Retrofitting Veolia's DLD & Exelys to Maximise Renewable Electricity Production

VEOLIA
WATER
Solutions & Technologies

Contents

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The Study Site’s Characteristics

1.1 Water Process Stream

- Plant Designed for 220,000 PE
- Conventional Treatment to Comply with UWWT Directive for Carbon Removal:
  BOD <25 mg/l (or 70% reduction) TSS <35 mg/l
- Preliminary Treatment
  6 mm 2D screen and Grit removal
- Primary Treatment
  3 off 37.0 m diameter PST
- Secondary Treatment
  3 Aeration Lanes (sludge age below 5 days)
  4 off 41.0 m diameter FST
- Biological Plant under loaded due to Lack of Population growth and cessation of seasonal waste stream

1.2 Sludge Process Stream

- Designed for Imports Sludge Liquids of ~600 tDS pa with separate indigenous Primary & SAS sources
- Plant Capacity 17 tDS/d or 6205 tDS pa
- Plant Comprises:-
  - Liquid Import
    - → Reception and Screening
  - Raw Sludge Buffer Tanks
    - → 2 off 1165 m^3 tanks
  - Thickening
    - → 2 off GBT units

1.2 Sludge Process Stream (cont)

- Mesophillic Anaerobic Digesters
  - → 2 off 2155 m^3 (gas mixed) c/w Boiler re-circulation to external concentric tube HEX units
- Dewatering
  - → 2 off Belt Press units
- Drying Plant
  - → 1 off ~1.6 tonne/h Unit c/w pelletiser
- Biogas System
  - → Gas Holder, Boiler CHP engine and Excess Flare

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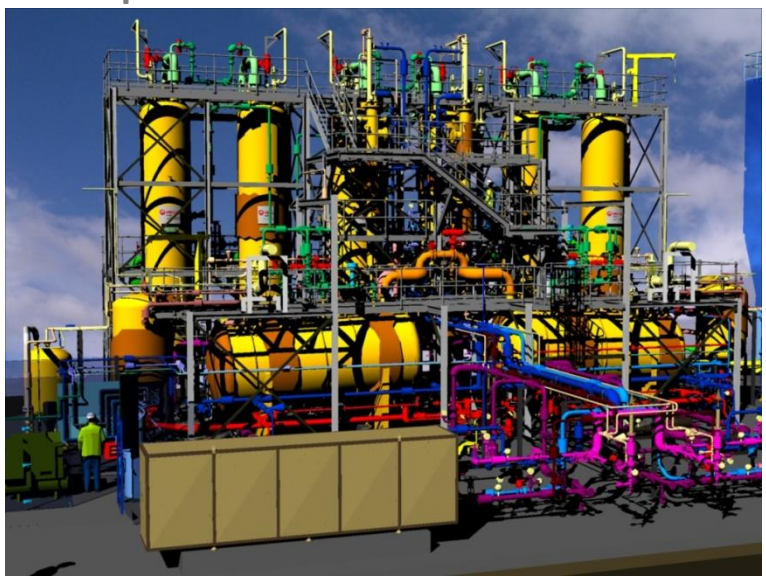
What are the Sites Drivers for Sludge Treatment

What are the site's drivers for sludge treatment?

- To minimise the final quantity of sludge
- Sludge disposal route is to agricultural re-use so Enhanced Treated Sludge is essential
- Currently the product is dried and gives an Enhanced Treated Sludge
- The Biogas produced by the AD plant was intended to operate the drying plant
- However, due to the revenue available from Biogas the plant has been retrofitted with a CHP facility to heat the digestion plant and generate ROC certified electricity
- Consequently the dryer is now fired with fossil fuel and Biogas used to produce electricity
- As a result the fuel OPEX costs are significant and the drying process and pelletiser has a high electrical demand

What are the site's drivers for sludge treatment? (cont)

- The operator has been reviewing the markets current driver to improve the biogas & electricity production and increase this revenue stream
- They needed to retain an Enhanced Treated product
- We were asked to review the sites current operating protocol and determine the viability of changing the sludge treatment process



- Clearly the driver was towards thermal hydrolysis

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The THP Options Considered

The THP Options Considered

- Veolia has introduced Bio Thelys™, their batch Thermal Hydrolysis process to the market with a number of references sites with capacities up to 32,700 tDS pa per treatment train
- Veolia continues to develop their sludge treatment portfolio and HAVE commercialised a Continuous Thermal Hydrolysis Process, Exelys™
- Two options have been considered:
  - Bio Thelys™, the Veolia batch TH system with a number of reference sites
  - Exelys™, the Veolia continuous TH system with already four installations in design or construction

Veolia THP References

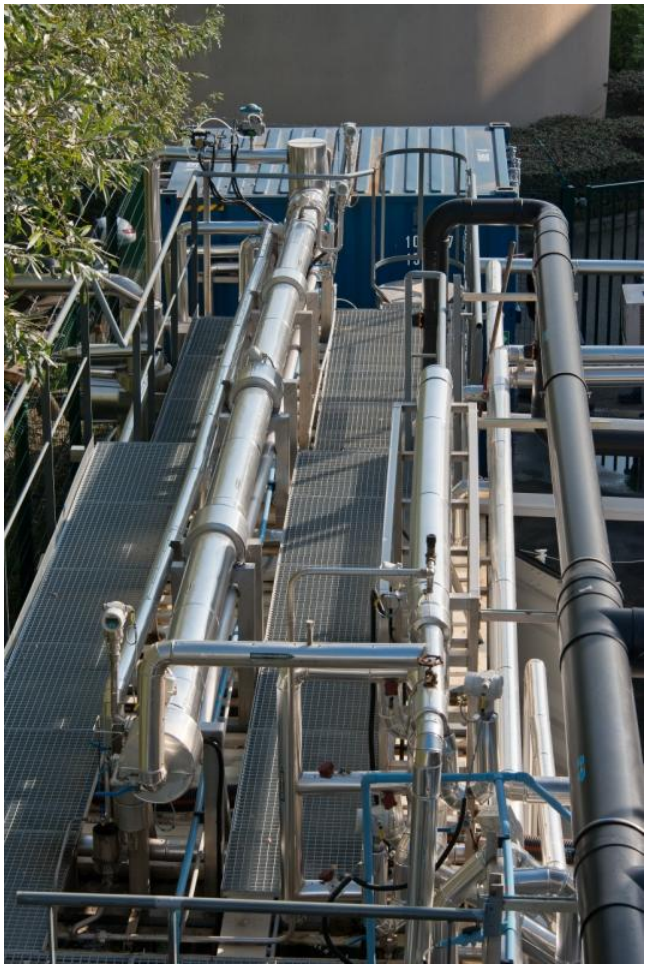
City	Country	Capacity	Capacity (pe)	Start-up	Process	Configuration
Saumur	France	1 600 tDS/y	60 000	2006	Bio Thelys™	LD
Château Gontier	France	1 000 tDS/y	38 000	2006	Bio Thelys™	LD
Le Pertuiset	France	2 000 tDS/y	80 000	2007	Bio Thelys™	LD
Hillerod	Denmark	700 tDS/y	50 000	2009	Exelys™	DLD
Tergnier	France	1 600 tDS/y	30 000	2011	Bio Thelys™	LD
Monza	Italy	10 200 tDS/y	700 000	2011	Bio Thelys™	LD
Bonneuil (prototype)	France	230 tDS / y	15 000	2012	Exelys™	LD/DL/DLD
Esholt	UK	32 800 tDS/y	2 100 000	2013	Bio Thelys™	LD
Oxford	UK	24 400 tDS/y	1 400 000	2014	Bio Thelys™	LD
Lille	France	22 000 tDS/y	620 000	2014	Exelys™	DLD
Versailles	France	8 300 tDS/y	330 000	2015	Exelys™	DL
Grindsted	Denmark	1 400 tDS/y	100 000	2015	Exelys™	DLD

3.1 Bio Thelys™

- To optimise the steam demand profile the site's capacity is considered too small to use paired reactors, instead the 3 reactor configuration is used
- This configuration gives a continuous steam demand to minimises boiler size
- Inlet Raw sludge flow circa 77.0 m^3/d at 22% w/w [DLD]
- Reactors are circa 10.3 m^3 each, plus buffer tank circa 20.0 m^3

3.2 Exelys™

- Simplicity of solution - a pipe system with small footprint
- Reactor contact zone 1.5 m^3 retention which is plug flow
- Total system volume ~12.5 m^3
- Energy optimisation with heat recovery from processed effluent
- Less steam usage due to more concentrated sludge feed circa 70.5 m^3/d at 24% w/w [DLD]



Bio Thelys™ or Exelys™?

- The best Veolia TH solution is site specific, depending on capacity and client requirements

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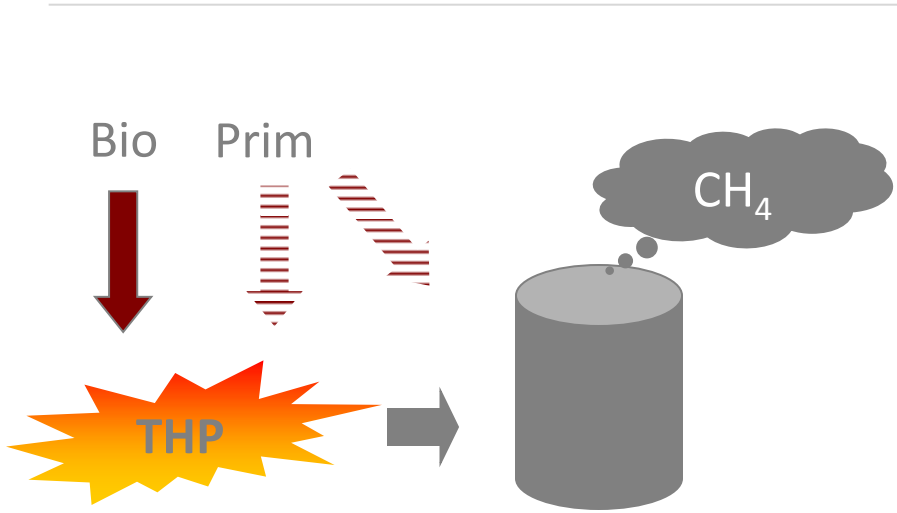
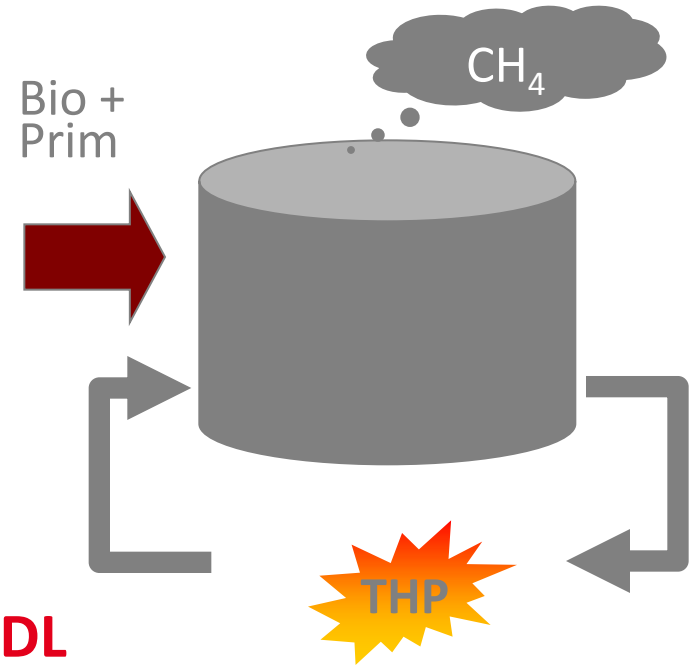
The THP Configuration LD or DLD

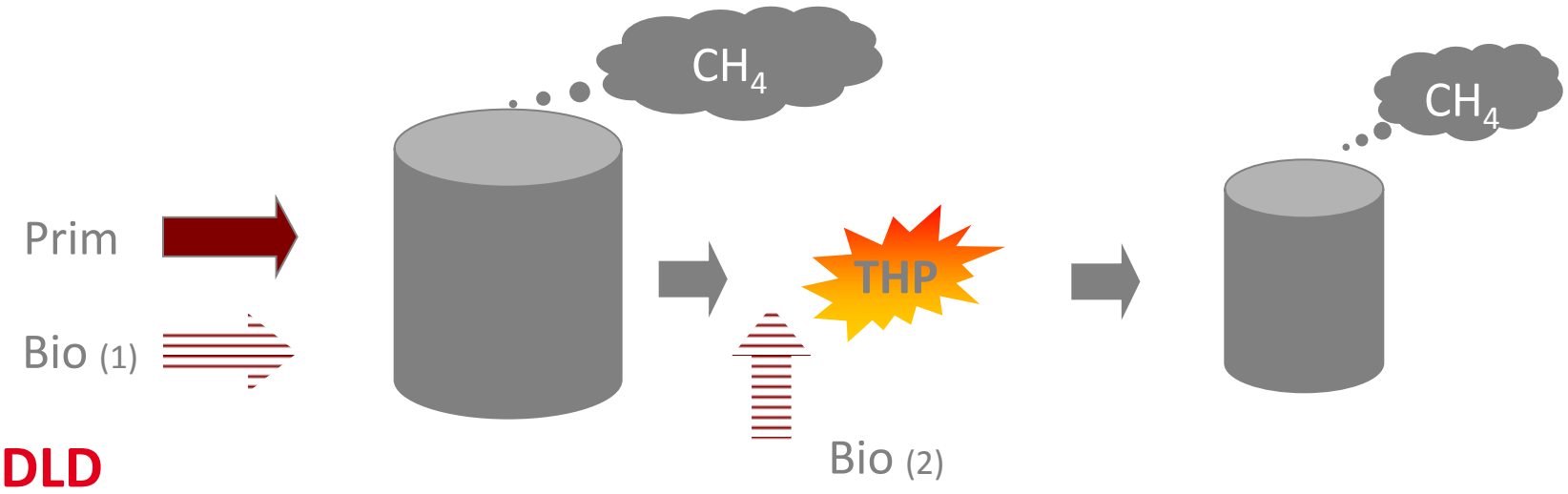
Different Thermal Hydrolysis Configurations



LD



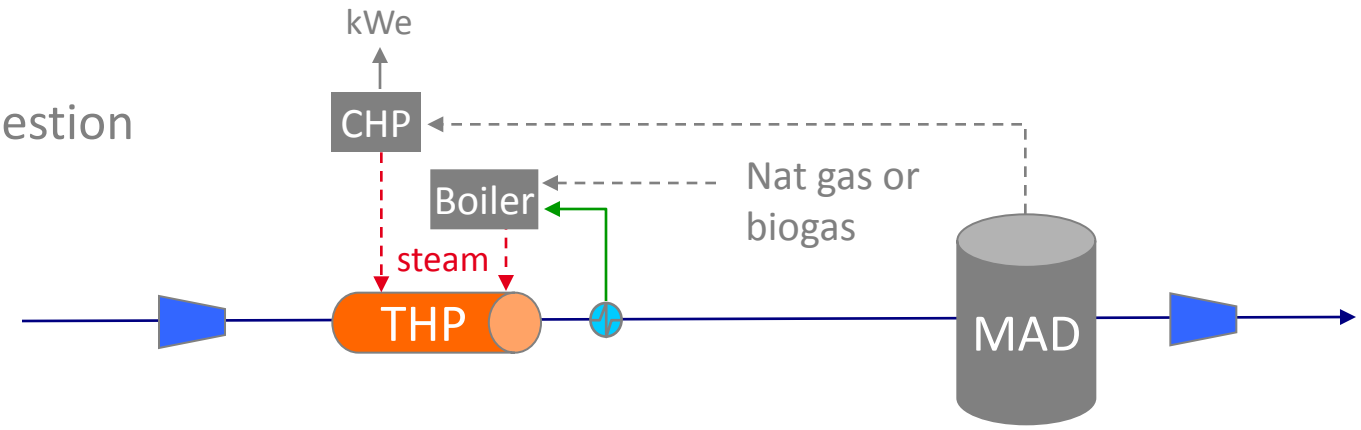
DL



DLD

Classical « LD » concept

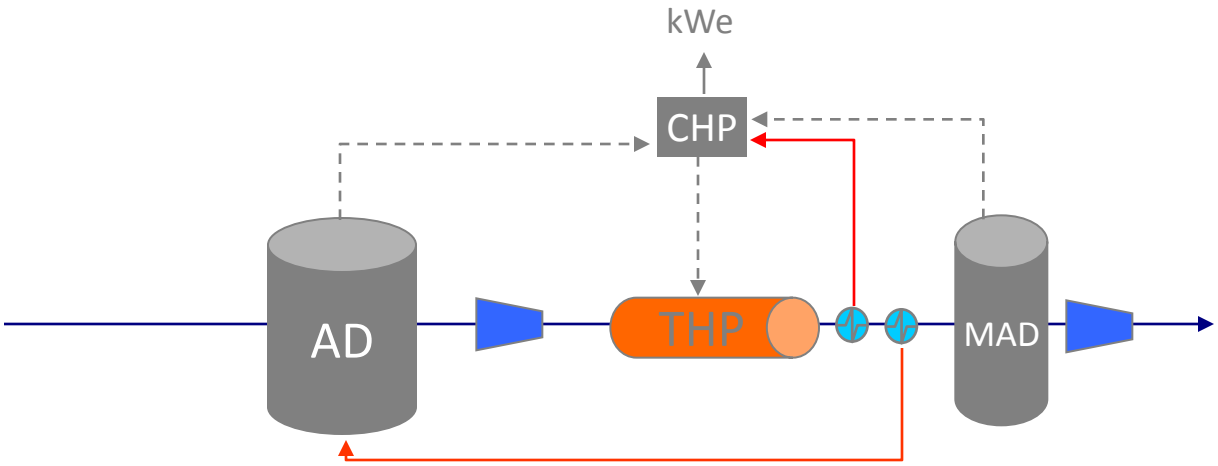
LD = Lysis + Digestion



- Thermal hydrolysis of fresh sludge
- Biogas used for steam production by CHP and boiler
- Enhanced treated sludge
- High sludge volume reduction
- Small anaerobic digester or existing capacity increase
- Well established and proven configuration

« DLD » concept (Veolia patent)

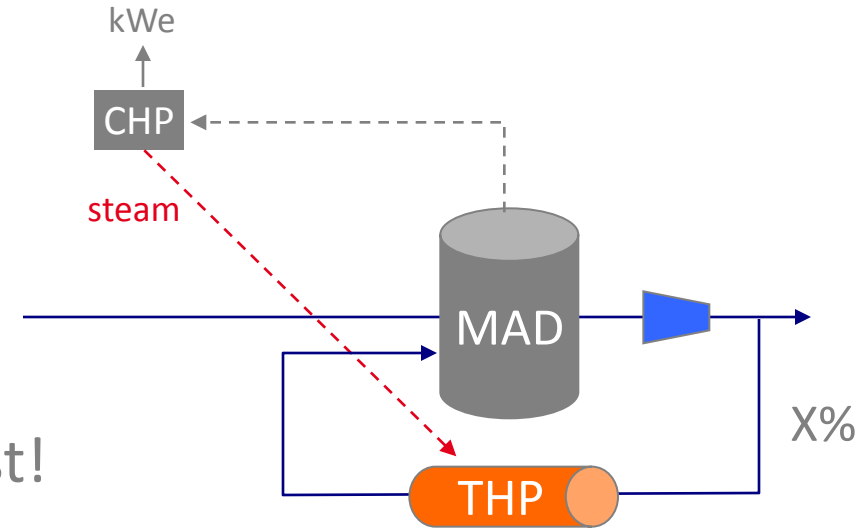
DLD



- Let biology work first!
- Providing TH to digested sludge (« refractory sludge ») thus reduces THP size & reduces steam consumption
- Increase of Biogas production
- Enhanced treated sludge
- Steam required, produced only by CHP thus electricity production optimised

« DL » concept

DL



- Let work biology first!
- « compact DLD » : Providing TH to digested sludge thus reduces THP design & reduces steam consumption
- Increase of Biogas production
- Steam is produced from the CHP, - defines THP capacity
- No capacity increase and not Enhanced Treated sludge

‘Conventional’ LD Configuration

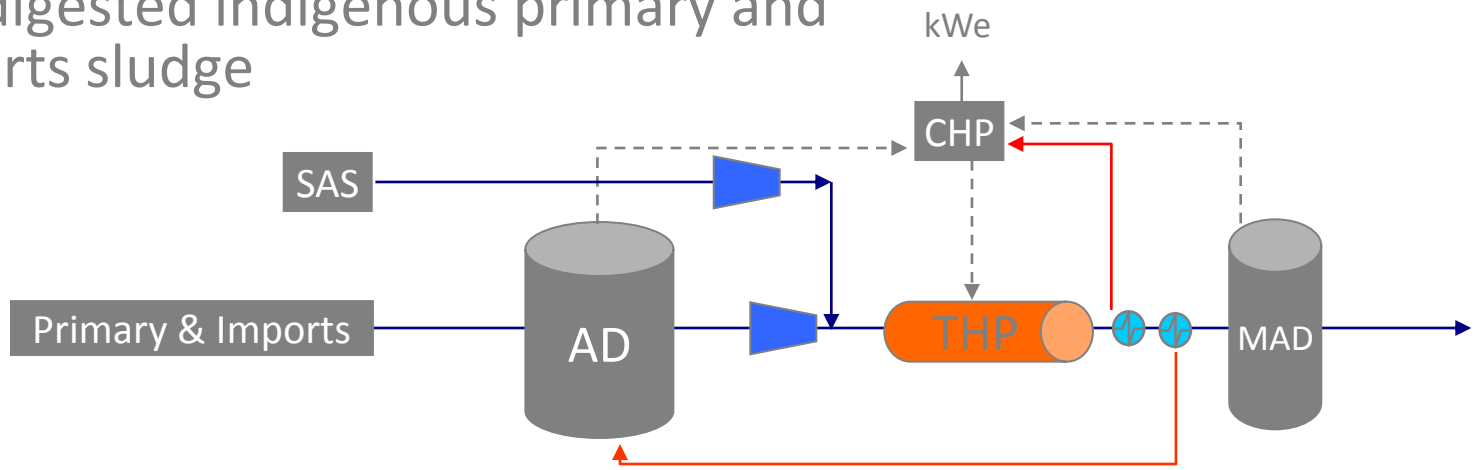
- Large capacity Exelys™ processing all sludge
- Increasing digester feed conc. from 7% w/w to 10% w/w increased digester retention to circa 26.5 days
- Possibility to increase imported sludge quantity/organic waste

  However no opportunity foreseen

- 2 Digesters lead to exploration of DLD opportunities

In DLD Configuration

- First stage digester volume too small to ensure good digestion of all sludge
- We then examined which sludge streams are best suited for DLD treatment and which suited LD alone
- First digester feed with readily degradable sludge (Primary plus imports)
- Second digester (post Exelys™) processing hydrolysed SAS and digestate from first digester
- Thus Exelys™ sized to process all indigenous SAS and the pre-digested indigenous primary and imports sludge



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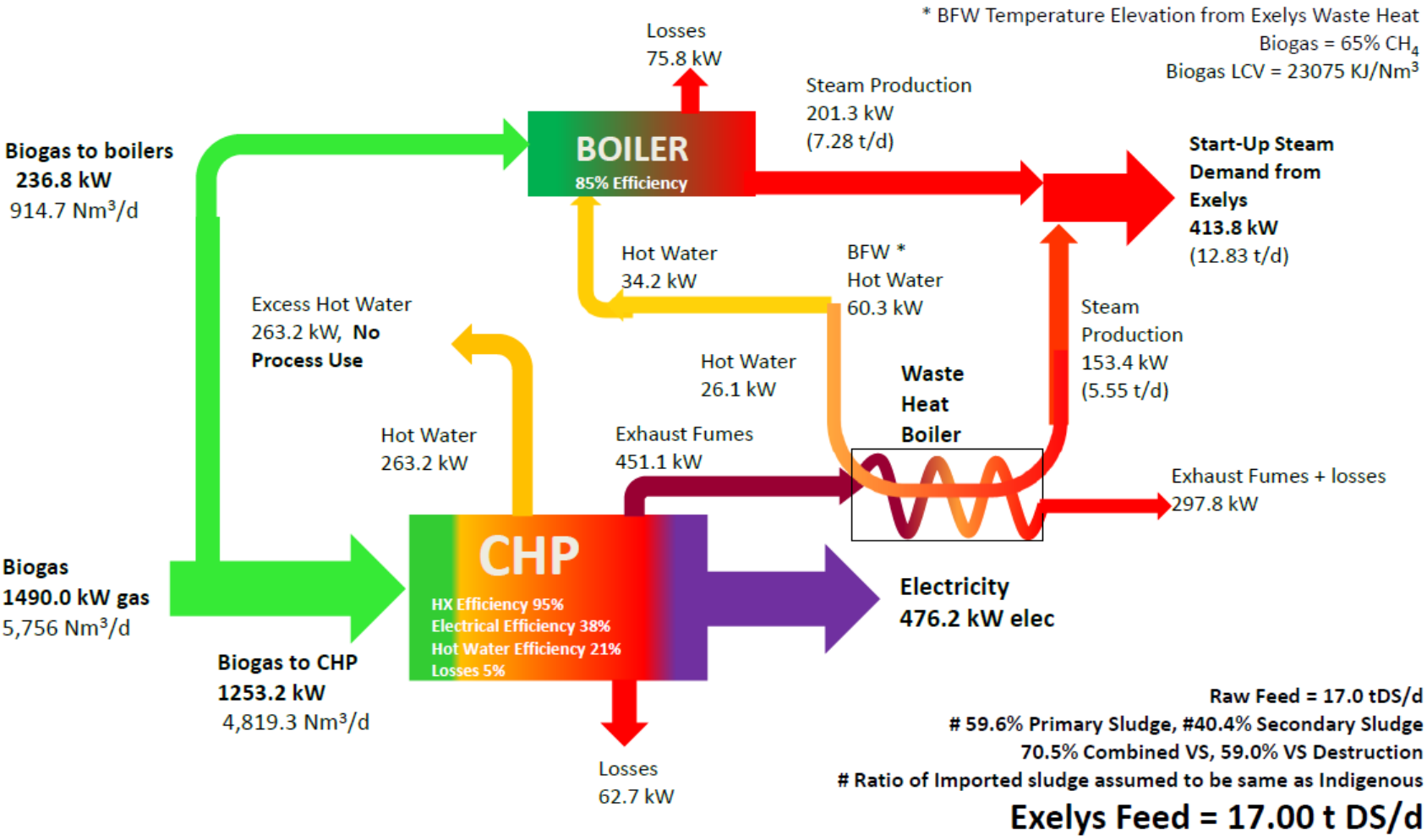
The preferred solution and conclusions

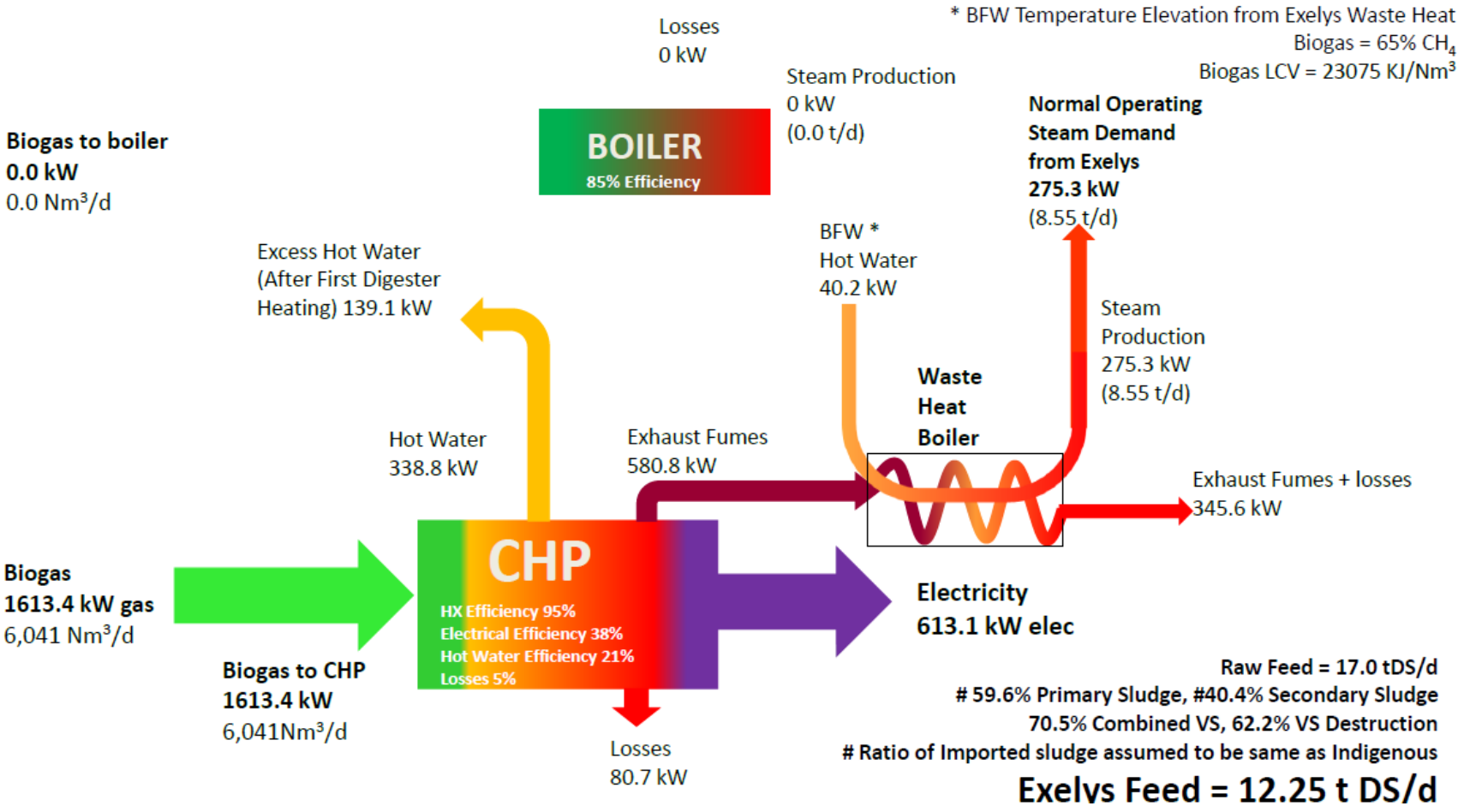
Comparison of DLD to LD

Item	DLD	LD	Difference
Biogas Yield, Nm^3/d	6,041	5,756	+ DLD 5% more
Steam Consumption, t/d	8.55	12.83	+++ DLD 33% less
Exelys™ Capacity, tDS/d	12.25	17.00	+++ DLD 30% less
tonne Steam per tonne DS feed to sludge treatment	0.50	0.75	+++ DLD removing readily degradable organics
Biogas to CHP, kW	1613.4	1253.2	++ DLD 29% more
Biogas to Boiler, kW	zero	236.8	+++ DLD self sufficient
Electricity Generated, kW_e	613.1	476.2	+++ DLD 29% more
Unused Hot Water (waste heat) kW	139.1 ~65% Recovery	263.2 Zero Recovery	No use for LD, Initial digester heating DLD

LD View

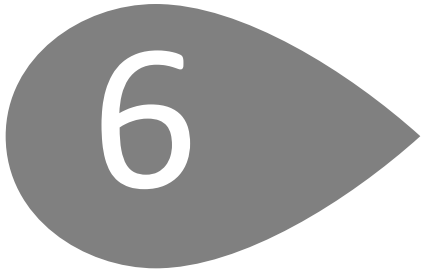

* BFW Temperature Elevation from Exelys Waste Heat
Biogas = 65% CH_4
Biogas LCV = 23075 KJ/Nm³
Losses
75.8 kW
Steam Production
201.3 kW
(7.28 t/d)
Biogas to boilers
236.8 kW
914.7 Nm³/d
BOILER
85% Efficiency
Start-Up Steam Demand from Exelys
413.8 kW
(12.83 t/d)
Hot Water
34.2 kW
BFW *
Hot Water
60.3 kW
Excess Hot Water
263.2 kW, No Process Use
Hot Water
26.1 kW
Steam Production
153.4 kW
(5.55 t/d)
Waste Heat Boiler
Hot Water
263.2 kW
Exhaust Fumes
451.1 kW
Exhaust Fumes + losses
297.8 kW
Biogas
1490.0 kW gas
5,756 Nm³/d
CHP
HX Efficiency 95%
Electrical Efficiency 38%
Hot Water Efficiency 21%
Losses 5%
Electricity
476.2 kW elec
Biogas to CHP
1253.2 kW
4,819.3 Nm³/d
Losses
62.7 kW
Raw Feed = 17.0 tDS/d
59.6% Primary Sludge, #40.4% Secondary Sludge
70.5% Combined VS, 59.0% VS Destruction
Ratio of Imported sludge assumed to be same as Indigenous
Exelys Feed = 17.00 t DS/d

DLD View


* BFW Temperature Elevation from Exelys Waste Heat
Biogas = 65% CH_4
Biogas LCV = 23075 KJ/Nm^3
Losses
0 kW
Steam Production
0 kW
(0.0 t/d)
BOILER
85% Efficiency
Biogas to boiler
0.0 kW
0.0 Nm^3/d
Normal Operating
Steam Demand
from Exelys
275.3 kW
(8.55 t/d)
BFW *
Hot Water
40.2 kW
Excess Hot Water
(After First Digester
Heating) 139.1 kW
Steam
Production
275.3 kW
(8.55 t/d)
Waste
Heat
Boiler
Hot Water
338.8 kW
Exhaust Fumes
580.8 kW
Exhaust Fumes + losses
345.6 kW
Biogas
1613.4 kW gas
6,041 Nm^3/d
CHP
HX Efficiency 95%
Electrical Efficiency 38%
Hot Water Efficiency 21%
Losses 5%
Electricity
613.1 kW elec
Biogas to CHP
1613.4 kW
6,041Nm^3/d
Losses
80.7 kW
Raw Feed = 17.0 tDS/d
59.6% Primary Sludge, #40.4% Secondary Sludge
70.5% Combined VS, 62.2% VS Destruction
Ratio of Imported sludge assumed to be same as Indigenous
Exelvs Feed = 12.25 t DS/d

The Preferred Solutions and Conclusions

- The chosen solution Exelys™ in DLD configuration minimised:-
  - Plant size
  - Steam demand
  - Self sufficient no fuel purchase required (saving OPEX costs)
- The chosen solution Exelys™ in DLD configuration maximised:-
  - Biogas production
  - Electricity generation potential
- Also the site would retain an Enhanced Treated Sludge



Any questions?