



University of Natural Resources and  
Life Sciences, Vienna  
Department of  
Water, Atmosphere, and Environment

# Small WWTPs -

## Treatment technologies and their performance

**Günter Langergraber**

Institute of Sanitary Engineering and  
Water Pollution Control

Rural Wastewater Treatment Workshop

19+20 January 2021

# Content

- Introduction
- Overview of technological solutions
- Performance of small WWTPs < 50 PE
  - Case study Upper Austria
- Other possible solutions
- Summary

# Introduction

## Small WWTPs – characteristics / requirements

### Characteristics

- highly fluctuating wastewater flows, and high concentrations of the wastewater constituents with high fluctuations.
- additionally only few trained personal is available to operate wastewater treatment plants

### → General requirements for small WWTPs

- simplicity of the technology,
- simple operation and maintenance,
- high robustness,
- large volume, to buffer the high fluctuations of flow and concentrations,
- high stability, and
- low sludge production

# Overview of technological solutions

## For secondary treatment

### Intensive treatment systems

- Technologies with fixed biomass
  - **Trickling filter**
  - **Rotating biological contactor**
  - Soil filter
  - etc.
- Technologies with suspended biomass
  - **Conventional activated sludge**
  - **SBR** (Sequencing Batch Reactor)
  - **MBR** (Membrane BioReactor)
  - etc.

### Extensive treatment systems

- **Treatment wetlands**
- Waste stabilization ponds

# Performance of small WWTPs < 50 PE

## Wastewater treatment in Austria - Basic data

Capacity (PE)	Number of WWTPs	%	Design load (million PE)	%
<b>51-500</b>	1'040	54	0.18	1
<b>501-5'000</b>	505	26	1.13	5
<b>5'001-50'000</b>	316	16	6.10	28
<b>&gt;50'000</b>	66	4	14.06	66
<b>Total &gt; 50 PE</b>	<b>1'927</b>	<b>100</b>	<b>21.47</b>	<b>100</b>
<b>≤ 50 PE</b>	<b>ca. 27'500</b>	<b>-</b>	<b>0.26</b>	

95.2 % of population connected to WWTPs > 50 PE

Wastewater treatment plants and design load with capacity > 50 PE (ÖWAV, 2019)

ÖWAV (2019): Branchenbild der österreichischen Abwasserwirtschaft 2020 (Sector report of Austrian wastewater management 2020).

Österreichischer Wasser- und Abfallwirtschaftsverband (ÖWAV), Vienna, Austria [in German];

<https://www.oewav.at/Publikationen?current=385139&mode=form>

# Performance of small WWTPs < 50 PE

## Case study Upper Austria

Data provided by the government of Upper Austria

- List of all small WWTPs currently in operation
- Measured data from external monitoring from the period 2009-2018

WWTPs have been grouped according on the main treatment step

- Conventional activated sludge (CAS)
- Sequencing batch reactors (SBR)
- Vertical flow wetlands (VF wetland)
- Trickling filter
- Rotating biological contactor (RBC)
- Membrane bioreactor (MBR)
- Soil filter, i.e. Bodenkörperfilter

# Performance of small WWTPs < 50 PE

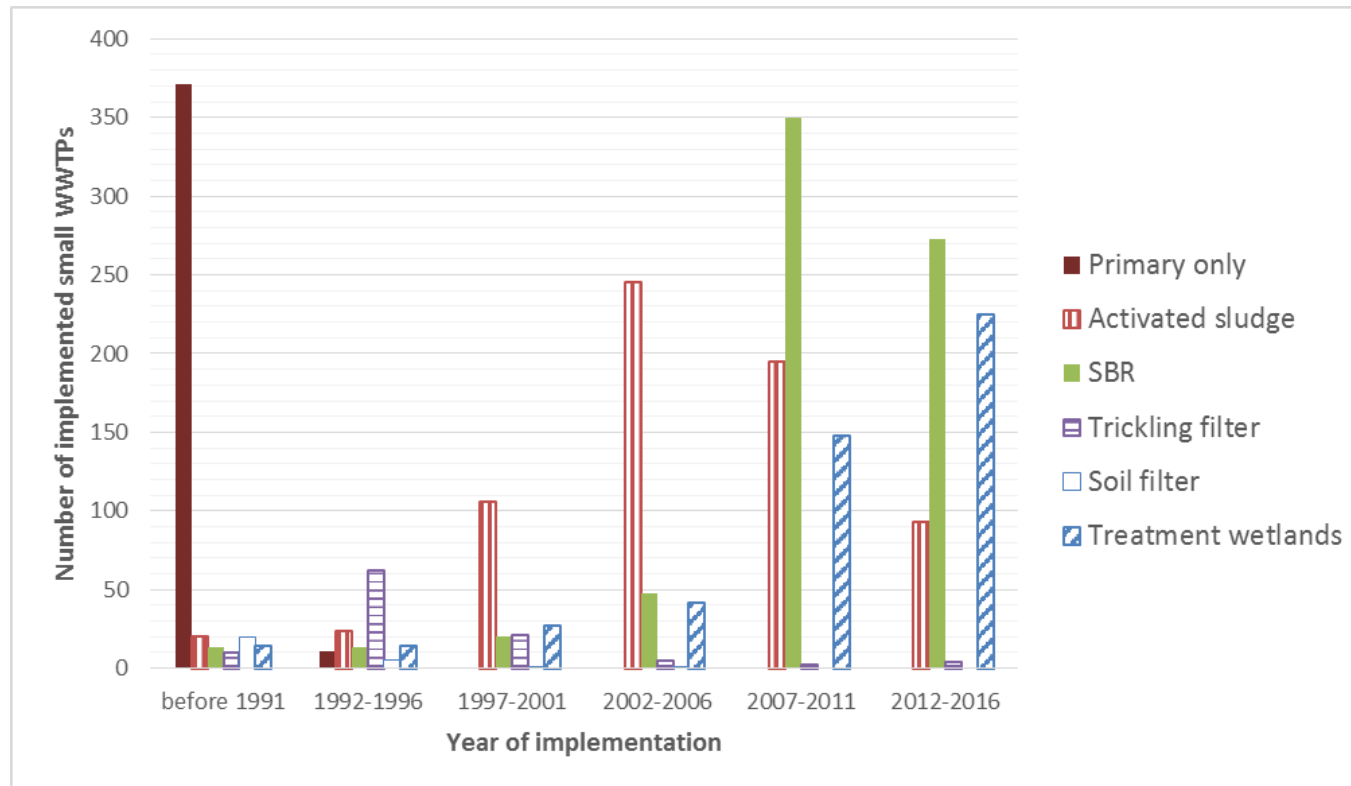
## Number of small WWTPs in Upper Austria

Technology	# 2016
SBR	702
CAS	646
VF wetland	475
Primary treatment only	381
Trickling filter	100
RBC	37
MBR	26
Soil filter	27
Unknown	4
<b>Total</b>	<b>2'398</b>



# Performance of small WWTPs < 50 PE

## Year of commissioning of small WWTPs in Upper Austria



Langergraber, G., Weissenbacher, N. (2017): Survey on number and size distribution of TWs in Austria. *Water Sci Technol* 75(10), 2309-2315.



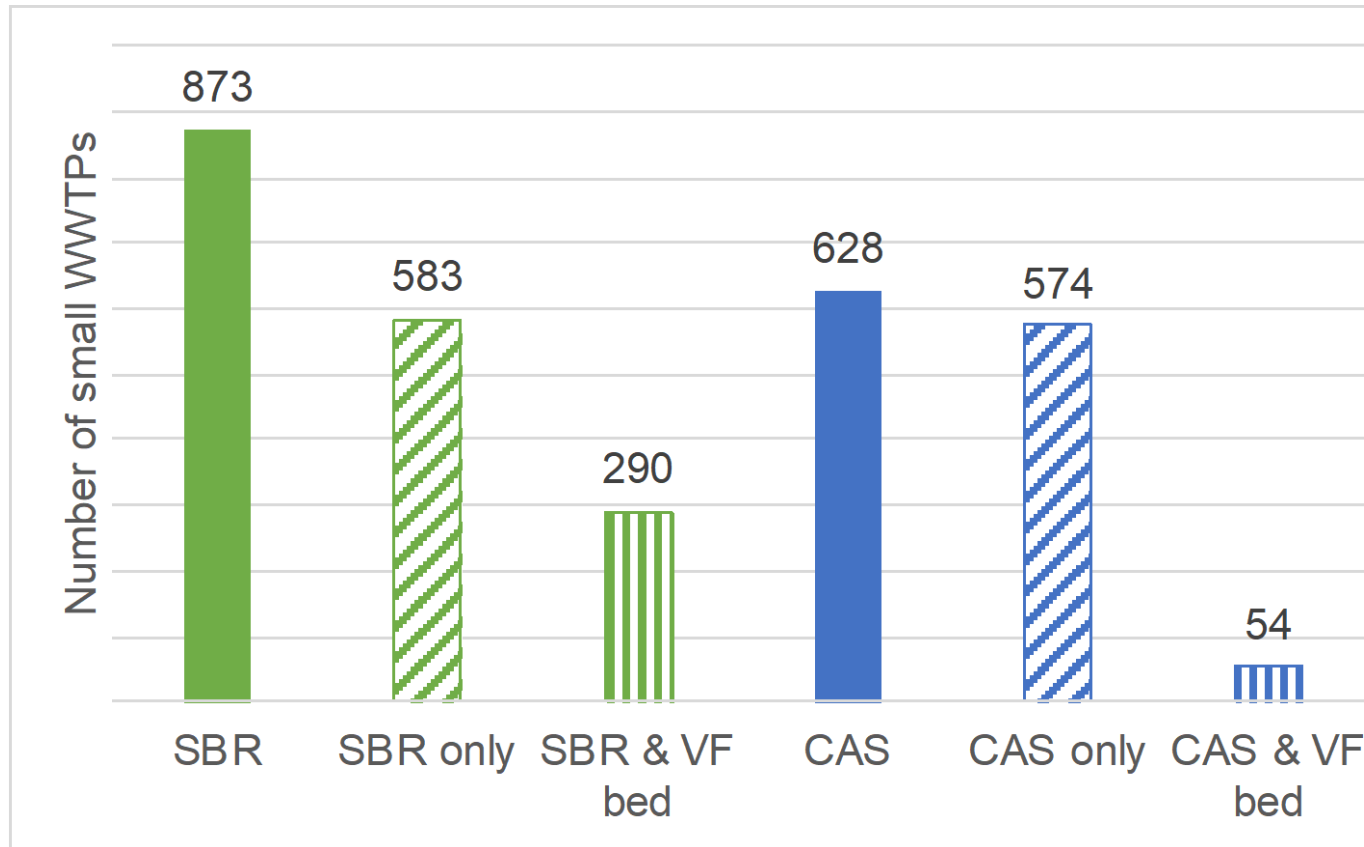
# Performance of small WWTPs < 50 PE

## Number of small WWTPs in Upper Austria

Technology	# 2016	# 2019	Difference
SBR	702	873	171
CAS	646	628	-18
VF wetland	475	535	60
Primary treatment only	381	302	-79
Trickling filter	100	97	-3
RBC	37	37	0
MBR	26	26	0
Soil filter	27	27	0
Unknown	4	1	-3
<b>Total</b>	<b>2'398</b>	<b>2'526</b>	<b>128</b>

# Performance of small WWTPs < 50 PE

## Number of small WWTPs in Upper Austria



# SBR + VF bed (50 PE) in Upper Austria



# Performance of small WWTPs < 50 PE

## Case study Upper Austria

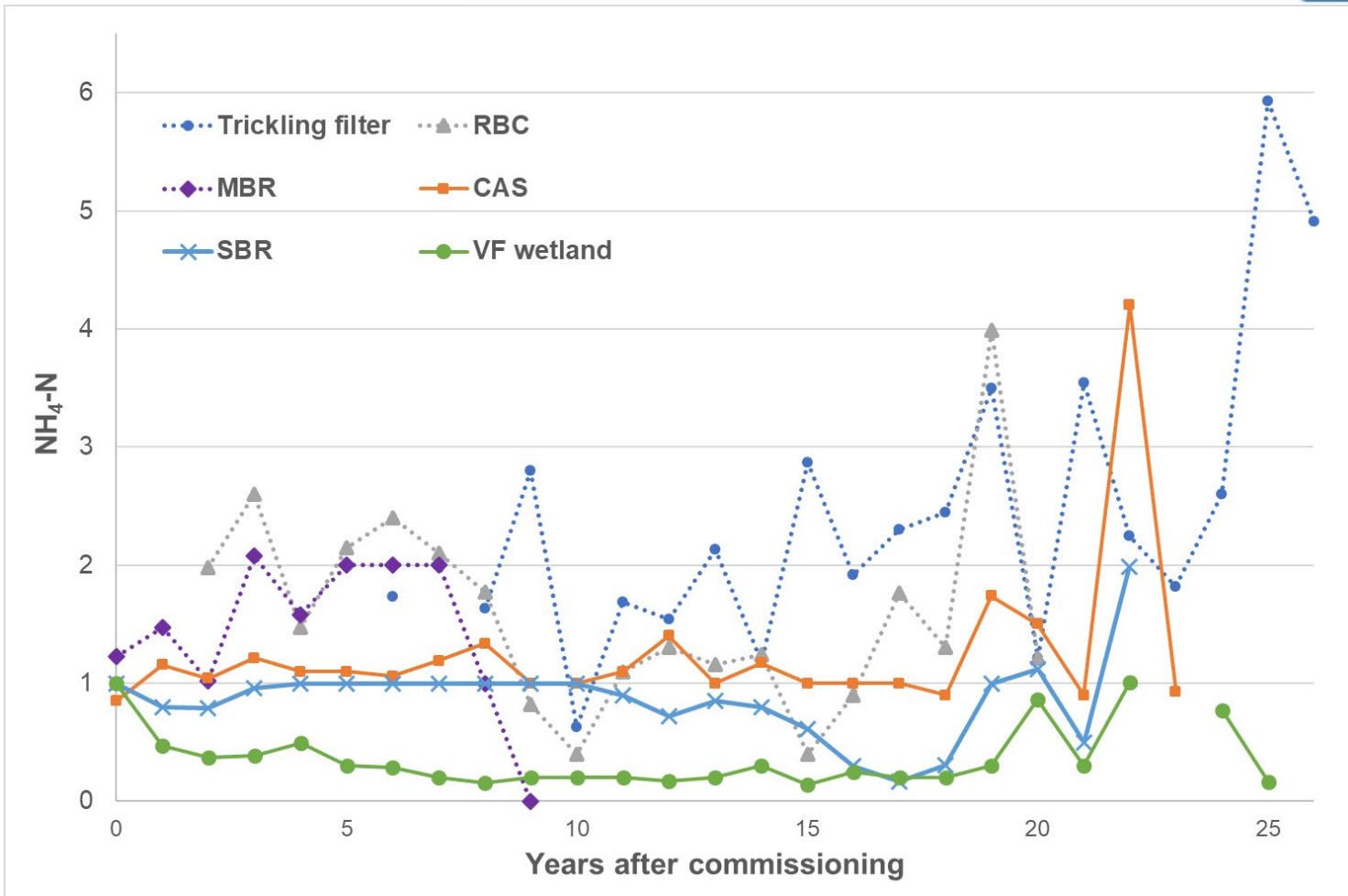
COD	SBR	SBR & VF wetland	CAS	CAS & VF wetland	VF wetland	Trickling filter	RBC	MBR	Soil filter	All data
Number of small WWTPs [ ]	493	252	540	52	491	85	36	25	7	1'981
Number of values [ ]	3'365	1'568	4'406	422	3'245	703	283	185	54	14'231
Values above threshold [ ]	48	7	53	1	4	11	4	0	0	128
[%]	1.4	0.4	1.2	0.2	0.1	1.6	1.4	0.0	0.0	0.9
<b>Median [mg/l]</b>	<b>37</b>	<b>24</b>	<b>35</b>	<b>24</b>	<b>21</b>	<b>44</b>	<b>43</b>	<b>27</b>	<b>33</b>	<b>31</b>
Mean [mg/l]	42	28	41	40	25	47	47	31	34	36
Standard deviation [mg/l]	25	16	38	249	14	22	21	15	14	51
NH4-N	SBR	SBR & VF wetland	CAS	CAS & VF wetland	VF wetland	Trickling filter	RBC	MBR	Soil filter	All data
Number of small WWTPs [ ]	493	252	540	52	491	85	36	25	7	1'981
Number of values [ ]	3'347	1'565	4'382	418	3'199	689	282	184	54	14'120
Values above threshold [ ]	72	13	137	9	48	42	17	6	6	350
[%]	2.2	0.8	3.1	2.2	1.5	6.1	6.0	3.3	11.1	2.5
<b>Median [mg/l]</b>	<b>1.00</b>	<b>0.68</b>	<b>1.09</b>	<b>0.24</b>	<b>0.37</b>	<b>2.20</b>	<b>1.2</b>	<b>1.78</b>	<b>2.66</b>	<b>0.98</b>
Mean [mg/l]	2.43	1.14	2.95	1.54	1.43	4.21	3.48	2.52	4.23	2.31
Standard deviation [mg/l]	5.08	2.35	5.85	4.19	2.91	6.18	6.17	3.99	4.69	4.84

Engstler, E., Kerschbaumer, D., Langergraber, G. (2019): Evaluierung von Kleinkläranlagen anhand der Fremdüberwachungsdaten. *Wiener Mitteilungen* 251, B1-B13.

# Performance of small WWTPs < 50 PE



## Performance related to the age of the plant

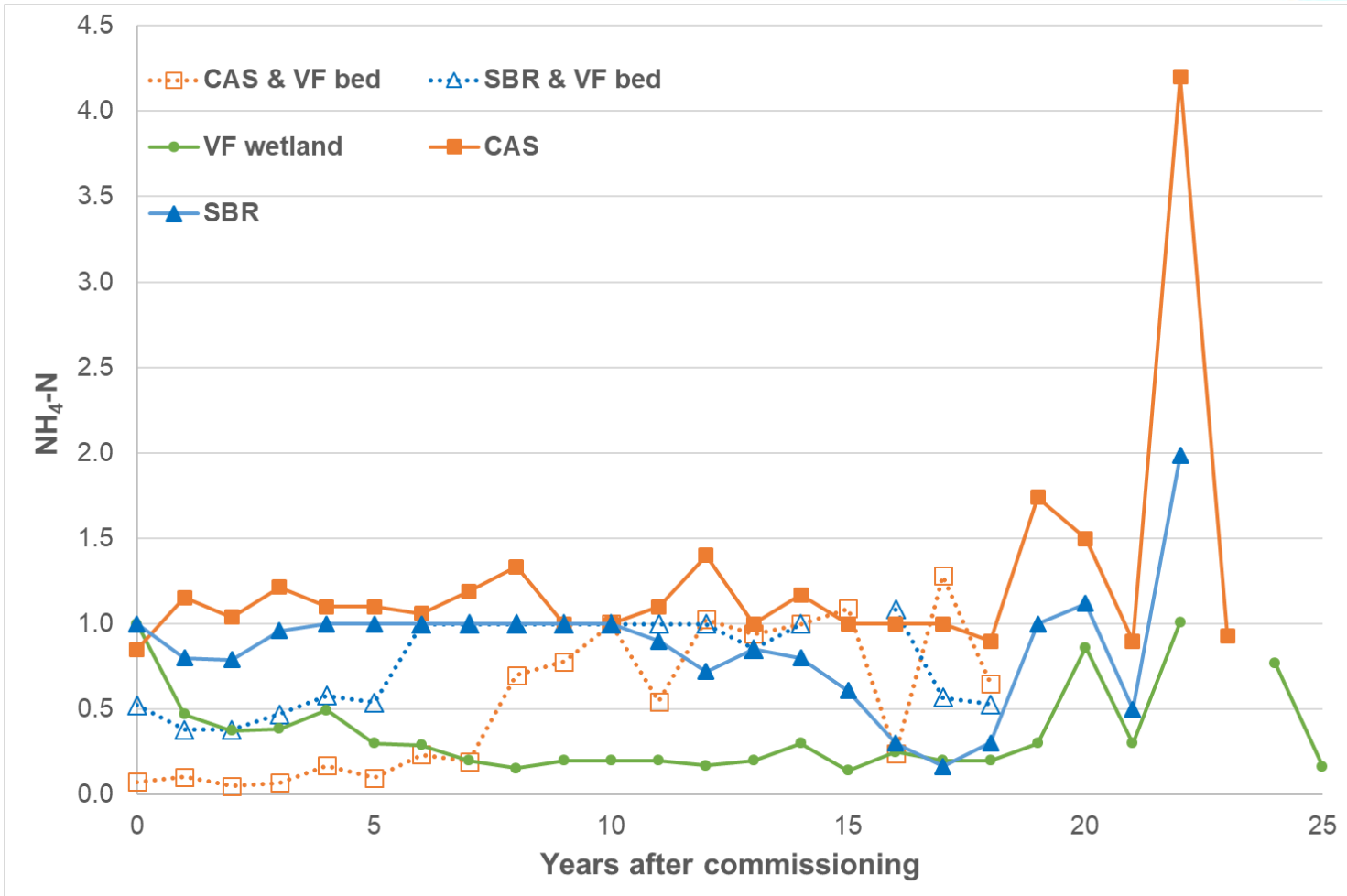




# Performance of small WWTPs < 50 PE



## Performance related to the age of the plant



## Other possible solutions

### Resources-oriented sanitation systems

- Wastewater as resource: e.g. **treated water, nutrients, organic nutrients, heat**
  - Separate collection of wastewater streams, i.e.
    - separation of **blackwater and greywater**
      - good opportunity for reusing treated greywater
      - more simple technologies for treatment of greywater
    - **source-separated urine**
      - production of NPK fertilizer
- ➔ If owners of WWTPs have an additional benefit besides treatment of wastewater, it is more likely that the WWTPs are operated well

## Summary

- All technologies comply with the required threshold values
- WWTPs including a VF bed show lower median values and less measurement values exceeding the respective threshold limits
- Significant changes of the treatment performance over the operation time cannot be proven in any technology
- WWTPs including a VF bed show less fluctuations of the median effluent concentrations
- Proper operation, monitoring and maintenance seems to be key fact for well functioning small WWTPs
- Resources-oriented sanitation solutions facilitates well functioning of systems





**University of Natural Resources and  
Life Sciences, Vienna**

Department of  
Water, Atmosphere, and Environment

## Contact

# Dr Günter Langergraber

University of Natural Resources and Life Sciences, Vienna (BOKU University)  
Department of Water, Atmosphere and Environment  
Institute of Sanitary Engineering and Water Pollution Control

Muthgasse 18, A-1190 Vienna, Austria  
Tel.: +43 (0)1 47654-81111  
Email: [guenter.langergraber@boku.ac.at](mailto:guenter.langergraber@boku.ac.at)