Energy Efficient Buildings
- new challenges -

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Webinar "energy efficiency" for "Clean Energy for EU Islands initiative“

March 31st 2020

Policy: European Climate Targets

	2005	2020	2030	2050
	494,6 Million People	515,4 Million People	524,1 Million People	528,7 Million People
Greenhouse gas emissions compared to 1990	5500 million tons CO_2 equivalent	-20%	>-40%	>-80%
Renewable energy compared to gross final consumption	9%	20%	32%	>55%
Energy efficiency compared to baseline scenario	Primary energy consumption: 1720 million tons oil equivalent	-20% 20% compared to baseline scenario 13% compared to 2005	-32,5% 32.5% compared to baseline scenario 26% compared to 2005	> 28% compared to 2005

Building play an important role in this

- *Buildings* are responsible for approximately
  40% of EU energy consumption and 36% of the CO2 emissions.
- In EU *households*, heating and hot water alone account for
  79% of total final energy use.

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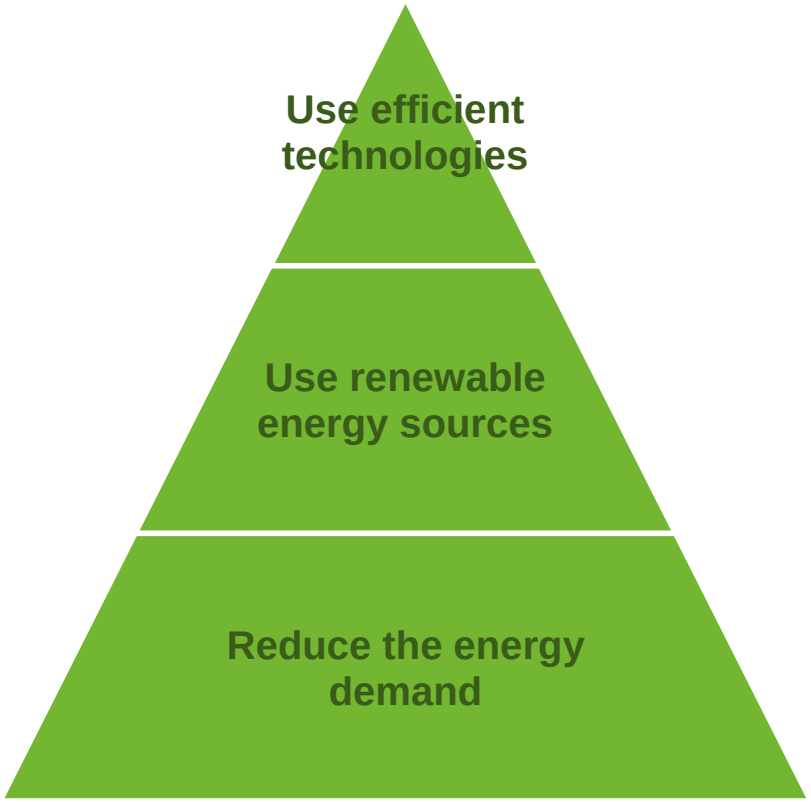
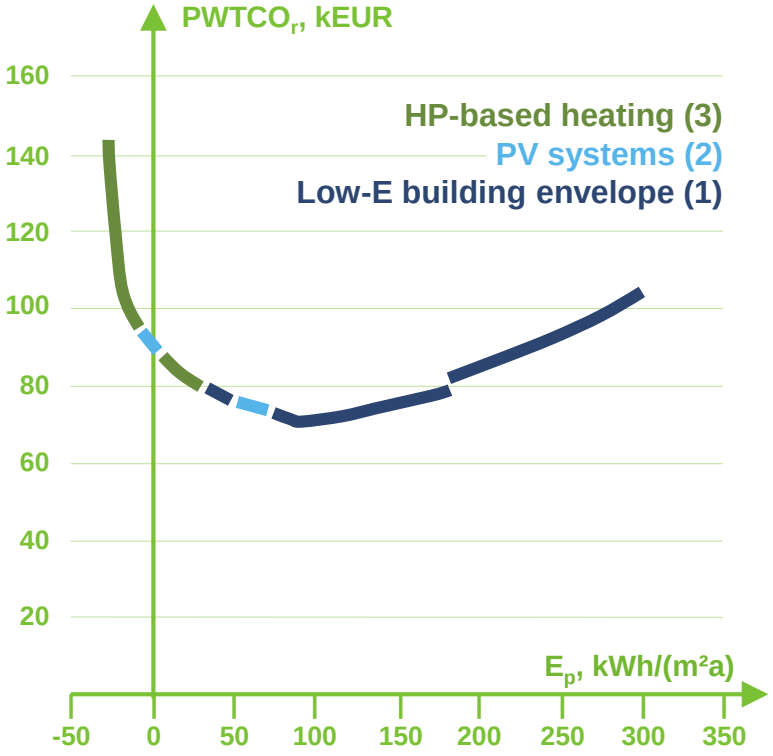
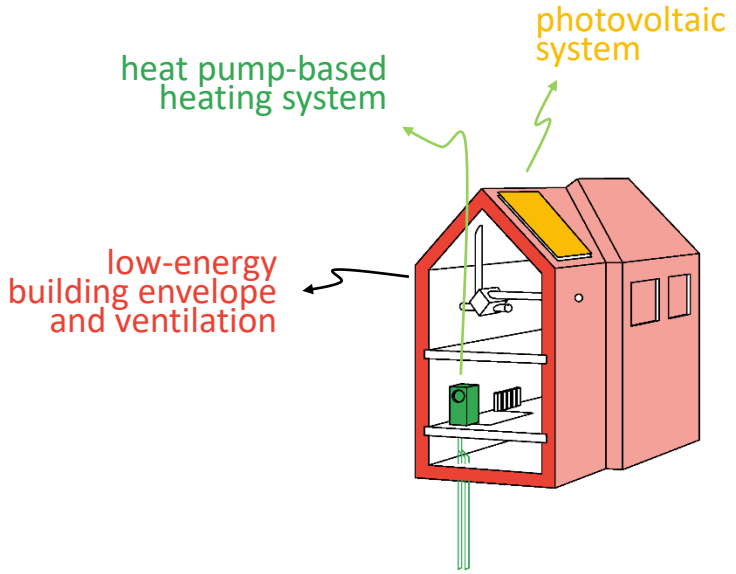
Energy Efficiency First principle



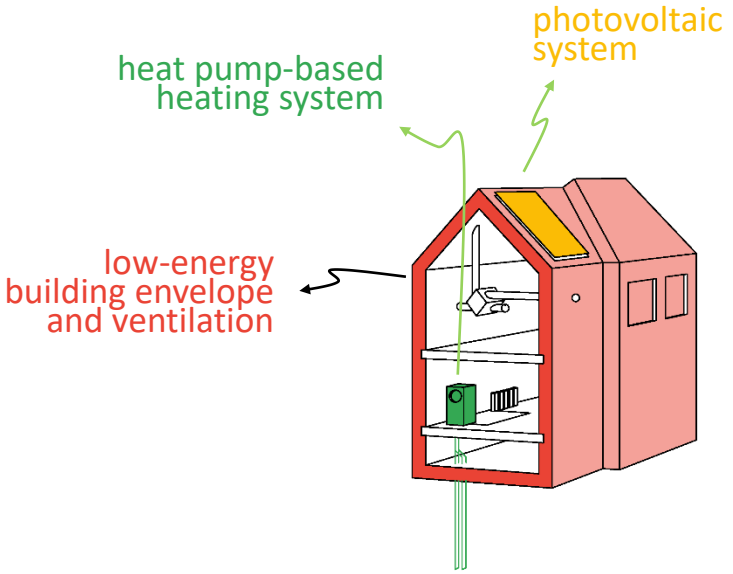
Typical solutions for residential buildings



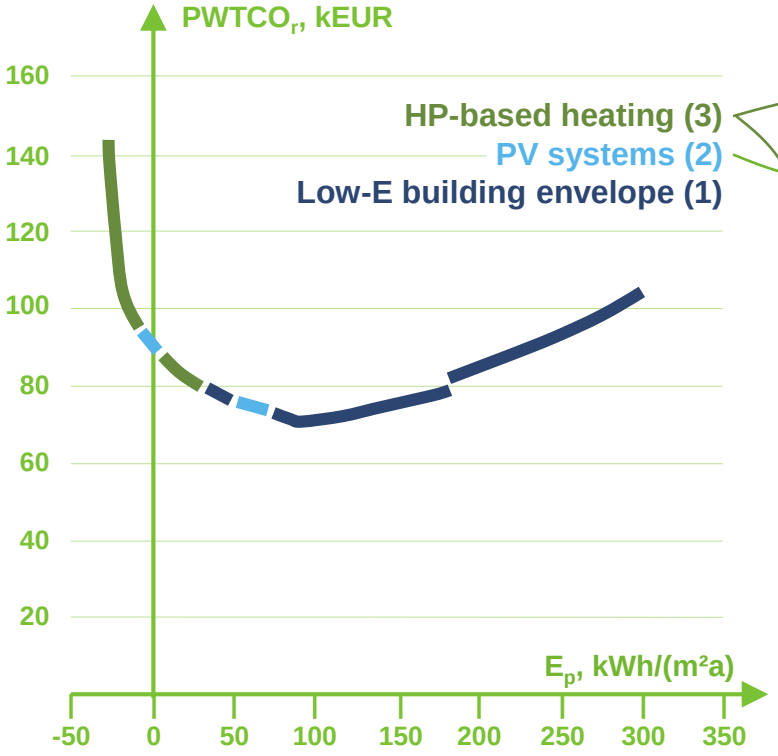
Source: J. Van der Veken et al. (2013). Studie naar kostenoptimale niveaus van de minimumeisen inzake energieprestaties van gerenoveerde bestaande residentiële gebouwen.



Question: who has a heat pump, PV, both or none?



From individual assessment …



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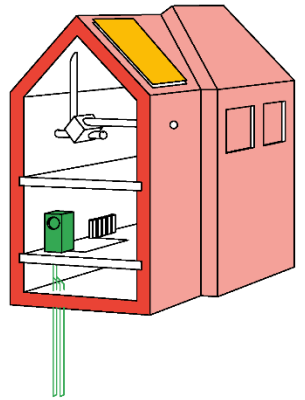
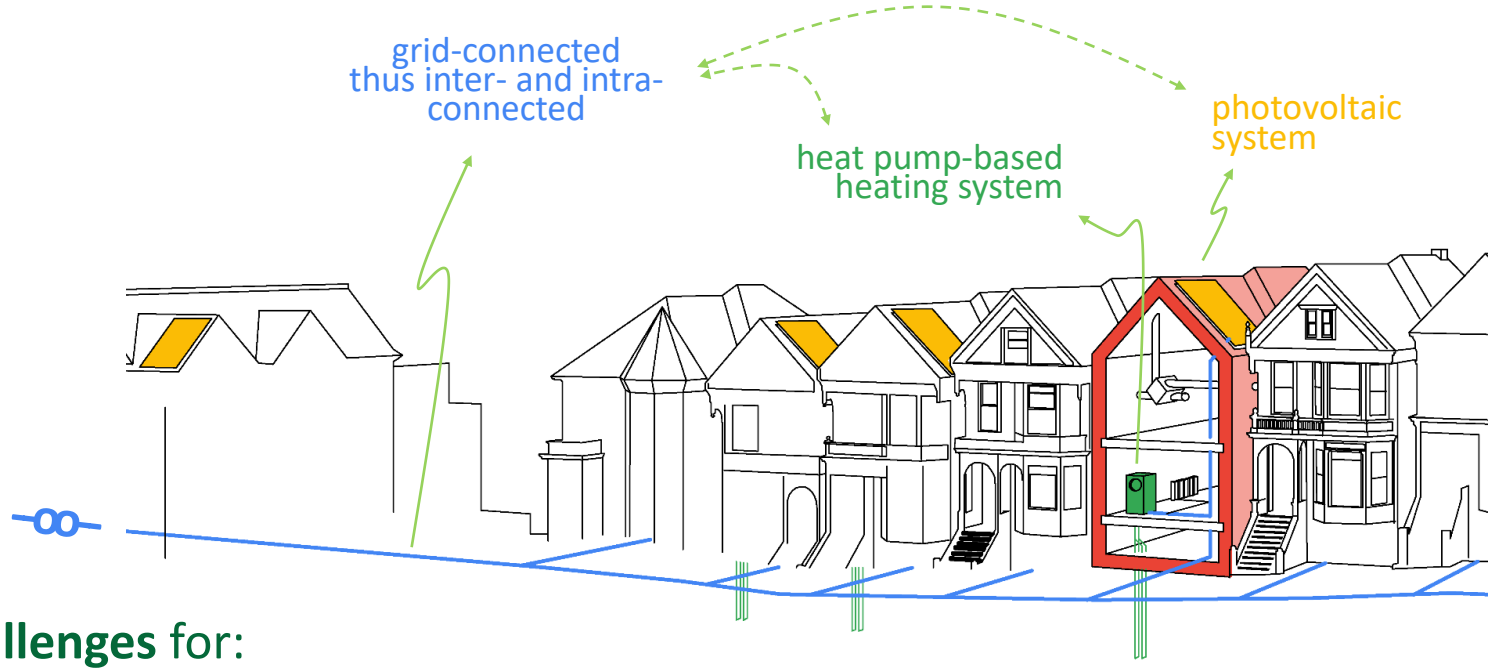
On the one hand,
Extra load for distribution network,
possibly resulting severe voltage drops
or overloading

On the other hand,
High thermal inertia, thus
significant amount of flexible consumption
if heating power can be controlled



… towards a system approach

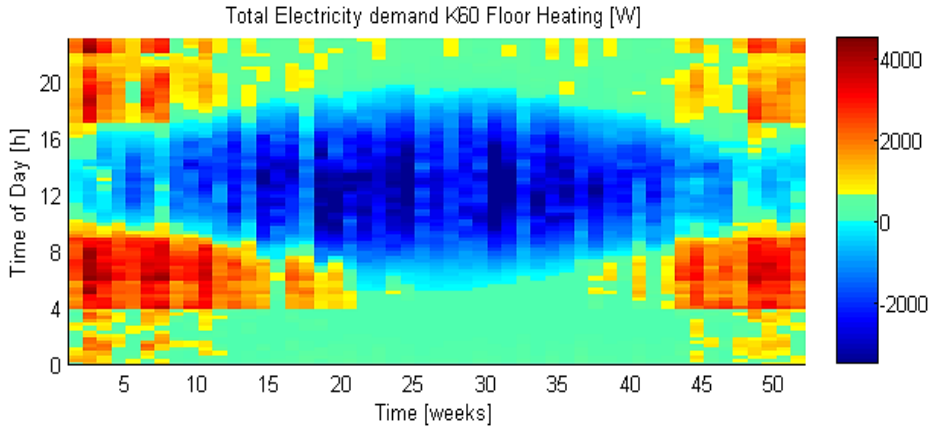


New **challenges** for:

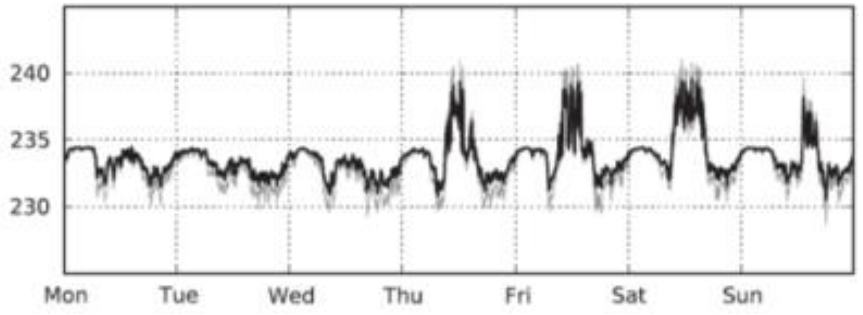
- Energy system + legislation
  - Requires new energy markets
  - Legislation currently focus on individual buildings
- Building simulation
  - Multi-domain modelling
  - Increase of dimensionality
  - Reduction of time-scale because of electricity

Integrated District Energy Assessment by Simulation (IDEAS)

- Modelica environment to assess PV integration in districts
- For PV there is a solar paradox: mismatch between supply and demand
- Typical solution is virtual storage in the grid



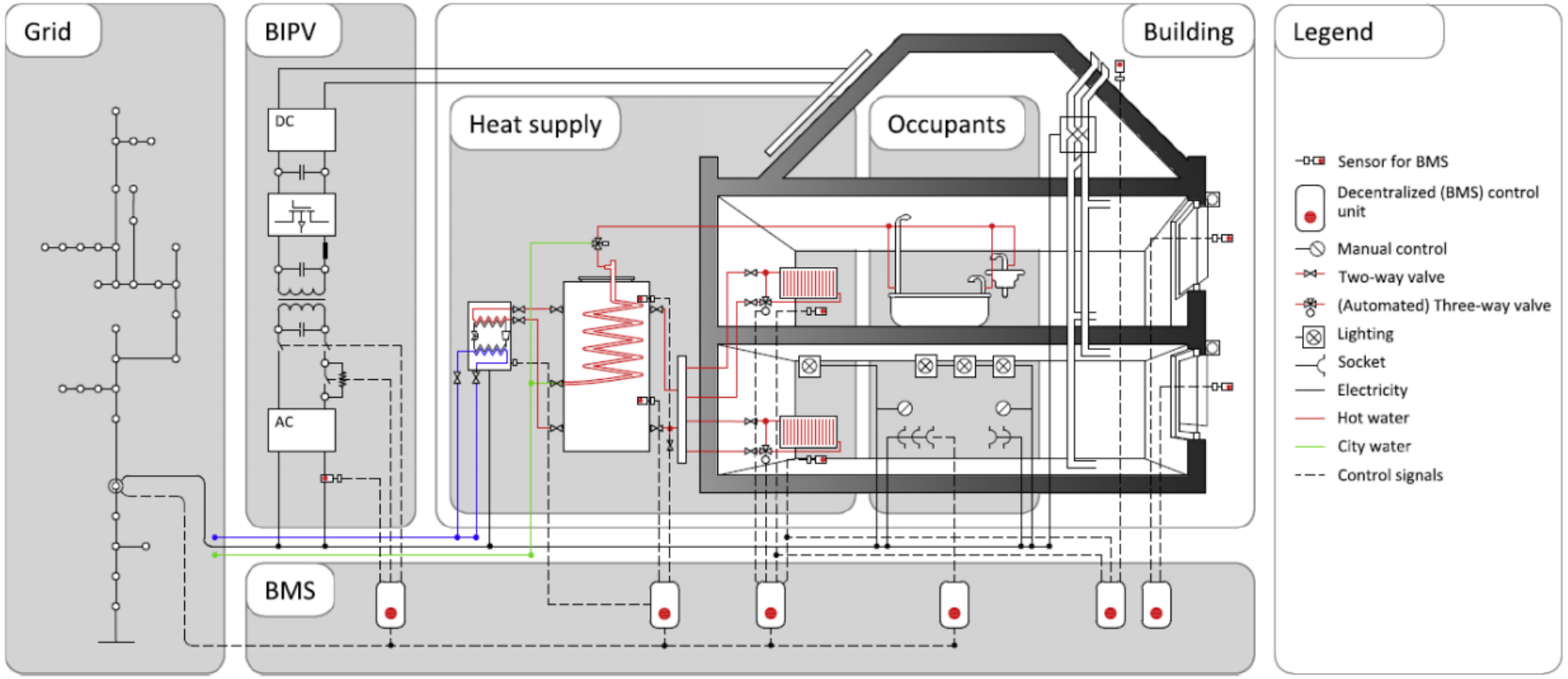
FEEDER VOLTAGE (V)



Reynders, G., Nuytten, T., Saelens, D. (2013). Potential of structural thermal mass for demand-side management in dwellings. Building and Environment 64, 187-199.

Baetens, R., Saelens, D. (2013). Multi-criteria grid impact evaluation of heat pump and photovoltaic based zero-energy dwellings. Proceedings of Building Simulation 2013. International Conference of the International Buildings Performance Simulation Association. Chambéry, France, 25-28 August 2013

Integrated District Energy Assessment by Simulation (IDEAS)



R. Baetens, R. De Coninck, J. Van Roy, B. Verbruggen, J. Driesen, L. Helsen, D. Saelens, Assessing electrical bottlenecks at feeder level for residential net zero-energy buildings by integrated system simulation, Applied Energy, Volume 96, August 2012, Pages 74-83, ISSN 0306-2619, 10.1016/j.apenergy.2011.12.098.

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Open-source library: github.com/open-ideas

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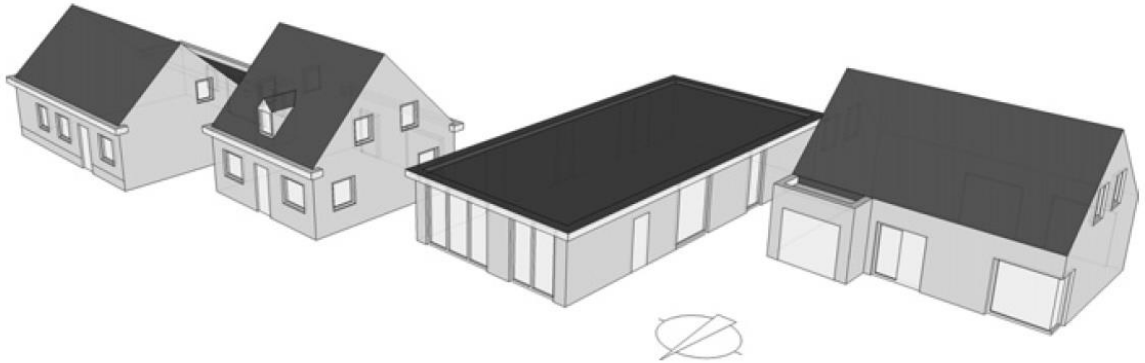
Assessment of effects on nZEB level

- Modeling of electricity use:
  - Heating with a heat pump
  - Stochastic use of appliances
- ZEB definition:
  total energy use is covered with the production of electricity from roof integrated PV



	Typ.1	Typ.2	Typ.3	Typ.4
Heated area, m^2	127	98	149	123
Window-floor ratio	0.12	0.19	0.16	0.13
Compactness, m	1.23	1.10	0.87	1.18
Infiltration rate n, h^{-1}	0.03	0.03	0.03	0.03
U_{av}, W/m^2 K	0.145	0.174	0.159	0.158
HRV efficiency	0.84	0.84	0.84	0.84
Design heat load, W/m^2	20.5	28.0	21.6	25.9

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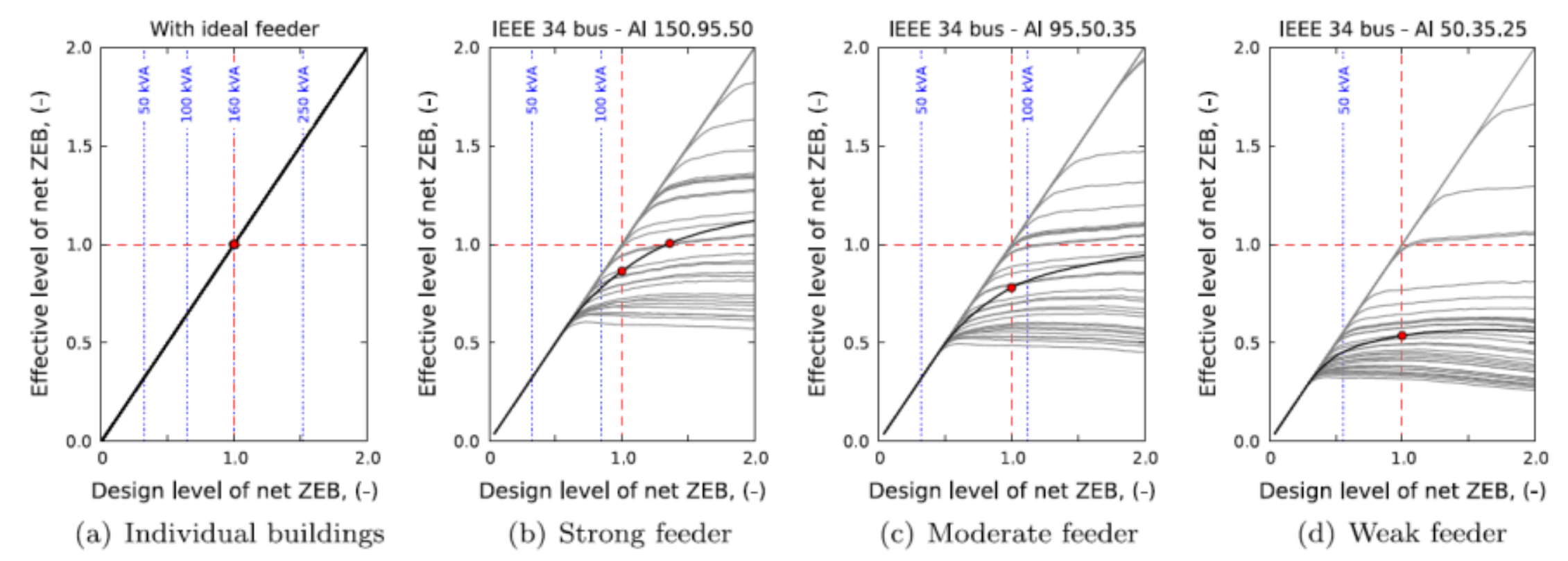
Assessment of effects on nZEB level

- Effective nZEB-level compared against design ZEB level on individual building level (grey) and aggregated neighborhood level (black).



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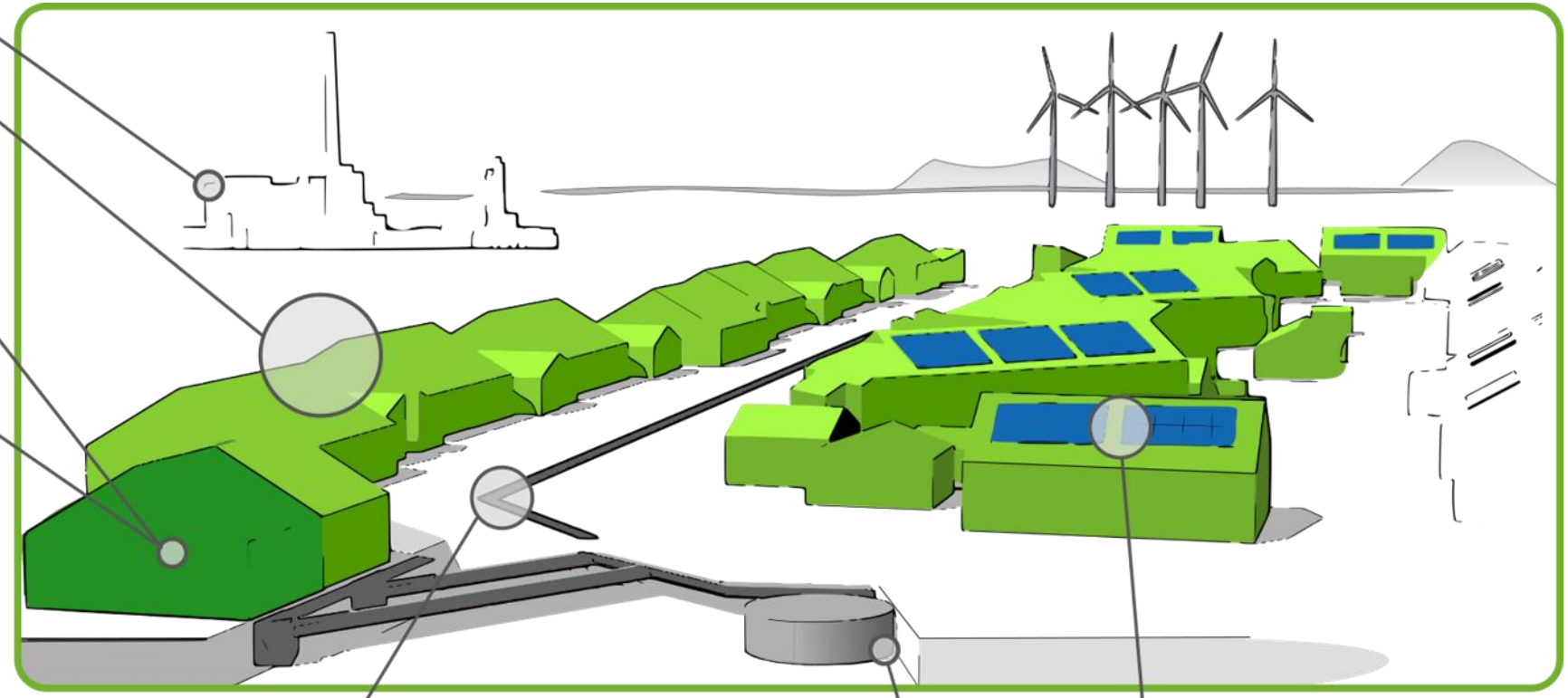
Not only electrical networks!

4th generation thermal networks and beyond … a system approach!



Take away messages

- Buildings represent large energy users
- Energy Efficiency First principle still applies
- Integrating renewable requires a system approach
  - Mismatch between supply and demand
  - Impact on effective results
  - Applicable for both electric and thermal systems

More info?

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