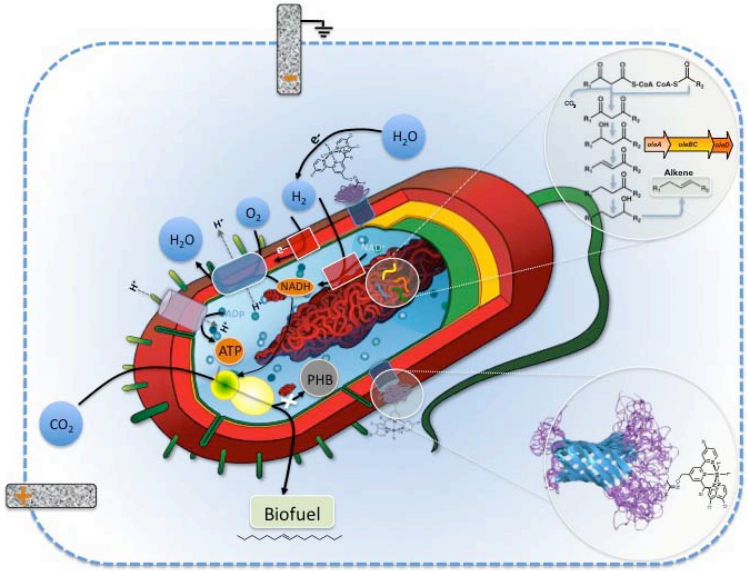
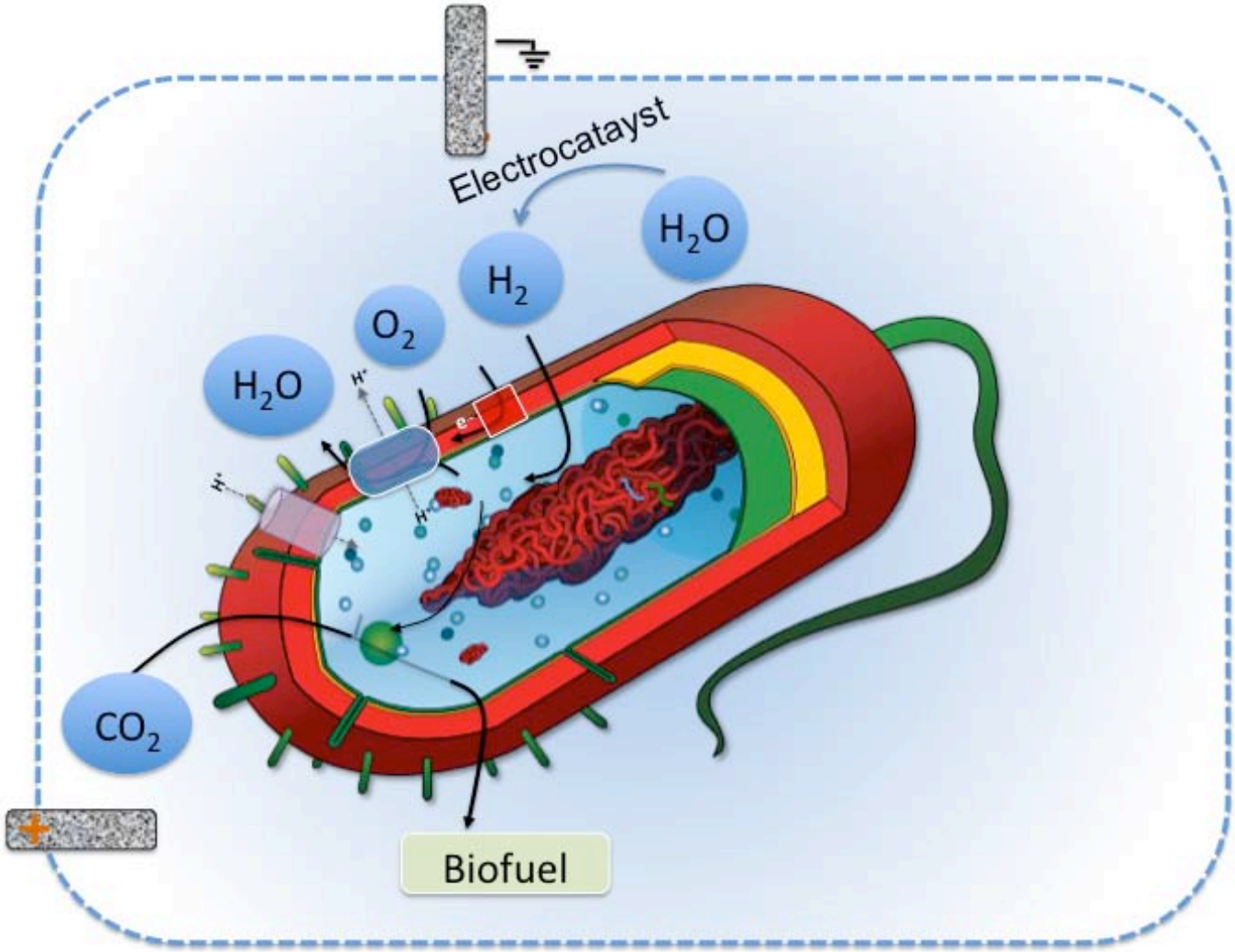
Microbial ElectroCatalytic (MEC) Biofuel Production

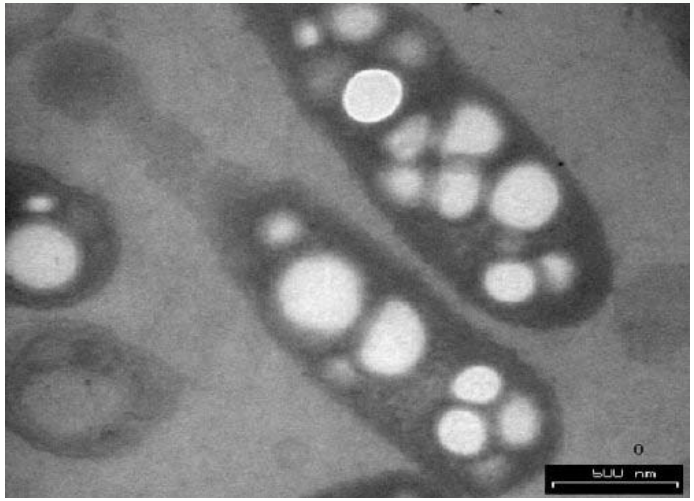


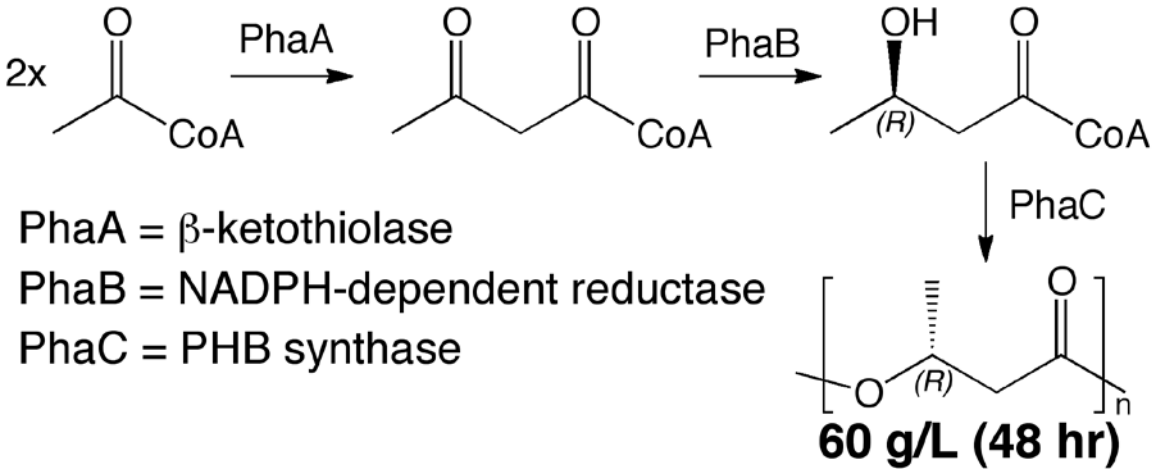
Integrating Microbial and Electrochemical Catalysis



Ralstonia eutropha: A Host for Electrofuel Production

- *R. eutropha* is a a common soil bacterium that can grow with organic compounds or H_2/CO_2
- *R. eutropha* is a model for studying bacterial H_2 metabolism and poly-hydroxybutyrate (PHB) production

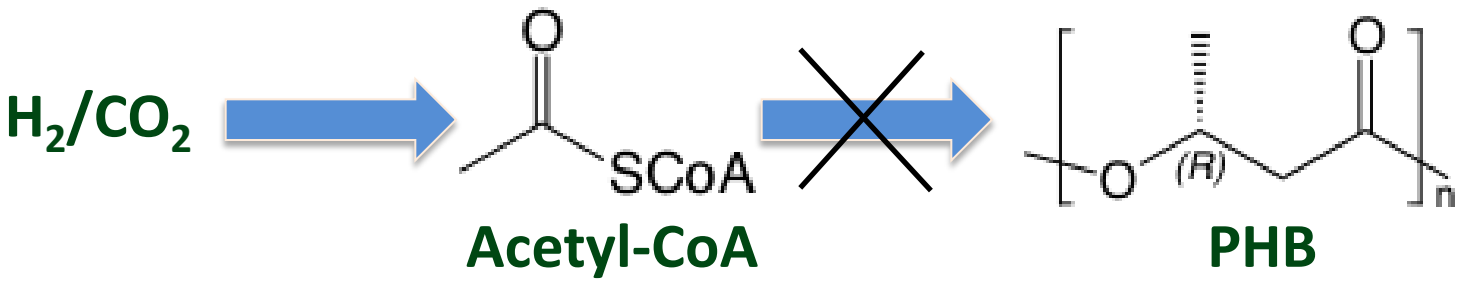




PhaA = β-ketothiolase
PhaB = NADPH-dependent reductase
PhaC = PHB synthase

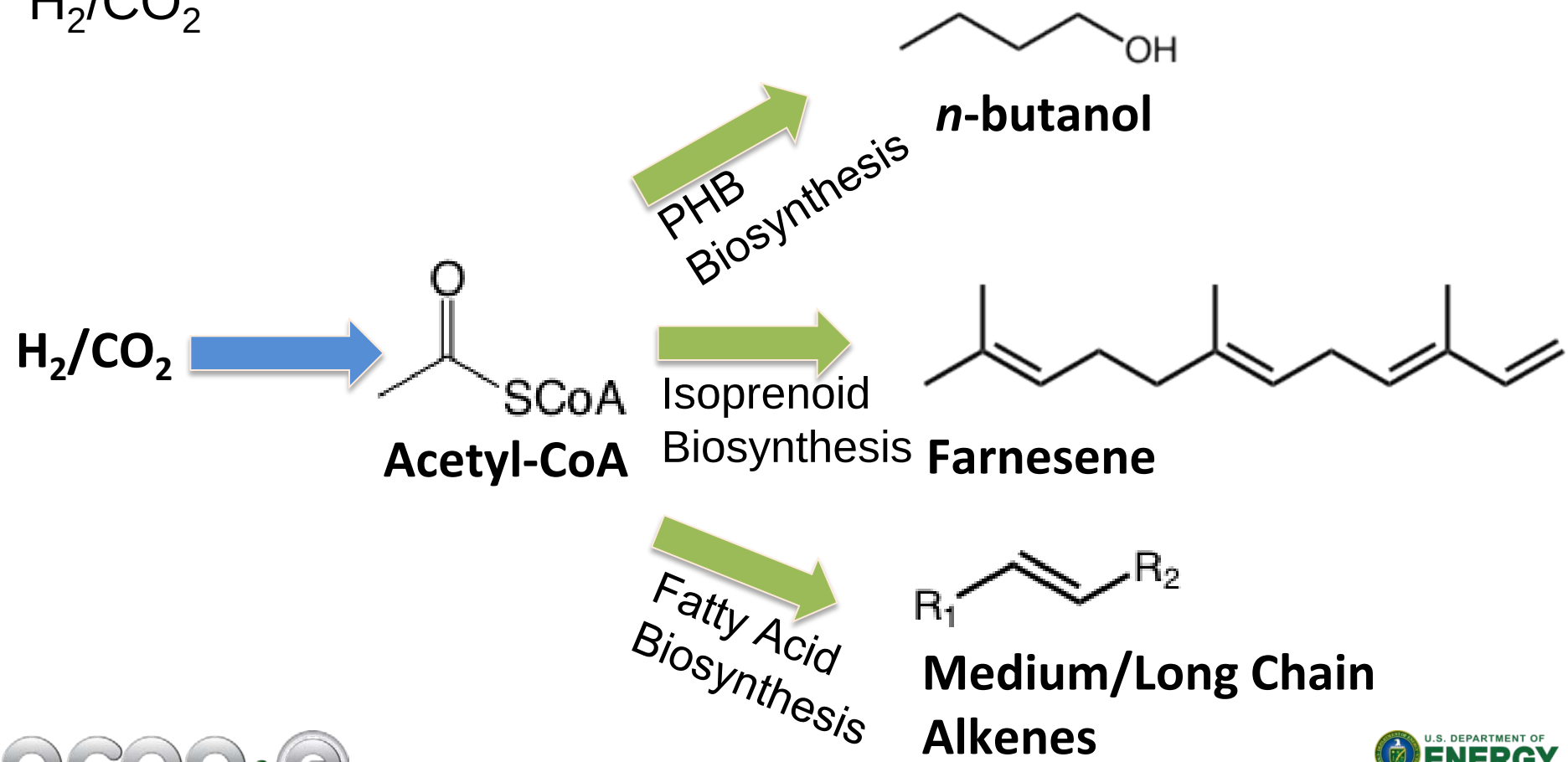
Metabolic Engineering of *Ralstonia eutropha*

Carbon flux to PHB synthesis will be diverted to produce butanol, fatty-acid derived alkenes and isoprenoids from H_2/CO_2



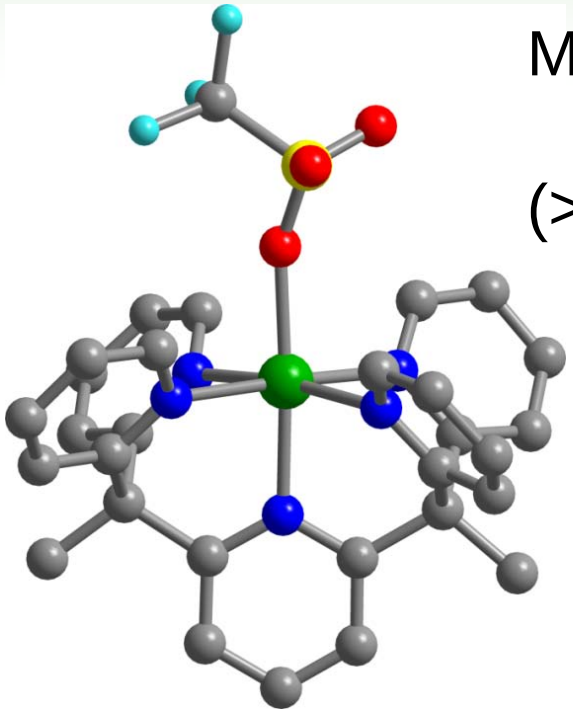
Metabolic Engineering of *Ralstonia eutropha*

Carbon flux to PHB synthesis will be diverted to produce butanol, fatty-acid derived alkenes and isoprenoids from H_2/CO_2

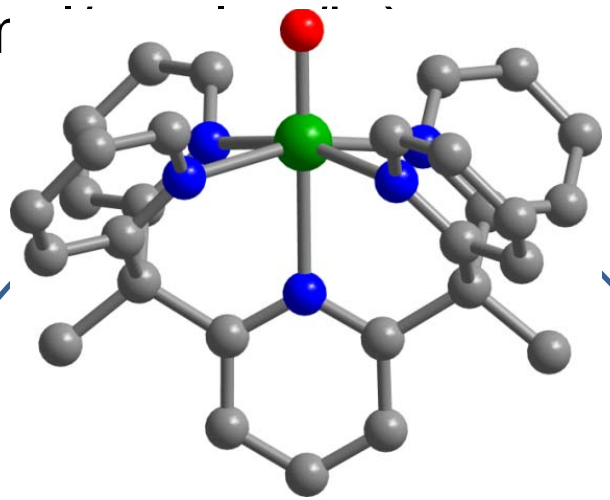


An Electrocatalyst for H_2 Production from H_2O

MoPy5 catalysts generates H_2 in neutral H_2O
(>10^6 mol H_2/m



$+ H_2O$
$- CF_3SO_3^-$



$+ H_2$

$2 e^-$

H_2

H_2O

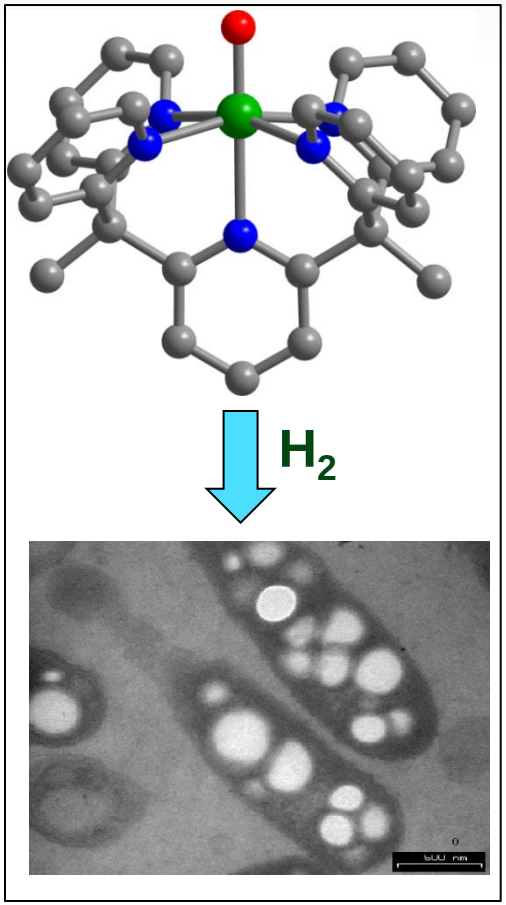
$[(PY5Me_2)Mo(CF_3SO_3)]^{1+}$

$[(PY5Me_2)MoO]^{2+}$

"$(PY5Me_2)Mo^{II}$"

Combining Electrocatalysis and Metabolic Engineering

Electricity



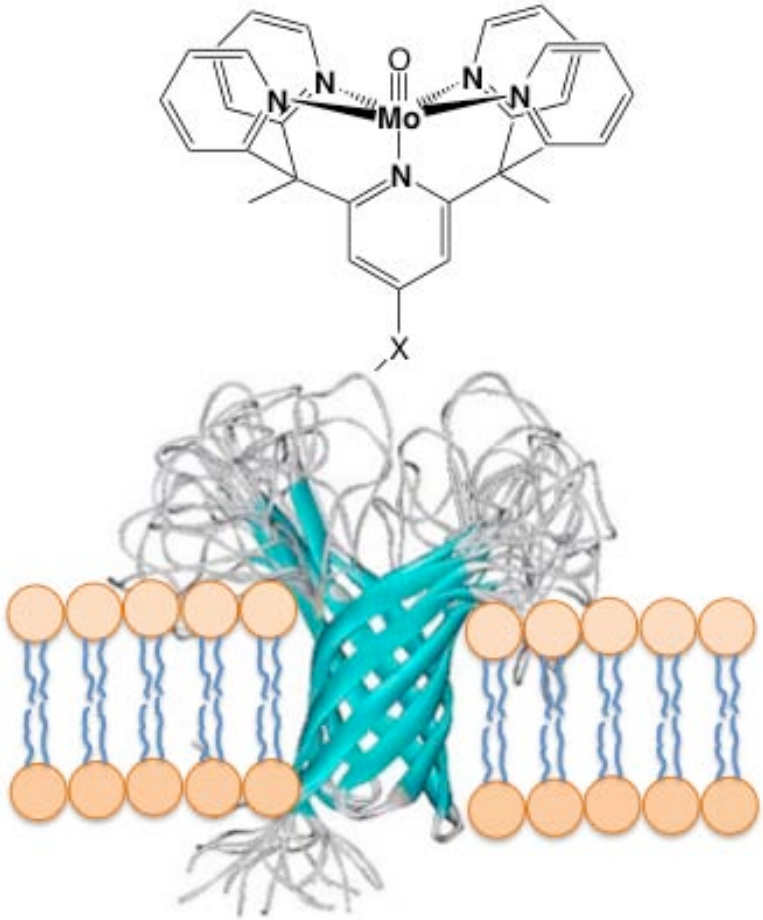
Hydrocarbons

CO_2

Can *R. eutropha* produce hydrocarbons from CO_2 in the presence of MoPy5 electrocatalyst?

Synthesizing Catalyst-Microbe BioConjugates

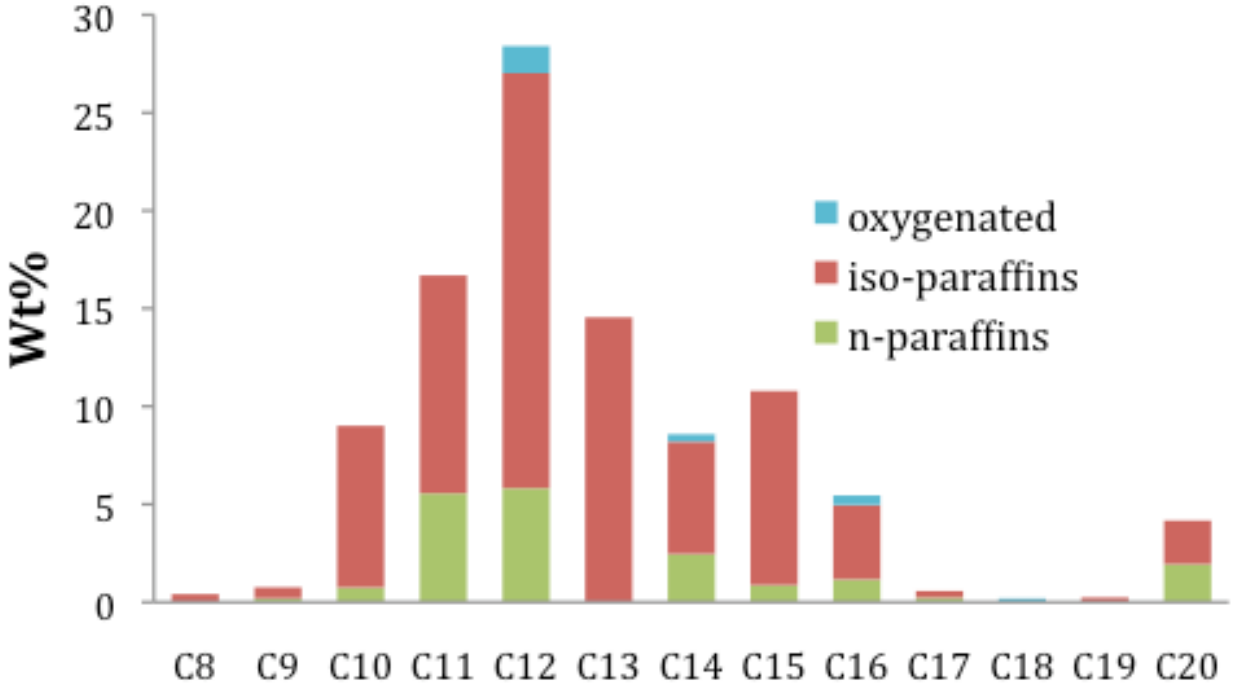
- Local concentrations of H_2 will be increased by tethering electrocatalysts and biofuel-producing *R. eutropha* strains



Chemical Catalysis for Electrofuel Production

Butanol produced by *R. eutropha* will be chemically transformed to jet fuel

$$\text{Electricity}/CO_2 \xrightarrow[\textit{R. eutropha}]{\text{Electrocatalyst}} C_4H_{10}O \xrightarrow[\text{Acid Catalysis}]{\text{Zeolite}} \text{Hydrocarbons } C_8\text{-}C_{16}$$



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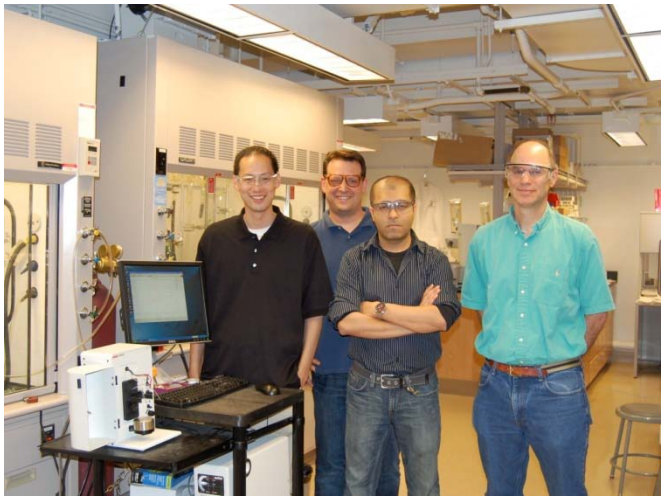
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