Integrated Solutions for Fast Growing Urban Areas

responsible reuse of water and energy

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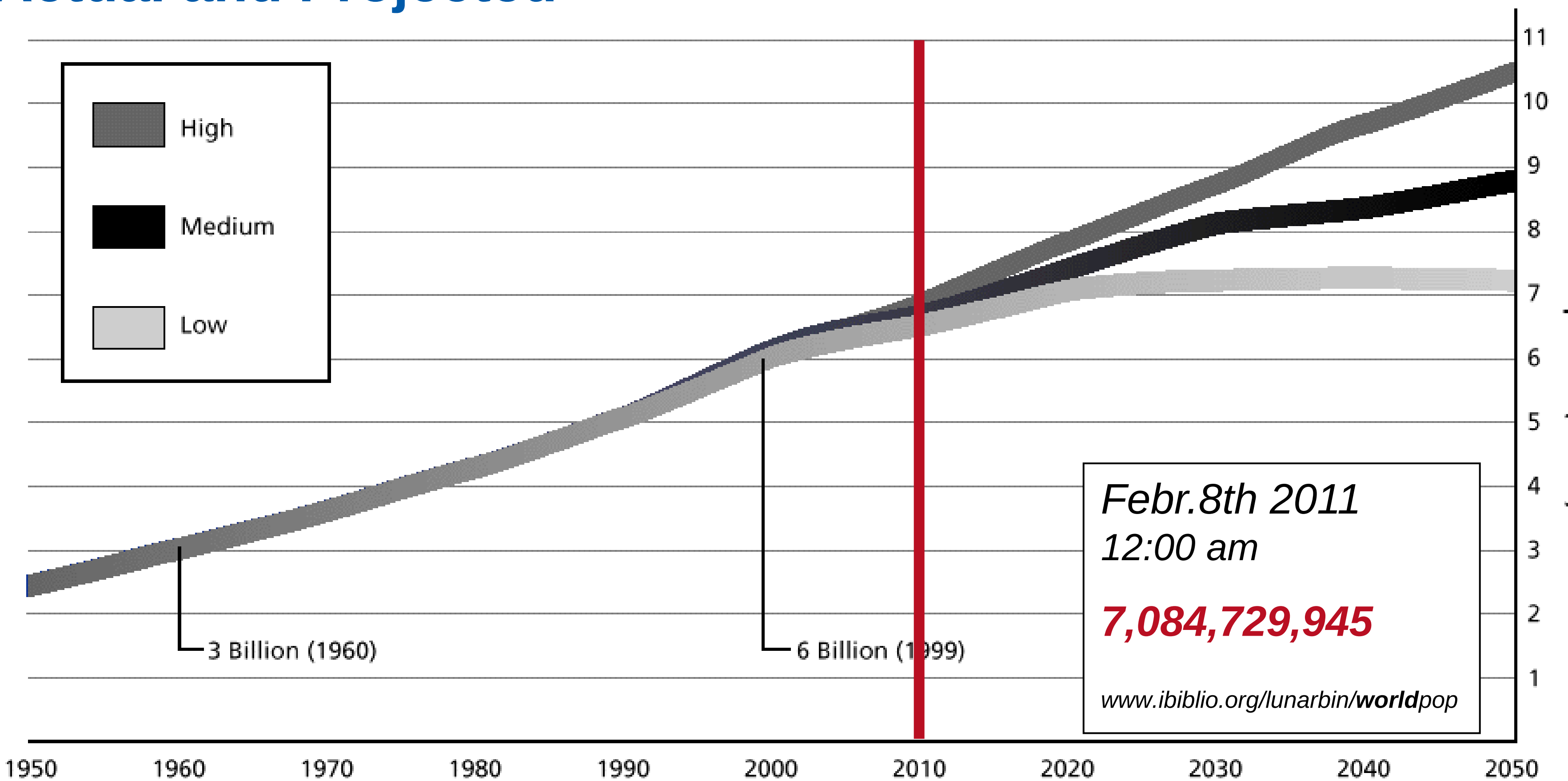
SEMIZENTRAL GERMANY

Overview

- Challenges of fast growing urban regions
- New Infrastructure Solutions needed
- The Semicentralized Approach
- Flexibility due to stepwise implementation
- Visualization
- Summary and Conclusions

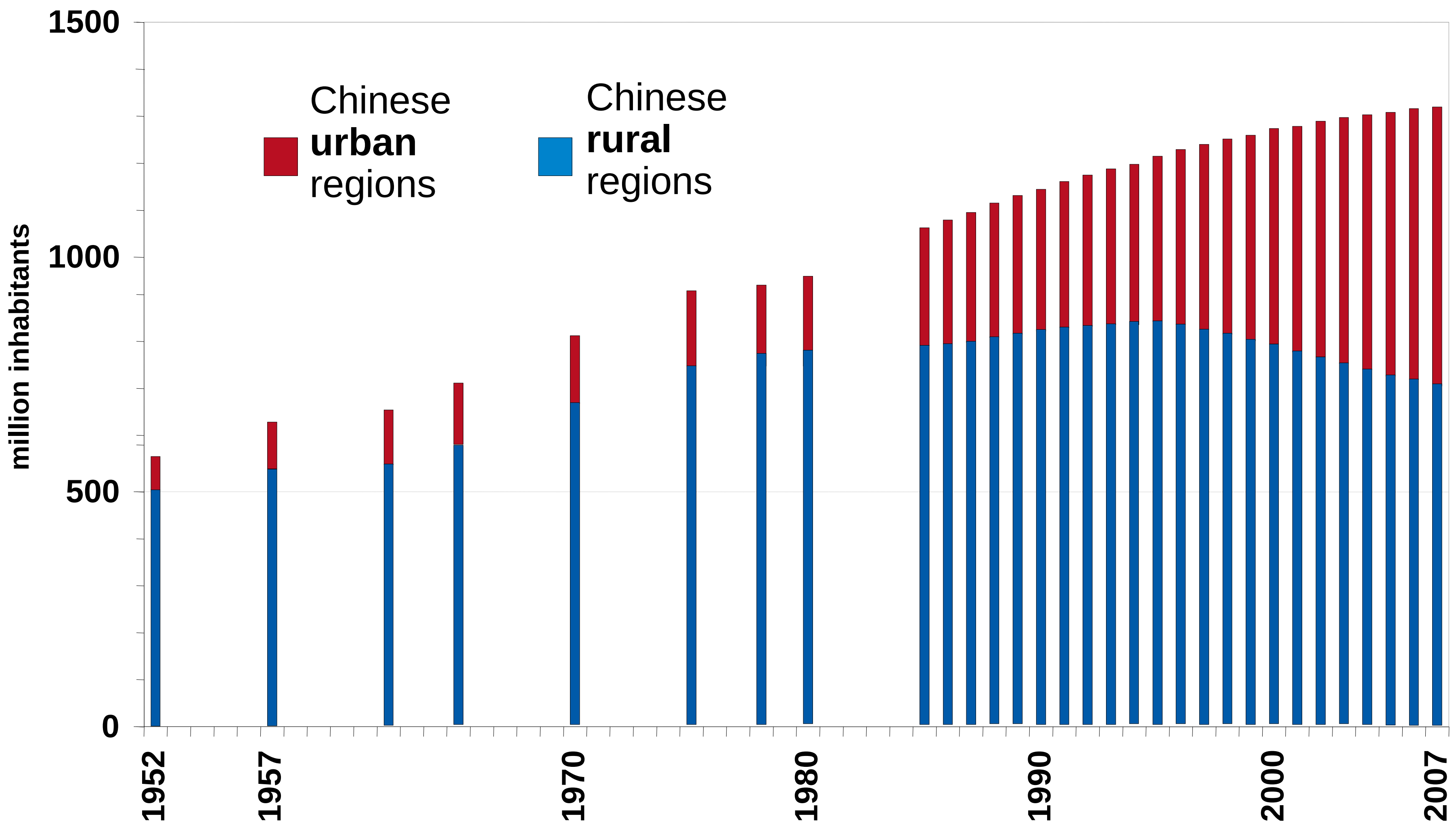
Challenge I: World Population Growth

Actual and Projected

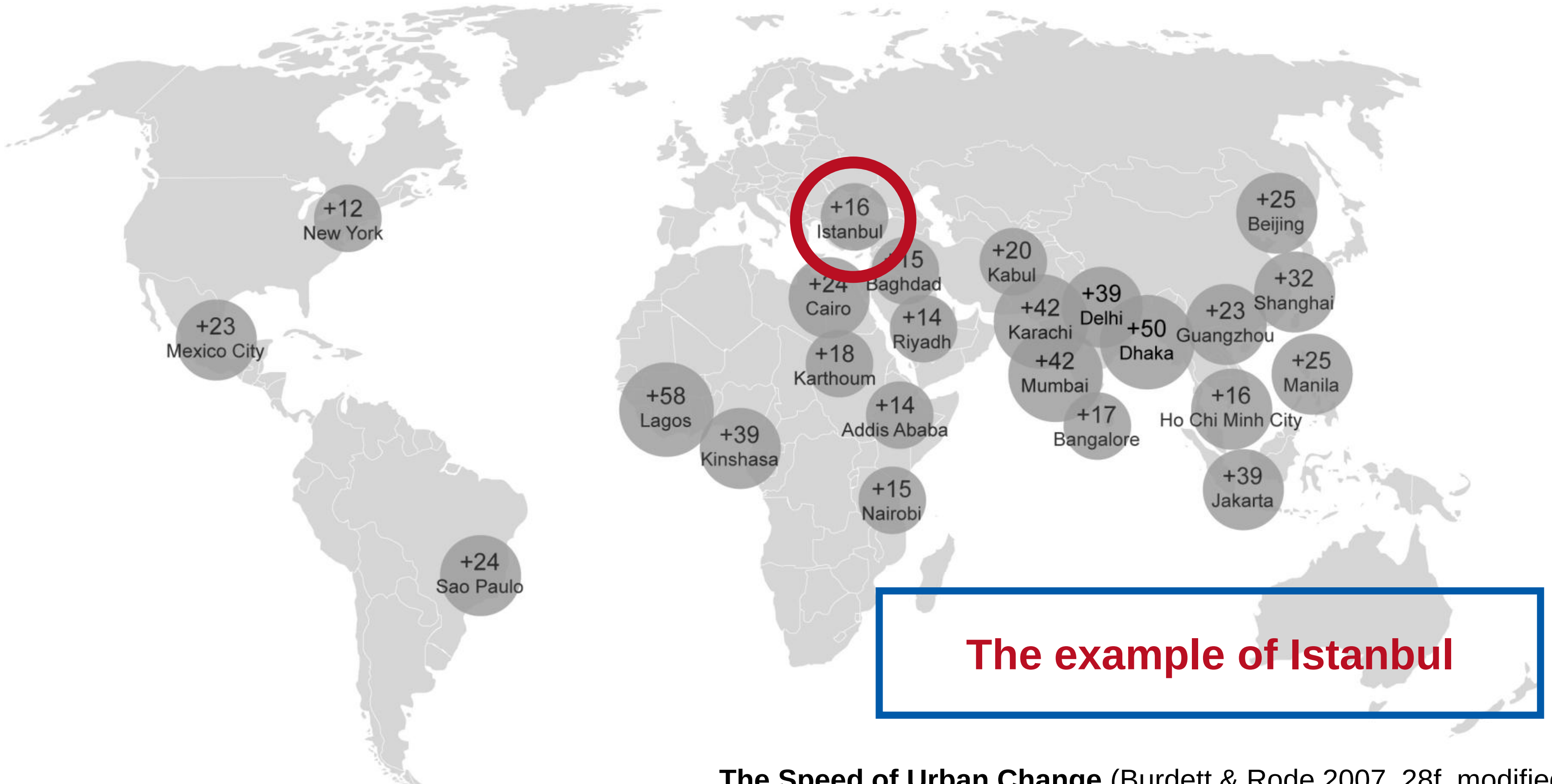


Source: United Nations. 1998. *World Population Prospects (The 1998 Revision).*

Challenge: movement from rural to cities



More specific: Urban Growth



The Speed of Urban Change (Burdett & Rode 2007, 28f. modified)

Growth rates e.g. Istanbul (12.8 Mio C)

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Population growth:

16 C/h → **140,160 C/y**

Additional water:

110 L/(C·d) → **15,418 m³/d**

Additional solid waste:

1 kg/(C·d) → **140 Mg/d**

Environmental effects

- **Polluted rivers**
  → endangering potable water supply and agricultural irrigation
- **decreasing ground water levels by overexploitation** [1)]
  - Beijing, Bangkok, Buenos Aires, Cairo, Calcutta, Dhaka, Jakarta, London, Manila, Mexico City, Shanghai und Tehran
  - E.g. Beijing:
    - Ground water level 1950: 5 m below top ground surface
    - Ground water level 2004: > 50 m below top ground surface
- **Countermeasure: giant projects**
  - Deviation of rivers
  - **E.g. the South-North Water Transfer Project in** China will divert 44.8 billion cubic meters of water annually to the population centers of the drier north in 2050 [2)]

[1)] United Nations Environment Program (2003)
[2)] http://www.water-technology.net/projects/south_north/ (September 2010)

New Infrastructure Solutions needed

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- **Needs** for supply and sanitation systems
  - reduce fresh water demand → **enable water reuse**
  - low cost, low energy demand (**energy self-sufficient** ??)
  - **ensuring high hygienic quality standards** for potable and process water
  - reliable and robust
  - minimizing unaccounted water losses
  - flexible and adjusted growth → **reducing planning horizons**
  - modular structure of supply and treatment units
  - “autarchic” suburbs / quarters
  - low vulnerability (natural disaster, terroristic attacks, electricity shut downs,….)

→ Conventional centralized supply and treatment systems as well as household based de-central sanitation can not fulfil these needs

A matter of Scale

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1. **Water reuse fosters decentralization**
   - minimizing energy demand for pumping
   - minimizing capex for sewer and pipe systems
   - minimizing water losses
2. **Energy recovery fosters decentralization**
   - heat recovery from greywater (showers, laundry,…) as close as possible to the source
3. **Adjusted growth and reduced vulnerability fosters decentralization**
4. **fulfilling high quality standards fosters professional operation**

   → rather **semi-central as de-central at household level**
5. **Energy self sufficiency fosters combined treatment of water and (organic) waste**

Integrated treatment on district level

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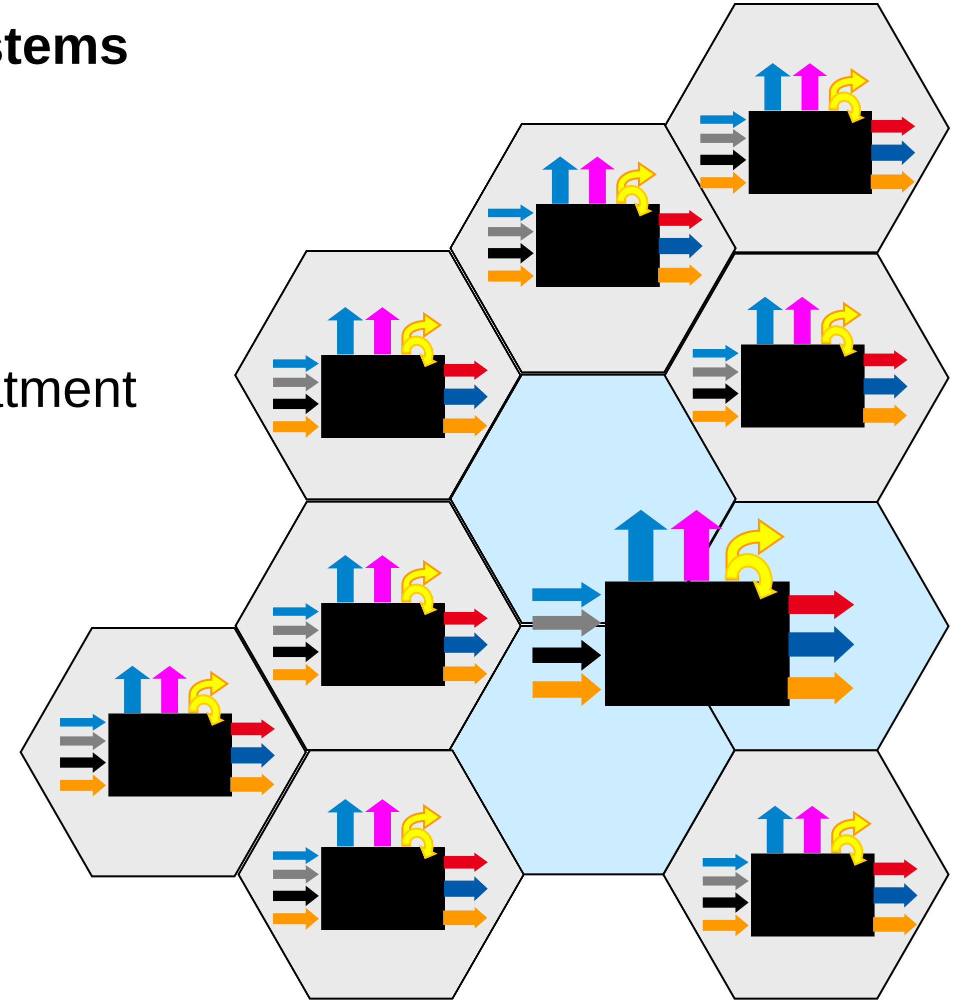
- **Integrated Semicentralized Systems therefore**
  - focus on smaller,
  - more compact units
- **Each district has its own** Semicentralized Supply and Treatment Centre (STC)
- integrated approach,
- focussing material flow-based management,
- utilizing synergy effects and re-use potentials



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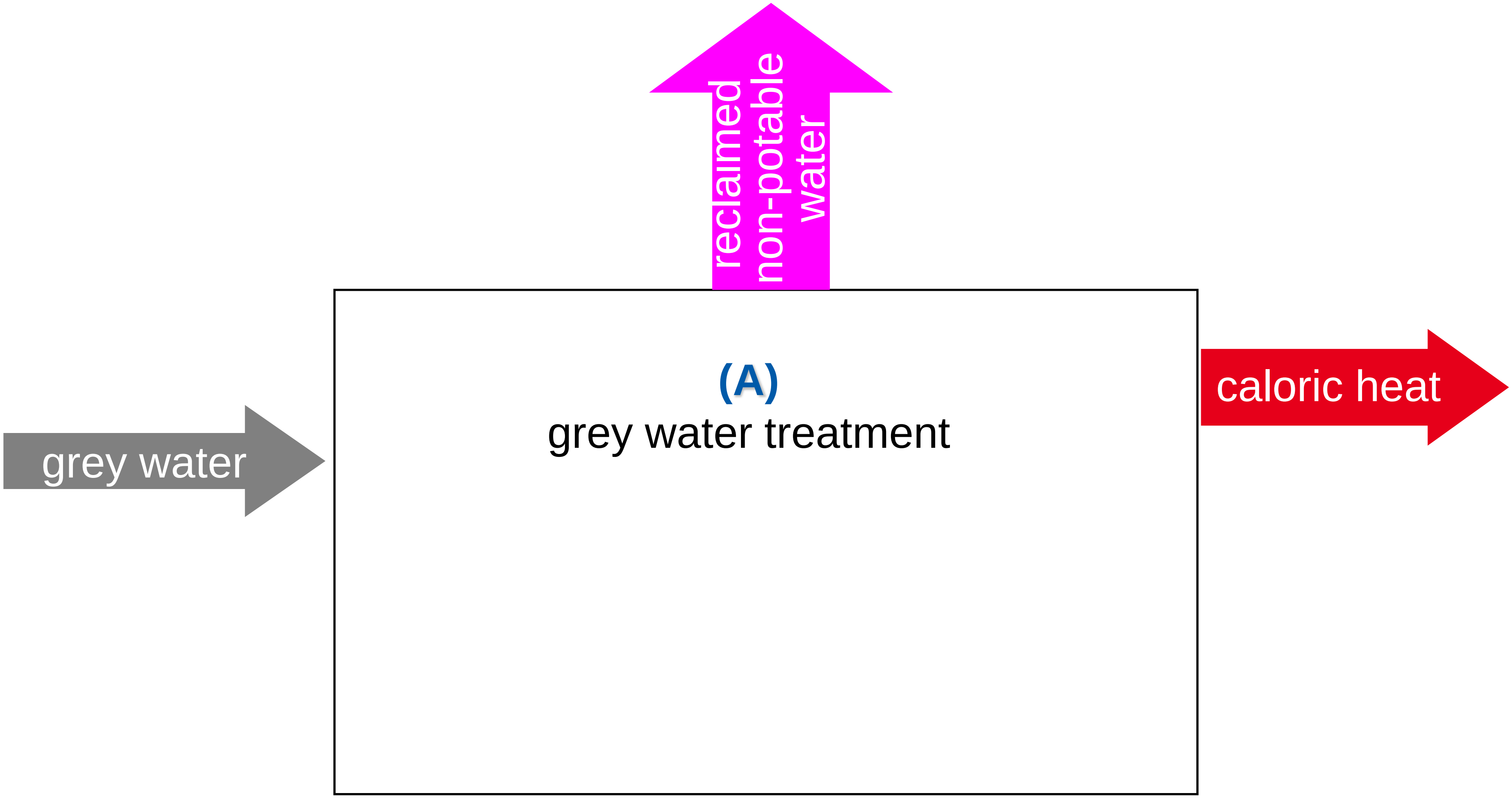
The semicentralized Approach

Stepwise implementation gives flexibility

1. Water reuse and heat recovery from greywater
2. Wastewater treatment for reuse and discharge
3. Separated Wastewater and solid waste treatment for reuse, discharge and energy

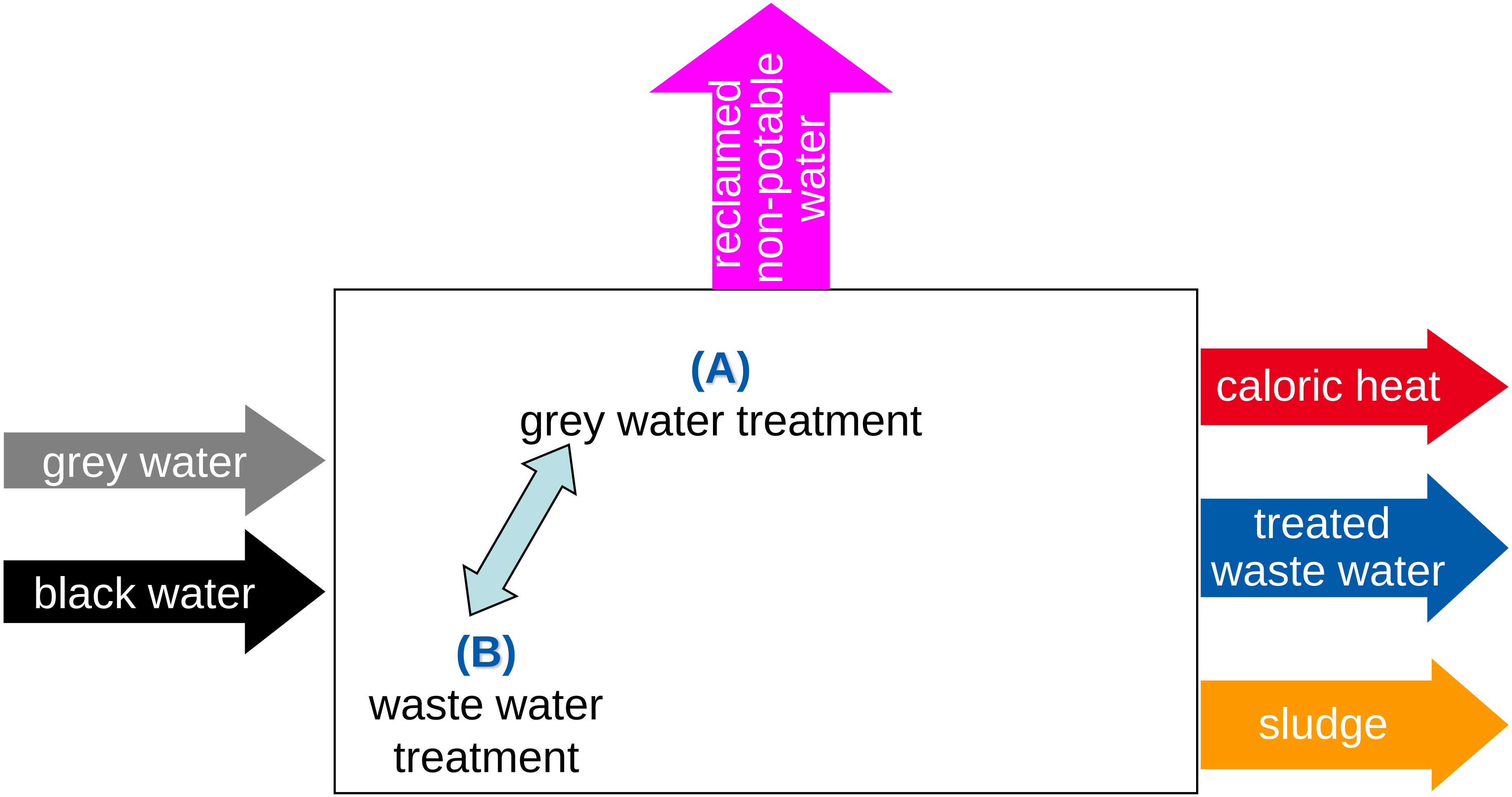
Water reuse and heat recovery



Water reuse and heat recovery from greywater

- Easy to treat (elevated temperature, no nutrient removal, ..)
- Can save 30 % of fresh water resources
  (e.g. for toilet flushing and irrigation)
- Increases by this capacity of existing water supply and sewer systems (more people can be served as fresh water demand and waste water amount is lowered)
- **Might save energy** as energy demand for treating greywater to non-potable reuse standards ranges about 0.3-0.6 kWh/m³ compared to 3 to 4 kwh/m³ for desalination of seawater
- heat recovery from greywater saves primary energy
  (e.g. preheating of shower-, laundry water with effluent water)
- Water quality standards for inner urban reuse required (direct contact of service water is possible)

Wastewater treatment for reuse and discharge



Wastewater treatment for reuse and discharge

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- Discharge in storm water sewer or drainage channel

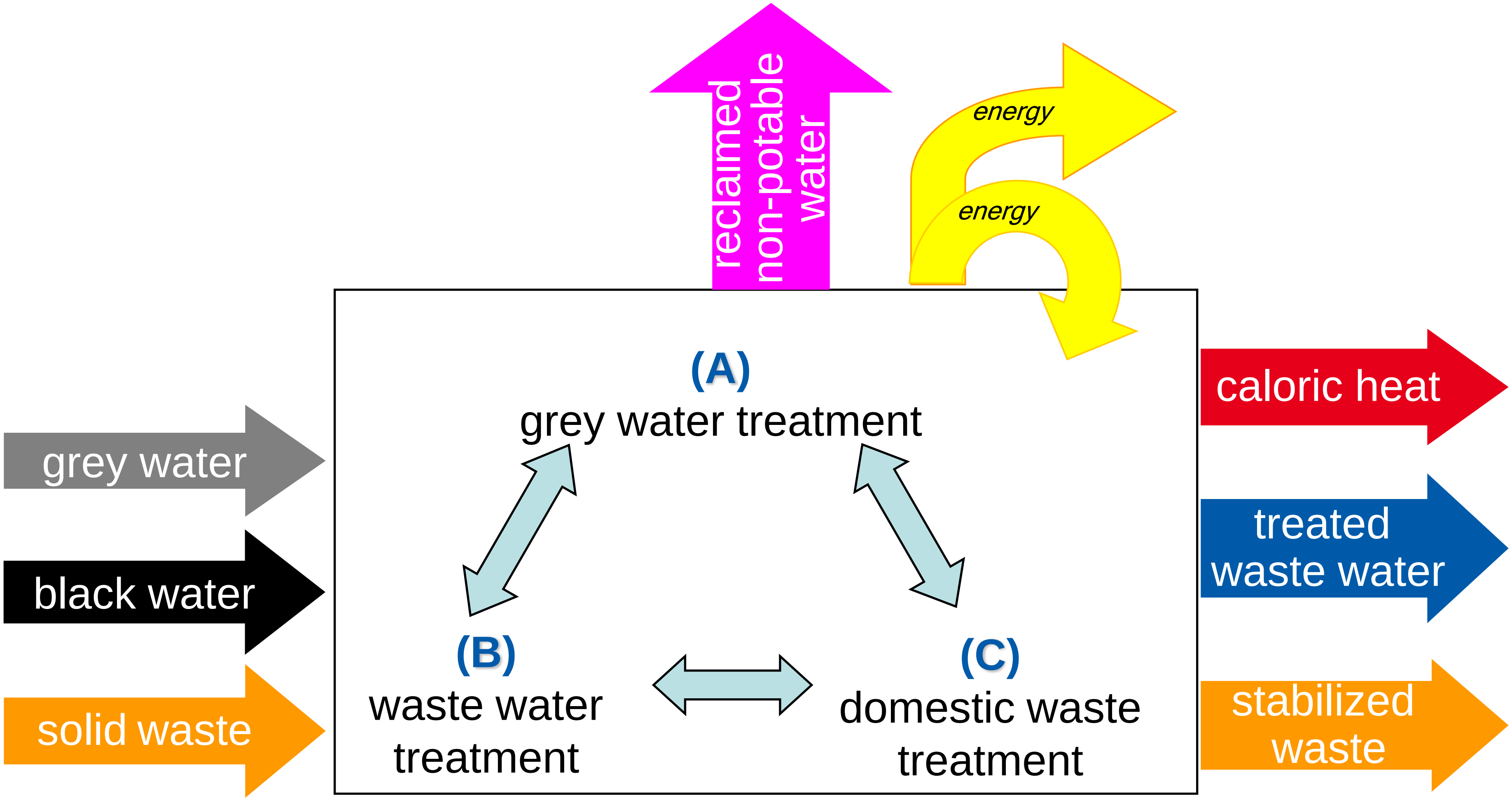
- Using waste water as a resource for
  - intra urban water reuse as process or irrigation water

    ➔ **Adequate treatment for the proposed reuse of**

    - Nutrients especially phosphorus if required
    - Caloric heat (if needed, e.g. in countries where heat is valuable)

- Full treatment to meet effluent/reuse standards
  - to be discharged in receiving waters (and indirectly reused, e.g. irrigation)
  - to be discharged (in stormwater sewer)
  - to be reused

The Semicentralized Approach – Saving Potentials and further Advantages



Complete implementation including solid waste

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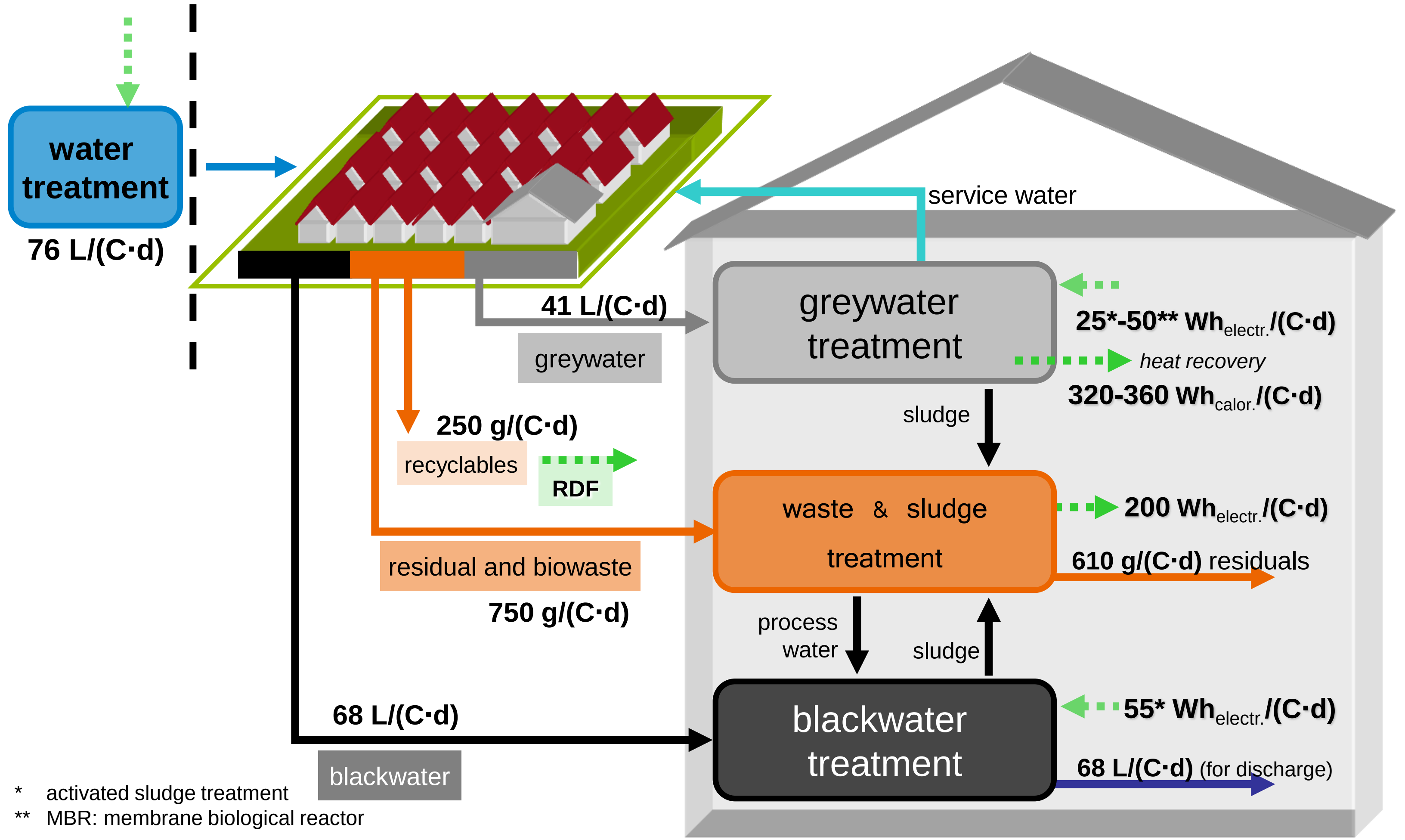
- **Solid waste treatment could compromise**
  - Separation of solid waste fractions
    - Organic material → digestion → energy production
    - Separation of the high caloric fraction,
      the so called refused derived fuel (RDF) as substitute for fossil energy source
    - Reducing the mass to be transported out of the city
    - Regain valuables as glass, plastics, paper, metal, …
- **Generating electric energy for treatment of material flows**
  - energetically self-sufficient Supply and Treatment Centers (STCs) intended
  - avoiding shut offs due to lack of electric energy contingents or lack of money to pay the energy bills (for ecological and safety reasons)

Exemplary material and energy flow



* activated sludge treatment
** MBR: membrane biological reactor

Requirements for intra-urban treatment facilities

- Acceptance by stakeholders
- Low in emission
  - noise
  - aerosols
  - odor
  - traffic

  → because of closed **indoor treatment** units

- Adaptable to boundary conditions
- Adaptable to different techniques and quality needs
- Stepwise extension and upgrade

Visualization of a Semicentralized Treatment Center (20,000 inhabitants, 60 x 60 m)

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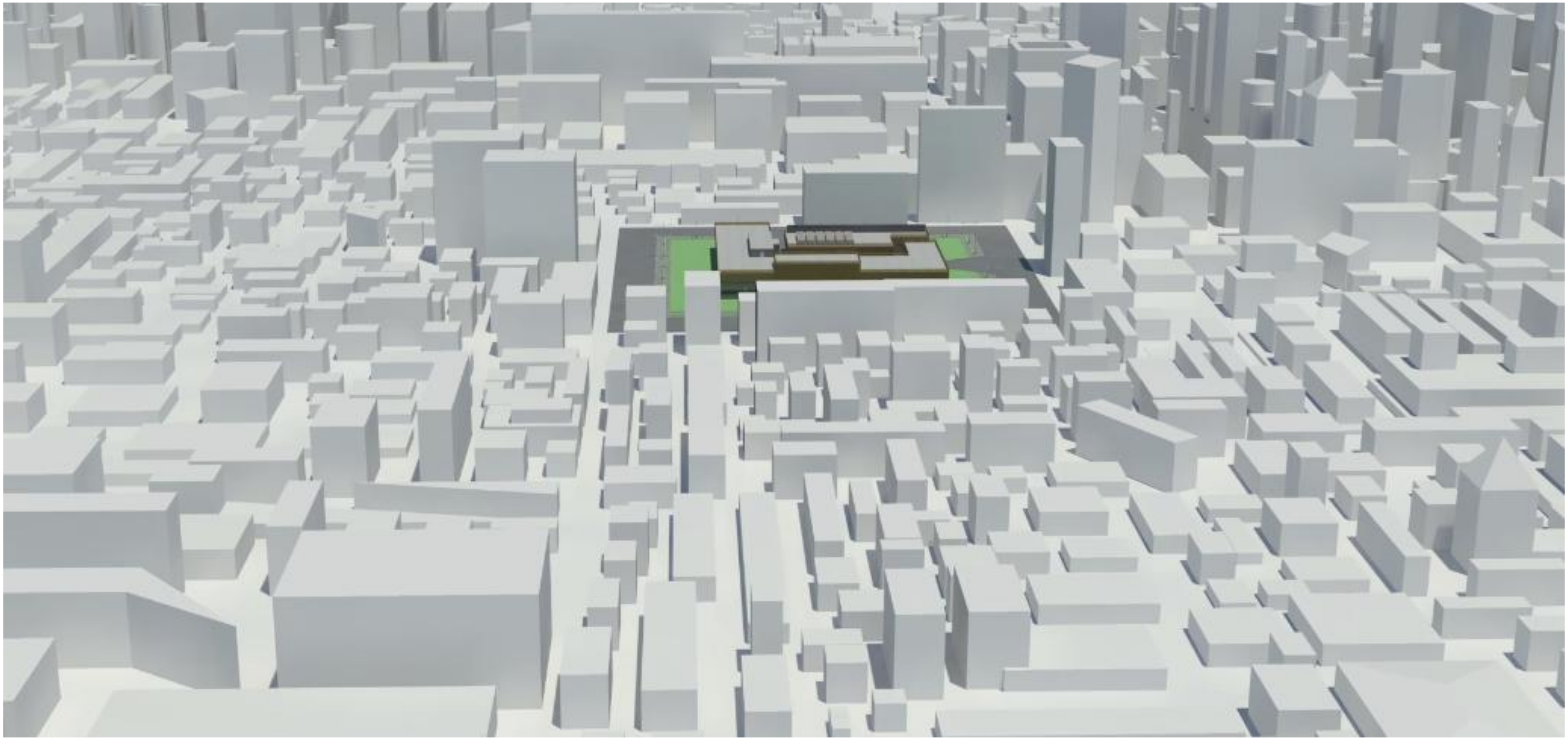

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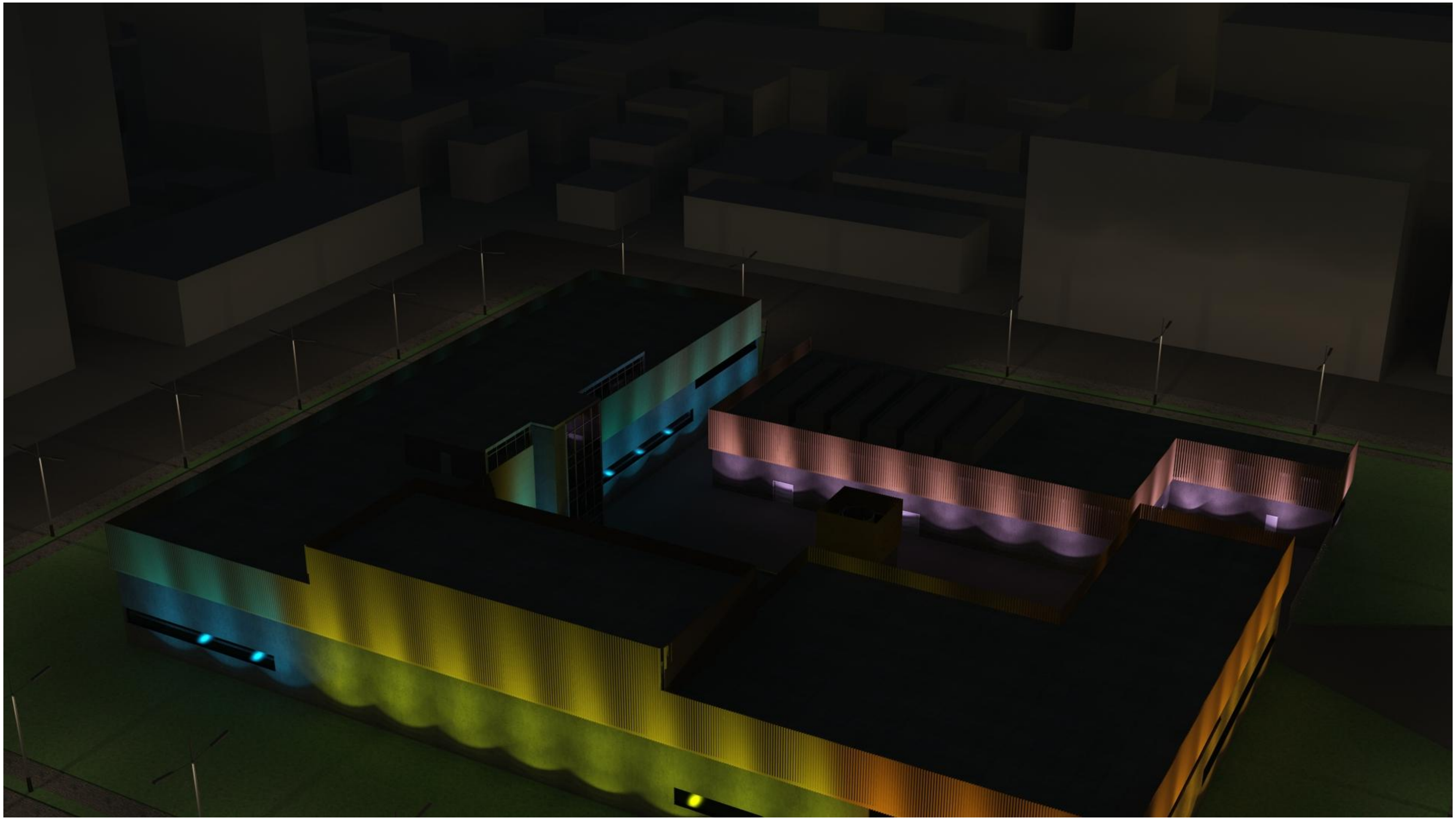

Interior view (e.g. SBR for greywater treatment)

Interior view (e.g. color codes)

Summary and Conclusions

- Integrated Semicentralized Treatment approach
  - can **save > 30 % of fresh water** resource (water reuse)
  - is **technical feasible** with proven technologies
  - offers the potential of **gaining** more **electric energy** than needed for operation
  - offers the **option of heat recovery**
- Capital commitment and planning certainty
  - Higher system flexibility because of
    - smaller and more compact units
    - Adaptable technical solutions (different techniques possible)
- Implementation strategies for semicentralized systems
  - ideal for new development areas
  - Can be combined with centralized treatment → increase of capacity of existing structures by newly-build quarters (the example of Hanoi)
  - Stepwise implementation increases flexibility

Obstacles

- **The integrated approach**
  - Does not reflect the organisational structures in politics, administration ….
    and even in financing
  - interdisciplinary thinking, negotiating and acting is not common at all
- **Prices, cost, fees**
  - Onsite treatment results in cost e.g. for greywater
  - Cost are competitive, **but not** necessarily **with subsidised** freshwater **cost**
- **Ownership**
  - Treatment facilities within private territory

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