Role of thermal storage for integration of energy systems and urban energy supply

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Content

- Context of energy supply: why are we worrying?
- Challenges for urban areas?
- Vision on urban energy supply.
- Present developments in *Parkstad Limburg.*

2020

What will happen in our cities in the future?

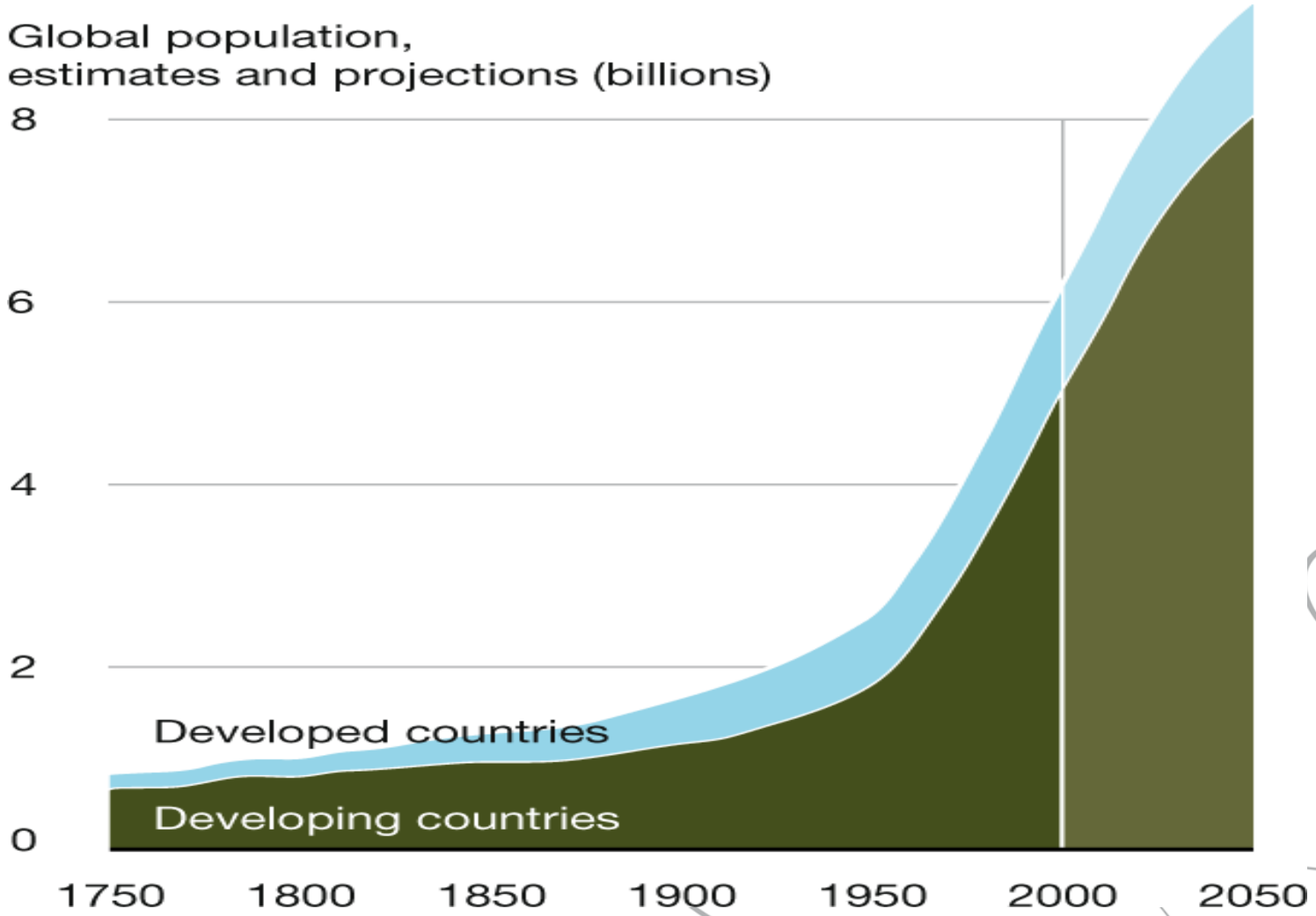
2025

2030

2040

2050

Increase of world population



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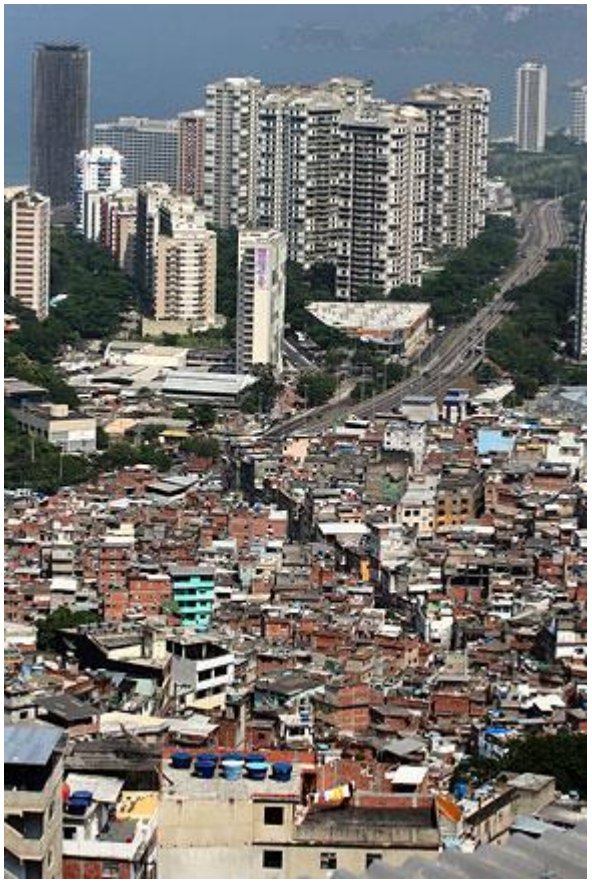
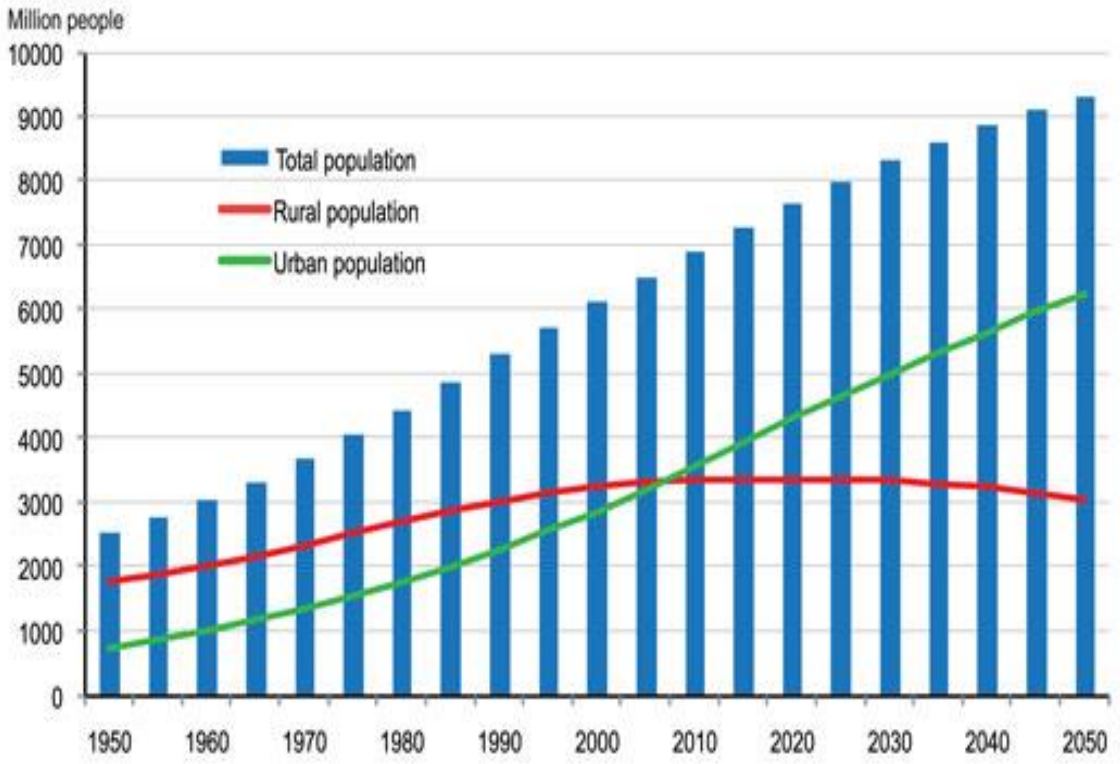
Source: Ahlenius, H. UNEP/GRID-Arendal, 2009
http://old.grida.no/graphicslib/detail/trends-in-population-developed-and-developing-countries-1750-2050-estimates-and-projections_1616

Urbanization

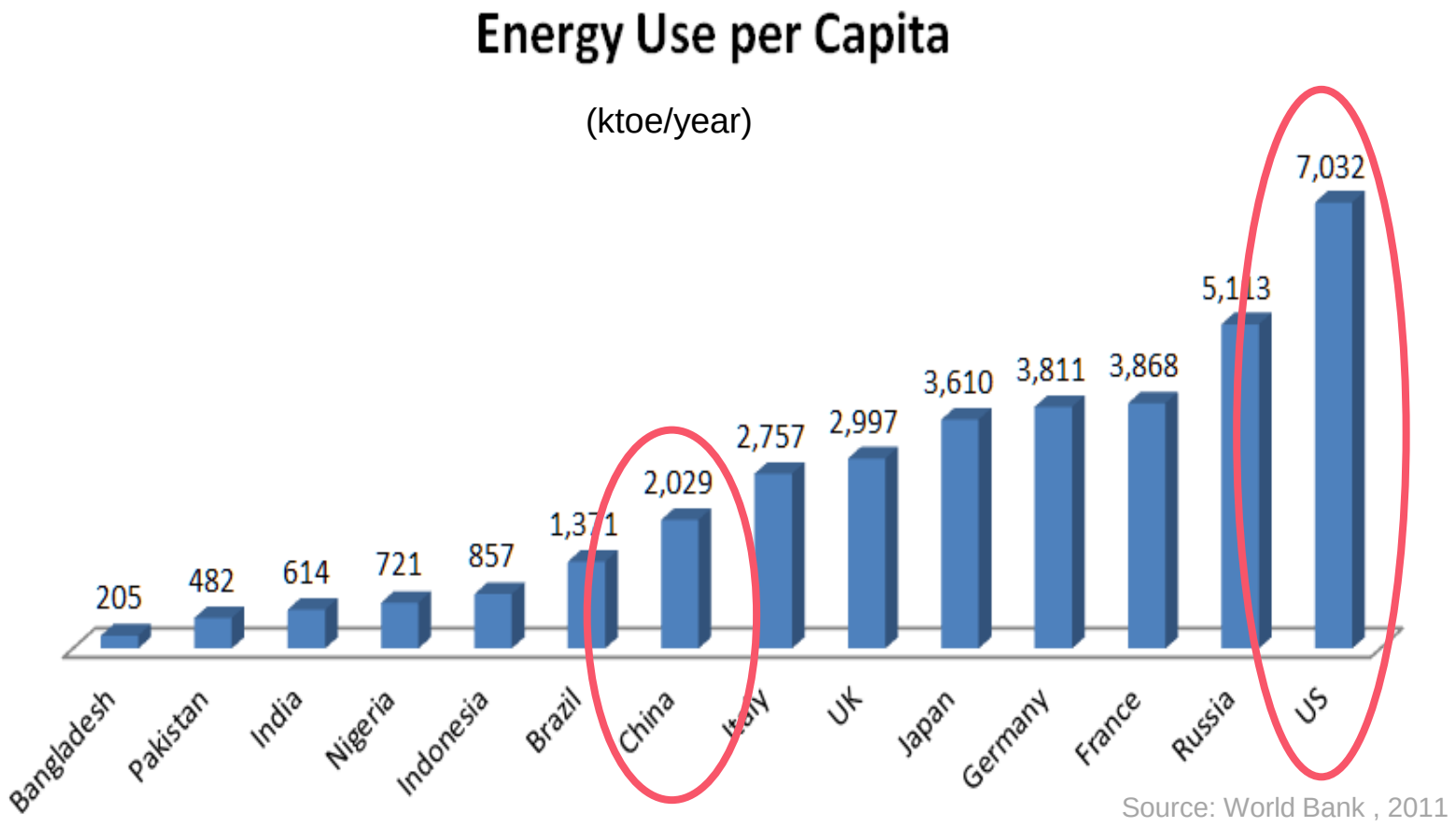


Source: Gaffuri, N., MDZ, 2010, http://www.mdzol.com/nota/256429-mdz-te-lleva-a-conocer-como-es-una-favela-en-brasil/



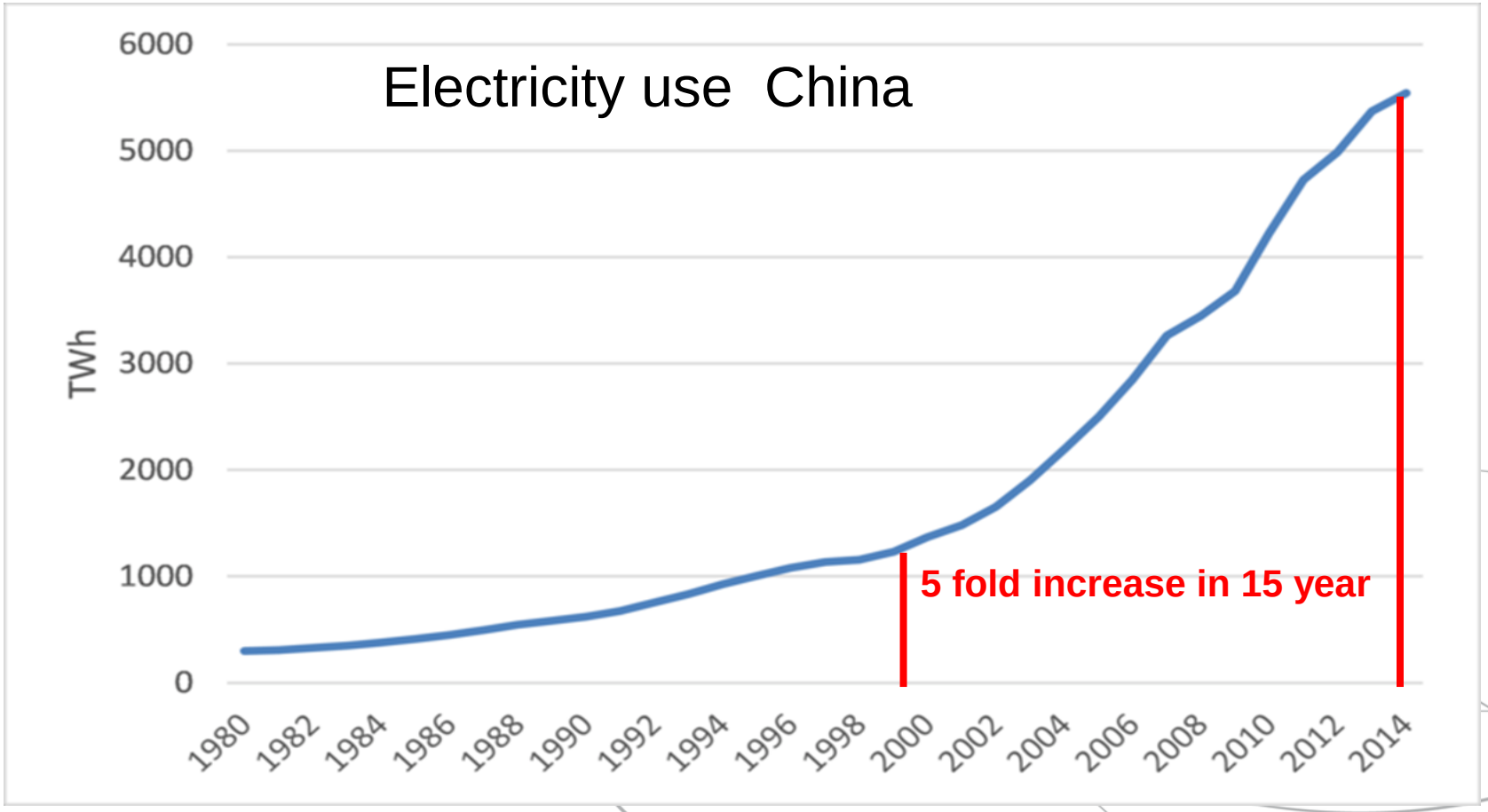
Source: Drawn from World Urbanization Prospects, the 2011 Revision (UN 2012)

Increase of energy use by prosperity growth



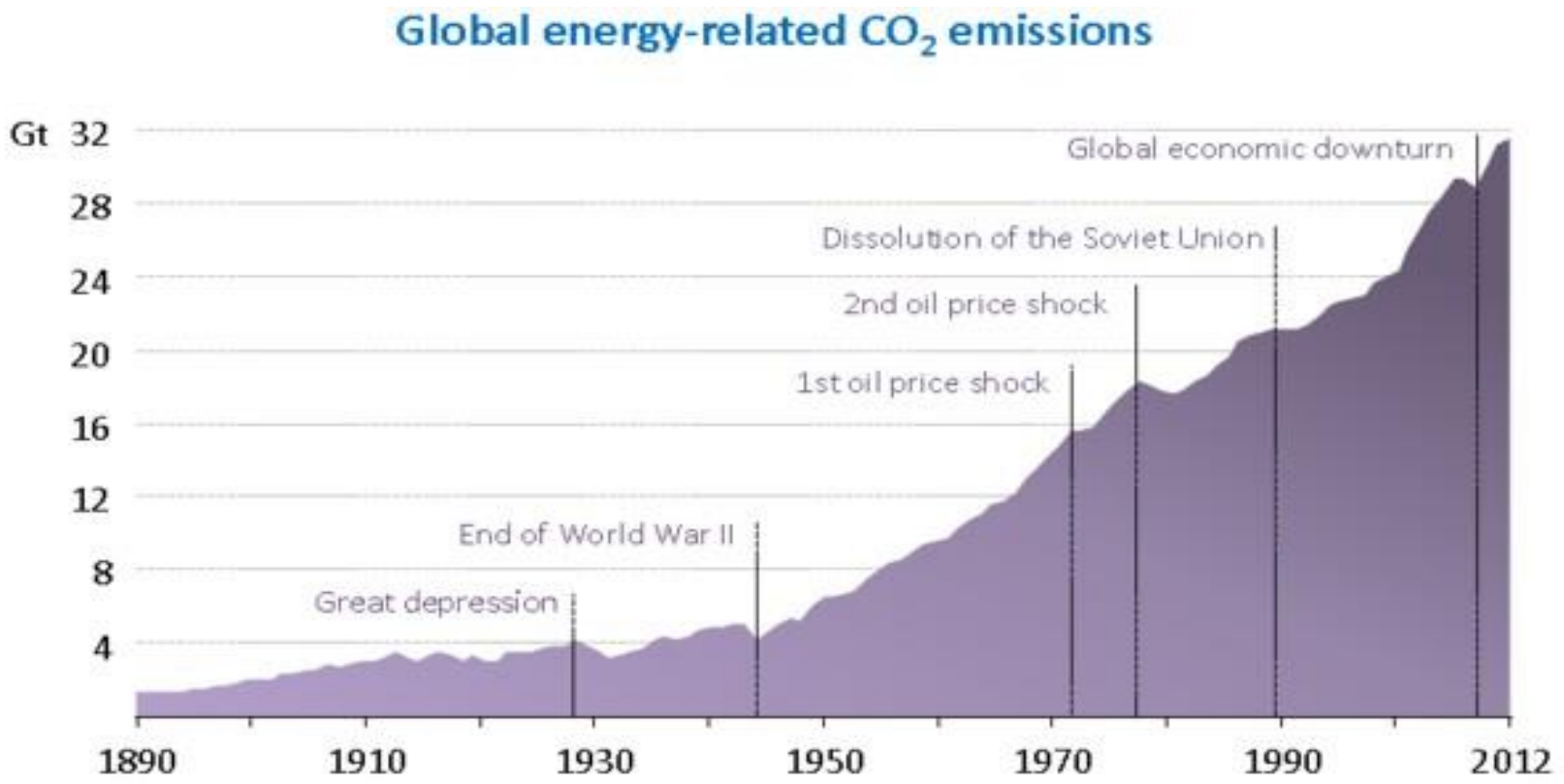
Source: World Bank , 2011

Increase of energy use



Source: the energy collective; primary data: China Electricity Council

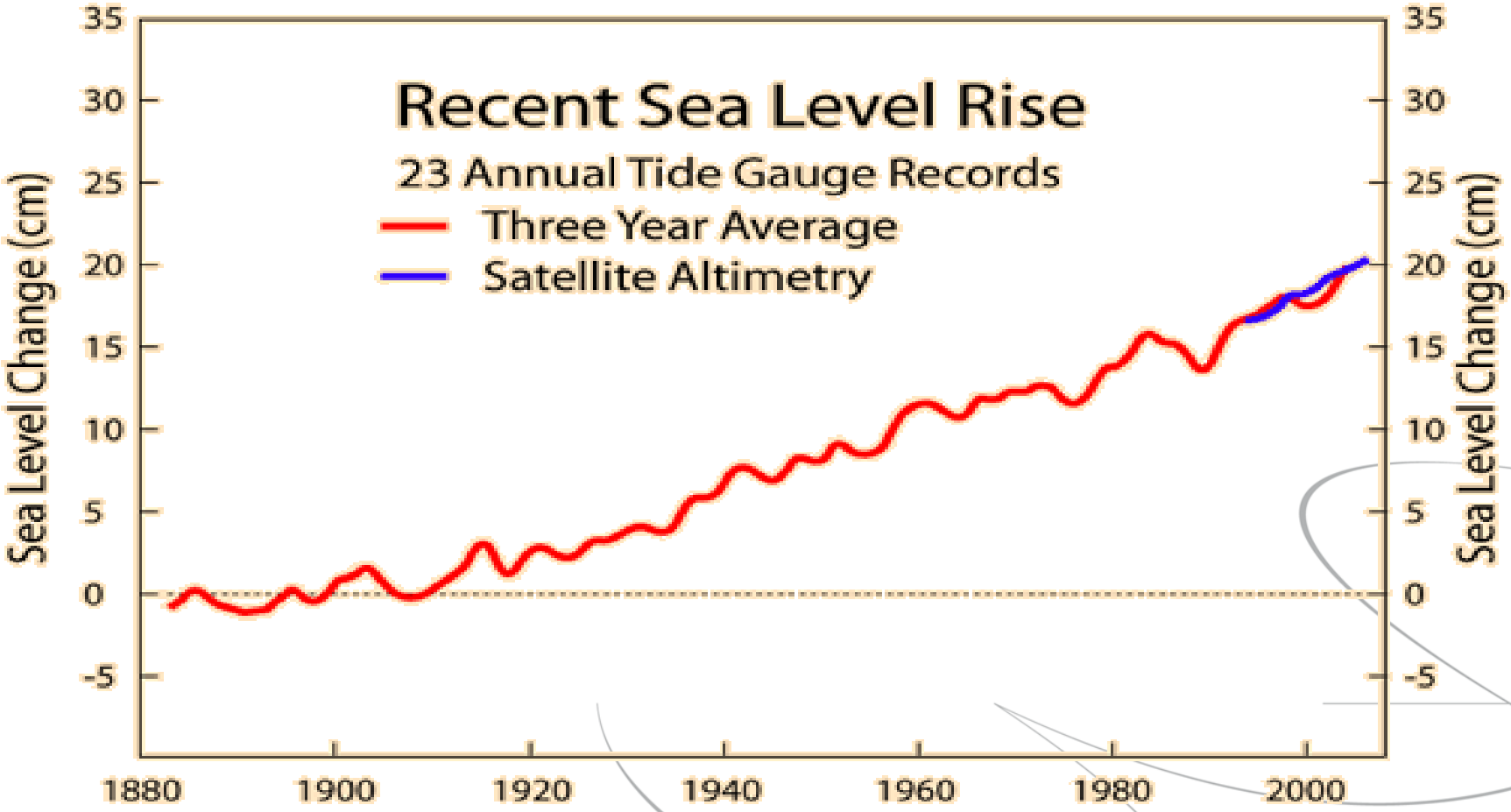
Increase greenhouse gas CO_2



CO_2 emissions trends point to a long-term temperature increase of up to 5.3 °C

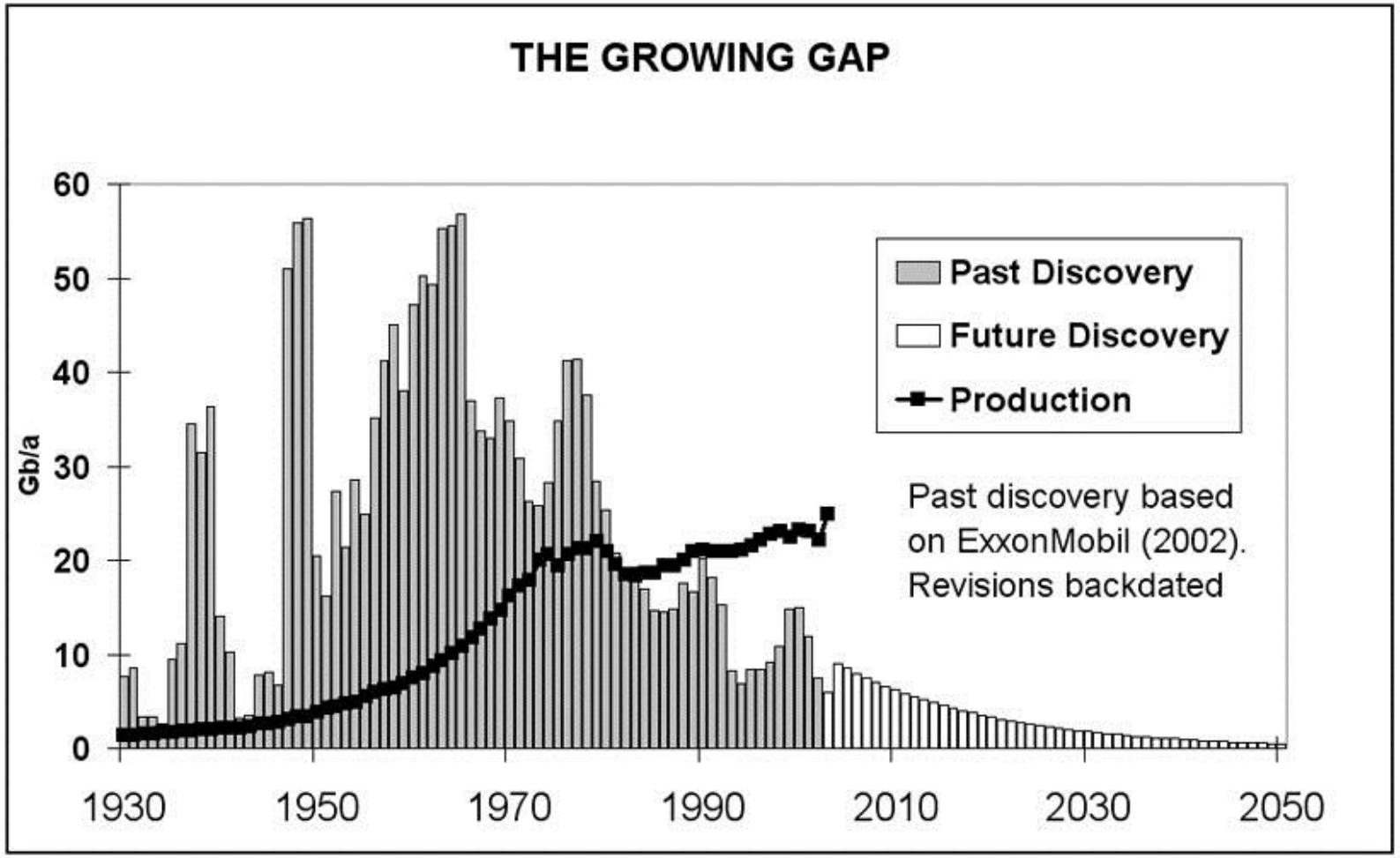
Source: GLOBE-NET.com

Sea level rise



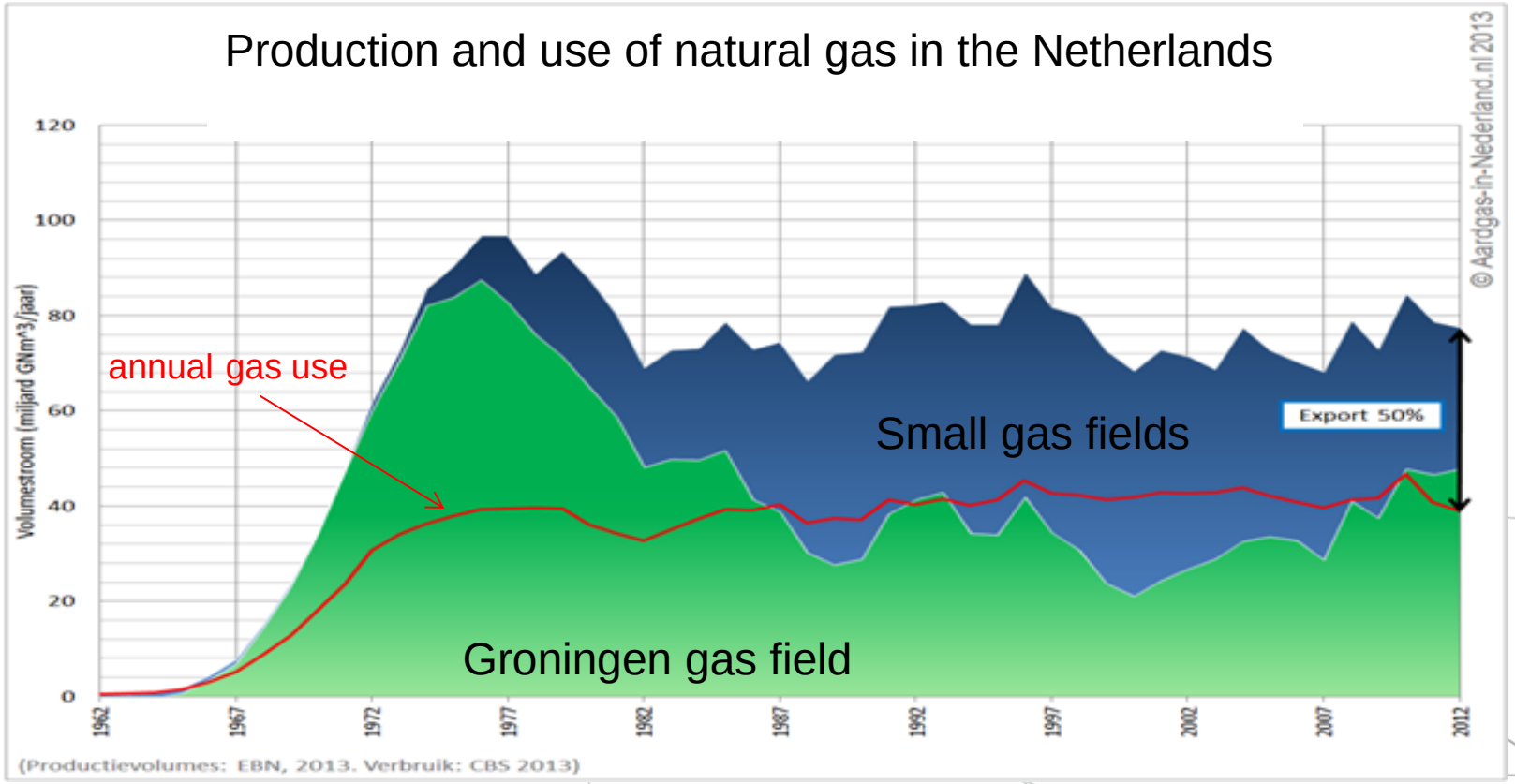
Source: Douglas, 1997

Depletion resources of fossil fuels



Source: Lynch, M, 2014, Forbes. https://www.forbes.com/sites/michaellynch/2014/07/07/peak-oil-4-the-urban-legend-of-inadequate-discoveries/#7c9bb2461858

Natural gas resources in The Netherlands



In stock 2016: 1100 billion m^3

Production 2015: 51 billion m^3/yr

→ **still 20 year?**

International dependence

- To what extent does a country want to depend on its energy supply from abroad?

Energy ambitions of cities

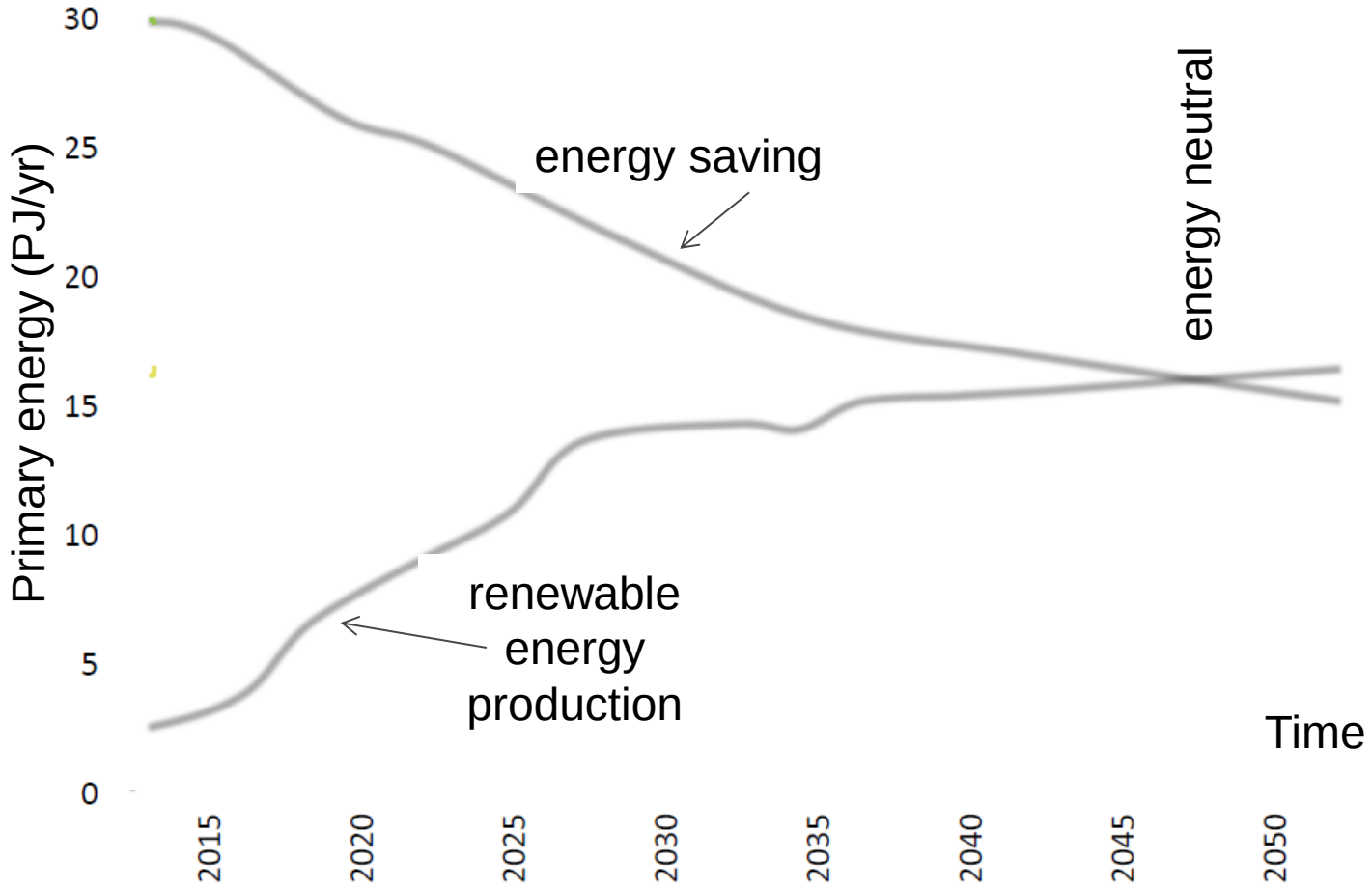
- Ambition cities: become energy-neutral in the foreseeable future
- Phasing out fossil input: like gas for heating
- What are the characteristics a future city without natural gas supply of the future look energetically? (supply and demand of energy, scenario's)
- Which infrastructure ensures a reliable and affordable CO_2-free city? (all-electric, district heating, thermal E-net, hybrid)
- How do we finance the transformation of existing infrastructure and buildings?

Fundamental choices

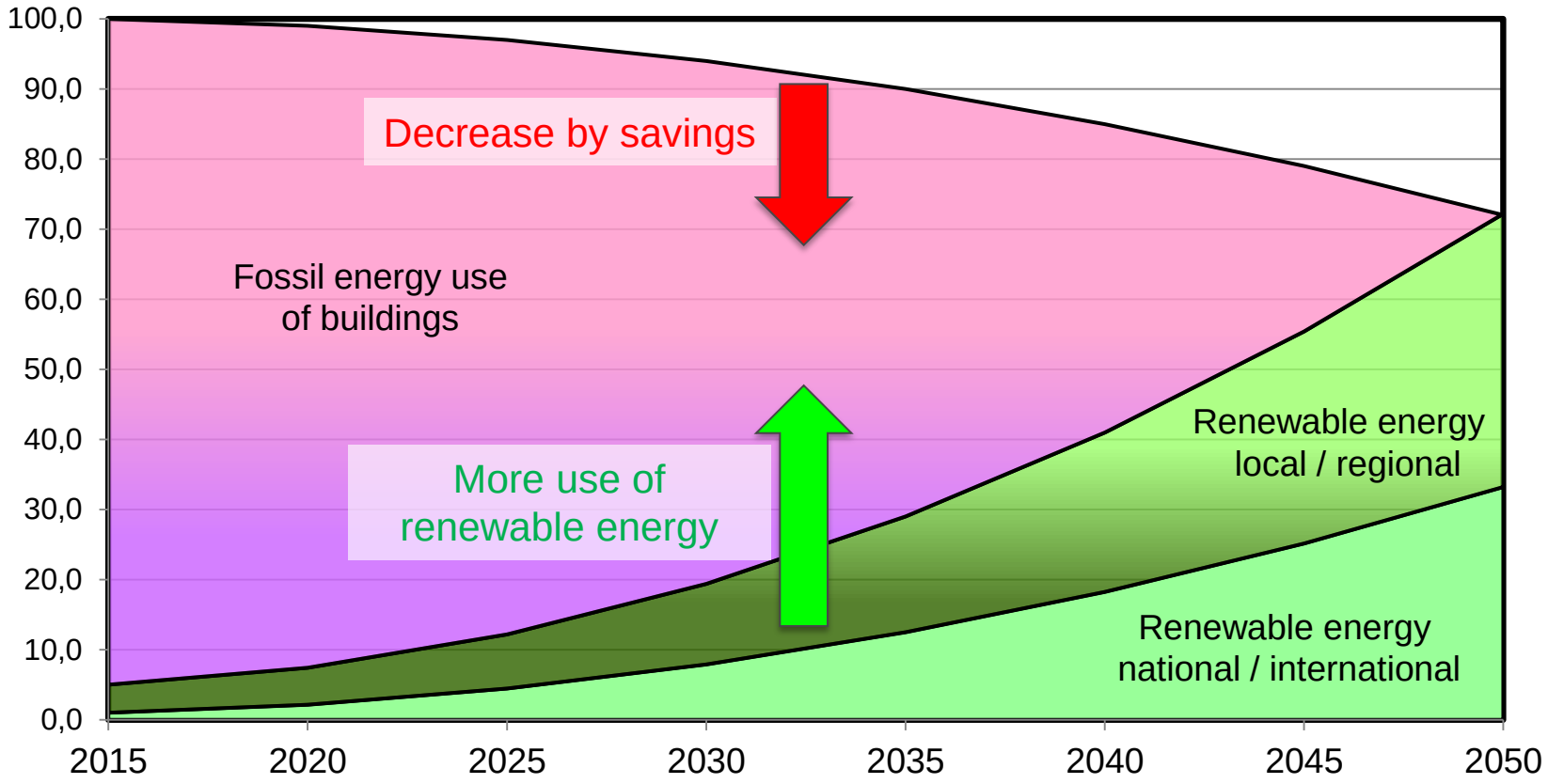
After 2023 fundamental other measures are needed:

- Large quantaties of energy should be “harvested”, transported and stored at an acceptable price
- Substantial investment in the next 50 year needed to replace the natural gas infrastructure
- Policies should be formulated timely; cities should develop a long-term vision and stick to it

Long term ambition (example: Parkstad Limburg)



Future scenario



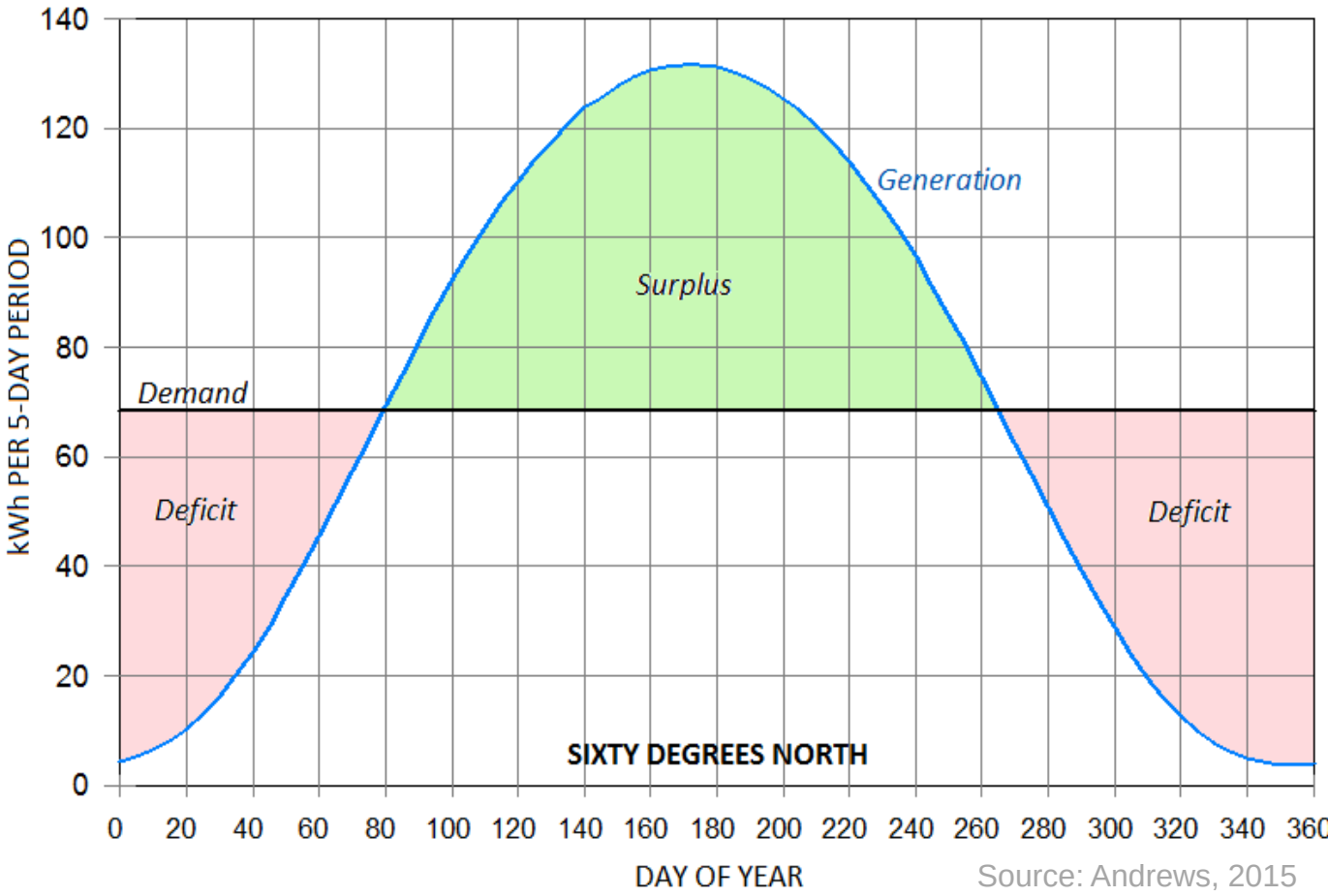
Renewable energy supply options for urban areas

Much attention for PV, wind and bio-energy

Problems:

- Nuisance (wind)
- Spatial use (bio-energie)
- Strong fluctuations in time (seasonly / daily)

Demand and supply do not match



Source: Andrews, 2015

Cover winter shortages:
1522 kWh to be stored;

153 Tesla 10kWh wall units
- costs: $535500
- mass: 15.3 ton

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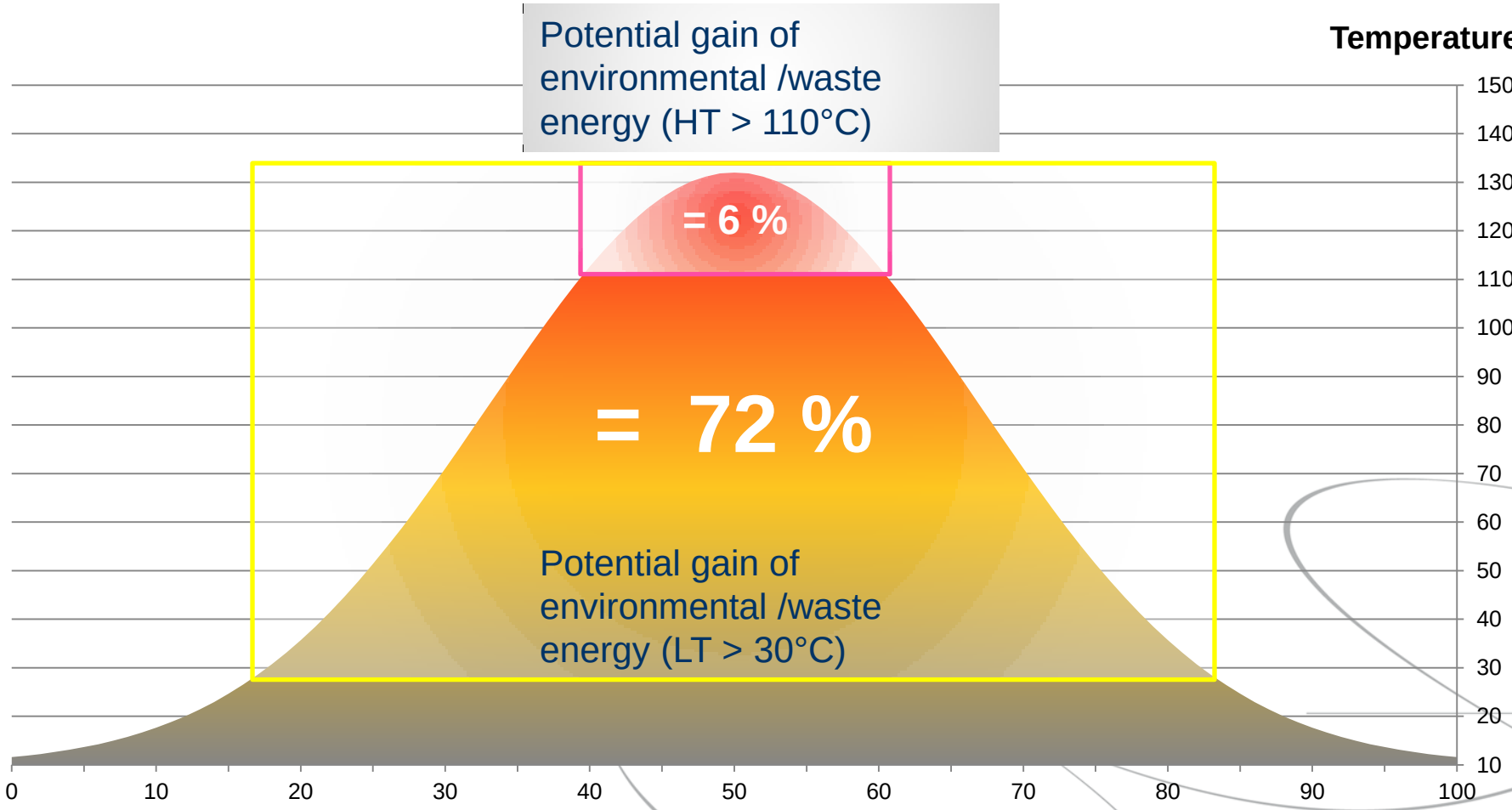
Sustainable energy supply of built environment

Characteristic:

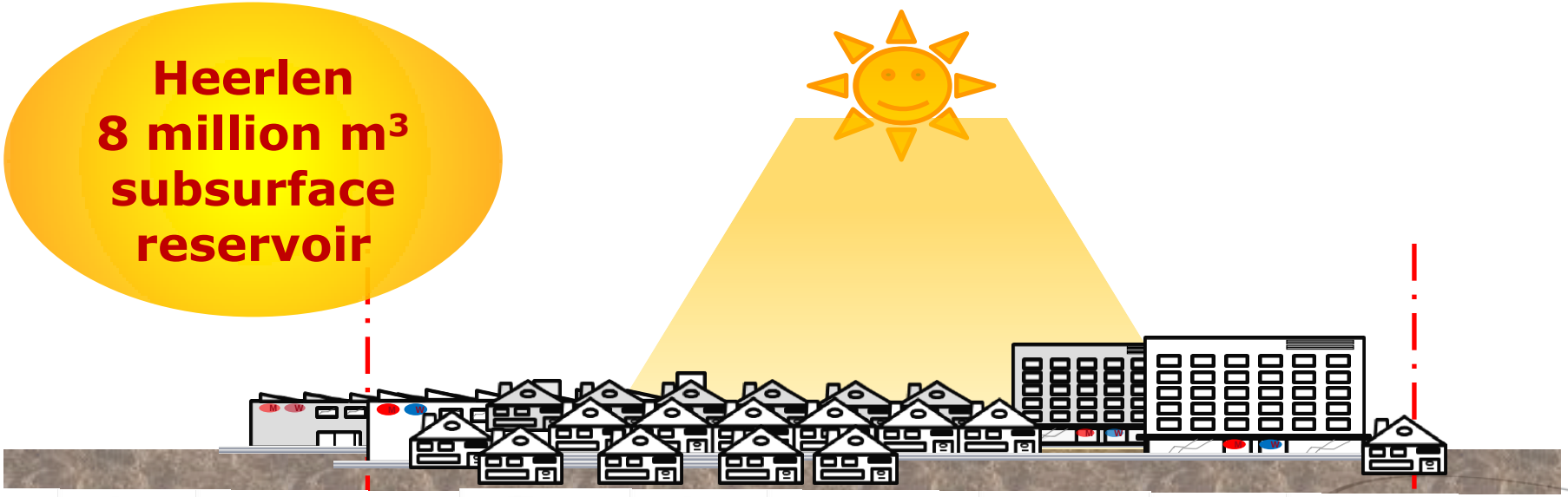
- 70 % of present energy demand in buildings concerns heat (supplied by natural gas).

Availability of heat at low temperature (low-exergy)



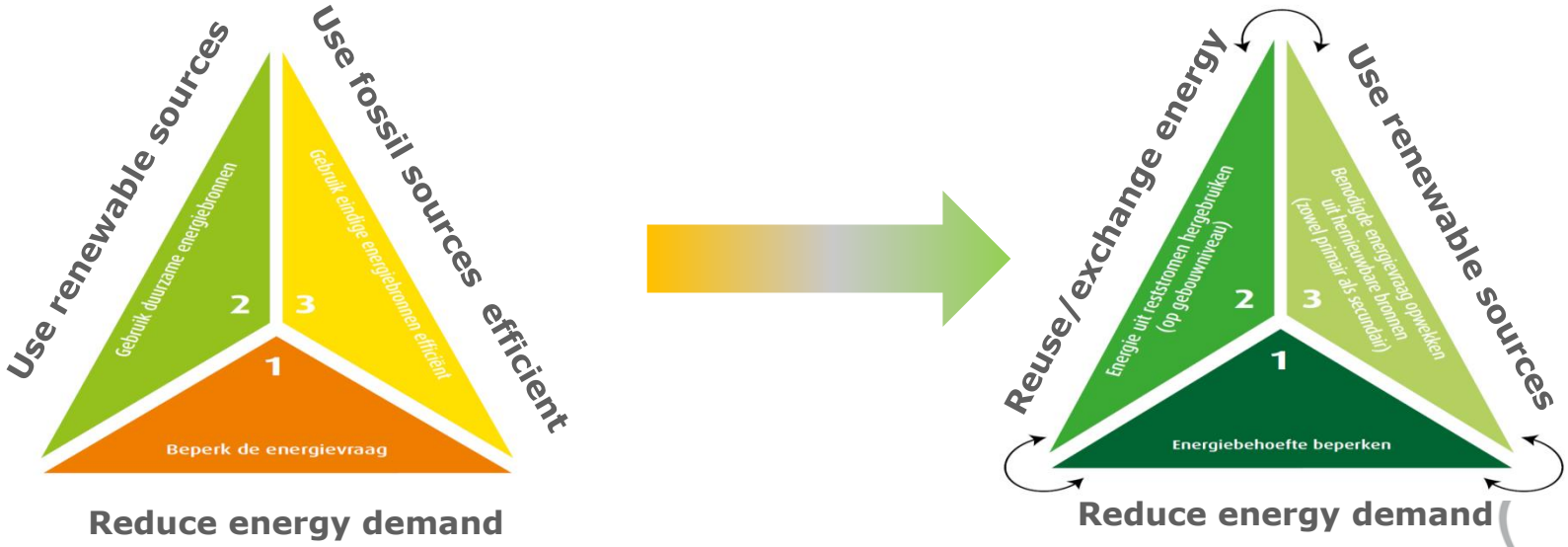
Possibilities for thermal storage (buffering)

Heerlen
8 million m³ subsurface reservoir



= 2,3 million Tesla 10kWh power walls

Vision: A new trias-energetica



1. Saving
2. Renewable
3. Efficient fossil

→

1. Saving
2. Exchange and buffering= re-use
3. Renewable

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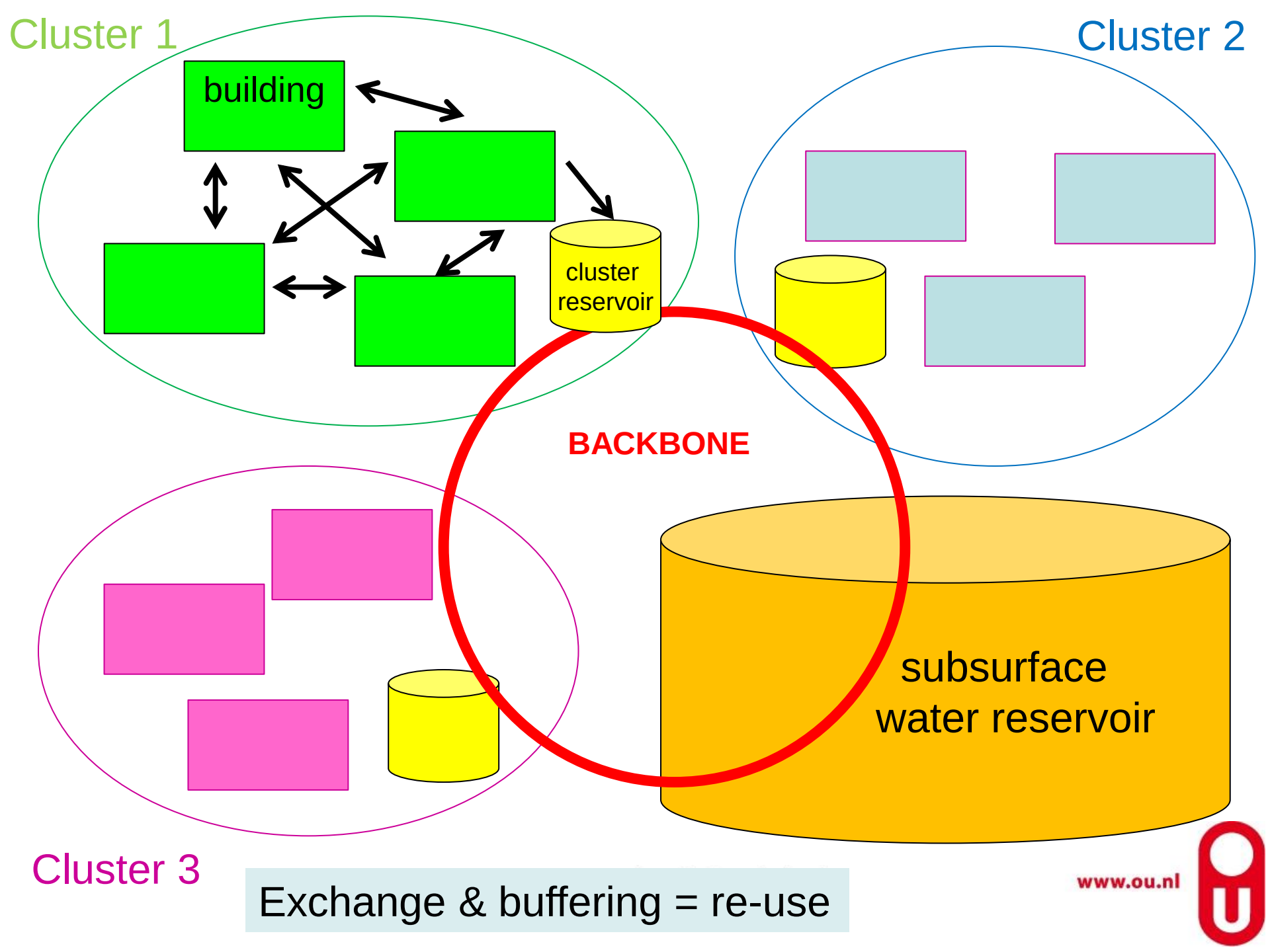
Cluster 1
Cluster 2
building
cluster reservoir
BACKBONE
subsurface water reservoir
Cluster 3
Exchange & buffering = re-use
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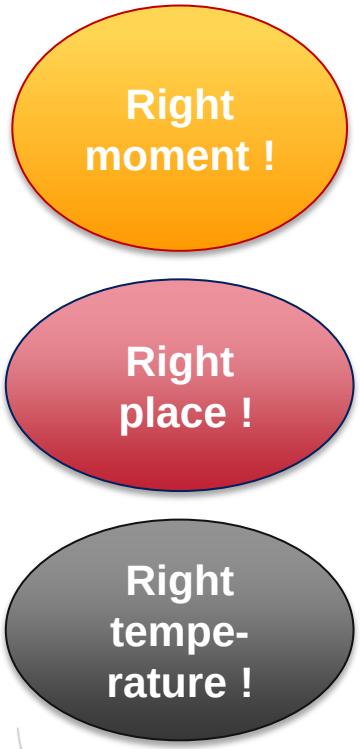
Concept of heat supply

Intelligent

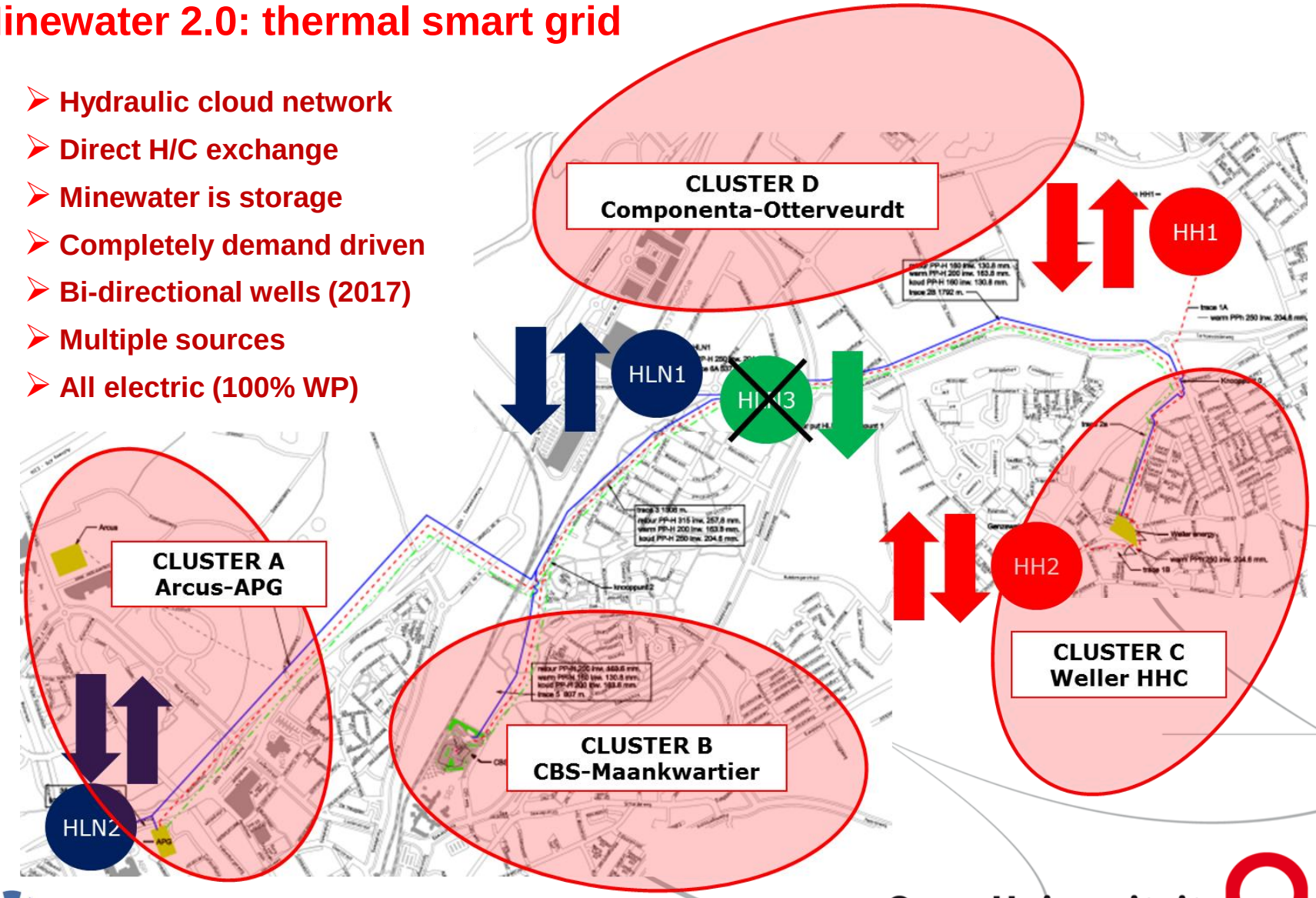
Adaptive

Learning



Minewater 2.0: thermal smart grid

- Hydraulic cloud network
- Direct H/C exchange
- Minewater is storage
- Completely demand driven
- Bi-directional wells (2017)
- Multiple sources
- All electric (100% WP)



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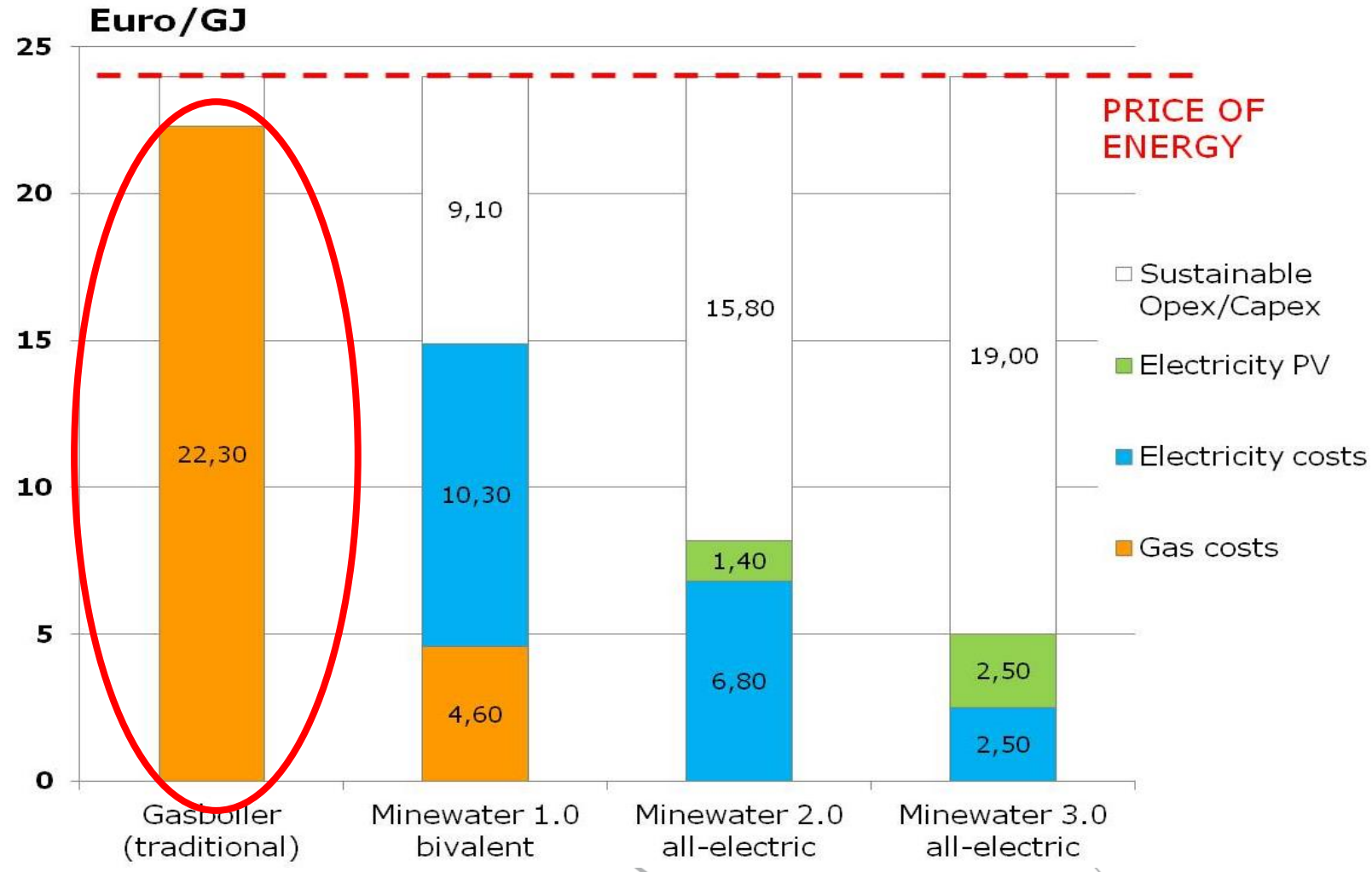
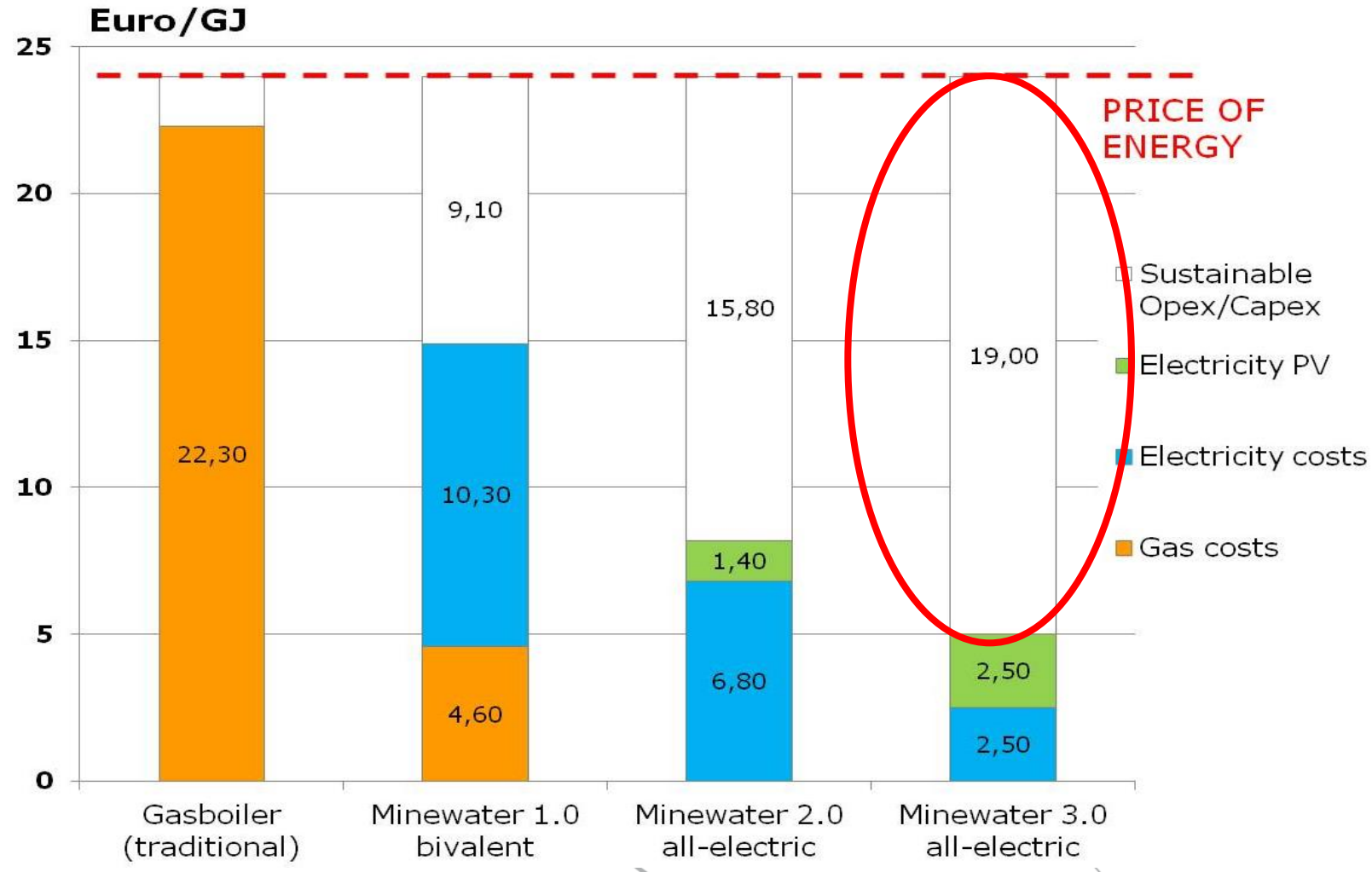
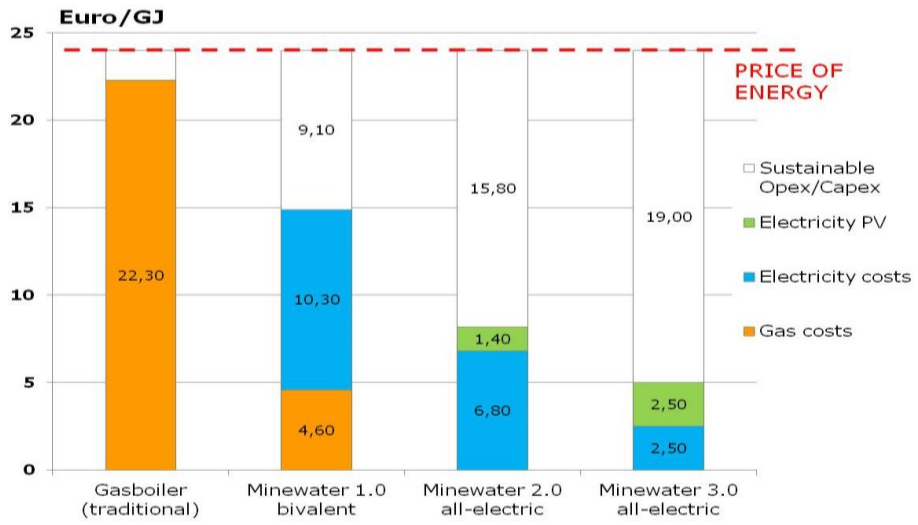
Minewater business case



Minewater business case



National application



National gas use for houses:

310 PJ/yr

Investment space:

€ 5,9 billion/ yr

Net present value in 30 year: € 100 billion

€ 14.500,- per house + € 4.000,- avoided costs boiler

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Conclusion

- Good opportunities for (entire) sustainable heat supply to urban built environment

- Besides energy saving:
  - Smart exchange at different spatial scales (re-use)
  - Buffering op LT-heat/cold at different spatial scales (re-use)
  - Use of large availability of low-exergetic (waste) heat
  - Heat/cold just in time, at the right spot, at the needed temperature (applying heat pump)

  - Required investment space becomes available free because there are no fossil fuel costs anymore

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Development, implementation, business case:

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