LIFE16 ENV/ES/000437

Life ALCHEMIA

Introduction to Cost Analysis tool for DWTP operators

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Topics and activities

- The aim of the CA tool
- The basis of CA
- Gathering background information
- Cost elements
- Output
- Progress
- Case studies

The aim of the CA tool

The aim of the cost analysis is to provide a helpful step in order to make a reasonable choice between technology in use and technology developed during LIFE Alchemia.

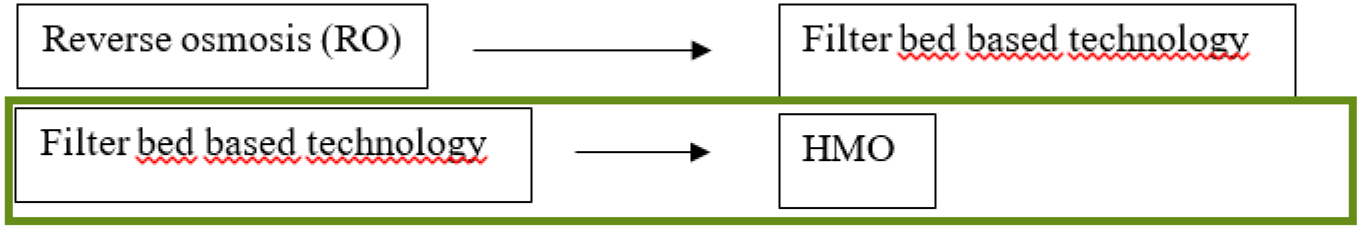
What is reasonable?

Appropriate decision in order to lower costs and reduce NORM.

The basis of CA

The CA is developed and conduced on the grounds of following aspects:

- can be done independently;
- does not include benefit separately – reducing costs are the benefit side;
- 30 year’s prospect
- Only economic aspects. In the final phase, social and other related aspects should also be considered if they prove to be important from the viewpoint of environmental, radiation protection etc.



The basis of CA (2)

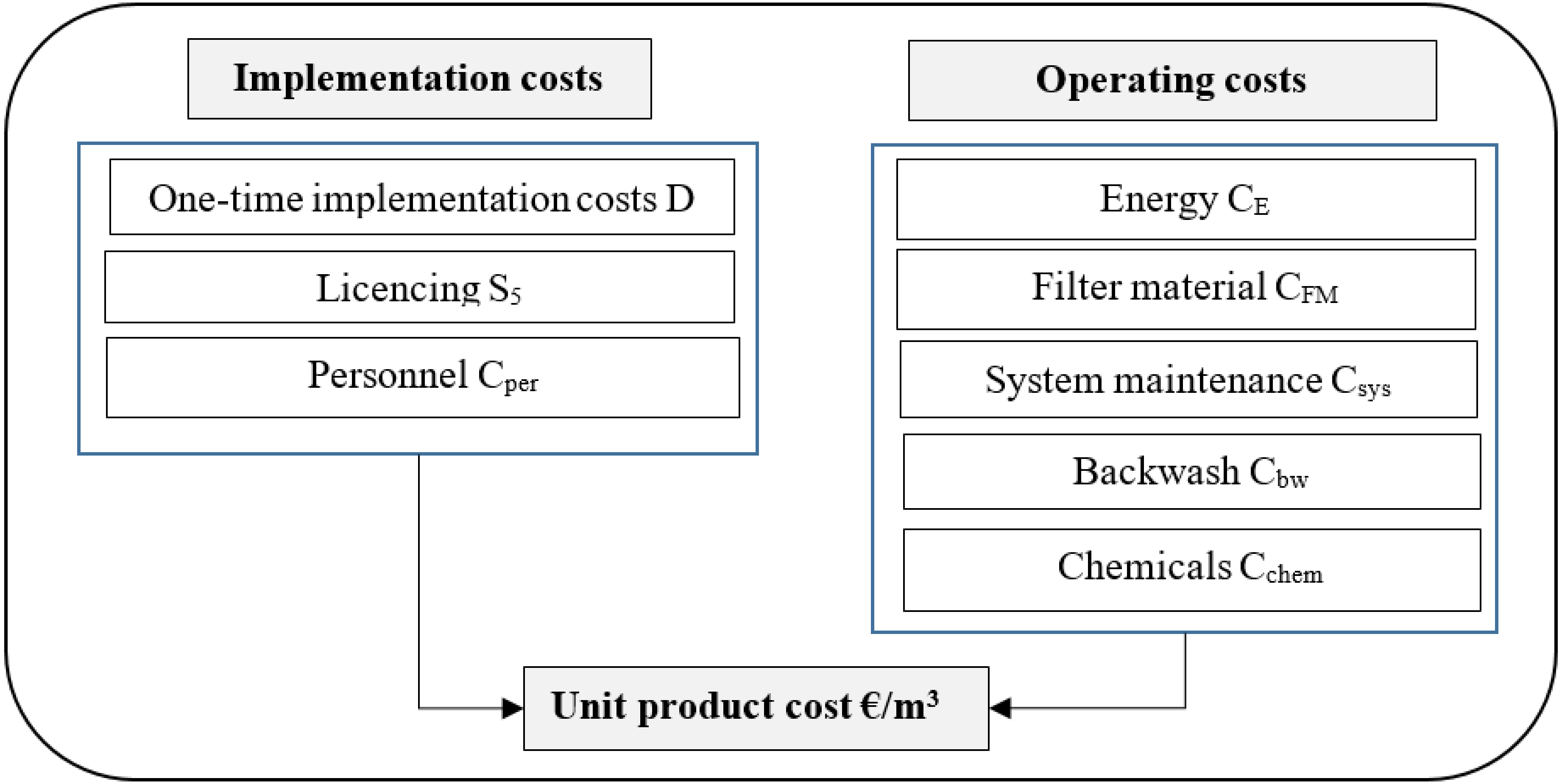
PARAMETERS:

- Local conditions – information about the WTP
- Selected criteria – acquired during the project and from initial feedback

When describing the parameters, the unit production cost in €/m^3 is used.

COSTS:

- Implementation costs – directly related to application of new technology
- Operating costs – continuous costs


Implementation costs
One-time implementation costs D
Licencing S_5
Personnel C_{per}
Operating costs
Energy C_E
Filter material C_{FM}
System maintenance C_{sys}
Backwash C_{bw}
Chemicals C_{chem}
Unit product cost €/m³

Gathering background information

Background situation should be known/described: legislative situation, national strategy for waste management etc

- What are the regulatory requirements on drinking water?
- What types of waste are generated in consideration of radiation protection?
- What is the local framework on waste generated in WTP-s - exemption and clearance levels, guidelines and strategies provided by the regulatory body?
- Is there any other important information necessary for making a rational choice?
- Additional: sampling?

Cost elements: Operation

Energy consumption

$$C_E = \frac{E_y}{V_y}$$

E_y	annual electricity cost as of conducting the analysis [€/yr]
V_y	annual water production capacity i.e. water produced in the WTP (not to be confused with water delivered to the consumer) [m^3/yr]

Input: annual energy consumption, price of electricity

Cost elements: Operation (2)

Filter material

$$C_{FM} = \frac{(F * m_1 + N * m_2)}{V_y * k}$$

F	purchasing cost for filter material [€/t]
m_1	volume of the new filter material [t]
N	waste management costs of the old filter material [€/t]
m_2	volume of the old filter material [t]
V_y	annual water production capacity i.e. water produced in the WTP (not to be confused with water delivered to the consumer) [m^3/yr]
k	usage time of the filter material [y]

Input: quotes from providers, WTP information

Cost elements: Operation (3)

System maintenance

Input: averaged yearly maintenance costs, exhanging apparatus etc

However, for selected criteria, one can use the value of 2% of implementation costs (D).

Cost elements: Operation (4)

Backwash

$$C_{bw} = C_1 * p$$

C_1	cost of producing 1 m3 of water [€/m^3]
p	% of water used for backwash

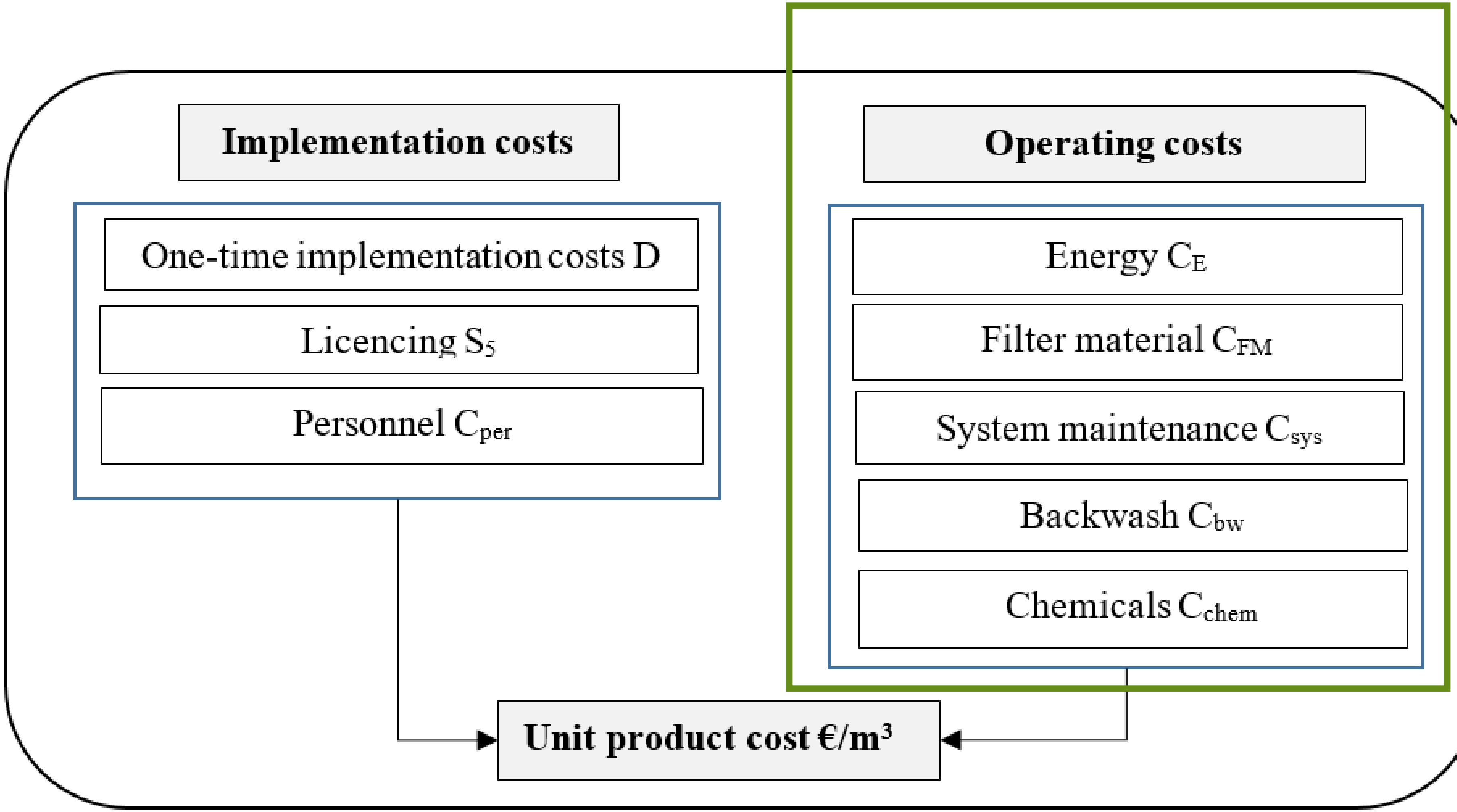
Input: According to the practice of Viimsi Vesi Ltd., backwash makes around 2% of overall production. Same value with pilot plant. However, some feedback showed higher values.

Cost elements: Operation (5)

Chemicals

For HMO, $MnSO_4$, NaOH, $KMnO_4$ are needed.

Input: qoutes from providers. Default values from pilot are provided.


Implementation costs
One-time implementation costs D
Licencing S_5
Personnel C_{per}
Operating costs
Energy C_E
Filter material C_{FM}
System maintenance C_{sys}
Backwash C_{bw}
Chemicals C_{chem}
Unit product cost €/m³

Cost elements: implementation

One-time costs include physical parts (equiptment, pumps, mixers) and costs regarding filter material if there is a need to replace it.

Also additional personnel costs may occur – need for training.

Output

The tool is only a helpful part, final decision may be affected from many other aspects.

Unit cost factors	Local condition cost factors	HMO cost factors [€/m3]	Difference [€/m3]
C_p	#DIV/0!	#DIV/0!	#DIV/0!
C_E	#DIV/0!	#DIV/0!	#DIV/0!
C_FM	#DIV/0!	#DIV/0!	#DIV/0!
C_sys	#DIV/0!	#DIV/0!	#DIV/0!
C_bw	#DIV/0!	#DIV/0!	#DIV/0!
C_chem	0	0	0
		ΣΔC	#DIV/0!

If $\sum \Delta c_n > 0$, then it is reasonable to implement a new technology and

when $\sum \Delta c_n < 0$, then it is not reasonable to implement a new technology.

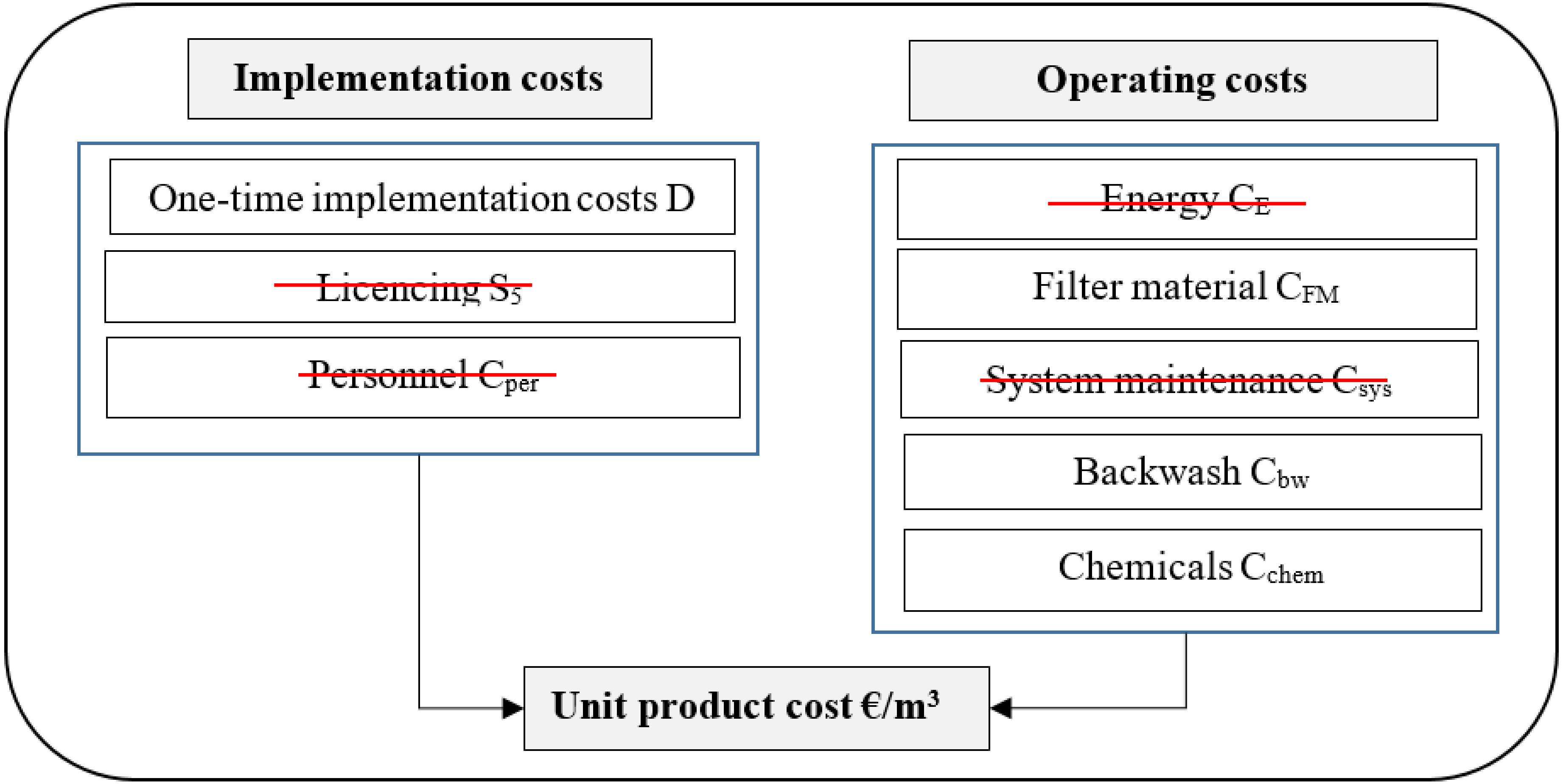
Progress

First feedback sent out and received:

- Hard to grasp, too detailed, unreasonable;
- Other unforeseen costs may be included when implementing a new technology;
- E.g. personnel

Summary: only to assess cost elements directly available from R&D i.e. pilot plant and also from practice from other operating WTPs.

Cost elements v2.0



LEGEND:

Insert input

LOCAL CONDITION COST FACTORS			
lifetime in years	L	30	y
capacity in a year	V_y		m^3/yr
capacity in a lifetime	V_L	0	m^3
Personnel	C_p	#DIV/0!	€/m^3
annual personnel cost	P_y		€/y
Energy consumption	C_E	#DIV/0!	€/m^3
annual energy consumption of the WTP	E		kWh/y
price of the electricity	E_€		€/kWh
annual cost for energy consumption	E_y	0	€/y
Filter material	C_FM	#DIV/0!	€/m^3
purchasing cost for filter material	F		€/t
volume of the new filter material	m_1		t
volume of the old filter material	m_2		t
waste management costs	N		€/t
usage time of the filter material	k		y
annual filter material related costs	FM_y	#DIV/0!	€/y
System maintenance	C_sys	#DIV/0!	€/m^3
annual maintenance costs	Sys_y		€/y
Backwash	C_bw	#DIV/0!	€/m^3
% of water used for backwash	p_1		%
cost of producing 1 m^3 of water	C_1		€/m^3
water used for backwash	V_bw	0	m^3/y
annual cost of backwash	BW_y	0	€/y

Cost element to be used when local cost factors NOT available		
Waste management costs N if classified as NORM	120	€/t
Waste management costs N if not classified as NORM	76.2	€/t
% of water used for backwash	2	%
Chemical prices		
$MnSO_4$	0.01425	€/m^3
NaOH	0.00095	€/m^3
$KMnO_4$	0.00324	€/m^3

SELECTED CRITERIA			
FILTER BED BASED WTP-8 (HMO implementation)			
Implementation costs	D	#DIV/0!	€/m^3
HMO dosagage system:	D_1	0	€
Containers for the solution	S_1		€
dosage pumps	S_2		€
mixers	S_3		€
Removal of the filter material			
volume of the filter material	m_3		t
waste management costs	N		€/t
other significant costs related to the removal	s		€
total costs for removal of the filter material	S_4	0	€
Licencing	S_5		€
Total costs for new technology implementation	ΣS_i	0	€
Implementation costs for one year	(ΣS_i)/L	0	€/y
Personnel	D_p	#DIV/0!	€/m^3
one time training costs	P_train1	0	€
one time training costs per capita	P_t		€/people
number of personnel needed to be trained	P_c		people
one time training cost for WTP lifetime	P_train	0	€/y
annual personnel costs	P_y		€/y
total personnel costs	P_L	0	€/y
Operation costs	C		€/m^3
Energy consumption	D_E	#DIV/0!	€/m^3
annyal energy consumption	E		kWh/y
price of the electricity	E_€		€/kWh
total cost for electricity per year	E_y	0	€/y
Filter material	D_FM	#DIV/0!	€/m^3
purchasing cost for filter material	F		€/t
volume of the new filter material	m_1		t
volume of the old filter material	m_2		t
waste management costs	N		€/t
usage time of the filter material	k		y
annyal costs related to filter material	FM_y	#DIV/0!	€/y
System maintenance	D_sys	#DIV/0!	€/m^3
annual cost for system maintenance	Sys_y	#DIV/0!	€/y
proportion of maintenance costs from implementing costs	p_2	2	%/y
Backwash	D_bw	#DIV/0!	€/m^3
% of water used for backwash	p		%
cost of producing 1 m^3 of water	C_1		€/m^3
water volume used for backwash	V_bw	0	m^3/y
annual cost for backwash	BW_y	0	€/y
Chemicals	D_kem	0	€/m^3
$MnSO_4$	C_Mn		€/m^3
NaOH	C_Na		€/m^3
$KMnO_4$	C_K		€/m^3

Unit cost factors	Local condition cost factors	HMO cost factors [€/m3]	Difference [€/m3]
C_p	#DIV/0!	#DIV/0!	#DIV/0!
C_E	#DIV/0!	#DIV/0!	#DIV/0!
C_FM	#DIV/0!	#DIV/0!	#DIV/0!
C_sys	#DIV/0!	#DIV/0!	#DIV/0!
C_bw	#DIV/0!	#DIV/0!	#DIV/0!
C_chem	0	0	0
		ΣΔC	#DIV/0!

If $\sum \Delta c_n > 0$, then it is reasonable to implement a new technology and when $\sum \Delta c_n < 0$, then it is not reasonable to implement a new technology.

LEGEND:	lifetime in years	L	30	y	capacity in a year	V_y		m^3/yr	capacity in a lifetime	V_L	0	m^3
Insert input												

LOCAL CONDITION COST FACTORS			
Filter material	*C_FM*	*#DIV/0!*	*€/m³*
purchasing cost for filter material	*F*		*€/t*
volume of the new filter material	*m_1*		*t*
volume of the old filter material	*m_2*		*t*
waste management costs	*N*		*€/t*
usage time of the filter material	*k*		*y*
annual filter material related costs	*FM_y*	*#DIV/0!*	*€/y*
Backwash	*C_bw*	*#DIV/0!*	*€/m³*
% of water used for backwash	*p_1*		*%*
cost of producing 1 m³ of water	*C_1*		*€/m³*
water used for backwash	*V_bw*	*0*	*m³/y*
annual cost of backwash	*BW_y*	*0*	*€/y*

Cost element to be used when local cost factors NOT available		
Waste management costs N if classified as NORM	*120*	*€/t*
Waste management costs N if not classified as NORM	*76.2*	*€/t*
% of water used for backwash	*2*	*%*
Chemical prices		
MnSO4	0.01425	*€/m³*
NaOH	0.00095	*€/m³*
KMnO4	0.00324	*€/m³*

SELECTED CRITERIA			
Filter material	*D_FM*	*#DIV/0!*	*€/m³*
purchasing cost for filter material	*F*		*€/t*
volume of the new filter material	*m_1*		*t*
volume of the old filter material	*m_2*		*t*
waste management costs	*N*		*€/t*
usage time of the filter material	*k*		*y*
annual costs related to filter material	*FM_y*	*#DIV/0!*	*€/y*
Backwash	*C_bw*	*#DIV/0!*	*€/m³*
% of water used for backwash	*p_1*		*%*
cost of producing 1 m³ of water	*C_1*		*€/m³*
water used for backwash	*V_bw*	*0*	*m³/y*
annual cost of backwash	*BW_y*	*0*	*€/y*
Chemicals	*D_kem*	*0*	*€/m³*
MnSO4	*C_Mn*		*€/m³*
NaOH	*C_Na*		*€/m³*
KMnO4	*C_K*		*€/m³*
Implementation costs	**D**	#DIV/0!	**€/m³**
HMO dosage system:	*D_1*	*0*	*€*
Containers for the solution	*S_1*		*€*
dosage pumps	*S_2*		*€*
mixers	*S_3*		*€*
Removal of the fliter material			
volume of the filter material	*m_3*		*t*
waste management costs	*N*		*€/t*
other significant costs related to the removal	*s*		*€*
total costs for removal of the filter material	*S_4*	*0*	*€*
total costs for new technology implementation	*ΣS_i*	*0*	*€*
implementation costs for the lifetime	*(ΣS_i)/L*	*0*	*€/y*

$$C_{FM} = \frac{(F * m_1 + N * m_2)}{V_y * k}$$

F	purchasing cost for filter material [€/t]
m_1	volume of the new filter material [t]
N	waste management costs of the old filter material [€/t]
m_2	volume of the old filter material [t]
V_y	annual water production capacity i.e. water produced in the WTP (not to be confused with water delivered to the consumer) [m³/yr]
k	usage time of the filter material [y]

$$C_{bw} = C_1 * p$$

C_1	cost of producing 1 m3 of water [€/m³]
p	% of water used for backwash

Filter material	
Local conditions	filter material is needed to be exchanged any way, default value
Selected criteria	same as the last one, but we need the accumulation rate from R
HMO	new technology requires new filter material

CASE STUDIES

What are we gonna do today?

- **Case 1:** small plant
- 1000 m3/d
- 35 tons of filter material

- **Case 2:** big plant
- 4500 m3/d
- 160 tons of filter material

- **Additional:** input from you on the basis of handouts

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