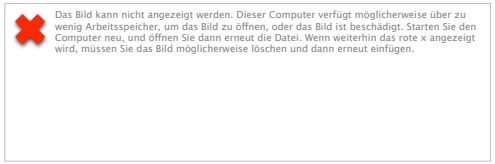

REALITY CHECK

OF A BRICK MADE PLUS ENERGY DWELLING

Tim Selke,

Florian Stift, Alexander Lehmden[2], Peter Jöchl[3]

SB13 Graz

International Conference on Sustainable Buildings
Construction Products and Technologies

Graz, Austria

25th to 28th September 2013

[2]Wienerberger AG

[3]Renewable Urban Energy Systems, FH Technikum Wien, Austria

REALITY CHECK

Tim Selke / Kissis-Kinderwelt.de

Story of the paper

- EU goals 20/20/20
- There is a variety of existing nearly zero energy building concepts

Trends

- New buildings becomes energy autonomous/ prosumer
- Buildings as an active player of the public grids (electric&heat)

Reality Check

- There is a need of SHOW CASES for future buildings with scientific support in planning and operation phase

REALITY CHECK

Technical Innovation of the project

(Source: Wienerberger AG)

POROTHERM W.i. 49
U-Value : 0.13 W/m² K

e4-Ziegelhaus 2020

- 277 m² heated gross area
- New generation of energy efficient bricks
- Thermally activated brick walls
- Zwettl/ Austria (1,096 kWh/m², 7,34°C)

Energy System

- 48 m² Flat-plate collectors
  (South/60°) roof integrated
- 9 650 liter hot water storage
  House integrated
- 40 kWth biomass fired boiler
- 6.5 kWpeak photovoltaic units
  Mounted on garage roof

REALITY CHECK

Previous scientific work

- Scientific support during design phase
(Experience and building simulation)

- Assessment of the annual energy performance of the building and of the combination of the solar system and the thermally activated brick walls
(Energy modeling and use of coupled transient building and system simulation, development sufficient 1D-model [1)] of the thermally activated brick walls)

- Development of a monitoring concept
(Concept development according to key research questions)

Key findings

- The ‘e4-Ziegelhaus2020’ concept leads into a negative annual primary energy (nr) balance, which means Plus Energy Building

- High solar fractions around 60% can be achieved with the combination of a large scale flat-plate collector field and thermally activated brick walls.

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Hypothesis

- The '*e4-Ziegelhaus2020*' is not only a plus energy building on paper, the 'reality check' proves the brick made dwelling in operation!

- The applied heat delivering system based on renewables (solar heat and biomass - Sonnenhaus concept) leads to high solar fraction above 60 per cent of the heating and domestic hot water demand!

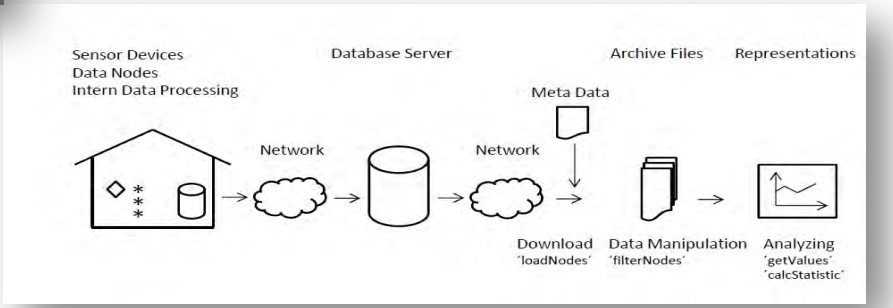
- The predicted energy performance of '*e4-Ziegelhaus2020*' by energy modelling in the 'Design Phase' meets closely the results of the conducted scientific monitoring!

Reality Check

Monitoring System

(Source: Wienerberger AG)

- Monitoring system in operation since October 2012
- Existing control unit of the heat delivering system is integrated
- Data acquisition interval 5 min
- Each 15 min automated data transfer and post-processing
- 182 data nodes

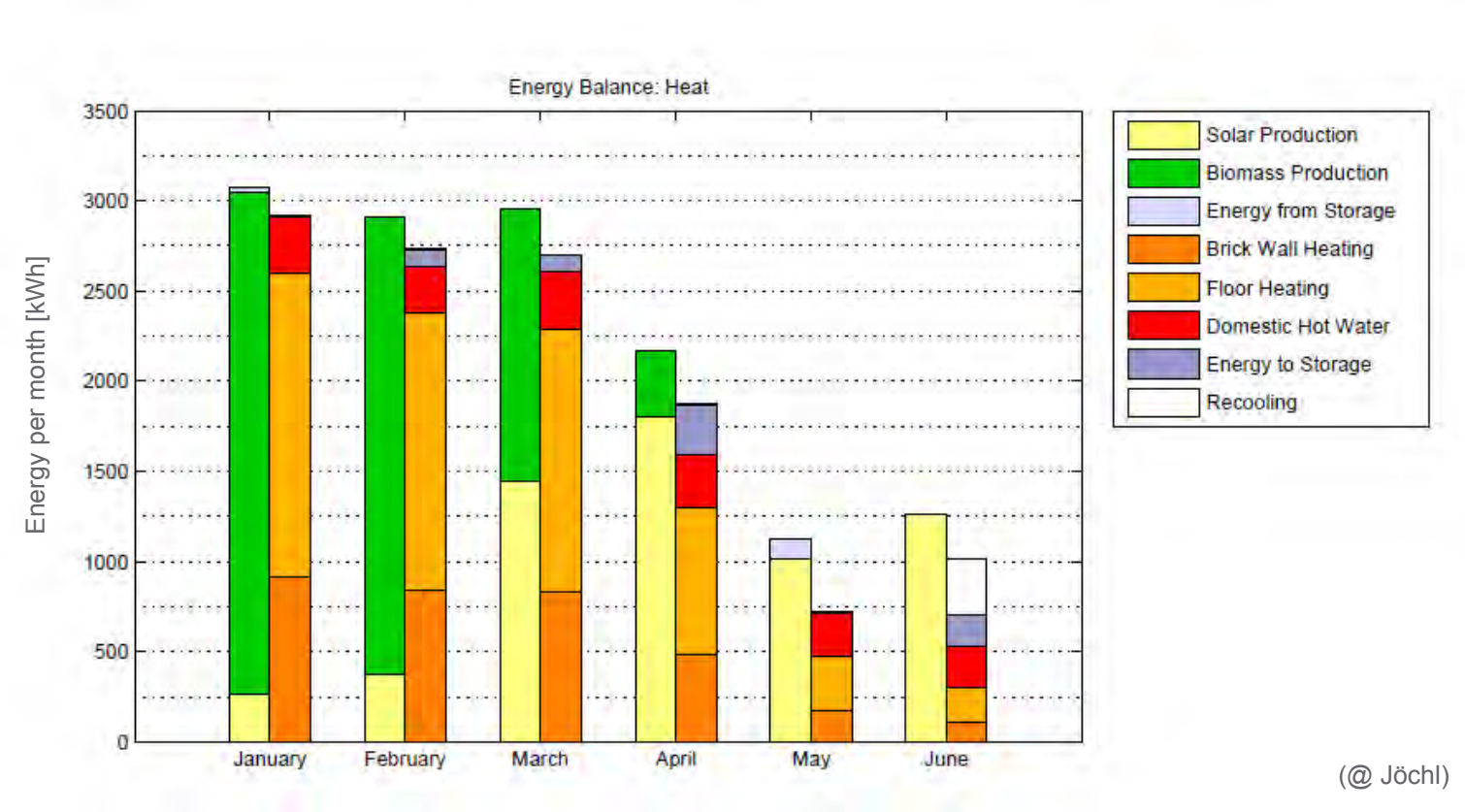


(@ Jöchl)

Reality Check

Monitoring Results

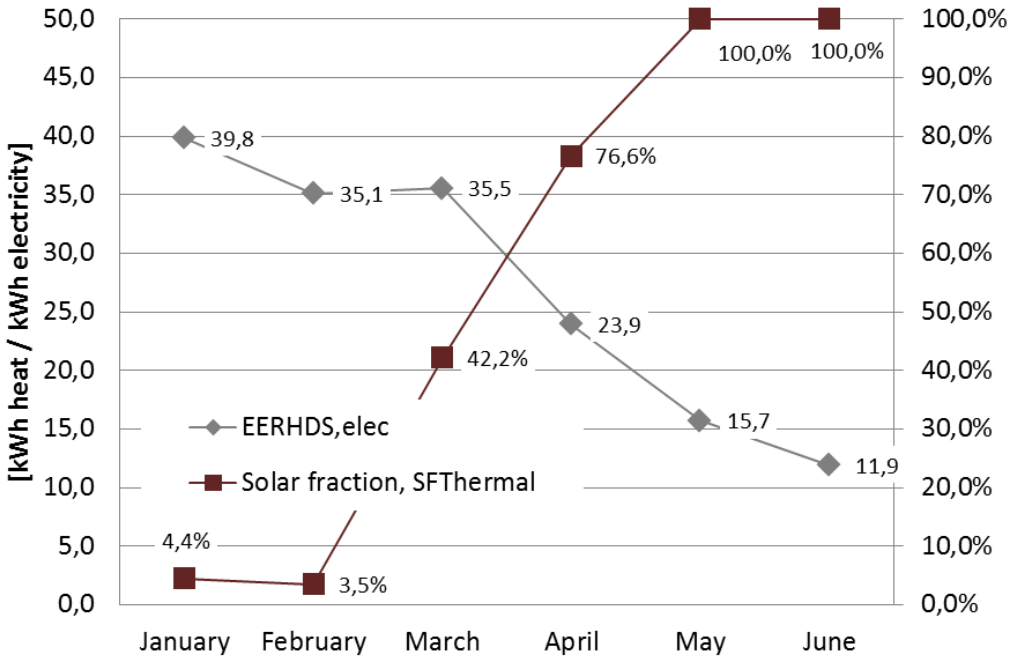
- **Heat balance from January till June 2013**
  (Heat delivered and heat transferred to the building mass and DHW)



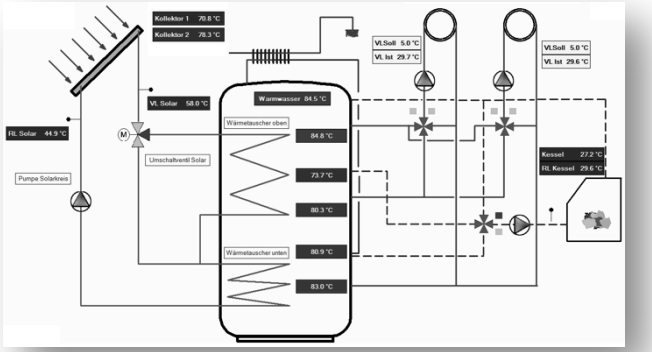
(@ Jöchl)

REALITY CHECK

Monthly Key Performance Indicators (SolarCombi-System)



Solar heat system		
$EER_{HDS,elec}$	[-]	29,1
Solar fraction, $SF_{Thermal}$	[%]	34,4%



$$SF_{thermal} = 1 - \frac{Q_{biomass}}{Q_{heating} + Q_{DHW}} \qquad \text{Equ. (1)}$$

with:

$SF_{thermal}$	solar fraction [-]
$Q_{biomass}$	heat delivered by biomass fired boiler [kWh]
$Q_{heating}$	heat delivered to the under floor and thermally activated brick walls [kWh]
Q_{DHW}	heat delivered for domestic hot water preparation [kWh]

$$EER_{HDS,el} = \frac{Q_{heating} + Q_{DHW}}{E_{HDS,pumps}} \qquad \text{Equ. (2)}$$

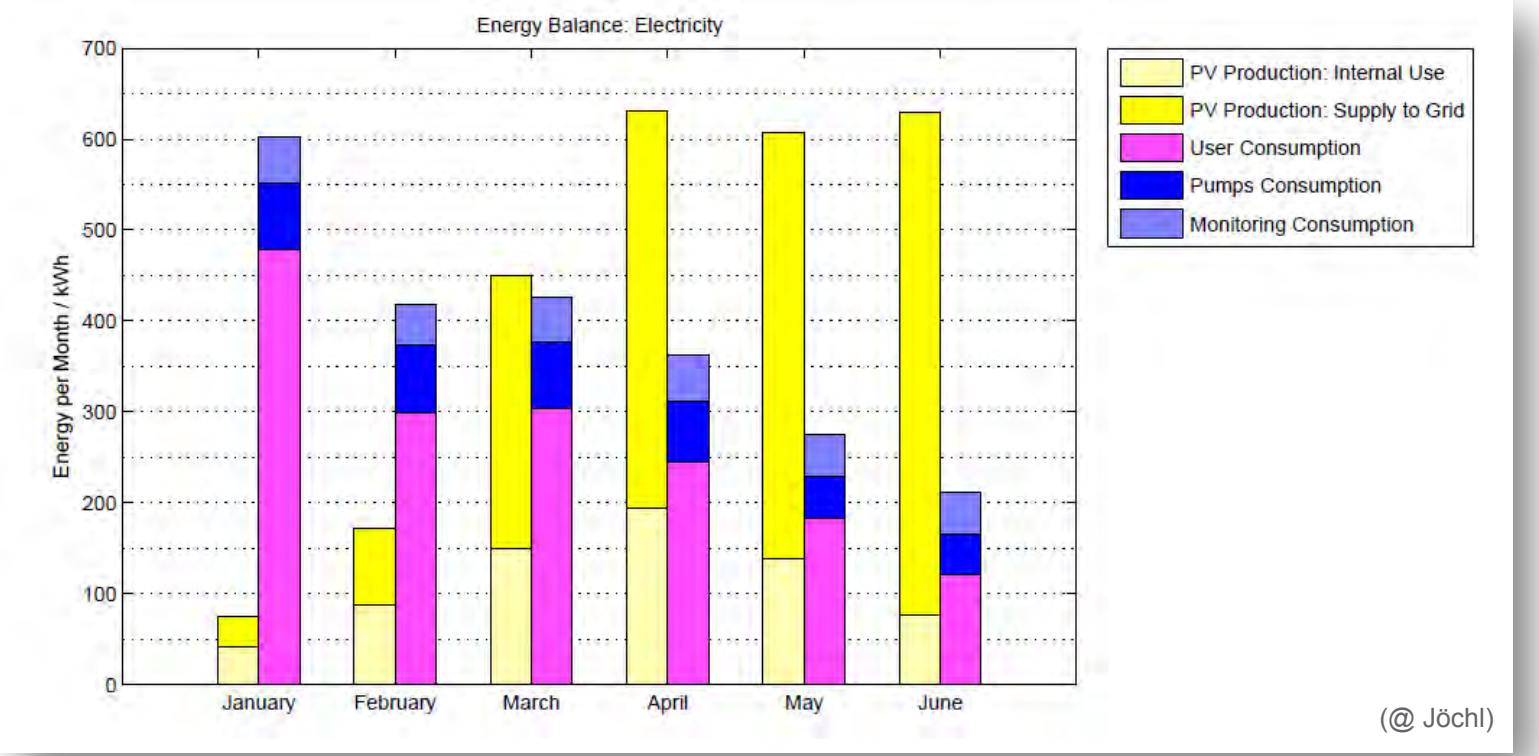
with:

$EER_{HDS,el}$	Electrical Energy Efficiency Ratio of the heat delivering system [-]
$E_{HDS,pumps}$	Electric consumption of all pumps as part of the heat delivering system [kWh]
$Q_{heating}$	heat delivered to the under floor system and thermally activated brick walls [kWh]
Q_{DHW}	heat demand for domestic hot water preparation [kWh]

Reality Check

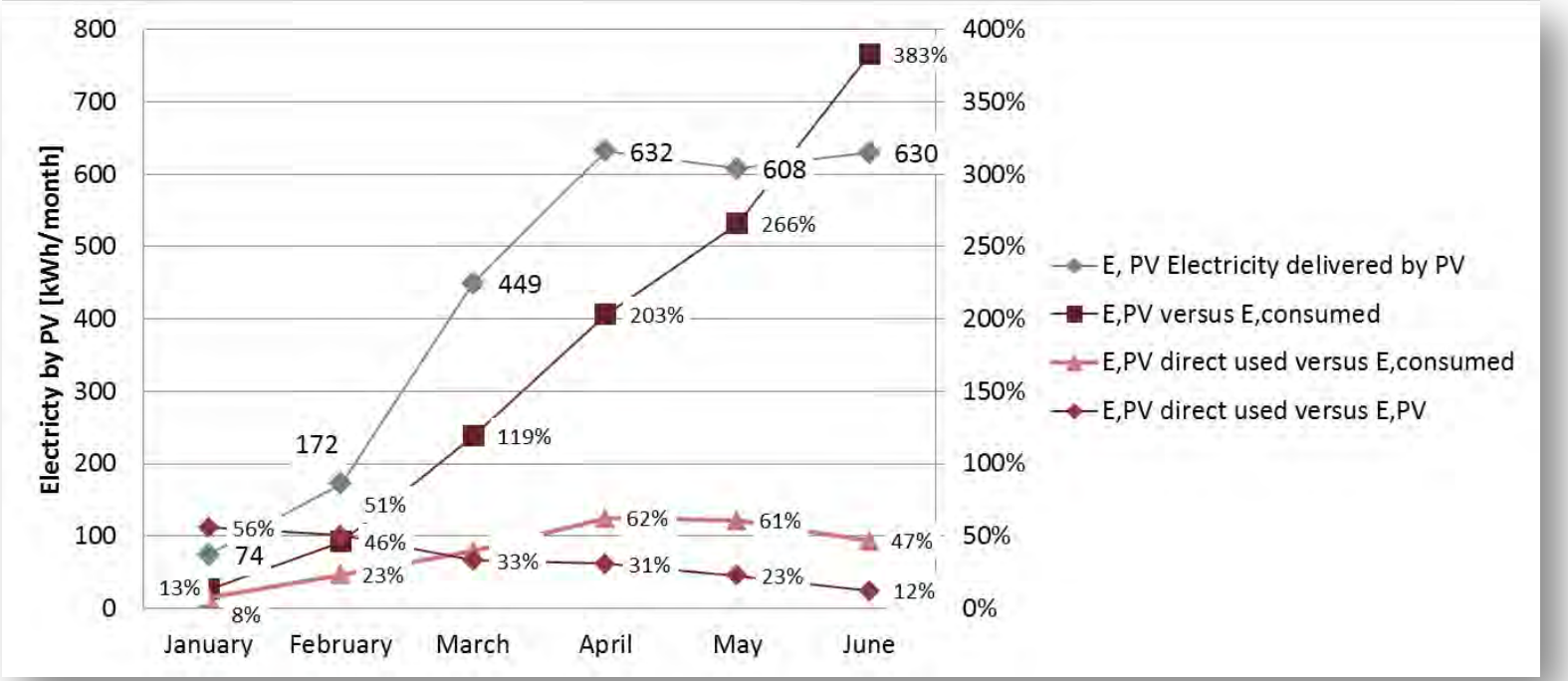
Monitoring Results

- Electricity balance from January till June 2013
  (electricity delivered by PV and consumed)



REALITY CHECK

Monthly Key Performance Indicators (PV System)



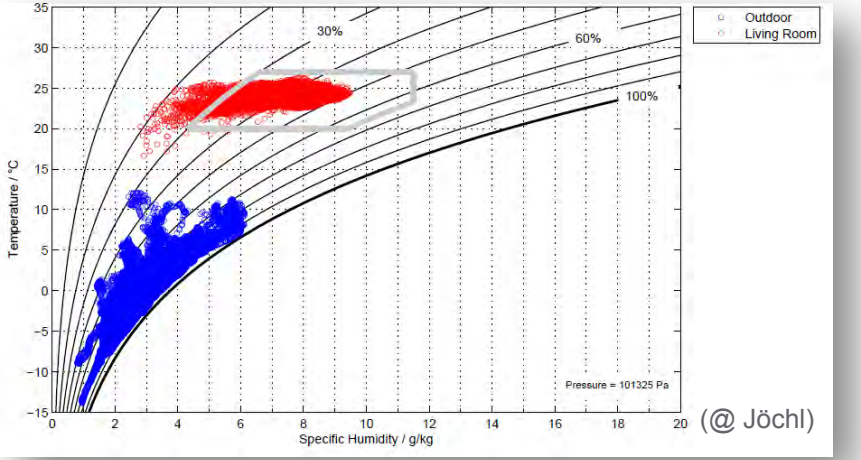
E, PV Electricity delivered by PV	[kWh]	2565
E,PV versus E,consumed	[%]	128%
E,PV direct used versus E,consumed	[%]	34%
E,PV direct used versus E,PV	[%]	27%

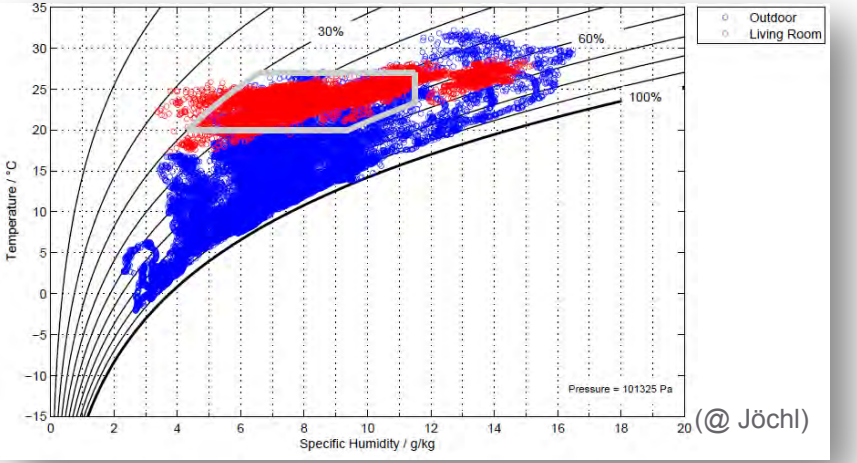
Reality Check

Monitoring Results

- **Thermal comfort of the living room** (Temperature versus humidity)

Measurement interval 5 Minutes





(January till March 2013)

2.2% are outside of comfort area

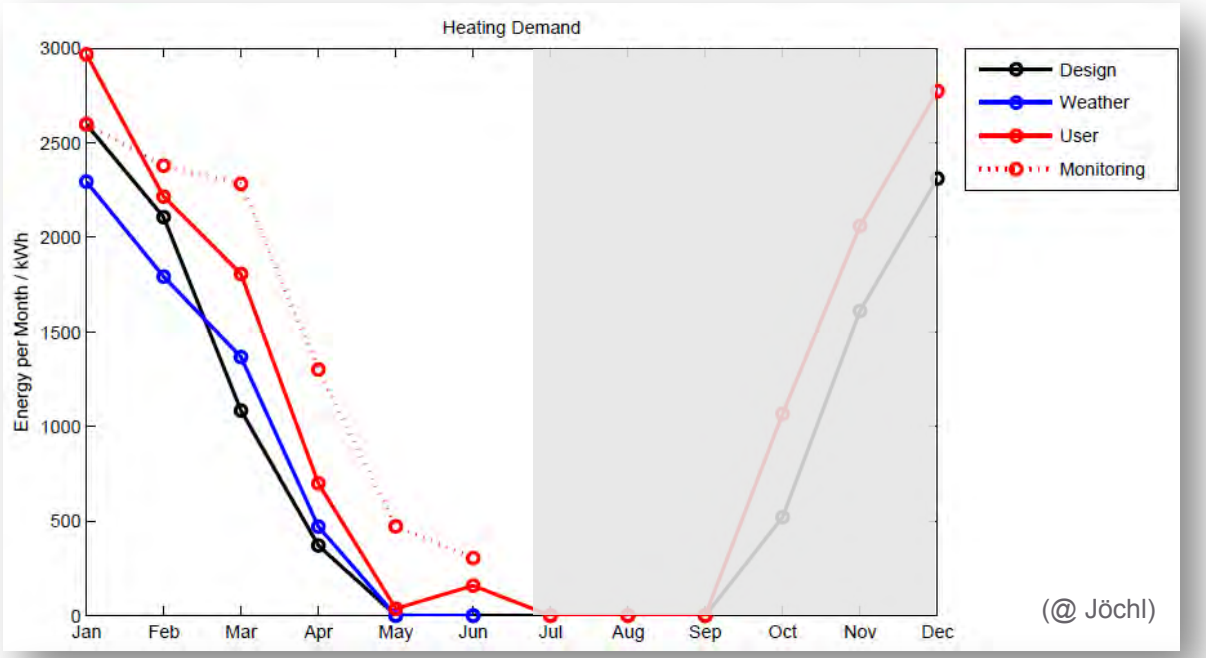
(5 min data points)

(April till June 2013)

7.9% outside of comfort area

REALITY CHECK

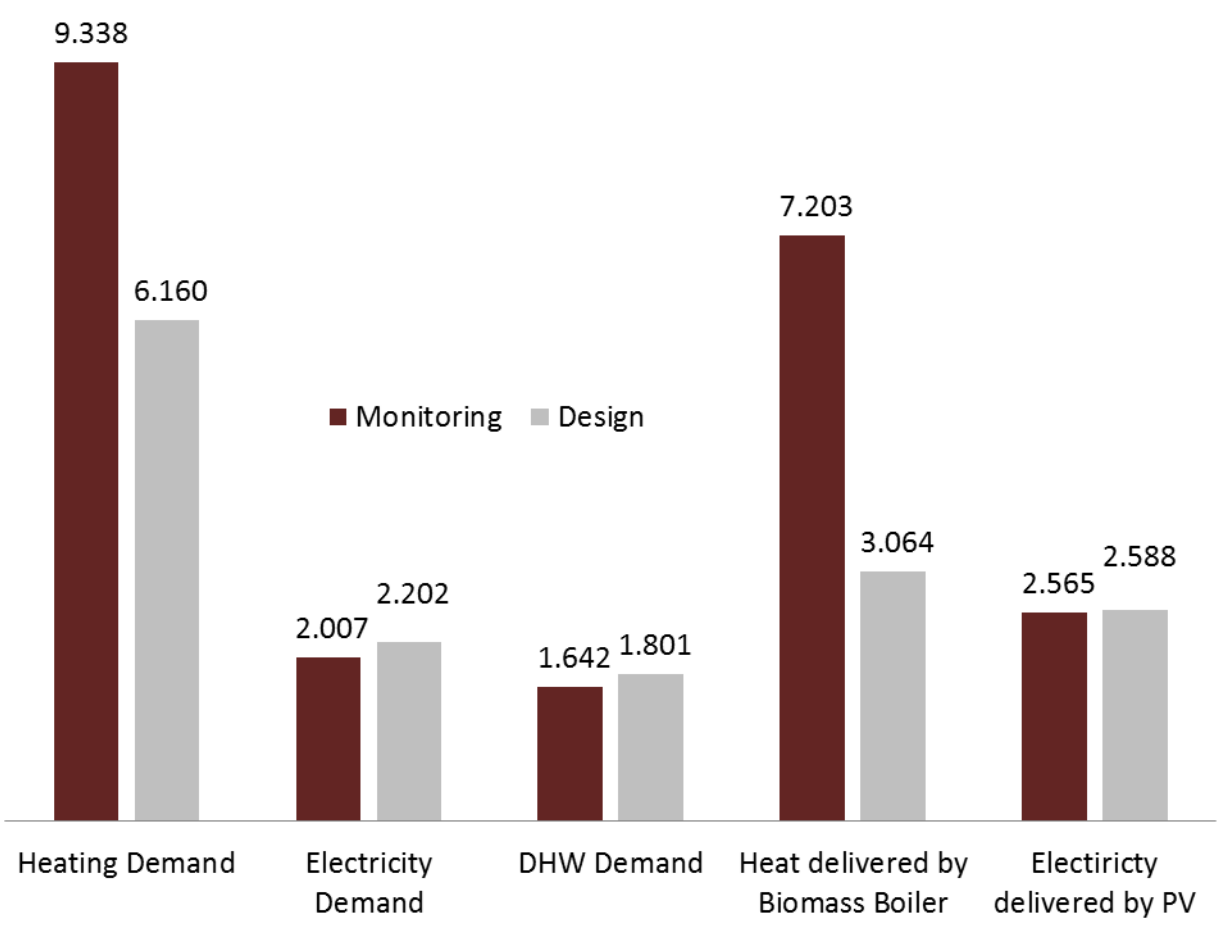
Comparison between Modeling and Monitoring – Space heating



Scenario	Heating Demand* / kWh	Deviation from Monitoring / kWh	Relative Deviation / %
Design	6159.5	-3178.2	-34.0
Weather	5924.9	-3412.8	-36.5
User	7883.6	-1454.1	-15.6
Monitoring	9337.7	0.0	0.0

REALITY CHECK

Comparison between Modeling and Monitoring



Reality Check

Key Findings

- Due to user behavior (24 degree Celsius air temperature, window opening and manual loading of the biomass boiler) the heat delivered to floor and wall heating system exceeds the calculated heating demand

- Due to marginal sun hours in Jan and Feb 2013 the amount of heat delivered by the flat-plate collector system led to very low solar fraction, e.g. in order to achieve high annual solar fraction above 60% in 2013 is not probable

- The ‘e4-Ziegelhaus2020’ will probably achieve a plus primary energy balance (nr) 2013 mostly because of both low electricity consumption and sufficient electricity delivered by PV

Reality Check

Key Findings

- The monitoring system operated with an average permanent electrical power of 68 Watt results into a share of 12,6% of the total electricity consumption

- In March 2013 the electricity delivered on site by the photovoltaic modules already exceeded the total electrical consumption. The percentage of directly used solar electricity in the '*e4-Ziegelhaus2020*' is 34% from Jan to June 3013

- The predicted energy performance of the '*e4-Ziegelhaus2020*' by energy modeling fit quite well to the monitoring data

But significant deviation are indicated for space heating due to user impact and model inaccuracy

REALITY CHECK

OUTLOOK

- Continuation of the scientific monitoring till the end of 2014
- Assessment of the annual energy performance of e4-Ziegelhaus2020 from Jan to Dec 2013
- Comparison of theoretical models with measurement data (especially heat delivering system)
- Analysis of both the thermal building performance and the heat delivering system in summer (e.g. risk of overheating, risk of stagnation of the collector field)

REALITY CHECK

Acknowledgements

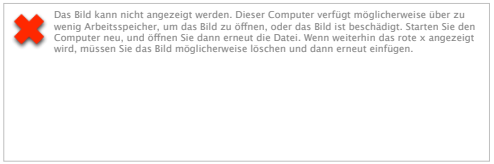
- This project ‘Solares Plus Haus’ is funded by the national ‘Klima- und Energiefonds’ within the programme ‚Neue Energien 2020’ 4th Call.

(Source: Wienerberger AG)

Project Partner

- Wienerberger AG
- Fa. Franz Schiller Gmbh

http://www.wienerberger.at/energieeffizientes-bauen/das-e4-ziegelhaus-2020



AIT Austrian Institute of Technology

your ingenious partner

Tim Selke
tim.selke@ait.ac.at