HOW PRE-TREATMENT REDUCES CONTAMINATION AND AIDS DIGESTION

LUIS VERGARA
TECHNICAL DIRECTOR
ULTRAWAVES REACTORS

How pre-treatment reduces contamination and aids digestion

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ULTRASONIC DISINTEGRATION OF THE BIOMASS TO BOOST ANAEROBIC DIGESTION EFFICIENCY

UK AD & BIOGAS | 3-4 JULY 2013 BIRMINGHAM NEC

ULTRAWAVES

ADBA
Anaerobic Digestion & Biogas Association

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1. ULTRASOUND ENGINEERING

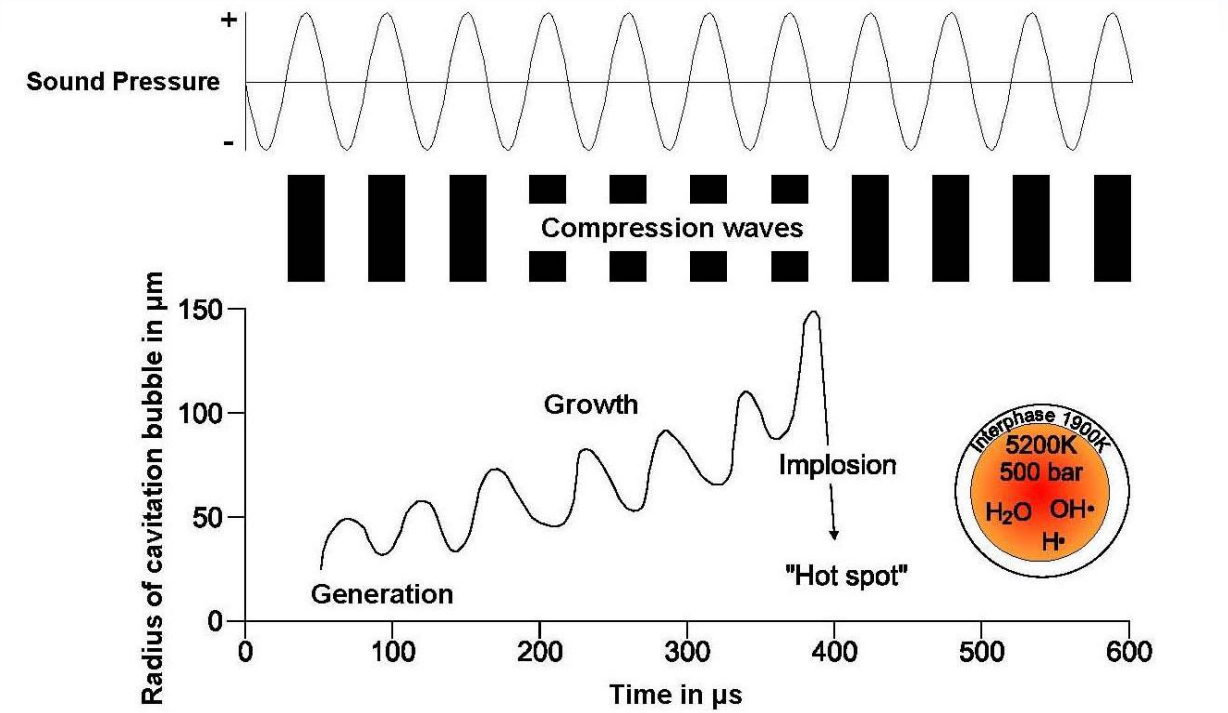
What is ultrasound?

- A wave is a disturbance travelling through a medium
- Sound is a wave where excited magnitude is pressure
- Ultrasound (US) is a sound wave where the frequency is beyond 20 kHz
- With adequate frequencies and intensities strong **ultrasonic cavitation** is produced

1. ULTRASOUND ENGINEERING

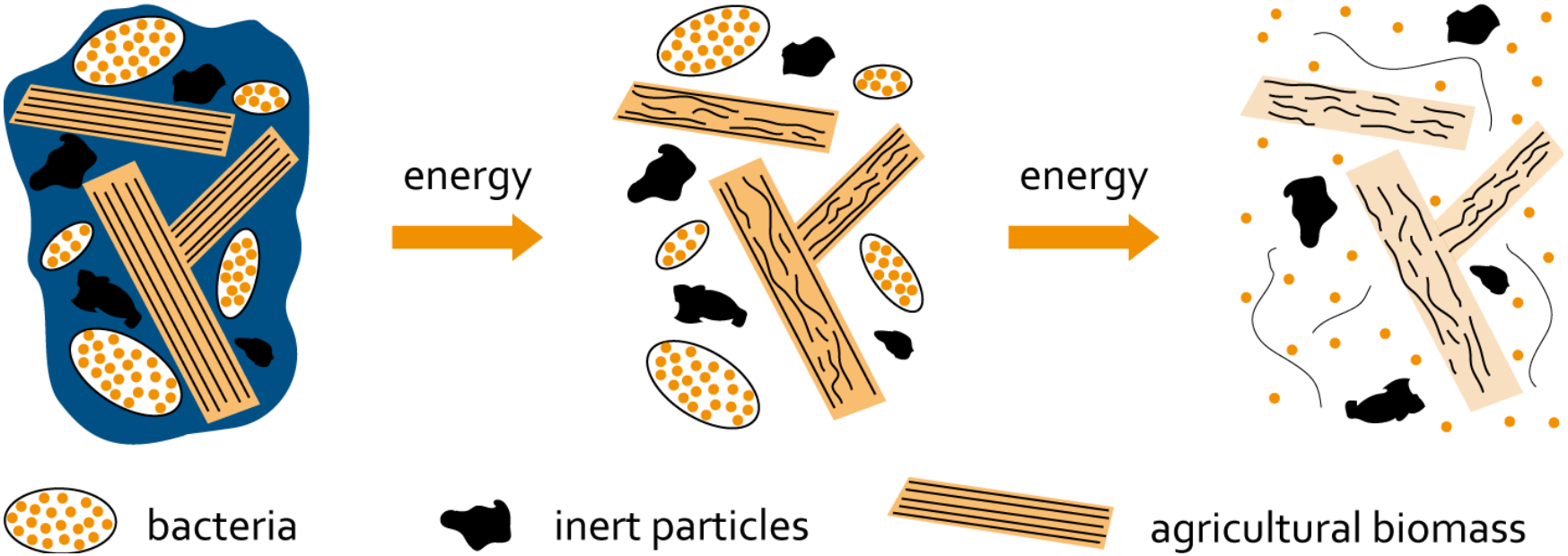
Ultrasonic cavitation

- Forceful implosion takes place and high energy is delivered
- Despite the extreme conditions inside the bubbles the US reactor works under normal T & P



1. ULTRASOUND ENGINEERING

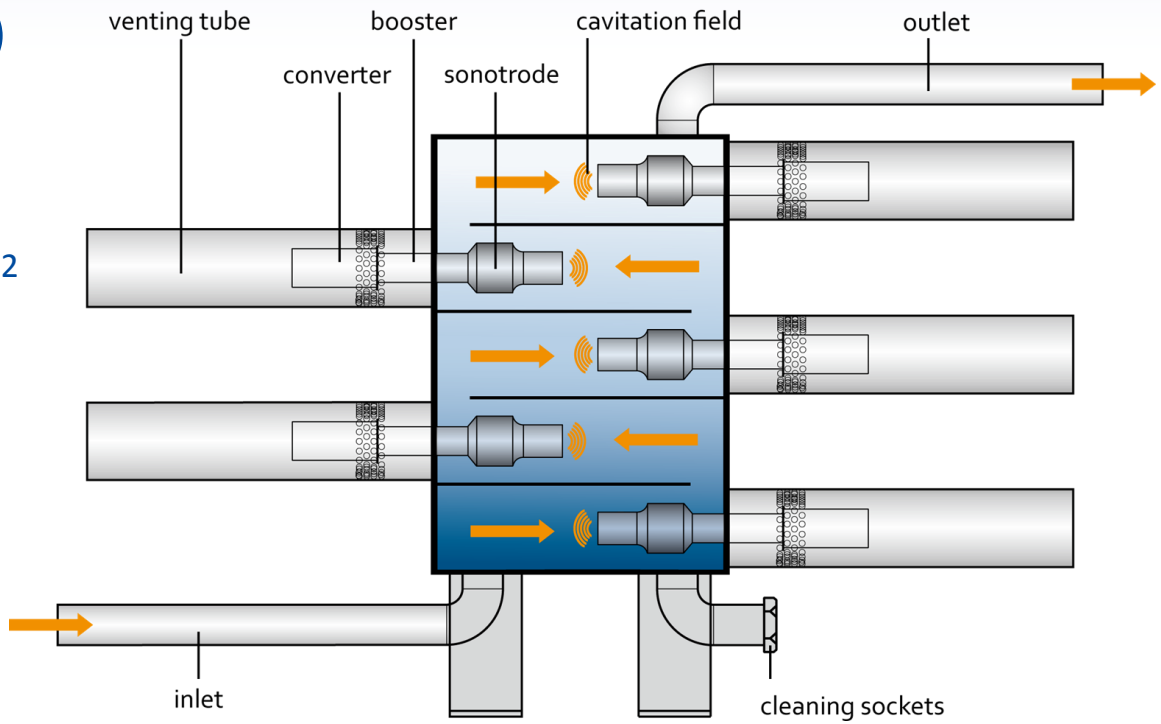
Effect on the biomass



1. ULTRASOUND ENGINEERING

The ultrasonic reactor

- 5 oscillators (1 kW each)
- Reactor volume 30 l
- Frequency 20 kHz & intensity 25 to 50 W/cm^2
- Sonication dose 1 to 9 kWh/m^3
- Sizes 1.5 x 1.1 x 0.35 m
- Scalable to all ADF sizes by multiple reactors configuration



1. ULTRASOUND ENGINEERING

Transferring energy to the sludge

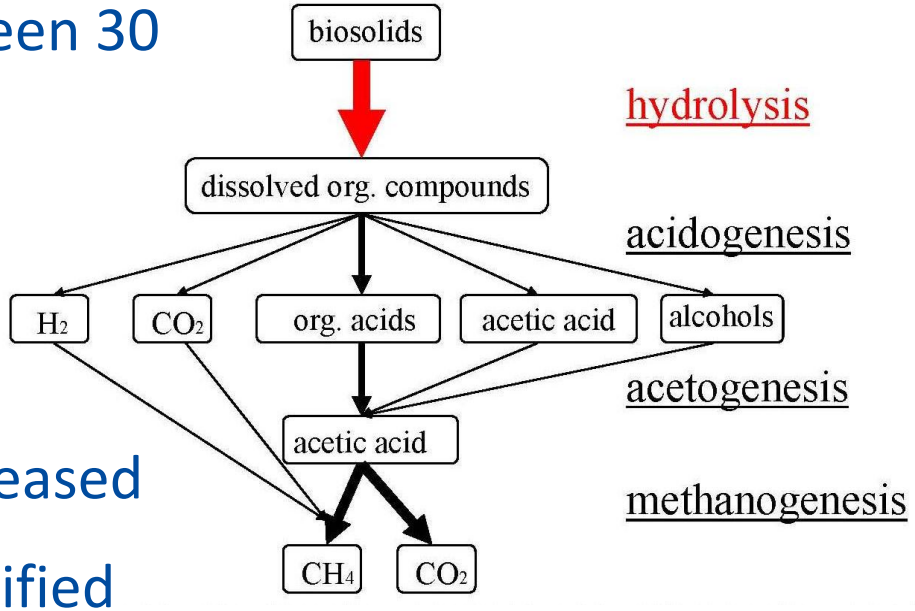
New sonotrode

Sonotrode after 1.5 to 2 years

2. ANAEROBIC DIGESTION APPLICATION

Process

- Biomass to be treated is between 30 and 50% of the wet flow
- US dose ≈ 4 kWh/m^3 to reach aggregates breakdown
- Readily biodegradable materials and enzymes are released
- Hydrolysis step is highly intensified
- The organic fraction is further degraded



2. ANAEROBIC DIGESTION APPLICATION

An example of common sizing

- Wet solids: 25 - 30 ton WS/d
- Dry solids content ≈ 20%
- Dry solids: 5 - 6 ton DS/d
- Dry solids (per year): 1,825 - 2,190 ton DS/y
- Plant capacity: 500 kW_{el}

It is only necessary a 5 kW US unit for each 500 kW_{el} of plant size…!!!

2. ANAEROBIC DIGESTION APPLICATION

Typical results obtained

- Increase in Volatile Solids degradation: 10 - 20%
- Increase in biogas production: 10 - 20% (1)
- Increase in methane content: 1 - 2%
- Decrease in viscosity: 15 - 25%
- Substrate saving: 10 - 20% (2) (1 or 2 is reached)

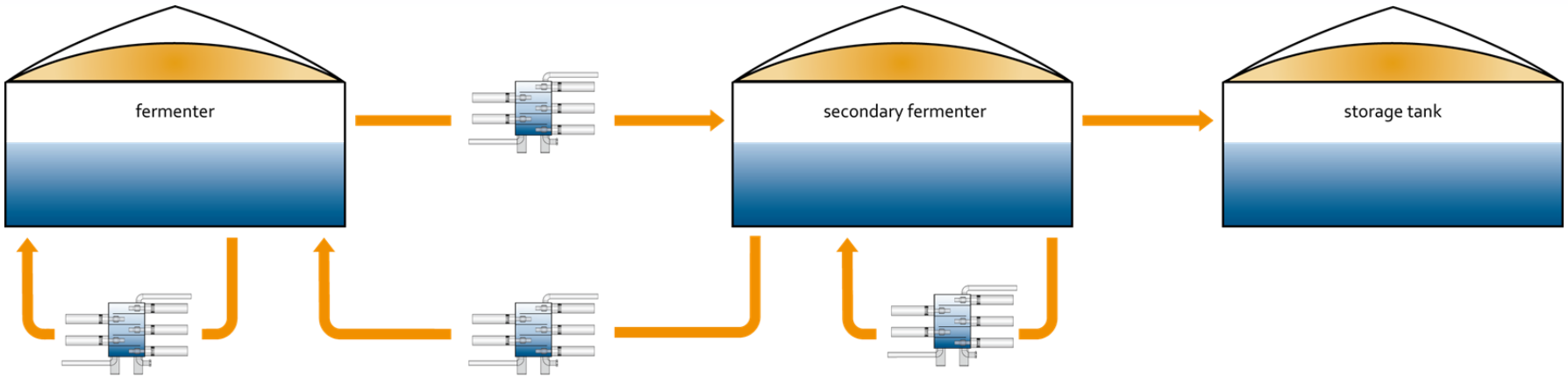
A 500 kW_{el} plant is optimised up to reach an extra of 50 - 100 kW_{el} with only 5 kW of US meaning a big net power production…!!!

2. ANAEROBIC DIGESTION APPLICATION

Tools: samples sonication & BMP tests

2. ANAEROBIC DIGESTION APPLICATION

Installation in ADFs



- Place to install the ultrasonic reactor depends on several factors
- Some factors are DS %, viscosity, biomass structure and type of AD process

3. REFERENCES

Bordesholmerland FBP

3. REFERENCES

Bordesholmerland FBP

Initial conditions

- 2 parallel lines (2 x 537 kW_{el}) to produce 2 x 6,150 m^3/d biogas @ 50% in methane content
- 2 main & 2 post digesters with 2 storage tanks (2,500 m^3 each)
- 2 x 25 ton maize/d fed to be digested within 90 d HRT

Goal

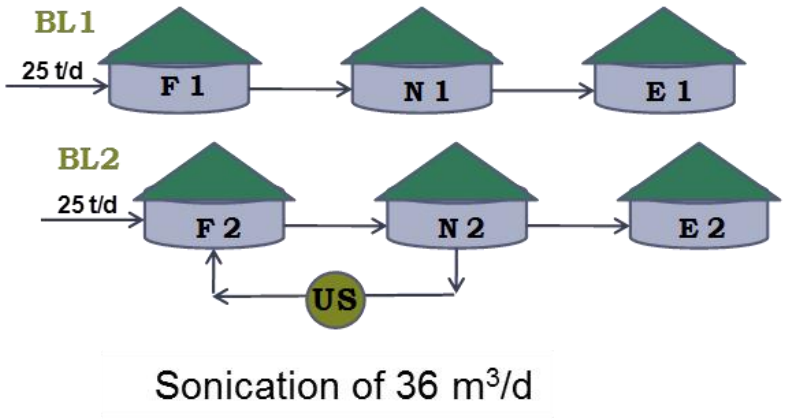
- Reduce amount of substrate

3. REFERENCES

Bordesholmerland FBP

US installation

- Sonication of 36 m^3/d @ 3.3 kWh/m^3 in line 2



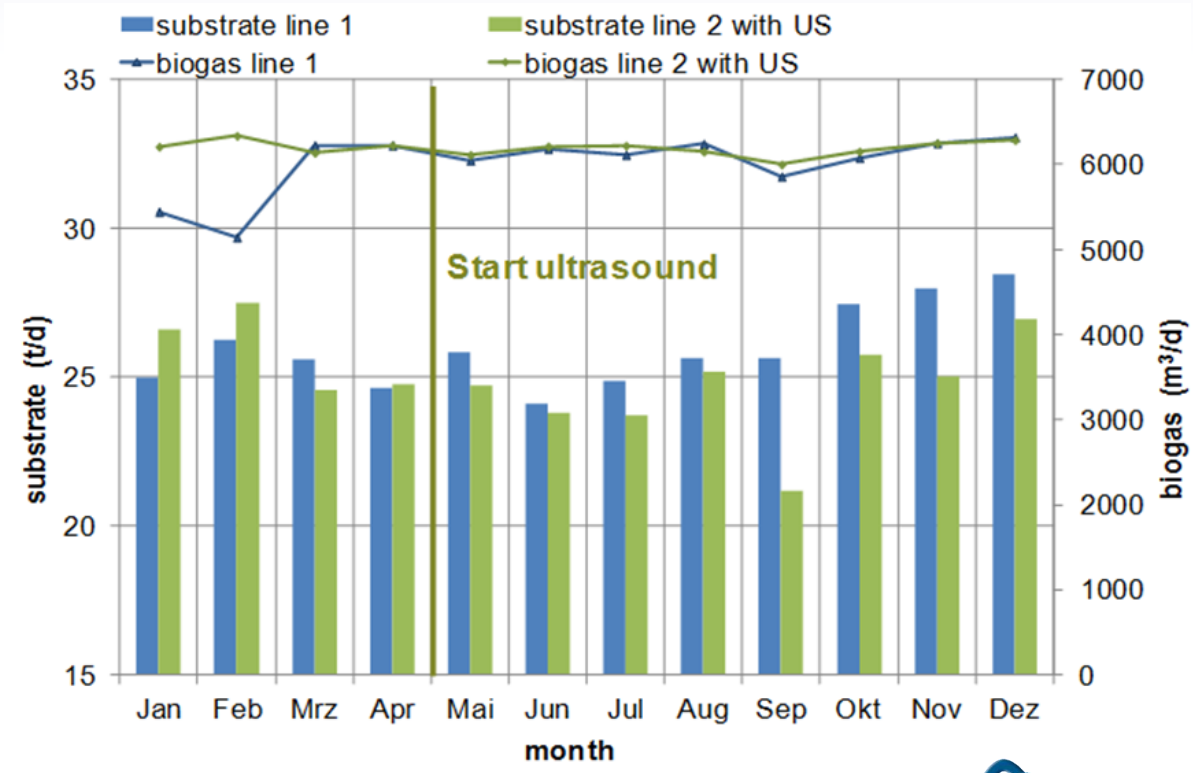
Sonication of 36 m^3/d

3. REFERENCES

Bordesholmerland FBP

Results

- 4 ton/d less substrate (- 17%)
- 2 % increase in methane content
- Decrease in viscosity



3. REFERENCES

Mariks FWBP

3. REFERENCES

Mariks FWBP

Initial conditions

- 2 main & 1 post digester (1,800 m^3 each) and 1 storage tank (5,000 m^3)
- 700 kW_{el} power production & methane content ca. 58%
- 73 ton/d fed to be digested within 40 d HRT

Goal

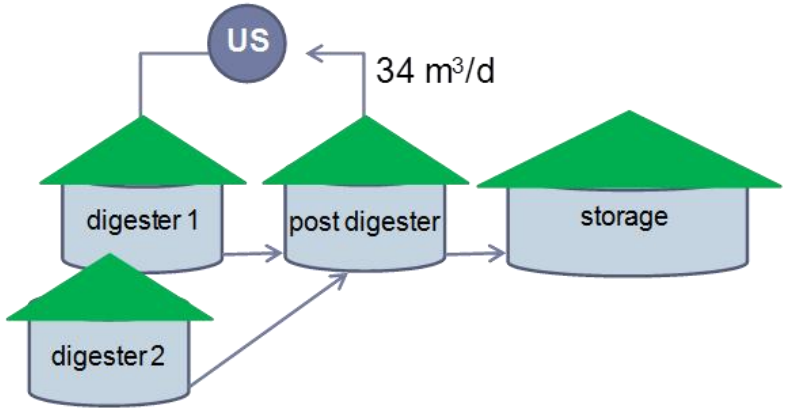
- Increase biogas production

3. REFERENCES

Mariks FWBP

US installation

- Sonication of 34 m^3/d @ 3.5 kWh/m^3 from post to main digester



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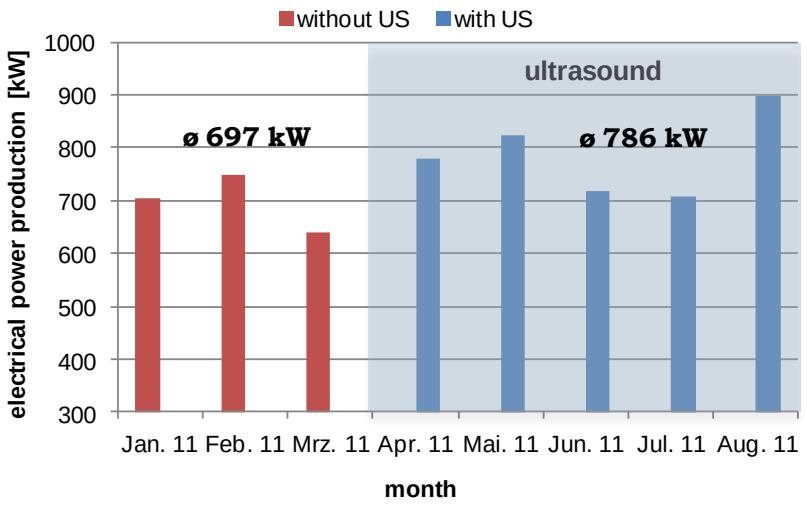
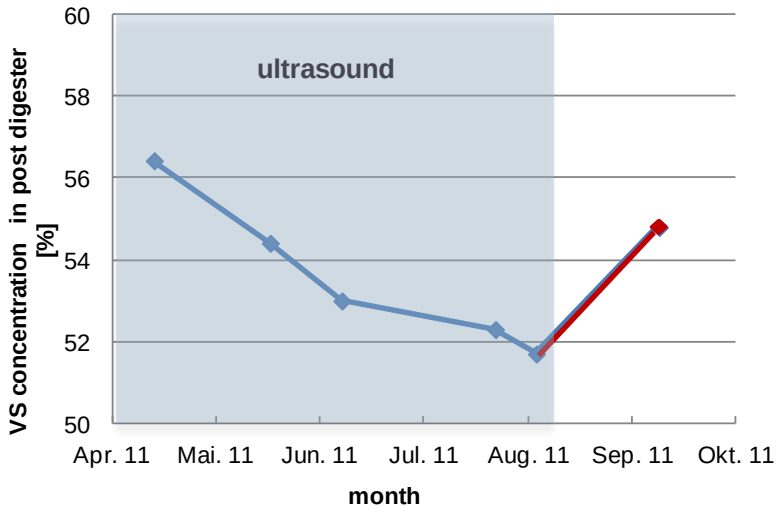
Mariks FWBP

Results





- kW_{el} power increased in 13% and volatile solids concentration in post digester decreased by 8%

3. REFERENCES

Bamberg WwTW

3. REFERENCES

Bamberg WwTW

Initial conditions

- 220,000 PE capacity by design was overloaded up to reach a treatment of 330,000 PE
- 150 m^3/d of primary sludge and 250 m^3/d of TWAS
- 35% average in VS degradation @ HRT of 18 d

Goal

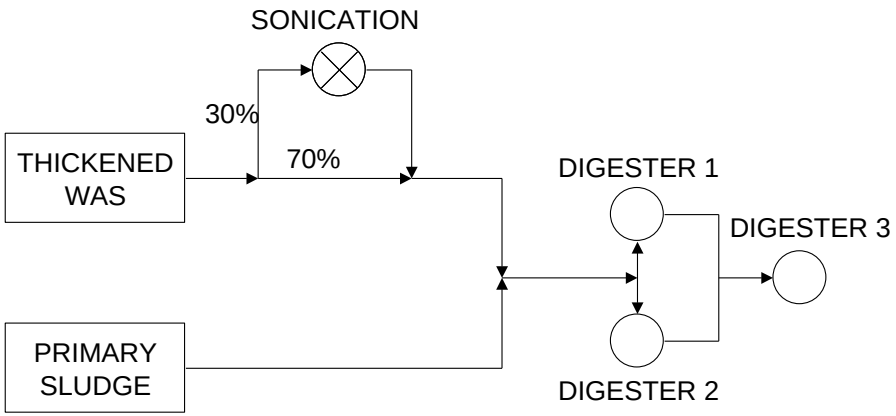
- Achieve a minimum of 45% in VS degradation

3. REFERENCES

Bamberg WwTW

US installation

- Sonication of 60 m^3/d of the TWAS @ 4 kWh/m^3



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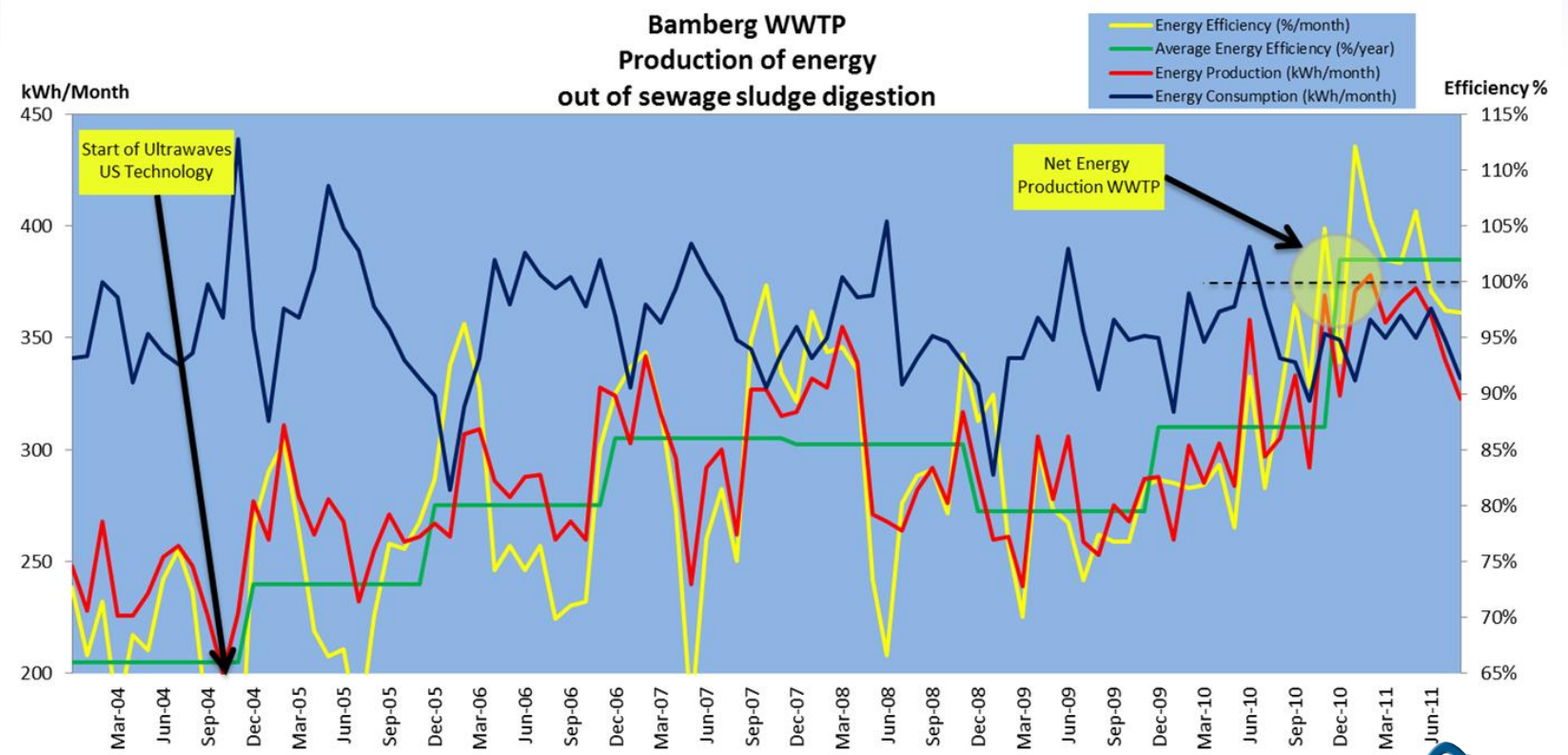
Bamberg WwTW



3. REFERENCES

Bamberg WwTW

Results

- VS degradation increased from 34 to 50% (average)
- Reduction of the VS in the digested sludge from 60 to 54%
- Significantly increase in biogas production (+ 30% average)
- A new anaerobic digester construction was **avoided** what meant a saving of 1.5 million €

Thank you

Luis Vergara

Technical Director

luis@ultrawaves.co.uk