

# Synthetic Biology and the Bioeconomy

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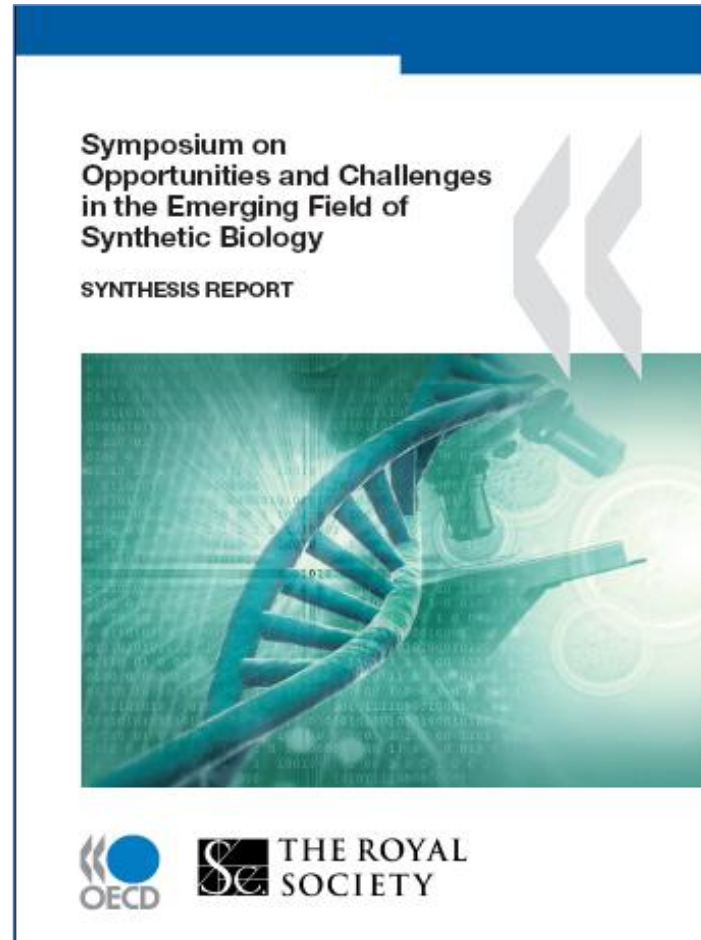
*“Ownership and Sharing:*

*Setting the Patent Framework for Innovation in Synthetic Biology”*

London

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# Publication of the conclusions of the Symposium: “Opportunities and Challenges in the Emerging Field of Synthetic Biology”



# Why synthetic biology?



COMMITTED TO  
IMPROVING THE STATE  
OF THE WORLD

At the Summit on the [Global Agenda 2012 in Abu Dhabi](#), United Arab Emirates, the World Economic Forum's [Global Agenda Council on Emerging Technologies](#) asked some of the world's leading minds within the entire GAC Network which technology trends would have the greatest impact on the state of the world in the near future. ***SYNTHETIC BIOLOGY CAME SECOND***

## 2. Synthetic biology and metabolic engineering

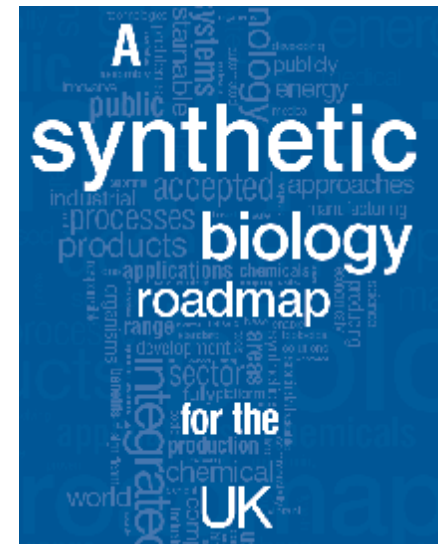
The natural world is a testament to the vast potential inherent in the genetic code at the core of all living organisms. Rapid advances in synthetic biology and metabolic engineering are allowing biologists and engineers to tap into this potential in unprecedented ways, enabling the development of new biological processes and organisms that are designed to serve specific purposes – whether **converting biomass to chemicals, fuels and materials**, producing new therapeutic drugs or protecting the body against harm.

[www.synbio.org.uk/synthetic-biology-index/2423-top-10-emerging-technologies.html](http://www.synbio.org.uk/synthetic-biology-index/2423-top-10-emerging-technologies.html)

# Linking synthetic biology to the bioeconomy

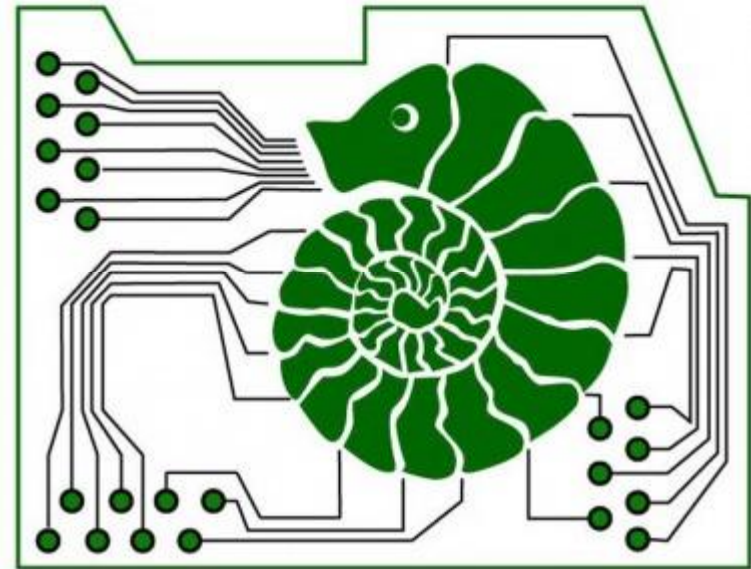
April 2012

- The *US National Bioeconomy Blueprint* (2012) mentions “synthetic biology” 18 times in the main body of text
- In the report *Bio-economy Innovation of the German Bio-Economy Research and Technology Council*, “synthetic biology” appears 8 times
- In *A Synthetic Biology Roadmap for the UK*, the term “bioeconomy” appears seven times
- Why are the terms linked ? Both synthetic biology and bioeconomy envision a future where manufacturing and economic growth are decoupled from GHG emissions



# OECD broad country view of synthetic biology...

- ...offers great potential for Bioeconomy impact
  - Important applications in Industrial Biotechnology
- BUT:
- Embryonic in technology, IP management and governance
  - Danger of being seen as GM re-branded



# Greatest opportunities for short to medium term success

- Energy security
- Climate change
- Industrial biotechnology
  - Biobased products
  - Biofuels
- Environmental biotechnology and “green growth”
- Marine biotechnology

# “Scientists call for action to tackle CO<sub>2</sub> levels” BBC News, May 11/2013

Scientists are calling on world leaders to take action on climate change after carbon dioxide levels in the atmosphere broke through a symbolic threshold. Daily CO<sub>2</sub> readings at a US government agency lab on Hawaii have topped 400 parts per million for the first time. Sir Brian Hoskins, the head of climate change at the UK-based Royal Society, said the figure should “*jolt governments into action*”<sup>1</sup>.

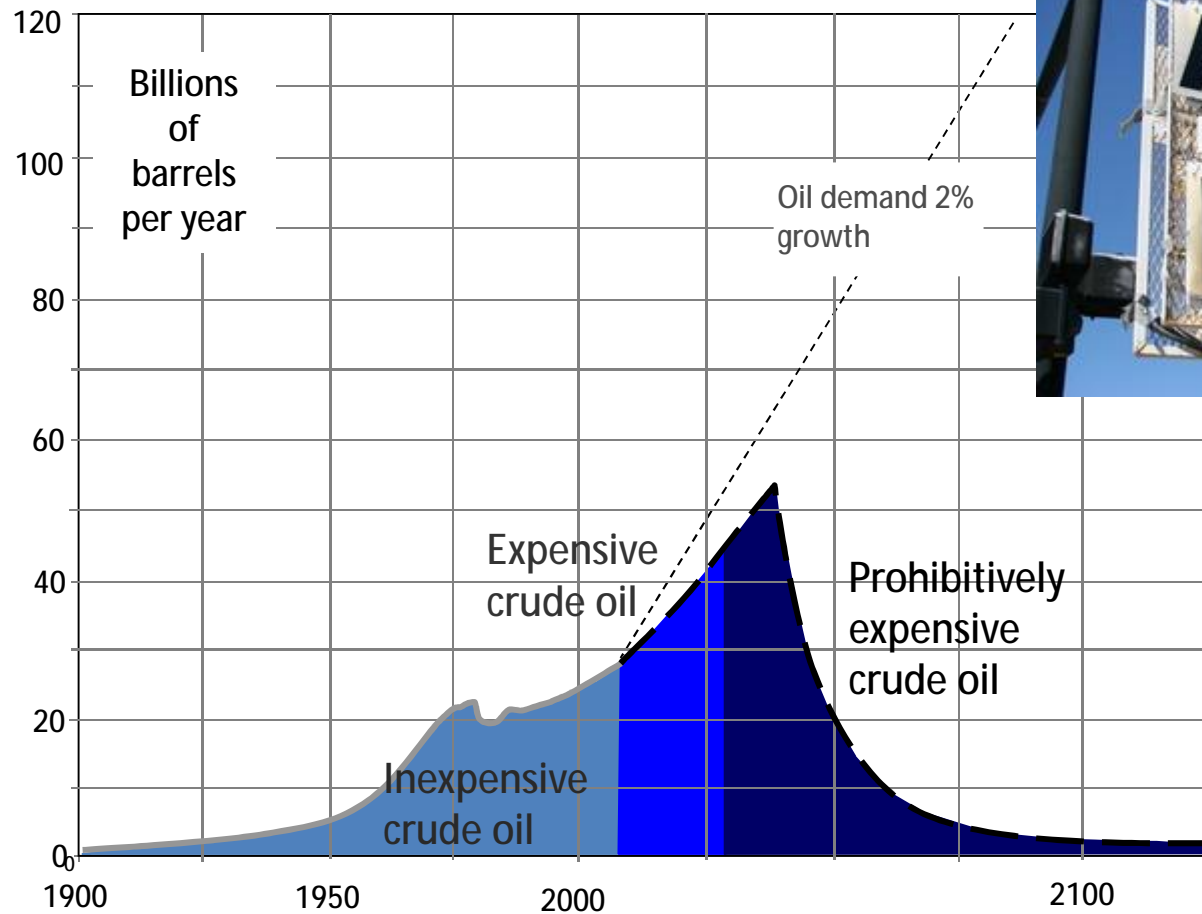
- 167 countries have adopted a global warming limit of 2°C or below
- Given known 2000–2006 CO<sub>2</sub> emissions, *less than half* the proven recoverable oil, gas and coal reserves can still be emitted up to 2050 to achieve such a goal<sup>2</sup>
- If GHG emissions are halved by 2050, there is a 12–45% chance of > 2°C
- Global energy-related CO<sub>2</sub> emissions *increased* by 1.4% to reach 31.6 Gt in 2012, a historic high<sup>3</sup>

1 <http://www.bbc.co.uk/news/science-environment-22491491>

2 Meinshausen et al. (2009). *Nature* 458, 1158-1163

3 IEA (2013). Redrawing the energy-climate map. World Energy Outlook special report.

# Energy security

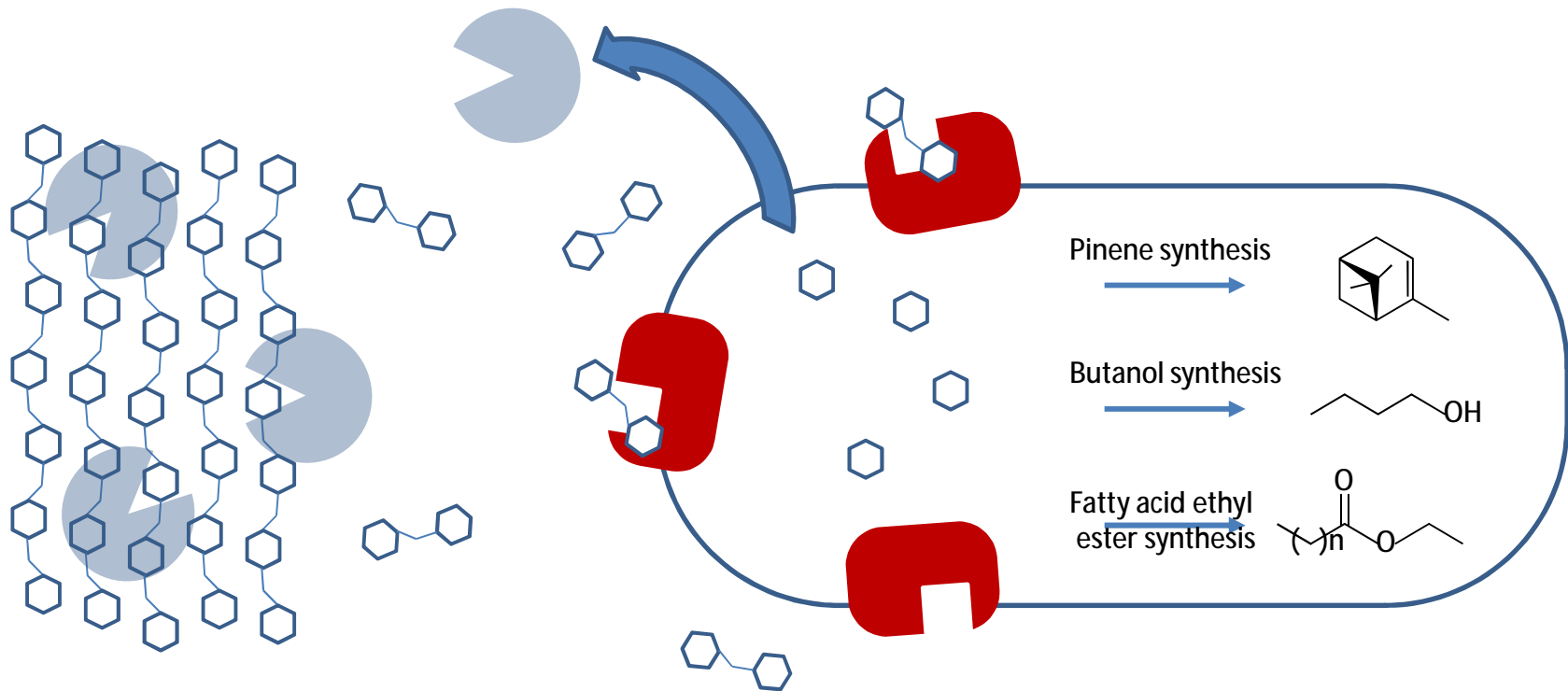


*"Out of the turmoil of the energy markets of the last 12 months and our evaluation of future influences ...The era of cheap oil is over."*

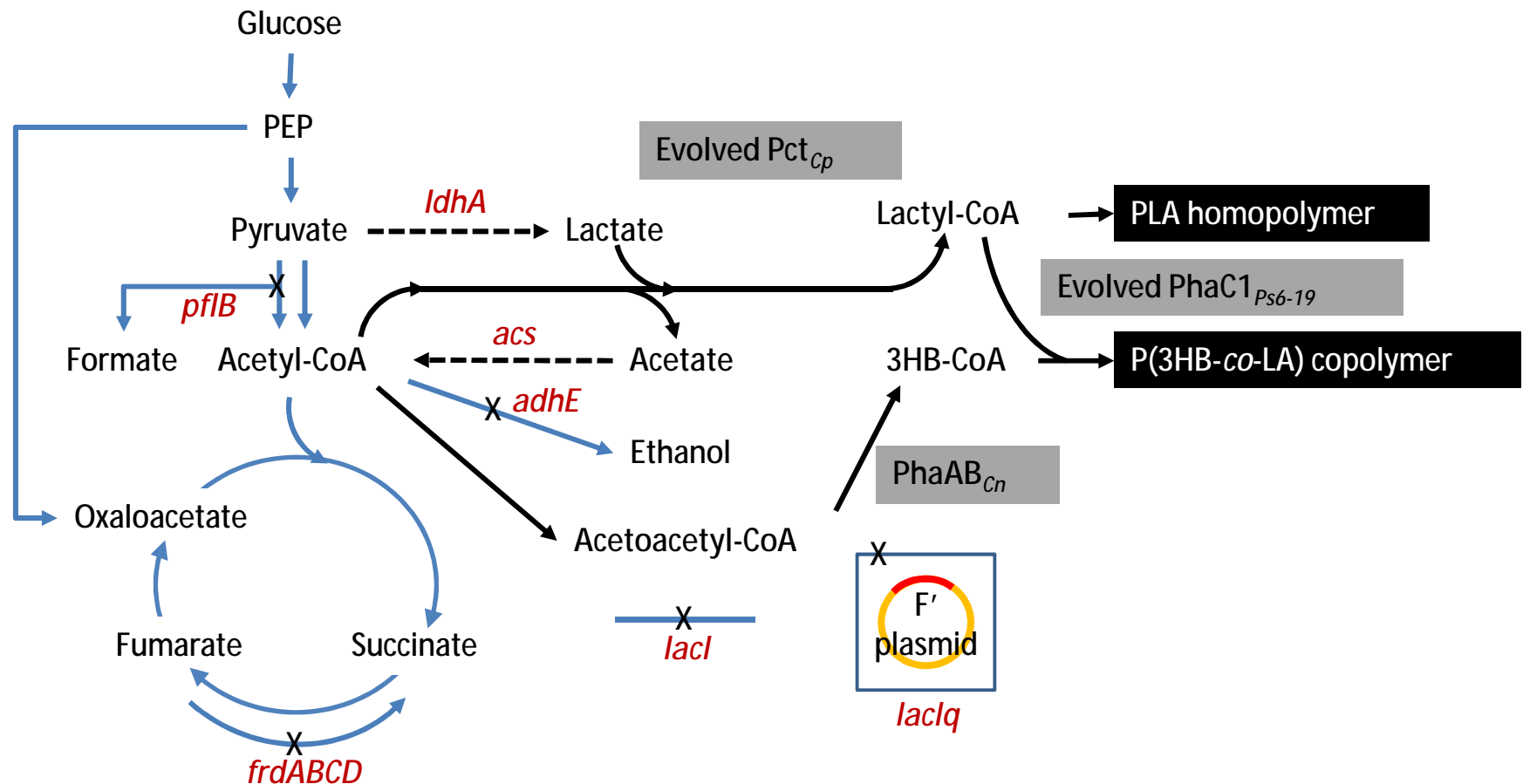
IEA (2008)



# *E.coli*, three fuels and switchgrass

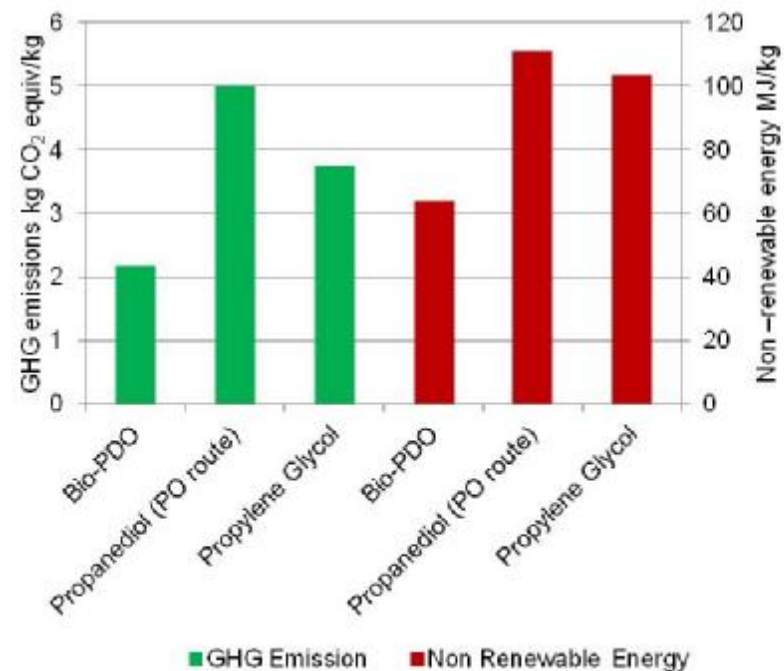


# Sugar to plastics: the direct fermentation to Polylactic acid



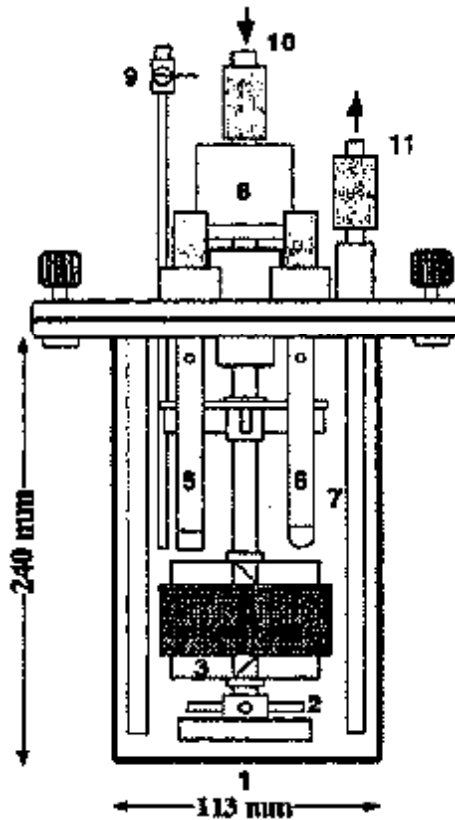
# Bio-PDO: a metabolic engineering classic

- 1,3-propanediol market is expected to grow from an estimated \$157 million in 2012 to \$560 million by 2019, with a CAGR of 19.9%
- DuPont – Genencor route to bio-PDO was aerobic, through metabolic engineering in *E. coli*
- Yield improvement from 78 g/l (typical anaerobic route) to 135 g/l
- Claimed improved environmental performance



# Waste gases to plastics and chemicals

Tanaka et al. (1995)<sup>1</sup>



LanzaTech, 2012<sup>2</sup>

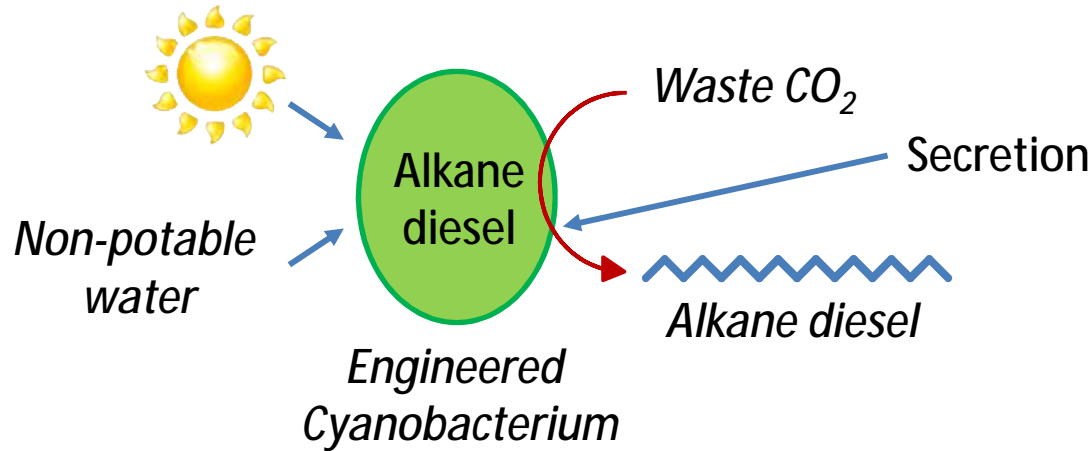


<sup>1</sup> Tanaka et al. (1995). *Biotechnology and Bioengineering* 45, 268-275.

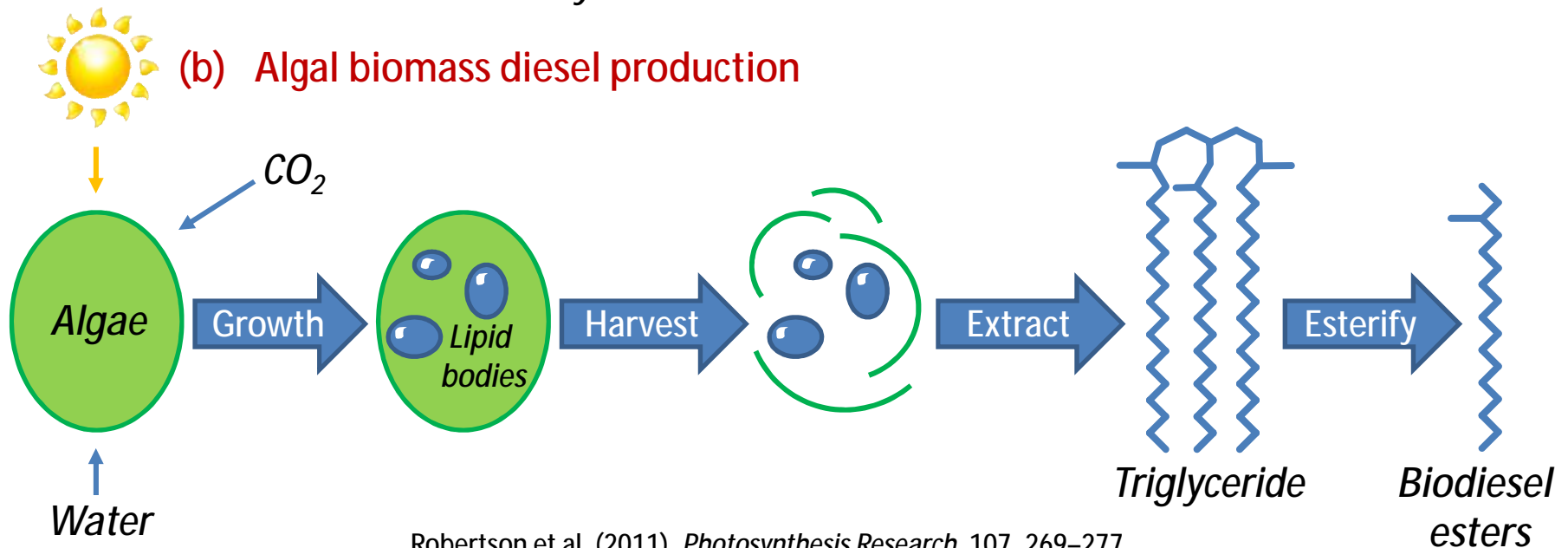
<sup>2</sup> Courtesy of LanzaTech, New Zealand, [www.lanzatech.com](http://www.lanzatech.com)

# The industrialisation of photosynthesis

(a) Direct, continuous process for renewable diesel production



(b) Algal biomass diesel production



Robertson et al. (2011). *Photosynthesis Research* 107, 269–277.

# Intellectual Property Issues associated with Synthetic Biology

- Patents
- Material Transfer Agreements
- Design
- Database operations
- Copyright
- Trademarks
- Clash of IP “cultures”
- Movement from “Own and Protect” to “Protect and Share”

# Acknowledgement & Appreciation

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  - Jim Philp
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