The EffiSludge for LIFE project: results and conclusions from the demonstration project

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EffiSludge is an operational concept that allows industrial wastewater treatments to save energy and chemicals while generating biogas.

EffiSludge for LIFE
LIFE14 CCM/SE/000221
(2015-2021)

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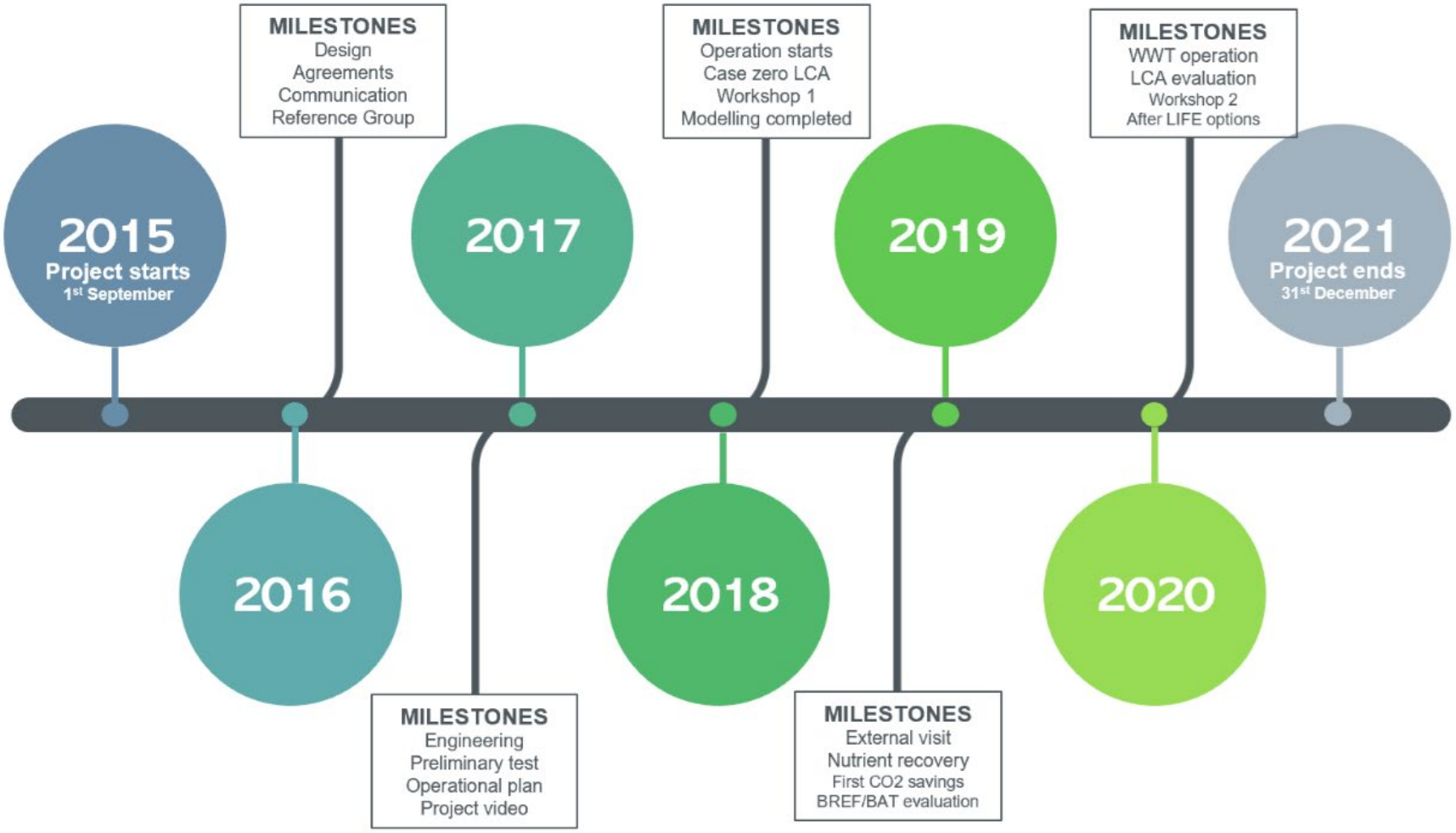
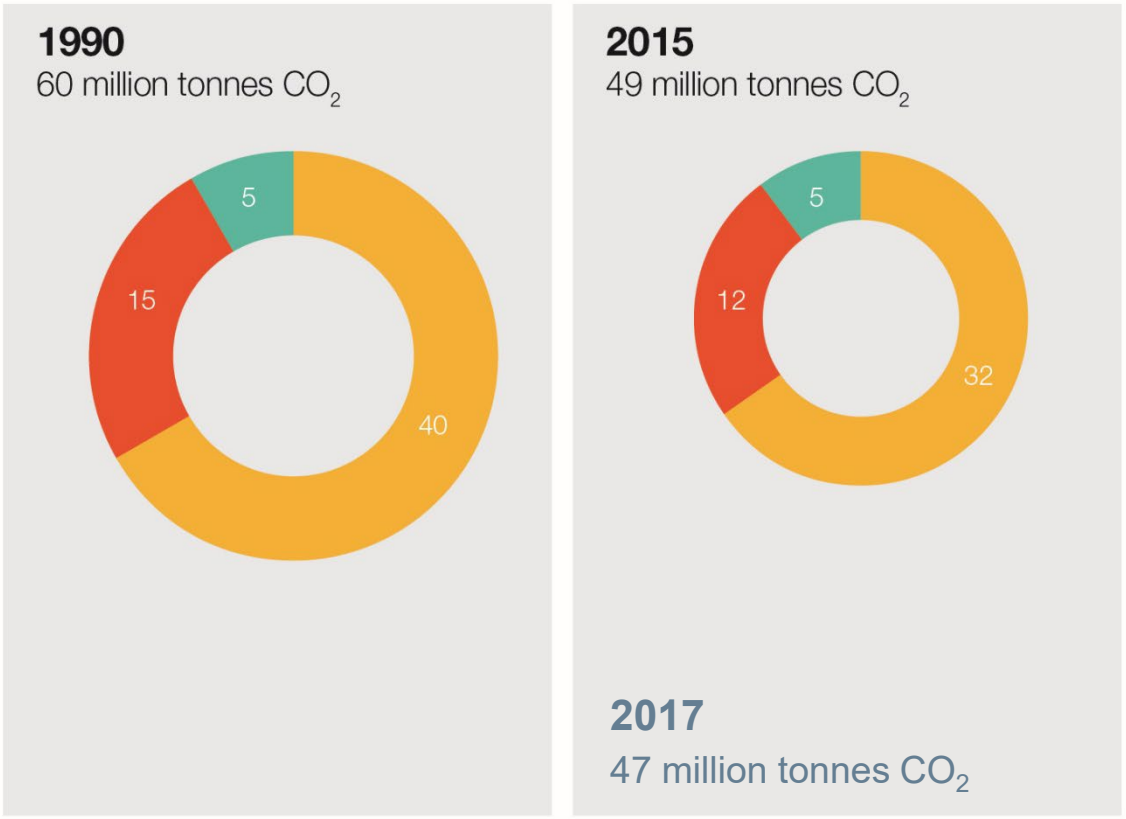
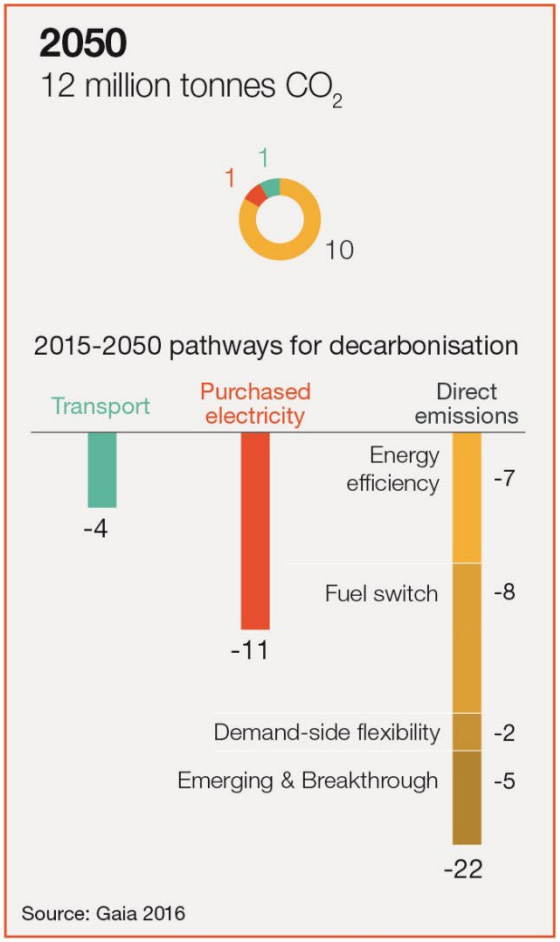
A long journey to make it real…



The Pulp and Paper Industry - Europe

Already in 2011, the PPI decided to decarbonising by 80%.

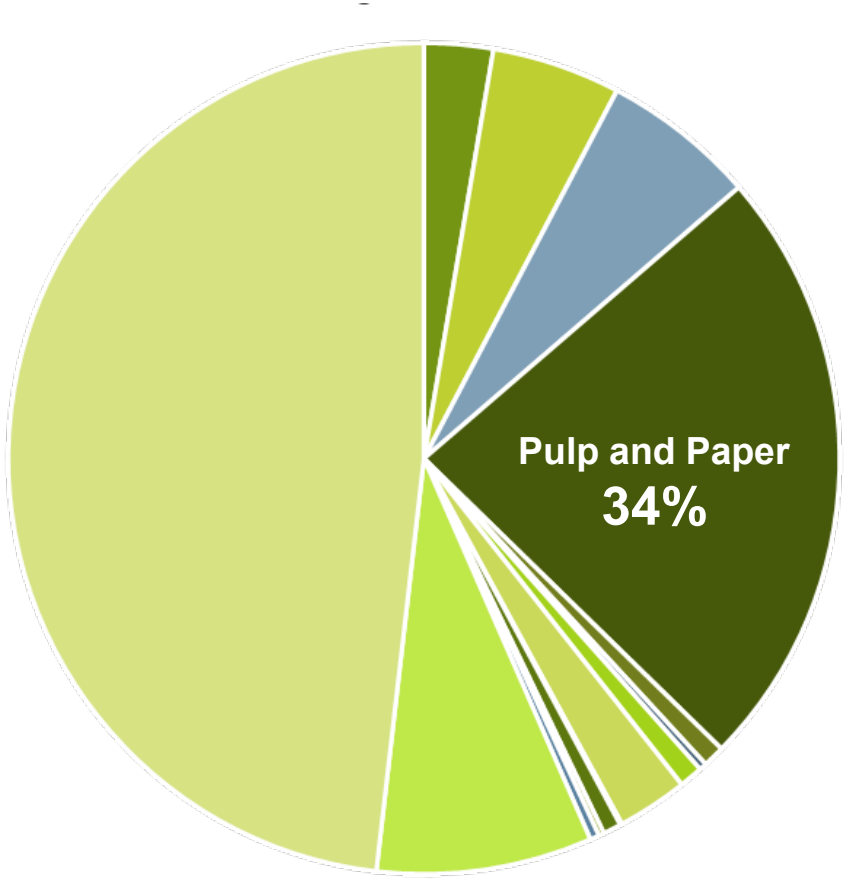




Over **20 billion Euro** investments needed

by Confederation of European Paper Industries (www.cepi.org)

The value of industrial wastewater



The **biogas potential**
from industrial wastewater is

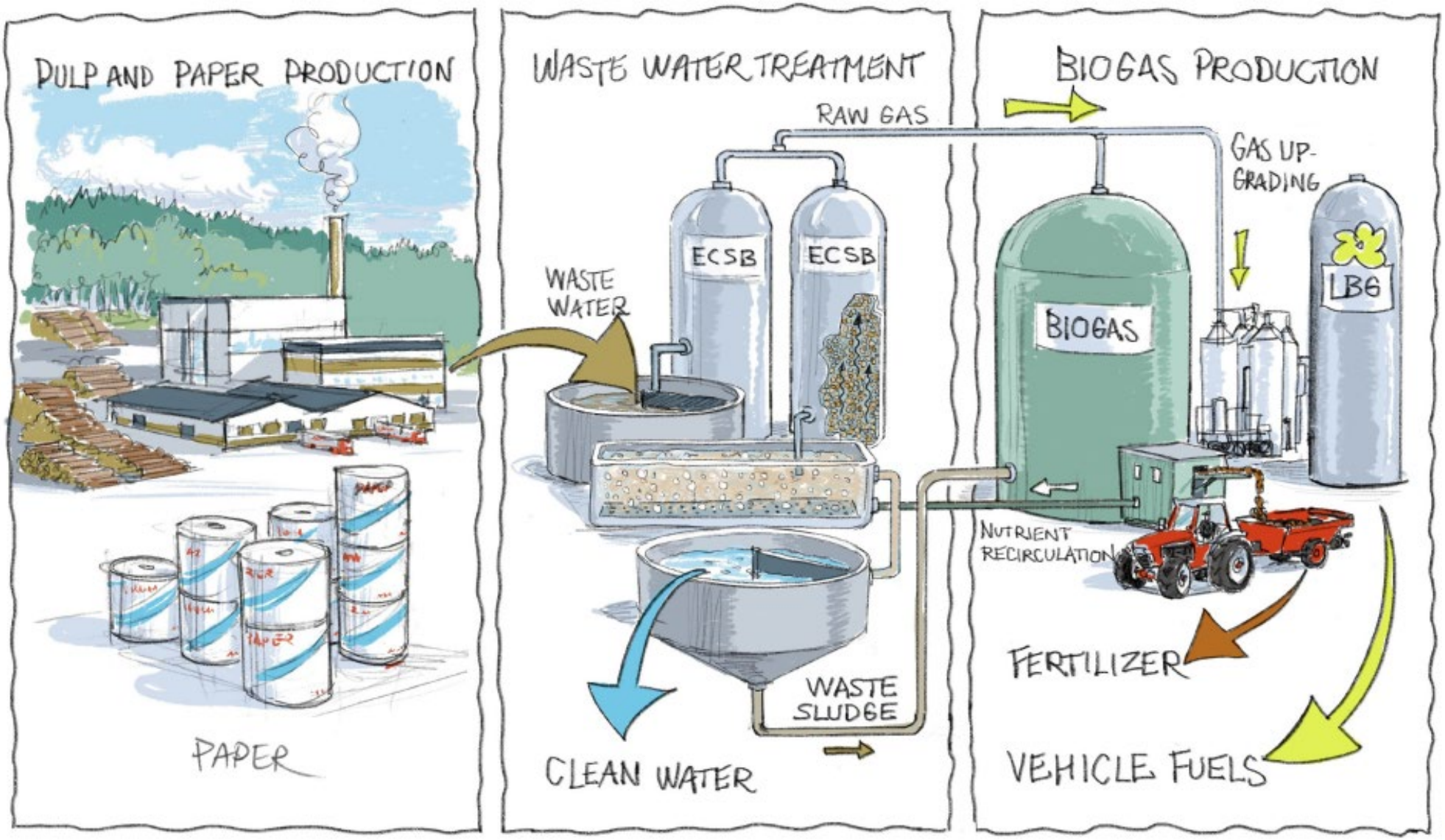
142 TWh

per year
(45 TWh from PPI)

"The role of biogas production from industrial wastewaters in reaching climate neutrality by 2050"
by European Biogas Association

Sustainability impact of EffiSludge

EffiSludge = Industrial Symbiosis



Industrial wastewater treatment (WWT)

Base case

1000kg Nitrogen and
100kg Phosphrus

Wastewater
paper mill
20 000 m^3

Primary clarifier

Neutralization basin

Activated Sludge Treatment

Secondary clarifier

Final recipient

RAS
(return activated sludge)

Sludge tank

WAS
(waste activated sludge)

Dewatering

Incineration with other materials

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Industrial wastewater treatment (WWT)

Base case

Nitrogen and Phosphrous

What can we do to reduce external dosing of N and P?

Wastewater paper mill 20 000 m^3

Primary clarifier

Neutralization basin

Activated Sludge Treatment

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What can we do to reduce energy demand and find a better use of the WAS?

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EffiSludge targets

100% Nitrogen saving

80% Phosphorous saving

as commercial chemicals are replaced with nutrients from fish waste, chemical addition is replaced from fish waste first processed via anaerobic digestion for biogas production

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50%

Energy saving

due to anaerobic digestion of wastewater prior the aerobic step and reduced biosludge age in the activated sludge process

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to replace fossil fuels

generated from wastewater and biosludge in co-digestion with nutrient rich biomass

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Zero CO_2

emissions from wastewater treatment

thanks to the combined effect of nutrient recovery, optimized biosludge production and biogas production

EffiSludge demonstration

500 000 ton/year of newsprint

20 000 m^3/day wastewater

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2015

Ground work started

2016-2017

Engineering work

2018

June
Inoculation CSTRs

July
Start-up operation

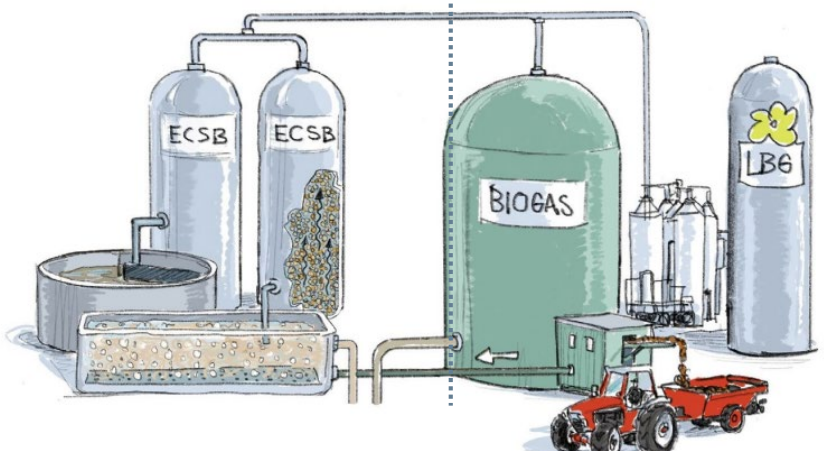
September
First delivery of LBG

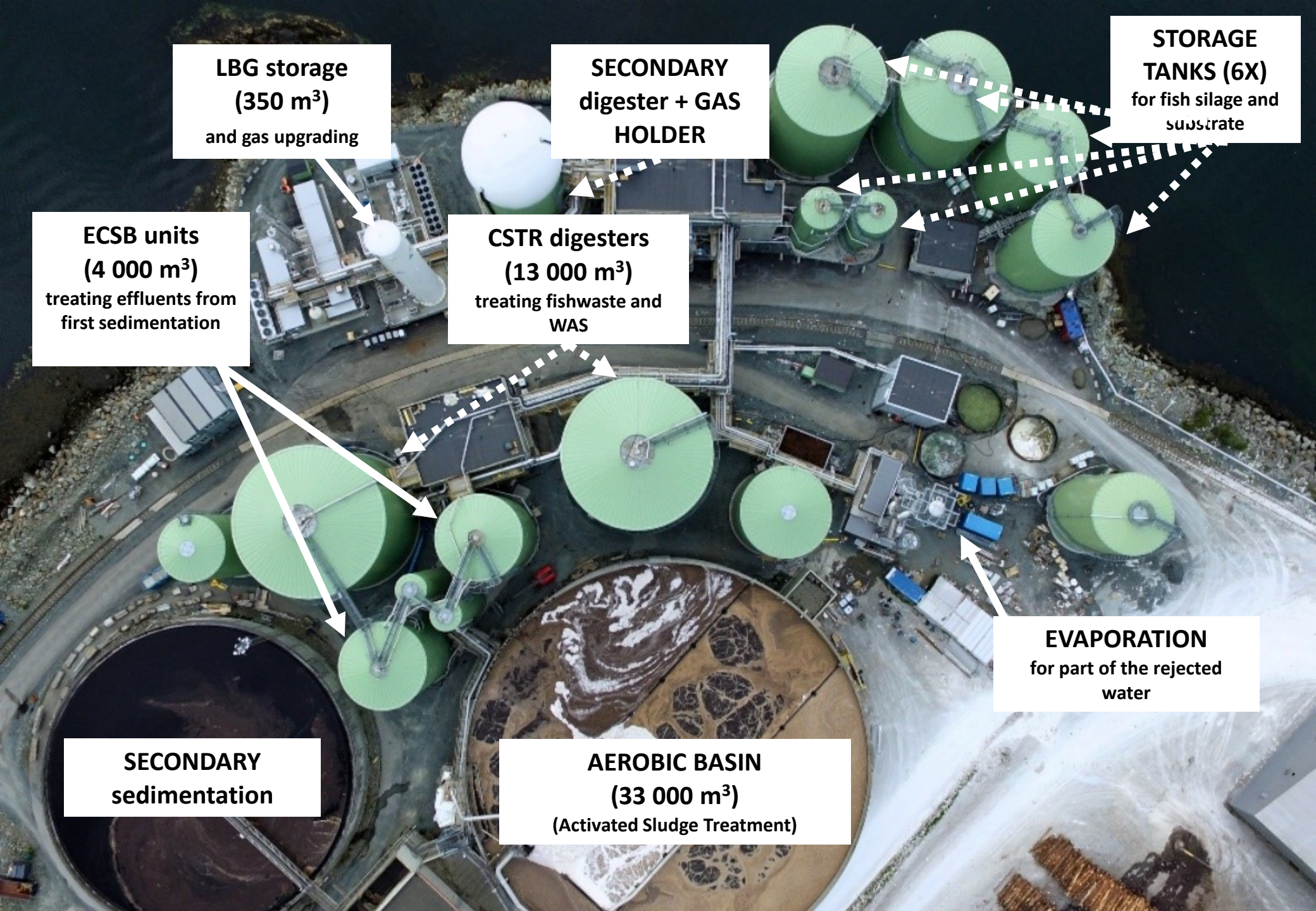
November
Start-up of ECSB

Biogas production

Two different production technologies applied

	External Circulation Sludge Bed (ECSB)	semi-Continuous Stirred Tank Reactor (CSTR)
Substrate	**Process water** after primary sedimentation from the mill	**Fish waste** from external, **WAS** from the mill + other
HRT	1-2 hours	15-20 days
Design capacity	2.5 million Nm^3 CH_4/year	12 million Nm^3 CH_4/year




LBG storage
(350 m³)
and gas upgrading
SECONDARY
digester + GAS
HOLDER
STORAGE
TANKS (6X)
for fish silage and
substrate
ECSB units
(4 000 m³)
treating effluents from
first sedimentation
CSTR digesters
(13 000 m³)
treating fishwaste and
WAS
EVAPORATION
for part of the rejected
water
SECONDARY
sedimentation
AEROBIC BASIN
(33 000 m³)
(Activated Sludge Treatment)


Fish waste
is delivered by boat
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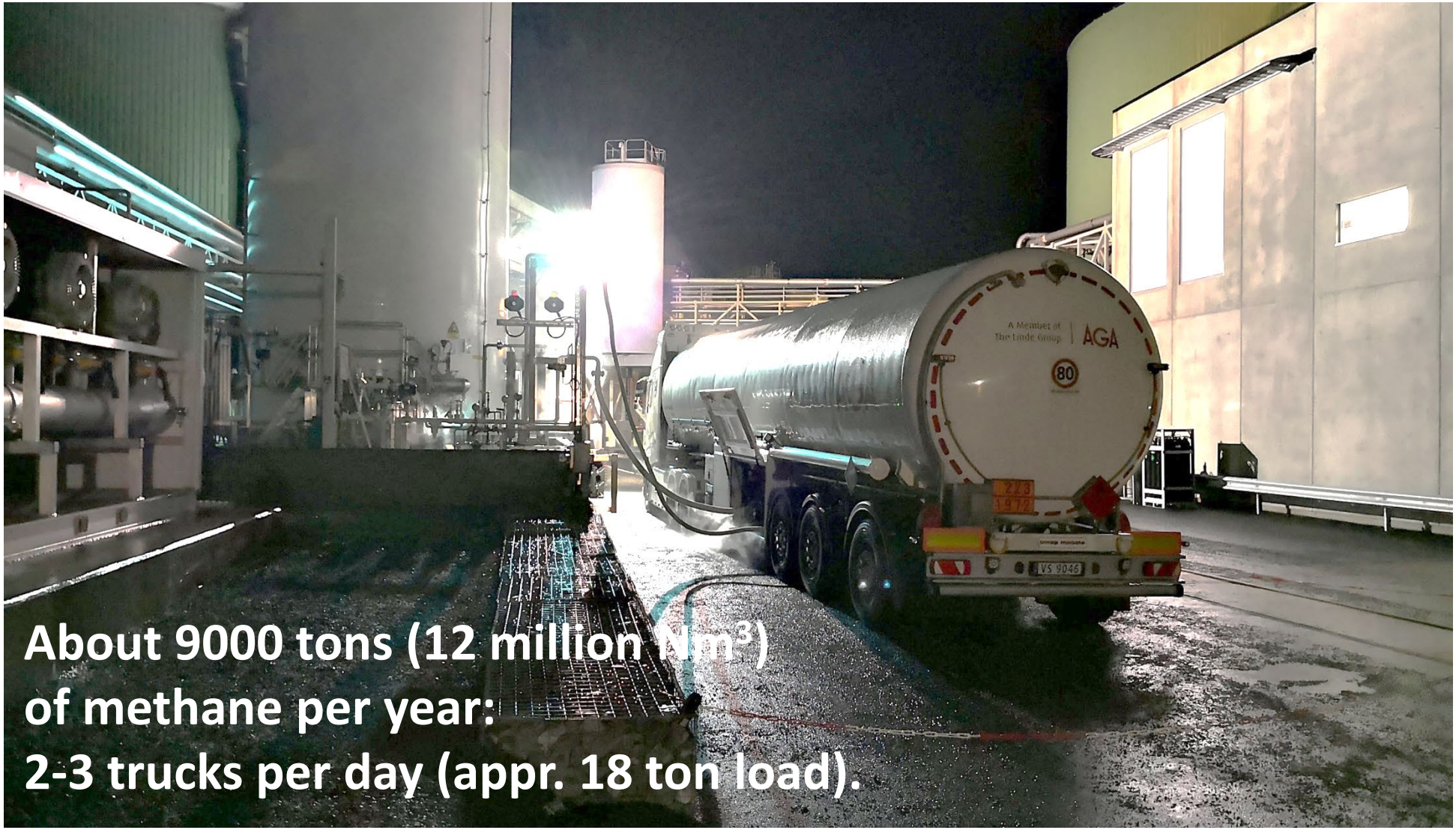
LBG is transported from site to final users



About 9000 tons (12 million Nm^3)
of methane per year:
2-3 trucks per day (appr. 18 ton load).

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Industrial WWT + Biogas production

EffiSludge case

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Industrial WWT + Biogas production

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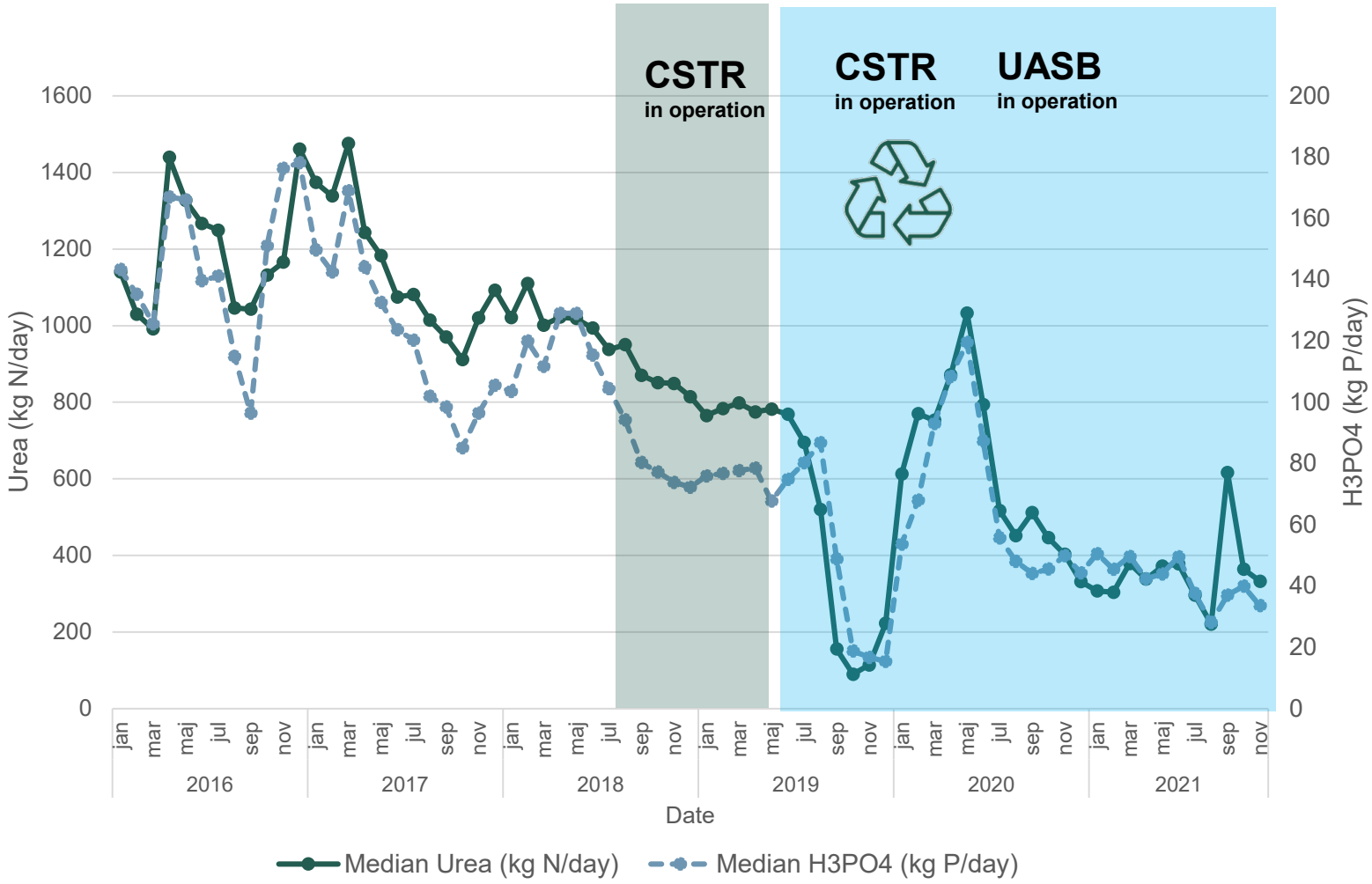
Nutrient recirculation



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Energy savings

- The ECSB reduce the loading of sCOD into the WWT by 50%.
- EffiSludge counts on a reduced sludge age for higher energy content in the WAS, resulting on reduced aeration demand in the WWT

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EffiSludge targets at Skogn

100% Nitrogen saving

90% Phosphorous saving

as commercial chemicals are replaced with nutrients from fish waste, chemical addition is replaced from fish waste first processed via anaerobic digestion for biogas production

50% Energy saving

due to anaerobic digestion of wastewater prior the aerobic step and reduced biosludge age in the activated sludge process

30% Biogas*

to replace fossil fuels

generated from wastewater and biosludge in co-digestion with nutrient rich biomass

*** 50% process flow, limited WAS usage and no sludge age reduction**

90% Zero CO_2

emissions from wastewater treatment

thanks to the combined effect of nutrient recovery, optimized biosludge production and biogas production

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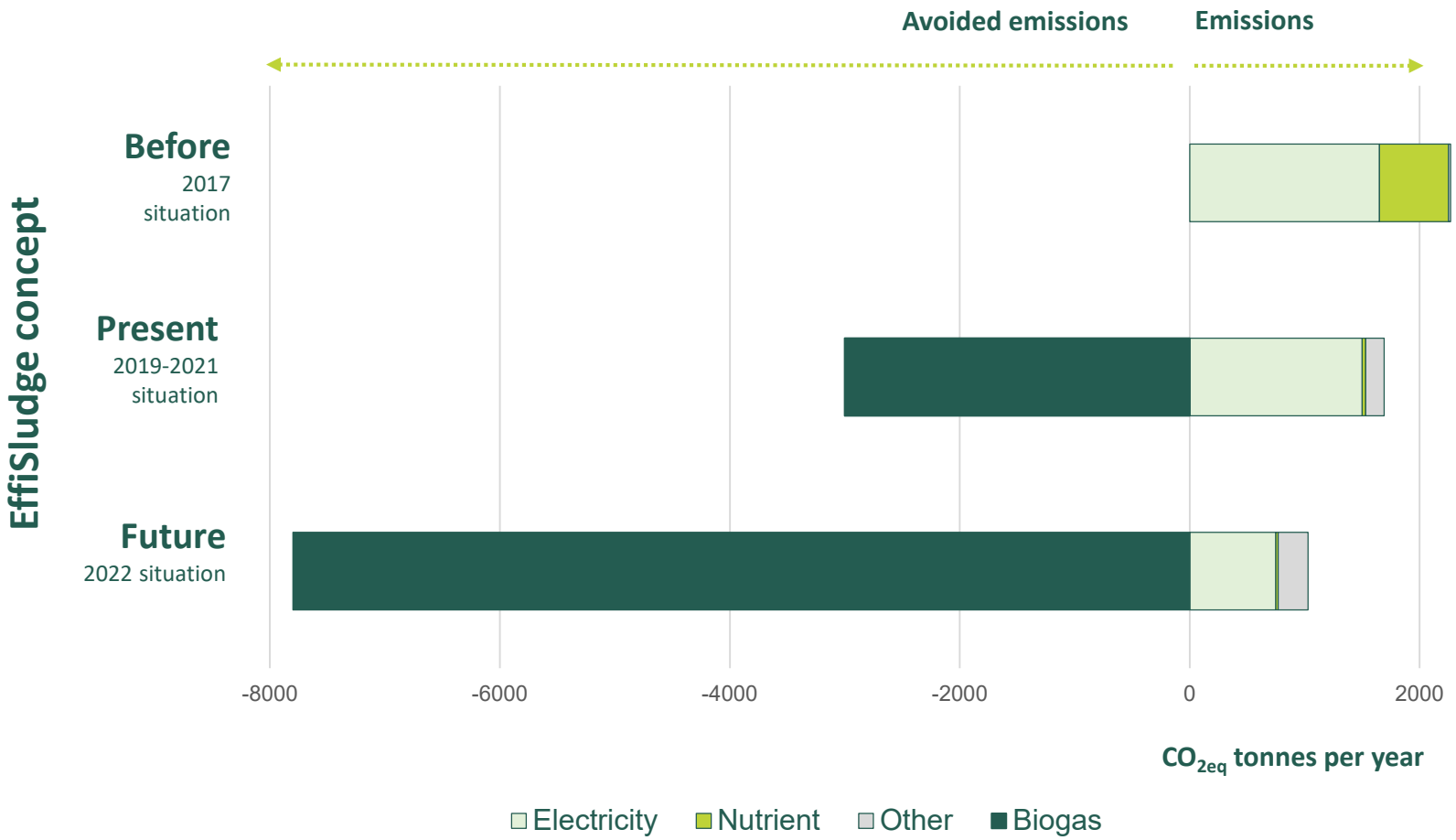
EffiSludge LCA

Key parameters for evaluation of the reduction of fossil CO_2-release by implementing EffiSludge

Parameter	Unit	Before EffiSludge[1]	Present EffiSludge[2]	Future EffiSludge[3]
Sludge age	days	13	12	6-8
Energy demand	MWh/day	30	23	15
Nitrogen addition (urea)	kg N/day	1000	100	0
Phosphoric acid addition	kg P/day	100	10	30
Biomethane from biosludge	Nm^3/day	0	180	1700
Biomethane from direct WWT	Nm^3/day	0	3400	7100

[1]The Before EffiSludge case is calculated from actual values for the year 2017. [2]The Present EffiSludge case is based on data from the full-scale implementation at Skogn for November 2019. 65% of the wastewater was during this period treated in the anaerobic wastewater unit while 100 m^3/day of the biosludge was digested together with nutrient rich residues from the Norwegian fish industry. The biomethane potential of the biosludge was set to 81 Nm^3/tonne VS for this sludge, that value is based on actual BMP measurements. [3]The Future EffiSludge Case assumes that all wastewater is treated in the anaerobic unit giving a 50% reduction of the organic material in the wastewater before going to aeration. The amount of biosludge digested has been assumed to increase due to the shorter sludge age (a factor of 0,28 kg SS/kg of COD_{red} was used for estimating the amounts). The biomethane potential for this biosludge was assumed to be 250 Nm^3/tonne VS.

Annual carbon emissions



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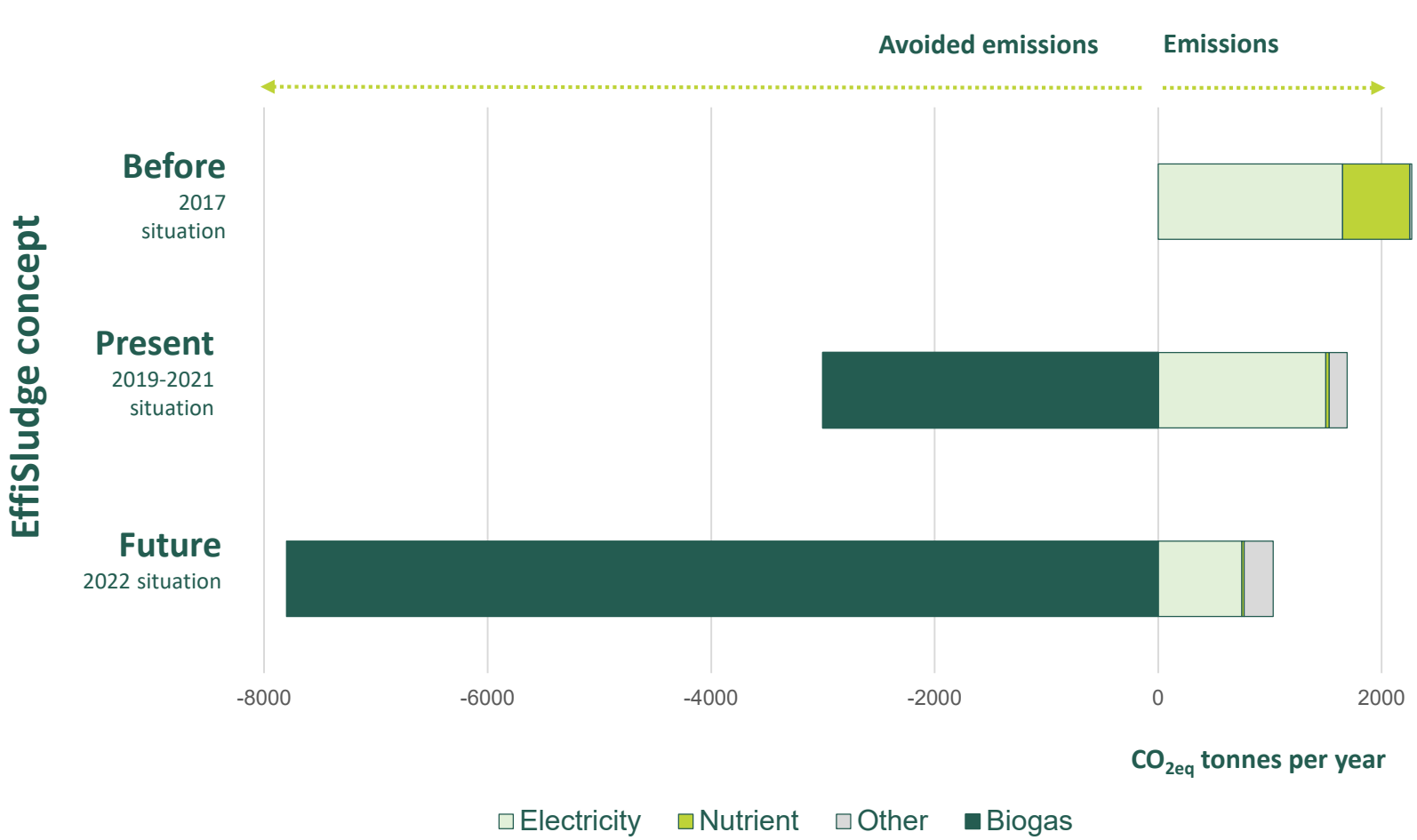
Annual carbon emissions



Savings

ton CO_{2eq}

0

3200

=0.4 $kgCO_2$ per m^3 wastewater

9000

=1 $kgCO_2$ per m^3 wastewater

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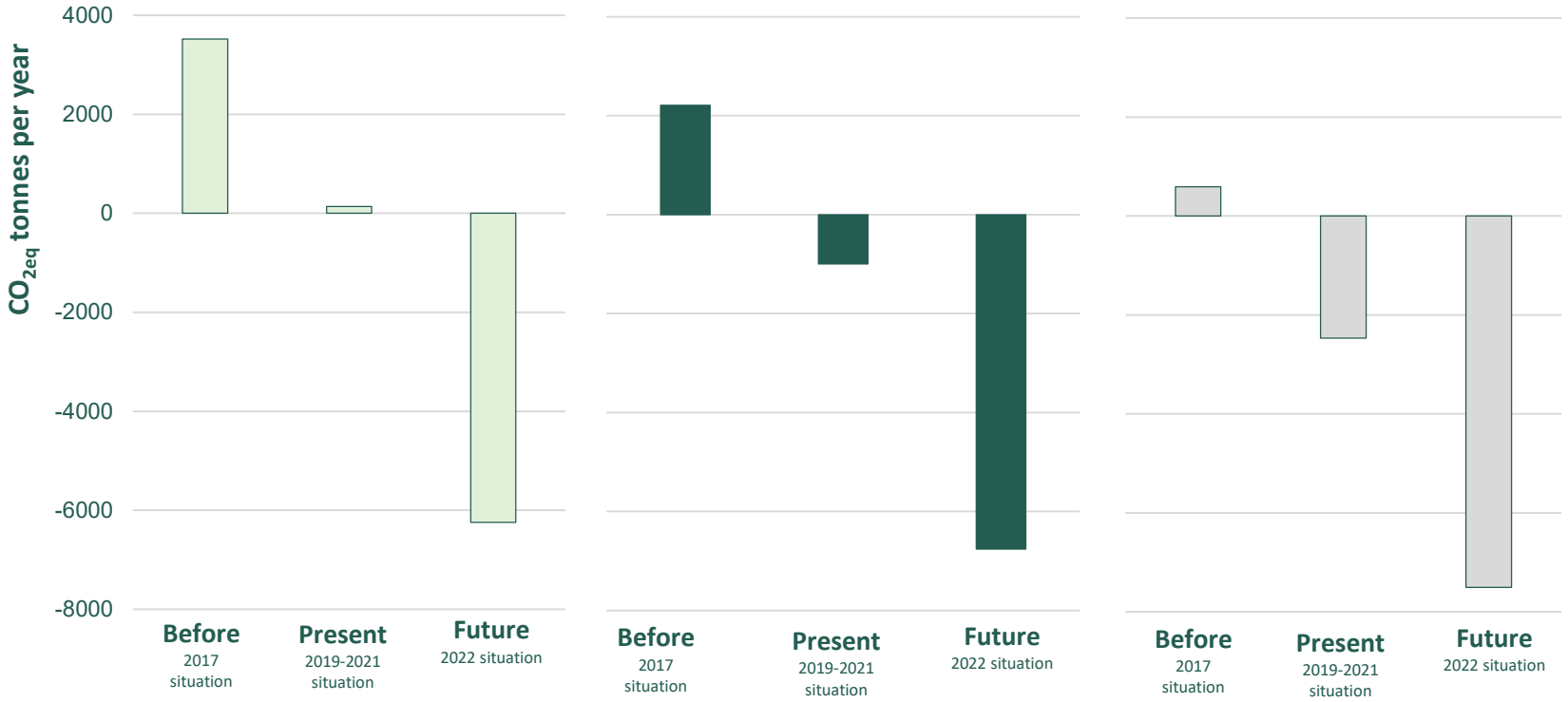
EffiSludge under different carbon factor conditions

EffiSludge achievement under different carbon factor conditions



High

Strong influence of fossil-based fuels energy- and nutrient production

EU mix 2021

European average with on high share of green energy in the electricity mix

Low

Green electricity (Norwegian case with mainly hydropower)

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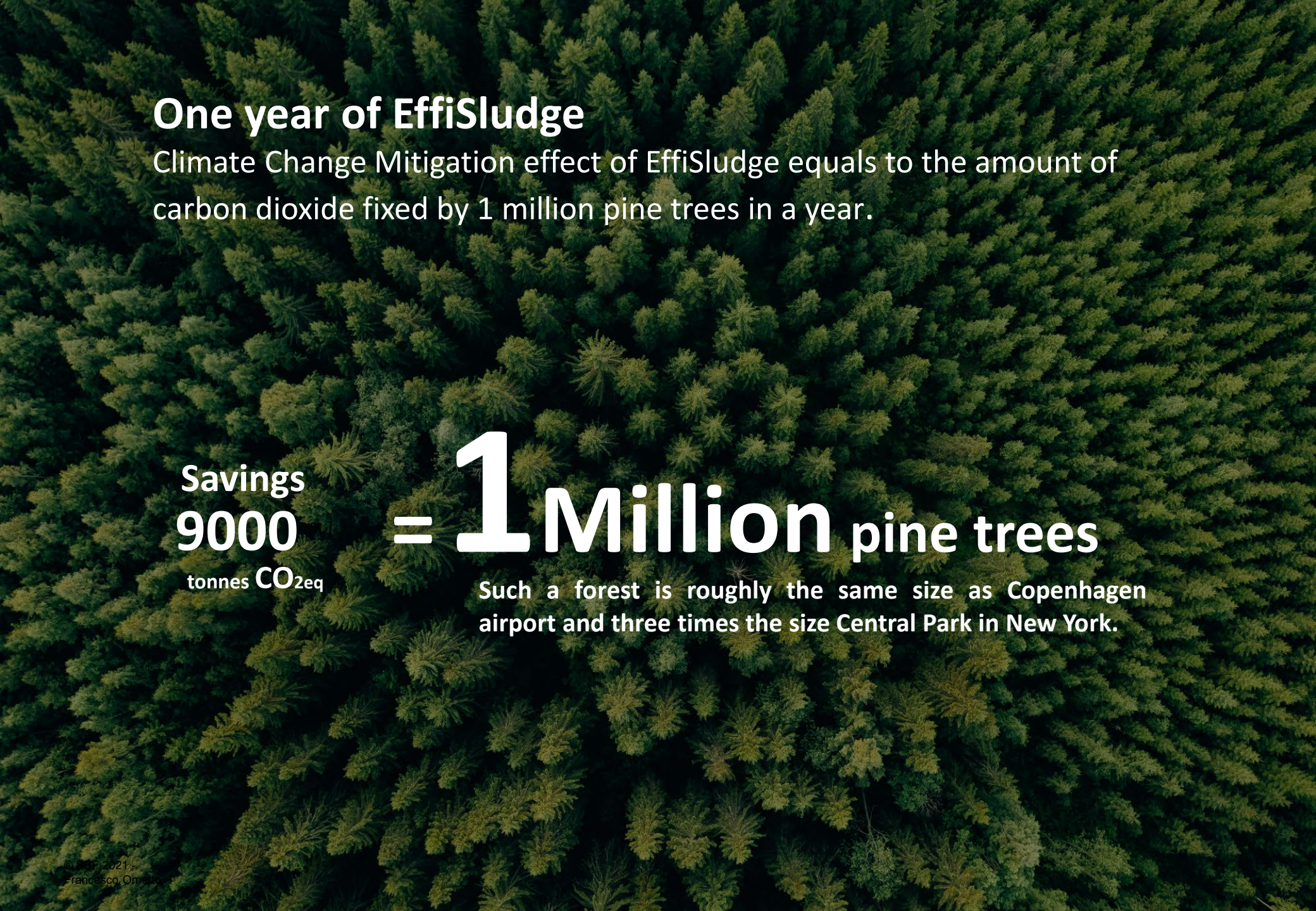

www.scandinavainbiogas.com/effisludge

General public

the project website offers an overview of the project development over time. Our regular newsletter "EffiNews" and twits reached thousands in Europe and beyond.

Target group

stakeholders from the pulp and paper industry and the biogas sector have been the key target groups. Our workshops have created opportunities for open discussions.

Experts

presentations on conferences, seminars, online events as well as scientific publication have disseminated the project to both the academia and the industry and also connected us with other projects in the field.

Policy Maker

the development of the project promoted a possible inclusion of the EffiSludge concept as a Best Available Technology (BAT).

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Thank you for listening!

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we deliver what we promise
with passion