Opportunities to tackle the full potential of wastewater

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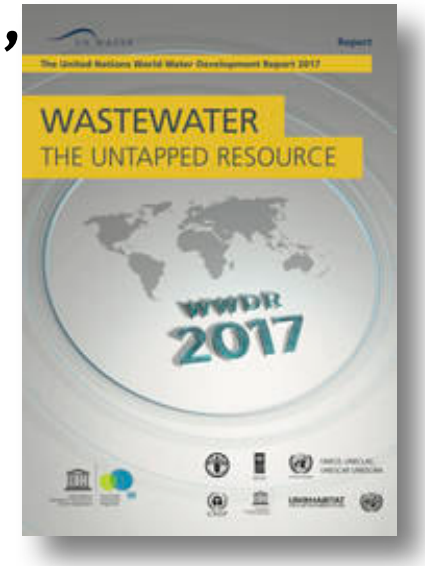
BLUE PLANET Berlin Water Dialogues
Wasser Berlin, 30 March 2017

Paradigm Shift – Wastewater is Part of the Solution

Paradigm shift from 'treatment and disposal' to 'reuse, recycle and resource recovery'



United Nations

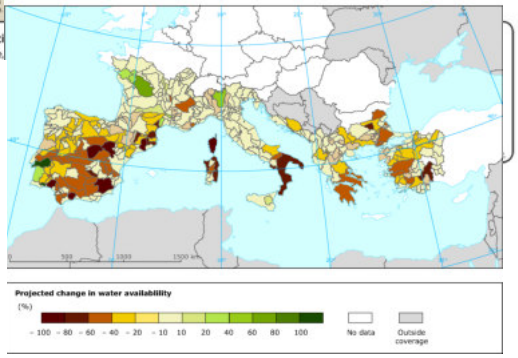
EU Circular Economy

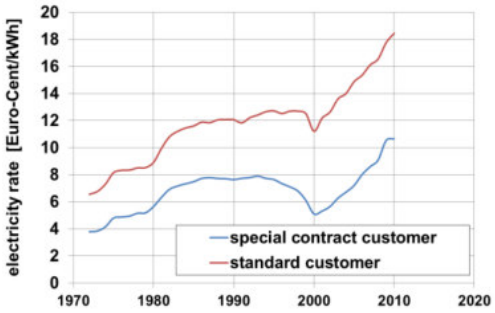
International Water Association (IWA)

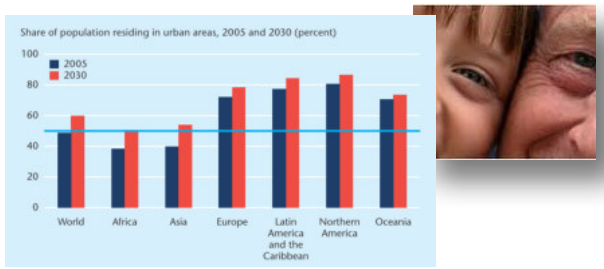
IWA WATER REUSE
the international water association

Challenges ahead

- Aging and failing infrastructure
- Water resource availability/scarcity
- Climate change impacts/variability
- Energy requirements
- Demographic changes
- New contaminants in the environment







Attributes of “modern” Water Supply and Sanitation

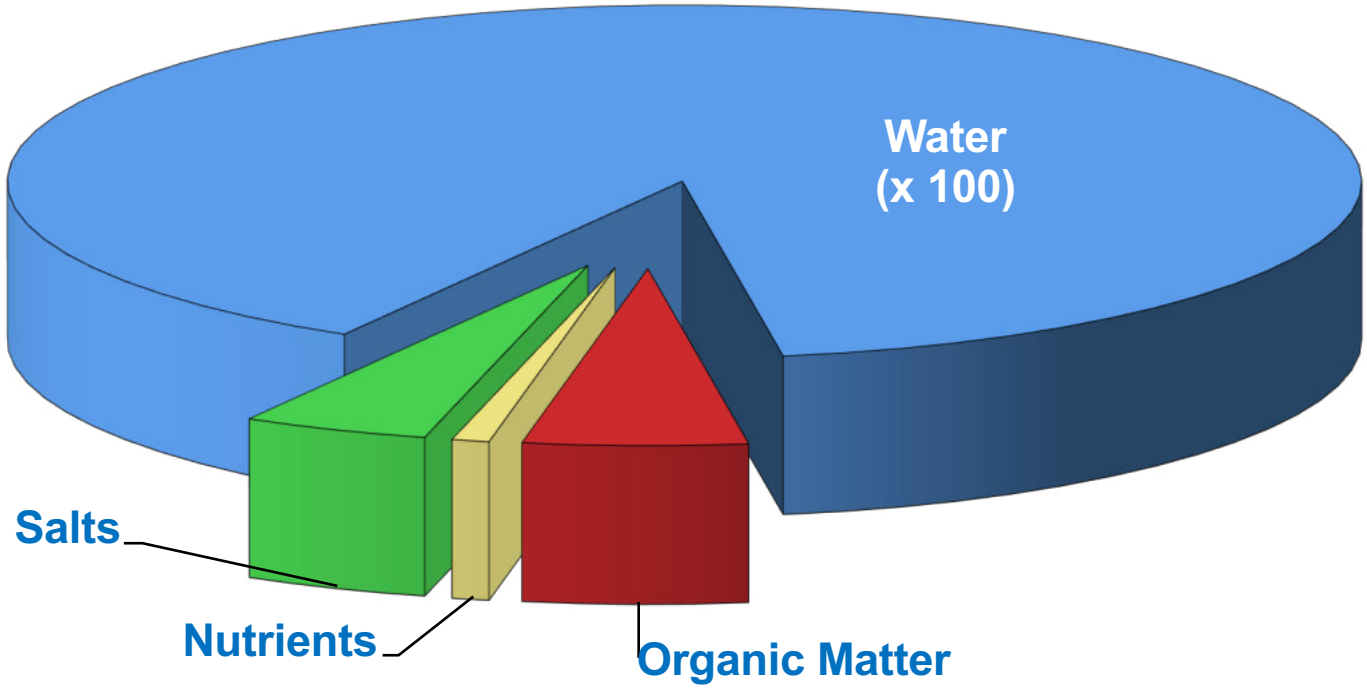
- Reliance on imported water
- Water is used once
- Energy has traditionally not been a key driver in design
- Discharge to receiving streams

Source: wasserfluesse.de; swm.de

What's in Wastewater?

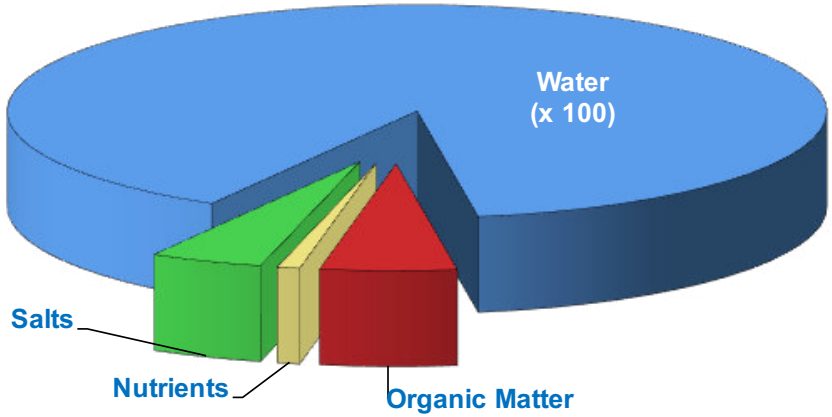
Source: Pituka.ch; huber.de

What is in Wastewater?



Source: Prof. Jürg Keller, University of Queensland, Australia

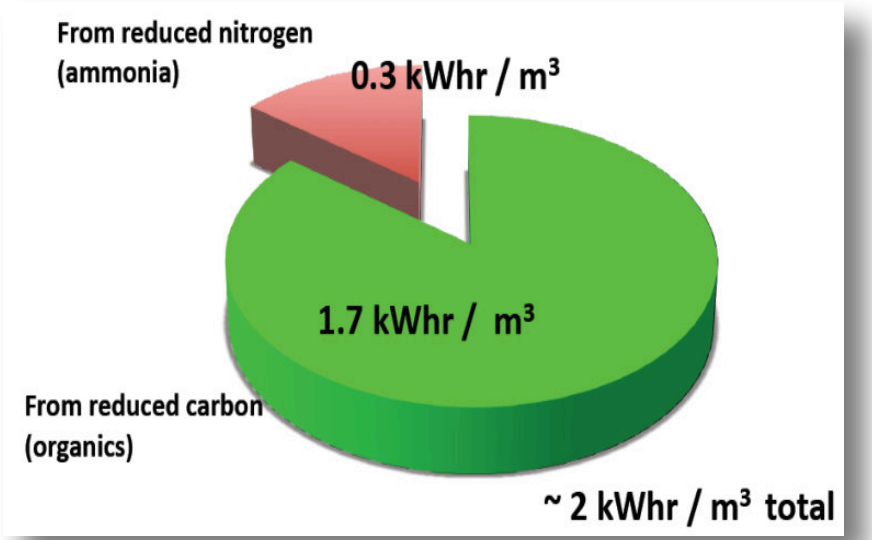
Used Water as a Resource



Water Recycling

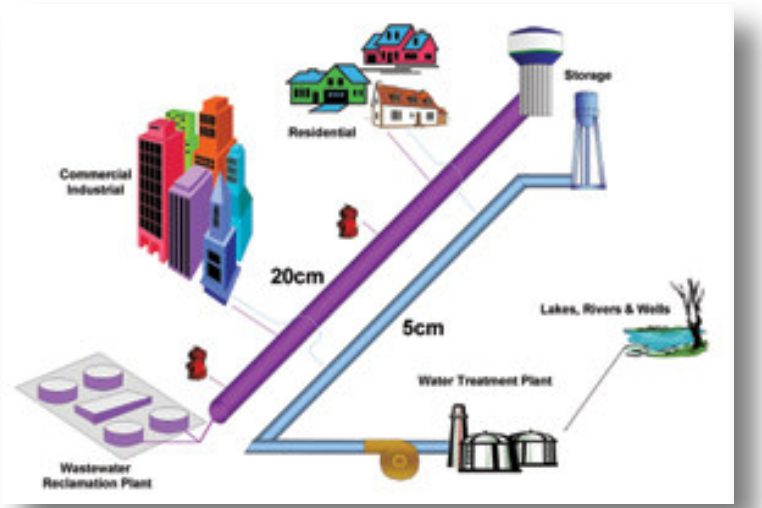
Nutrients

Bio-Energy



Evolution of Water Reclamation and Reuse

- Water reuse was added to the mix, usually as an afterthought

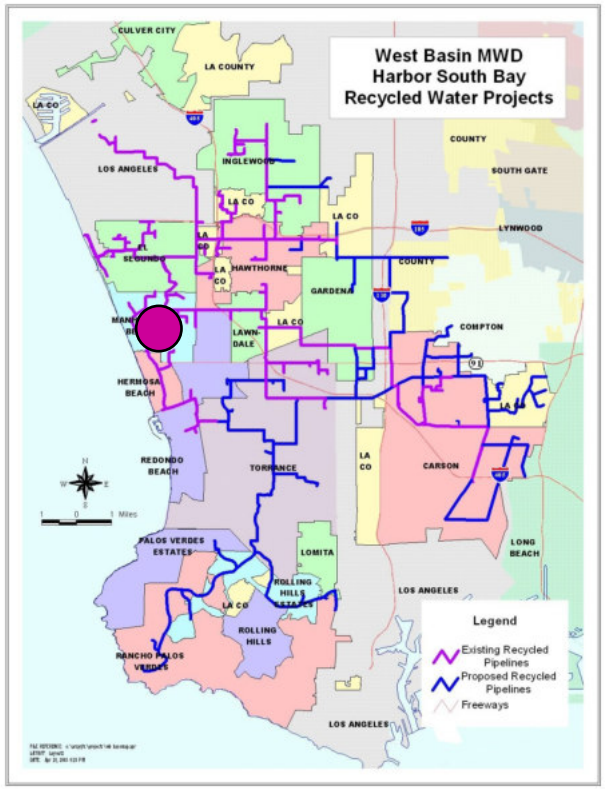


- Large reuse customers preferred
- Construction/expansion of dual-distribution systems is expensive
- Wastewater treatment plants were not intended for reuse
- One effluent quality limits type of reuse

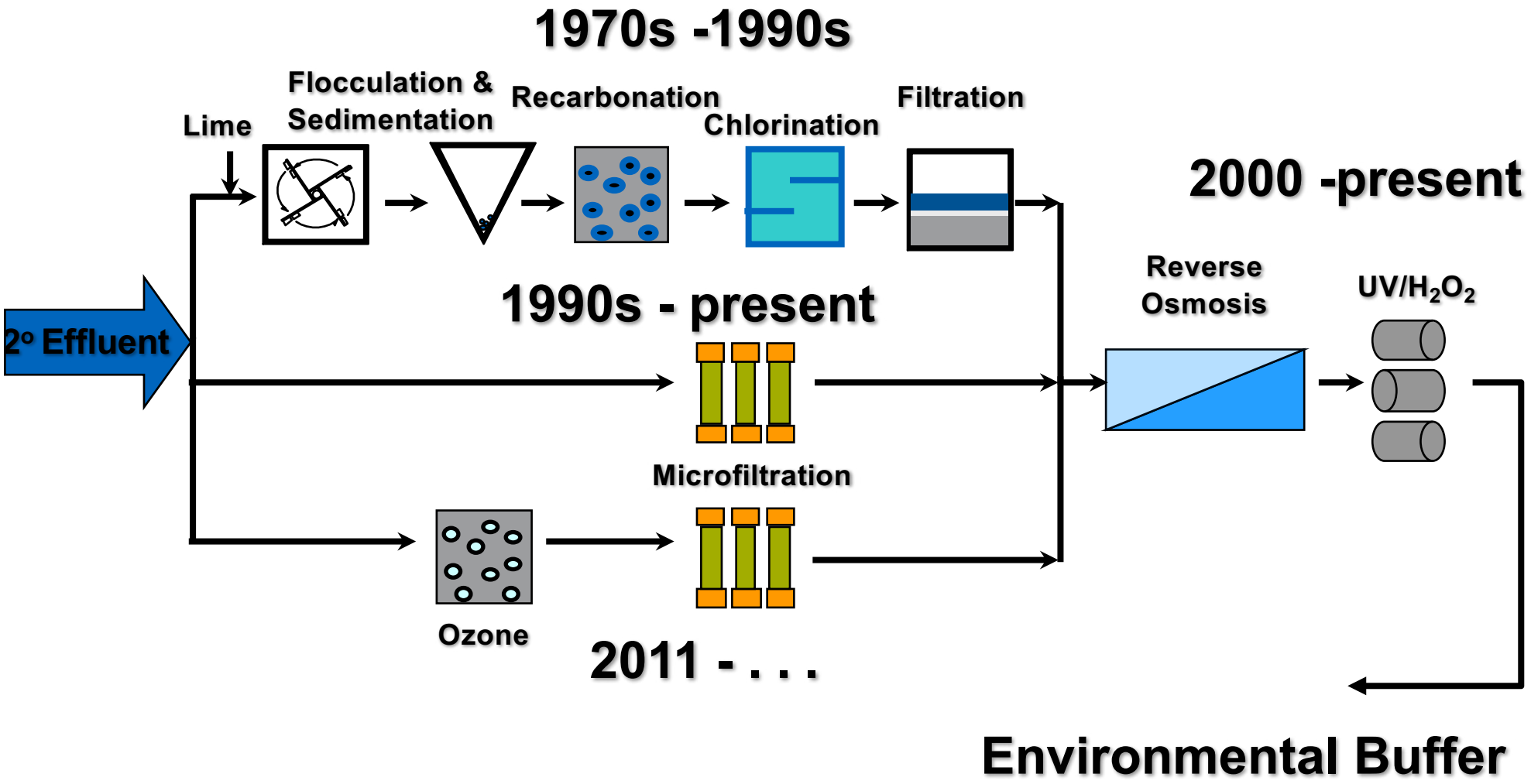
Diversifying Reuse Portfolios: Fit for purpose

- West Basin Municipal Water District, California, USA

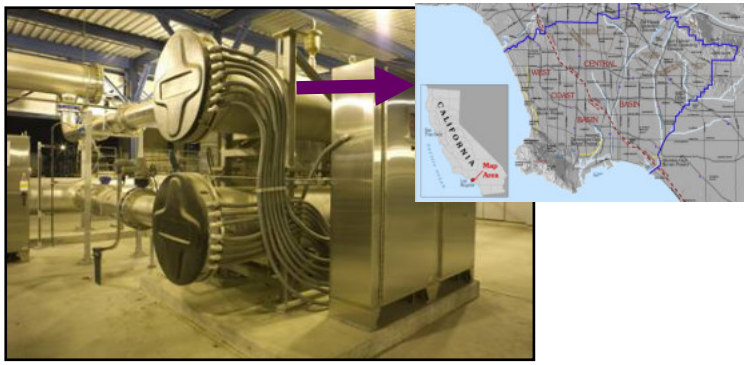
Edward C. Little Water Recycling Facility (47,000 m^3/d)



West Basin Municipal Water District - Advanced Treatment Evolution



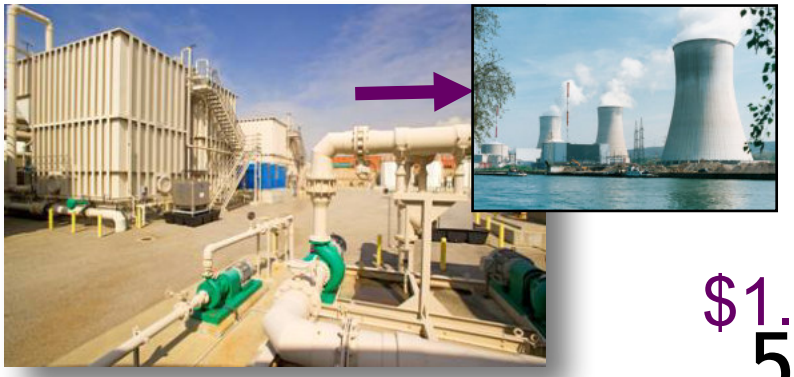
"Designer Waters" at West Basin MWD



3
Reverse Osmosis: Barrier Water

$0.84/m³
1
Tertiary Water

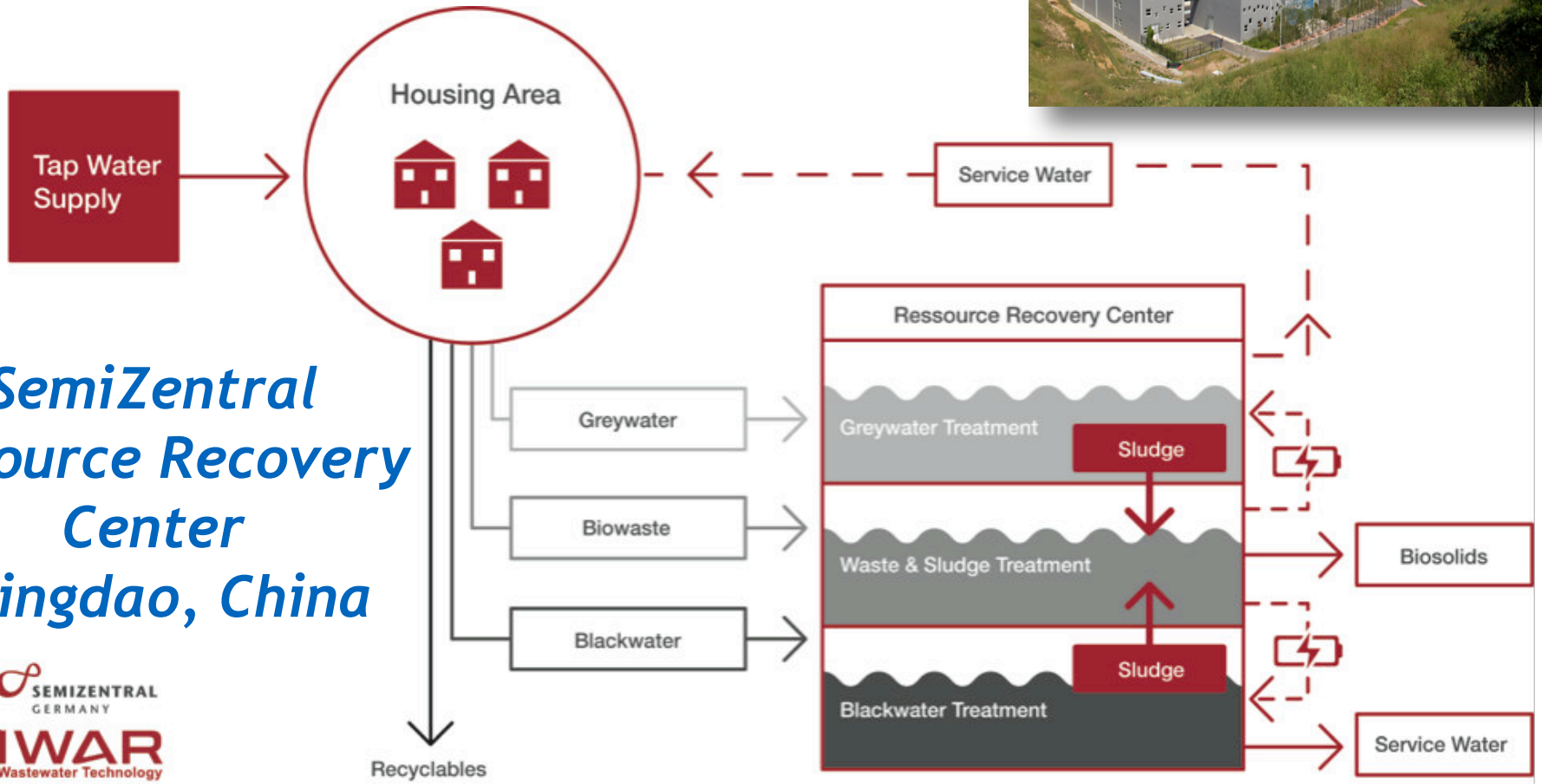
4
Reverse Osmosis: Single Pass



2
Nitrified Water

$1.58/m³
5
Reverse Osmosis: Double Pass

Water Systems at a Neighborhood Scale: Fit for purpose

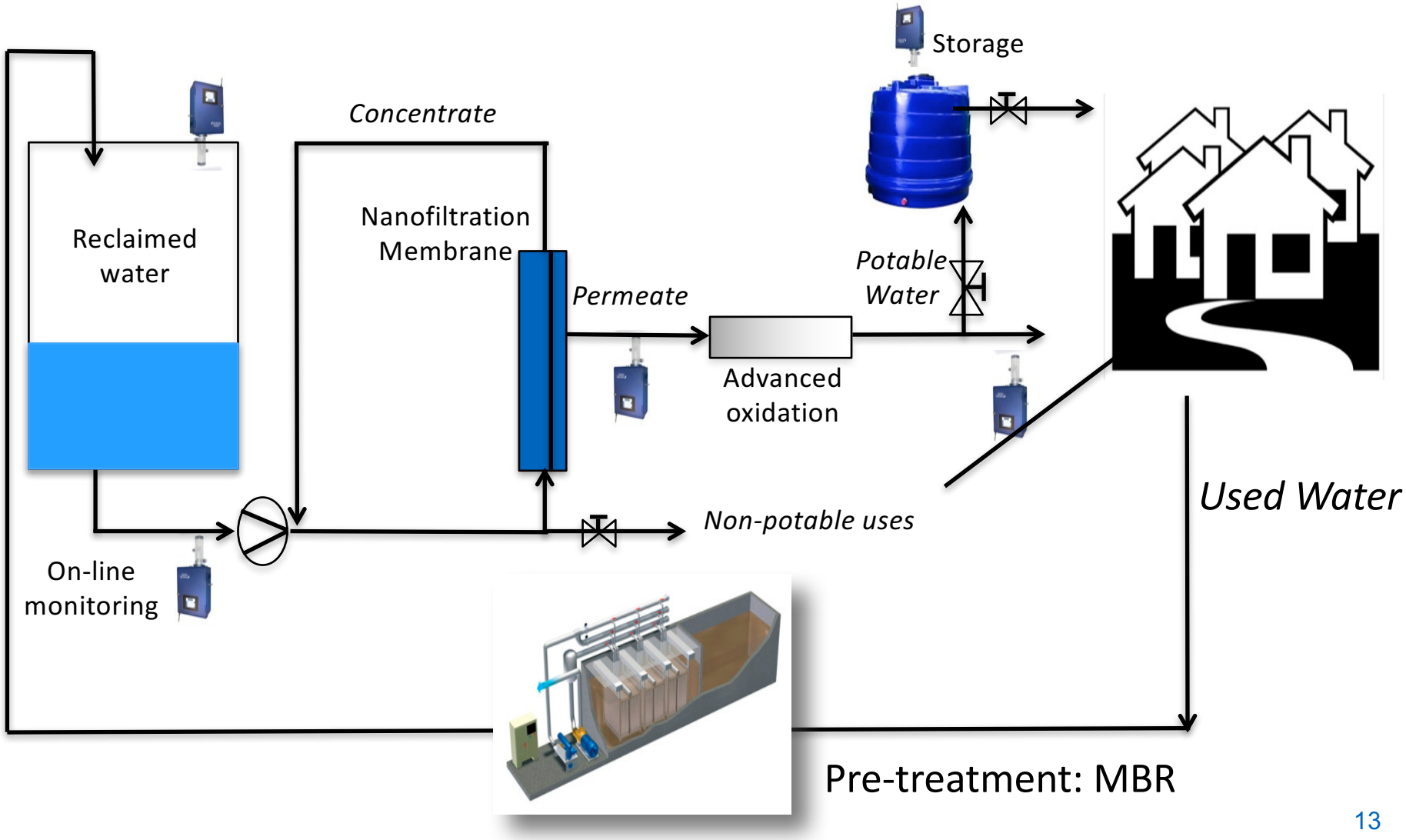


SemiZentral Resource Recovery Center Qingdao, China

SEMIZENTRAL GERMANY
IWAR Wastewater Technology

Source: Tolksdorf & Bieker (2016)

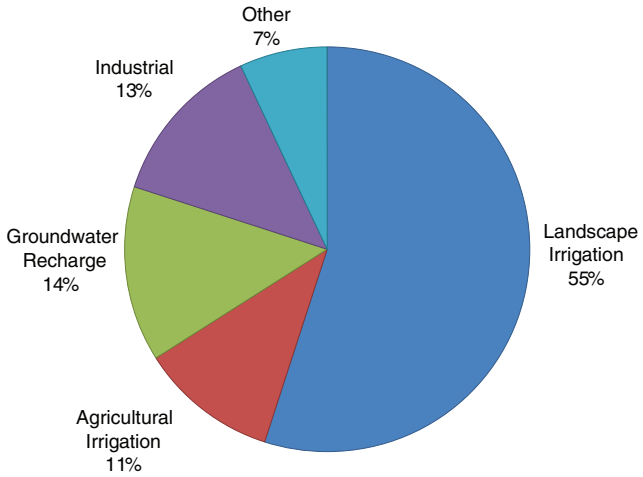
Water Systems at a Building Scale: Fit for purpose



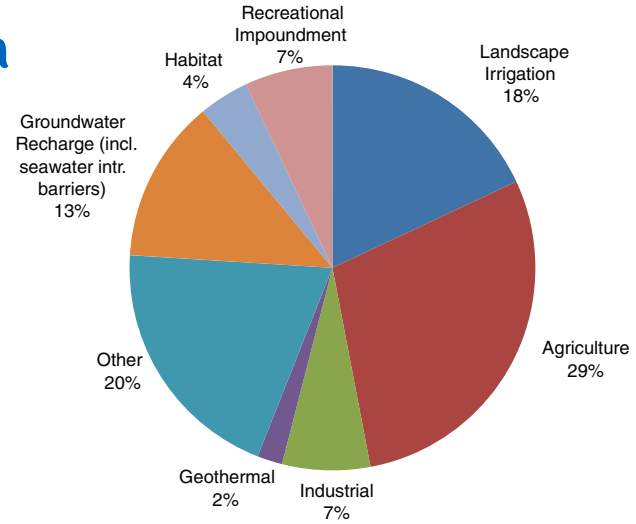
Water Reuse in the USA widely accepted

- 43 of the 50 U.S. states are practicing water reuse

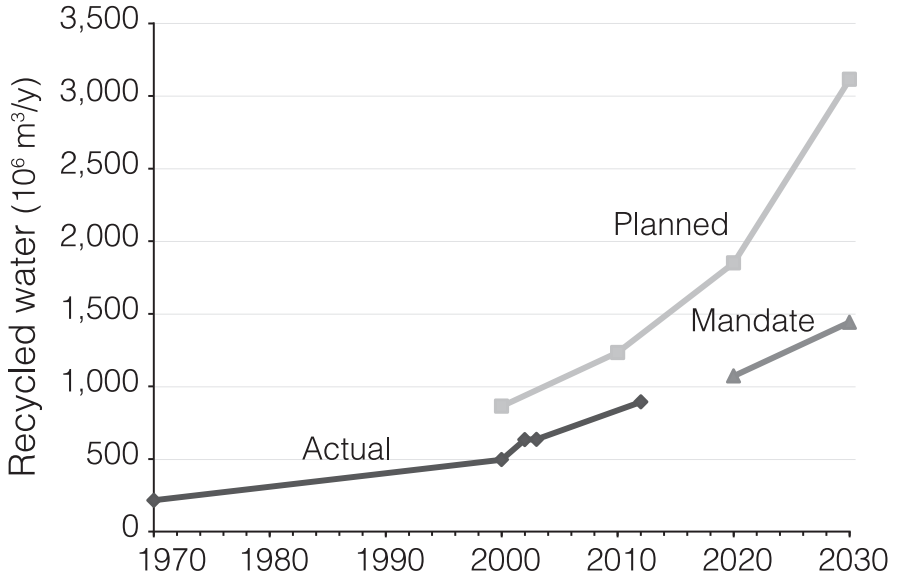
Florida



California



California Recycled Water Policy



Source: National Research Council (2012); Harris-Lovett and Sedlak (2015)

Water Reuse in Europe

European Union

- Current water reuse, approximately **1.1 billion m³/a**
  (<3% of the total volume of wastewater generated)
- Growth projection until 2025: approx. **3.2 billion m³/a**
- Beside Spain, biggest reuse potentials in Italy, Germany, France, Portugal, and Greece

Spain

- Current water reuse, approx. **0.55 billion m³/a**;
  goal until 2018: **1.2 billion m³/a**
- Since 2007, **national standards** for various reuse practices
- Supplemented by **National Plan** to foster water reuse

Source: Bio by Deloitte (2013)

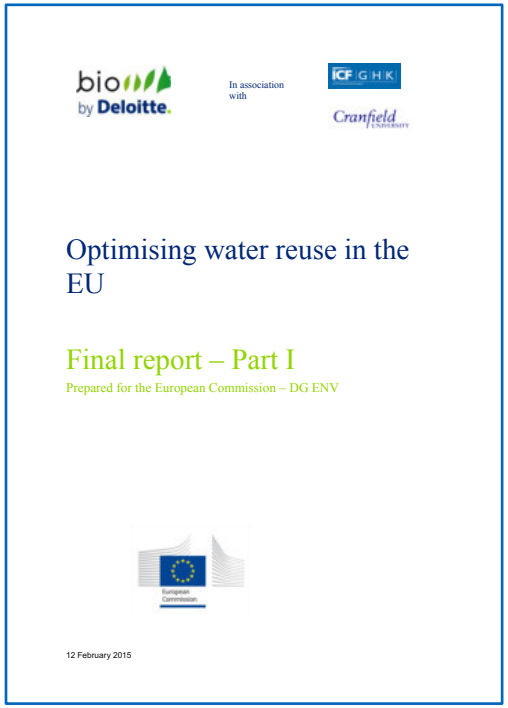
EU Minimal Requirements for Water Reuse

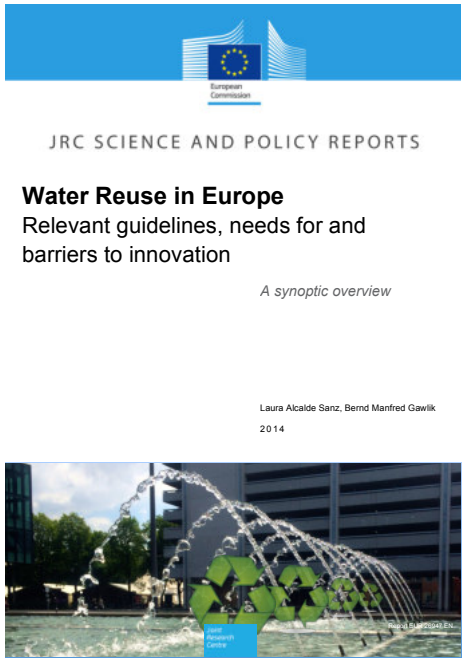
- Agricultural irrigation
- Groundwater recharge (indirect potable reuse)

Development of minimum quality requirements for water reuse in agricultural irrigation and aquifer recharge

Draft V.3.1
October 2016

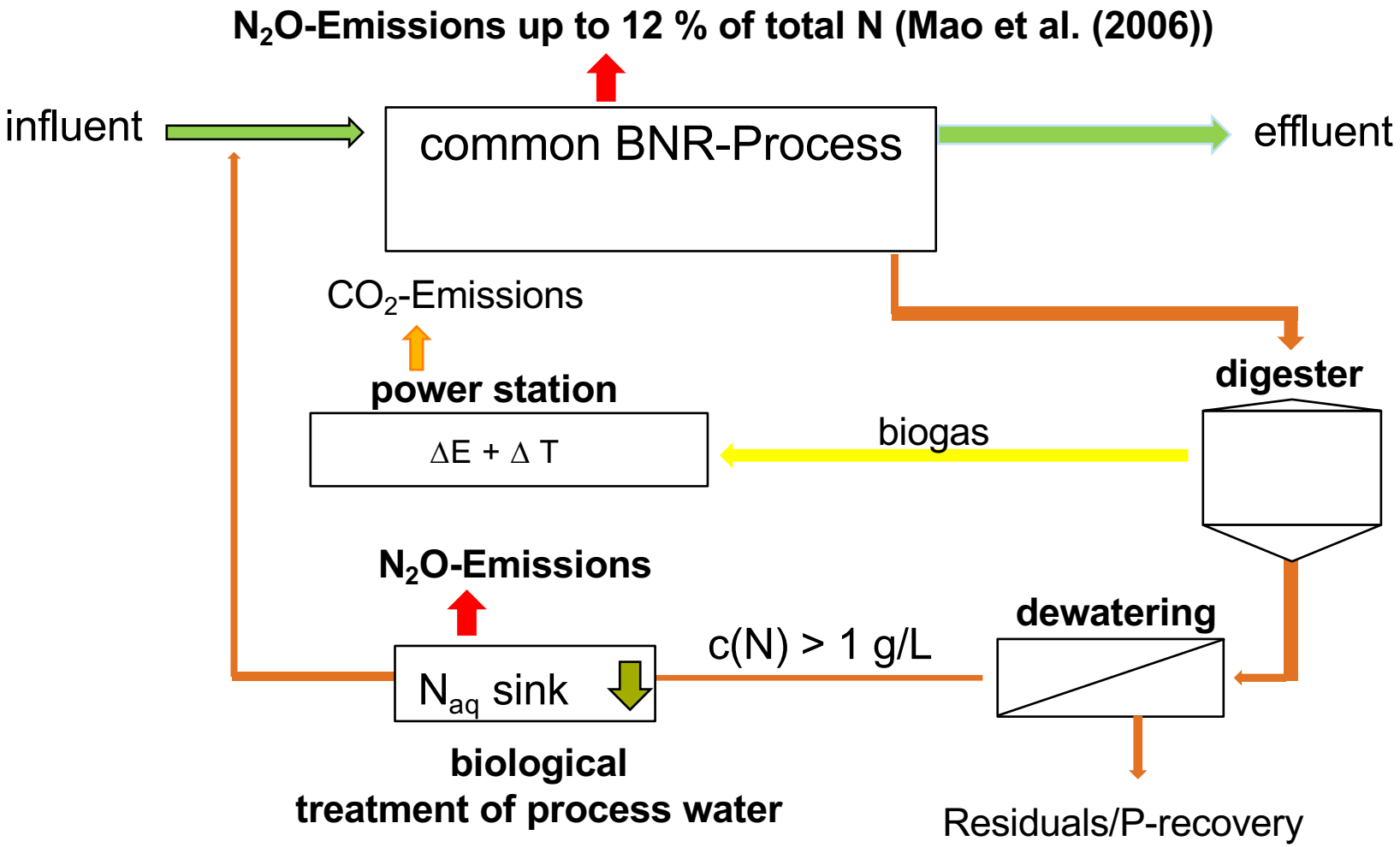
NOTE
This document is a living document and will be updated to take account of experiences and information from the Member States, from MS competent authorities, and other stakeholders.





Present Situation of Conventional WWTPs

Conventional process scheme with process water treatment



N_2O – an Additional Energy Source?

Approach

- Energy recovery by intentional N_2O generation and subsequent combustion:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O, \qquad \Delta H°_R = -890 \text{ kJ mol}^{-1}$$

$$CH_4 + 4N_2O \rightarrow CO_2 + 2H_2O + 4N_2, \qquad \Delta H°_R = -1219 \text{ kJ mol}^{-1}$$

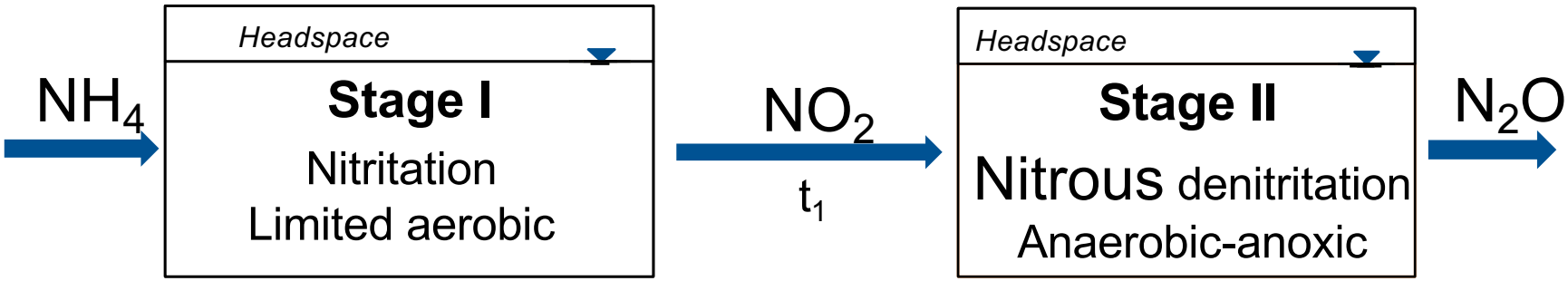
- Theoretical energy output 329 kJ mol^{-1} higher for the same O/N stoichiometry due to exthermal N_2O decomposition

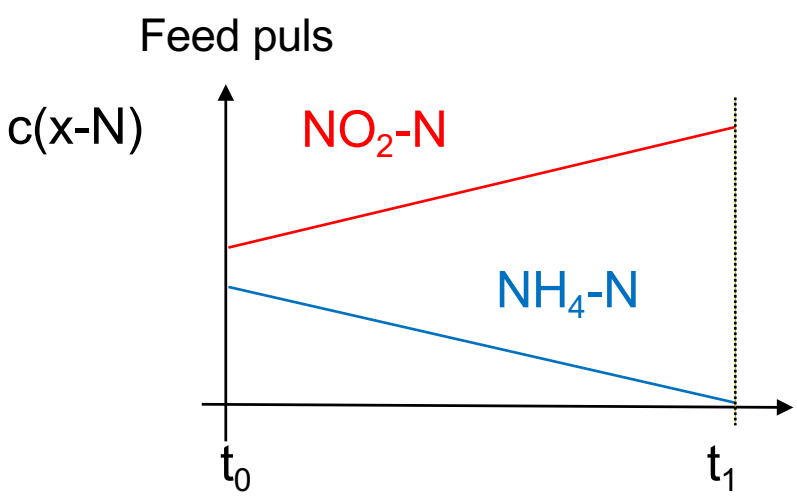
- Scherson et al. (2013) already demonstrated the possibility of intentional N_2O generation in a BNR process known as **C**oupled **A**erobic-anoxic **N**itrous **D**ecomposition **O**peration (CANDO)

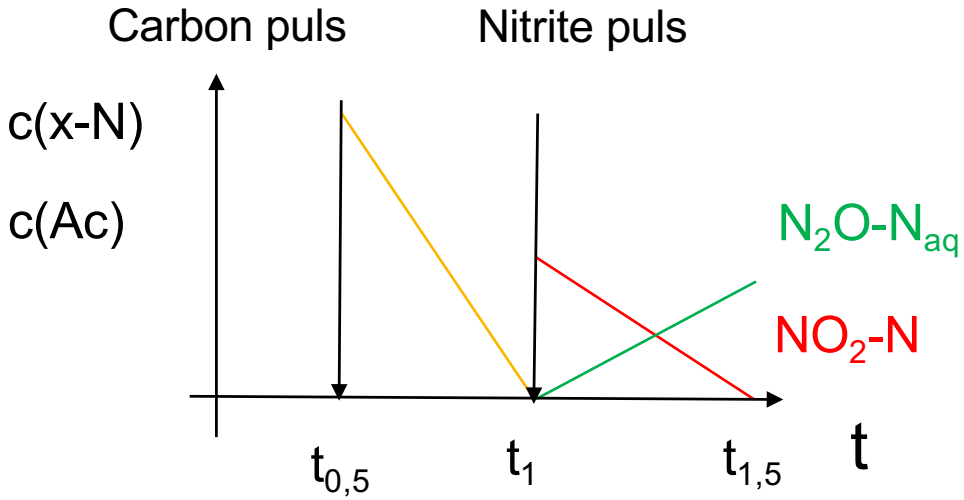
The CANDO Process

CANDO process operation scheme

- Reactors run in sequencing batch mode

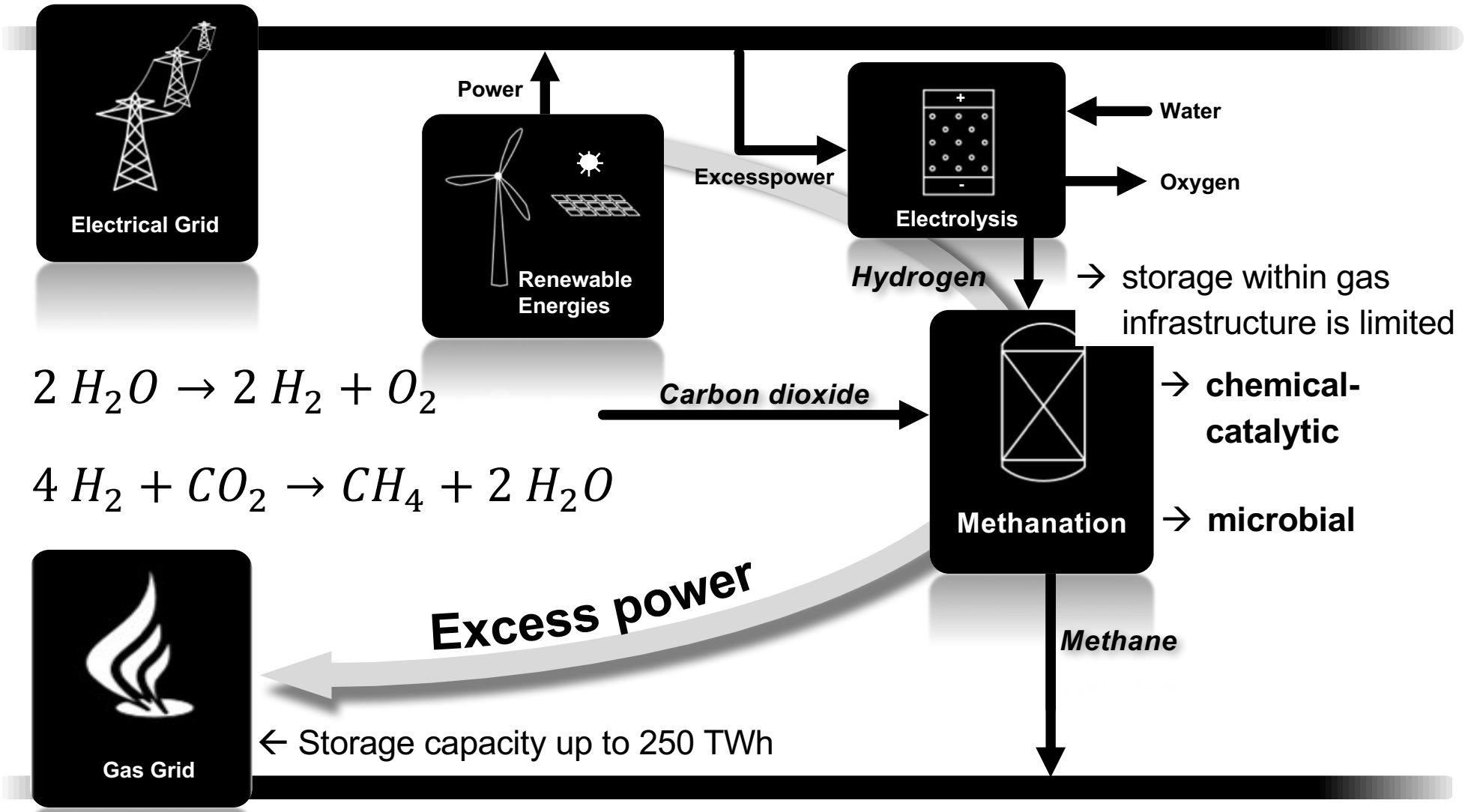




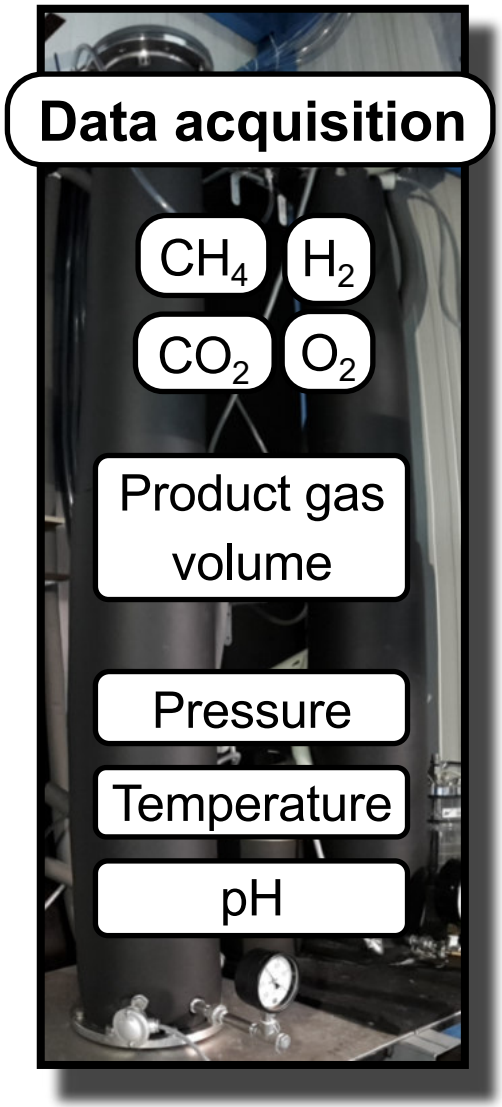


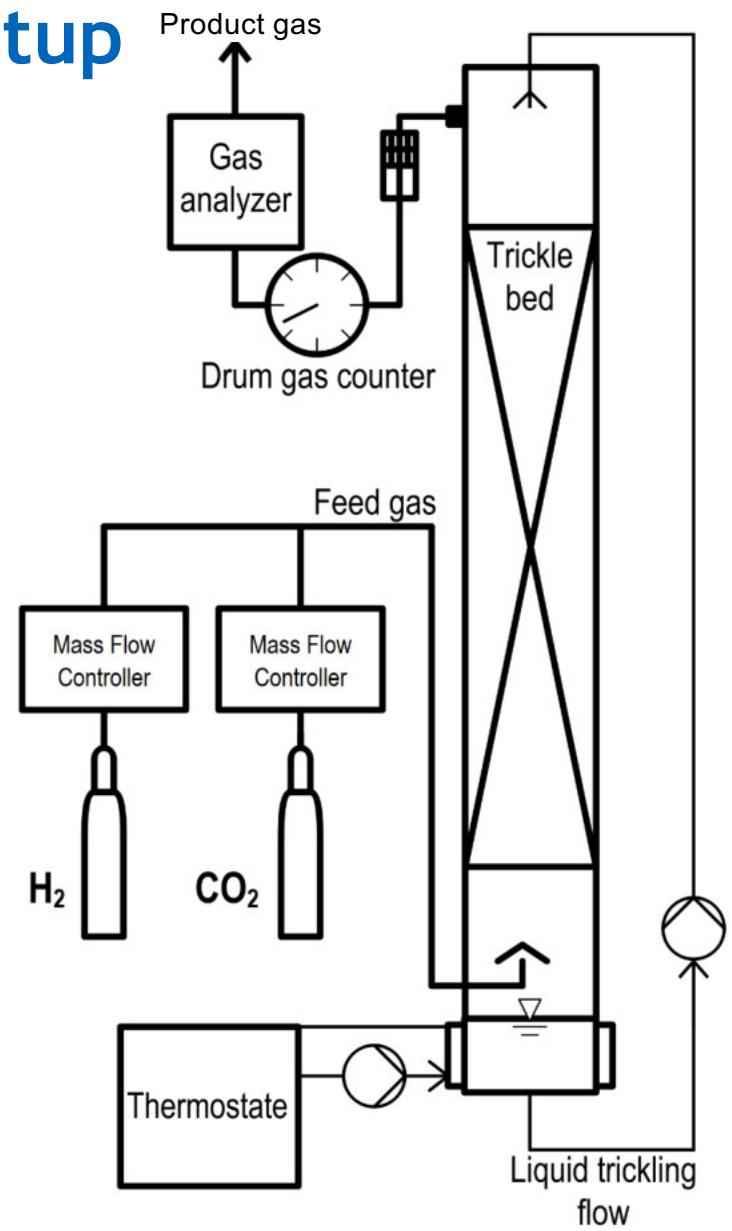
Modified according to Scherson et al. (2013)

Energy Transition: Power-to-Gas



Experimental setup





Trickle bed: 58 L

Height / Diameter: 7.4

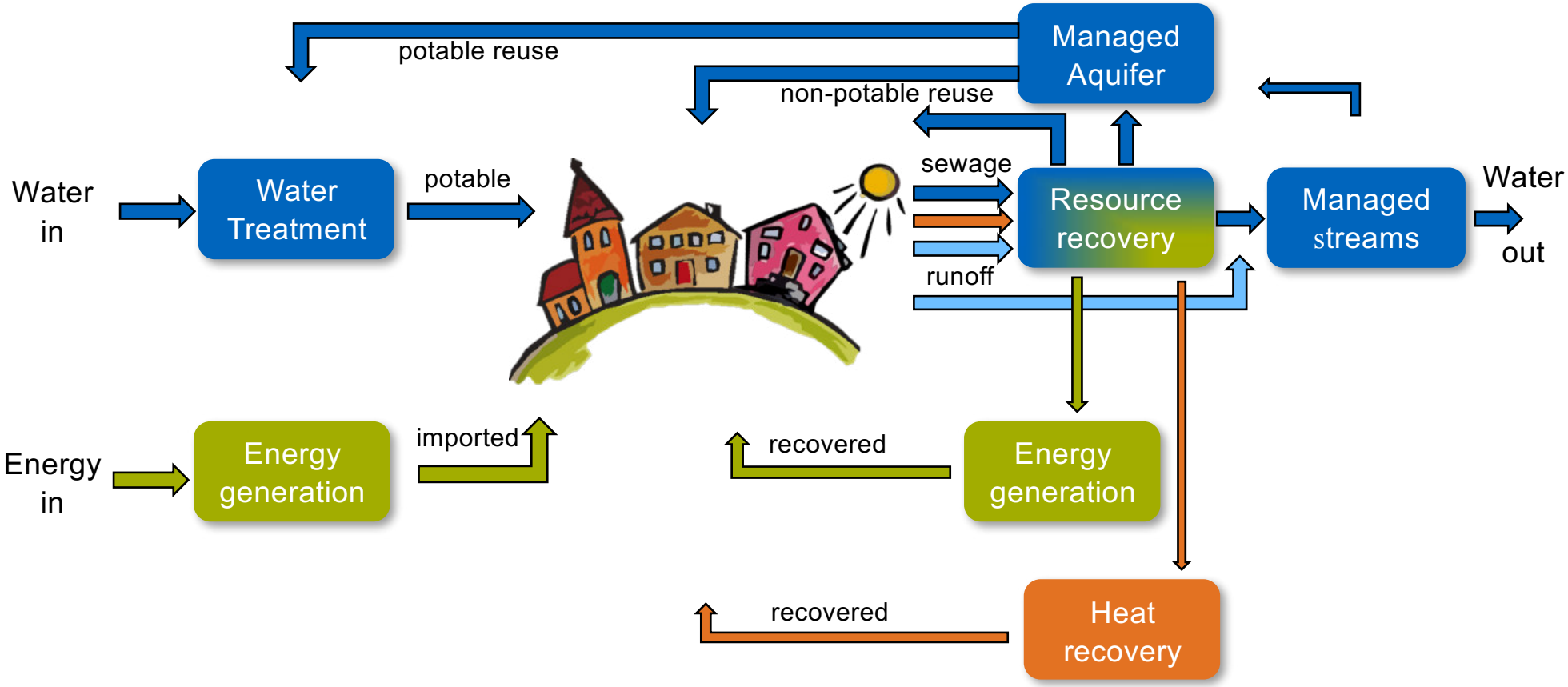
Process conditions

1 bar

55°C

pH 6.5 - 7.5

Water in Cities of the Future:
Towards an Integrated Urban Water/Energy Management Concept



Source: Drewes & Horstmeyer, Österr Wasser- und Abfallw (2016) 68:99–107

Water in Cities of the Future:
Towards an Integrated Urban Water/Energy Management Concept

- Plan, design and operate from a system perspective to utilize synergies and full potential of resource recovery

- Scale of operation will depend on local conditions and available markets
- Need for adopted and new regulations and requirements for procurement to facilitate water reuse and resource recovery including legislation on quality standards for products
- New business models and opportunities for water utilities
- For a contemporary wastewater management, appropriate levels of human capacity need to be in place
- Organizational and institutional capacity in the wastewater management sector needs to adjust to new solutions
- Education of future engineers and scientists needs to embrace the resource recovery concept

Thank you!

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