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Integrated water infrastructure for megacities – needs and strategies for a sustainable development

Dr.-Ing. Susanne Bieker, Prof. Dr.-Ing. Peter Cornel

Wastewater Technology and Spatial Planning

Technische Universität Darmstadt, Germany

Institute **IWAR**

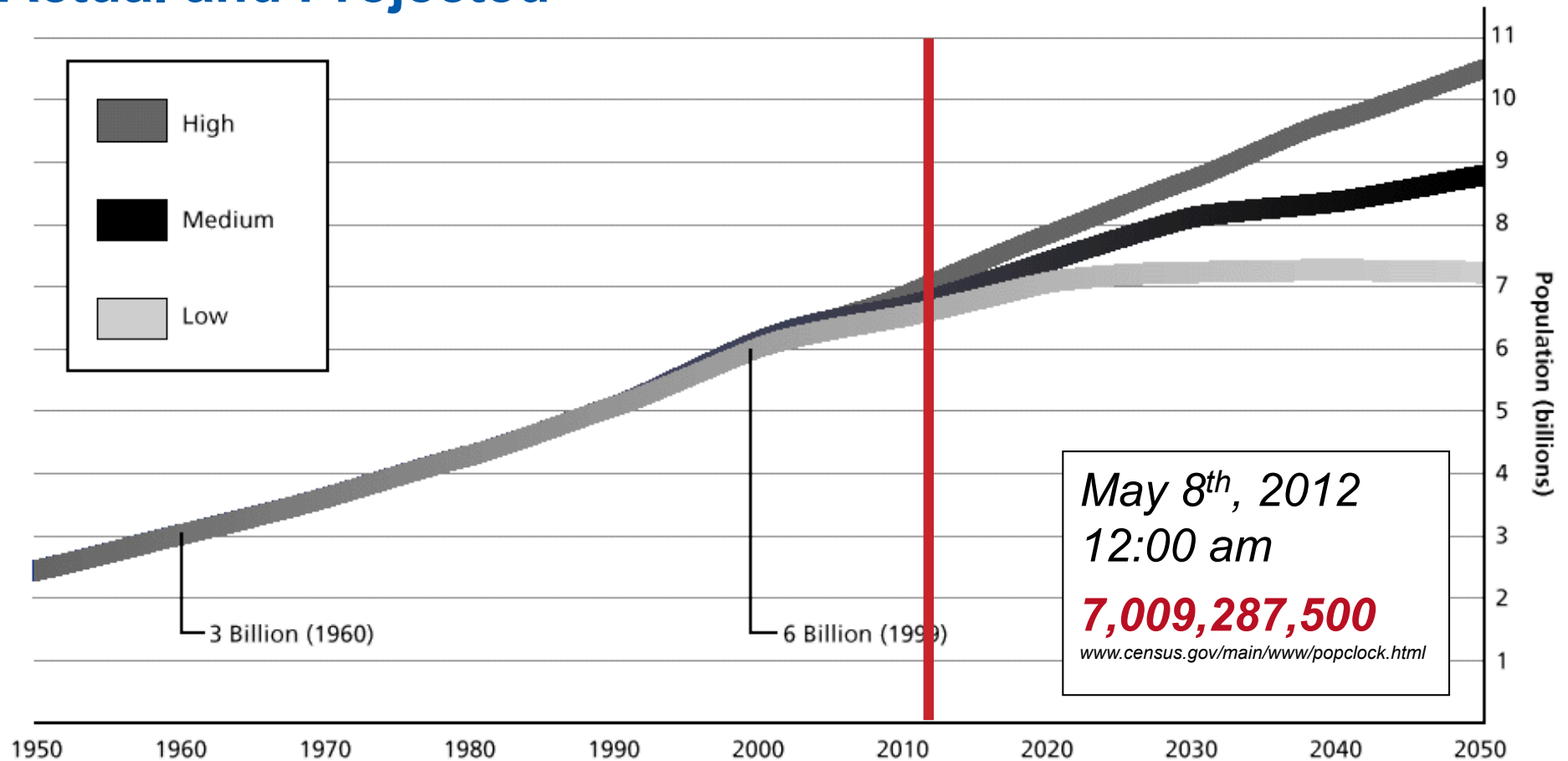


Challenge I: World Population Growth



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Actual and Projected



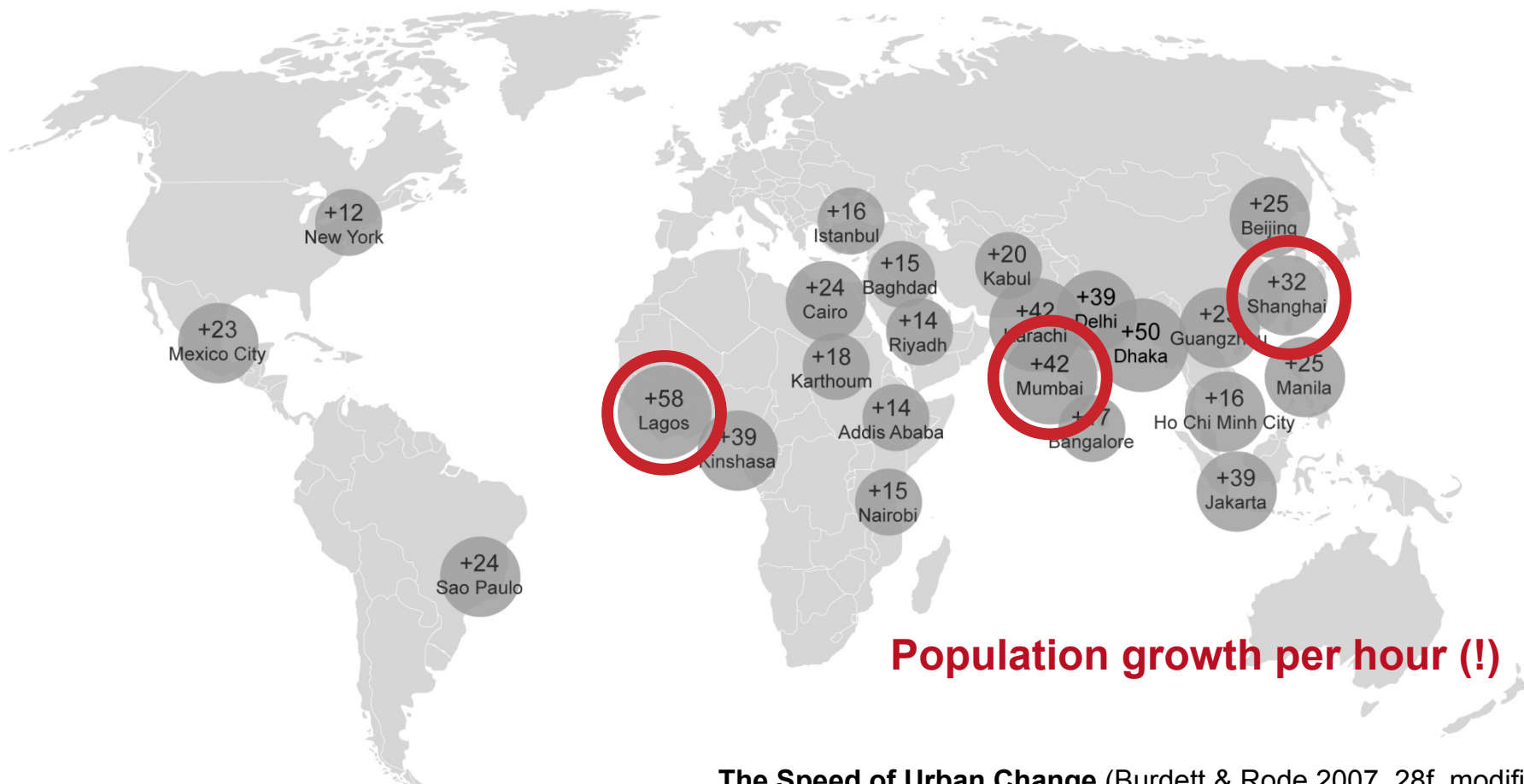
Source: United Nations. 1998. *World Population Prospects (The 1998 Revision)*.

Challenge II: Urban Growth (Capita/hr)



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In total around 1 Million per week in cities



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

Growth rates e.g. Shanghai



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Population growth:

32 C/h → **280,320 C/y**

Additional water:

132 L/(C·d) → **36,442 m³/d**

Additional solid waste:

1 kg/(C·d) → **280 Mg/d**

Challenges III: Limited resources



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■ Scarcity on resources

■ Water

- Population Growth
- Increasing living standards
 - Higher personal water consumption
 - Increasing meat consumption → higher water consumption in agriculture per person

■ Energy

- Energy and Water are linked
 - Fuel Abstraction, Power Production, Cooling
 - Energy for extracting, treating and distributing water
 - Energy for (domestic) water heating

■ Nutrients

- Nitrogen, unlimited but energy intensive
- Phosphorus, a limited resource

We have to answer the Question



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Can a system that was evolved

- more than 100 years ago
- for global population < 2 billion
- mostly rural
- lacking modern technology

be the solution when

- global population is > 7 (8) billion
- mostly urban
- experiencing resource constraints ??

Adapted from IWA-President Daigger, G.;
Change in Paradigm: Waste to Resource,
Weftec '10; New Orleans

Further Questions



- **Can we effort not to re-use limited resources ?**
 - Water
 - Energy
 - Phosphorus
 -
- **What does it really cost to do nothing ?**
 - Dramatically decreasing ground water tables by overexploitation
 - Pollution of rivers
 - water born diseases
 - endangering potable water supply and agricultural irrigation
 - ...
 - running out of fertilizer
 - climate change

What do we need to ensure with new infrastructure-systems?

- **Adaptability**

- A „growing“ system for growing cities

- **Flexibility**

- A system being able to react to changes in development-reality

- **Resource-efficiency**

- All-in-all amounts of resources needs in urban areas (with high population densities) exceed the natural resources

A matter of scale...



- **Water reuse** fosters small(er) units
 - minimizing investment cost for sewer and pipe systems
 - minimizing energy demand for pumping
 - minimizing water losses
- **Energy recovery** fosters small(er) units
 - e.g. heat recovery from greywater (showers, laundry,...)
- High quality standards and **professional operation** foster **minimum scales** (to ensure low costs)

→ Combining Requirements in **Semicentralized Scales**

(20,000 to 100,000 Capita for the boundary conditions of fast growing urban regions in China)

A matter of integration...



- **Energy self-sufficiency** fosters integrated treatment of waste water and (organic) waste
 - **Flexibility in planning** needs harmonization of treatment and material flows
 - **Case-adapted solutions** can only be reached within holistic and comprehensive approaches considering juridical, organizational and technical framework conditions as well as user interests and business environment
- **Combining requirements in integrated solutions**, integrating
- spatial and departmental planning as well as
 - different sectors of departmental planning (water supply, waste water treatment and waste treatment)

Integrated treatment on district level



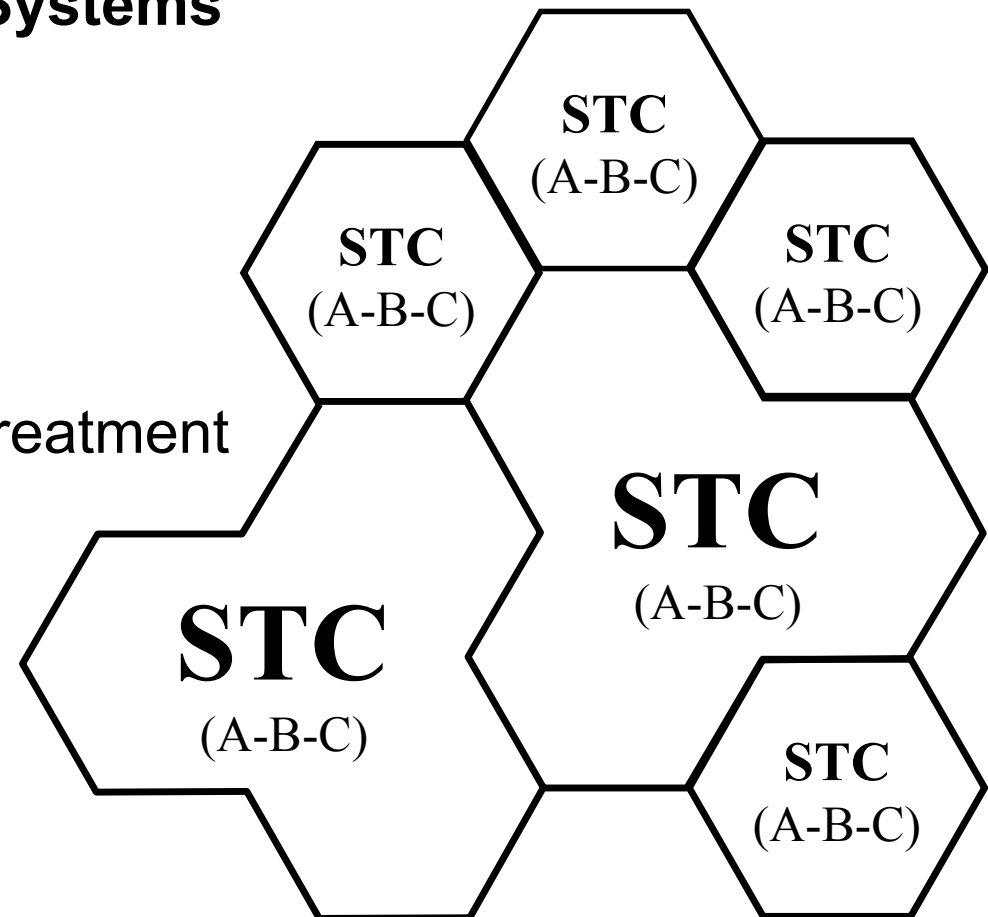
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- **Integrated Semicentralized Systems therefore**

- focus on smaller,
- more compact units

- **Each district has its own Semicentralized Supply and Treatment Centre (STC)**

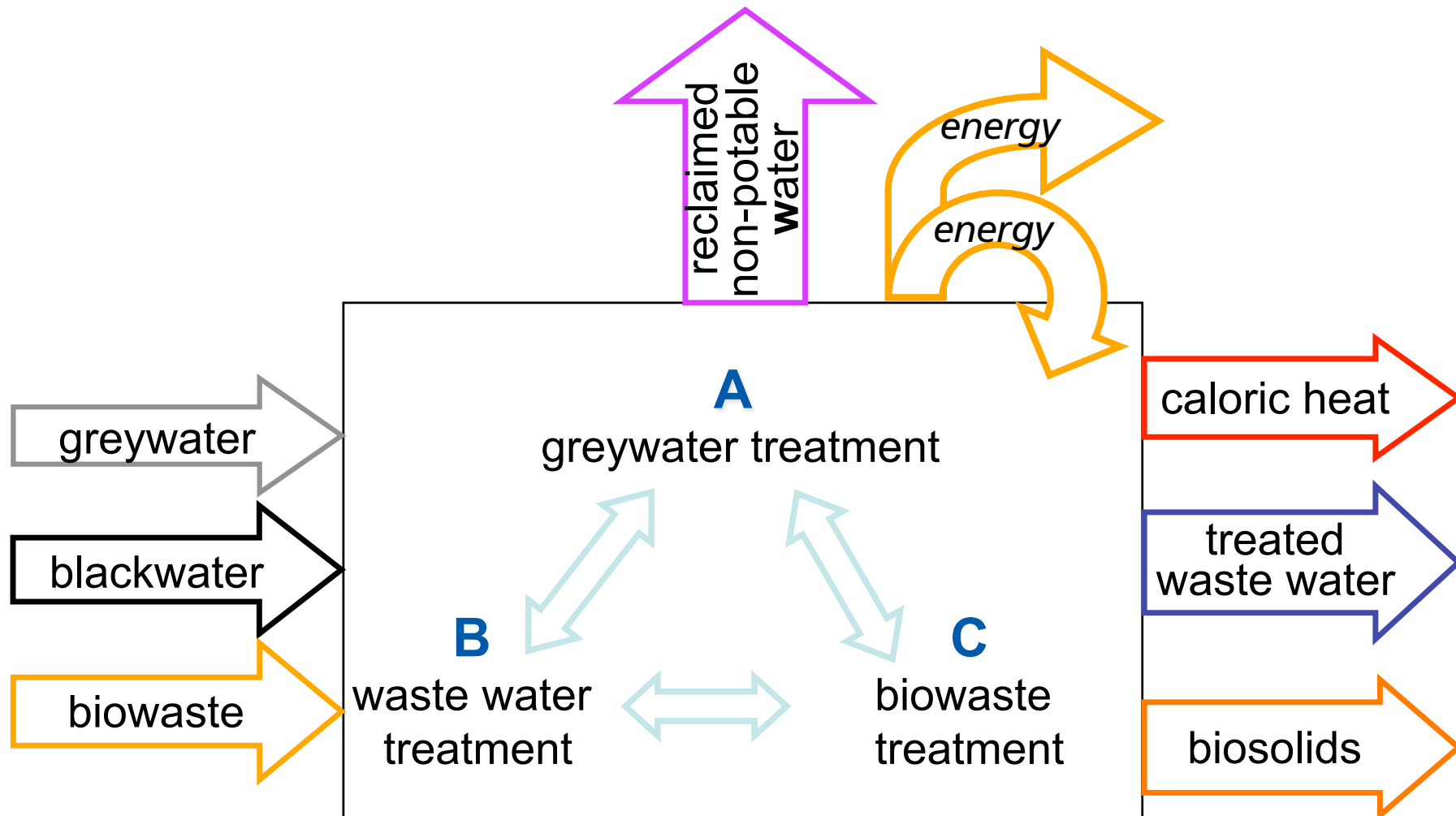
- integrated approach,
- focussing material flow-based management,
- utilizing synergy effects and re-use potentials



The Semizentral Approach



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Case Study Qingdao, P.R. China



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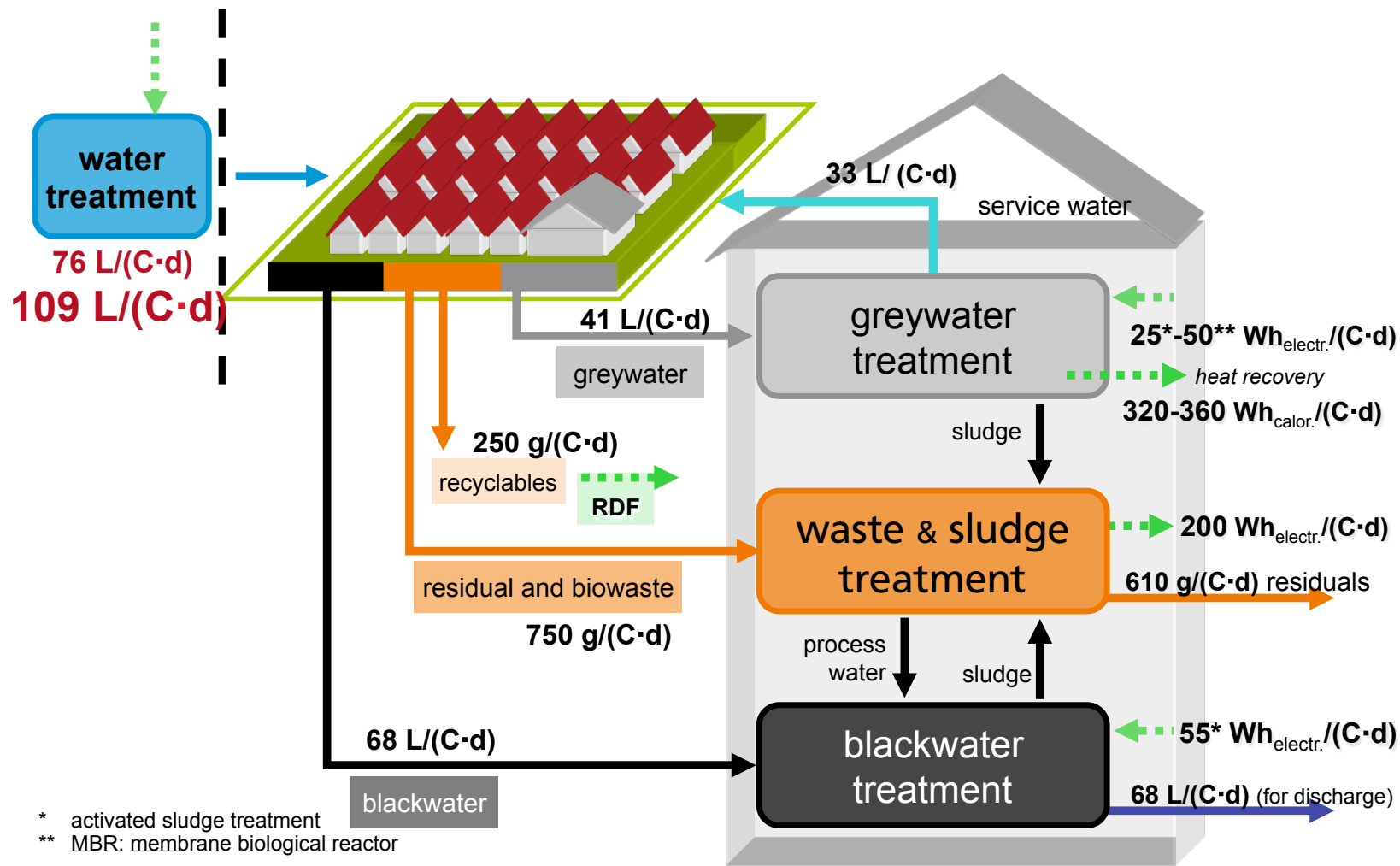
- Emerging Metropolis at the Coast of Shandong Province
 - Currently 3.4 million urban population – overall 8.5 million
 - Urban Growth – intention of over 5 million urban inhabitants till 2020
- Natural Water Resources limited
 - Not enough for “additional” citizens
 - Population growth needs more water
 - Qingdao solution: seawater desalination
 - **Energy needs: 3 to 4 kWh/m³**
- “Semizentral” solution: saving 30% of fresh water demand by intra-urban reuse
 - **Energy needs: 0.3 to 0.5 kWh/m³**



Energy and Material Flows - The Qingdao Case



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Potentials of the „Semizentral“ approach



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- **Separated greywater treatment**
 - **Reduced fresh water demand**
 - Saving natural resources and biospheres
 - Reducing waste water amounts
 - Saving energy and costs
- Secured and controlled waste and sludge treatment
 - **Gaining biogas by anaerobic treatment**
 - Energy self-sufficient operation of the STC – consistent treatment independent from external energy sources and settings
 - Reduced greenhouse-gas emissions at landfills
 - **Reduced and stabilized amounts of waste and sludge**
 - Reduced transportation capacities
 - Reduced environmental impacts by “alternative” dumping

Potentials of the „Semizentral“ approach



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- **Higher planning safety of investments**
 - Short times frames of planning and realization
 - Reduced costs
 - Higher reliability of implementation (proximity of time between planning and realization)
 - Short time frames of full-usage of facilities
 - short-term redemption/ recovery of investments
- **Flexibility in infrastructure development**
 - Adapted to actual (not prognosted!) rural and urban development
 - Reduced starting-investments
 - Minimized investments overall – investing only in shortly needed infrastructure modules
 - Adapted to boundary conditions
 - Adaptable to different techniques and quality needs
 - Stepwise extension and upgrade

The next steps – from research to implementation

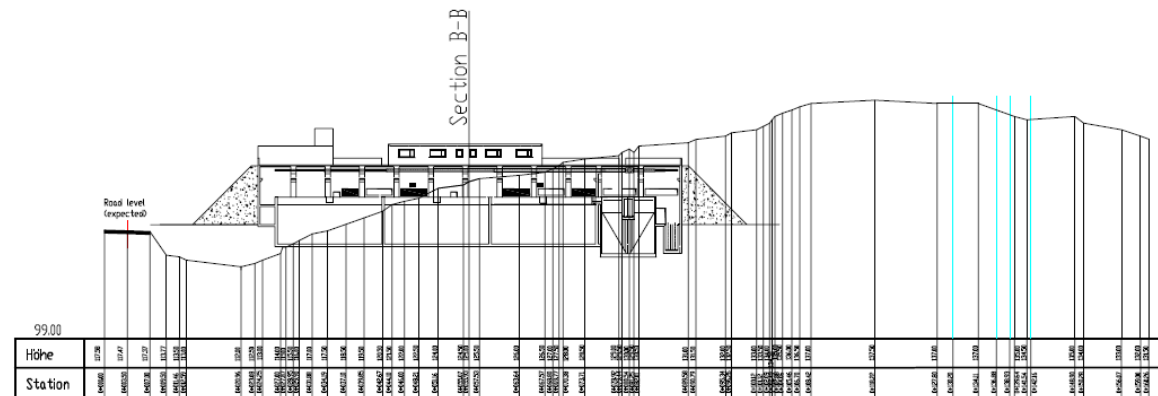
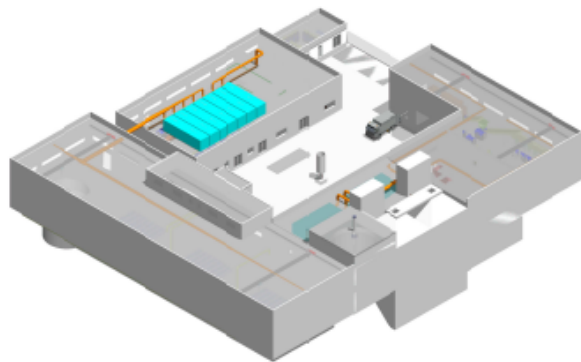


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- **After 8 years of research** in the different fields of
 - water reuse, recontamination and disinfection,
 - membrane technology,
 - integrated biowaste and sludge treatment,
 - implementation strategies,
 - integrated operation,
 - ...
- **the SEMIZENTRAL approach will be realized.**

The next steps – from research to implementation

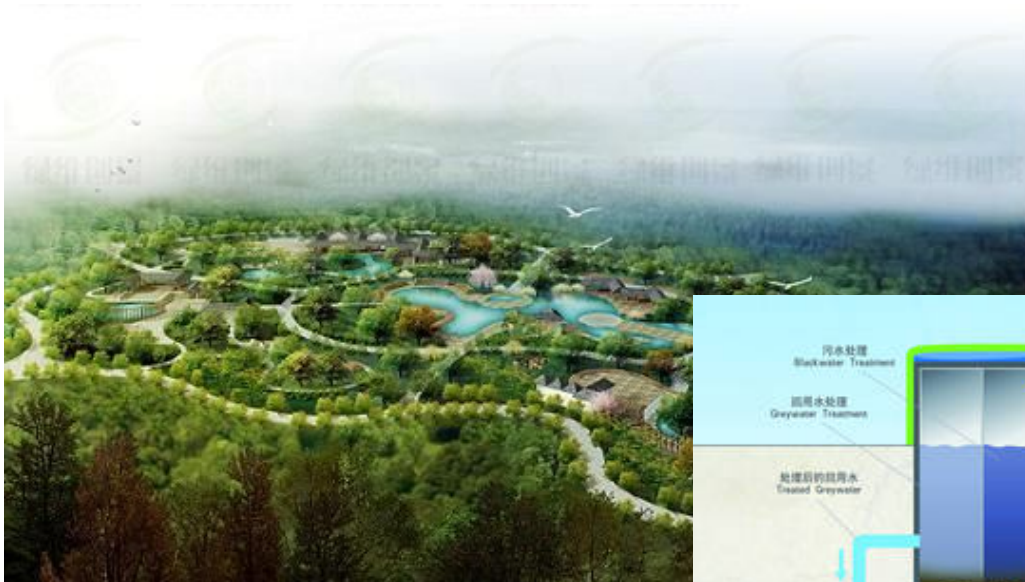
- **City of Qingdao:**
Host of the World Horticulture Exposition (WHE) in 2014
- **Semicentralized Supply and Treatment System** comprises
 - new development areas around the expo-site of about 6,000 Capita
 - 2 Hotels with > 1,000 Capita
 - the „WHE-Village“ with about 4,800 Capita



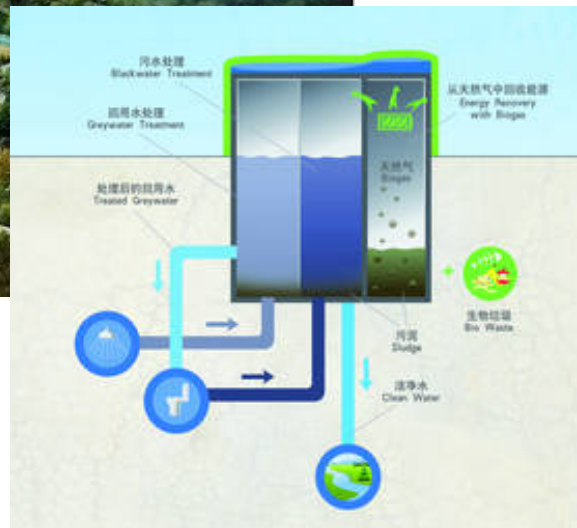
The next steps – from research to implementation



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