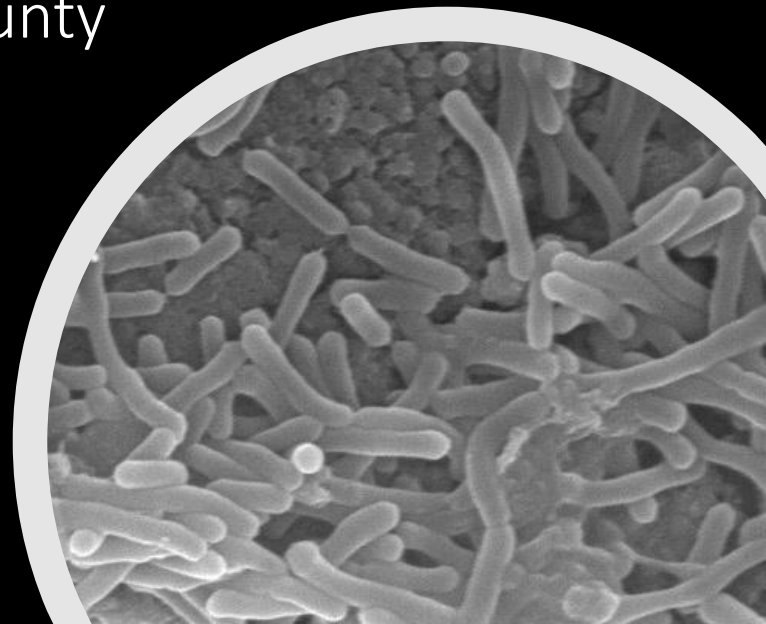
Donna Adenine: FreeImages

Harnessing the Power of Microbial Consortia

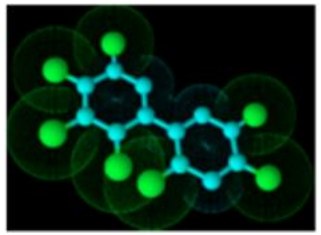
US DOE ARPA-E, 18 November 2022

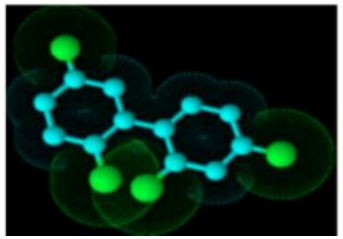
Hal May, Ph.D., Medical University of South Carolina

Kevin Sowers, Ph.D., University of Maryland – Baltimore County

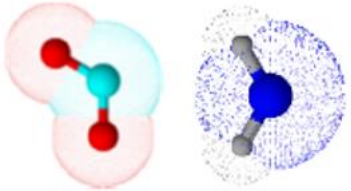


Defined Consortium for Bioremediation of PCBs





O_2



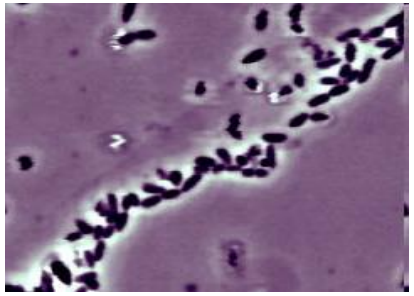
$CO_2 + H_2O$

Anaerobe

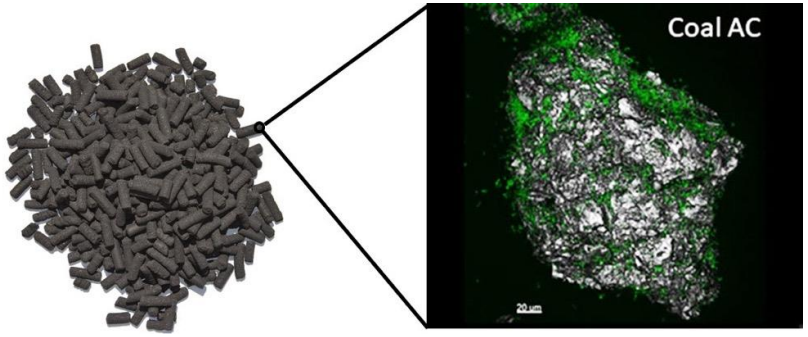
"Dehalobium chlorocoercia" DF-1

+

Aerobe



Paraburkholderia xenovorans LB400



Ghosh et al. *Environ. Sci. Technol.* 2011; Kjellerup et al. *Water Res.* 2014; May & Sowers. In: *Organohalide Resp. Bact.* 2016

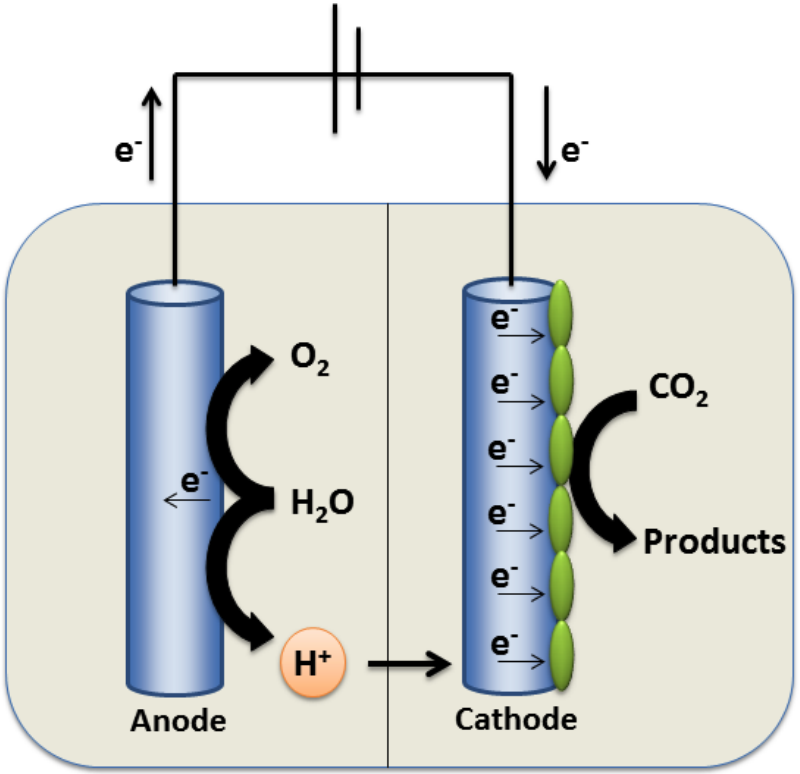
Field Treatment

- 30-52% reduction in total PCBs in sediment
- 80% reduction in coplanar PCBs
- 84-95% reduction of PCBs in porewater
- Several other sites now in trial (Rembac)

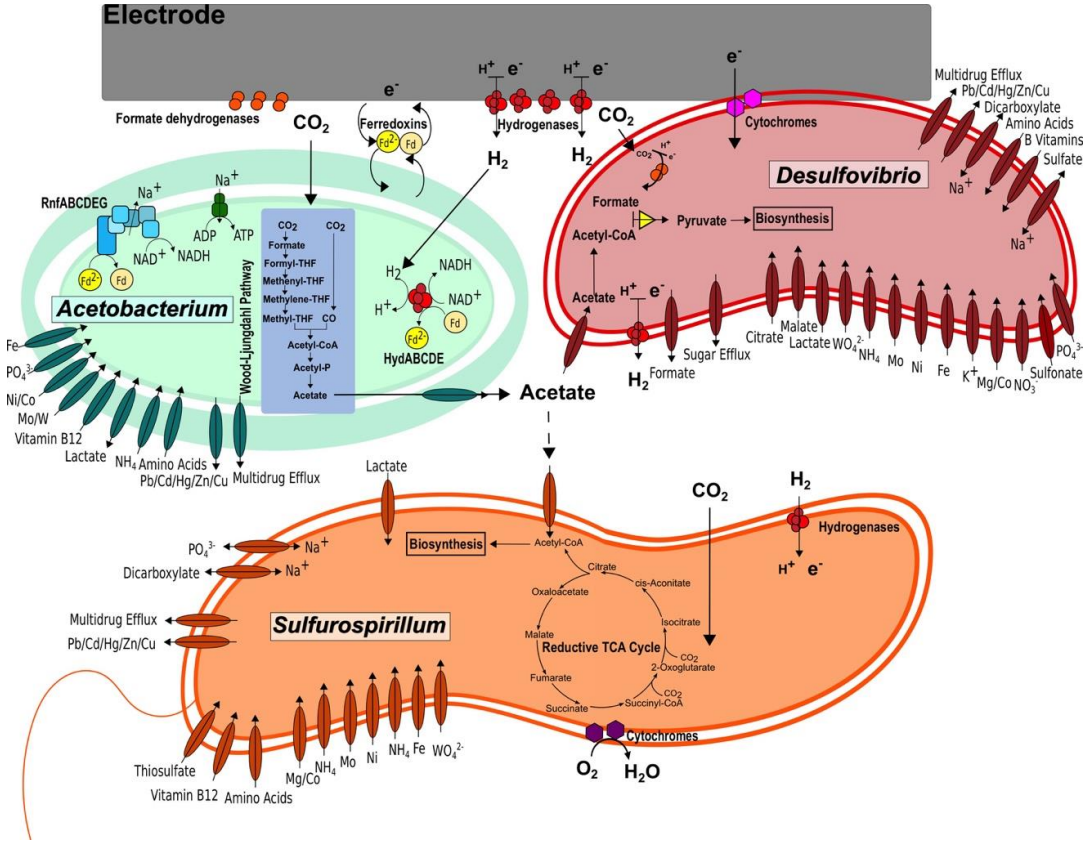
Payne et al., *Environ. Sci. Technol.* 2017; Payne et al., *Environ. Sci. Technol.* 2019.

Enriched Consortium to Valorize CO_2 by Bioelectrosynthesis

Electrobiome®

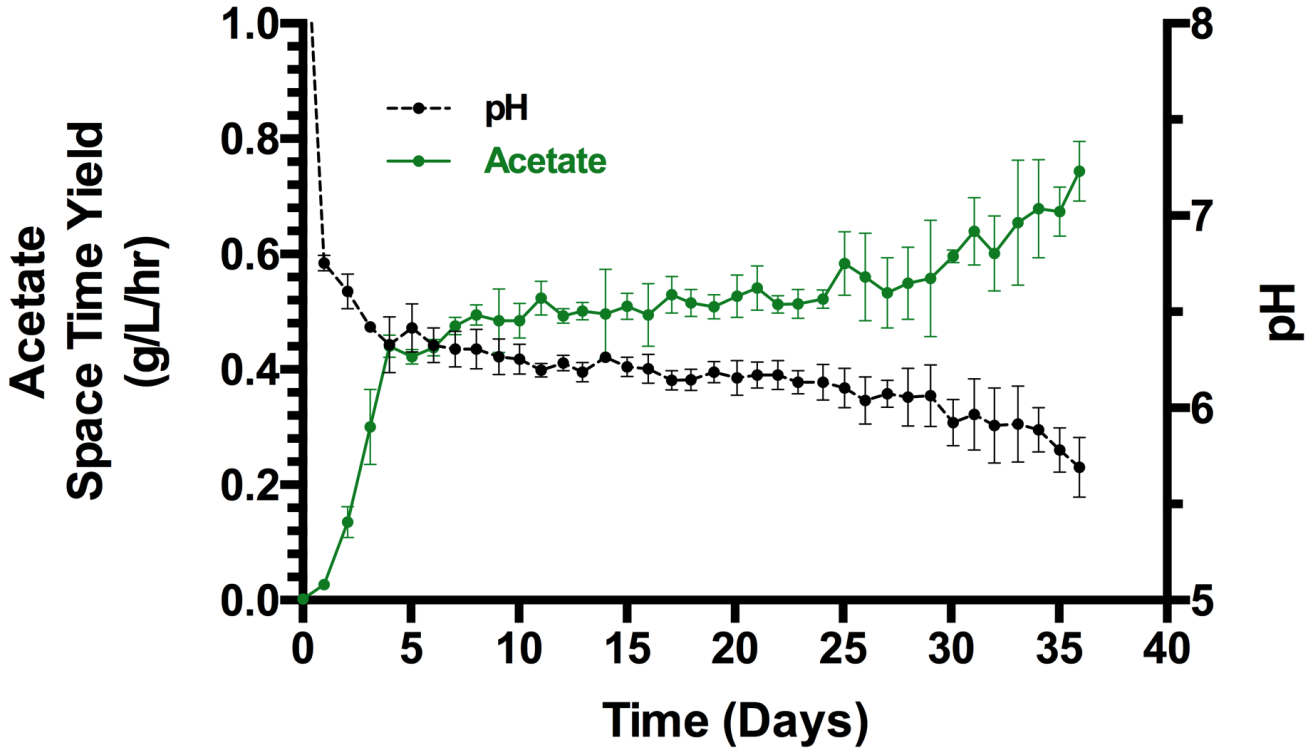


Microbial Electrosynthesis



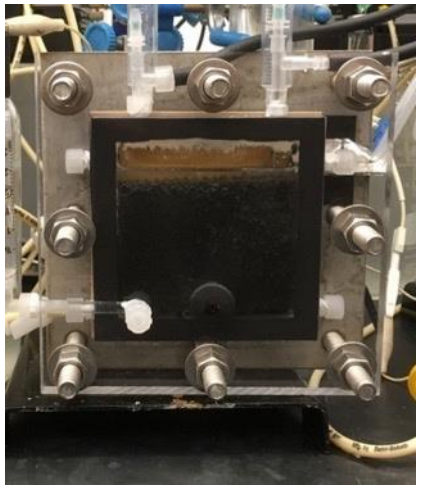
Marshall et al. *Sci. Rep.* 2017; Ross et al. *mSystems* 2020; LaBelle et al. *Accts. Chem. Res.* 2020.

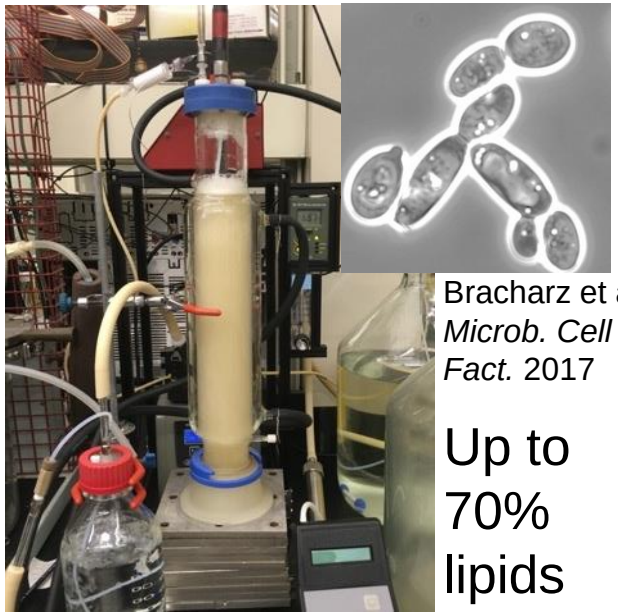
Productivity vs. Efficiency vs. Selectivity



83.3 A/m^2, 3-5 g/L
35% energy eff., 35% faradaic eff.

Cutaneotrichospron oleaginosum





MES Effluent

Bracharz et al. *Microb. Cell Fact.* 2017

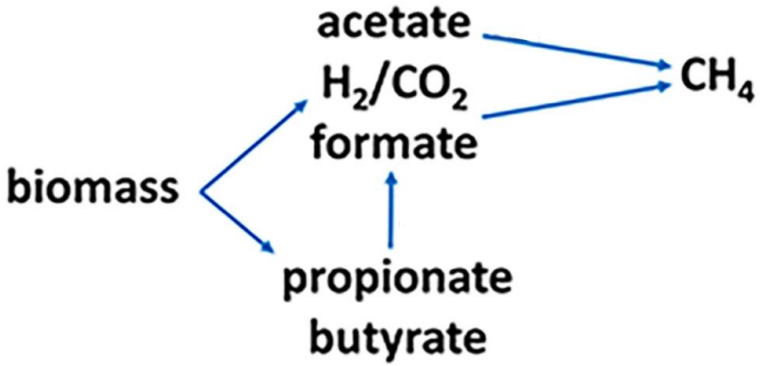
Up to 70% lipids

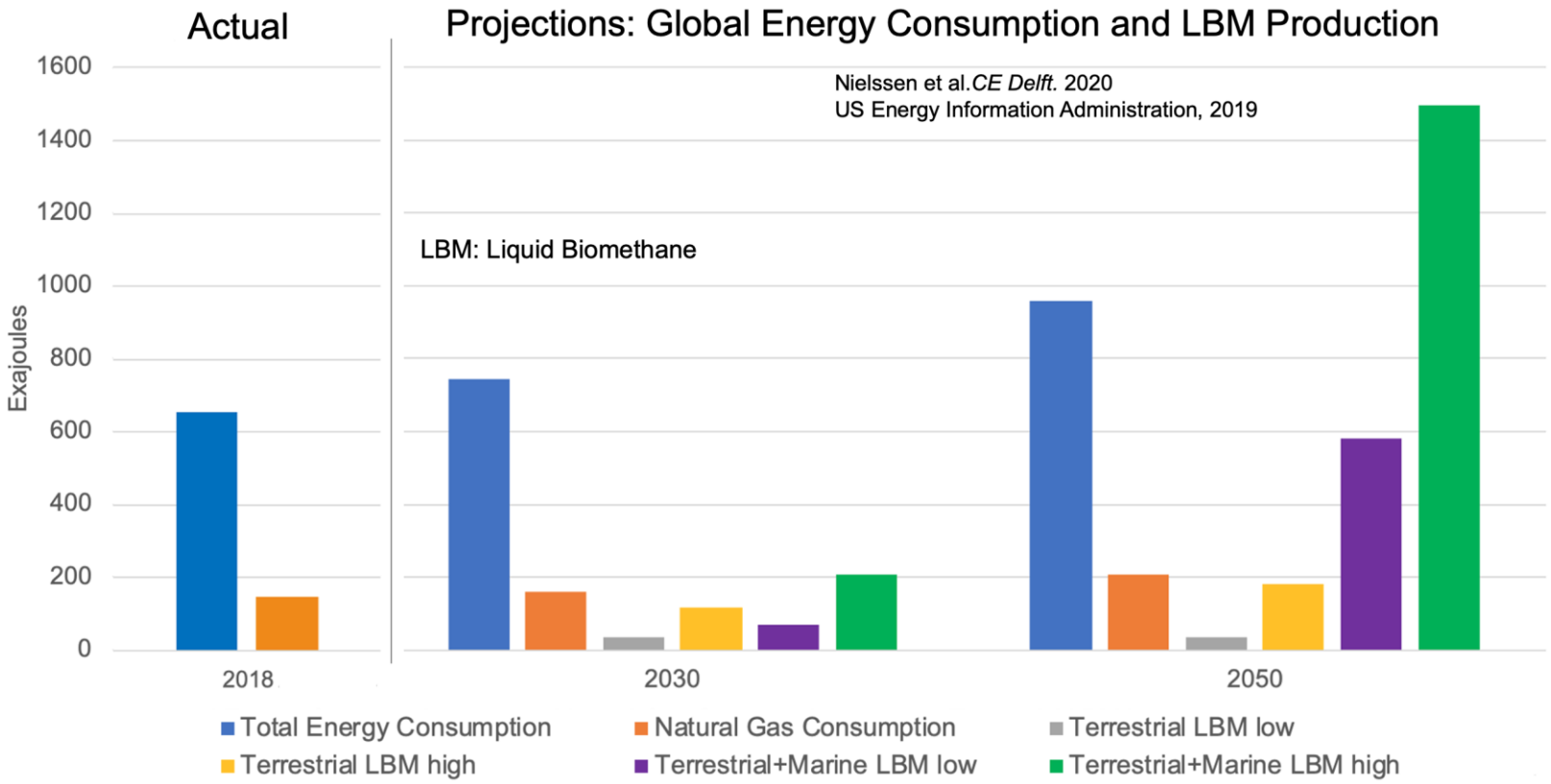
HTL: 0.69 g biocrude oil / g biomass
(Bi et al. Appl. Energy, 2018)
1.5 gal/d biocrude / m^3 biocathode

LaBelle et al., *Front. Microbiol.* 2017; LaBelle et al. *Accts. Chem. Res.* 2020.

Microbial Consortia to Convert Marine Biomass to CH_4

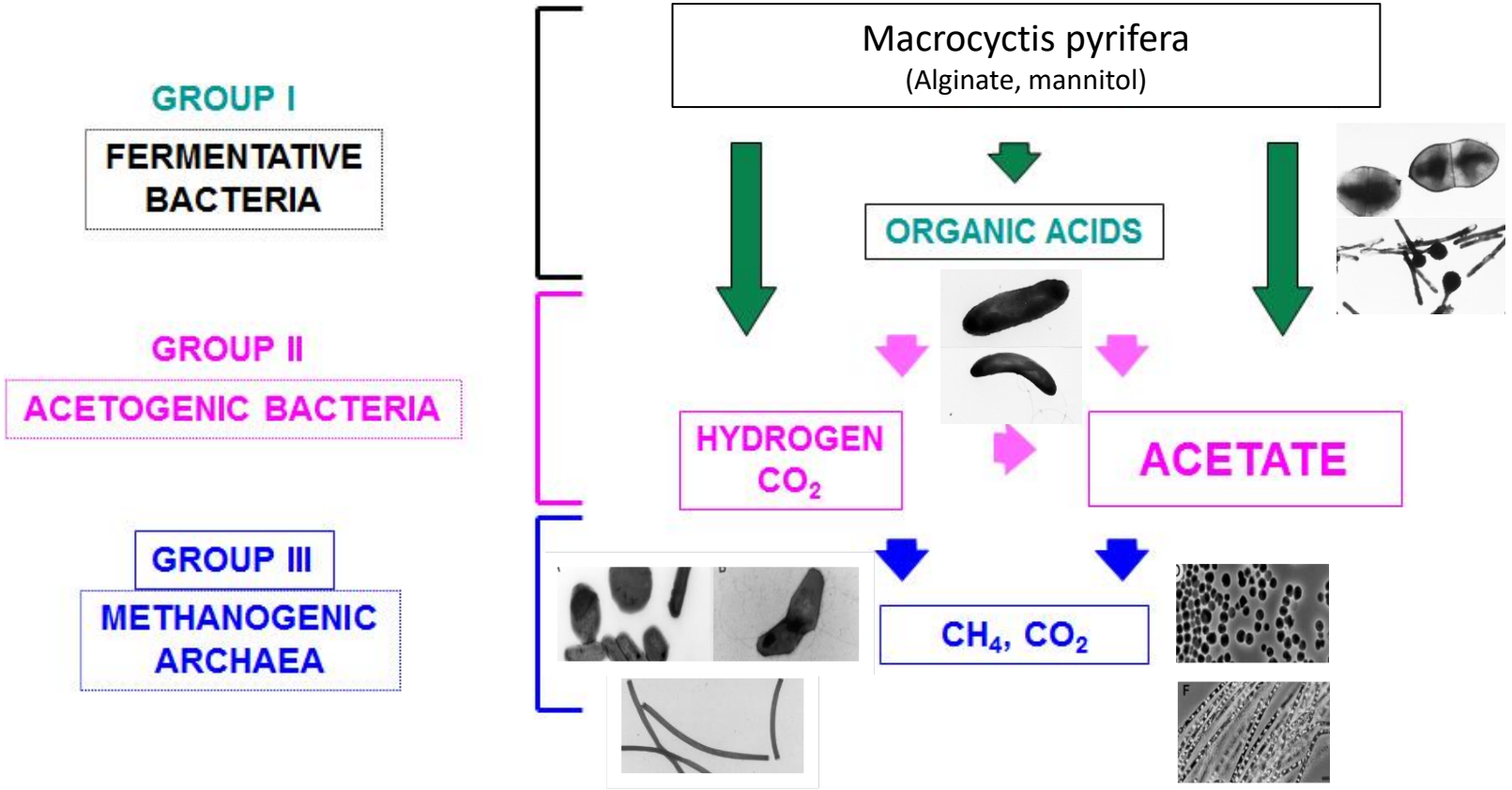
A New/Old Idea



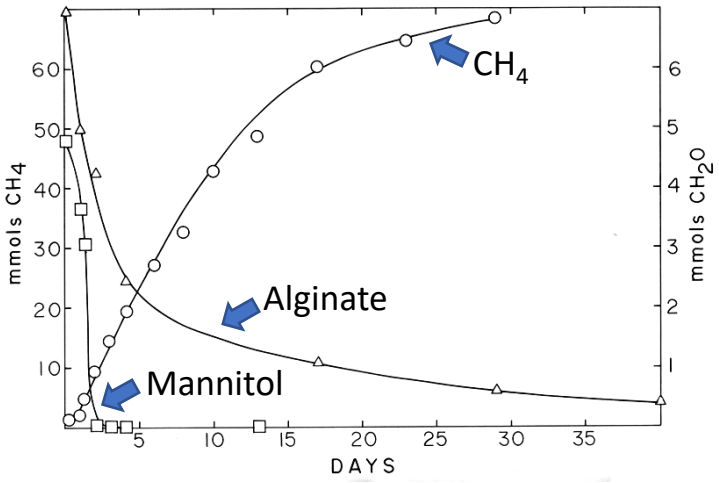


Defined Consortium for Converting *Macrocystis pyrifera* to Biogas

Marine Consortium



In Seawater



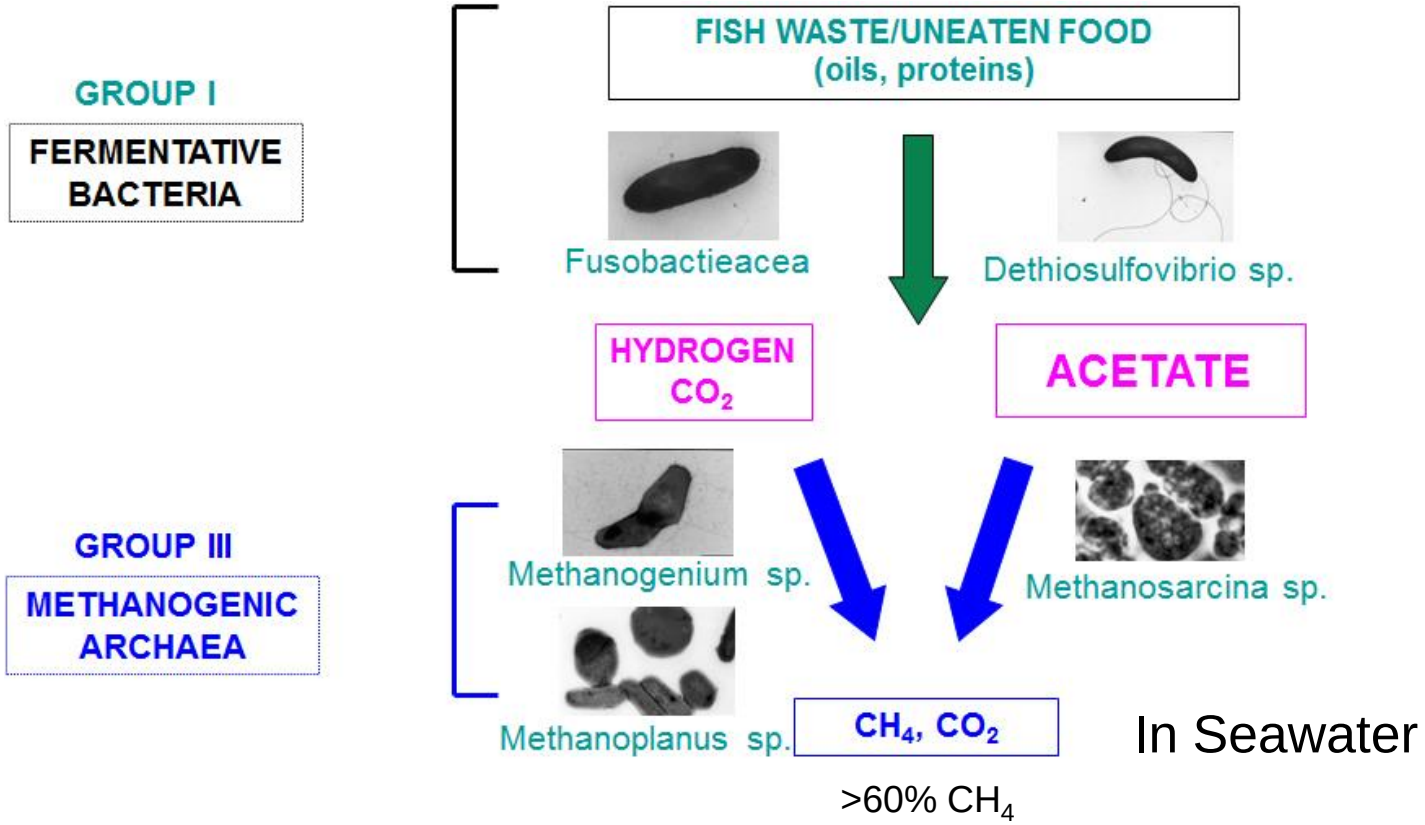
- 90% reduction TOC
- 70% fuel-grade methane

Gas Research Institute Funded

Sowers and Ferry, 1984

Defined Consortium for Land-Based Aquaculture: Mediterranean Seabream Waste to Biogas

Marine Consortium



In Seawater

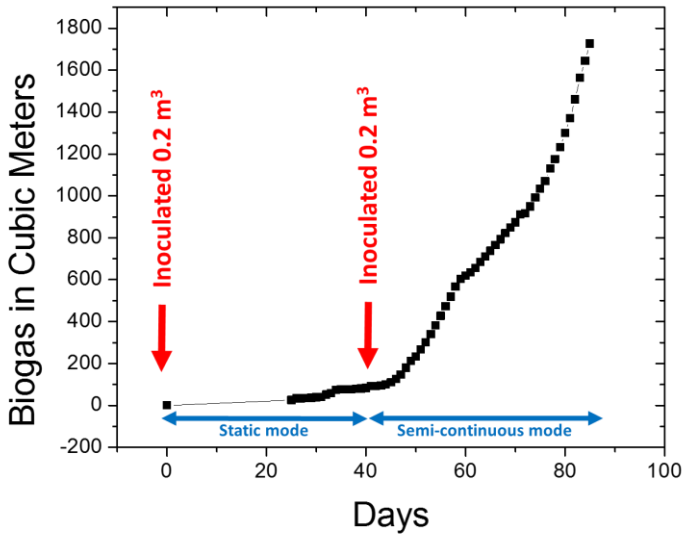
>60% CH_4

Quinn et al. *Aquaculture* 2016

Defined Consortium for Conversion of Salmon Smolt Waste to Biogas – Forsan, Norway

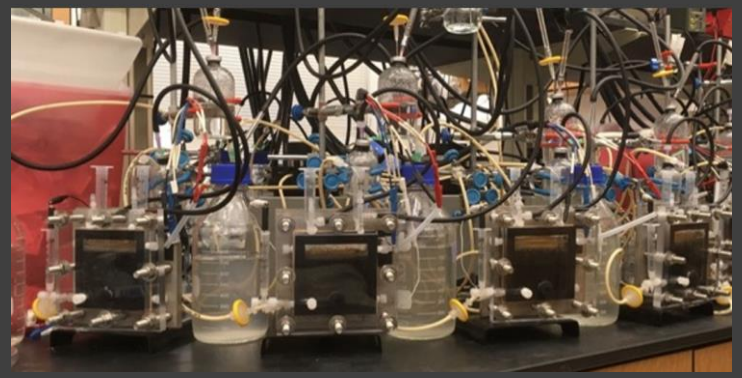
Freshwater Consortium

First commercial-scale biogas plant built for land-based aquaculture



Current biogas production 175 m^3/day used to heat aquaculture plant water

CERMAQ sterner Institute of Marine and Environmental Technology



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