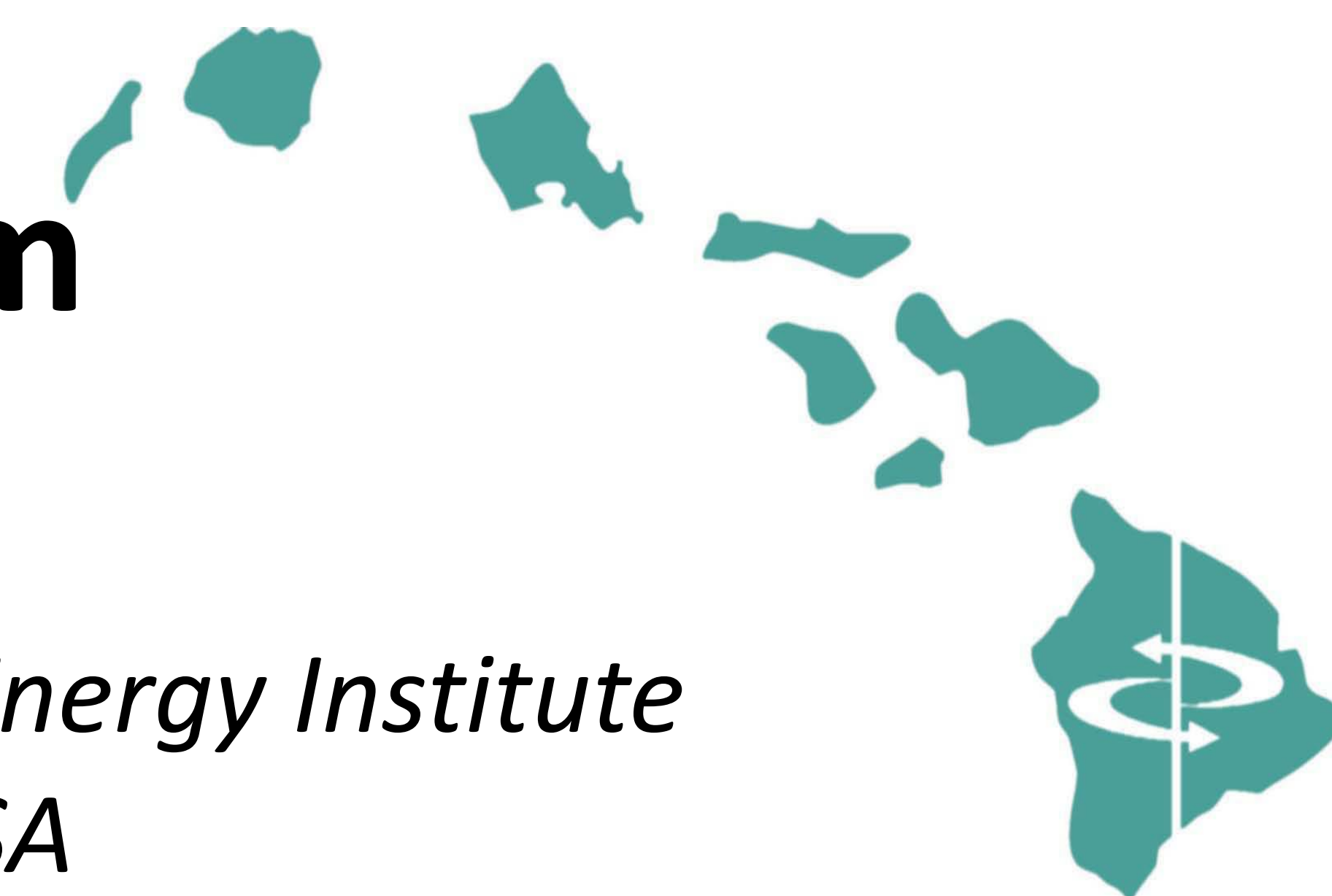




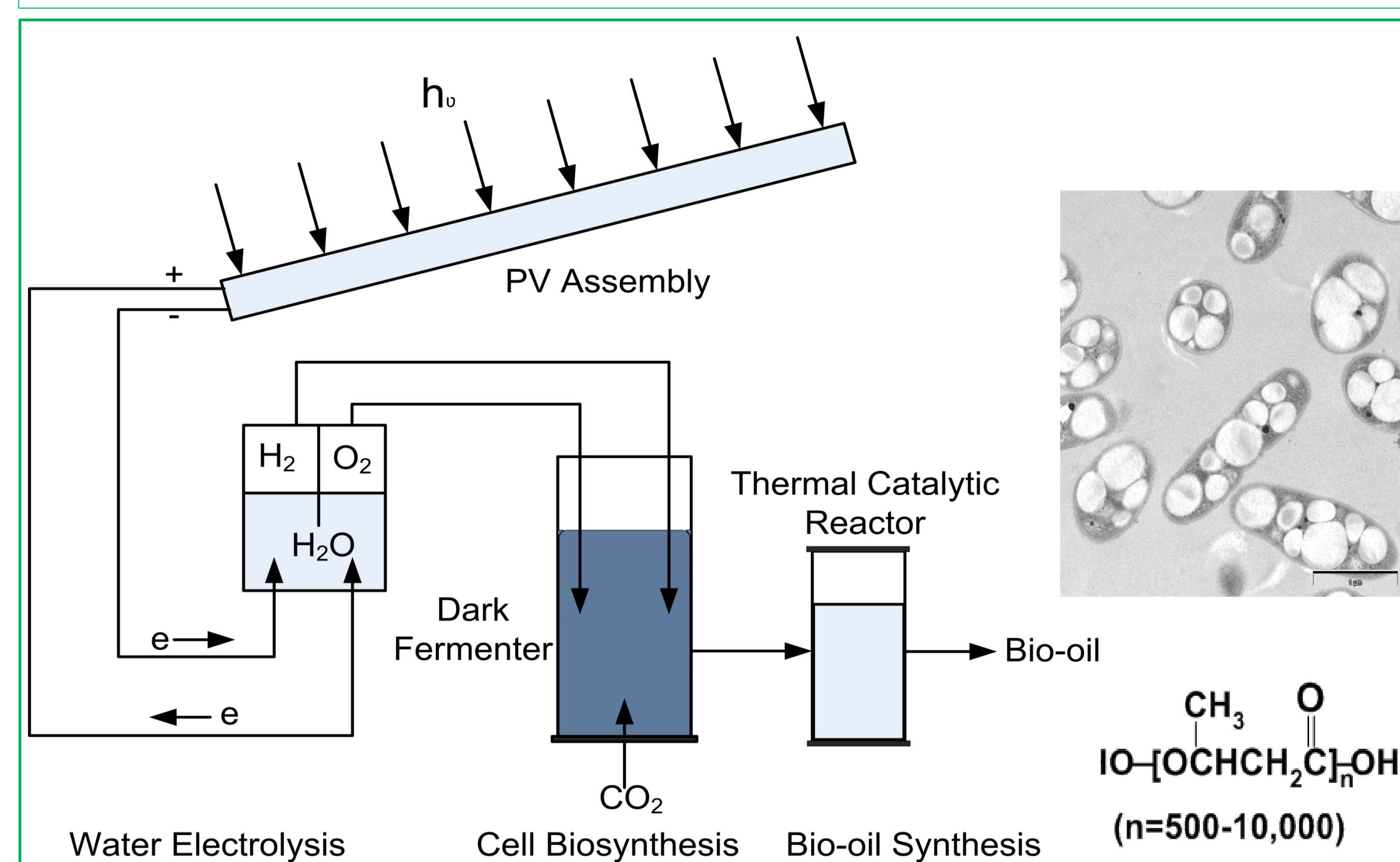
Renewable Hydrocarbon Oils and Chemicals from Solar Energy and Carbon Dioxide

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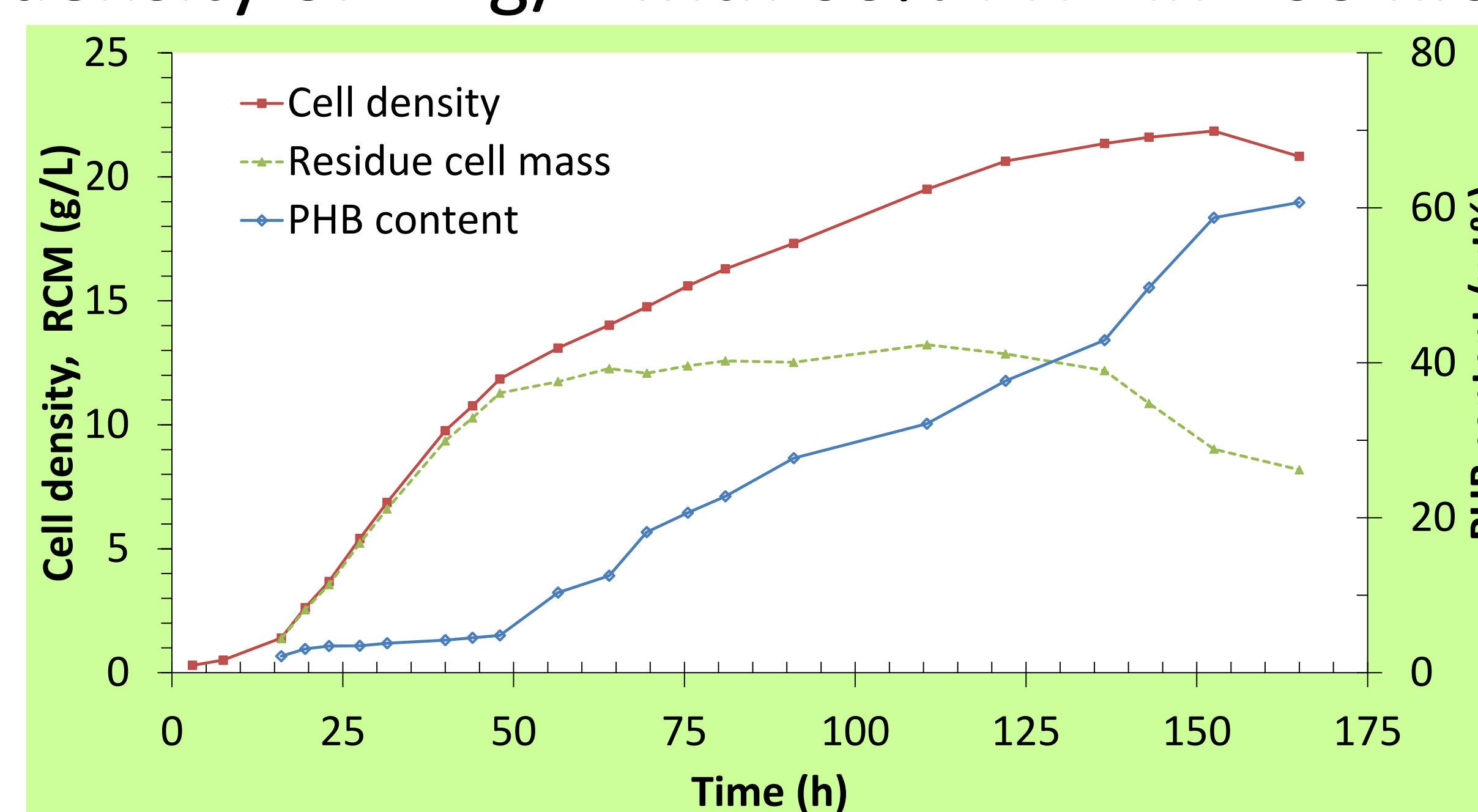


Introduction: A novel technology is being developed to produce hydrocarbon oil and chemicals (C7-C16) from CO₂ and solar energy. The process consists of water hydrolysis with solar electricity, hydrogen-based CO₂ fixation by an autolithotrophic bacterium under dark conditions, and thermal catalytic conversion of the cell mass into hydrocarbon oil. Aromatics are the major compounds in the oil. High performance transportation fuels can therefore be produced, by refining the renewable oil.

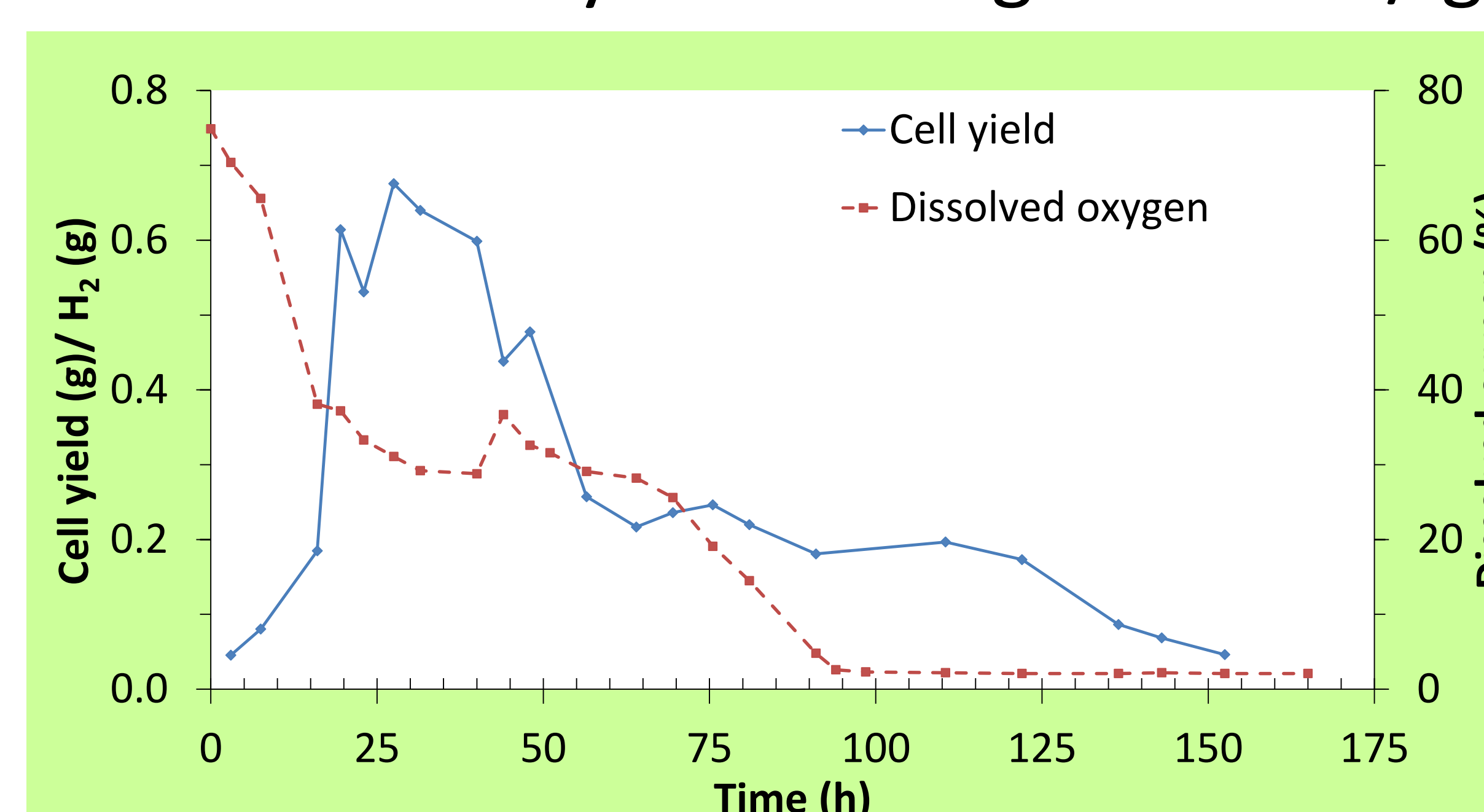
Method: The process consists of a photovoltaic assembly, a water electrolyzer, a dark fermenter in which autotrophic hydrogen-oxidizing bacterium assimilates CO₂ with H₂ and O₂. The biomass is converted into renewable oil and chemicals in a thermal reactor.



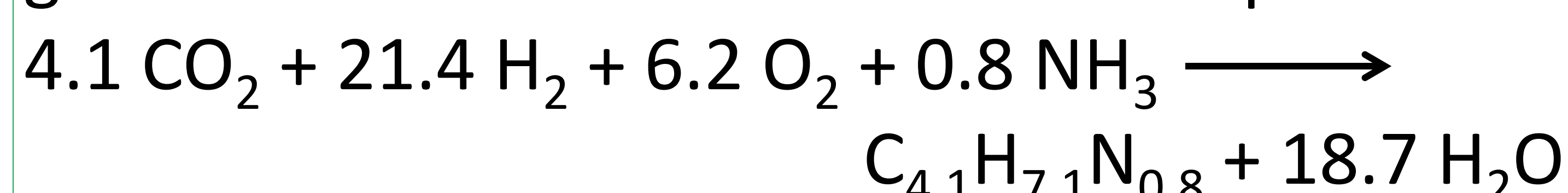
Result 1: CO₂ assimilation and cell growth on flue gas (CO₂:H₂:O₂:N₂ =9:39:13:39) and PHB formation with nitrogen nutrient depletion: high cell density of 22 g/L with 60% PHB in 160 hrs.



Result 2: Maximum yield of 0.7 g Cell mass/ g H₂



Stoichiometric equation: for the exponential growth of the cells and PHB in autotrophic culture

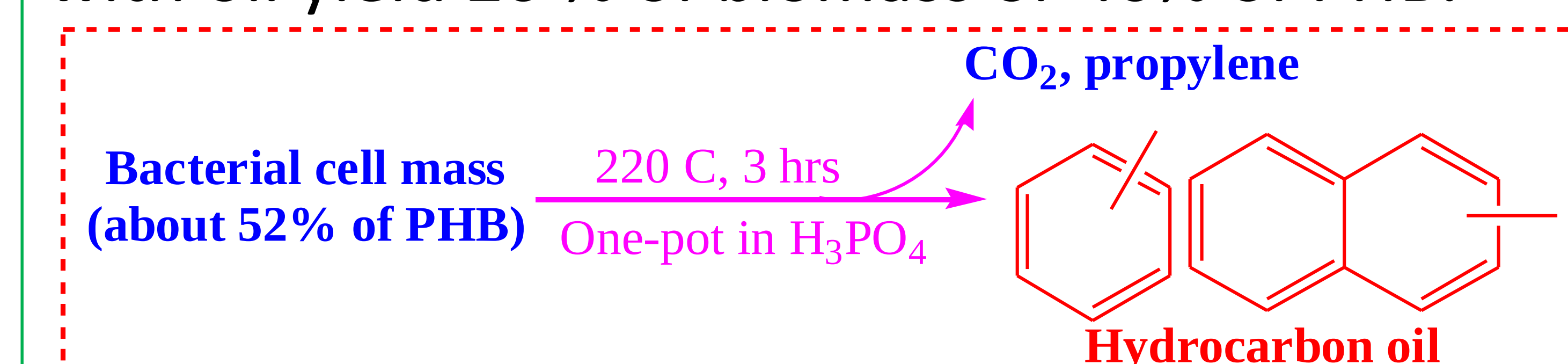


PHB accumulation:



Ref. Tanaka K. et al. (1995) *Biotech. Bioeng.* 45:268-275

Result 3: One-pot conversion of cell mass into hydrocarbon oil in 100% H₃PO₄, 220 °C, 3 hours with oil yield 20 % of biomass or 40% of PHB.



Result 4: Composition of PHB oil with GC-MS

Chemicals	Oxygenate	Acyclic alkane	Cyclo-alkane	Acyclic alkene	Cyclo-alkene	Benzene	Naphthalene
Area (%)	7.9	0.6	0.1	0.1	2.0	79.0	10.4
Carbon distribution	<C7	C7-C8	C9-C10	C11-C12	C13-C14	C15-C16	>C16
Area (%)	ND	0.1	8.2	18.8	52.7	19.2	ND

Ref. Kang S. & Yu J.(2014) *RSC Adv.* 4(28): 14320-14327.

Result 5: High performance transportation fuels from PHB oil (light & heavy fractions)

Fuels	Gasoline	PHB oil-Light	PHB oil-heavy	Ethanol
BP (°C)	40-200	40-250	>250	78
C (wt%)	80.4	83.2	65.5	52.2
H (wt%)	12.3	10.3	8.6	13.0
O (wt%)	6.4	6.3	25.6	34.8
HHV (MJ/kg)	41.8	42.1	34.4	29.7

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