p2m berlin GmbH
Tubli Water Pollution Control Centre –
Expansion of Sewage Treatment Plant with
First Sludge to Energy Concept in the Middle East
Berliner Wasserbetriebe
Water Supply and Waste Water Disposal for the Capital of Germany
p2m berlin GmbH
Engineering Company of Berlinwasser

Data and Facts about p2m:

- Founded in: 1992
- Representative Offices in:
  - Berlin (Headquarter)
  - Albania
  - Azerbaijan
  - Kingdom of Bahrain
- Subsidiary Company: pbv potsdam GmbH
Fields of Competence

p2m berlin GmbH

- Administration
- Accounting
- Controlling
- Quality Management
- Safety Regulations
- Building Construction
- Structural Design
- Process Design
- Plant Construction
- E/PLT

BWB
- Regional
- National
- International

Drinking Water Supply
- Stormwater Management
- Waste Water Collection
- Waste Water Treatment
- Sludge Management
- Project Management
- Consulting and Supervision
Sludge Management - Introduction

Main Keys to Sustainable Sludge Management:

- **Sustainable Sludge Reuse/Disposal Routes**
  - Land availability
  - Existing industries
  - Existing agriculture/landscaping

- **Sludge to Energy Concepts** (Energy Recovery)
  - Biogas
  - Mono-Incineration (sludge only)
  - Co-Incineration
    (cement industry, solid waste)

- Sludge Treatment Options depend on those 2 key factors

Source: Veolia.com
Sludge Disposal in GCC & Middle East

- Mostly sludge drying and disposal in landfills
  - NOT A SUSTAINABLE SOLUTION
- Limited reuse in agriculture and landscaping
  - sludge quality concerns (Pathogens, Heavy Metals),
  - limited/insufficient land availability
  - LIMITED SUSTAINABILITY
    limited by climate & geology, farmland availability, cultural concerns and acceptance
Sludge Disposal in Bahrain

- Sludge is Dried to 90% and pelletised
- Agricultural Reuse not accepted by farmers due to limited sludge quality – odour and vermin problems
- Bahrain is a small island with limited land availability
- Sludge Production by far exceeds Demand
- All sludge is trucked to landfill

➤ NOT A SUSTAINABLE SOLUTION

- In 2010 decision to incinerate sewage sludge to reduce quantities and increase reuse options
Energy Content in Sewage Sludge – Germany

Energy Equivalent

10 kg org. DS ~ 6 ltr. diesel

Generated Sewage Sludge in Germany:

- Total Dry Solids (2014): app. 1,900,000 t/a
- Organic Content: app. 50 - 55 %
- Total Organic Matter (2014): app. 1,000,000 t/a
- Specific Heat Value: app. 23,000 kJ/kg

Total Energy Content in the Sewage Sludge:

- Total Energy Content: app. 23,000,000,000 MJ/a
- Natural Gas: app. 500,000,000 m³/a
- Diesel (fuel): app. 600,000 m³/a

Source: Wikipedia.org

Source: maritime-connector.com
**Basis:** 100 tDS/d with 70% oDS; equiv. to WWTP with app. 400,000 m³/d dry weather inflow

Total organic content of sludge does not change in the individual sludge handling processes, including sludge drying.

The entire sludge energy content can be transferred into electricity and thermal waste energy (heat) in a sludge incineration plant.
For sludge incineration without add. external fuel (autothermal incineration), the incinerated sludge is required to have a specific heat value of more than 4,000 kJ/kg DS.

For autothermal incineration of undigested sludge a dryness of app. 33–38% DS is sufficient.
**Tubli Water Pollution Control Centre, Bahrain**

Sludge to Energy

**Client:** Ministry of Works, Kingdom of Bahrain  
**Period:** 09/2007 – 12/2017

**Project data:**
- Expansion and rehabilitation to 400,000 m³/d
- New STP with deep lifting station, sand & grit removal, SBR, filtration, Ozonation and sludge incineration

**Sludge Incineration:**
- Currently sludge is dried to 90% and disposed off in local landfill – capacity approx. 45 tDS/d
- New sludge treatment with dewatering, drying and incineration of up to 118 tDS/d
- Electrical energy approx. 15 GWh/a
- Reuse of dried sludge as fertiliser possible
Tubli WPCC - Location

Located in the Middle East - Kingdom of Bahrain
Tubli WPCC
Overview Existing STP

Sludge Treatment
Secondary Treatment
Tankered Waste Receiving
Headworks
Tertiary Treatment
Tubli WPCC
Plant History, Current Load & Condition

**Plant History:**
- Phase 1 – Initial Construction of Tubli WPCC 1982 54,000m³/d
- Phase 2 – First Expansion of Tubli WPCC 1989 124,000m³/d
  incl. Phase 1 Tertiary Treatment for Treated Sewage Effluent (TSE) 1989 60,000m³/d
- Phase 3 – 2nd Expansion of Tubli WPCC 2002 200,000m³/d
  incl. Phase 2 – TSE 2002 200,000m³/d
- Phase 3a – Sludge Dewatering and Drying Plant with Thermal Drying 2004 32 tDS/d
- Phase 3b – Short Term Measures 1&2: refurbish major plant components, increase sludge treatment capacity, install HYBACS system 20010-2017 230,000m³/d
  with 2 stage bio-reactors to increase treatment capacity, major concrete refurbishment work

**Current Load & Condition:**
- Plant receives 300,000-320,000 m³/d
- Plant is heavily overloaded
- Several Parts of the STP have exceeded their lifetime and are in poor operating condition
- Result: discharge of partially treated wastewater to nearby Tubli Bay
Expansion Project Parameters:

- New Headworks with 20m Deep Lifting Station for 400,000m³/d
- New Biological Treatment with SBR for 200,000m³/d
- New 2 Stage Tertiary Treatment with Disc & Sand Filtration, 2 Stg. Ozonation 200,000m³/d
- New Sludge Treatment incl. Incineration and Energy Recovery for 118 tDS/d

Expansion Project Timeline:

- Consultancy Tender for Expansion DBO Tender 2007
- DBO Tender Ready for publishing Budget Crisis did not allow for tendering Oct. 2008
- STM-1&2, HYBACS 2009-2017
- GCC Funding for Expansion in 2012
- Feasibility Study completed 2013
- Tender Documents Expansion Phase 4 completed 2014
- PQ and Stakeholder Approvals 2015
- Tender published and tendering 2016
- Tubli STP Expansion Phase 4 Award Dec. 2017
- Expansion Completed 2021
Tubli WPCC
Expansion Project

Expansion Area
Tubli WPCC Expansion Project – Feasibility Study

Cost Comparison of all major WWTP options with sludge incineration

- CAS - UF - incineration
- MBR - int. - incineration
- SBR - UF - incineration
- CAS - sand filt. - incineration
- SBR - sand filt. - incineration

Legend:
- Orange: Sea Outfall
- Blue: Auxiliary
- Red: Sludge
- Green: Tertiary
- Purple: Biology
- Brown: Inlet
Tubli WPCC Expansion Project

- Sludge Treatment/Incineration
- Secondary Treatment SBR
- Tertiary Treatment New
- Tertiary Treatment Old
- Secondary Treatment Old Clarifiers
- Secondary Treatment Old Bio-Reactors
- Old Inlet Works: DEMOLISH
- New Inlet Works
- Hybacs
Sludge Dewatering, Drying and Incineration:

- Plant capacity: 118 t DS / d
- Solid content raw sludge: 0.8 % DS
- Raw sludge flow: 615 m³/h
- (Thickening by Micro-floatation: 1 line)
- Dewatering by centrifuges: 6 lines
- Solid content after dewatering: > 24 %
- Partial drying for autothermal incineration: 2 lines
- Solid content after drying: app. 38% DS
- Incineration in fluidized bed incinerators: 2 lines
- Steam turbine for electrical power generation
Tubli WPCC Expansion Project
Sludge Treatment – Process Overview
Tubli WPCC Expansion Project
Sludge Treatment – Process Step: Partial Drying

Main equipment:
- Dryers: 2
- Type: Disc
- Heat medium: steam
- Evaporation: > 4,500 kg / h
- Disc surface: > 300 m²
- Solid content inlet: > 24 % DS
- Solid content outlet: > 38 % DS
- Steam boiler: 1
- Capacity: app. 4 MW
- Steam pressure range: 6 – 10 bar
- Specific water evaporation: 15 kg /m² at 10 bar

Steam Dryers to utilise excess heat from incinerator flue gas

Source: haarslev.com
Main equipment:

- Incinerator: 2
- Type: Fluidized bed
- Capacity sludge: 59 t DS / d (each)
- Inlet DS: approx. 38% DS
- Heating-up burning chamber: 2
- Fluidized air fan: 2
- Waste steam boiler: 2
- Steam pressure (minimum): 40 bar

Exhaust Heat from flue gas will be utilised for drying and power generation
Main equipment:

- **Boiler:** 2
- **Type:** Horizontal / vertical
- **Pressure level:** 40 bar
- **Temperature:** 400 °C
- **Turbine:** 1
- **Type:** backpressure steam
- **Generator:** 1
- **Capacity:** 1.7 MW
- **Power Generation:** 40 MWh/d, 15 GWh/a

Exhaust Heat from flue gas will be utilised for drying and power generation
Tubli WPCC Expansion Project
Energy Balance

**Total Tubli WPCC:**
- Demand Load: 30 MW
- Power Consumption: 380 MWh/d
- Power Generation: 40 MWh/d
- Covers 10.5% of Demand
- Covers 12% of STP Demand (without inlet LS)
- Covers up to 16% of STP Demand after rehabilitation of ex. STP (replace aeration, add. filtration, reduced Ozonation)

**Demand SIP:**
- ~21 MWh/d

**Output:**
- ~40 MWh/d

SIP Produces about 2 times Power it consumes
Discover Sewage Sludge as a Resource not a Waste Product
  ⇒ Sludge is an Energy Source

Diversify sludge treatment and reuse options
  ⇒ Stop landfill disposing of dewatered/ dried sludge

Implement sustainable sludge management strategies
  ⇒ Safe reuse in agriculture & landscaping
  ⇒ Sustainable reuse:
    • as Fertilizer,
    • in Construction, as ad-mixture in concrete, asphalt, etc.
  ⇒ Maximise energy recovery
  ⇒ Nutrient/ Phosphorus recovery
Vielen Dank  Thank you  谢谢  Merci  شكراً