1st IWA Development Congress (Mexico City)

Water and Sanitation Services
– what works in developing countries

Semicentralized Supply and Treatment Systems
Integrated Infrastructure Solutions for Urban Areas

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Overview

- Challenges of fast growing urban regions
- The Alternative: The Semicentralized Approach
- Reuse - not only a matter of natural resource efficiency
- Capital Commitment and Planning Certainty
- Summary and Conclusions
Urban Growth

Where The Big Cities Are

While every region of the world has a number of cities with over 1 million inhabitants, a new generation of megacities with over 10 million people is developing across Asia and some parts of Africa, Central and South America.
Urban Growth

Urban growth: additional people per hour! [endlesscity 2007]
Challenges of fast growing urban regions

- Chinese urban regions
- Chinese rural regions

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban Region</th>
<th>Rural Region</th>
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<tbody>
<tr>
<td>1952</td>
<td>1957</td>
<td>1970</td>
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<td>1980</td>
<td>1990</td>
<td>2000</td>
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<td>2007</td>
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- Appr. 300 millions
- Appr. 220 millions
New Infrastructure Solutions needed

Needs for supply and sanitation systems

- ensuring high hygienic quality standards for potable and process water
- Water is scarce! reduce fresh water demand ➔ enable water reuse
- low cost, low energy demand
- reliable and robust systems
- minimizing unaccounted water losses
- adjusted to local needs
- use of synergy potentials between supply and treatment units

Conventional sectored centralized supply and treatment systems can not fulfil these needs
The Alternative: The **Semicentralized Approach**

A Question 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**
The Alternative: The **Semicentralized Approach**

**A Question of Integration**

- **Energy self-sufficiency** fosters integrated treatment of water and (organic) waste
- **Flexibility** in Planning needs harmonization of treatment and material flows
- **Case-adapted solutions** can only be reached within holistic 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)
Comparison of Conventional and Semicentralized Supply and Disposal Systems

Semicentralized Systems follow

- integrated approach,
- focussing material flow-based management,
- utilizing synergy effects and re-use potentials
The Semicentralized Approach – integrated treatment on district level

- Integrated Semicentralized Systems therefore
  - focus on smaller,
  - more compact units

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

**Activated Sludge Treatment**
- 250 g/(C·d)
- 33 L/(C·d)
- 200 Wh_{electr.}/(C·d)

**MBR (Membrane Biological Reactor)**
- 25*-50** Wh_{electr.}/(C·d)
- 320-360 Wh_{calor.}/(C·d)

**Greywater Treatment**
- 76 L/(C·d)
- 750 g/(C·d)
- 750 g/(C·d) residuals

**Waste & Sludge Treatment**
- 610 g/(C·d) residuals
- 68 L/(C·d) (for discharge)

**Blackwater Treatment**
- 68 L/(C·d)

**Recyclables**
- 41 L/(C·d)

**Service Water**
- 109 L/(C·d)

**Notes:**
- * Activated sludge treatment
- ** MBR: Membrane Biological Reactor
Implementing “alternative” solutions

Chatzis (1999) distinguishes 3 stages/ phases in a life cycle of given practices

- genesis
- institutionalisation (routinisation) and
- crisis

Changes in practices are only to be expected within the first and third phase

In context of infrastructure systems the crises of our days can be described as:

- Climate change and the according adaptation needs (floods, droughts, heavy rainfalls, rising sea level, etc.); especially developing countries are concerned: 2/3 of the world’s megacities are located within delta regions or at coastlines

- Water scarcity – a general phenomenon in highly densed urban redions – independent from arising climate related changes (because of limited local/ regional ressources)

- High dynamics in spatial/ urban development, therefore rinsing needs for ressources and attached to that for flexible and reliable infrastructure systems

Challenge of tomorrow in dev. countries: demographic changes and there impacts on infrastructure systems, espec. On grid-bounded systems
Implementing “alternative” solutions

Furthermore changing routines is always correlated with risks and causes expenditures – in time, manpower and therefore also in financial matters.

ERGO: Additional benefits need to be generated in order to take those drawbacks and to enable changes.

The Integrated Semicentralized Treatment Approach therefore offers:

- savings of > 30% of fresh water resource
- technical feasibility with proven technologies
- generation of electric energy – more than needed for its own operation
- options of heat recovery
Water Reuse
- not only a matter of natural resource efficiency

- activated sludge treatment
- MBR: membrane biological reactor

**WaterQReuseQeOnotOonlyOaOmatterOofOnaturalOresourceOefficiency**
Water Reuse
- not only a matter of natural resource efficiency

Integrated Semicentralized Treatment Approach
• technical feasible with proven technologies
• saves > 30 % of fresh water resource

Energy demand and Expenses
• Energy demand of treating of wastewater to be used as service water ranges about 0.3 kWh/m³*
• Energy demand of desalination ranges between 2 and 4 kWh/(C*d)

➔ High potentials of reducing energy consumption and greenhouse gas emissions

*California Energy Commission (2005)
Energy Recovery
- not only a matter of natural resource efficiency
Energy Recovery
- not only a matter of natural resource efficiency

Electric Energy

Combined treatment of sewage sludge and (organic) waste gains more electric energy than needed for operation of the Supply and Treatment Centre

- biogas potential ranges about 500 Wh/(C*d)
- about 300 Wh/(C*d) for waste treatment and 25-50 Wh/(C*d)

⇒ surplus output ranges about **150-175 Wh/(C*d)**

Thermal Energy

Heat recovery from *greywater* (further potentials to gain from integr. Sludge and waste treatment)

- Thermal potential of greywater ranges about 720 Wh/(C*d)
- Heat Pump efficiency factor of approx. 0.45 to 0.5.

⇒ Usable energy capacity of **320 to 360 Wh/(C*d)** – only from greywater
70% - 80% of manufacturing costs of a wastewater treatment result from the **sewer system**
- shorter distances induce lower investment needs, reduced operation costs and potential of system changes

Planning and Operation of Semicentralized Systems are more reliable
- smaller and better manageable frames in time and space
  - reduced probability of economical disaster and technical challenges

Full capacities of new development areas can be reached within a few years
- Reduced risk for developers and investors
  - *Risk rises with increasing scale of development areas*
Capital Commitment and Planning Certainty

Investment and operational costs

Szenario 1
(without dynamic of moving-in)
Capital Commitment and Planning Certainty

Investment and operat. costs

13,000 C  26,000 C  52,000 Capita  104,000 Capita  208,000 C

△ Szenario 1
(without dynamic of moving-in)

System size
Capital Commitment and Planning Certainty

![Graph showing the relationship between system size and investment and operating costs for two scenarios: Szenario 1 (without dynamic of moving-in) and Szenario 2 (considering moving-in).](Image)

- **Szenario 2** (considering moving-in)
- **Szenario 1** (without dynamic of moving-in)
Capital Commitment and Planning Certainty

![Graph showing capital commitment and planning certainty over system size. The graph plots investment and operating costs against system size with two scenarios: Szenario 2 (considering moving-in) and Szenario 1 (without dynamic of moving-in). The x-axis represents system size, while the y-axis represents investment and operating costs. The graph shows a minimum cost point in the middle range of system sizes.]
Capital Commitment and Planning Certainty

- 70% - 80% of manufacturing costs of a wastewater treatment result from the sewer system
  - shorter distances induce lower investment needs, reduced operation costs and potential of system changes

- Planning and Operation of Semicentralized Systems are more reliable
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- Full capacities of new development areas can be reached within a few years
  - Reduced risk for developers and investors
  - Risk rises with increasing scale of development areas

- Semicentralized System Scales are a lot less vulnerable in terms of external influences
Summary and Conclusions

☒ Urban growth brings up new challenges in infrastructure planning

☒ New challenges require infrastructure systems with improved resource efficiency than conventional systems

☒ New dynamic in development foster more flexible infrastructure solutions, being adaptable to changes in demand, quality, technology, etc.

☒ **Integrated Semicentralized Systems offer higher resource efficiency**
  - Water savings of about 30% and more
  - Energy self-sufficient operation (treatment)
  - Potentials of heat recovery

☒ **Integrated Semicentralized Systems offer flexibility and individual adoption**
Acknowledgement

The projects

*Semicentralized Supply and Disposal Systems for urban areas in China*

- Part I: 02WD0398
- Part II: 02WD0607
- Project period: 2003 – 2009

*Solutions for Semicentralized Supply and Disposal Systems in Urban Areas - A Case Study in Hanoi, Vietnam*

- Project Number: 02WA0973
- Project period: 2008 – 2011
Thank you for your attention!

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