Teknologiasta liiketoimintaa

Finnish Experiences on Very Low and Zero Energy Buildings

REHVA 2011

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Definitions

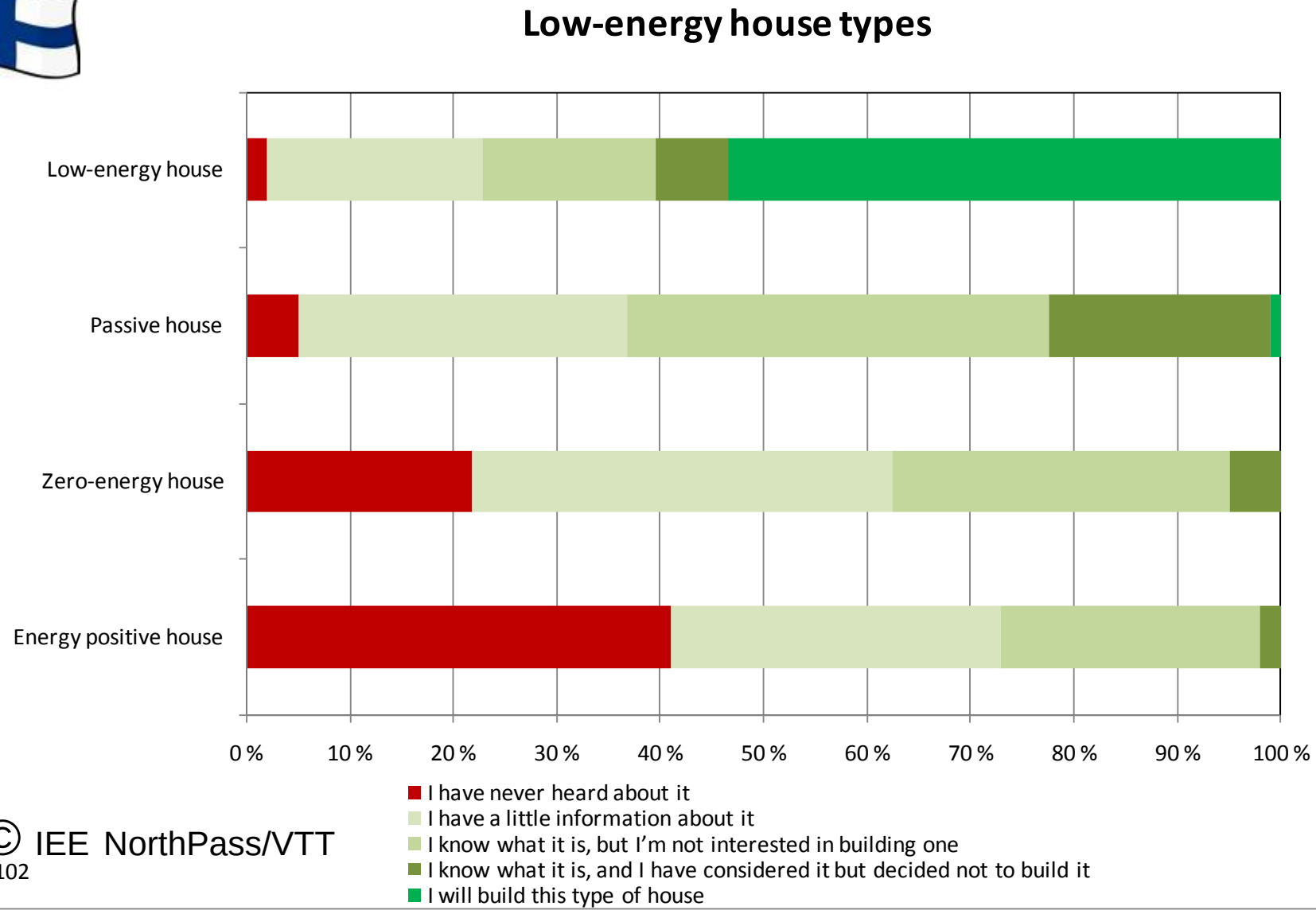
Net zero energy buildings

- The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building
- Yearly balance
  - Definition based on preliminary work of IEA Task40/Annex52 Towards Net Zero Energy Solar Buildings
- Pilots in Finland: Kuopio, Järvenpää, Mäntyharju, Hyvinkää (2013), Luukku/Aalto-Yliopisto (Solar Decathlon competition)

EPBD: Nearly zero energy building

- NZEB's are buildings with very high energy performance and their energy requirements are covered by renewable energy sources to a significant extent
- Example in Finland: Pietarsaari 1994
- Lahti (2013)

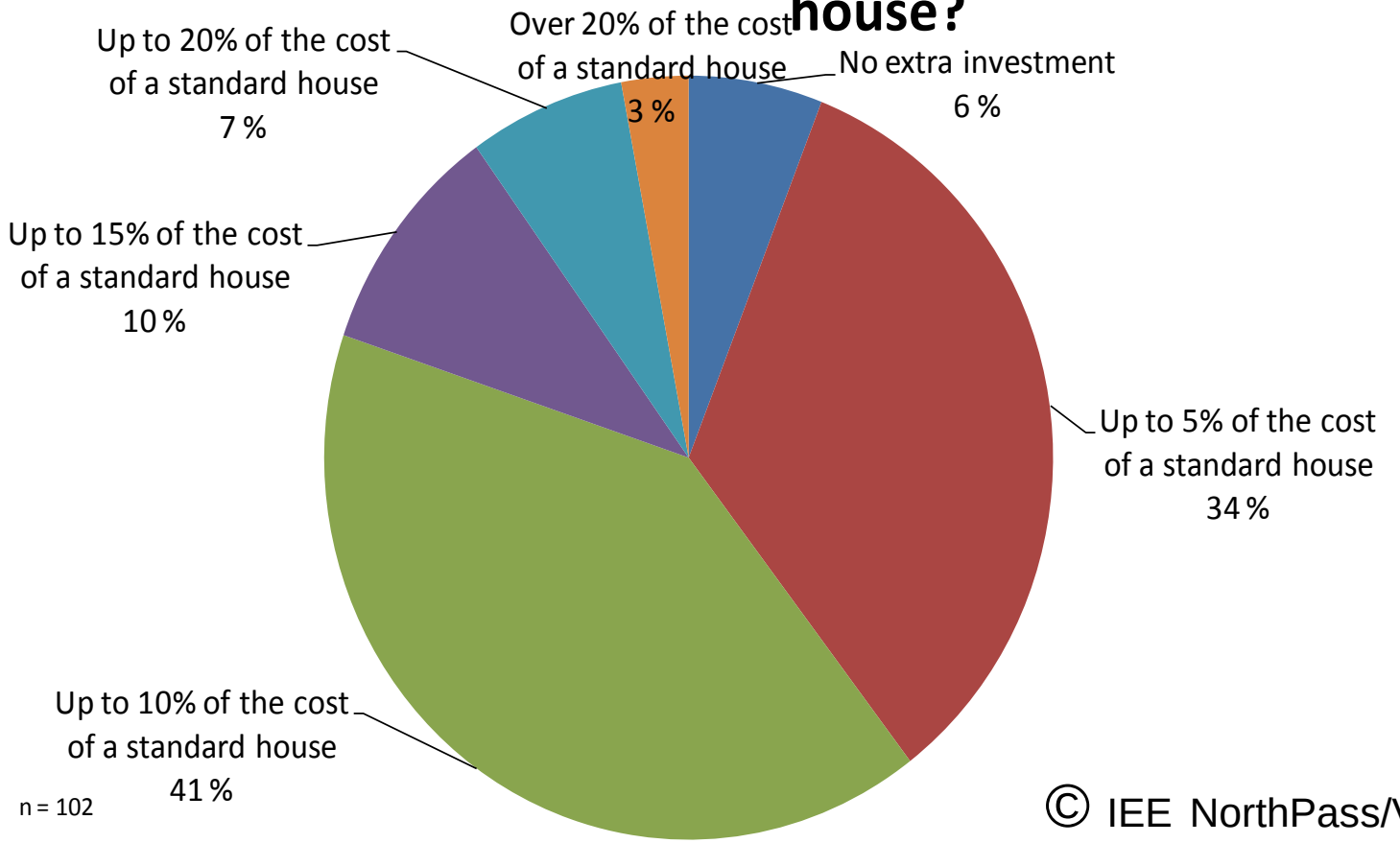
Zero energy buildings are not well known



n = 102

Extra Investment cost up to 10%

What is maximum extra investment cost that you would accept in order to build a low energy house?



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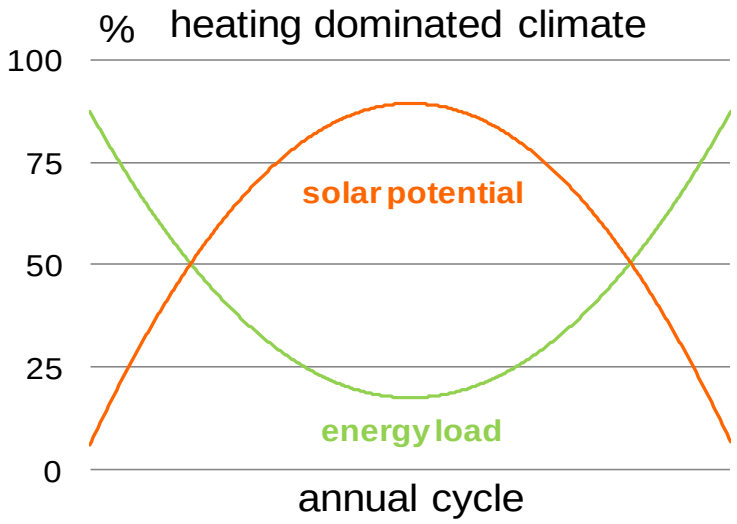
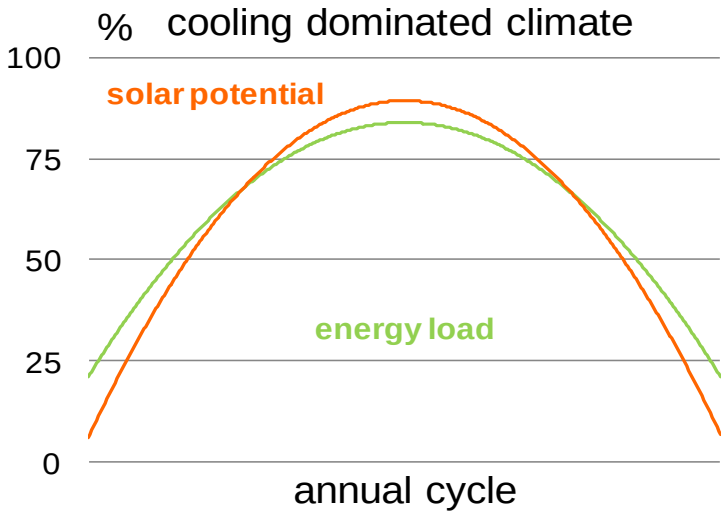
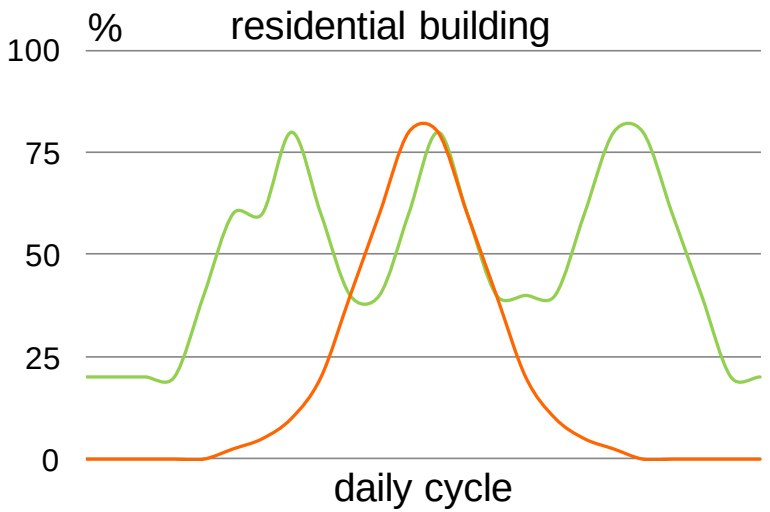
Energy use and supply mismatch



- Optimization of yearly demand and supply
- Energy efficiency reduces mismatch
- Other means
  - Energy storages
  - Orientation (PV): Supply responses demand more efficiently

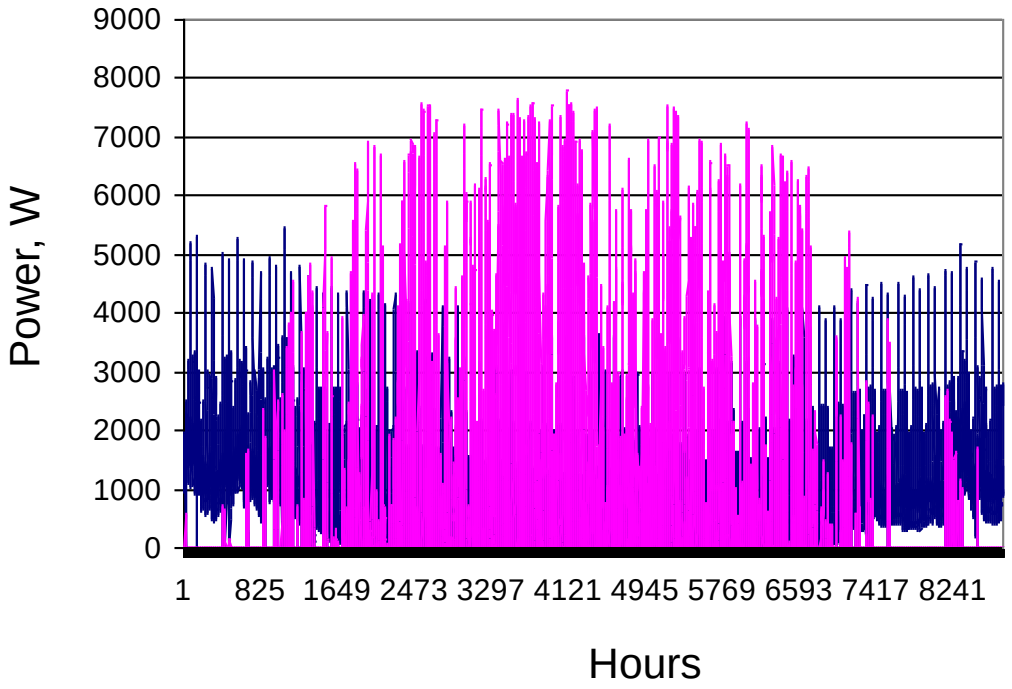




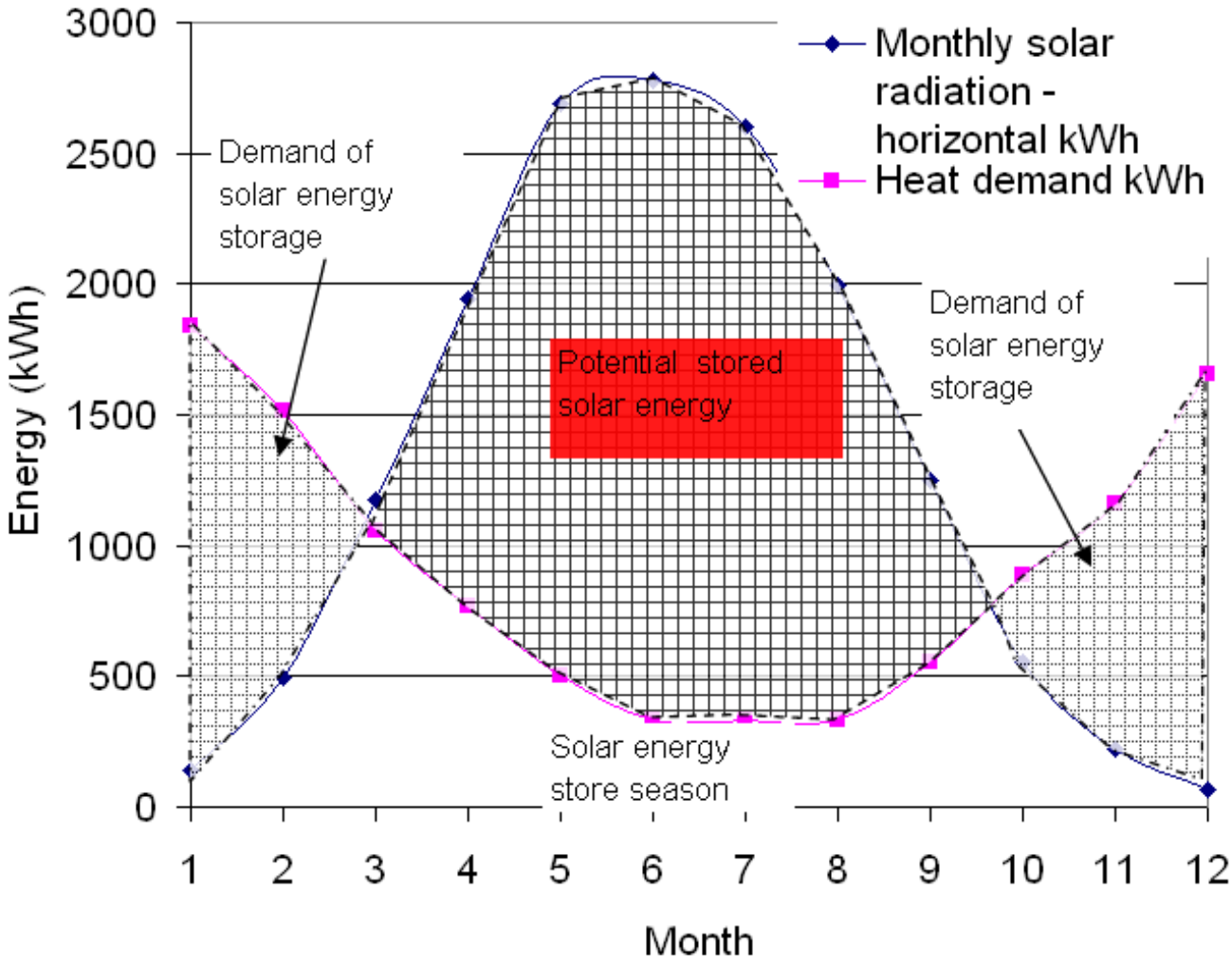
Zero energy design challenges

- Mismatch between local energy use and production
- Dark and cold winter vs. bright and sunny summer
- Energy storages in off-grid solutions
- Grid integration (electricity, district heat and district cooling)
- System dependencies: heating, cooling, thermal mass, internal loads, solar load
- Whole building solution
- Cost effectiveness

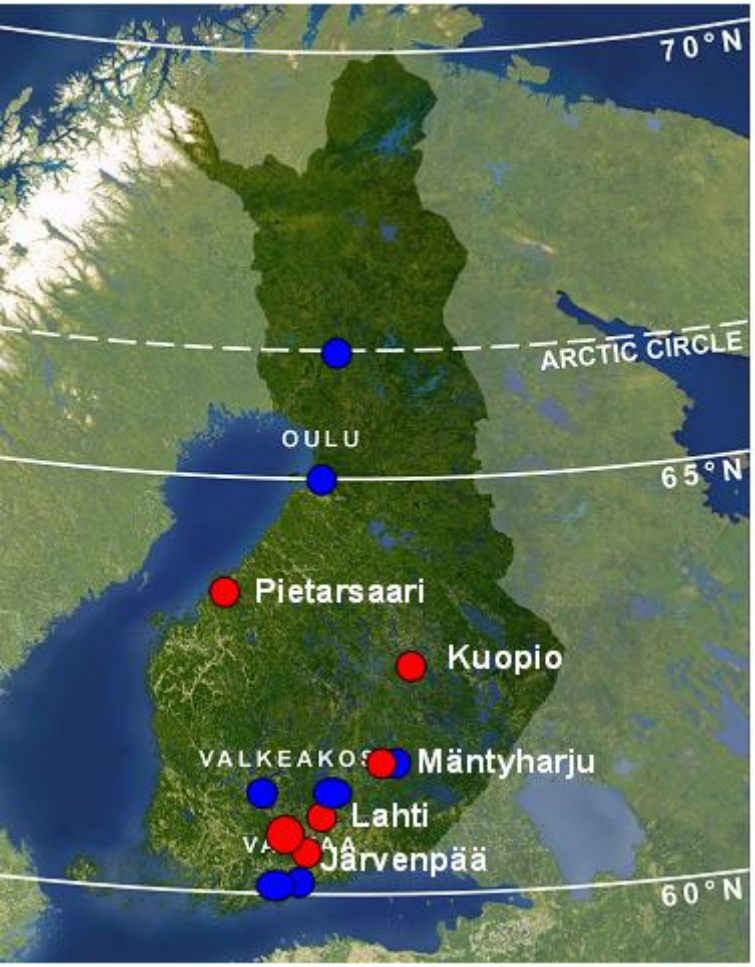
Hourly performance of a zero energy house. Total demand 8400 kWh/m^2. 10 kW PV



Solar heat potential



Examples of net zero and nearly zero energy buildings in Finland



- Net zero energy buildings:
  - Järvenpää: Apartment house 2124 m^2
  - Kuopio: Apartment house 2124 m^2
  - Mäntyharju: Single-family house 154 m^2
  - Hyvinkää: Single-family house (design phase)
  - Mäntyharju: Demo house (Aalto University) 50 m^2
- Nearly zero energy buildings:
  - Pietarsaari: Single-family house 165 m^2
  - Lahti: Elderly service centre 16 500 m^2 (design phase)

Net zero and nearly zero energy buildings
Passive buildings

Net zero energy building, Kuopio

www.nollaenergia.fi

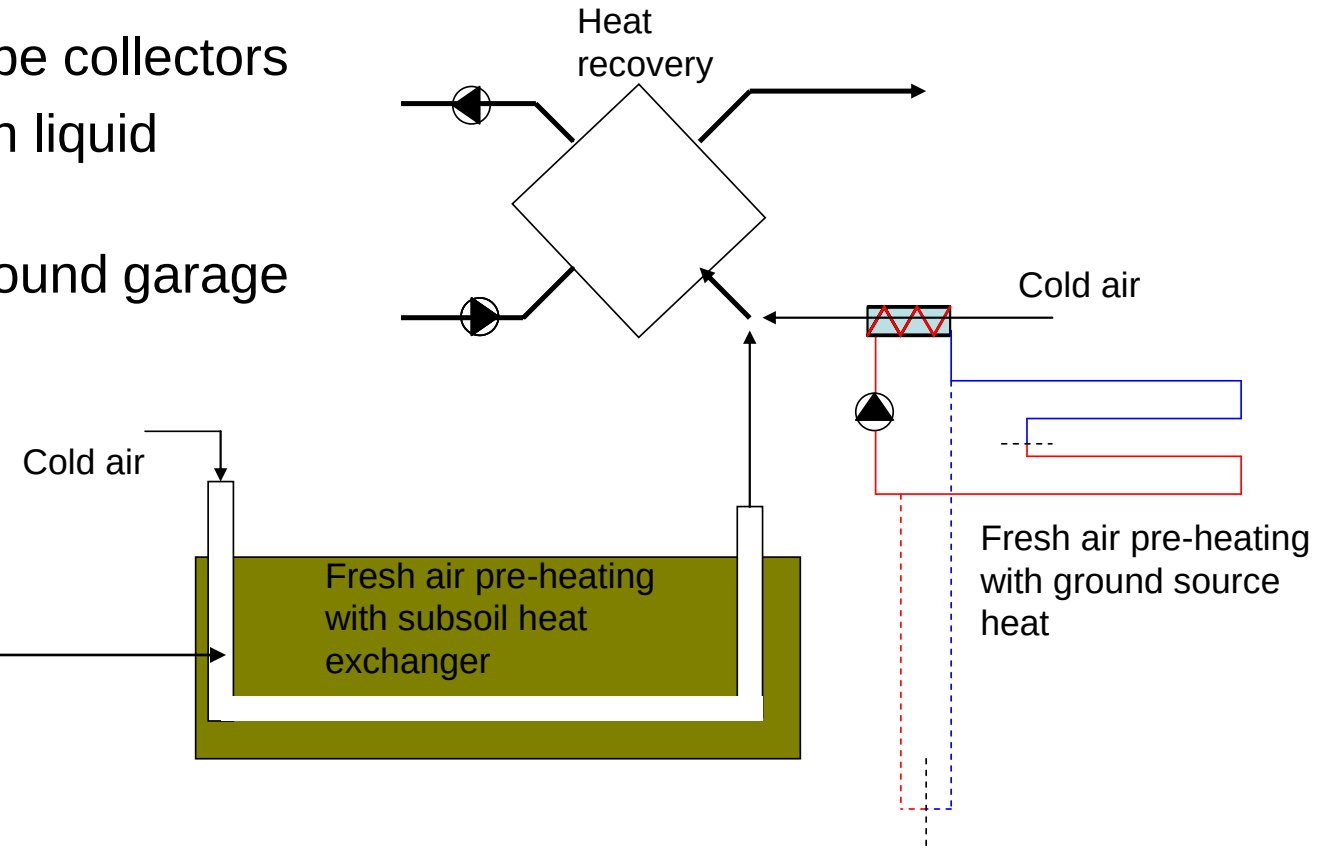
Energy demand	
Space heating	12 kWh/m^2
Water heating	13 kWh/m^2
Electricity, facility	6 kWh/m^2
Total	31 kWh/m^2
Renewable energy	
PV	7 kWh/m^2
Solar thermal	16 kWh/m^2
Ground heat	12 kWh/m^2
total	35 kWh/m^2
Excluded	
Residents electricity	16 kWh/m^2

ZEB solutions

- **Quality: design & on site supervision and management**
- Low demand
- Air tightness n_{50} < 0,4 1/h
- High insulation level
- Solar shading by exterior shading structures, e.g., PV panels
- All equipment energy classified: A++
- Low water consumption: 30 m^3/person/year
  - Water saving fixtures, low pipe pressure, metering (user pays)
- Low electricity demand of all HVAC equipment
- Building integrated renewables
  - Energy supply to neighboring buildings
- Back-up heat: district heat
- Back-up electricity: grid

Renewable energy systems

- PV panels: 14 kW
- Solar collectors: vacuum tube collectors
- Ground heat exchanger with liquid circulation
- Energy supplied to underground garage



High energy benefit –

Air quality in the long-term?

Net Zero Energy apartment house, Järvenpää 2011

Elderly home incl. 24h services

- PV 14 kW
- Solar thermal 126 m^2
- Energy supplied to neighboring buildings
- Solar shading by exterior shading structures, e.g., PV panels
- Preliminary total cost estimate:
  - NZEB ~2900 €/m^2
  - Typical for new elderly homes 2400 – 3000 €/m^2

www.nollaenergia.fi

Net zero energy house, Mäntyharju

- Systems integration, building system
- Ground source heat pump heating
  - Low-temperature floor heating
- Solar collectors for hot water heating (50 %)
- Water saving fixtures (25 % savings)
- Lighting: LED (30 – 50 % savings)
- Shading / blinds
- Ventilation pre-heating/cooling
- Energy classified household appliances
- Energy demand 7000 kWh = 45 kWh/m^2
- Solar collectors 5 m^2
- PV panels 8 kW_p

www.suutarinen.fi

IEA5-Solar House

- Ground source heat pump
- Solar thermal
- PV
- Quality
- Professional use
- High insulation level

	Pietarsaari 1993	Tavallinen 2011
Component	**U-value [W/m²K]**	
Wall	0,12	0,17
Roof	0,09	0,09
Floor	0,1	0,16
Door	0,4	1,0
Window	0,7	1,0

Nearly zero energy house

- Pietarsaari 1993:
  - Energy demand 98 kWh/m^2
  - Purchased energy 48 kWh/m^2
- Technical development:
  - PV:
    - Present system 2 kW$_p$
    - Planned renewal ~8 kW$_p$
  - Ground source heat pump:
    - Original: COP 2,4
    - New: COP 3,5 ... 4,0 (45 ^{o}C, back-up for hot water)
- Pietarsaari 2011: Purchased energy 30 ... 40 kWh/m^2
- Pietarsaari 2012: Purchased energy 0 ... 10 kWh/m^2

Elderly home, Lahti

- Nearly zero energy building
- Energy demand 60 kWh/m^2 primary energy
- 16500 m^2
- Priority in user needs
- Procurement and tendering process:
  - 60% weight on price
  - 40% weight on energy and quality
- Ground heat/cool
- District heating (renewable!)
- PV

Nearly zero housing area

- Mainly detached, semi-detached and row houses
- Total floor area 27000 m^2
- Energy systems for varying energy efficiency levels
  - Building code 2010
  - Building code 2012
  - EPBD 202
- Heat pump heating
- Electricity supply
  - Wind power
  - PV

Nearly zero approach

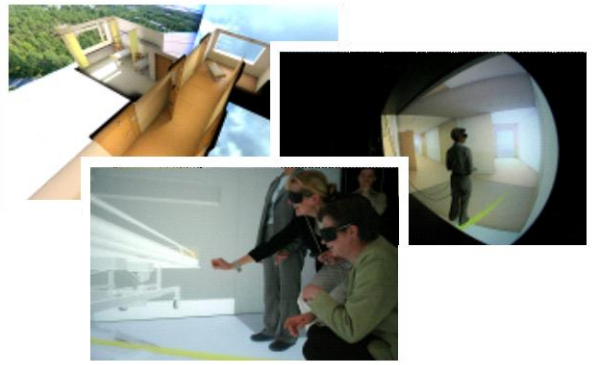
Solar electricity 50 %

Wind power 50 %

Level	Electricity for heating GWh	Other electricity GWh	Total GWh	PV electricity kW_p	PV m^2/k-m^2	Wind Power kW	Investment on renewables and buildings	
							Renewables €/m^2	Buildings €/m^2
2012	0,8	0,8	1,6	940	0,04	320	150...	0
2020	0,3	0,8	1,1	647	0,03	220	100...	100

Summary

- Nearly zero energy buildings 2018 / 2021: costs are not the main problem
  - Competence, knowhow, skills
  - Design and construction quality
  - Cold climate with long winter is a challenge
- Whole building solution is a must
  - Partial system optimization is not enough
  - Building services as an integrator
  - Dynamic approach for over the year performance
  - Demand for design accuracy increases
- Testing of systems
  - Tools missing at the moment
- New low energy demand systems required
  - Systems integration increases



Thank you!

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