Interreg CENTRAL EUROPE

European Union
European Regional
Development Fund

REEF 2W

INCREASED RENEWABLE ENERGY AND ENERGY EFFICIENCY BY INTEGRATING, COMBINING URBAN WASTEWATER AND WASTE MANAGEMENT SYSTEM

TAKING
COOPERATION
FORWARD

ECOMONDO - Nov 05, 2019 - Rimini

Integrated Sustainability Assessment of Wastewater based Energy Supply

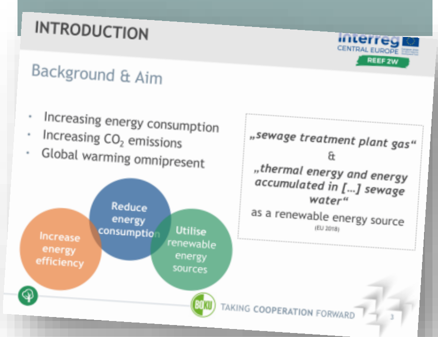
BOKU: P. Lichtenwöhrer

CONTENT

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
REEF 2W

Introduction

- Background and aim

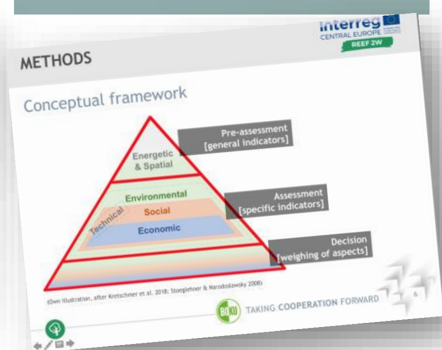


Methods

- Framework

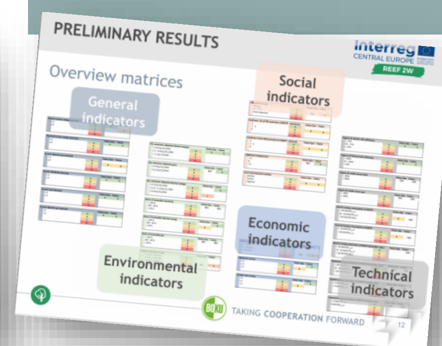
- Implementation

- Case study

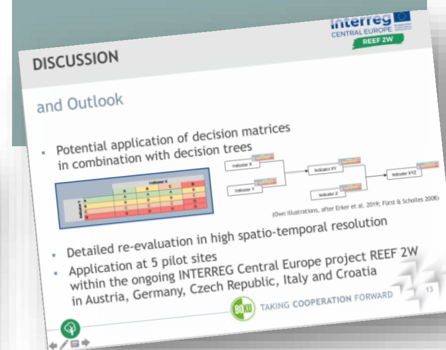


Preliminary Results

- Sample matrices



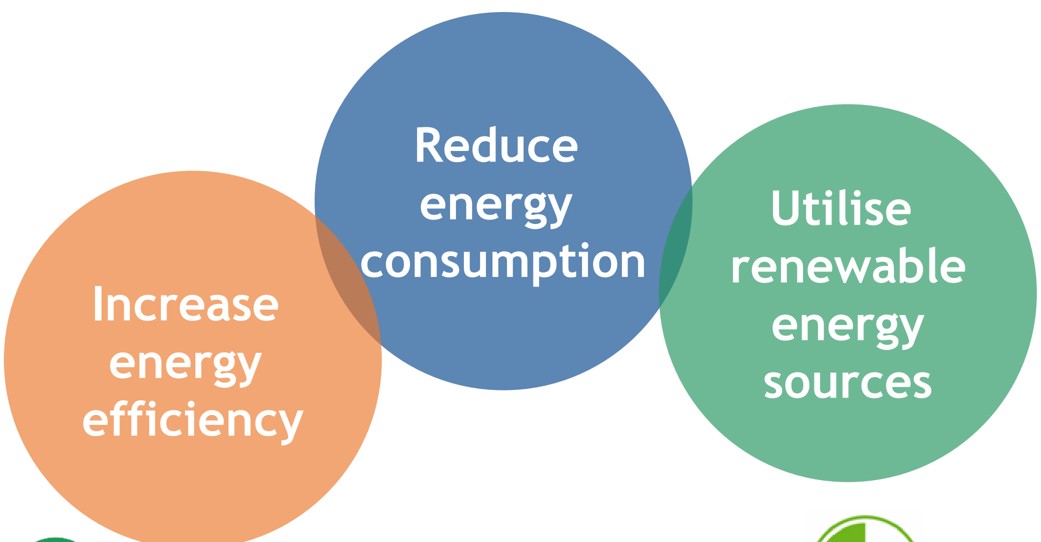
Discussion & Outlook



Interreg CENTRAL EUROPE — European Union, European Regional Development Fund — REEF 2W

Background & Aim

- Increasing energy consumption
- Increasing CO_2 emissions
- Global warming omnipresent



> ***„sewage treatment plant gas“***
>
> &
>
> ***„thermal energy and energy accumulated in [...] sewage water“***
>
> as a renewable energy source
>
> (EU 2018)

INTRODUCTION

Background & Aim

*INTERREG Central Europe project "**REEF 2W** - Increased renewable energy and energy efficiency by integrating, combining and empowering urban wastewater and organic waste management systems"*

- Different distribution paths for excess energy:
  - Upgraded biogas
  - Electricity
  - Thermal energy
- Multifaceted context and the coupling of energy sectors calls for a variety of different disciplines and a comprehensive approach
  - Sanitary Engineering and
  - Integrated Spatial and Energy Planning

Background & Aim


Heat Supply from Wastewater Treatment Plants - A Methodological Approach for Integrated Sustainability Assessment

Introduction

Methodological Approach

Conclusion and Outlook

Acknowledgement

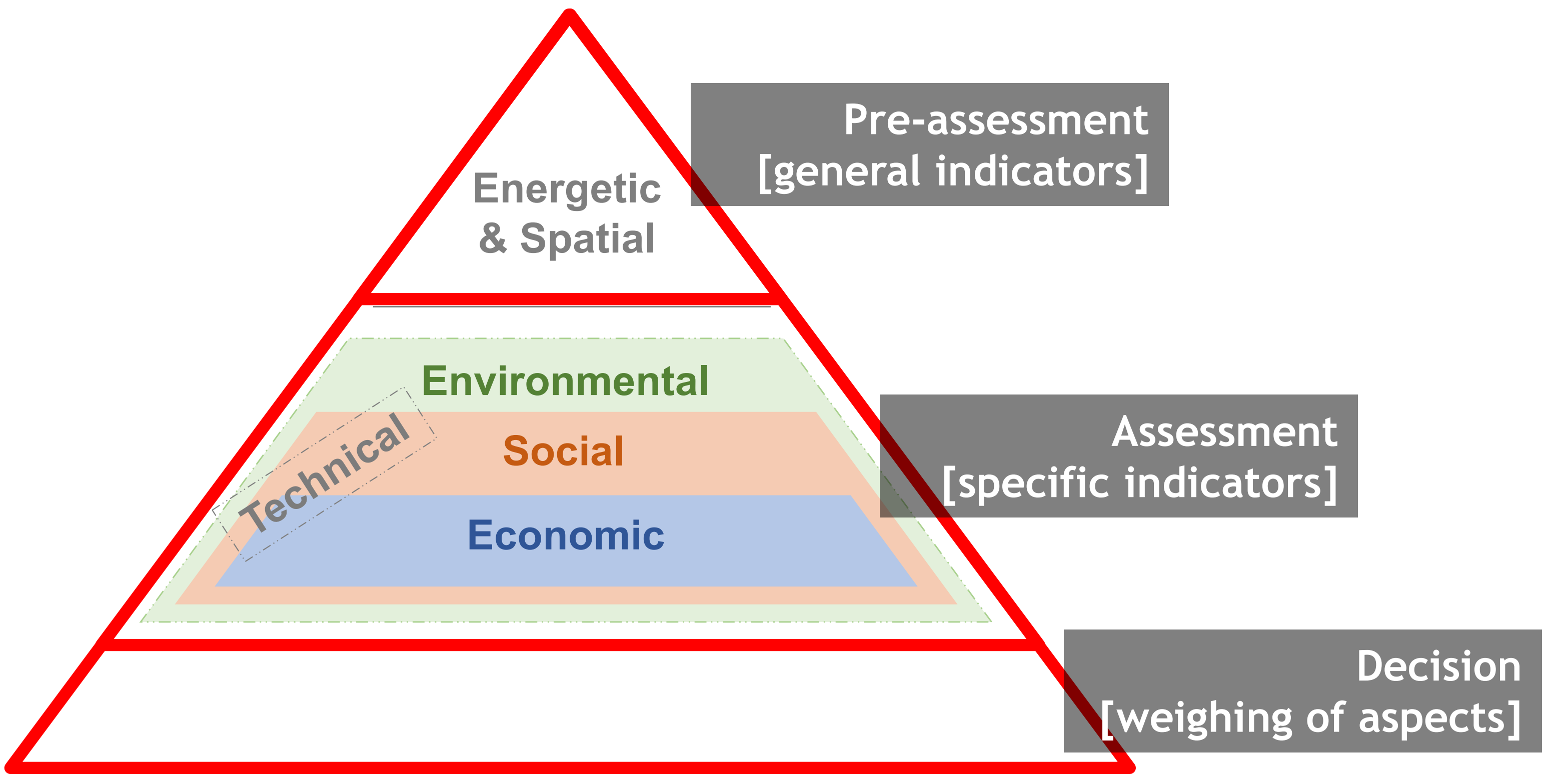
(Kretschmer et al. 2018)

Aim

Development *and* ***application*** *of an* ***Integrated Sustainability Assessment (ISA)*** *methodology. The practical decision support framework helps to* ***identify the most sustainable solution for utilising excess energy from WWTPs.***

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
REEF 2W

Conceptual framework



(Own illustration, after Kretschmer et al. 2018; Stoeglehner & Narodoslawsky 2008)

METHODS

Implementation

Sample matrix:

Indicator [X]			Status Quo	Future
	1	A		A
	2	B		
	3	C	C	
	4	D		

(Own illustration 2019 after Erker et al. 2019, Fürst & Scholles 2008)

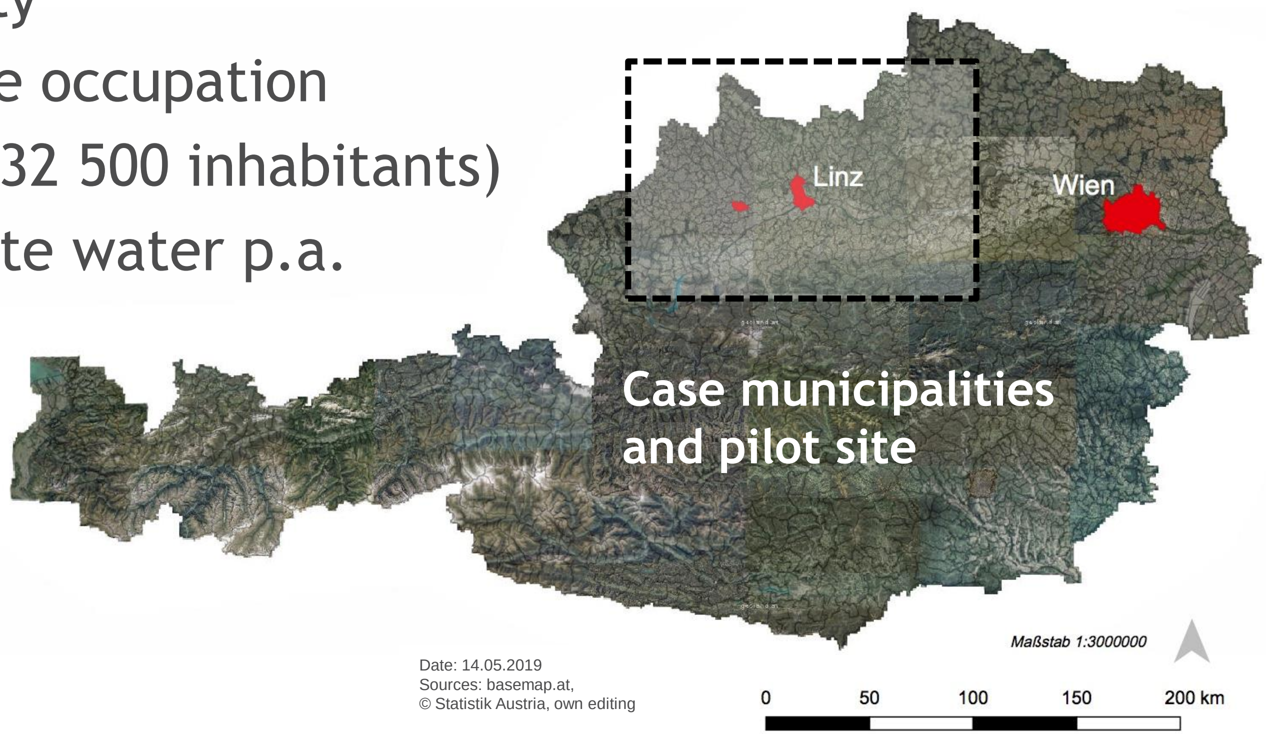
- Indicator development
  - 6 general indicators
  - 26 specific indicators
- Up to 4 categories/graduations

(Lichtenwöhrer 2019)

Interreg CENTRAL EUROPE European Union European Regional Development Fund REEF 2W

Implementation

- 74 000 PE capacity
- 50 000 PE average occupation
- 13 communities (32 500 inhabitants)
- 6 000 000 m^3 waste water p.a.
- Co-fermentation
- Digester towers

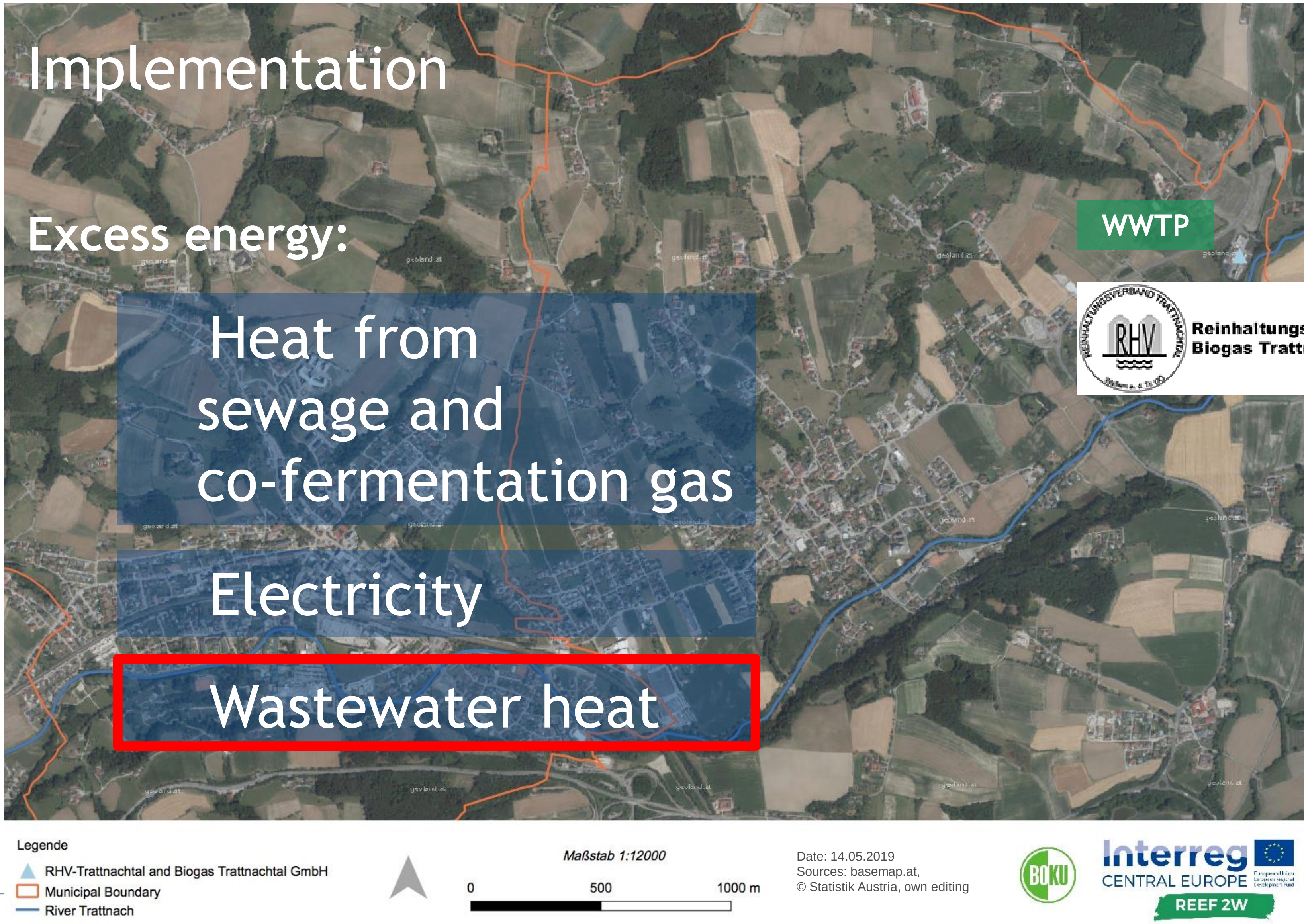


METHODS

Implementation

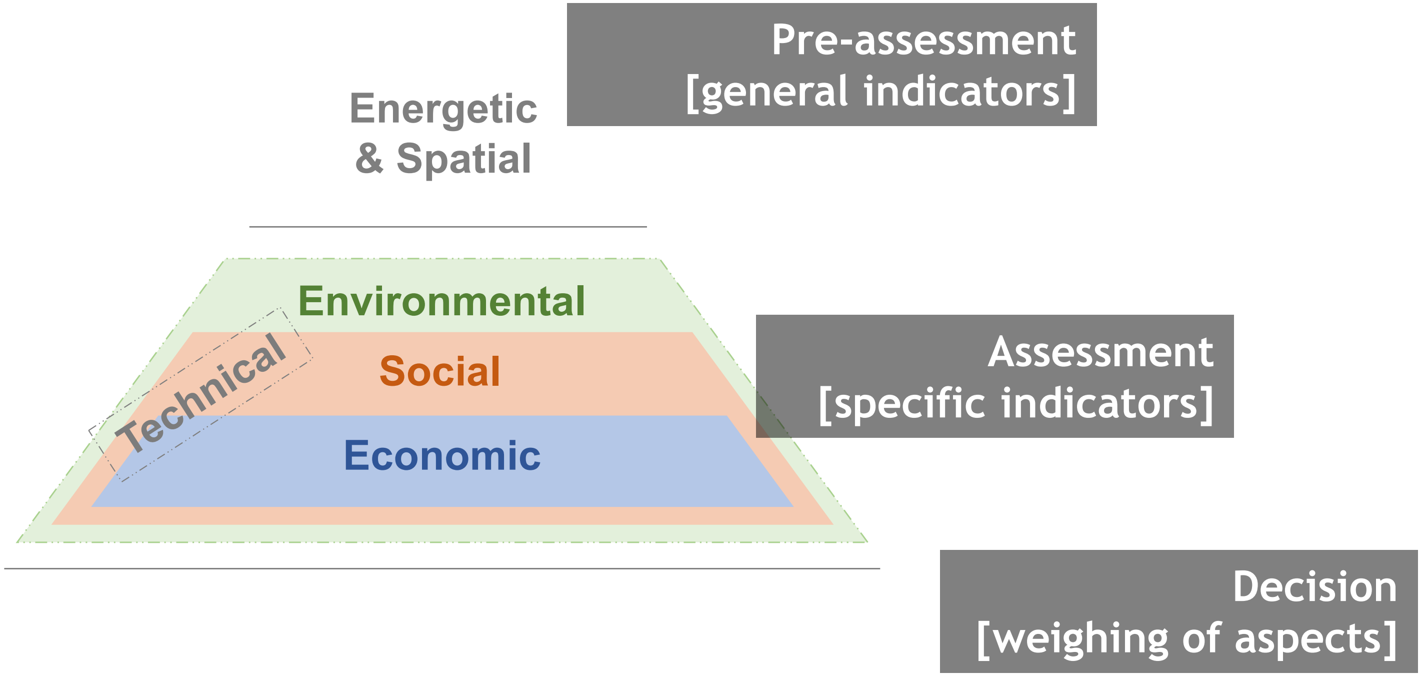
Excess energy:

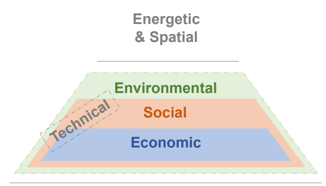
- Heat from sewage and co-fermentation gas
- Electricity
- Wastewater heat



Interreg CENTRAL EUROPE
European Union
European Regional Development Fund
REEF 2W

Sample matrices

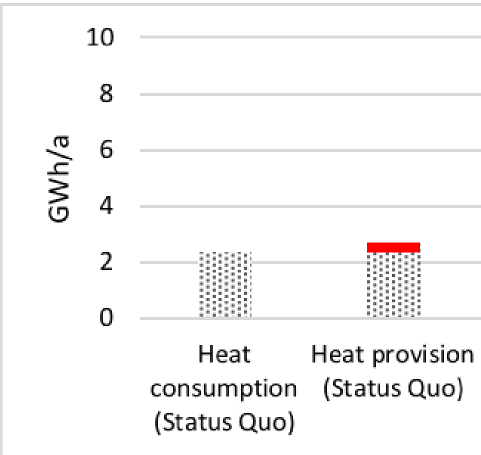


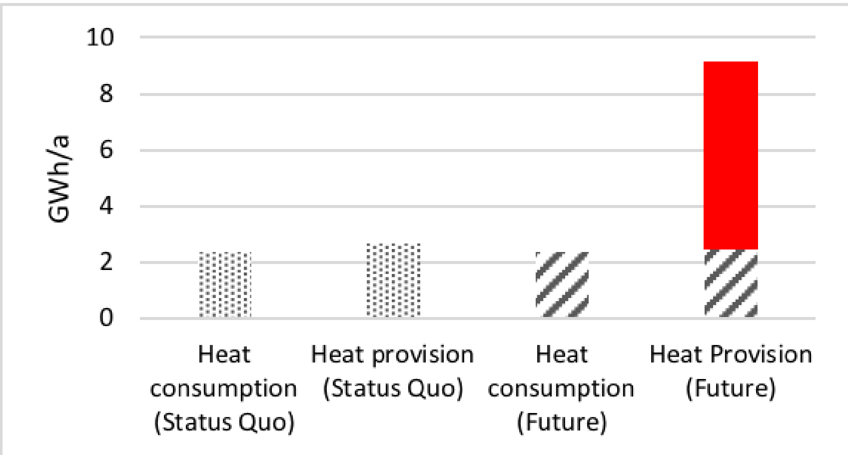


Sample matrices

General indicator

Thermal excess energy from WWTP				Status Quo	Future
	> 0	> 9 GWh/a	A	A	A
	≤ 0		B		





PRELIMINARY RESULTS

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
REEF 2W

Overview matrices

General indicators

Electric excess energy provision		Status Quo	Future
> 0	A	A	
≤ 0	B		B
	C		
	D		

Thermal excess energy provision		Status Quo	Future
> 0	A	A	A
≤ 0	B		
	C		
	D		

Excess digester gas provision		Status Quo	Future
> 0	A		
≤ 0	B	B	B
	C		
	D		

Excess electricity demand		Status Quo	Future
> 0	A	A	A
= 0	B		
	C		
	D		

Excess heat demand		Status Quo	Future
> 0	A	A	A
= 0	B		
	C		
	D		

Excess digester gas demand		Status Quo	Future
> 0	A	A	A
= 0	B		
	C		
	D		

Environmental indicators

CO_2 emissions reduction (electric energy)		Status Quo	Future
< 0.05 kg CO_2/kWh	A	A	A
1.1 - 0.05 kg CO_2/kWh	B		
> 1.1 kg CO_2/kWh	C		
	D		

CO_2 emissions reduction (gas)		Status Quo	Future
< 0.22 kg CO_2/kWh	A	N/A	A
> 0.22 kg CO_2/kWh	B		
	C		
	D		

CO_2 emissions reduction (thermal energy)		Status Quo	Future
< 0.12 kg CO_2/kWh	A		A
> 0.23 - 0.12 kg CO_2/kWh	B		
> 0.23 kg CO_2/kWh	C	C	
	D		

Share of renewable electricity		Status Quo	Future
> 100 %	A	N/A	N/A
100 - 40 %	B		
< 40 %	C		
	D		

Share of renewable thermal energy		Status Quo	Future
> 100 %	A		A
100 - 40 %	B	B	
< 40 %	C		
	D		

Share of renewable gas		Status Quo	Future
> 100 %	A	N/A	N/A
100 - 40 %	B		
< 40 %	C		
	D		

Sludge production change		Status Quo	Future
< 0 Delta t DM/year	A		
= 0 Delta t DM/year	B		
> 0 Delta t DM/year	C	N/A	C
	D		

Social indicators

Affordable energy		Status Quo	Future
cheaper	A		
+/- 10 %	B	N/A	B
more expensive	C		
	D		

Resilience I (# of RES provision at WWTP - electricity)		Status Quo	Future
3	A		
1 - 2	B	B	B
0	C		
	D		

Resilience II (# of RES provision at WWTP - thermal)		Status Quo	Future
3	A		
1 - 2	B	B	B
0	C		
	D		

Additional employment		Status Quo	Future
> 0	A	N/A	A
0	B		
< 0	C		
	D		

Local environmental welfare		Status Quo	Future
positive	A		
neutral	B	B	B
negative	C		
	D		

Economic indicators

Return of investment (ROI)		Status Quo	Future
< 3 years	A		
3 - 10 years	B		
> 10 years	C	N/A	C
	D		

Additional income		Status Quo	Future
> 0	A		A
= 0	B	B	
< 0	C		
	D		

Energy costs saving		Status Quo	Future
> 0	A		A
= 0	B	B	
< 0	C		
	D		

Technical indicators

Degree of electric self-sufficiency		Status Quo	Future
> 75%	A	A	A
25 - 75%	B		
< 25%	C		
	D		

Degree of thermal self-sufficiency		Status Quo	Future
> 100%	A	A	A
20 - 100%	B		
< 20%	C		
	D		

Degree of usable excess heat		Status Quo	Future
> 100%	A	N/A	N/A
< 100%	B		
	C		
	D		

Degree of usable excess gas		Status Quo	Future
> 100%	A	N/A	N/A
< 100%	B		
	C		
	D		

Electric energy consumption at WWTP		Status Quo	Future
< 20 kWh/PE_{120}.a	A		
20 - 50 kWh/PE_{120}.a	B	B	N/A
> 50 kWh/PE120.a	C		
	D		

Thermal energy consumption at WWTP		Status Quo	Future
≤ 30 kWh/PE_{120}.a	A		
> 30 kWh/PE_{120}.a	B	B	N/A
	C		
	D		

Electric energy generation at WWTP (anaerobic stab.)		Status Quo	Future
> 20 kWh/PE_{120}.a	A		N/A
10 - 20 kWh/PE_{120}.a	B		
< 10 kWh/PE120.a	C		
	D		

Thermal energy generation at WWTP (anaerobic stab.)		Status Quo	Future
> 40 kWh/PE_{120}.a	A	N/A	N/A
20 - 40 kWh/PE_{120}.a	[illegible]		
< 20 kWh/PE120.a	C		
	D		

Electric energy generation at WWTP (aerobic stab.)		Status Quo	Future
> 0 kWh/PE_{120}.a	A	N/A	N/A
< 0 kWh/PE_{120}.a	[illegible]		
	[illegible]		
	D		

Thermal energy generation at WWTP (aerobic stab.)		Status Quo	Future
> 0 kWh/PE_{120}.a	A	N/A	N/A
0 kWh/PE_{120}.a	B		
	C		
	D		

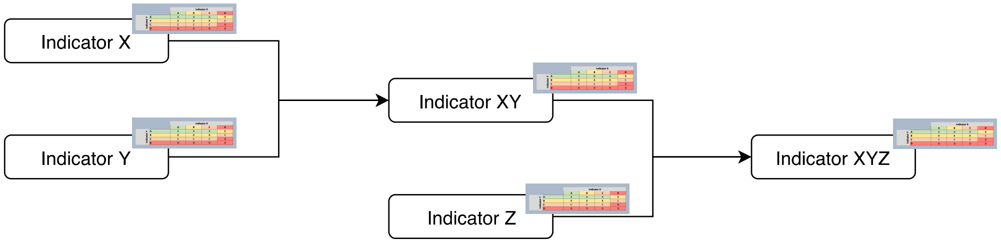
BOKU

DISCUSSION

and Outlook

- Potential application of decision matrices in combination with decision trees

		Indicator X			
		A	B	C	D
Indicator Y	A	A	A	A	B
	B	B	B	B	C
	C	C	C	C	D
	D	D	D	D	D



(Own illustrations, after Erker et al. 2019; Fürst & Scholles 2008)

- Detailed re-evaluation in high spatio-temporal resolution
- Application at 5 pilot sites
  within the ongoing INTERREG Central Europe project REEF 2W
  in Austria, Germany, Czech Republic, Italy and Croatia

THANK YOU!

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
REEF 2W

Final conference
29 April 2020 in Venice

Project website
www.interreg-central.eu/reef-2w

Authors:

Peter Lichtenwöhrer

(REEF 2W-Tool Trainer)

peter.lichtenwoehrer@boku.ac.at

Florian Kretschmer
Günter Langergraber
Georg Neugebauer

Acknowledgement:

Similar presentation was previously held at IWARR 2019:
Integrated Sustainability Assessment of Wastewater Treatment Plants as Local Energy Suppliers. [IWA Resource Recovery Conference - IWARRC2019, Venice, Italy, 8-11 September 2019]

Sources:

Erker S, Lichtenwoehrer P, Zach F, Stoeglehner G (2019) Interdisciplinary decision support model for grid-bound heat supply systems in urban areas. Energ Sustain Soc 9:11. doi: 10.1186/s13705-019-0193-4

EU (2018) Directive 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources. European Parliament and the Council, Brussels

Fürst D, Scholles F (2008) Handbuch Theorien und Methoden der Raum- und Umweltplanung, 3., vollst. überarb. Aufl. Rohn, Dortmund

Kretschmer F, Neugebauer G, Zach F, Loderer C, Farina R, Santi D, Jenicek P, Varga Z, Lichtenwoehrer P, Stoeglehner G, Langergraber G (2018) Heat Supply from Wastewater Treatment Plants - A Methodological Approach for Integrated Sustainability Assessment. Graz

Stoeglehner G, Narodoslawsky M (2008) Implementing ecological footprinting in decision-making processes. Land Use Policy 25:421-431. doi: 10.1016/j.landusepol.2007.10.002

Partners

ENEA
Italian National Agency for New Technologies, Energy and Sustainable Economic Development

Unioncamere Veneto

Montefeltro servizi

adelphi

KOMPETENZZENTRUM Wasser Berlin

BOKU

RHV Reinhaltungsverband Trattnachtal
Biogas Trattnachtal GmbH

UNIVERSITY OF CHEMISTRY AND TECHNOLOGY PRAGUE

VEOLIA

REGIONALNA ENERGETSKA AGENCIJA SJEVEROZAPADNE HRVATSKE

ZAGREBAČKI HOLDING d.o.o.