

# Pulsed electric field pretreatment for enhanced biogas production



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# Introduction

- There is abundance of hydro and geothermal energy



- 92% of housing heated with geothermal energy
- 98% of electricity is hydro-/geothermal power

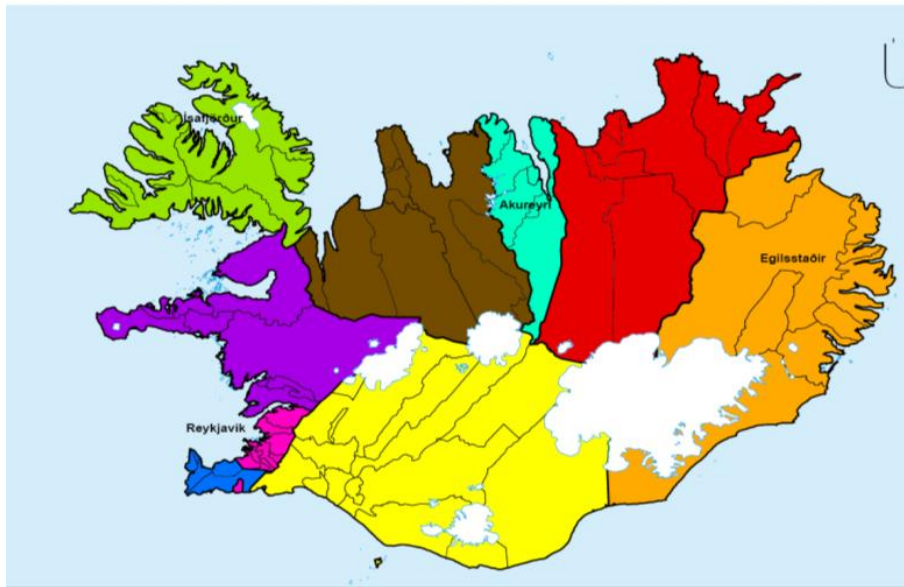
- The raw materials for biogas production are limited in Iceland and must be upgraded to bio-methane to be used for transport

# Methane – fuel for transport

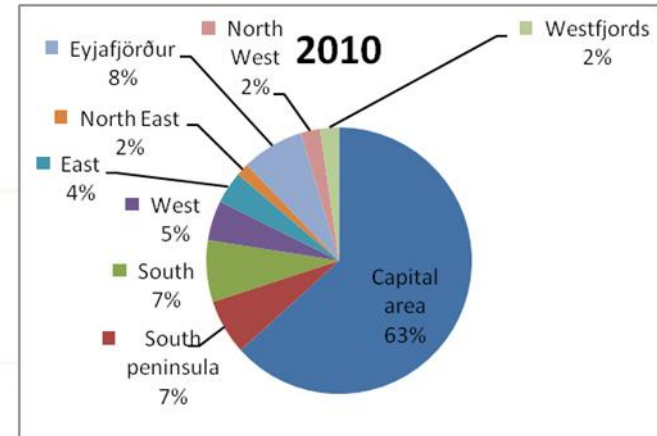
- The aim of EU is to have 10% of the fuel as bio-fuel in (biodiesel, bio-gas, bio-ethanol) in 2020
- This means that Iceland should produce about 30 million Nm<sup>3</sup>/year of methane (or other biofuel)

# Available raw material - organic waste in MSW

- About 180-260.000 tons of organic waste from MSW from Reykjavik and surroundings
- Total of 300-360.000 for the country



## Population distribution



# Other available raw materials

- Total production of manure for the country is about 900.000 to one million tons
- Other waste like unused hay and straw are in the range 30 to 50.000 tons
- Sewage is roughly 8000 tons in Reykjavik area
- Other available materials for fuel production are estimated to be in the range 80 to 150.000 tons

# Other possible biomass sources

- Biomass could be increased by using abandoned hayfields to give 60 to 90.000 tons
- By cultivating energy crops it is possible to grow between 300.000 to 700.000 tons of biomass on area of 1000 km<sup>2</sup>.
- Total area that can be cultivated in Iceland is 15.000 km<sup>2</sup>, but only 10% is in use (1.500 km<sup>2</sup>)

## Methane yield (Nm<sup>3</sup>/ha) for different crops

Crop type	Yield
Wheat (whole)	3100 ±700
Rye grain	1710 ±350
Fodder beet	5680 ±1100
Legumes	2930 ±700
Grass	2350 ±650

# Methane in Iceland

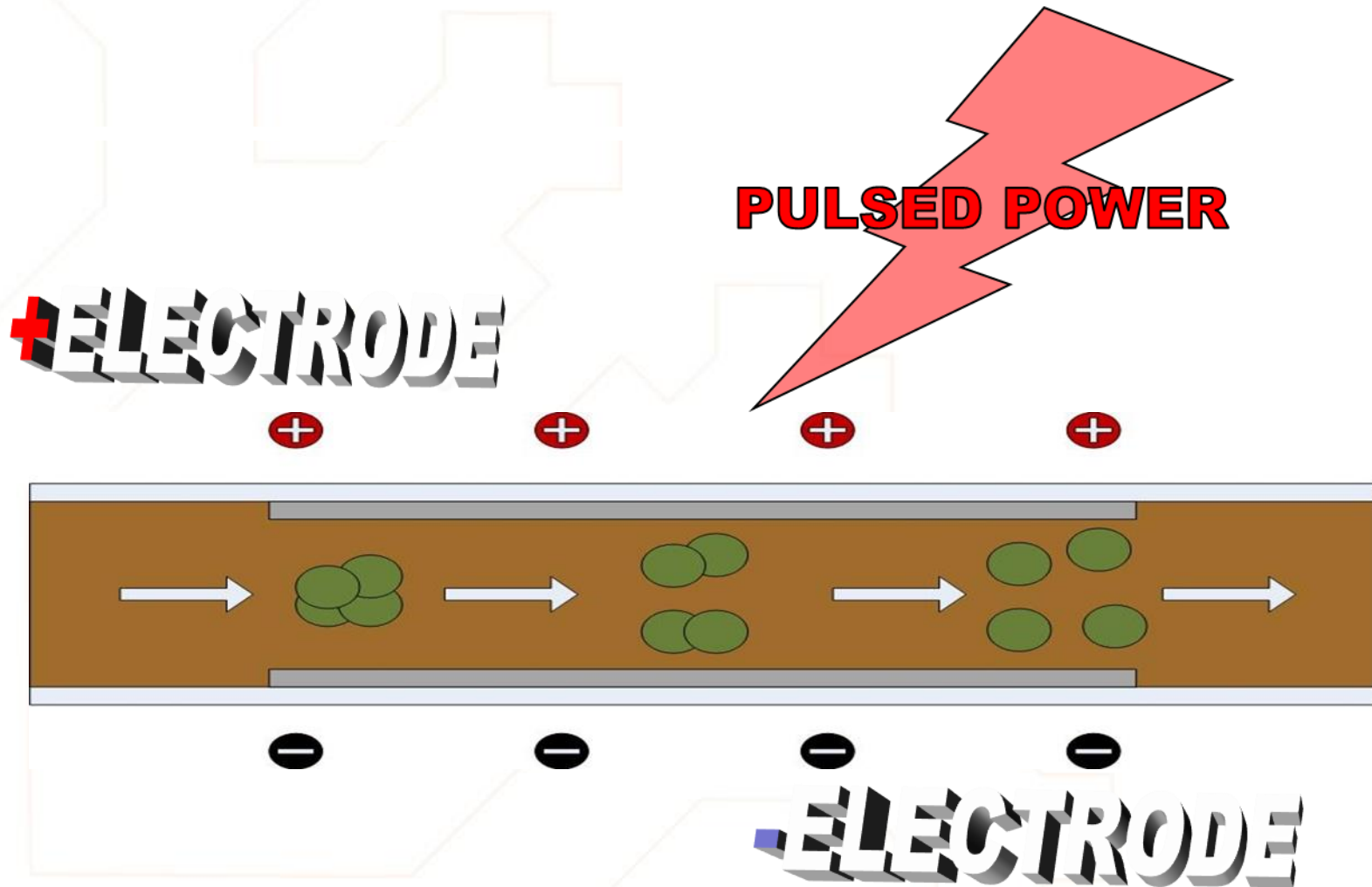
- About 26 million Nm<sup>3</sup> of methane is probably obtainable, based on current raw material availability.
  - Manure roughly 10 million Nm<sup>3</sup>
  - Organic waste 10 million Nm<sup>3</sup>
  - Sewage 1.5 million Nm<sup>3</sup>
  - Other waste 5 million Nm<sup>3</sup>
  - Total of 26.5 million Nm<sup>3</sup>
- SORPA is currently producing 2 million Nm<sup>3</sup> but could increase it to 3-4 million Nm<sup>3</sup> from landfill sites
- By using anaerobic digestion reactors, SORPA could increase the production further by 3-4 million Nm<sup>3</sup> from 30.000 tons
- 500 km<sup>2</sup> made available for crops for biogas production could produce between 100 and 150 million Nm<sup>3</sup> of methane.



# Pretreatments of bio-waste for anaerobic digestion

- Mechanical – ultrasound and pressure
- Chemical – use of alkali, peroxide, acids and enzymes
- Thermal – use of thermal hydrolysis and microwave
- Electrical – methods like PEF (Pulsed Electric Field)

# PEF treatment in continuous flow

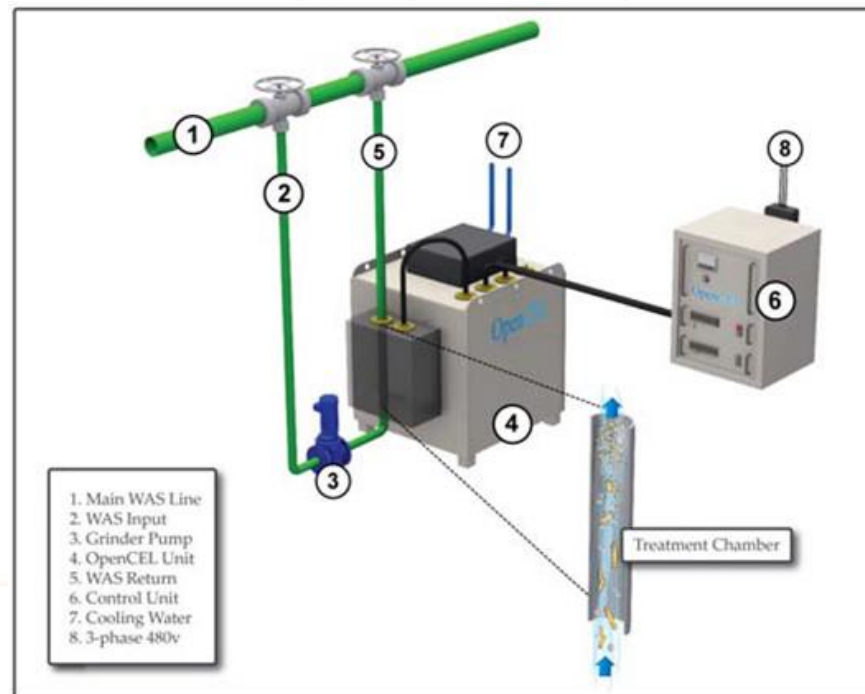


# Effect of PEF-pretreatment

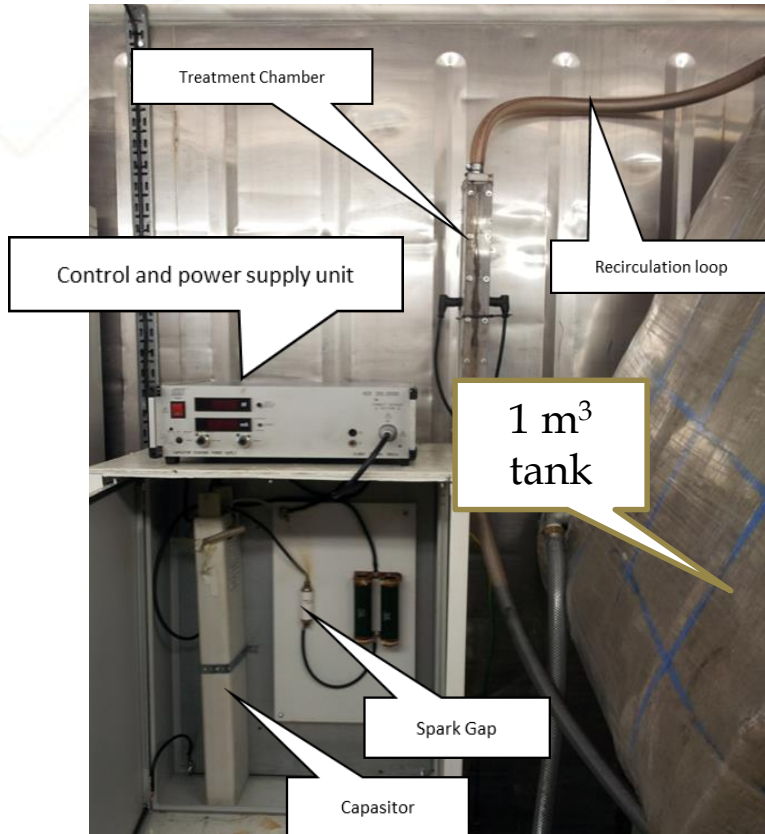
- Destroys or damages cellular membranes, breaks down large aggregates and reduces organic molecules to simpler forms
- After PEF treatment the organic solids are more bio-available and hydrolyzed i.e. there is an increase in soluble organic material
- As a consequence there is more material available for methane forming bacteria to produce methane which can increase the biogas yield
- The quantity of bio-solids decreases
- PEF treatment pasteurizes the raw material without destroying the methane forming bacteria
- Increased digester capacity

# Full scale PEF pretreatment and methane production In water reclamation plant at Mesa Arizona

- 200 m<sup>3</sup> of thickened WAS flow rate per day solids content of WAS material between 4% and 6% and 30-35 day retention time
- The PEF treatment system is made by Opencel



# Two biogas systems 1 m<sup>3</sup> and 1 L bioreactors



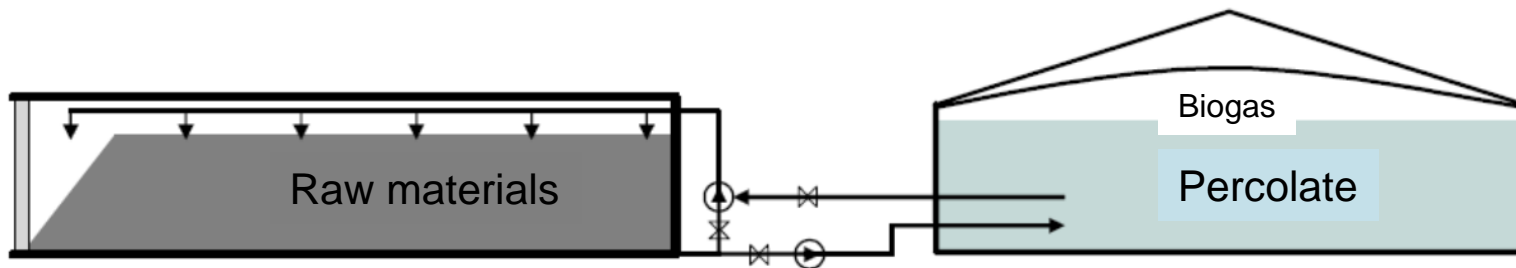
# Materials used for treatment

Pig manure treated up to 15 kwh/m<sup>3</sup>

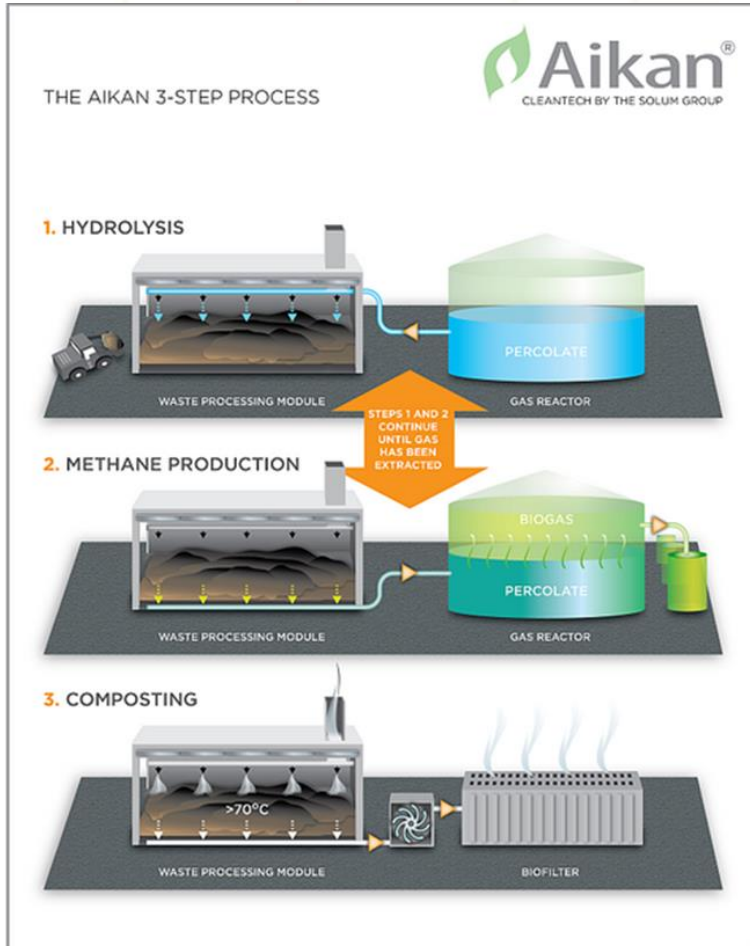
Cow manure treated up to 30 kwh/m<sup>3</sup>

Leachate from landfill treated up to 50 kwh/m<sup>3</sup>

More test will be done on landfill leachate and leachate from our percolation system, also on mixed food waste and other organic wastes



# Aikan processing



- The percolation will be part of the Aikan solution which will be build Sorpa
- For experimental purposes lab-scale percolation system has been build
- We can test percolation at temperatures from 10 to 90°C

# PEF treatment at 20 kV/cm on pig manure

Some chemical disintegration indicators

	Control	Treatment A	Treatment B	% max change
Treatment	0	8 kwh/m <sup>3</sup>	15 kwh/m <sup>3</sup>	
TS (g/L)	9.1	9.0	9.2	1%
TDS (g/L)	5.2	5.0	4.9	-6%
VDS (g/L)	1.5	1.5	1.2	-20%
SCOD (g/L)	4.1	4.4	4.9	20%

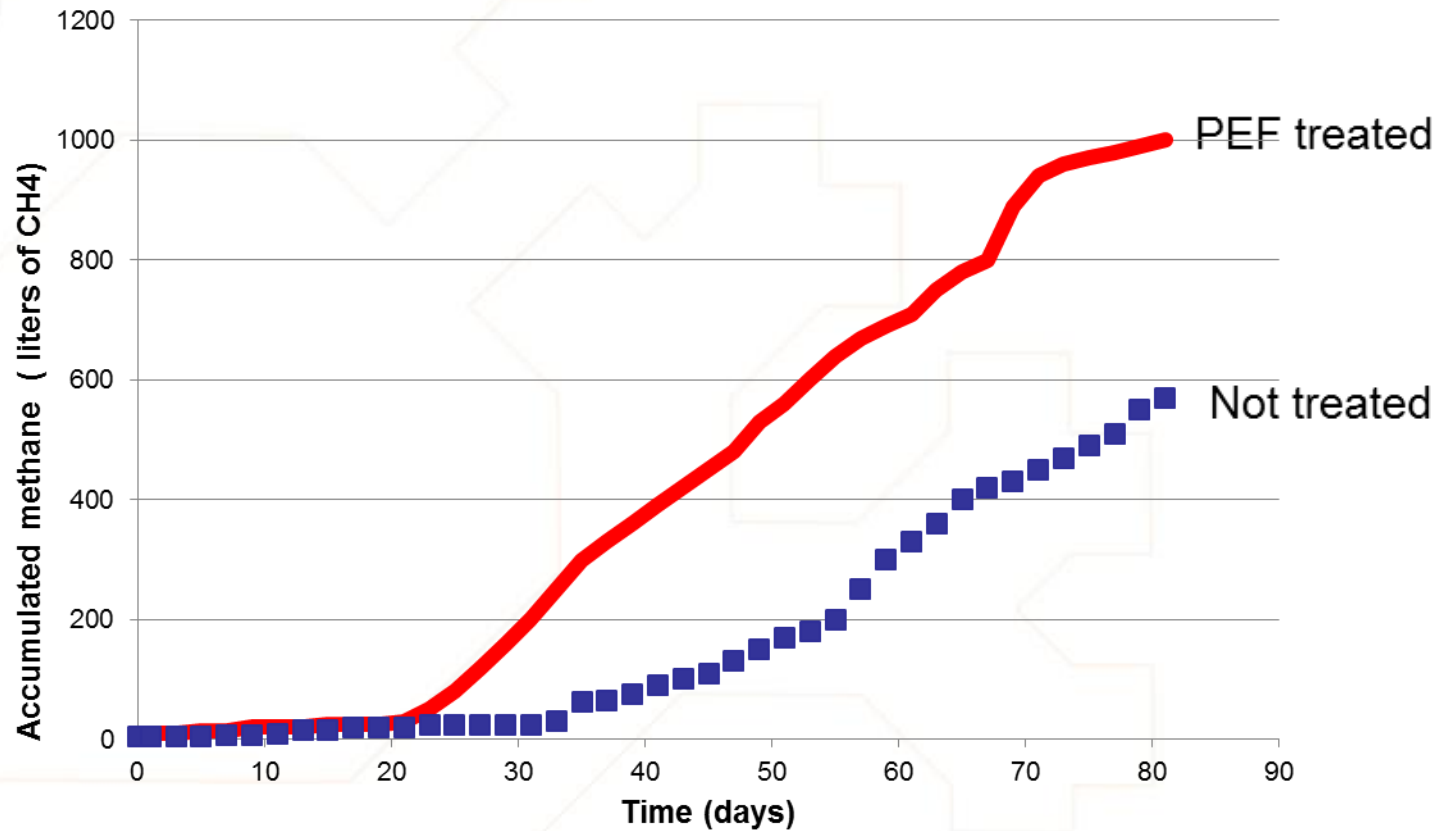


# PEF treatment on cow manure at 20 kV/cm

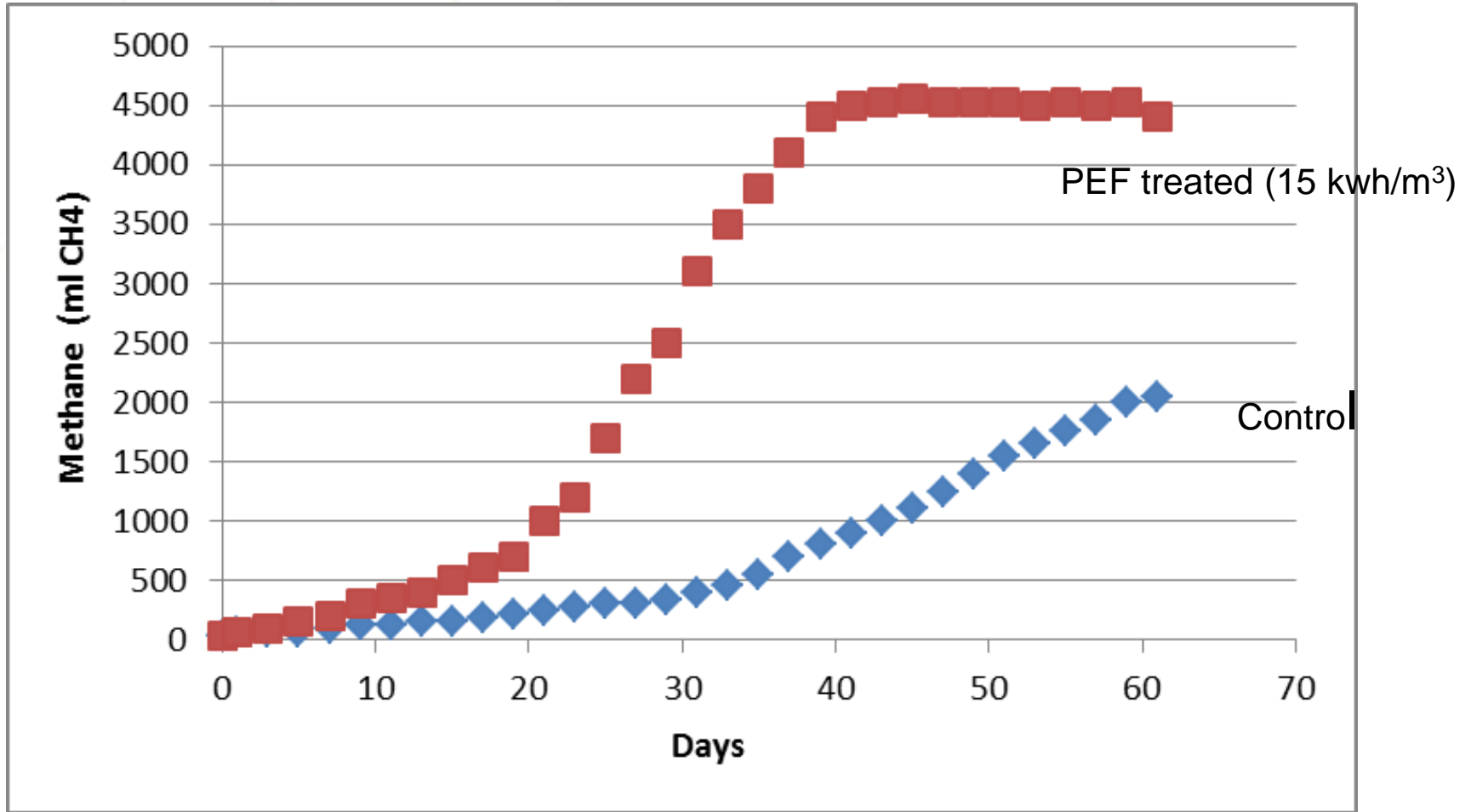
## Some chemical disintegration indicators

	Control	Treatment A	Treatment B	% max change
Treatment (kwh/m <sup>3</sup> )	0	10	20	
TS (g/L)	26.8	26.5	26.8	0%
TDS (g/L)	7.4	8.8	9.2	24%
VDS (g/L)	4.3	4.7	5.4	25.6%
SCOD (g/L)	2.7	3.1	3.5	21%

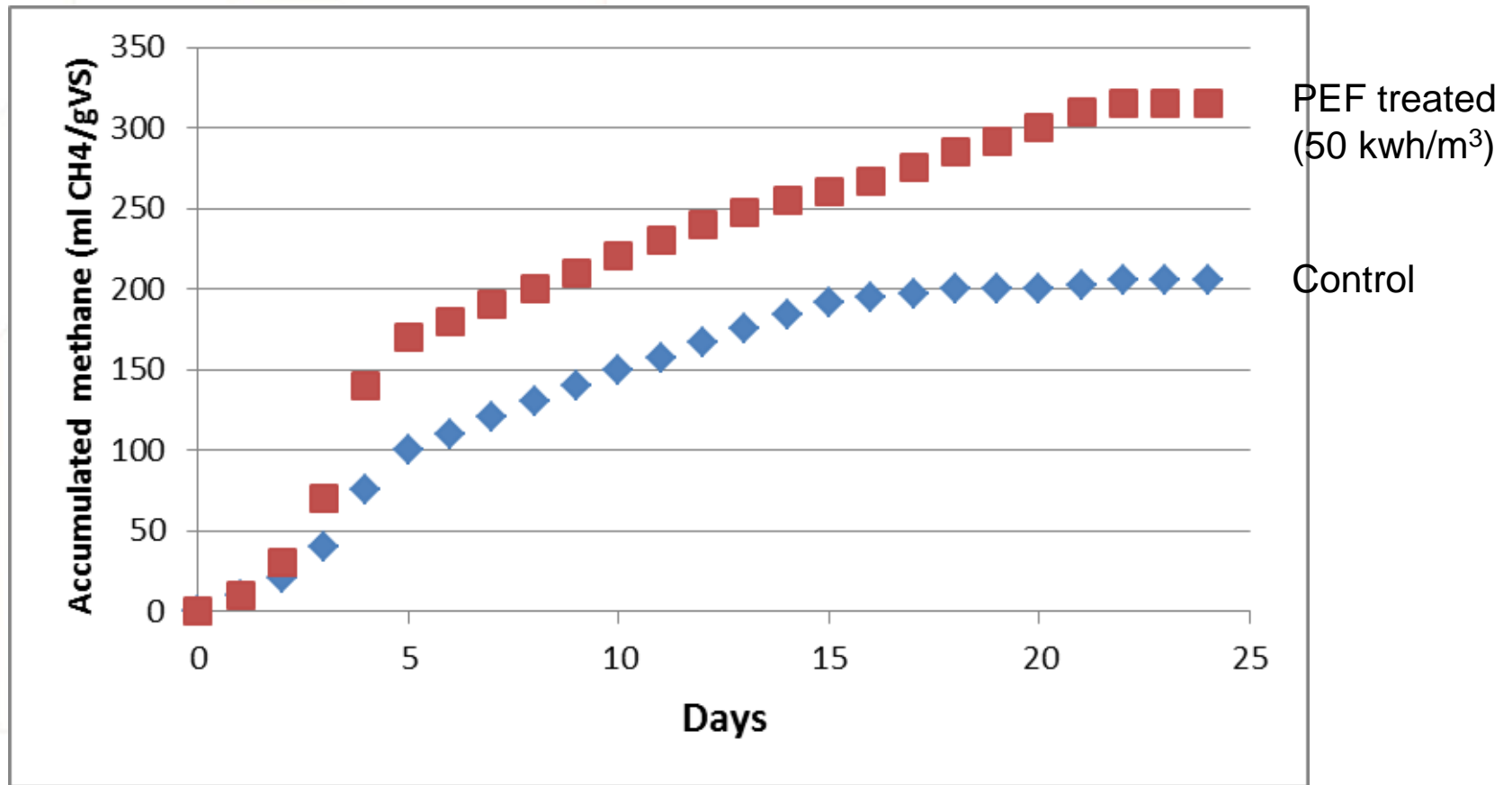
# Accumulated methane from anaerobic digestion of pig manure In 1 m<sup>3</sup> system (1% solids)



# Accumulated methane for PEF treated pig manure in 1 L system (3% solids)



# Methanization of PEF treated leachate in 1 L system (1% solids)



**Thank you for your attention**

