Alternative Scenarios of Urban Water Infrastructure Systems

Dr.-Ing. Harald Hiessl
Fraunhofer ISI, Karlsruhe, Germany

OECD Expert Meeting on "Sustainable Financing for Affordable Water Services: From Theory to Practice"
Union de l'Europe Occidentale, Paris
14-15 November 2007
Outline

- Urban water infrastructure systems
- Challenges
- Strategic Foresight
- Centralization / decentralization
- Case Studies
  - The AKWA-2100 Project
  - The AKWA Dahler Feld Project
  - The DEUS 21 Project
- Conclusion
Conventional Urban Water Supply and Sanitation

- Concept of centrality (technical, institutional)
- Water supply (WS) utility institutionally independent of wastewater (WW) utility
- Regional Monopoly w.r.t. WS und WW
- One-time use
- WS: Potable water quality for all uses
- WW: mixing various WW-streams
- High fixed costs
Urban water infrastructure systems – the "hardware"

Technical Subsystem "Utilities":
Plants, equipment and network on public grounds for water supply, sanitation, storm water management

Technical Subsystem "Users":
In-house water using equipment and components / pipe systems for water supply and sanitation (incl. equipment for on-site water supply / sanitation)
Challenges for Urban Water Infrastructure Systems (UWIS)

- Need for rehabilitation of UWIS and for renovation of stock of buildings (window of opportunity!)
- Increasing incompatibility between inhouse (users') and outdoor (utilities') subsystems of UWIS
- Need to adapt to demographic change (in D: deconstruction and urban renewal, inter-communal competition for residents)
- Need to adapt to climate change
- Vulnerability of existing conventional UWIS (terrorism, natural disasters)
- Unfavorable cost structure of conventional UWIS (fixed costs!)
- Increasing scarcity of important resources (e.g. phosphate, fossil fuels)
- New (regulatory) requirements (e.g. micro pollutants, pharmaceutical residues, hygienic load on receiving waters, ...)
- Systematic utilisation of continuous technological progress
- Provision of sustainable UWISs (urbanization in developing countries; MDGs)
If you don't know where you're going, you may wind up somewhere else!
Elements of Strategic Foresight

- **Framing**: defining the scope and focus of the problem requiring strategic foresight.
- **Scanning**: scanning the external environment for information and trends relating to the issue at hand.
- **Forecasting**: generating the widest range of creative possibilities, then consolidating and prioritizing the most useful for the organization to actively consider or prepare for as it moves forward.
- **Visioning**: bringing the consideration of the future back to the present by addressing the question, "So what?".
- **Planning**: evaluating the strategic options.
- **Acting**: creation of a comprehensive intelligence system to provide ongoing external and internal feedback on the effectiveness of the strategy that has been implemented.
Organisational Innovations: Perspectives on (De-)Centralization

<table>
<thead>
<tr>
<th>Perspectives</th>
<th>Degree of (De-) Centralization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Decentralization</td>
</tr>
<tr>
<td>Technical Concept</td>
<td>Point-of-Use / Point of Entry treatment</td>
</tr>
<tr>
<td>Ownership</td>
<td>Homeowner</td>
</tr>
<tr>
<td>Operation</td>
<td>Homeowner</td>
</tr>
</tbody>
</table>
AKWA 2100 Project (1)

- Project duration: 2000-2003
- Goal: Development of long-term scenarios of urban water infrastructure systems (time horizon 2050 + ) with two municipalities as case studies:
  - Asseln (suburb of city of Dortmund): 9,200 inhab.
  - Bork (suburb of the city of Selm): 6,700 inhab.
- Assessment of sustainability of the scenarios
- Development of transition strategies from existing conventional system to a new concept as represented by a scenario (change management)
### AKWA 2100: Scenarios

<table>
<thead>
<tr>
<th>Driving factors</th>
<th>Value</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Regulation</td>
<td>Regulated</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deregulated</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Degree of Centrality</td>
<td>Centralized</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decentralized</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Degree of differentiation of wastewater streams</td>
<td>Small</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Degree of closure of anthropogenic water and material cycles</td>
<td>Small</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of the scenario</th>
<th>Continuation</th>
<th>Municipal Water Reuse</th>
<th>Local Recycling</th>
</tr>
</thead>
</table>
### AKWA 2100: Cost assessment

<table>
<thead>
<tr>
<th>Case</th>
<th>Scenario / Concept</th>
<th>Dortmund-Asseln</th>
<th>Selm-Bork</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: „green field“</td>
<td>Municipal Water Reuse</td>
<td>23 %</td>
<td>22 %</td>
</tr>
<tr>
<td>Local Recycling</td>
<td>11 %</td>
<td>5 %</td>
<td></td>
</tr>
<tr>
<td>B: „step-by-step“ Transition</td>
<td>Municipal Water Reuse</td>
<td>27 %</td>
<td>26 %</td>
</tr>
<tr>
<td>Local Recycling</td>
<td>15 %</td>
<td>11%</td>
<td></td>
</tr>
</tbody>
</table>
Dahler Feld in Selm:

- Rural residential area (29 houses, approx. 100 inhabitants) on the periphery of the city of Selm (NRW)
- Individual water supply through private wells
- Individual wastewater systems by private cesspits / septic tanks
- Need for renewal of the private wastewater systems (to meet new regulatory standards)
Modernisation of the wastewater management with a *contracting business model* ("centralized operation of decentralized treatment units") by the Lippeverband (LV) – a regional wastewater utility.

Advantages:

- LV provides innovative MBR-micro treatment units as part of long-term service contracts with the homeowners
- Cost cutting through bundling (procurement, construction, operation, maintenance)
- Home owners pay a fixed monthly fee for waste water services – no investments!
- Professional operation of the micro treatment plants
- Depreciation of the micro treatment plant assets through LV
- MBR-technology instead of conventional SBR-technology
DEUS 21 – Decentralized Urban Water Infrastructure System, Knittlingen

- New residential area for 105 houses
- Mostly single family homes
- At present: about 25 houses finished and occupied
- Site of "Waterhouse"
DEUS 21, Knittlingen

Potable water from public water supply

Potable water (very low hardness, from rainwater)

Vacuum sewer system

Domestic wastewater + organic kitchen wastes

Rainwater treated wastewater (acc. to EU "Bathing water standards")

Biogas generation for energy production

Nutrient recycling (Phosphorous, Nitrogen)

Rainwater treatment (Ultrafiltration)

Anaerobic wastewater treatment (Microfiltration)

According to drinking water standards! (very low hardness)

For personal hygiene, hot water preparation, laundry, cleansing, toilet flushing

Fraunhofer Institute System- und Innovationsforschung
Summary and Conclusions

- UWIS are complex (technical, socio-economic, judicial, and institutional) systems with a large number of actors/stakeholders involved.
- Existing conventional UWIS are under pressure for a variety of causes. There is
  - a huge need for re-investments.
  - a window of opportunity for switching to sustainable systems concepts.
- Re-development: major issue is to initiate and manage system transition. Requires long-term thinking and systemic transition management!
- Technological as well as organizational and institutional changes provide new options for more sustainable UWIS in developed and developing countries:
  - Flexible UWIS concepts to allow for assimilation of technological change.
  - UWIS concepts need to realize synergies between various utility sectors.
- We need more pilots with innovative UWIS concepts to gain experience!
Thank you for your attention!