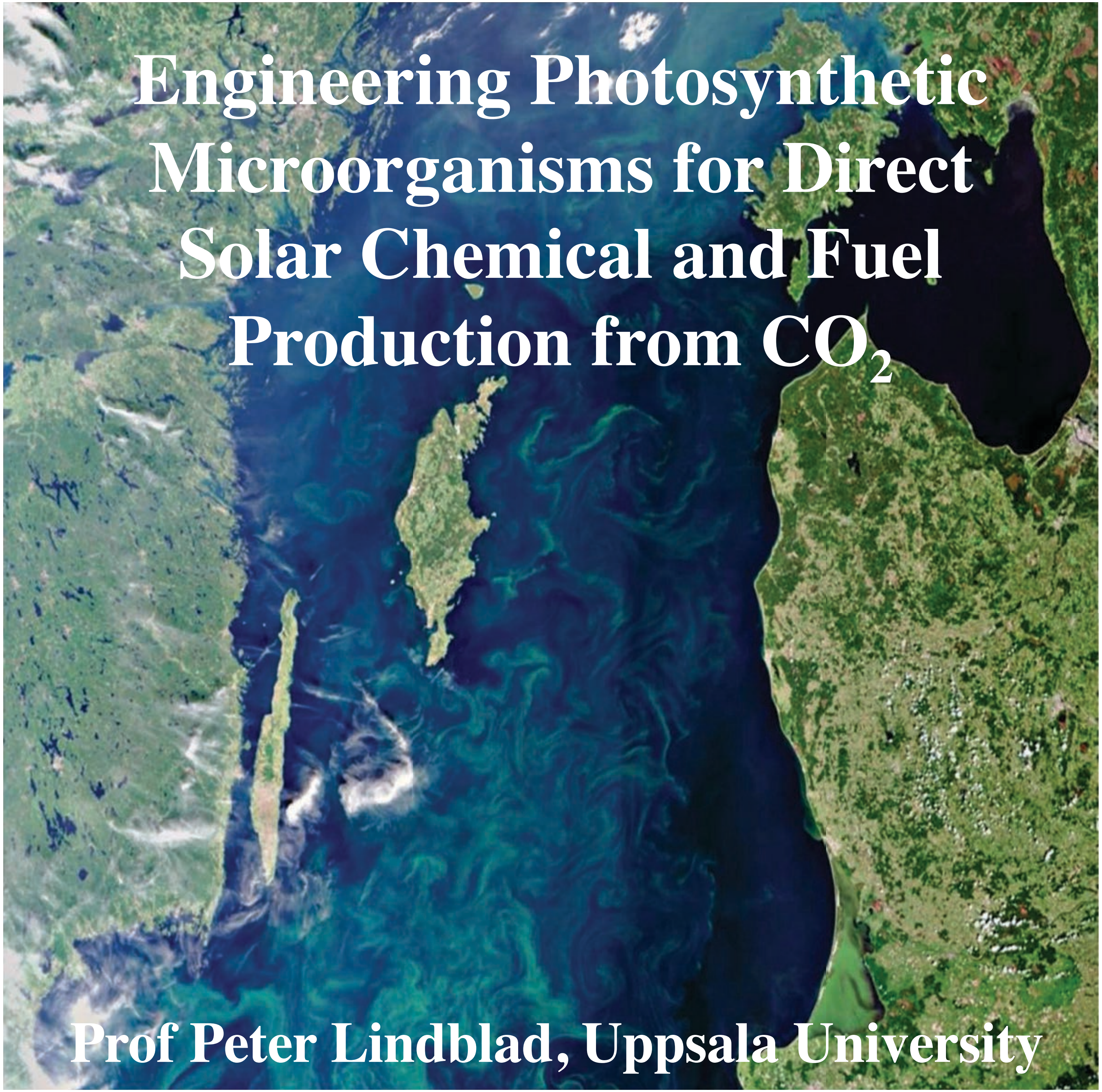
Engineering Photosynthetic Microorganisms for Direct Solar Chemical and Fuel Production from CO_2



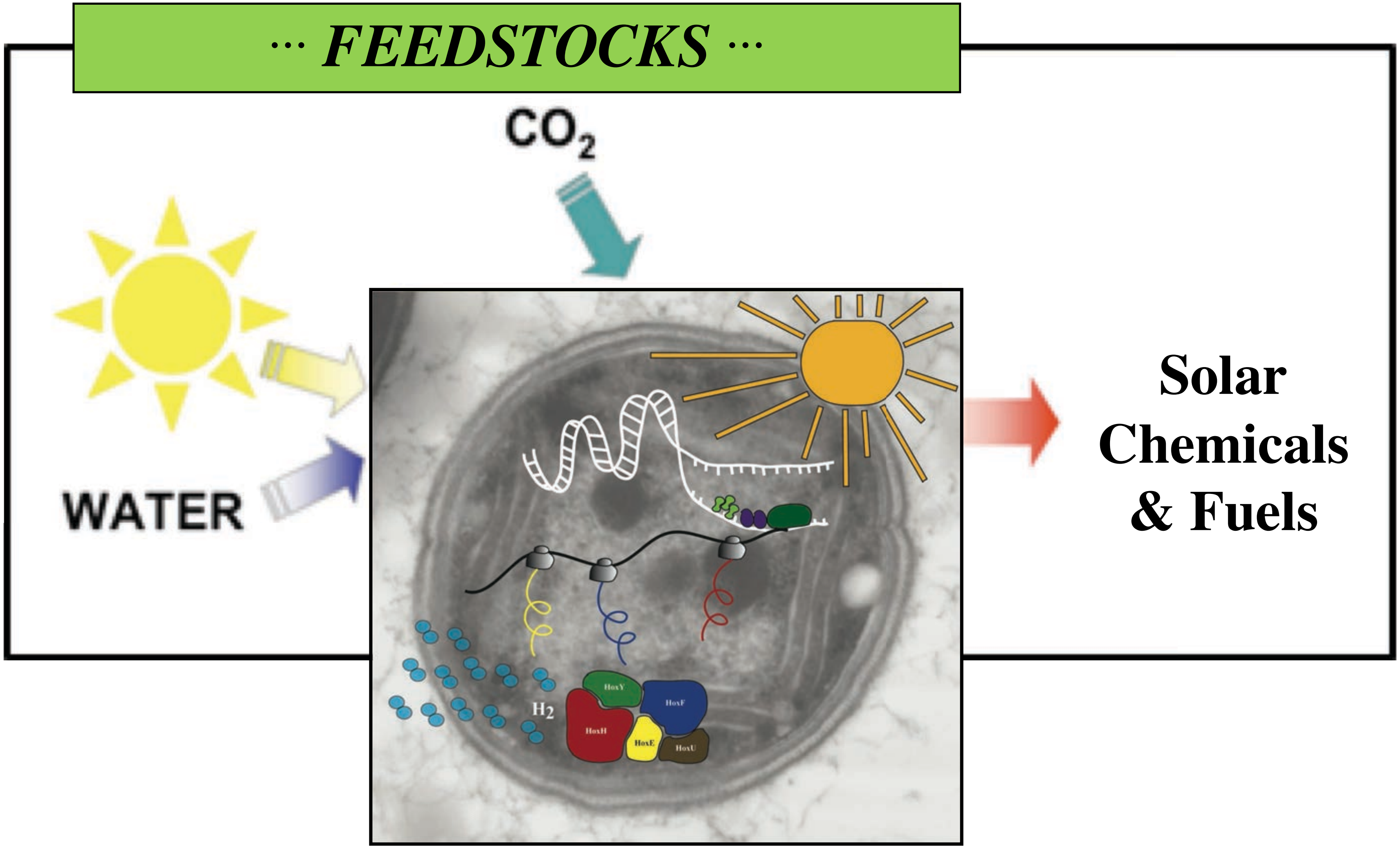
Prof Peter Lindblad, Uppsala University

Gröna Cell-Fabriker

Green Cell Factories

UPPSALA
UNIVERSITET

Aim: Green Cell Factories



Cyanobacteria

Green organisms: Plants, algae, cyanobacteria

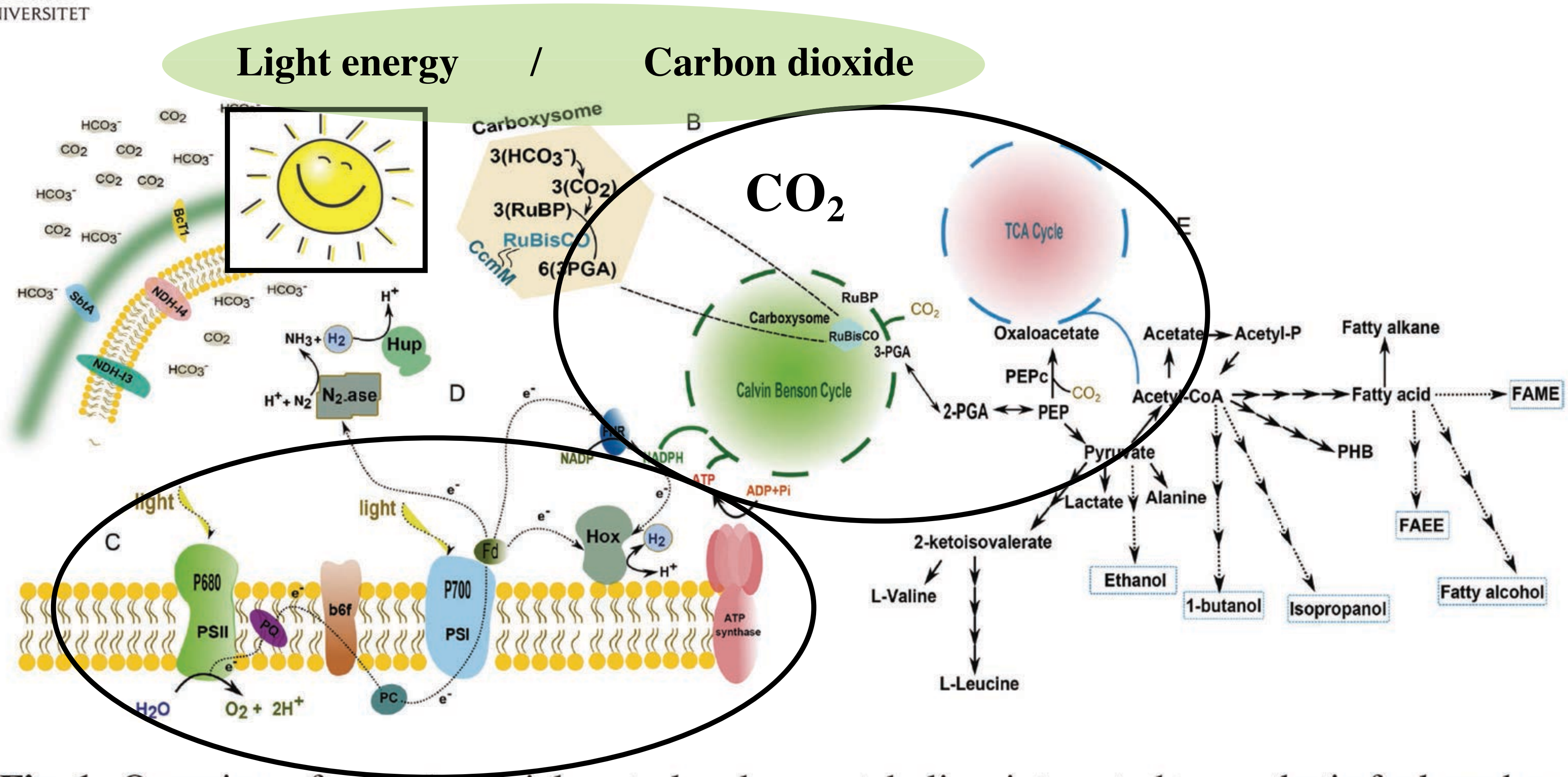
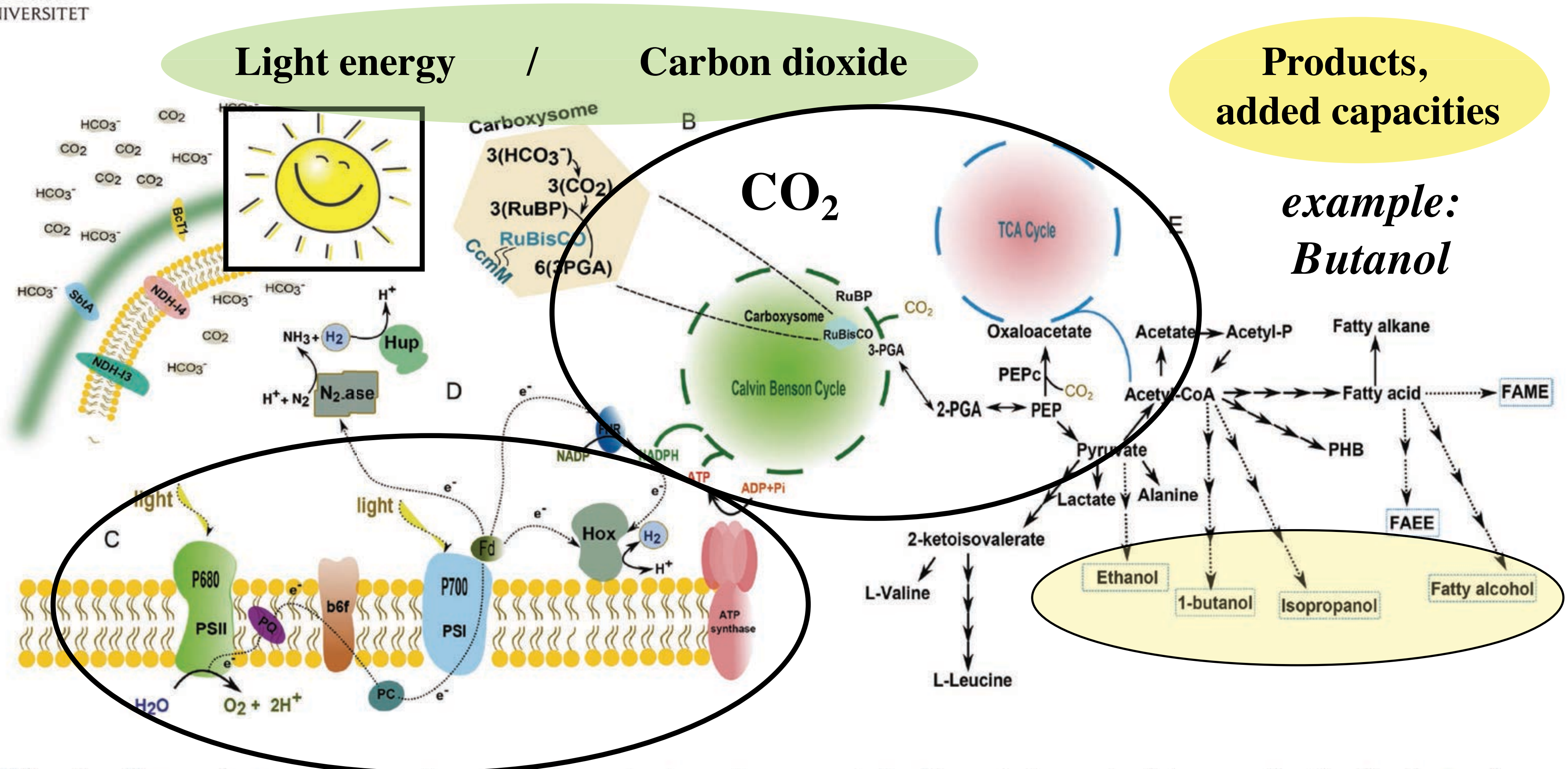


Fig. 1 Overview of cyanobacterial central carbon metabolism integrated to synthetic fuel production pathways. Carbon transporter systems (A), carbon fixation systems (B), photosynthetic systems (C), hydrogen production systems (D), pyruvate and acetyl-CoA-based metabolic systems (E). *Dotted lines* in E represent the introduced heterogenous pathways for different biofuels discussed in this chapter. The chemicals in *blue boxes* represent the potential biofuel molecules

Rui et al (2017) In: Modern Topics in the Phototrophic Prokaryotes 11: 351-393

Cyanobacteria



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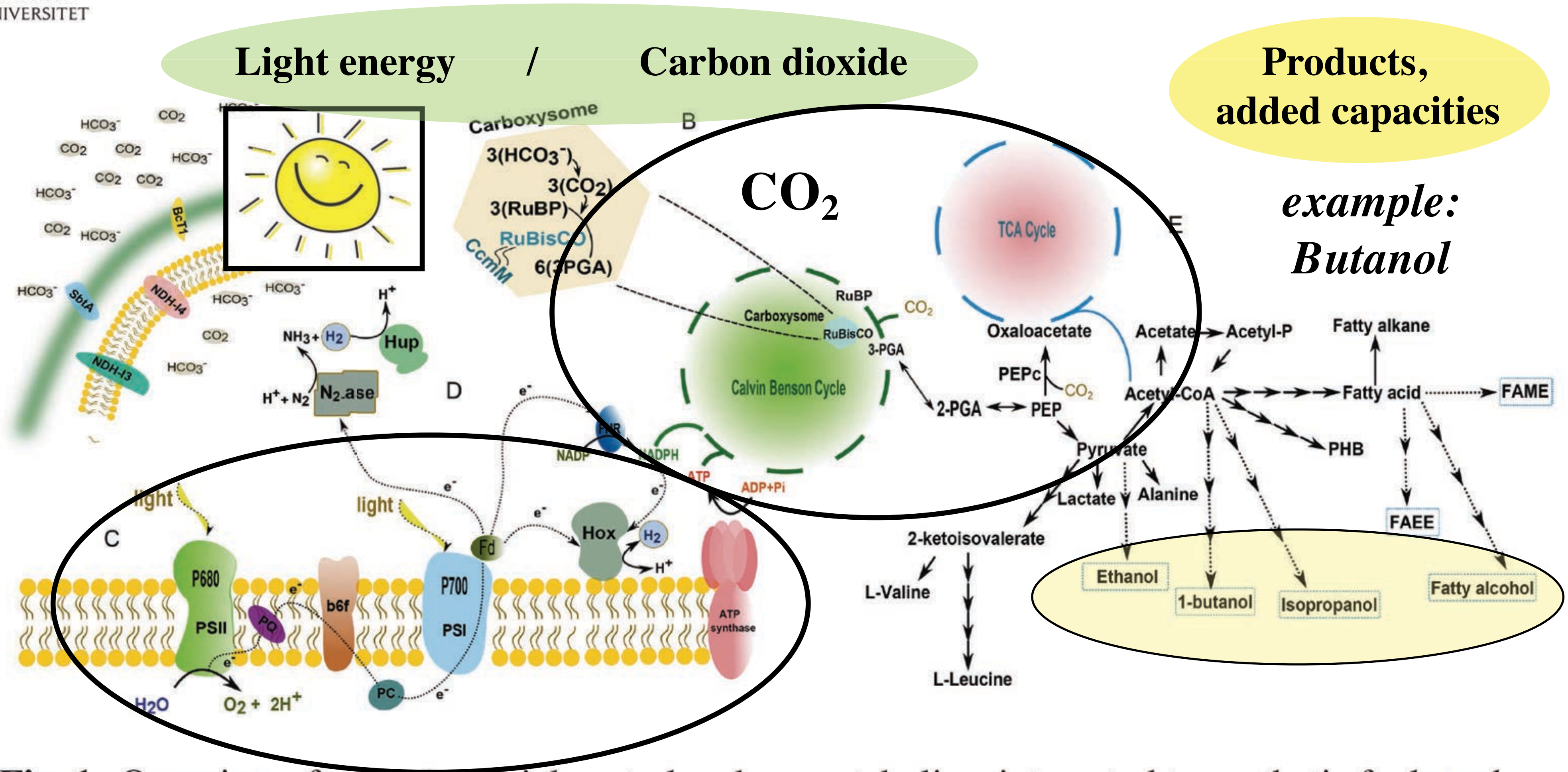
Growth *vs* Production



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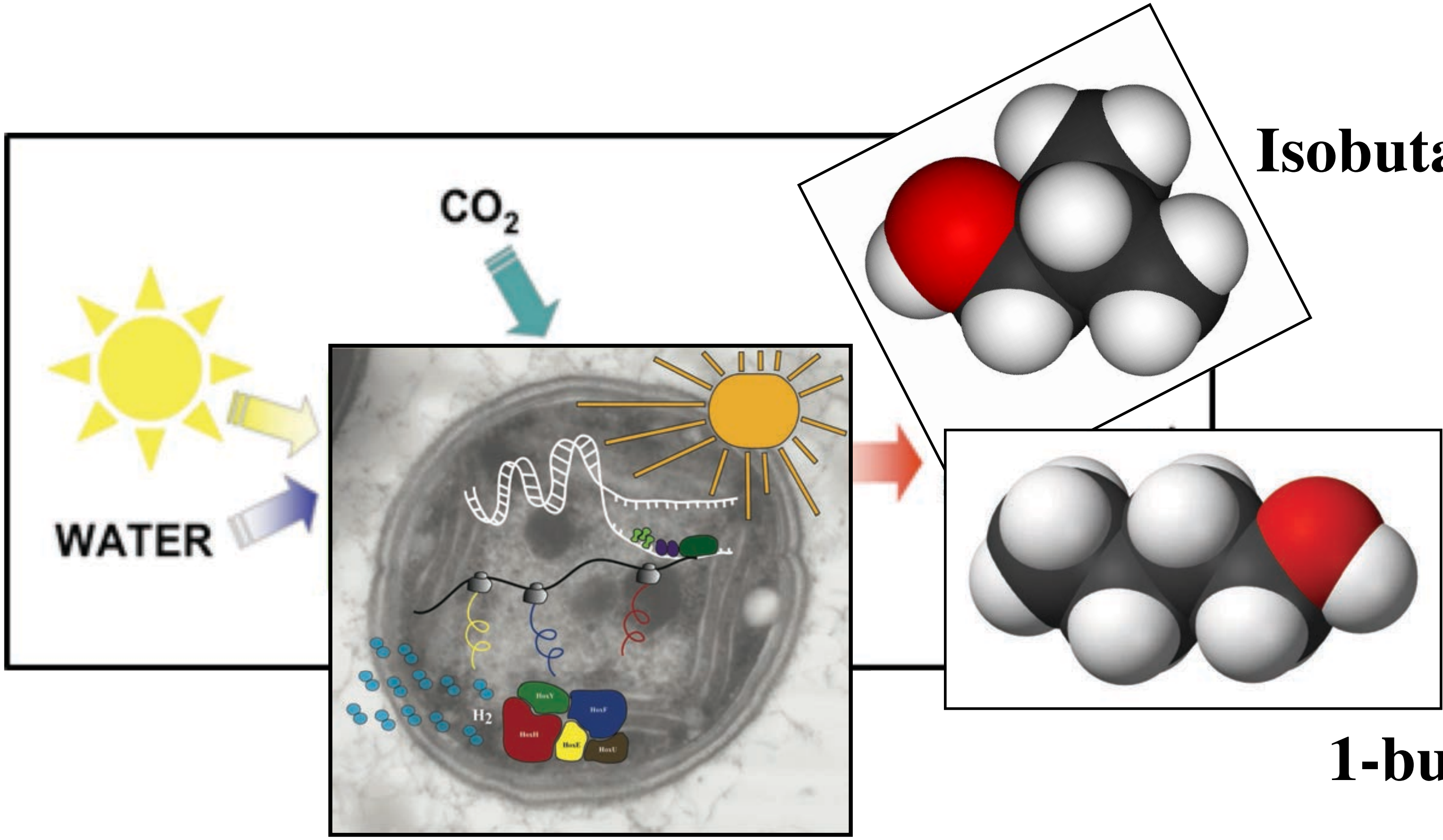
Rui et al (2017) In: Modern Topics in the Phototrophic Prokaryotes 11: 351-393

example

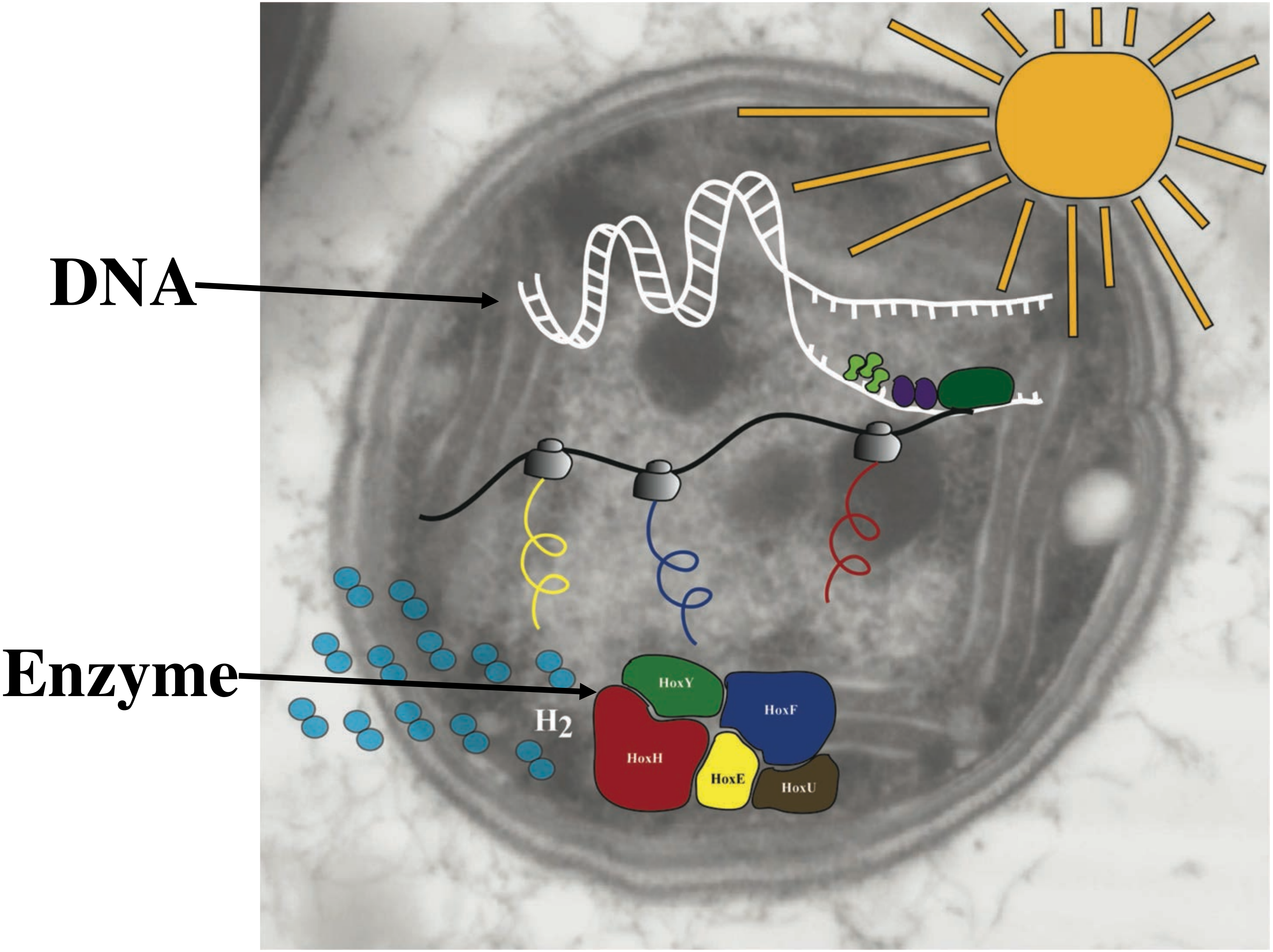
Engineering a photosynthetic cyanobacterium to produce butanol



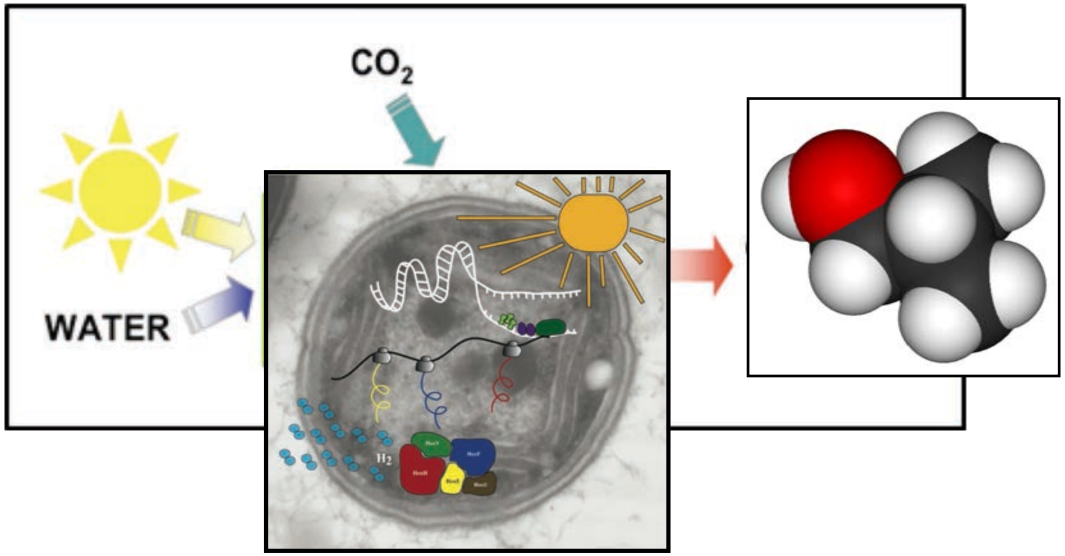
Isobutanol

1-butanol

EU-Horizon2020 project, 2016-2020, VW coordinator

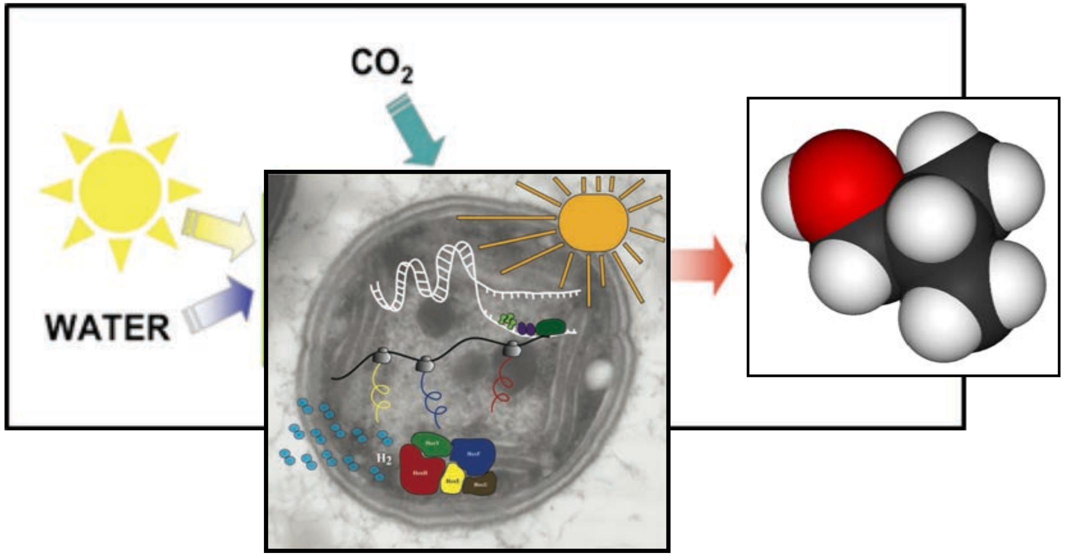

DNA
Enzyme
H2
HoxY
HoxF
HoxH
HoxE
HoxU

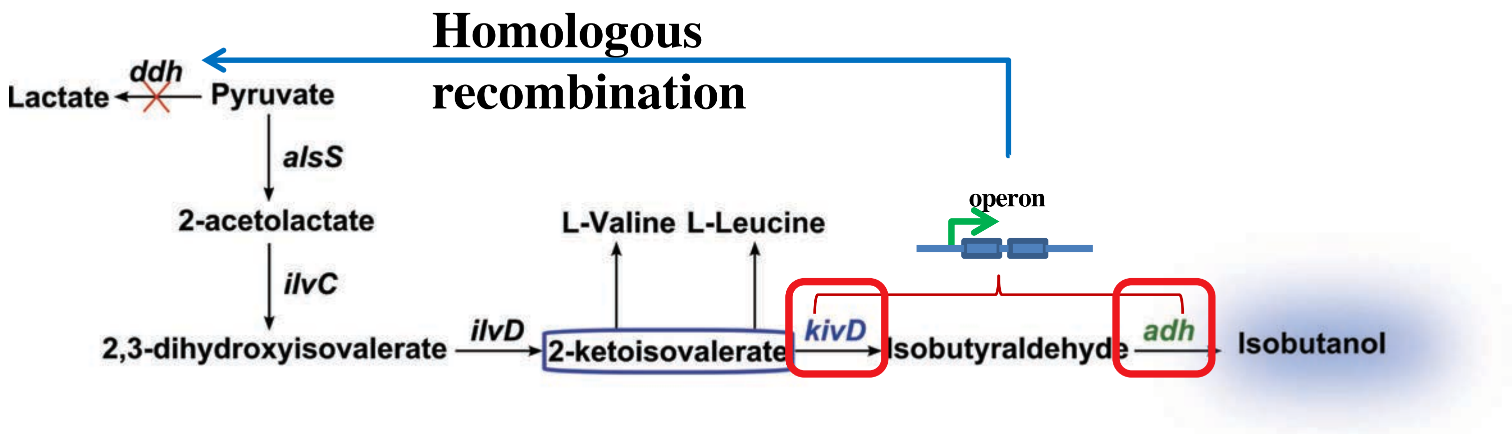
Engineering *Synechocystis* PCC 6803 to produce isobutanol



?

Engineering *Synechocystis* PCC 6803 to produce isobutanol

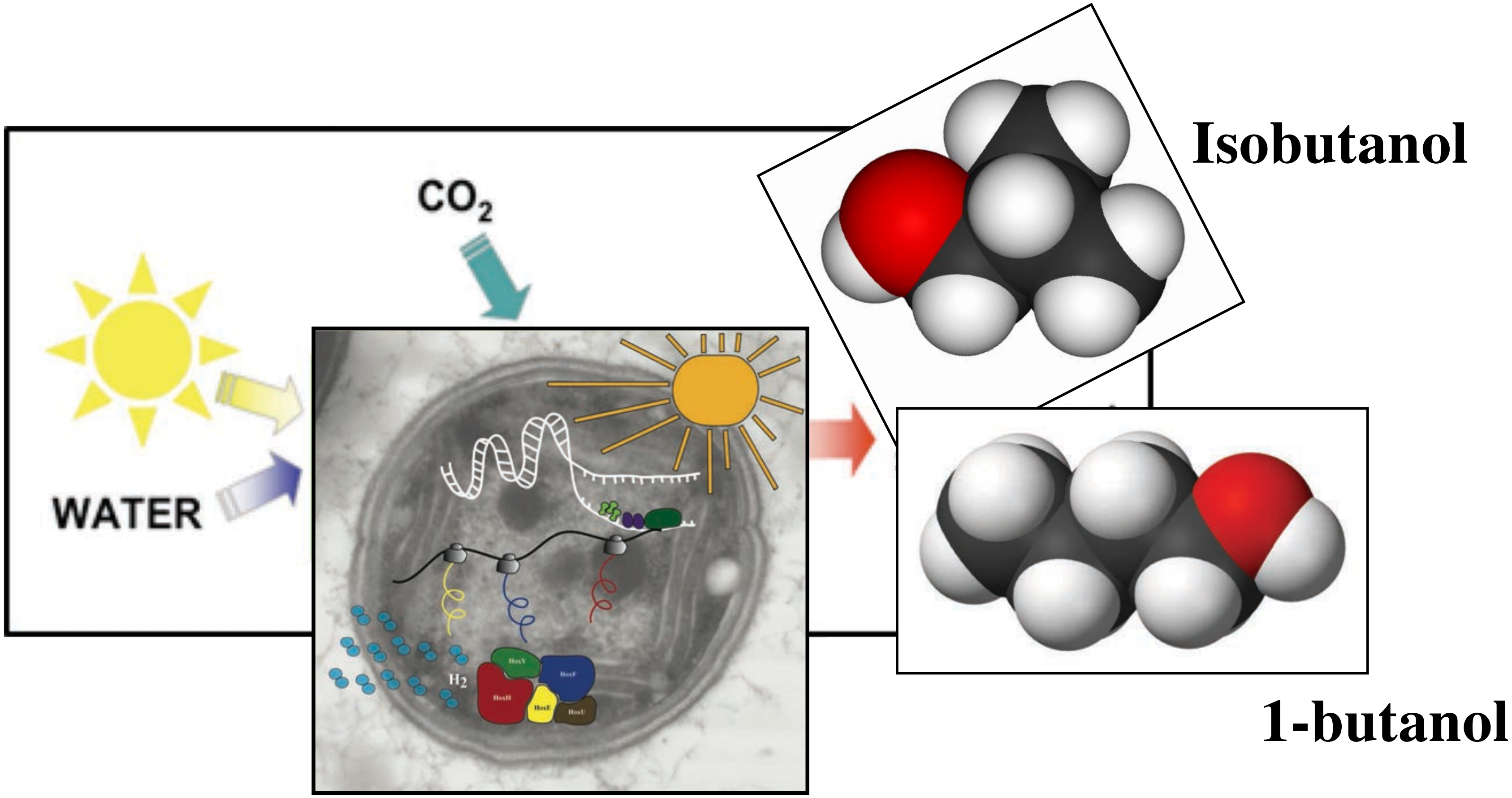




-> Isobutanol production, photosynthetic isobutanol

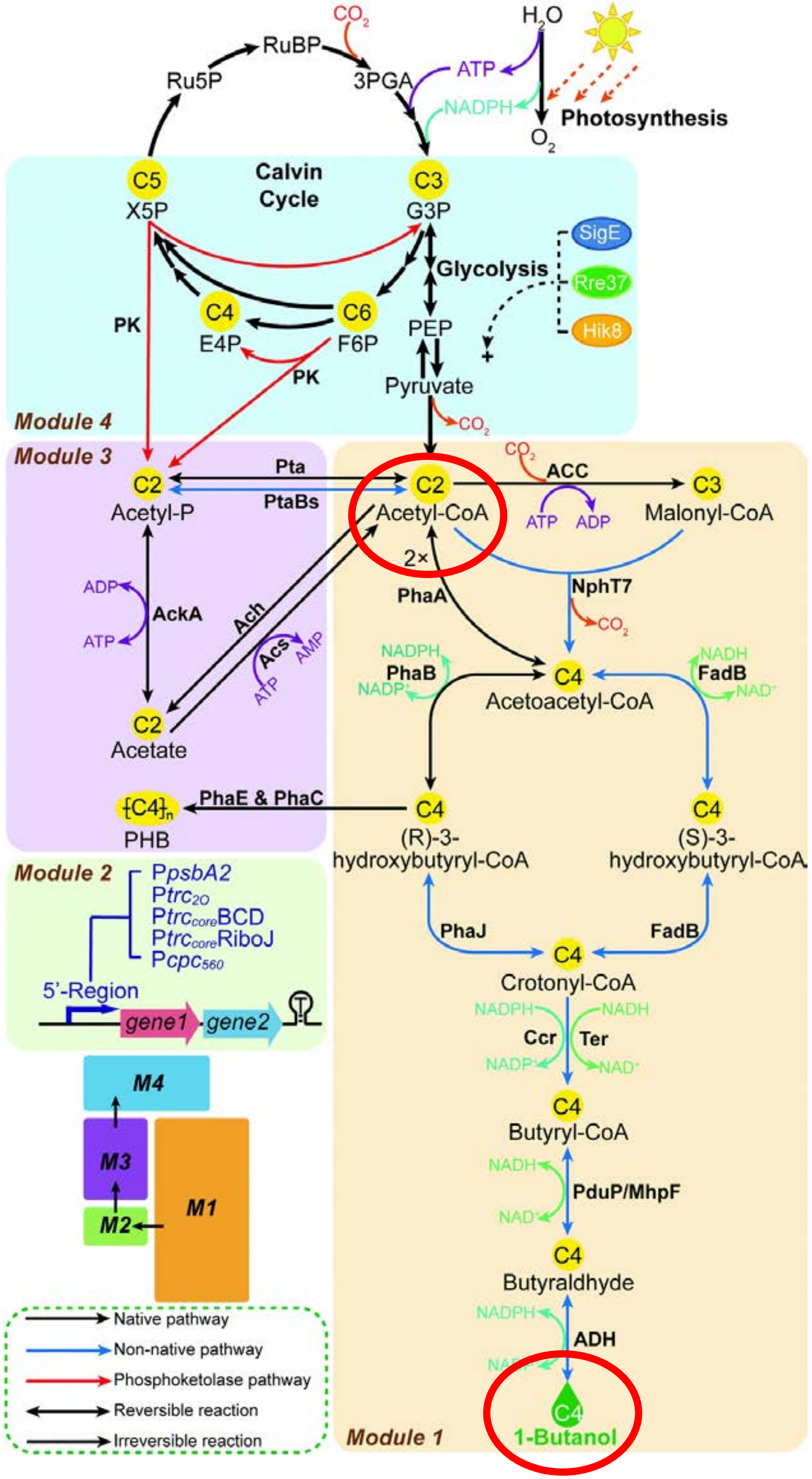
example

Engineering a photosynthetic cyanobacterium to produce butanol



PHOTOFUEL

EU-Horizon2020 project, 2016-2020, VW coordinator



Design

&

Engineer

Add/delete capacities

Control

Synthetic biology

Photosynthetic 1-butanol

Introduce genetic construct into *Synechocystis* PCC 6803

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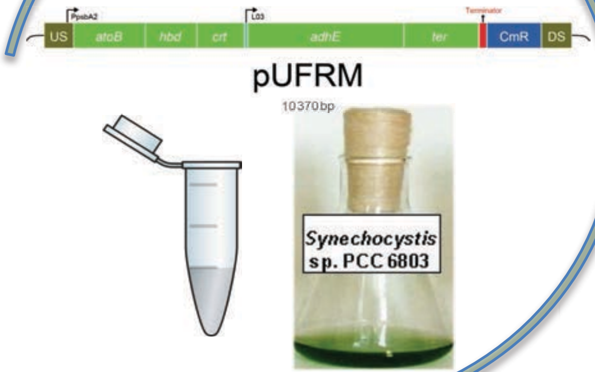
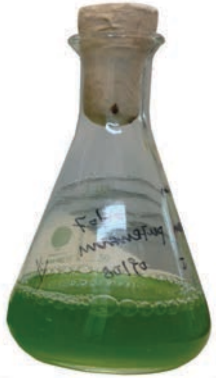
Plasmid+wild type cells

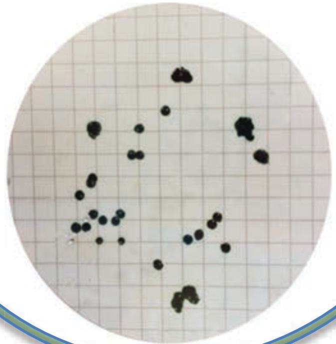


Larger scale cultivation

(25ml BG11, Antibiotic, High light)

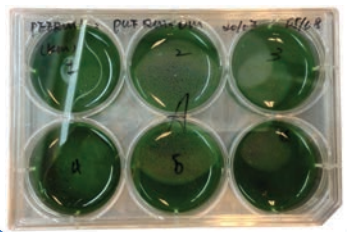


Engineered cells survive on selective plate



Cultivate positive colonies on six-well plate

(3ml BG11, Antibiotic, Low light)



Bubbling bottle (Air)

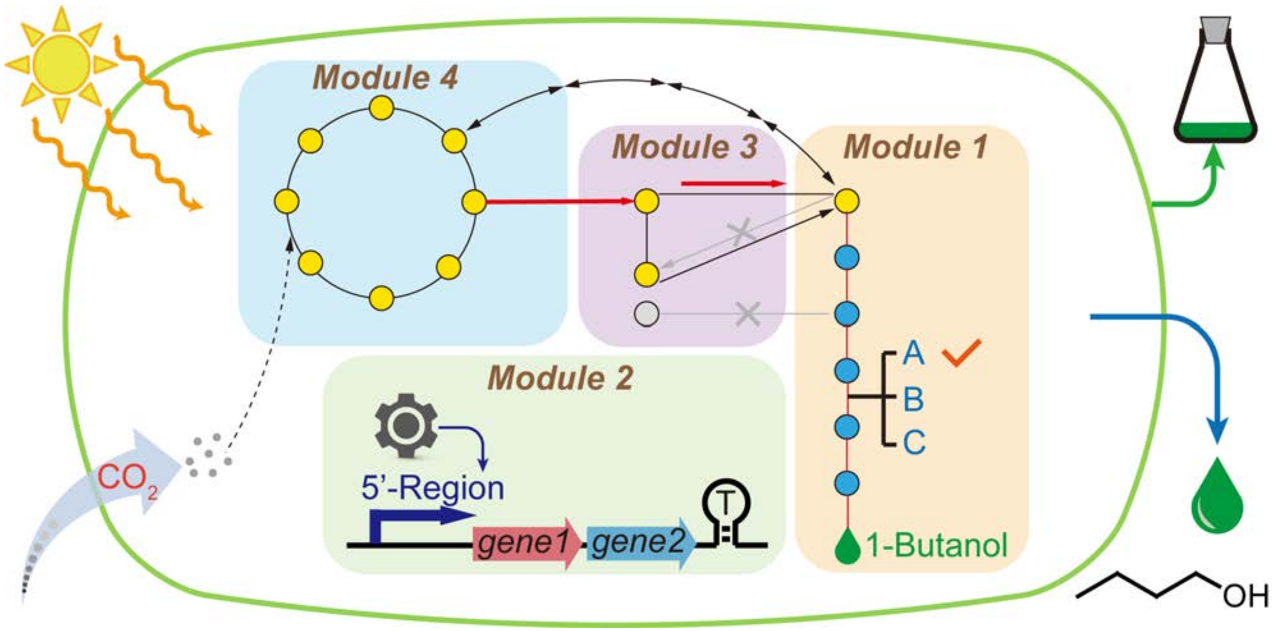
CHEMISTRY WORLD

Engineered cyanobacteria turn carbon dioxide into petrol substitute

BY ENNA GUADALUPE | 14 AUGUST 2019

Strategy transforms wild photosynthetic organism into a system that could reduce humanity's reliance on fossil fuels

Scientists in Sweden have engineered cyanobacteria that can photosynthesise the petrol substitute butanol out of carbon dioxide. The microorganisms could not only provide a way to make transportation fuels that don't depend on fossil fuels, but they could also remove carbon dioxide already present in the atmosphere.



Articolo

Stoccolma, 30 luglio 2019

L'energia solare diventa butanolo senza bisogno del fotovoltaico

Share 131 Tweet

I ricercatori dell'Università di Uppsala hanno modificato dei microrganismi per produrre in modo efficiente l'alcol butanolo utilizzando anidride carbonica e luce

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Selected as a

Top 10 Innovation in Research & Development with Commercial Potential of the Technological Innovation by 2050 by ICEF

ICEF: *Innovation for Cool Earth Forum*, a yearly event hosted by the Government of Japan (initiated by Japan's Prime Minister Shinzo Abe) Tokyo, Oct 2019

www.icef-forum.org/top10

Top 10 Innovations

Research & Development: Commercial Potential of the Technological Innovation by 2050

No. A8

タイトル / Title

太陽光発電パネルを用いないバイオ燃料の製造

Solar energy becomes biofuel without solar cells

機関 / Organization

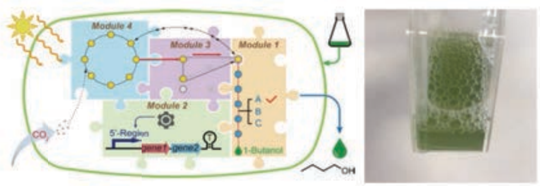
Uppsala University

期間 / Period

2019年6月

June/2019

ウプサラ大学は、バイオマスや太陽電池がなくても、二酸化炭素と太陽エネルギーからブタノールを効率的に産出できる微生物の開発に成功した。



Cyanobacteria producing 1-butanol from solar energy and CO_2

写真提供 / Source Uppsala University

Uppsala University has successfully developed microorganisms that efficiently produce butanol directly from carbon dioxide and solar energy, without the need for biomass or solar cells.

ICEF 2019

Vår forskning är med på **IVAs 100-lista 2020** som listar forskningsprojekt inom området **hållbarhet** med stor potential att skapa nytta genom exempelvis affärs- och metodutveckling eller samhällspåverkan.

IVA

Research2Business

IVAs 100-lista

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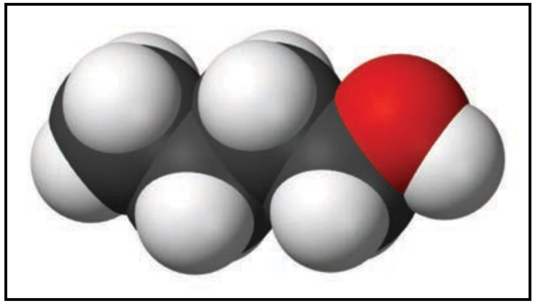
The **global market for butanol** is very large, valued at USD 3.89 billion in 2016 and is projected to reach USD 5.58 billion by 2022.



There is already a market for **green bio-butanol**. Existing bio-butanol is prepared by fermenting, using strains of *Clostridium*, starch, sugar, or cellulose such as wheat, beet, corn, and wood. It is the understanding that the existing green bio-butanol market will grow significantly from 2020 to 2028.

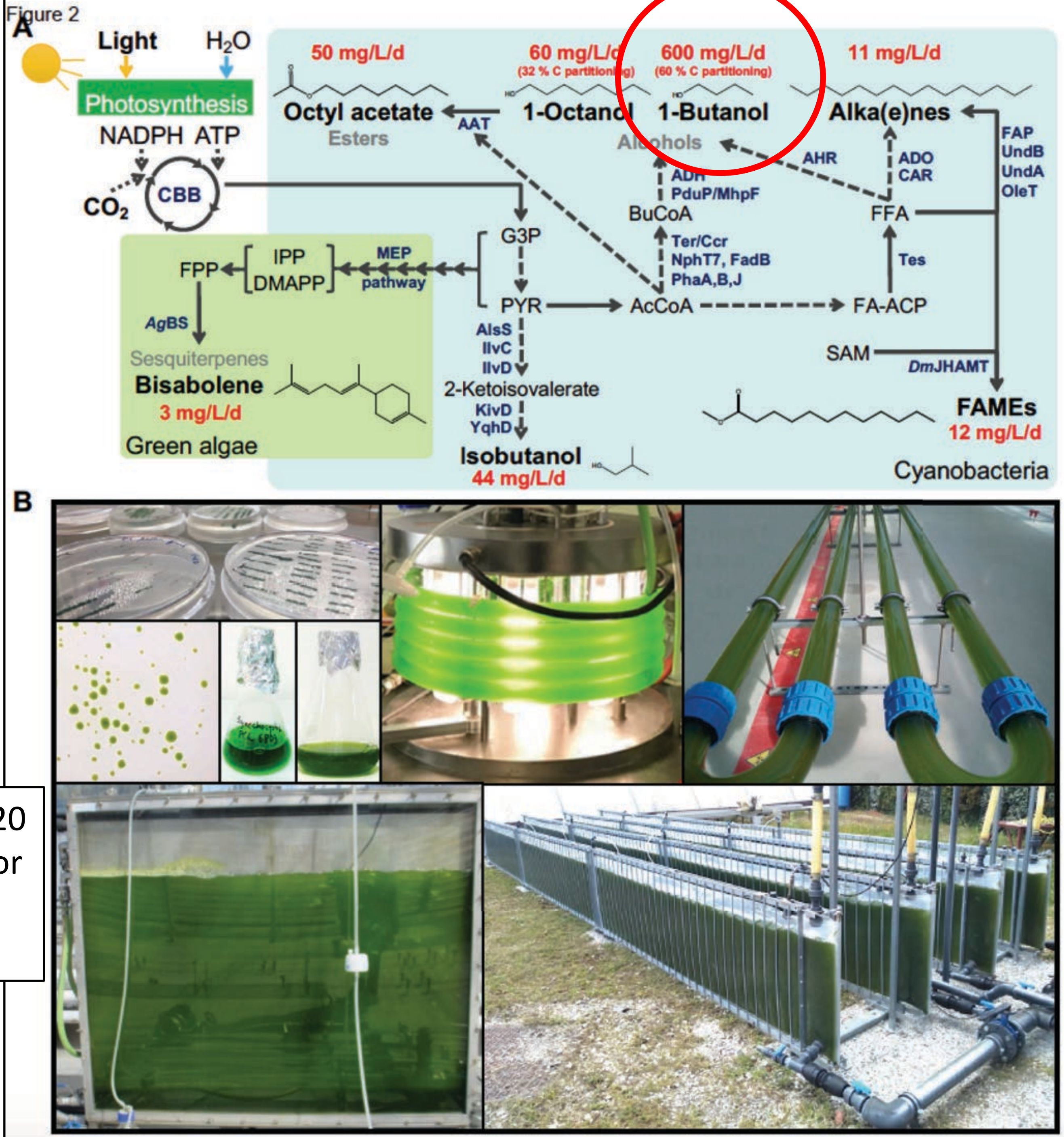
Trends in Biotechnology

Scientific Life

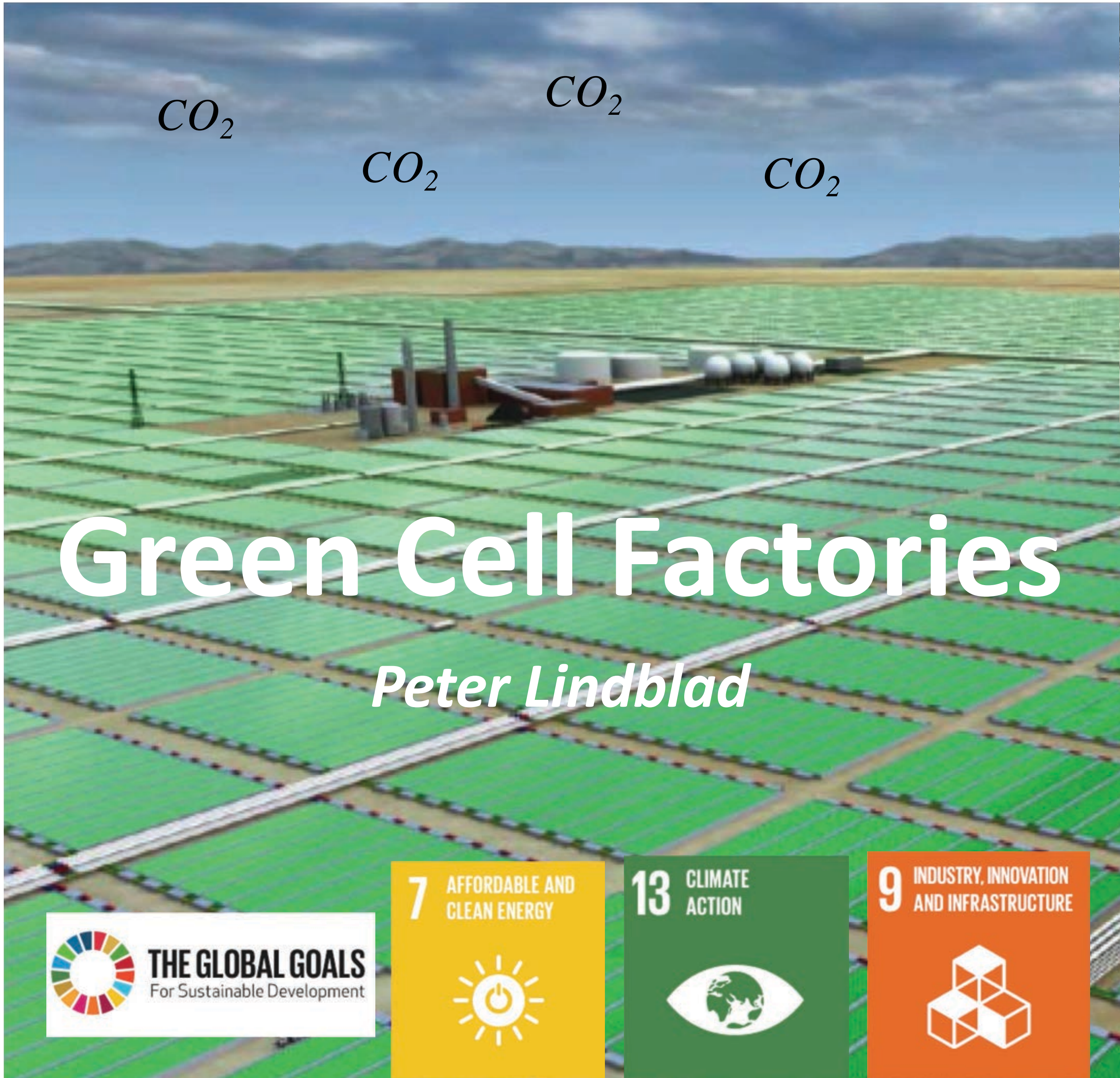
Engineering Biocatalytic Solar Fuel Production: The PHOTOFUEL Consortium

Julian Wichmann,[1] Kyle J. Lauersen,[1] Natascia Biondi,[2] Magnus Christensen,[3] Tiago Guerra,[4] Klaus Hellgardt,[5] Simon Kühner,[6] Markku Kuronen,[7] Pia Lindberg,[8] Christine Rösch,[9] Ian S. Yunus,[10] Patrik Jones,[10] Peter Lindblad,[8] and Olaf Kruse[1,*]

EU-Horizon2020
VW coordinator
Volvo, Neste,
KIT, A4F, etc

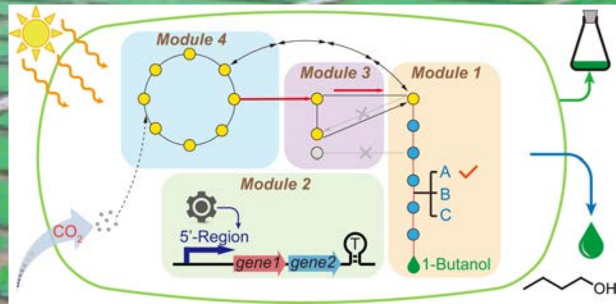


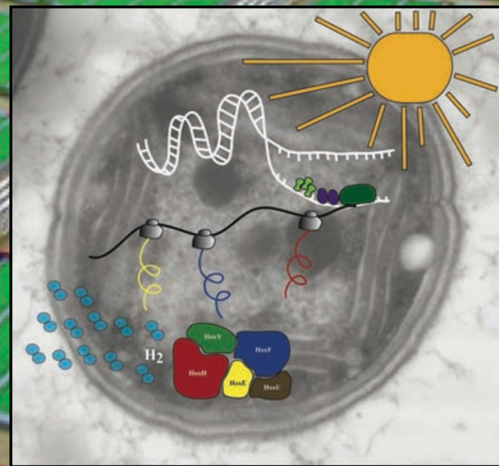
Wichmann et al (2021) doi: 10.1016/j.tibtech.2021.01.003



Green Cell Factories

Peter Lindblad





THE GLOBAL GOALS
For Sustainable Development

7 AFFORDABLE AND CLEAN ENERGY

13 CLIMATE ACTION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Swedish Energy Agency

NordForsk

PHOTOFUEL