ecosan project at the GTZ headquarters, main office building, Germany

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commissioned by

4th WORLD WATER FORUM, Mexico City, March 16-22, 2006
Background

- GTZ main office building is being renovated (2004-06/2006)
- The building provides offices facilities for 650 employees, canteen, meeting rooms and conference facilities
Urine and brownwater reuse project
at the main building of GTZ

4th WORLD WATER FORUM, Mexico City, March 16-22, 2006

GTZ headquarters, main building, Germany

ecosan pilot projects

separation toilets, waterless urinals, yellowwater piping, storage tank, MAP-precipitation + ammiona stripping

brownwater piping, Activated sludge + membrane filtration
Objectives of the ecological sanitation concept

- Development and demonstration of a high comfort innovative urban ecosan system
- Reduction of water consumption
- Reduction of emissions (pathogens, organics, nutrients, micro contaminants, etc.)
- Nutrient recovery for agricultural use
- Research on ecosan technologies and operation for modern urban buildings

Roediger No Mix toilet
Keramag Centaurus waterless urinal
Technical components of the urine and brownwater reuse system

### Urine reuse system
- 56 urine separation toilets, 25 waterless urinals,
- Separate urine pipes
- Collection in a 10 m³ urine tank
- Urine treatment
  - MAP-precipitation and ammonia stripping
  - Prolonged storage for hygienization
- Agricultural use of urine and urine products on research plots

### Brownwater reuse system
- Separate brownwater pipes
- Biological treatment (activated sludge) + membrane filtration
- Agricultural use of excess sludge on research plots
- Use of treated effluent as service water (alternative uses: green irrigation, groundwater recharge or discharge)
Urine and brownwater reuse project at the main building of GTZ

### Previous conventional system

- **Wastewater**: 6950 m³/a
- **Rainwater**: 2350 m³/a
- **Drinking water**: 3000 m³/a
- **Service water**: 300 m³/a
- **Yellow-water**: 550 m³/a
- **Black-water**: 1400 m³/a
- **Greywater**: 400 m³/a
- **Service water**: 1500 m³/a

**Sewarage, Sewage treatment**
Overview of the ecological sanitation concept

Service water (ground water)

Drinking water

Kitchenettes and sanitary sinks

Urine separation toilets and waterless urinals

Urine storage, MAP-precipitation, ammonia stripping

Urine

Process water

MAP

Excess sludge

Activated sludge reactor + membrane filtration

Agricultural reuse

Treated effluent: Re-use as service water, irrigation, infiltration or direct discharge

Greywater

Sewerage and sewage treatment

Service water

Drinking water

Kitchenettes and sanitary sinks

Urine separation toilets and waterless urinals

Urine storage, MAP-precipitation, ammonia stripping

Urine

Process water

MAP

Excess sludge

Activated sludge reactor + membrane filtration

Agricultural reuse

Treated effluent: Re-use as service water, irrigation, infiltration or direct discharge

Greywater

Sewerage and sewage treatment
Ecosan demonstration project

Demonstration of new technological and management options for ecosan in a modern urban context:

- Decentralised and modular solution
- High tech ecological sanitation
- Autonomy possible: no connection to sewer network
- Model solution for:
  - modern office buildings
  - new urban settlements / extension areas
  - situations where the extension of conventional sanitation infrastructure cannot keep pace with fast urbanisation

Demonstration of doing our ecosan-“homework” in the industrialised world as part of the GTZ development cooperation ecosan progam
Research and capacity building

Research component

- Development of technologies for urine and brownwater treatment and reuse practices
- Operation and maintenance
- Acceptance, environmental and health impact (particularly with regard to micro pollutants)
- Legal and economic aspects
- Resource efficiency
- Costs

Capacity building component

- Ideal location for a demonstration project: daily visits of decision makers from all over the world
- Special demonstration room and guided tours
- Good complementarity with the ecosan project in the KfW building in Frankfurt (vacuum toilets and sewerage and greywater recycling)
### Economic aspects: comparison of 3 scenarios

<table>
<thead>
<tr>
<th>Scenario 1: Conventional system</th>
<th>Scenario 2: GTZ building prototype</th>
<th>Scenario 3: ecosan large-scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>public water supply for all uses</td>
<td>use of public water supply for kitchenette and handwashing</td>
<td>use of public water supply for kitchenette and handwashing</td>
</tr>
<tr>
<td></td>
<td>use of well water for toilet flushing</td>
<td>use of recycled greywater for toilet flushing</td>
</tr>
<tr>
<td>no water saving devices</td>
<td>waterless urinals</td>
<td>waterless urinals</td>
</tr>
<tr>
<td></td>
<td>watersaving separation toilets</td>
<td>watersaving separation toilets</td>
</tr>
<tr>
<td>no reuse</td>
<td>reuse, infiltration or discharge of treated brownwater</td>
<td>Reuse, infiltration or discharge of treated grey- and brownwater</td>
</tr>
<tr>
<td></td>
<td>reuse of urine</td>
<td>reuse of urine</td>
</tr>
<tr>
<td>discharge of wastewater in public sewer system</td>
<td>discharge of greywater in public sewer</td>
<td>no sewer connection</td>
</tr>
</tbody>
</table>
## Economic aspects: estimated investment costs

### Sanitary infrastructure

<table>
<thead>
<tr>
<th></th>
<th>Conventional system (€)</th>
<th>GTZ building prototype (€)</th>
<th>ecosan large-scale (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional urinals</td>
<td>10.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Waterless urinals</td>
<td>10.000</td>
<td>10.000</td>
<td>10.000</td>
</tr>
<tr>
<td>Conventional toilets</td>
<td>15.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>UD toilets</td>
<td>76.000</td>
<td>25.000</td>
<td></td>
</tr>
<tr>
<td>Blackwater pipe system</td>
<td>35.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Urine pipe system</td>
<td>-</td>
<td>33.000</td>
<td>20.000</td>
</tr>
<tr>
<td>Brownwater pipe system</td>
<td>-</td>
<td>35.000</td>
<td>20.000</td>
</tr>
<tr>
<td>Greywater pipe system</td>
<td>-</td>
<td>20.000</td>
<td>20.000</td>
</tr>
<tr>
<td>Urine collection tank + pumps</td>
<td>-</td>
<td>45.000</td>
<td>20.000</td>
</tr>
<tr>
<td><strong>Subtotal Sanitary Infrastructure</strong></td>
<td><strong>60.000</strong></td>
<td><strong>219.000</strong></td>
<td><strong>115.000</strong></td>
</tr>
</tbody>
</table>

### Treatment infrastructure

<table>
<thead>
<tr>
<th></th>
<th>Conventional system (€)</th>
<th>GTZ building prototype (€)</th>
<th>ecosan large-scale (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine treatment</td>
<td>-</td>
<td>45.000</td>
<td>20.000</td>
</tr>
<tr>
<td>Brownwater treatment</td>
<td>-</td>
<td>60.000</td>
<td>30.000</td>
</tr>
<tr>
<td>Greywater treatment</td>
<td>-</td>
<td>-</td>
<td>30.000</td>
</tr>
<tr>
<td>Sewerage network (proportionately)</td>
<td>450.000</td>
<td>450.000</td>
<td></td>
</tr>
<tr>
<td>Sewage treatment (proportionately)</td>
<td>45.000</td>
<td>23.000</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal Treatment</strong></td>
<td><strong>495.000</strong></td>
<td><strong>578.000</strong></td>
<td><strong>80.000</strong></td>
</tr>
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</table>

### Total

<table>
<thead>
<tr>
<th></th>
<th>Conventional system (€)</th>
<th>GTZ building prototype (€)</th>
<th>ecosan large-scale (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>555.000</strong></td>
<td><strong>797.000</strong></td>
<td><strong>195.000</strong></td>
</tr>
</tbody>
</table>

### Difference

<table>
<thead>
<tr>
<th></th>
<th>Increase (€)</th>
<th>Increase (€)</th>
<th>Decrease (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>+ 0</td>
<td>+ 242.000</td>
<td>-360.000</td>
</tr>
</tbody>
</table>

(Compared to conventional scenario)
### Economic aspects: estimated operation and maintenance costs

<table>
<thead>
<tr>
<th></th>
<th>Conventional system (€/year)</th>
<th>GTZ building prototype (€/year)</th>
<th>ecosan large-scale (€/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water supply</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>urinals</td>
<td>1100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>toilets</td>
<td>4800</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>kitchenettes, sanitary sinks</td>
<td>1600</td>
<td>1600</td>
<td>1600</td>
</tr>
<tr>
<td><strong>Wastewater fees</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7500</td>
<td>1600</td>
<td>0</td>
</tr>
<tr>
<td><strong>Onsite treatment + transport</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yellowwater</td>
<td>0</td>
<td>5000</td>
<td>2500</td>
</tr>
<tr>
<td>brownwater</td>
<td>0</td>
<td>7000</td>
<td>3500</td>
</tr>
<tr>
<td>greywater</td>
<td>0</td>
<td>0</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Income from products</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fertilizer value of urine and sludge</td>
<td>0</td>
<td>not considered</td>
<td>not considered</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15000</td>
<td>15200</td>
<td>10600</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(compared to conventional)</td>
<td>0</td>
<td>200</td>
<td>-4400</td>
</tr>
</tbody>
</table>
Other urban urine separating projects: Huber Company, Germany

- Huber company: manufacturer of wastewater treatment technology
- Office building of Huber company, 200 staff,
- Urine separation toilets, waterless urinals
- Separate collection of urine, brownwater and greywater
- Development of technology for treatment of urine, brownwater and greywater
Other urban urine separating projects:
Solar City Linz, Austria

- New constructed urban setting for 3500 inhabitants
- Separate collection of urine and brownwater
- Onsite treatment of brownwater
- Agricultural reuse of urine

Urine tanks (photo: Otterwasser GmbH)  Buildings (photo: Otterwasser GmbH)
Other urban urine separating projects: Gebers collective housing project, Sweden

- Ecological cooperative housing project for 80 inhabitants
- Urine diverting composting toilets
- Agricultural reuse of urine and compost

Source: EKBO, SEI, Verna
Other urban urine separating projects:
China-Sweden Erdos Eco-Town Project, China

Ecosan practises in an entire functioning modern town:
- Urine-diverting dry toilets and collection systems for multi-storey buildings
- Greywater collection and treated in decentralised system
- Composted faeces and urine reused in agriculture