

CETESB
Energy From Biogas
April 23rd – 24th 2003



***Biogas Use in Industrial
Anaerobic Wastewater
Treatment***



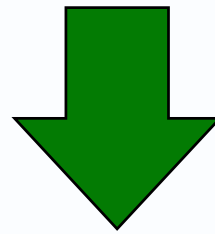
Dr Stephen P Etheridge
Environmental Biotechnology Limited

Anaerobic Treatment



Waste + Heat (35°C/55°C)

**90 % COD
Removal
ENDOTHERMIC**



**Slow Growing Bugs...
No Sludge, COD to Biogas**

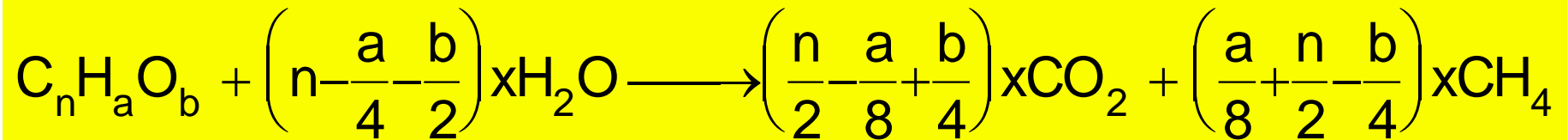
**Low COD Effluent +
Biogas (65%CH₄ + 35% CO₂)**

Energy Costs

Larger Reactors

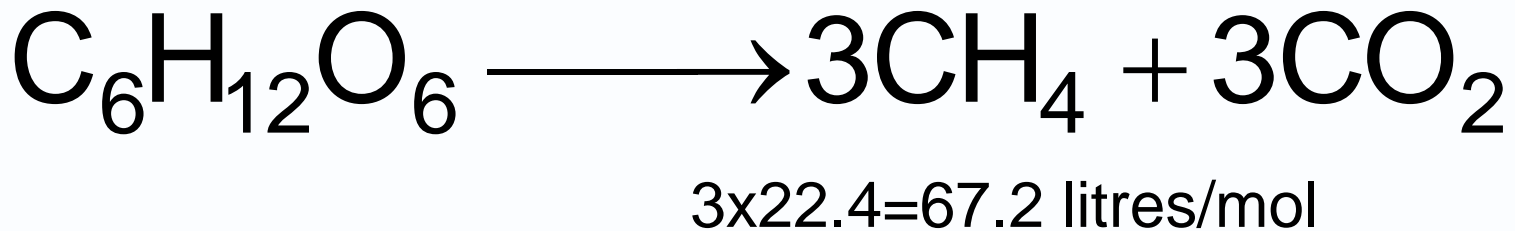
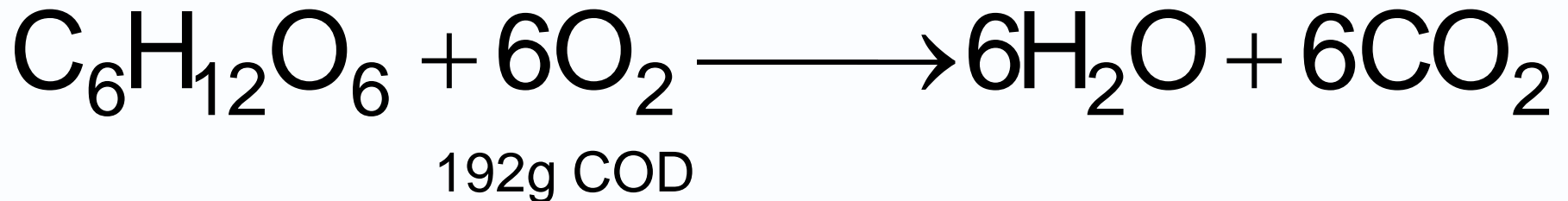


The Buswell Equation



Buswell & Mueller (1952)

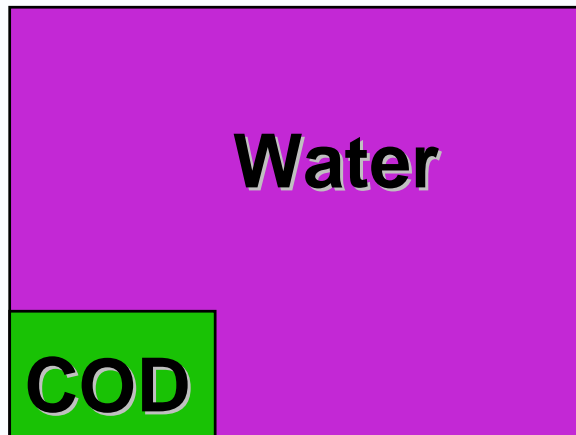
How Much Biogas Can I Get?



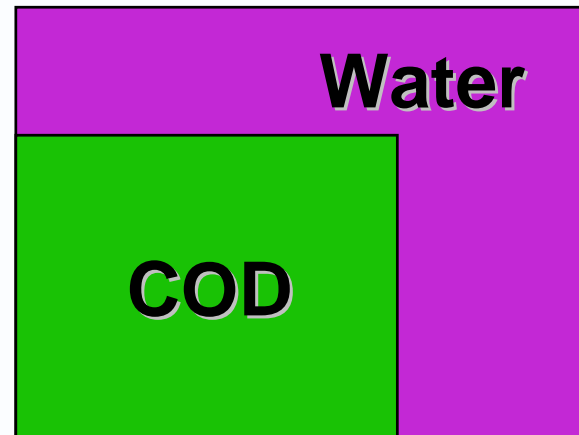
$$\frac{1000}{192} \times (67.2) = 0.35\text{m}^3 / \text{kg COD}$$



COD Density



Low Strength



High Strength

What is Biogas Worth?



Fuel	MJ/m³
Coal Gas	16.7-18.5
Biogas	20-26
Methane	34-38.6
Propane	86-94
Butane	109-118

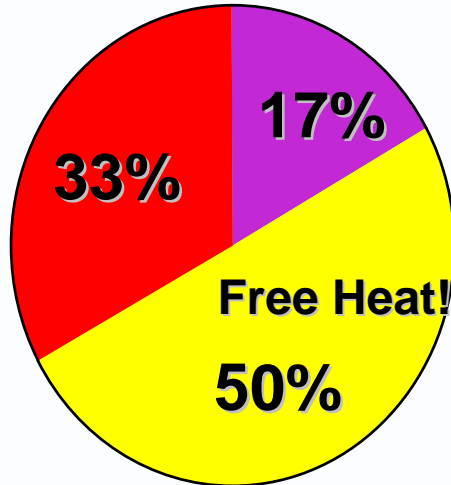
Cogeneration from Biogas



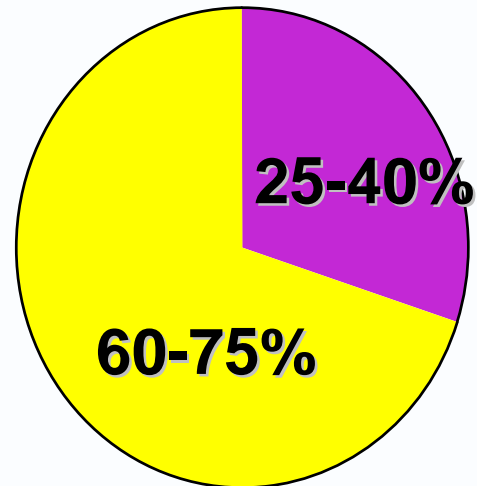
Electricity or Boiler Fuel?



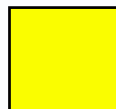
Cogeneration



Boiler Use



electricity

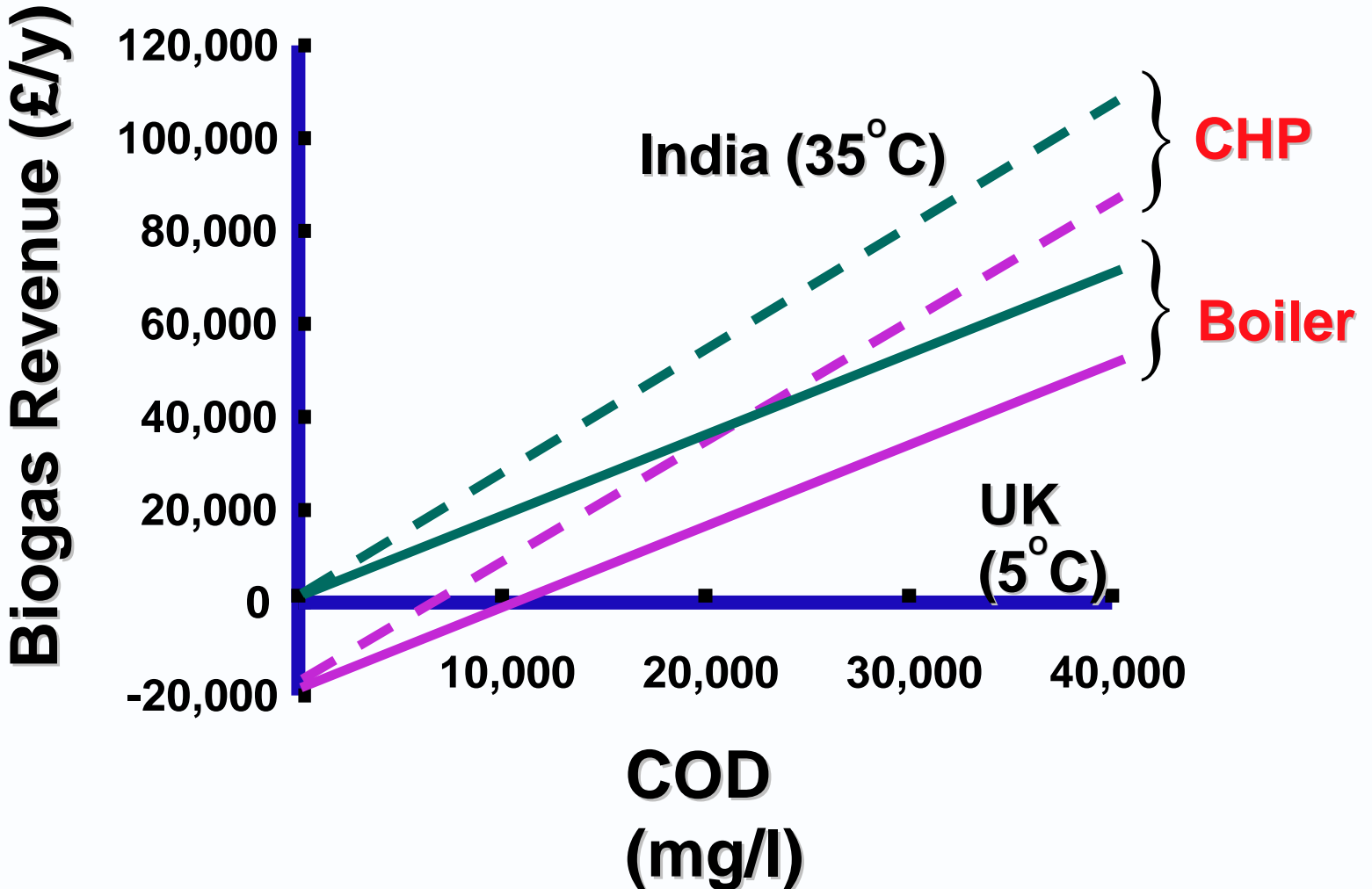


hot water



waste heat

Comparison of Hot and Cold Climate Applications



Micro- Turbines



Micro-Turbines



CHP sets



Flare



Pilot Plant



Flame Trap



How Much Electricity Can I Get?

Effluent Flow Rate = 1000m³/d



COD (mg/l)	100	1,000	5,000
Biogas (m³/d)	48	485	2,423
Energy (MJ/d)	1,071	10,710	53,550
Electricity (kWe)	4	40	200
<i>Annual Value £/year:</i>			
Electricity Value	1,737	17,374	86,900
Hot Water Value	926	9,263	46,320
Total Cogeneration	2,663	26,640	133,220
Total Boiler	1,853	18,530	92,634

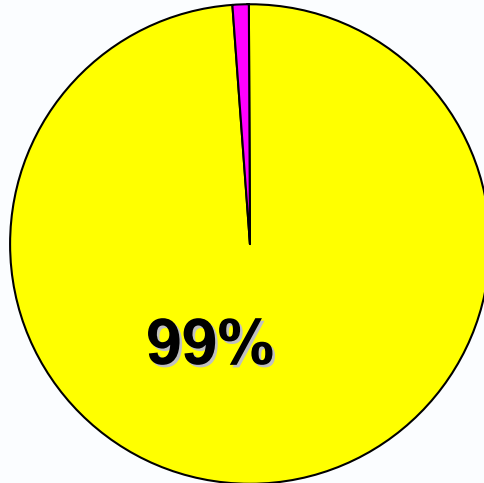
Hall & Woodhouse Limited



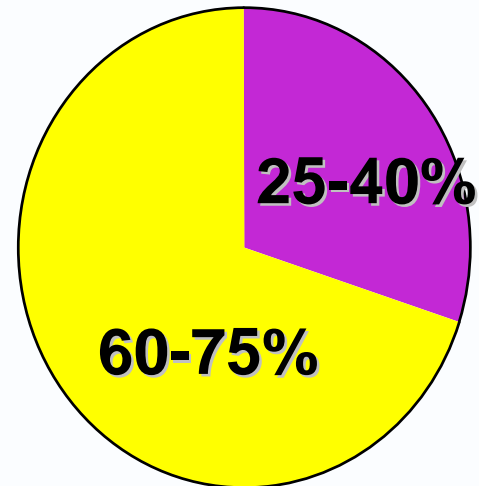
Submerged Combustion



Submerged Combustion



Boiler Use

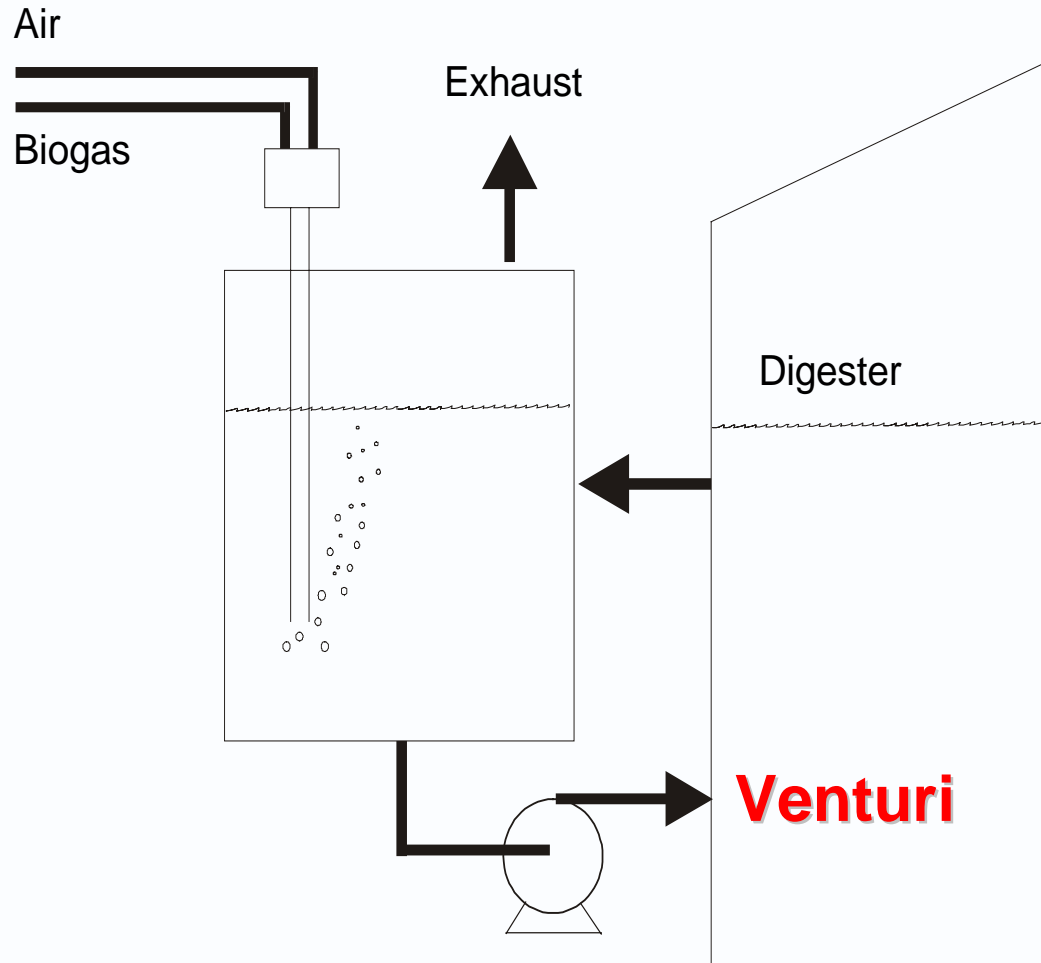


hot water

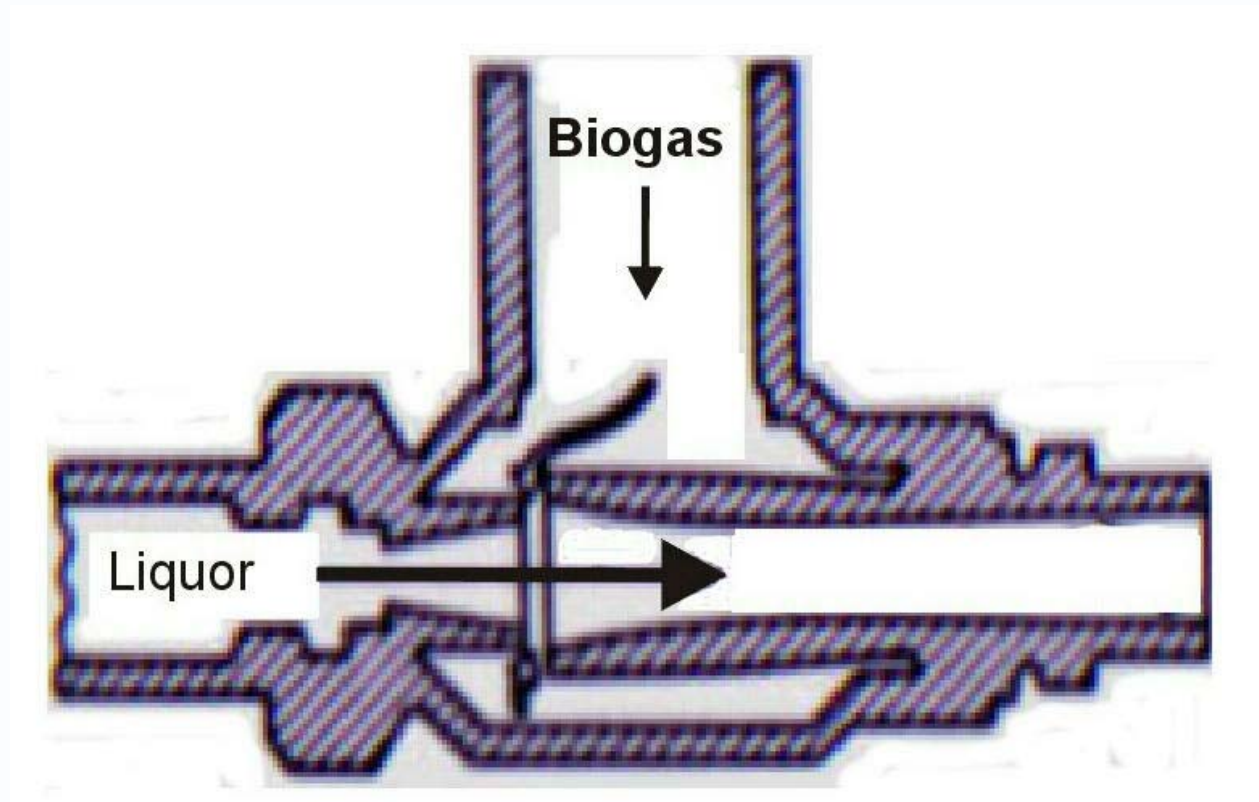


waste heat

Submerged Combustion



Venturi Mixing System





The End