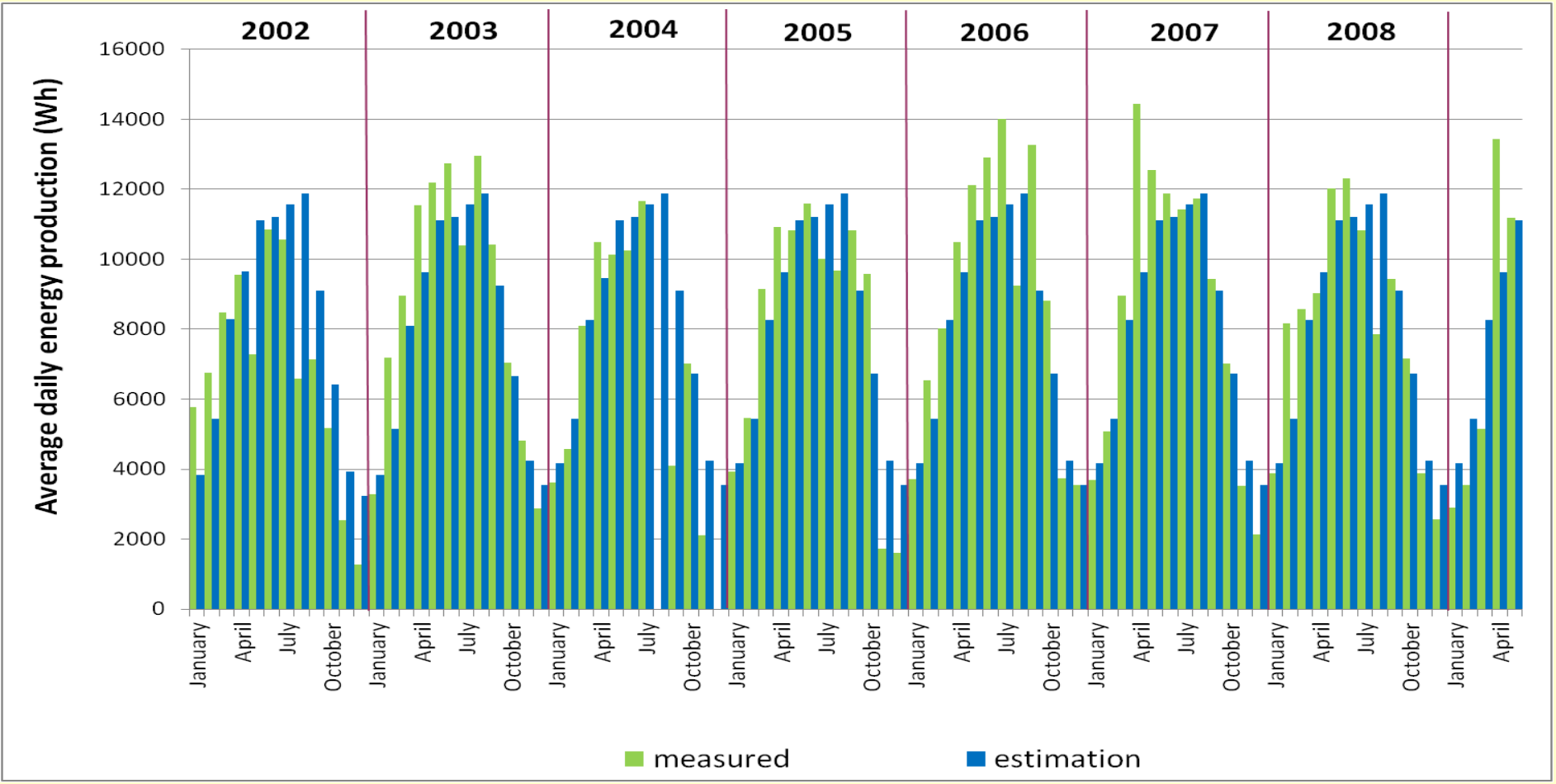
Type of inverter	*Sunrise Mini*	*Sunrise Micro*
Input voltage	120 - 300 V	120 - 300 V
Nominal input voltage	170 V	170 V
Maximum input voltage	350 V	350 V
Output voltage	230 V,+10/-15%	230 V,+10/-15%
Output frequency	50 Hz,+/-0,2 Hz	50 Hz,+/-0,2 Hz
Output nominal current	4,4 A	3,2 A
Output nominal power	1000 W	750 W
Harmonic distortion	< 3%	< 5%
Maximum effectivity	93%	92%
Dark consumption	0 W	0 W

Parameters of Sunrise inverters

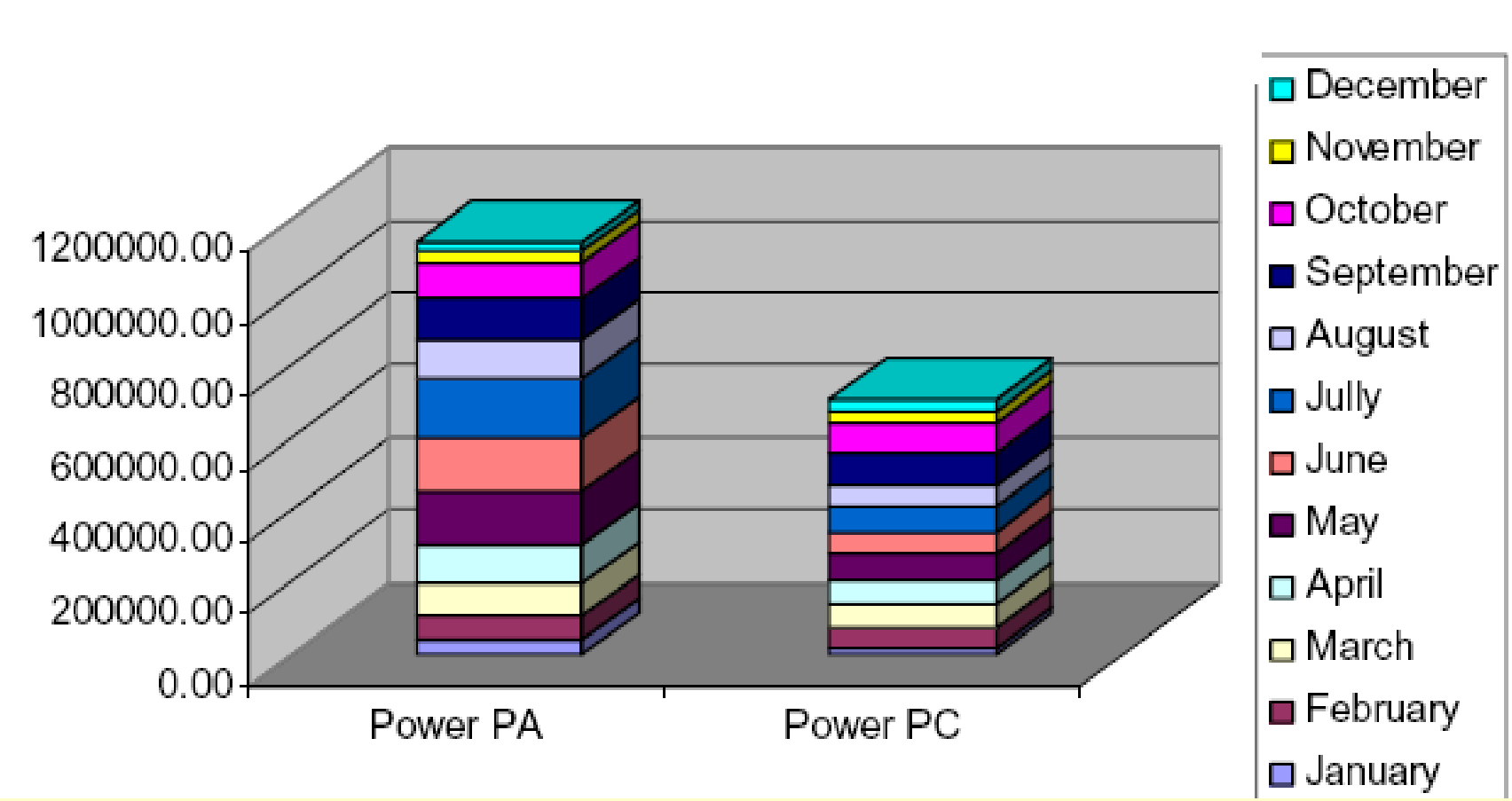
Energy produced by individual PV fields in period from January 2002 to May 2009



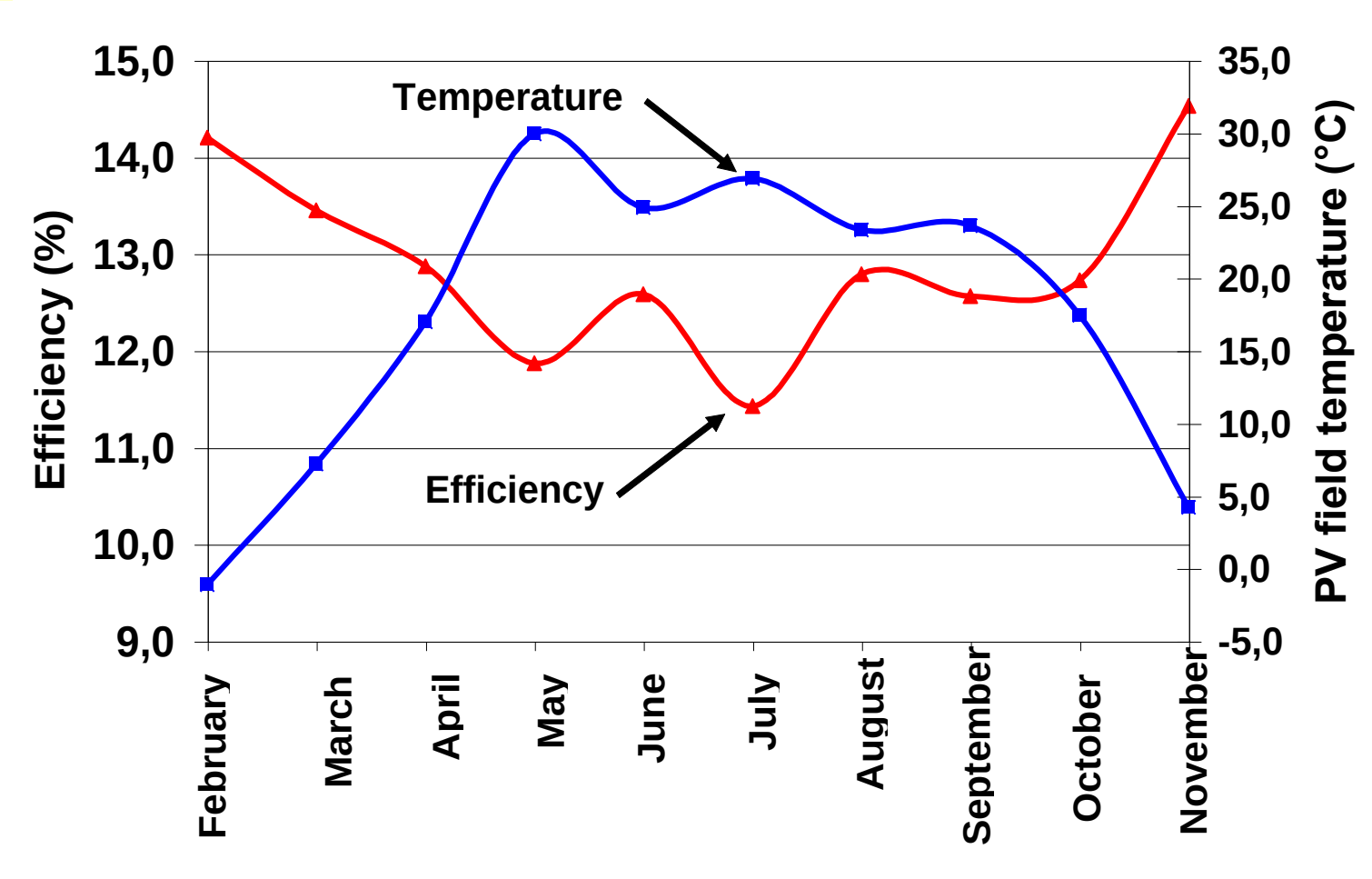
A comparison of estimated and measured energy production in period from January 2002 to May 2007



Comparison of on-roof and façade PV field in the year 2006

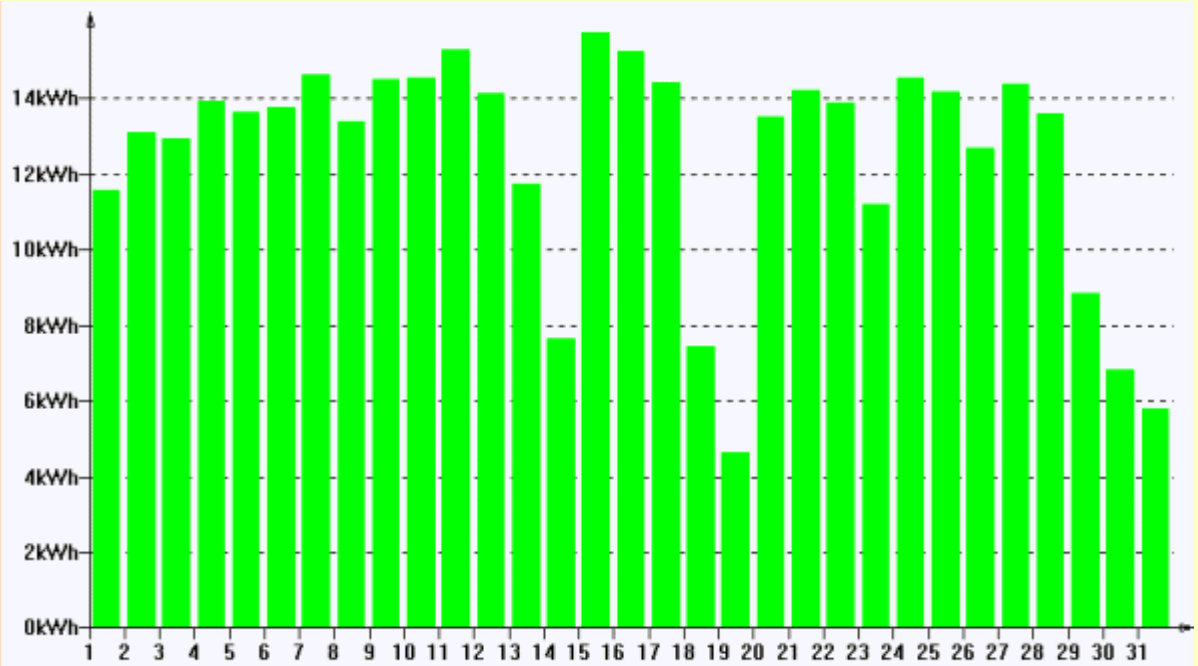


Temperature dependece of energy conversion efficiency

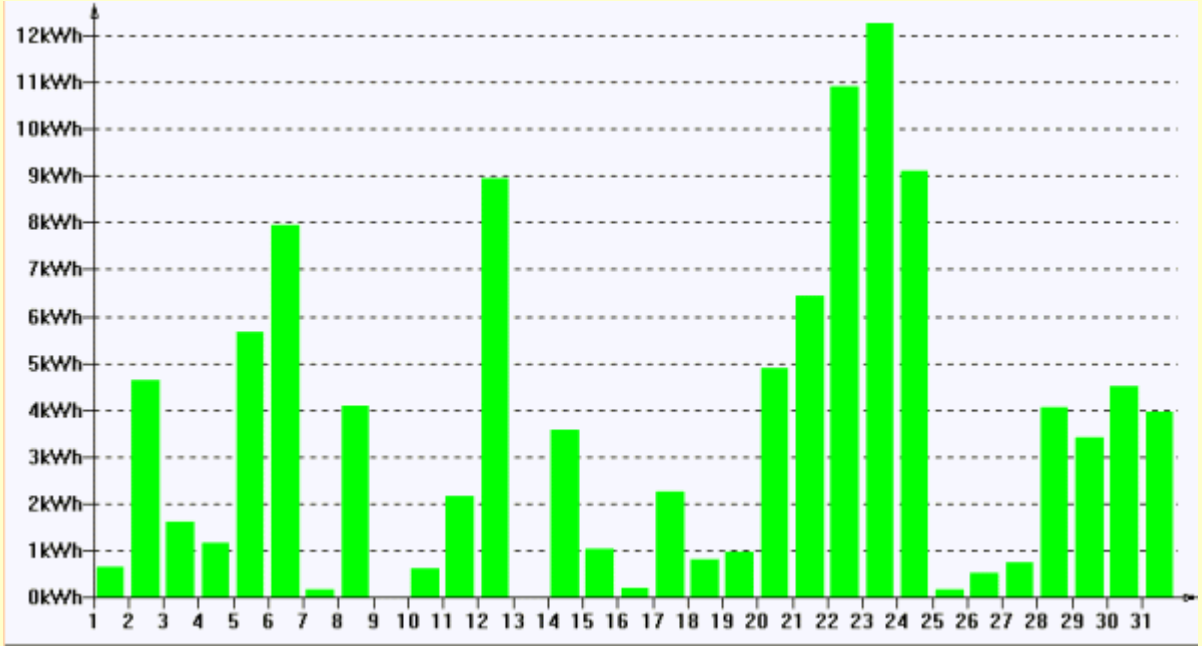


This gives the efficiency decrease of about 0.6% per 1K, which is higher than supposed decrease of cell efficiency (about 0.4% per 1K).

It means that an increase of losses with increasing temperature in other parts of system cannot be neglected.



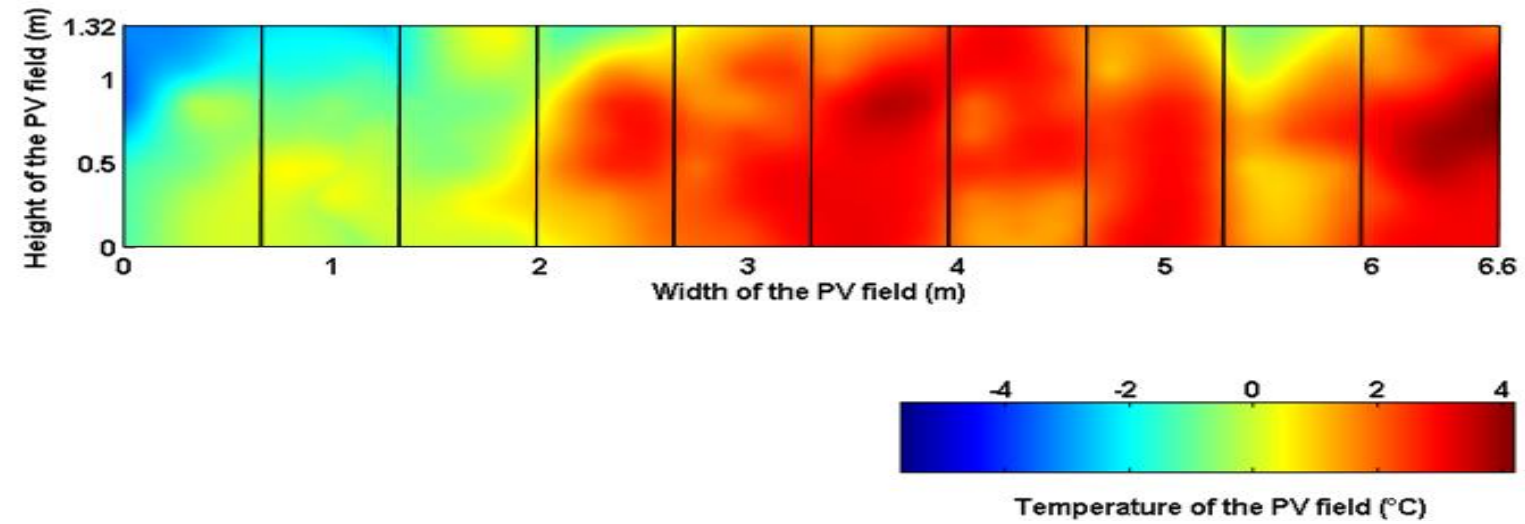
August



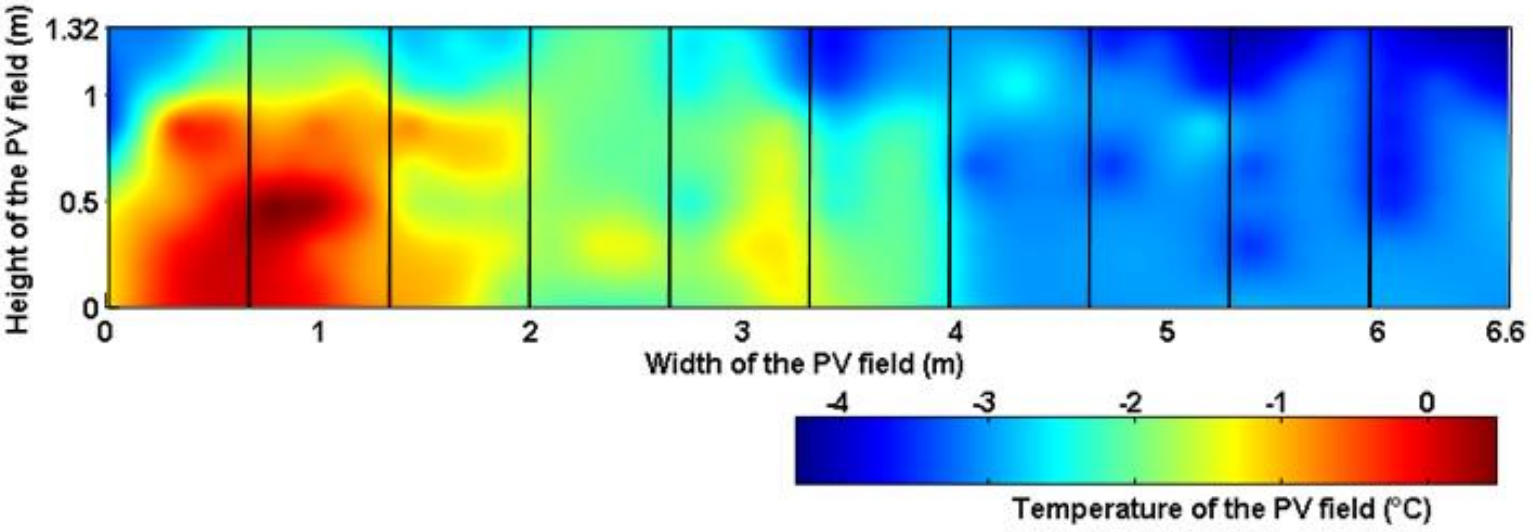
January

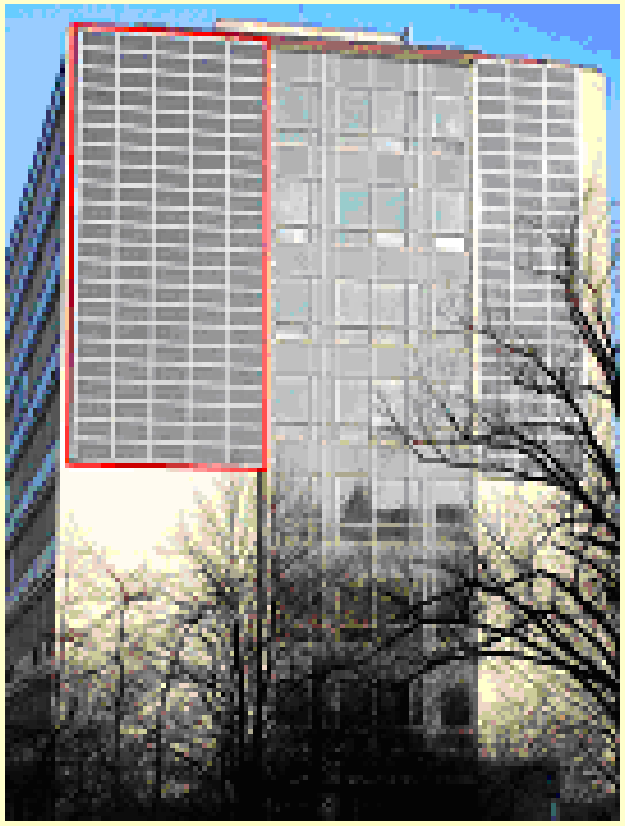
Temperature distribution over the PV field areas

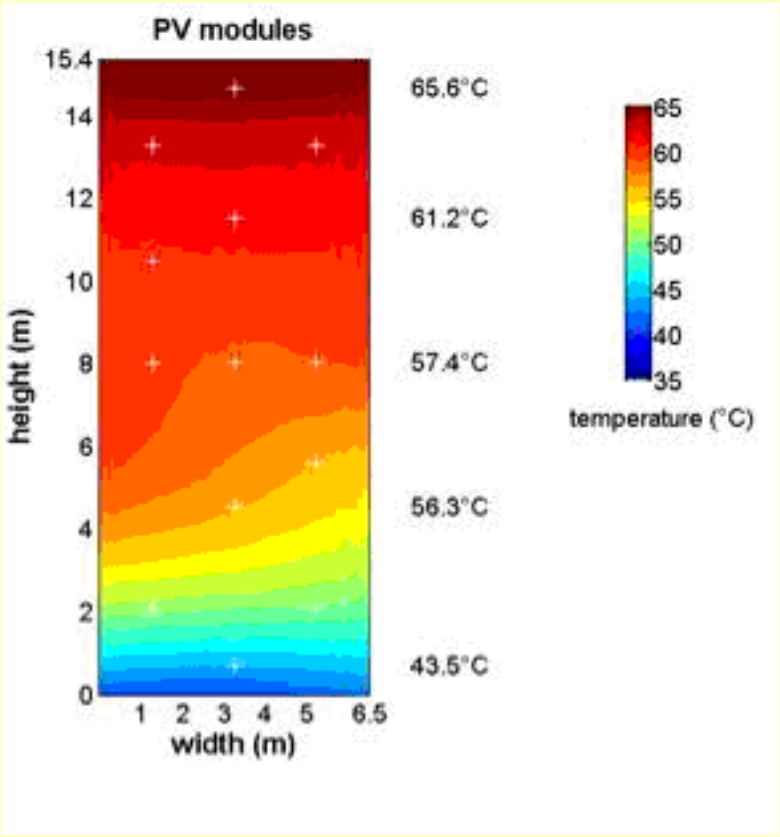
45° (roof)



90° (façade)

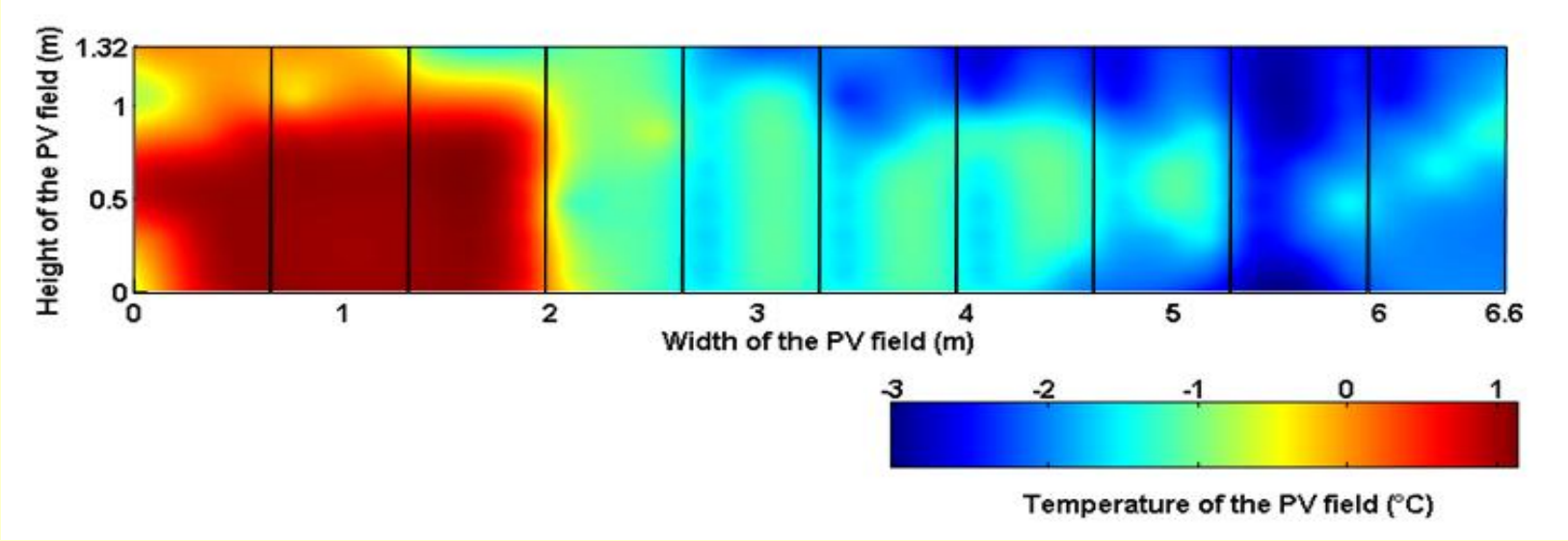


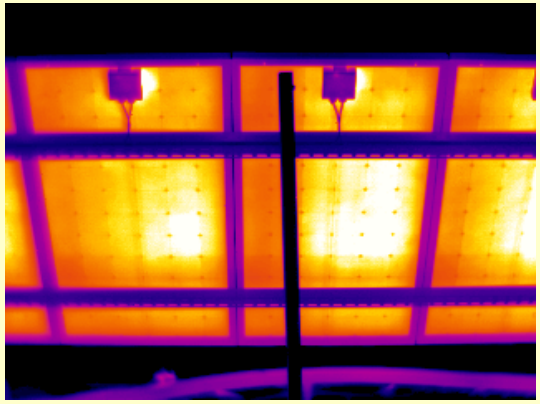


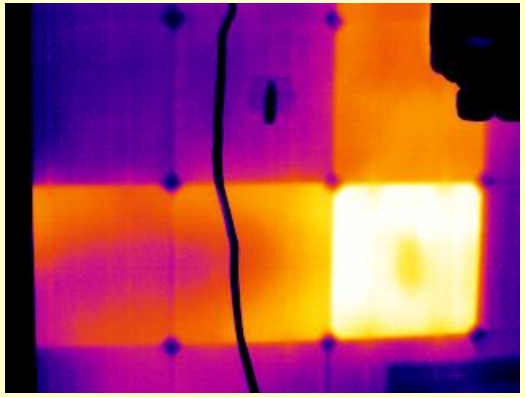

PV modules
15.4
14
12
10
8
6
4
2
0
height (m)
65.6°C
61.2°C
57.4°C
56.3°C
43.5°C
1 2 3 4 5 6.5
width (m)
65
60
55
50
45
40
35
temperature (°C)

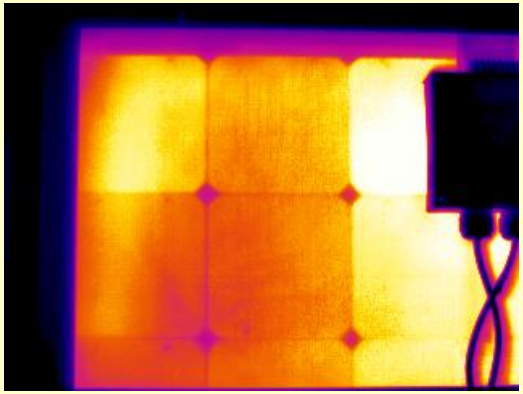
Temperature distribution over the PV field areas

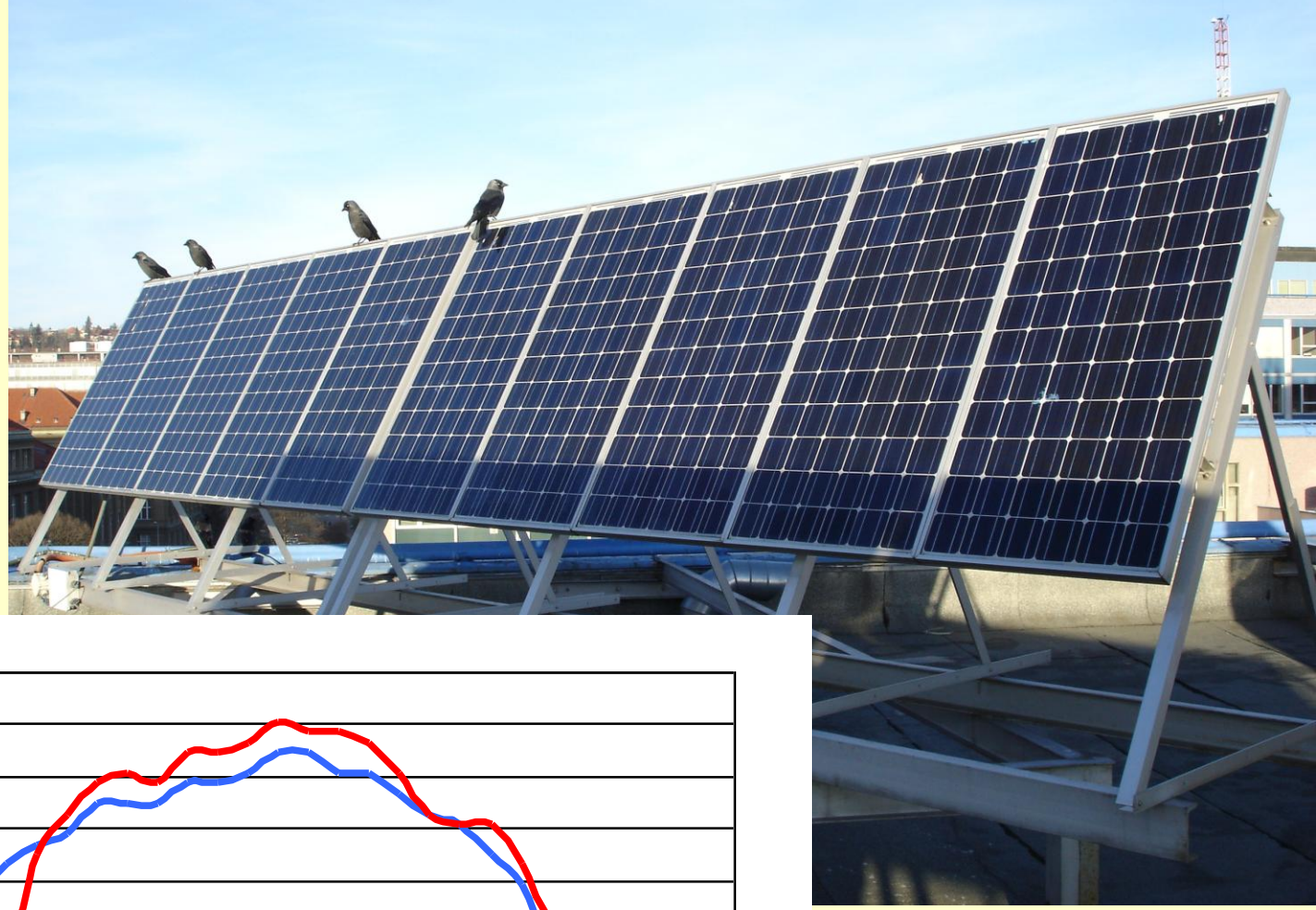
30° (roof)

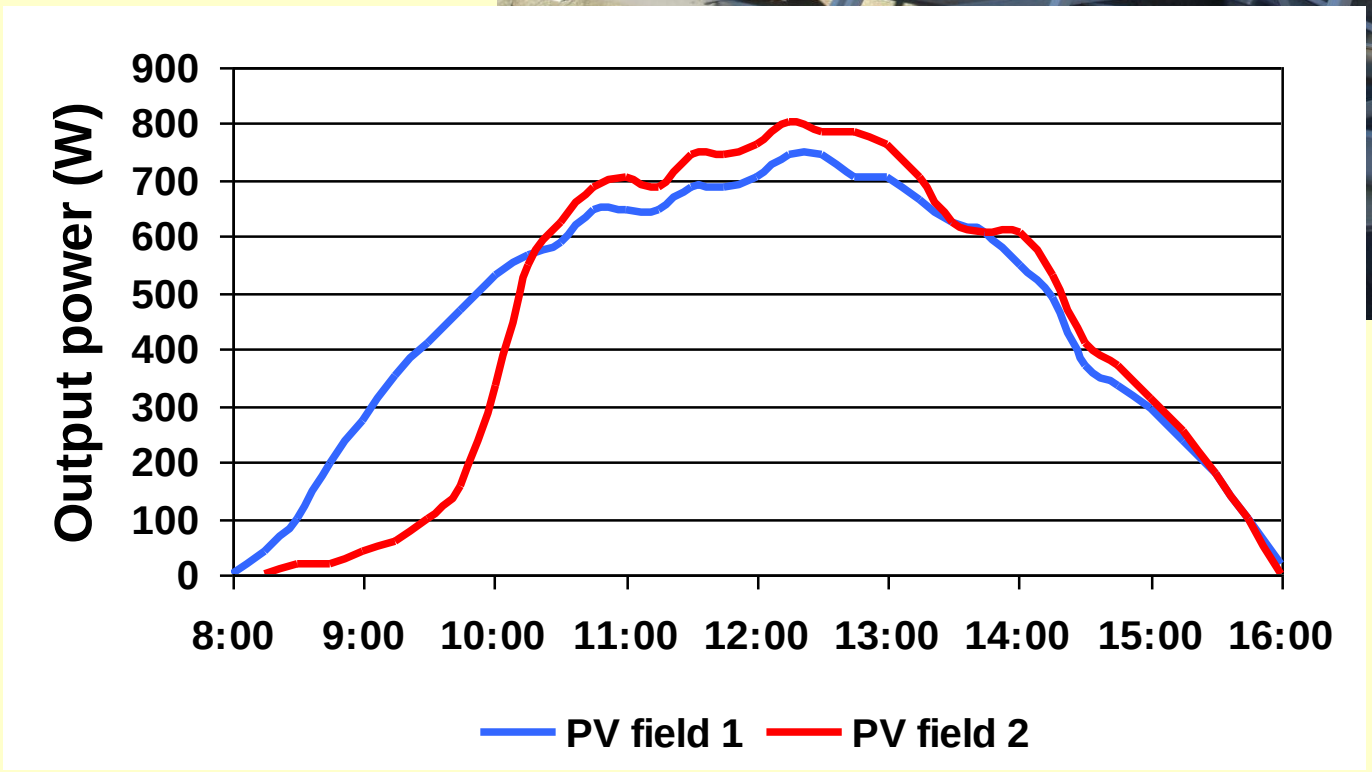











Output power (W)
900
800
700
600
500
400
300
200
100
0
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
PV field 1
PV field 2

Conclusions

- Facade PV system applications can produce about 66% of electrical energy produced by the roof (45° tilted) one
- Efficiency of PV systems is strongly influenced by temperature
- PV field constructions should allow an effective cooling of PV modules

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