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Integrated AcoD system of the organic fraction of MSW and sewage sludge: Case study

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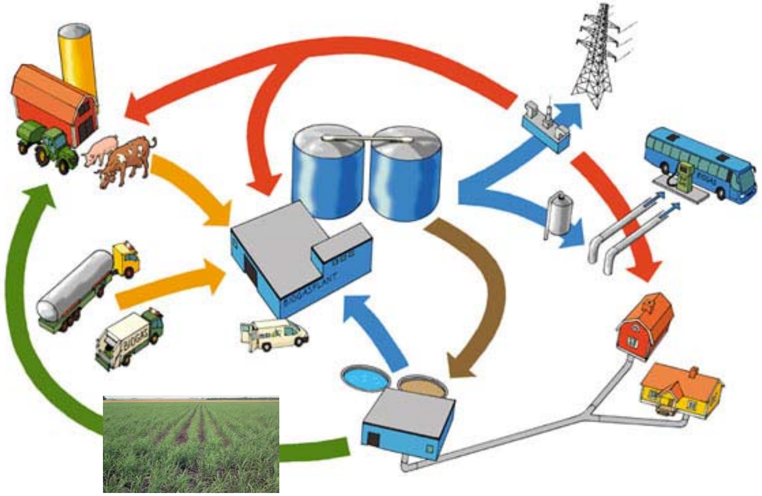
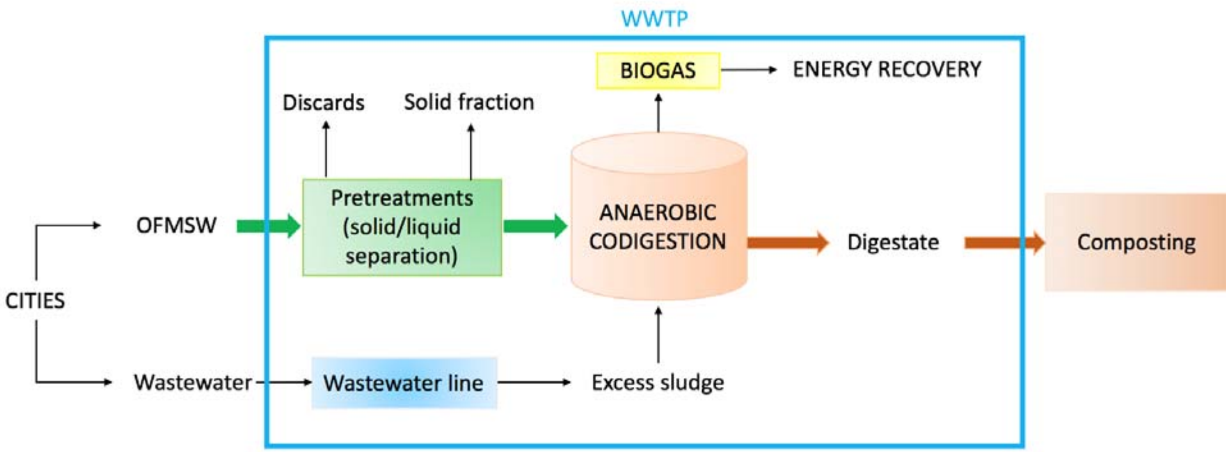
ACoD: as territory service was discussed in the 2th IC-SSWM according to the following schemes



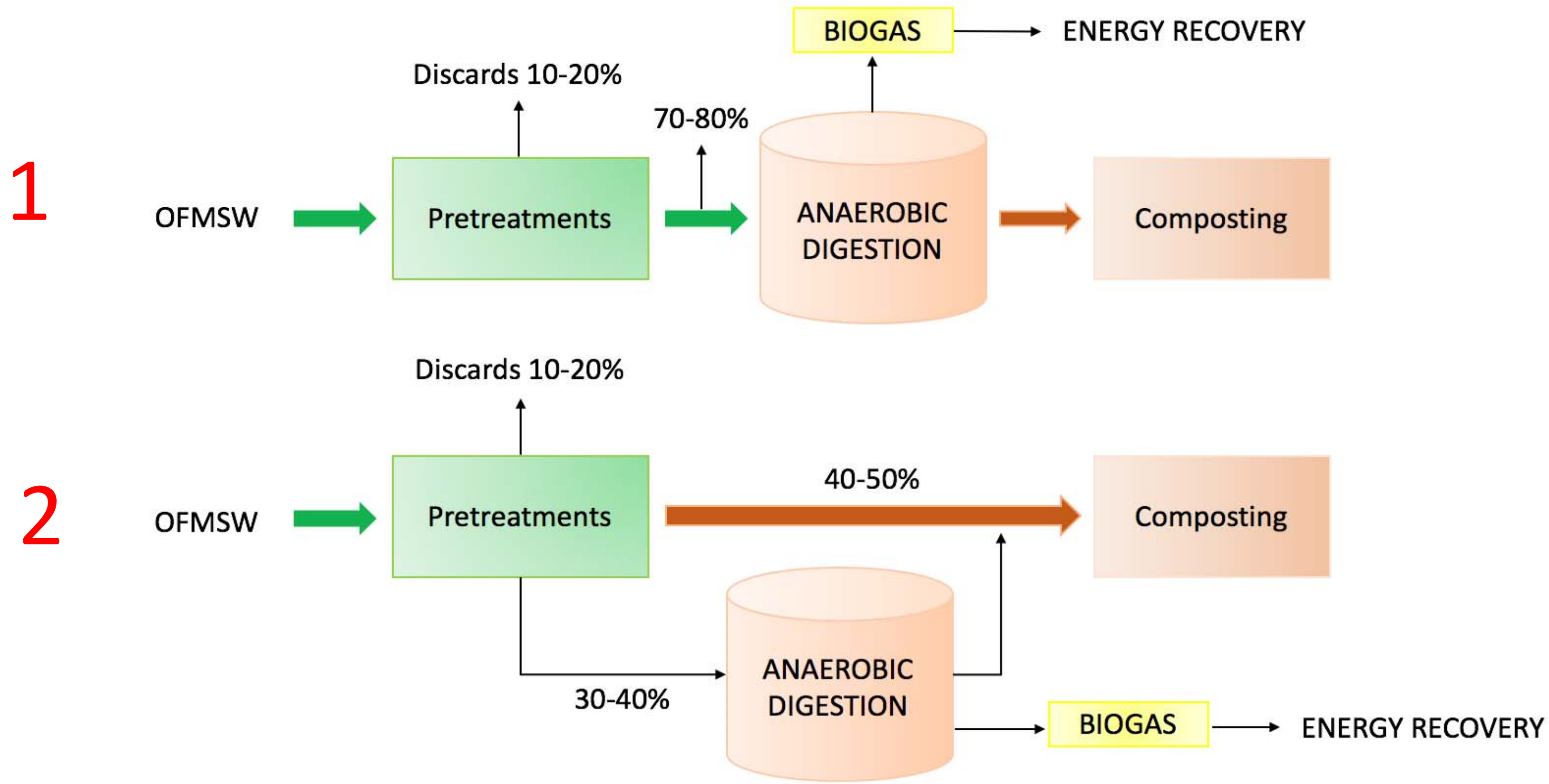


Cecchi F., et Al. (1994). Water Science & Technology; Cecchi and Cavinato (2015), Waste Management and Research

Two main objectives for OFMSW recovery and valorisation trough AcoD:

1 Maximisation of **energy recovery**

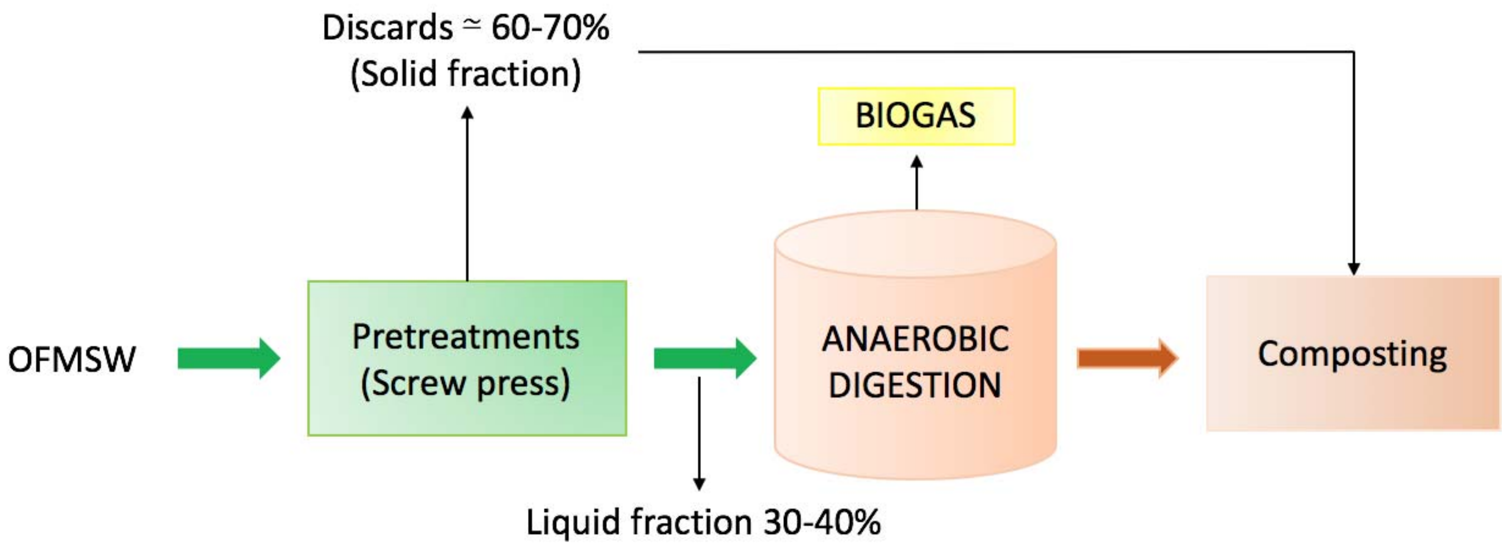
2 Maximisation of **matter recovery**



The choice is driven by territory diversity and available technologies

Case Study Approach

Screw press flowchart



- **Squeezed wet biowaste contains approx. 15-20% TS**
- **This approach could favour ACoD with SS in nearby WWTPs**

Case study: full-scale implementation of OFMSW-SS AcoD Treviso WWTP

Squeezed OFMSW from door-to-door separate collection ensures **high quality organic waste**

Parameter	Mean ± St. Dev.	Max	Min
TS, g/kg	135 ± 52	211.0	33.2
TVS, g/kg	113 ± 44	176.6	24.9
TVS/TS, %	84 ± 3	97	75

Organic waste recycling in Treviso Province = **85.3%**
(ARPAV, 2017)

Case study: full-scale implementation of OFMSW-SS AcoD
Treviso WWTP

- **Treviso (TV)**

A.T.S. S.r.l. WWTP

Feedstock mixture characterization

Parameter	Mean ± St. Dev.	Max	Min
TS, g/kg	33.8 ± 5.3	48.9	19.4
TVS, g/kg	24.9 ± 3.8	34.9	13.8
TVS/TS, %	74 ± 4	88	55
pH	5.4 ± 0.25	5.92	5.08
COD, gCOD/kgTS	811 ± 52	979	693
TKN, gN/kgTS	41.3 ± 6.2	48.9	19.2
P_{org}, gP/kgTS	11.0 ± 3.1	20.0	4.8

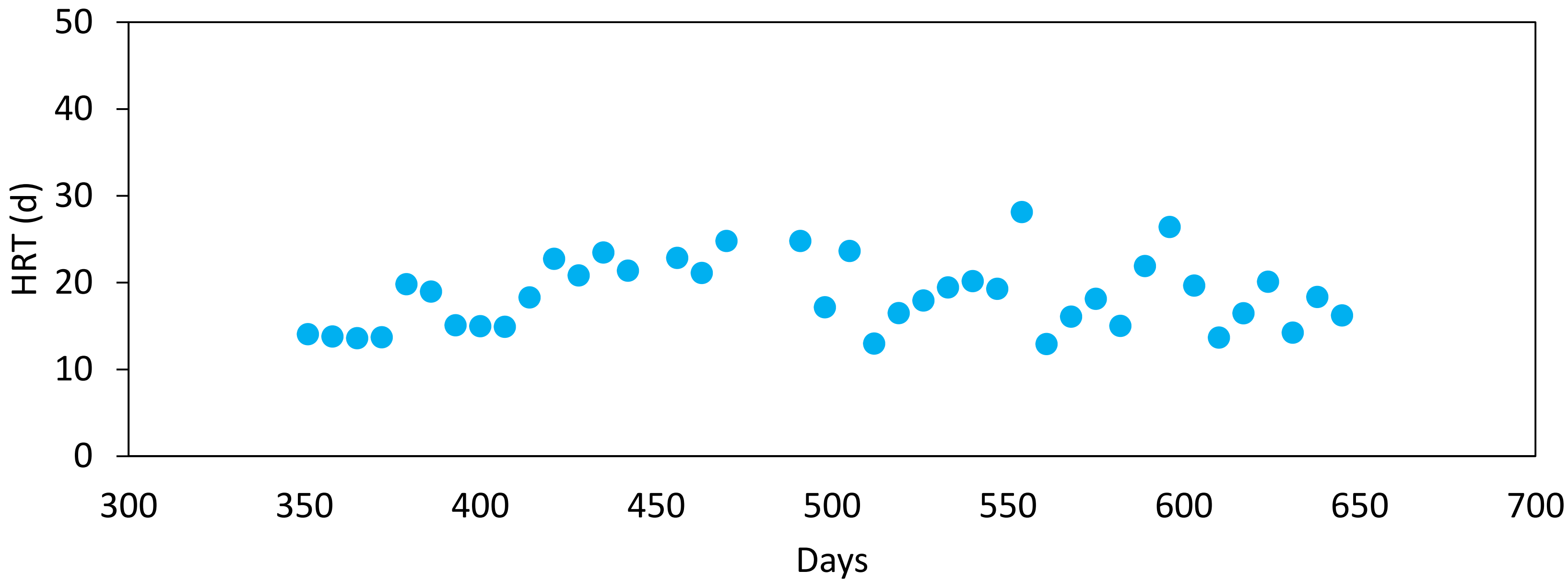
2000 m^3 anaerobic digester CSTR

Effluent characterization

Parameter	Mean ± St. Dev.	Max	Min
TS, g/kg	18 ± 2.7	28.0	13.5
TVS, g/kg	12.1 ± 2.3	19.0	8.0
TVS/TS, %	67 ± 7	88	52
COD, gCOD/kgTS	736 ± 53	906	648
TKN, gN/kgTS	40.0 ± 8.1	49.1	19.1
P_{org}, gP/kgTS	13.7 ± 3.7	27.1	9.1

Steady state conditions operating parameters

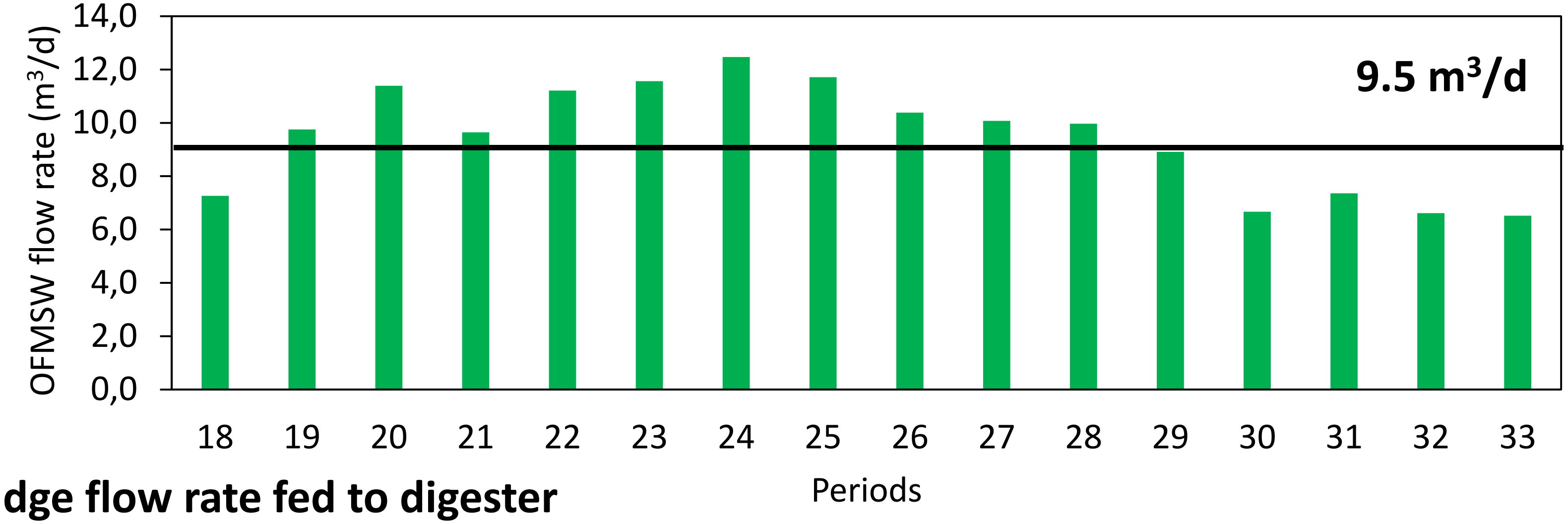
Hydraulic Retention Time



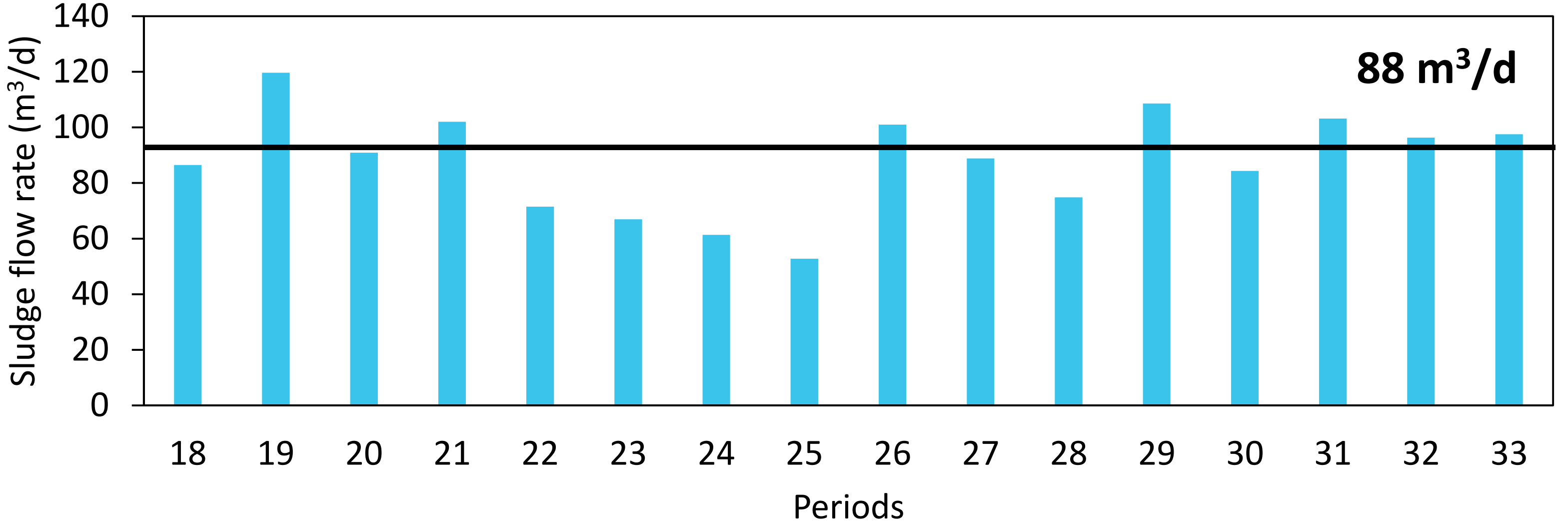
During steady state conditions an average **HRT = 20 days** was mantained

Parameters of steady state operating conditions

OFMSW flow rate fed to digester

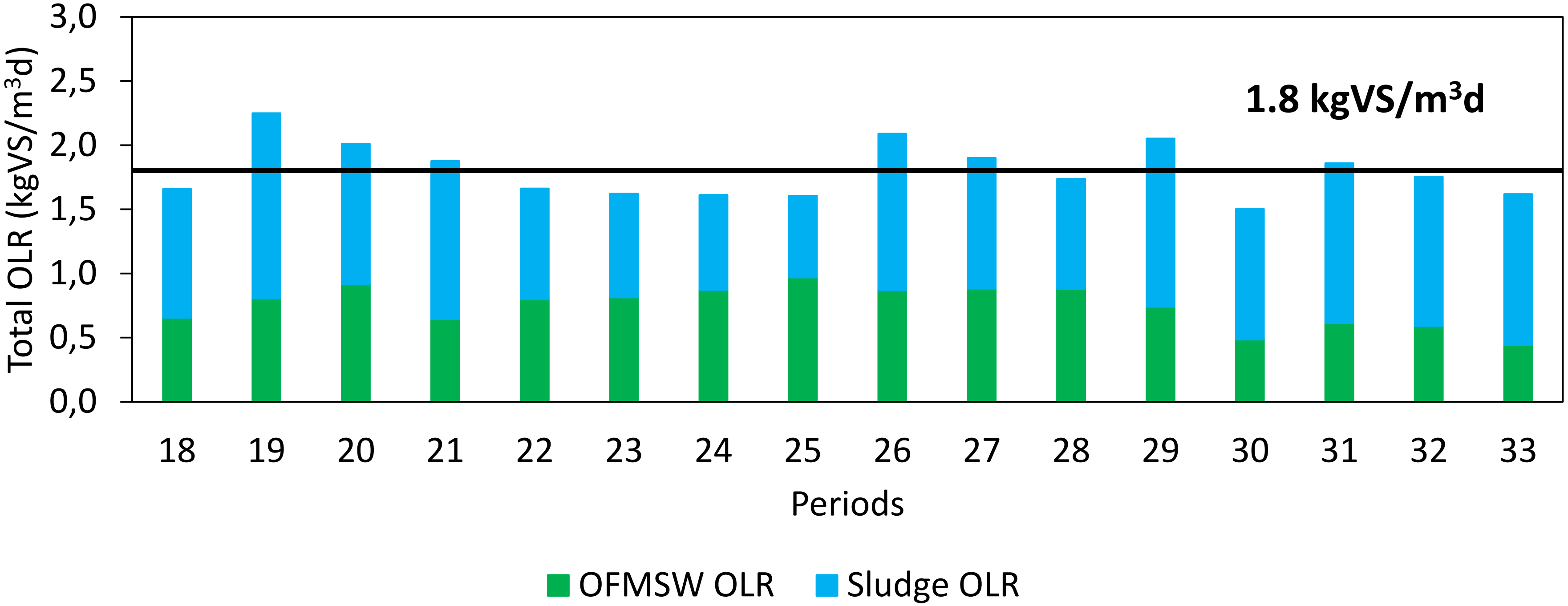


Sludge flow rate fed to digester



Parameters of steady state operating conditions

Organic Loading Rate

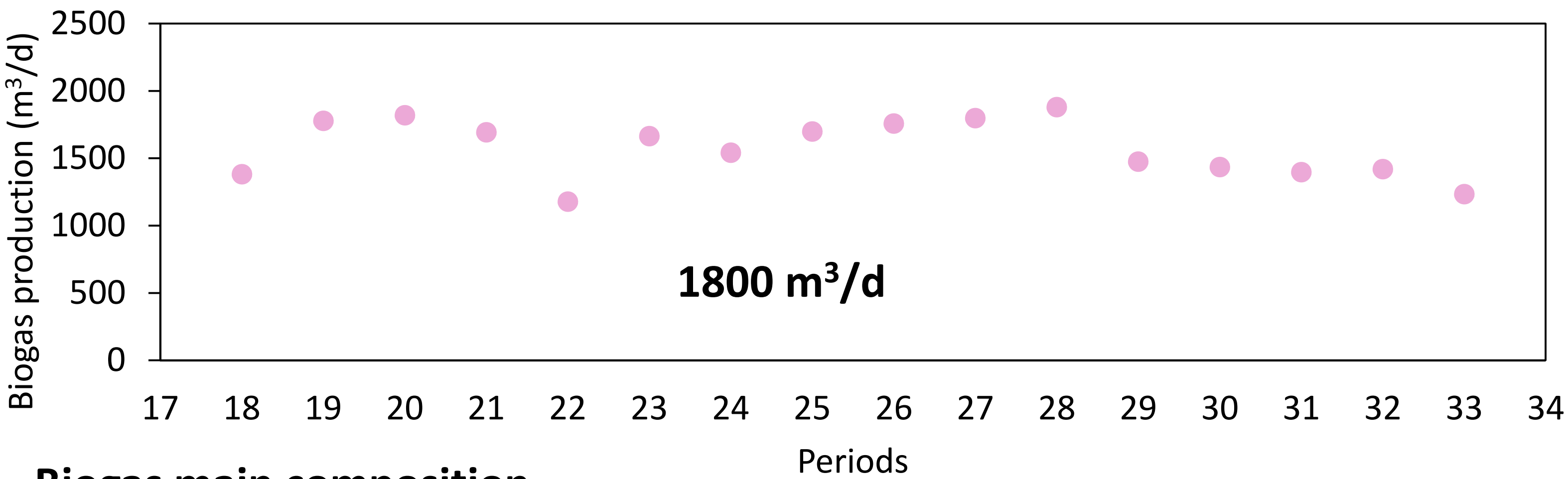


- Average OFMSW OLR = 0.7 kgVS/m^3d
- Average Sludge OLR = 1.1 kgVS/m^3d

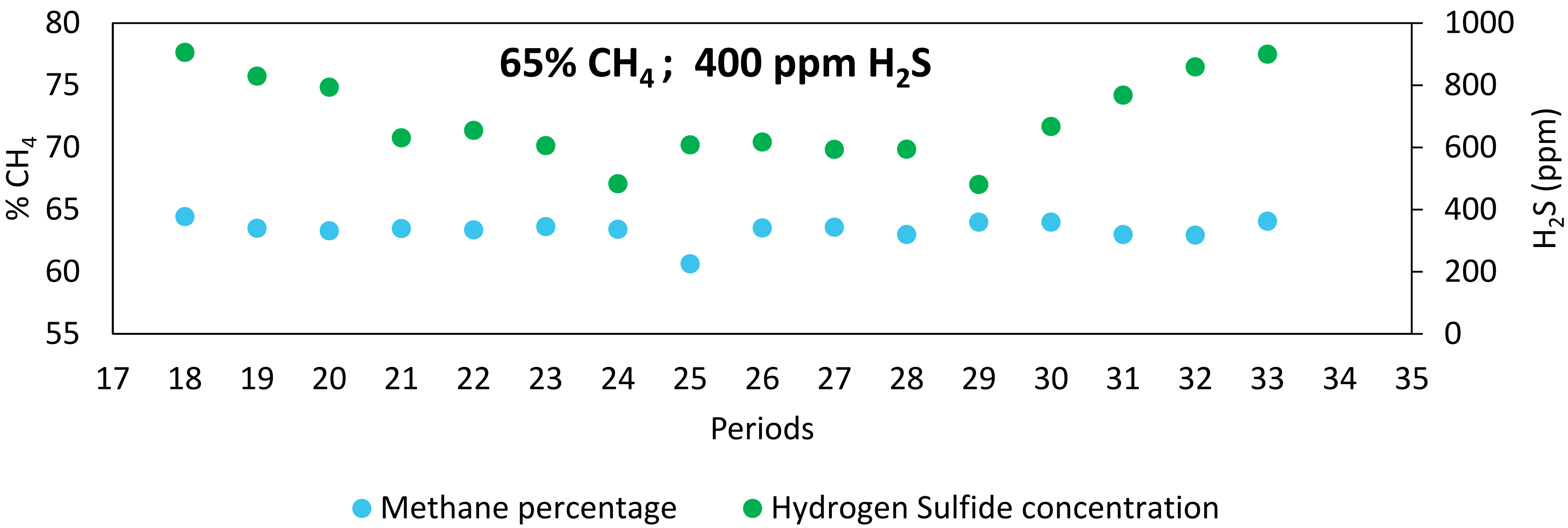
*All results shown are related to steady state conditions and based on an average of 20 days
Steady state conditions cover a time period from 22/04/17 to 28/02/18

Steady state conditions performance parameters

Biogas production

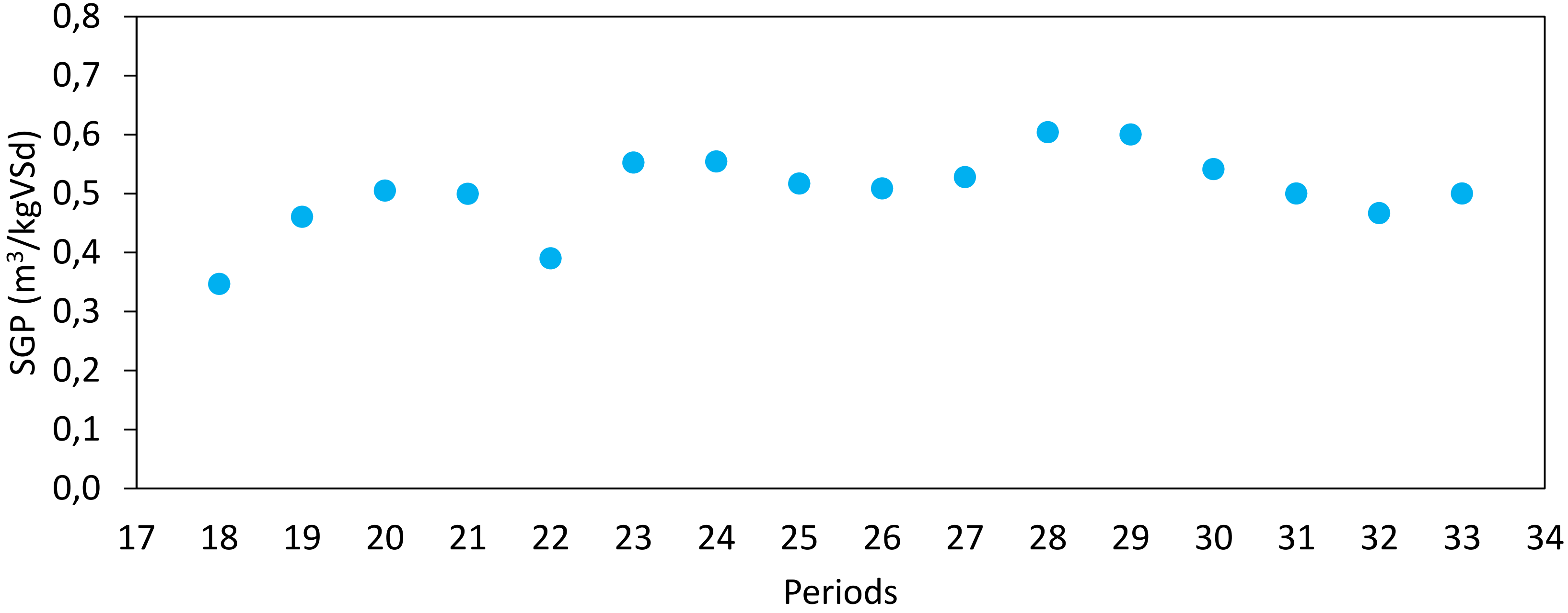


Biogas main composition



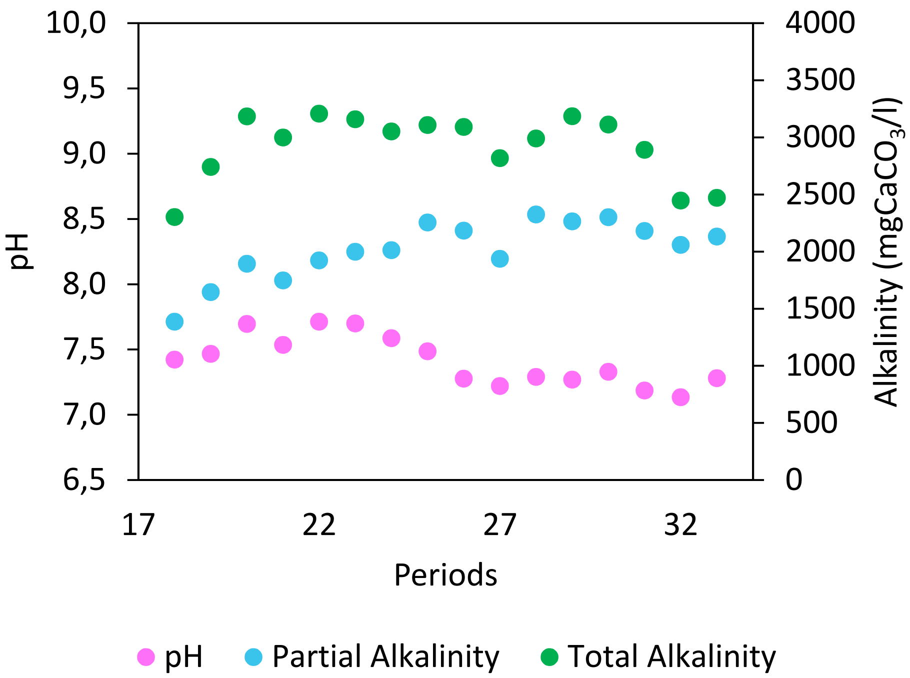
Steady state conditions performance parameters

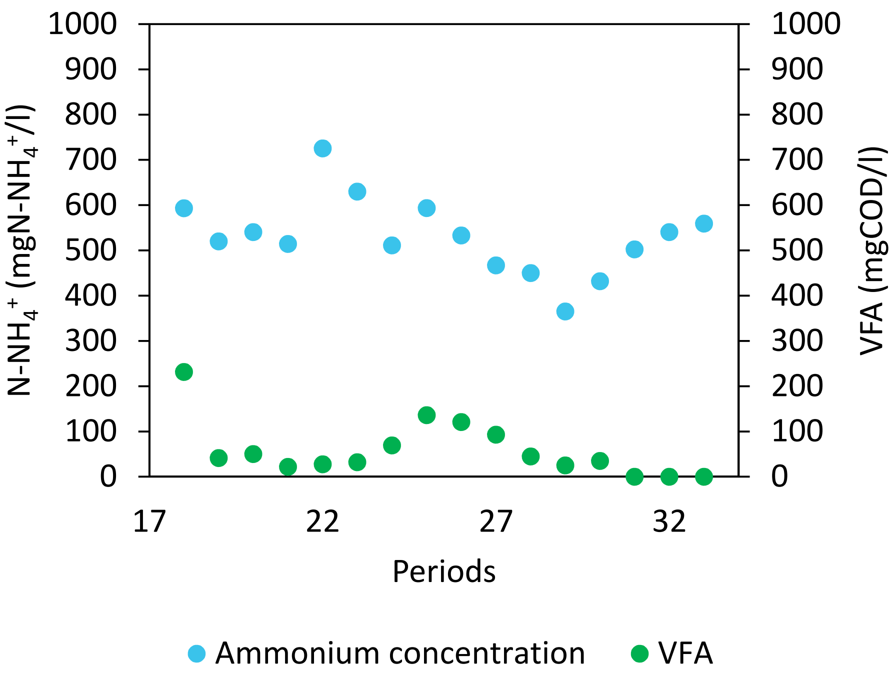
Specific Gas Production



Stable **SGP** was observed with an average value of **0.5 m^3/kgVSd**

Steady state conditions: process stability parameters

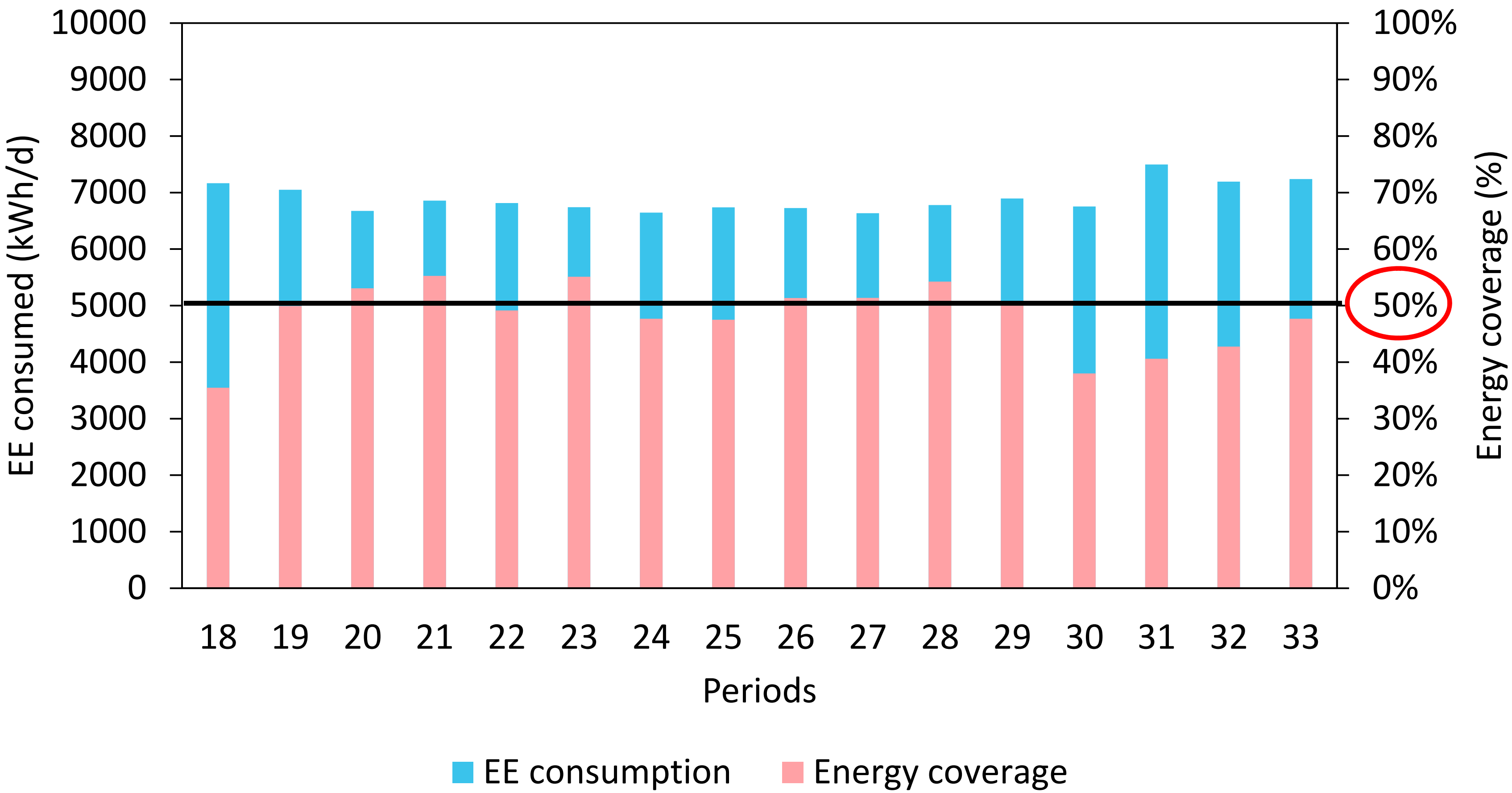




Parameter	Mean ± St. Dev.	Max	Min
pH	7.4 ± 0.19	7.7	7.1
Alk pH6, $mgCaCO_3/l$	2015 ± 258	2326	1387
Alk pH4, $mgCaCO_3/l$	2932 ± 290	3208	2303
$N-NH_4^+$, $mgN-NH_4^+/l$	530 ± 84	726	365
VFA, mgCOD/l	58 ± 23	232	0

Steady state conditions were characterized by stable pH, alkalinity, ammonium and VFA concentrations

Energy consumption and recovery

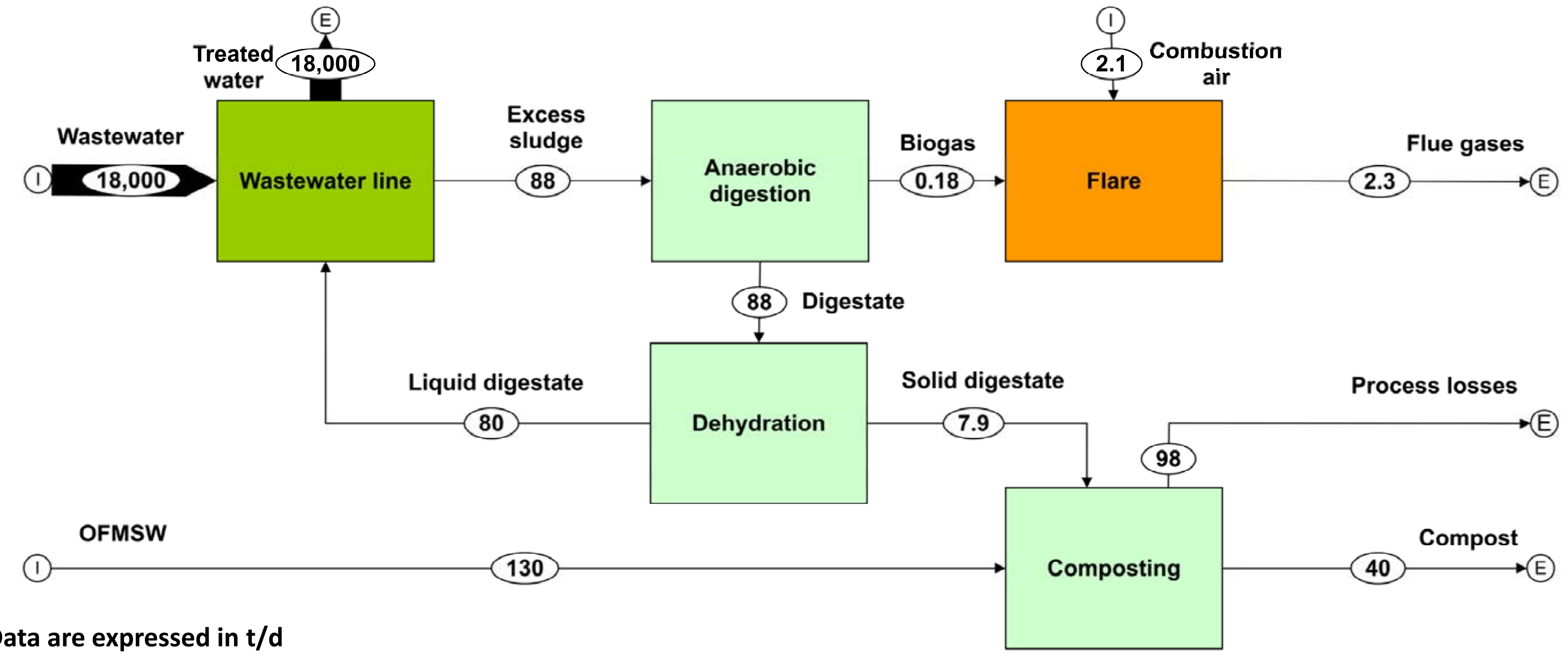


- Electric energy is autoproduced through a 185 kW_{el} CHP motor
- Energy produced accounts for **50% of the total plant energy demand**

Preliminary LCA study

Two different LCA scenarios: **past** scenario **VS** **present** scenario

- **Past scenario:** OFMSW composting

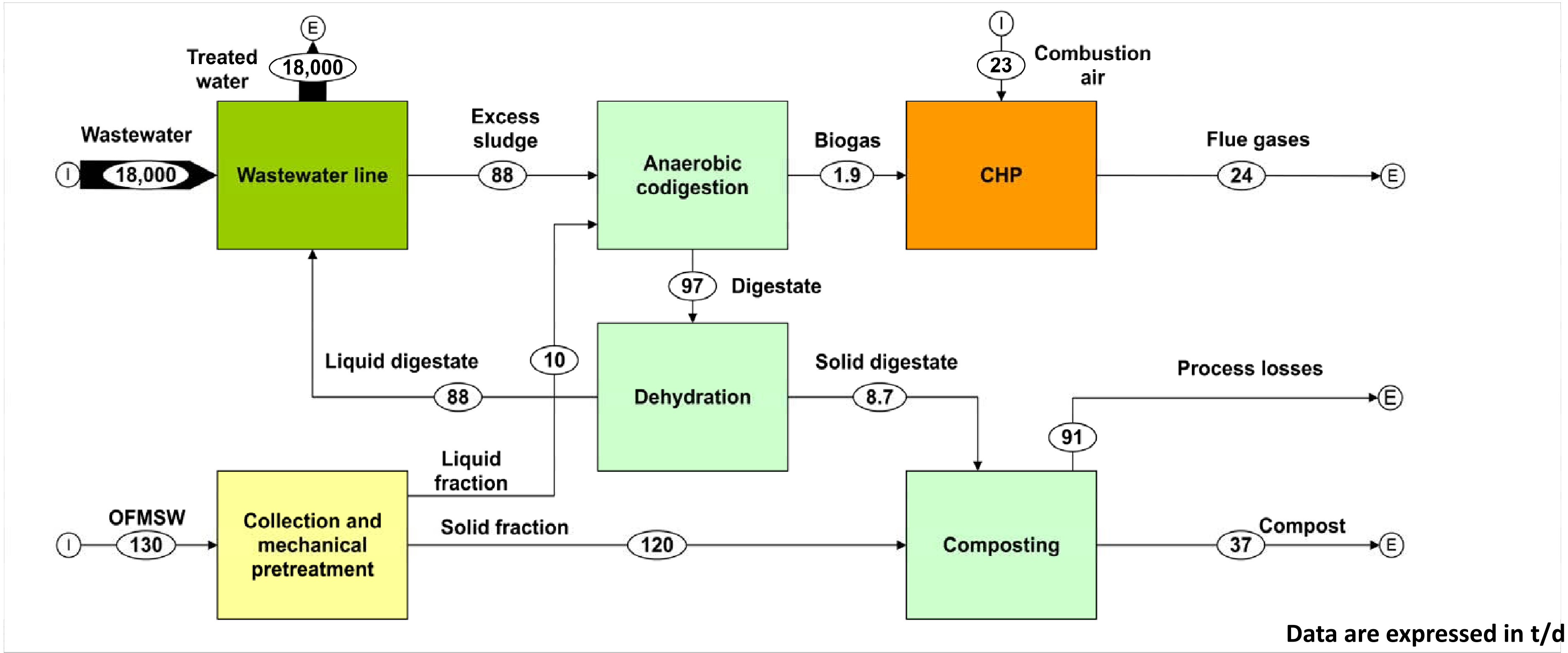


Data are expressed in t/d

Preliminary LCA study

Two different LCA scenarios: **past** scenario **VS** **present** scenario

- **Present scenario:** OFMSW pretreatment → AcoD + Composting



Preliminary LCA study

		"Past" scenario		"Present" scenario		Delta (Present-Past)
	Specific electrical consumption, kWh/t_{IN}	Input, t_{IN}/d	Electrical consumption, kWh/d	Input, t_{IN}/d	Electrical consumption, kWh/d	Electrical consumption, kWh/d
Composting	69	138	9515	129	8880	-635
Wastewater line	0.04	180000	6667	180000	6667	0
	Recovered EE, $kWh/t_{Biogas\ to\ CHP}$	Biogas to CHP, t_{IN}/d	Recovered EE, kWh/d	Biogas a CHP, t_{IN}/d	Recovered EE, kWh/d	Recovered EE, kWh/d
Recovered EE from CHP	1771	-	-	1.89	3345	3345
Total electrical consumption		kWh/d 16182		kWh/d 12202		kWh/d -3979

Global Warming Potential of the Italian electrical mix:

0.437 kg $CO_{2\ eq}$ for the production of 1 kWh *(from: IPPC 2001 500a, and IEA 2016)*

Potential avoided GWP: 1739 kg CO_2 eq. per day

Conclusions

OFMSW codigestion with SS ensures:

- Valorisation of organic wastes through energy recovery
- Best territorial service for citizens
- Simple operational work
- Stable operating condition under SSC
- Higher revenues
- Slight increase in sludge production
- High energy savings due to CHP biogas conversion
- Undeniable overall convenience in terms of LCA

Applicable to any WWTP with reduced upgrading costs

THANK YOU FOR YOUR ATTENTION!