Concrete structures in a single-family-house used as micro-energy hub for surplus wind power

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• Changes in the energy system

• Austrian demo project with wind surplus energy
  – Building physics

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• Outlook
Wind and sun (and the feed in tariffs) are driving the power price

German electricity production and spot prices in week 8/2017

Source: Energy Charts, Fraunhofer ISE, 2017
Wind and sun (and the feed in tariffs) are driving the power price.

**German electricity production and spot prices in week 4/2017**

- **Wind**
- **Sun (PV)**
- **Fossil fuels**

Source: Energy Charts, Fraunhofer ISE, 2017
One sustainable solution!

Thermal storage of peak loads within the building structure by

- activation of massive building parts in
- nearly zero energy buildings with energy supply
- via heat pump linked to the grid
Energy harvest from wind energy

Available excess wind energy March 2017

(Source of data: [WEB15])
Thermal activation of ceilings

Pipe grid

reinforcing steel

concrete

photo credits: Aichinger Hoch- und Tiefbau
Temperature distribution

High living comfort in the room

- Heating load $\leq 25$ W/ m$^2$
- Cooling load $\leq 40$ W/ m$^2$
- Low surface temperatures
- Heating medium 25 - 30 °C
Why is concrete the material of choice?
“Concrete feels cold - thank God!”

It is the combination of:

- high heat conductivity \([2.5 \text{ W/mK}]\)
- high specific gravity \([2.400 \text{ kg/m}^3]\)
- high heat storage capacity \([1 \text{ kJ/kgK}]\)

→ the effective areal storage capacity \([\text{KJ/m}^2\text{K}]\) is the decisive property!
Thermal activation of ceilings - cost effectiveness

Heat flow lines

No change of the standard ceiling structure!

The major part of heat released by the pipe register flows to the room below the ceiling.

screed
footfall sound isolation
levelling layer

concrete 20 cm

AnTherm V.7.125 2013.10.03 © T.Kornicki www.kornicki.com
Cool down behavior

Period without heating demand:
- convective heating: 20 h
- thermal activation of ceiling: 75 h

Vienna, design day (cold and sunny)

24 °C

23 °C

operative temperature °C

range of accepted temperature

heated  unheated

convective heating:

thermal activation of ceiling:

Convective heating

© Dr. Klaus Kreč
Cool down behavior

Period without heating demand:

- Convective heating: 47 h
- Thermal activation of ceiling: 142 h

Vienna, design day (cold and sunny)

Range of accepted temperature

© Dr. Klaus Kreč
Utilisation of excess peak electricity via concrete structures

- One family house close to Vienna, ca. 120m² living area
- **Construction** | mid-July 2015 to mid-December 2015

**Objectives**

- Energy supply solely via heat pump:
- Excess peak electricity from wind power - Ground collector
- Simplest possible Heating/cooling System
- Simplest possible control
- Most economic solution

**Partners**

Planning of the building services | FIN – Future Is Now, Kuster Energiesolutions GmbH
Supporting research | Univ.-Prof. Dr. Klaus Kreč, TU Wien | Dr. Simon Handler, Allplan
Partner wind energy: Roman Prager, W.E.B. wind energy company, Austria
Cement Industry: Dipl.-Ing. F. Friembichler, Dipl.-Ing. S. Spaun, VÖZ
Demo project:

Single-family house in Austria

“An idea as simple as it is brilliant”
„Renewable (surplus) energy for everyone“

Official opening on 2 June 2016

(Fotos: © Z+B/Herfert)
Simulation – Results

Heat loaded into the building structure during times of wind release in % of the overall heat delivery.

Promising results for the first winter 2016/2017

„70 % of the heating demand from renewable and surplus wind *) energy “

93% in November 2016 (steady winds)

63% in January 2017 (coldest since 30 years!)

Expecting >> 80 % (mean) in the second monitoring year
(improving the air-tightness, dry building fabric)

*) one single wind park
Monitoring data-forecast

winter 2016/2017

January 2017

ground floor (°C)

1st floor (°C)
One year 2016/2017 Monitoring data-forecast

winter period

°C

Temp concrete ceiling
Temp ground floor
Vienna: Multi-family house (155 apart.)

Construction starts end 2017

Source: www.wohnen.at/angebot/objekt-detail/?id=223
From the demo project to multi-storey residential housing

Vienna: Apartment house (14 apart.)

Construction starts 11/2017
Family and senior citizens' residential park (NÖ)
Construction starts Nov. 2017

windpark under construction
• Wellbeing and thermal comfort through the use of efficient radiant heat
  • No (dust) turbulences
  • Uniform heat distribution
  • Ecologically cooling possibility
• Use of ambient heat and renewable energy sources
• Heating and cooling and buffering with a single system
• Independent of urban space conditions
• No additional construction measures
• Almost no additional costs for efficient buildings
Thank you for the support!!

A project report in the framework of the program CITY of Tomorrow on behalf of the Federal Ministry for Transport, Innovation and Technology

Sebastian Spaun, Roman Prager
Research results and data bases:
http://zement.at/services/publikationen/energiespeicher-beton

Thank you for the attention!

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