“ A Sense of the Future ”

"So we went to Atari and said, 'Hey, we've got this amazing thing, even built with some of your parts, and what do you think about funding us?
Or we'll give it to you. We just want to do it. Pay our salary, we'll come work for you.' And they said, 'No.' So then we went to Hewlett-Packard, and they said,
'Hey, we don't need you. You haven't got through college yet.'" -- *Steve Jobs on attempts to get Atari and HP interested in his and Steve Wozniak's Apple PC.*

Why ? Why invest ? Why eAGE?

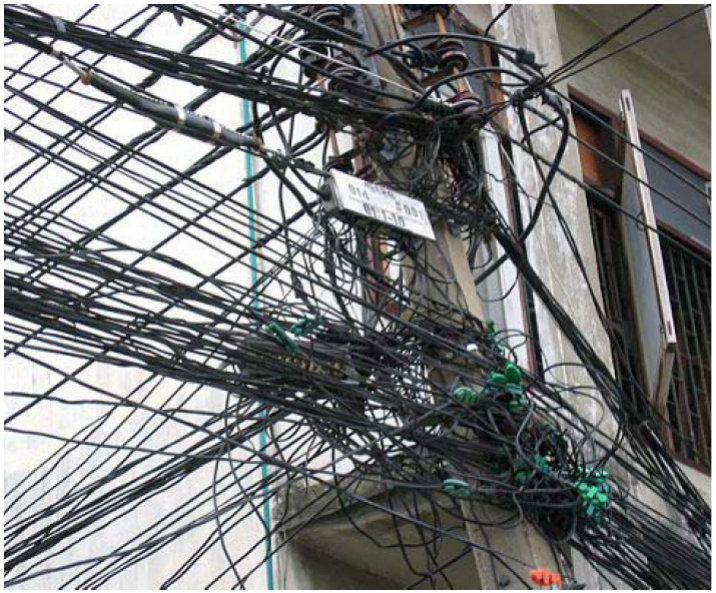
Tools to improve the quality of life and living are an index of the progress of (material) civilization. Invention and innovation of such tools seed economic growth but only with dissemination, diffusion and adoption of these tools at a granular level sufficient enough to induce paradigm shifts. Commodities such as bricks, glass, metal alloys and paper do not even register on our mind, today, because availability of these items, globally, is taken for granted. In recent times, computation has undergone a similar transformation from the ENIAC to iPad. The power of computation coupled with the decrease in price of storage media, distributed to the masses, has enabled quantum leaps of productivity and the outcome speaks for itself [1]. It has catalyzed a new era of social interaction epitomized by the 500 million subscribers Who choose to connect on a single platform (Facebook) and the services provided by companies such as Google and Baidu.

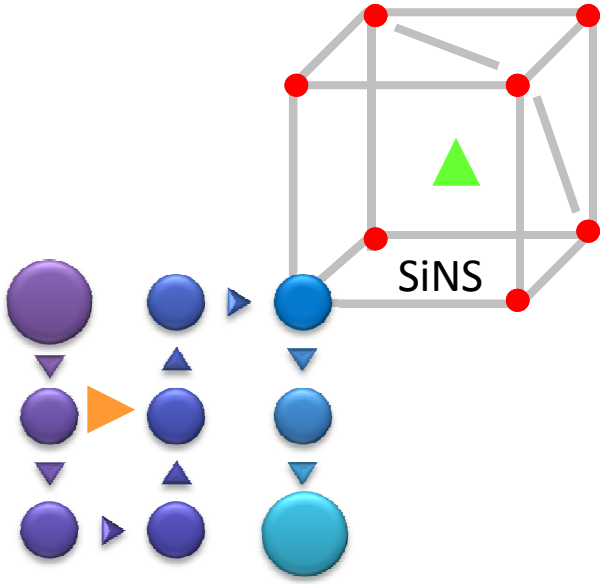
Here, I have used the "distributed" paradigm and applied it to energy. I expect comments [2] similar to that of Thomas Watson (*there is a world market for five computers*, 1943). Energy is one of the four pillars of civilization but the development of energy resources, thus far, has been restricted in the hands of a few, for justifiable reasons. Dissemination of the knowledge to manufacture non-fossil energy and adoption of the tools for domestic manufacture of liquid fuel may be analogous to making bread at home, daily, by investing to buy a Zojirushi BB or Panasonic SD breadmaker. Global economic development is held hostage by an oligopoly of fossil-based energy producers or power manufacturing systems that may not have a 'miniaturization' prospect, eg, hydroelectric. To reduce the uncertainty due to energy cost and its volatility on global economic growth, there must be alternatives to the rate-limiting steps of energy manufacturing. The future portfolio of energy may contain fission and fusion with renewable sources, eg, wind, solar and biofuels, but will the generation of power and distribution still remain an oligopoly? This proposal suggests otherwise and offers a potential for an energy agnostic global economy.

Bacterial production of liquid fuel, eg, butanol (C4) and pentanol (C5) has been proven. Bacterial can also produce glucose (C6). The scale up necessary for these non-fossil and non-vegetative liquid fuel are in progress. These activities are covered by patents and the patent owners may be the members of the oligopoly who may control the future non-fossil energy market in a manner similar to the fossil fuel cartels (OPEC). The engineering of bacteria to produce C4/C5 /C6 are based on fundamental principles of molecular biology. Hence, it is an opportunity for cooperative investment to develop liquid fuel as global public goods and aggressively replicate the process worldwide to provide a non-fossil, non-vegetative, carbon neutral energy alternative. It is not a panacea but one solution which can be used in a domestic capacity as well as industrial and potentially for large-scale energy manufacturing distributed over the future smart grid.

Domestication and self-sufficiency of energy which does not add to the global concern regarding green house gas (GHG) emissions makes economic sense for catalyzing global growth and makes a direct contribution to worldwide sustainability. This proposal achieves this lofty goal. It seeks investment to transform this vision to reality by those who may choose to act as global benefactors but without sacrificing their capital ***and*** earn a decent return on their investment (ROI). The potential for profitability from the global manufacturing nd sale of liquid fuel may be only limited by our imagination. The investors will make it possible for the energy-starved nations to ramp up production by reducing the barrier to access technology. Hence, only those investors are invited who may invest not only for a ROI but also to serve as purveyors of civilization.

[1] http://www.boston.com/business/articles/2011/01/31/despite_chinas_threat_us_production_still_no_1/
[2] http://www.rinkworks.com/said/predictions.shtml





FUTURE FOR NON-FOSSIL LIQUID FUEL?

SEABORG • GRANGER FOUNDATION

ENERGY AGNOSTIC GLOBAL ECONOMY

Dr Shoumen Datta
Co-founder, eAGE

Is there a need for alternatives? Oil Reserves 1,500 billion barrels

Source: CIA

1	Saudi Arabia	264,600,000,000	1 January 2010 est.
2	Canada	175,200,000,000	1 January 2010 est.
3	Iran	137,600,000,000	1 January 2010 est.
4	Iraq	115,000,000,000	1 January 2010 est.
5	Kuwait	104,000,000,000	1 January 2010 est.
6	United Arab Emirates	97,800,000,000	1 January 2010 est.
7	Venezuela	97,770,000,000	1 January 2010 est.
8	Russia	79,000,000,000	1 January 2009 est.
9	Libya	47,000,000,000	1 January 2010 est.
10	Nigeria	37,500,000,000	1 January 2010 est.

Reality Check - Coal and Gas

COAL – Emissions & Reserves

- 0.9 kg-CO2/kWh-e
- 900 billion tons
- 4,000 billion barrels oil eq

GAS – Emissions & Reserves

- 0.4 kg-CO2/kWh-e
- 16,200 Trillion cubic feet
- 2,700 billion barrels oil eq

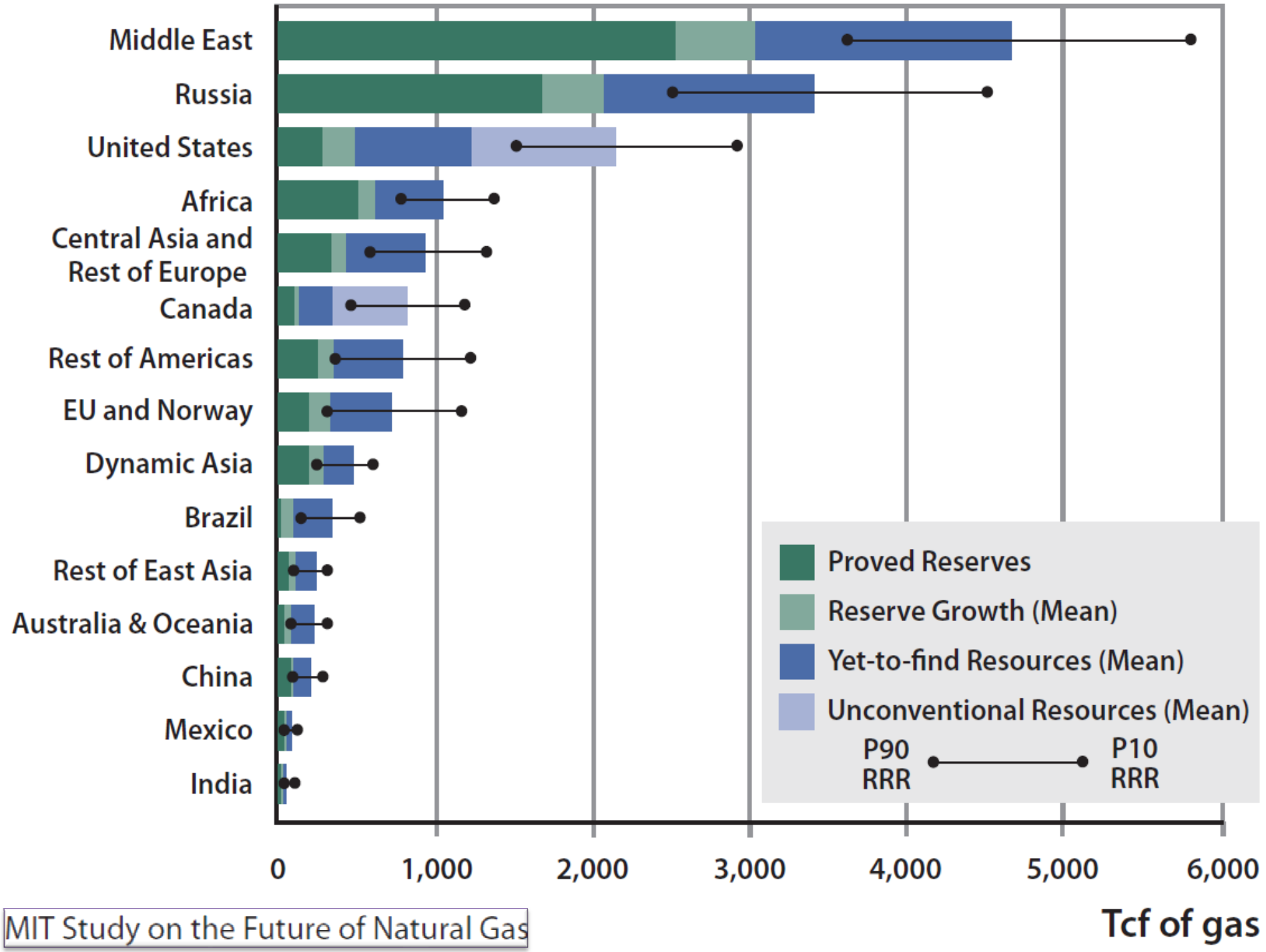
Can LNG be a part of the bridge to the hydrogen economy? Current oil consumption = 30 billion barrels, coal = 6 billion tons and gas consumption = 100 trillion cubic feet per year. Coal provides 70% energy in China (2.2 billion tons oil eq).

Reason for Silent Resistance to NonFossil Fuels?

MAJOR GLOBAL COAL RESERVES (90%)

	Bituminous Anthracite	Sub-Bituminous Lignite	TOTAL Million Tonnes	% Share
United States	111,338	135,305	246,643	**22.6**
Pakistan	0	185,000	185,000	**17.0**
Russia	49,088	107,922	157,010	**14.4**
China	62,200	52,300	114,500	**12.6**
India	90,085	2,360	92,445	**10.2**
Australia	38,600	39,900	78,500	**8.6**
South Africa	48,750	0	48,750	**5.4**

BP & Wikipedia



MIT Study on the Future of Natural Gas

150

Oil, Gas and Coal combined
meets our energy demand.

years

LIQUID FUTURE by S. Datta

FUTURE Post-2100

Chloroplast nano-chip

Non-sugar synthesis

DE NOVO

CORN

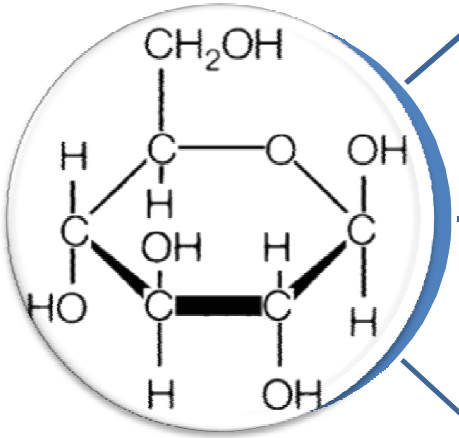
PLANT GROWTH

COSKATA

WASTE CARBON

Bacteria Algae

PHOTO



Butanol

- Prather 2009
- Atsumi 2008

Pentanol

Ethanol

- Stephanopoulos 2006

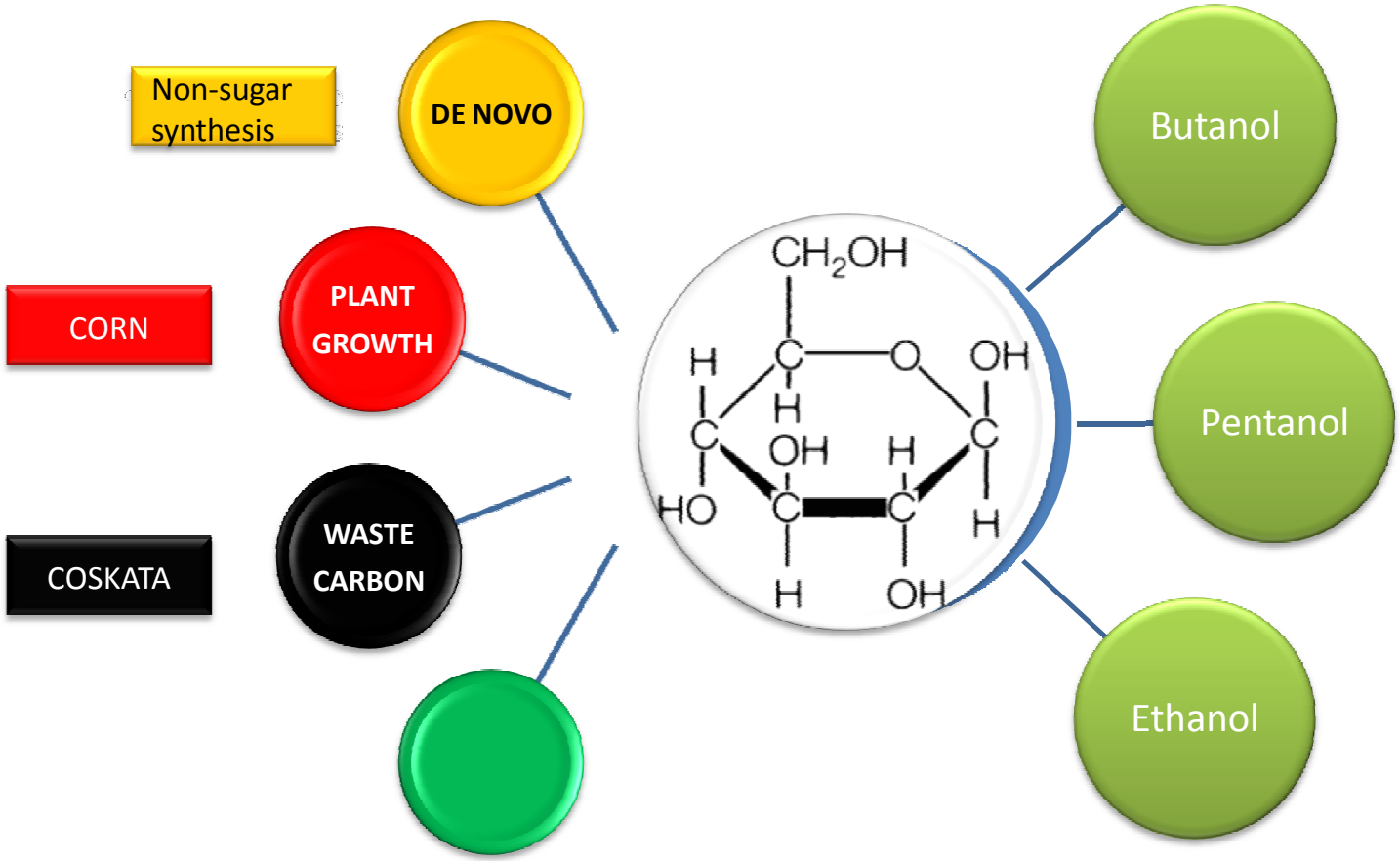
Immobile Enzymes

Home Butanol Generator

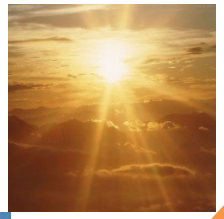
In the post-2020 era, energy from nuclear fission and fusion may predominate grid based power but if liquid fuel demand still exists, it may catapult glucose manufacturing as a new LOB for small and medium enterprises. High insolation zones may directly produce C4-C5 liquid fuel as well as glucose.

The World Is Not Flat – One Shoe Does Not Fit All

Glucose as a Commodity for Liquid Fuel Supply Chain
Is Glucose an intermediary in low insolation zones?



Photosynthetic Butanol Production in High Insolation Zones



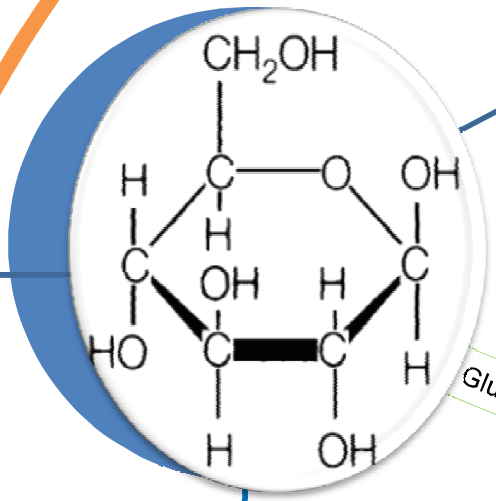
C 4
C 5

Butanol
Pentanol

Low Insolation Commodity

Micro Algae

Cyano Bacteria



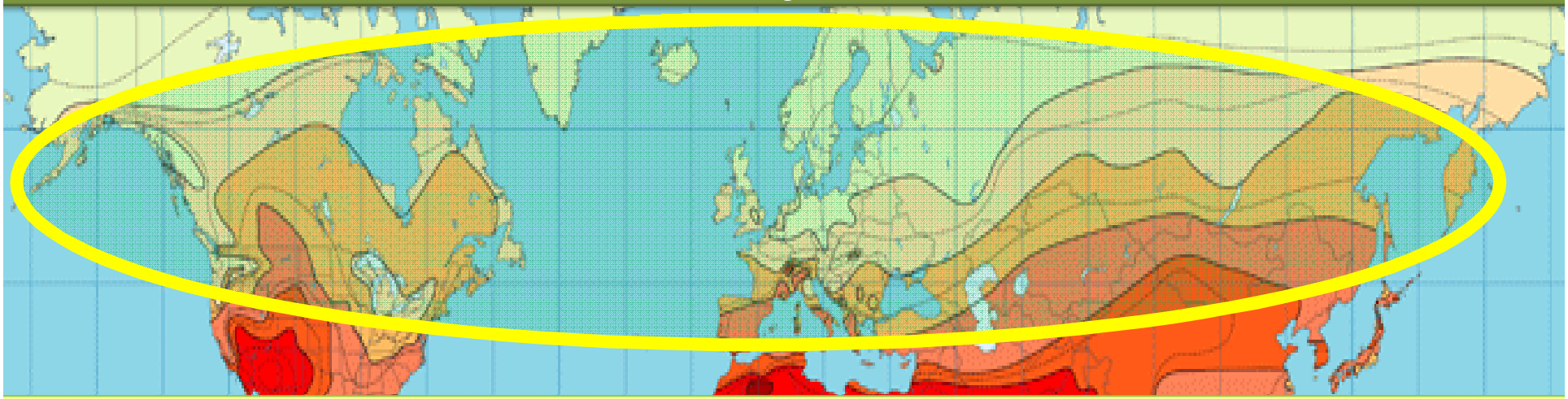
Glucose

C 6

Glucose Commodity

Butanol Generator

Glucose as a Commodity for Liquid Fuel Supply Chain
Is Glucose an intermediary in low insolation zones?



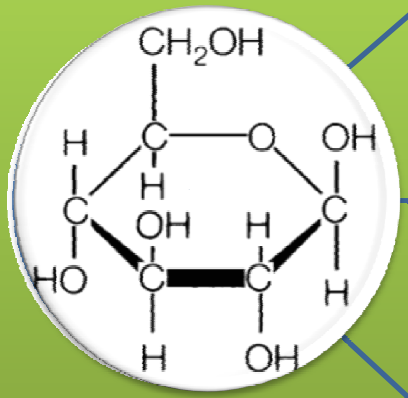
DE NOVO

CORN

PLANT GROWTH

COSKATA

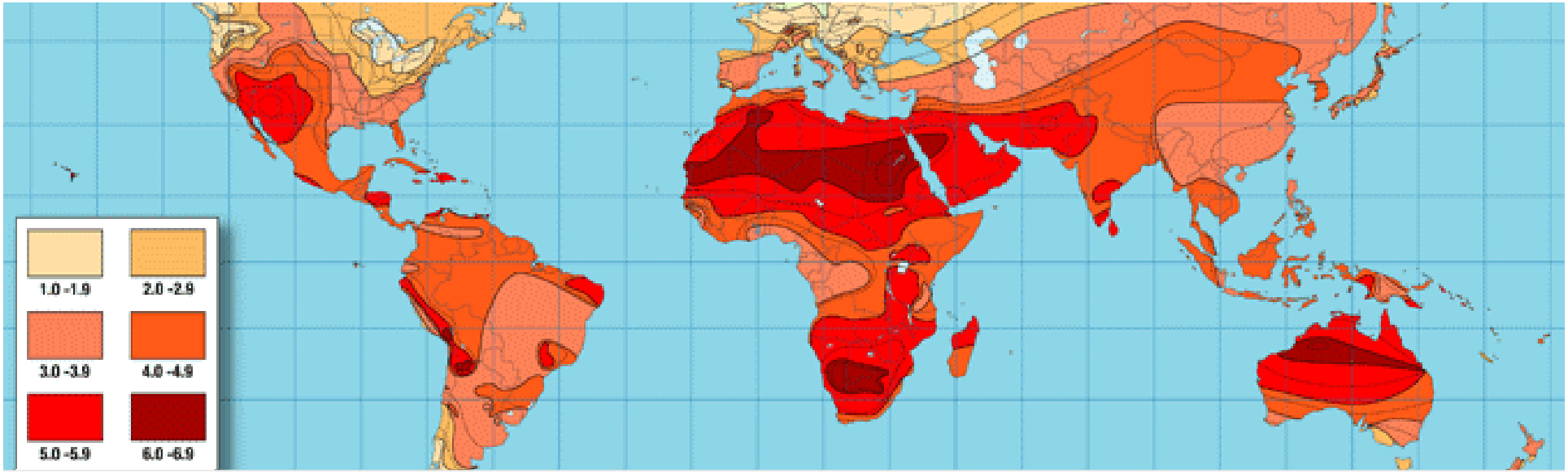
WASTE CARBON



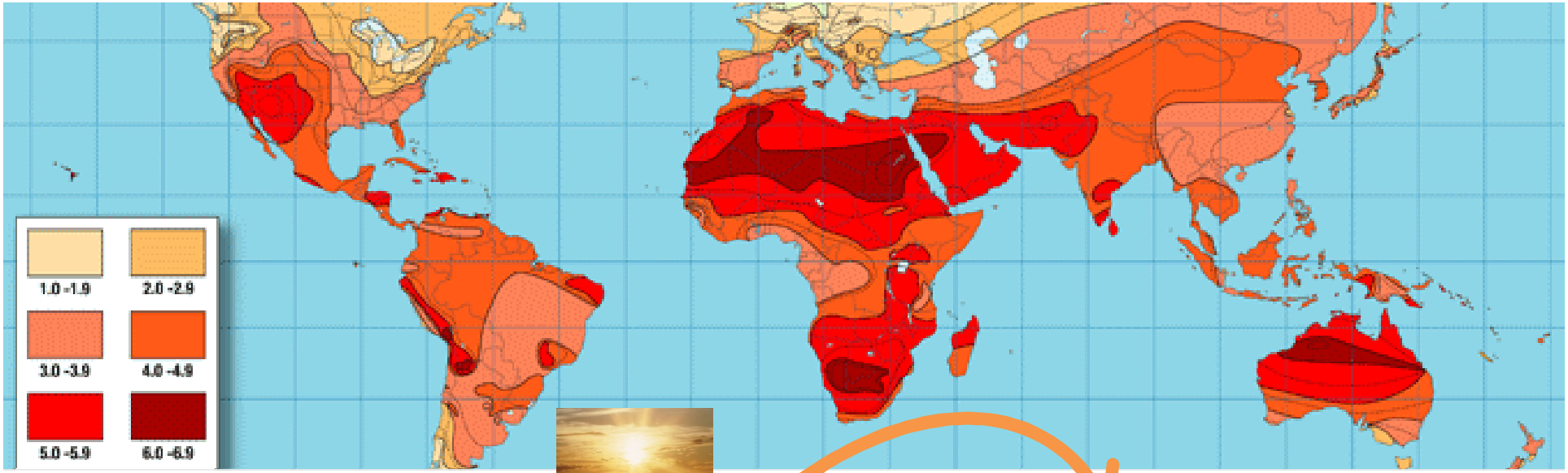
Butanol

Pentanol

Ethanol

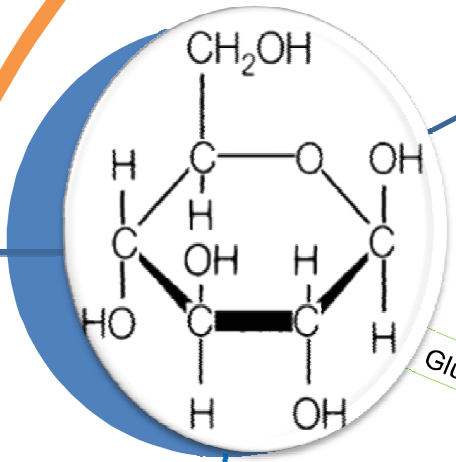


High Insolation Zones



Micro Algae

Cyano Bacteria



Glucose

Liquid Fuel Generator

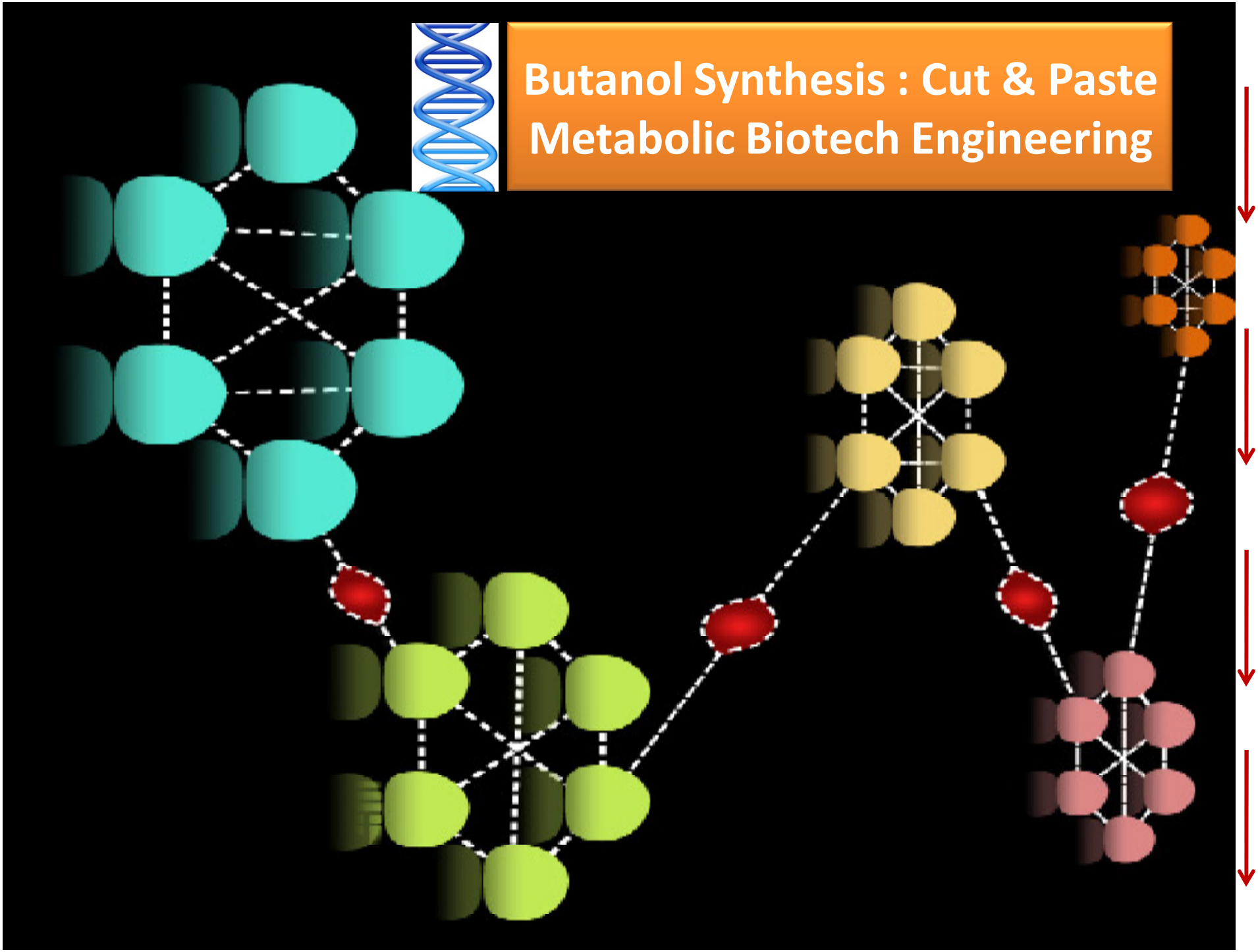
C 4
C 5

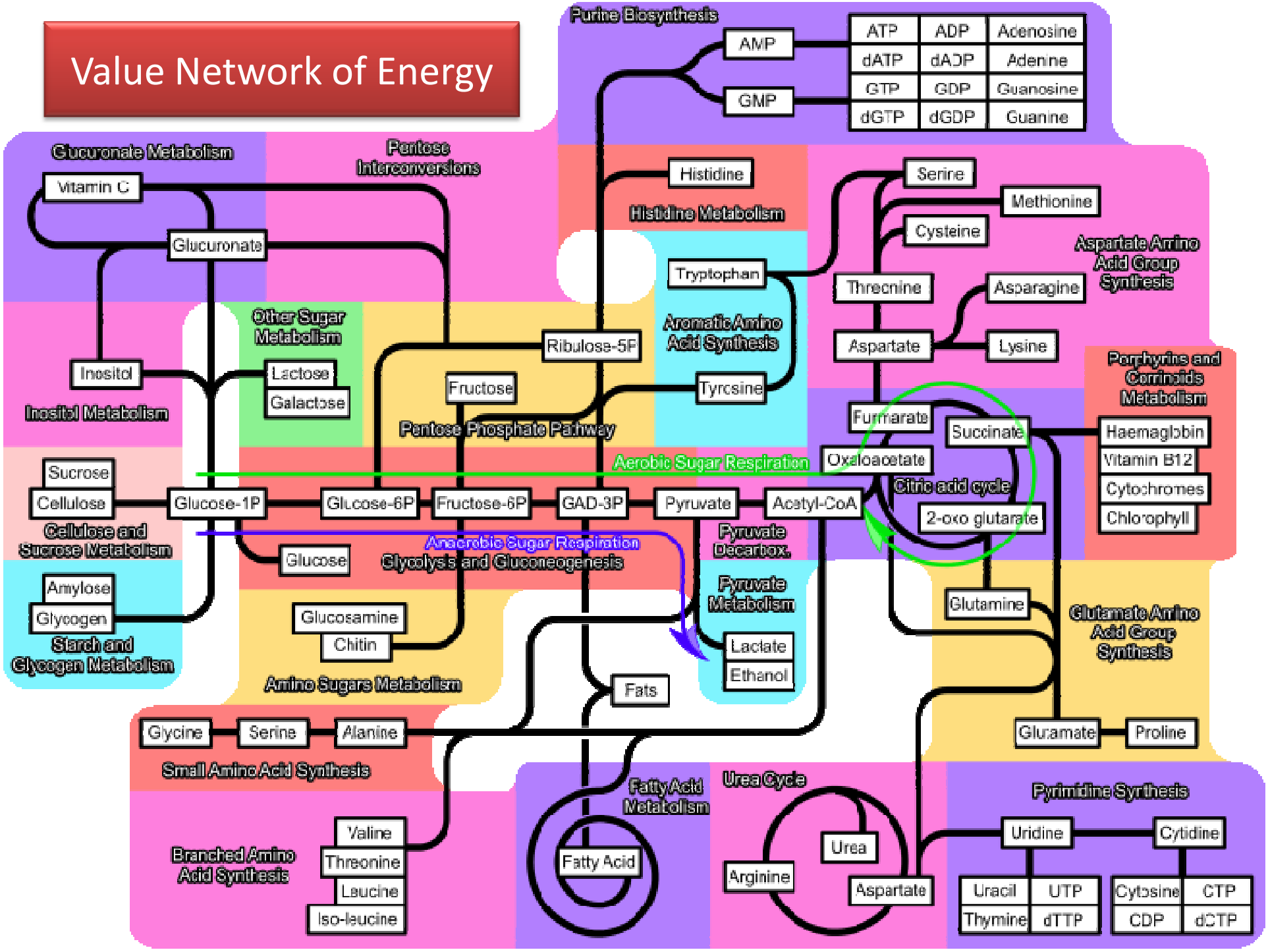
Butanol
Pentanol

Glucose

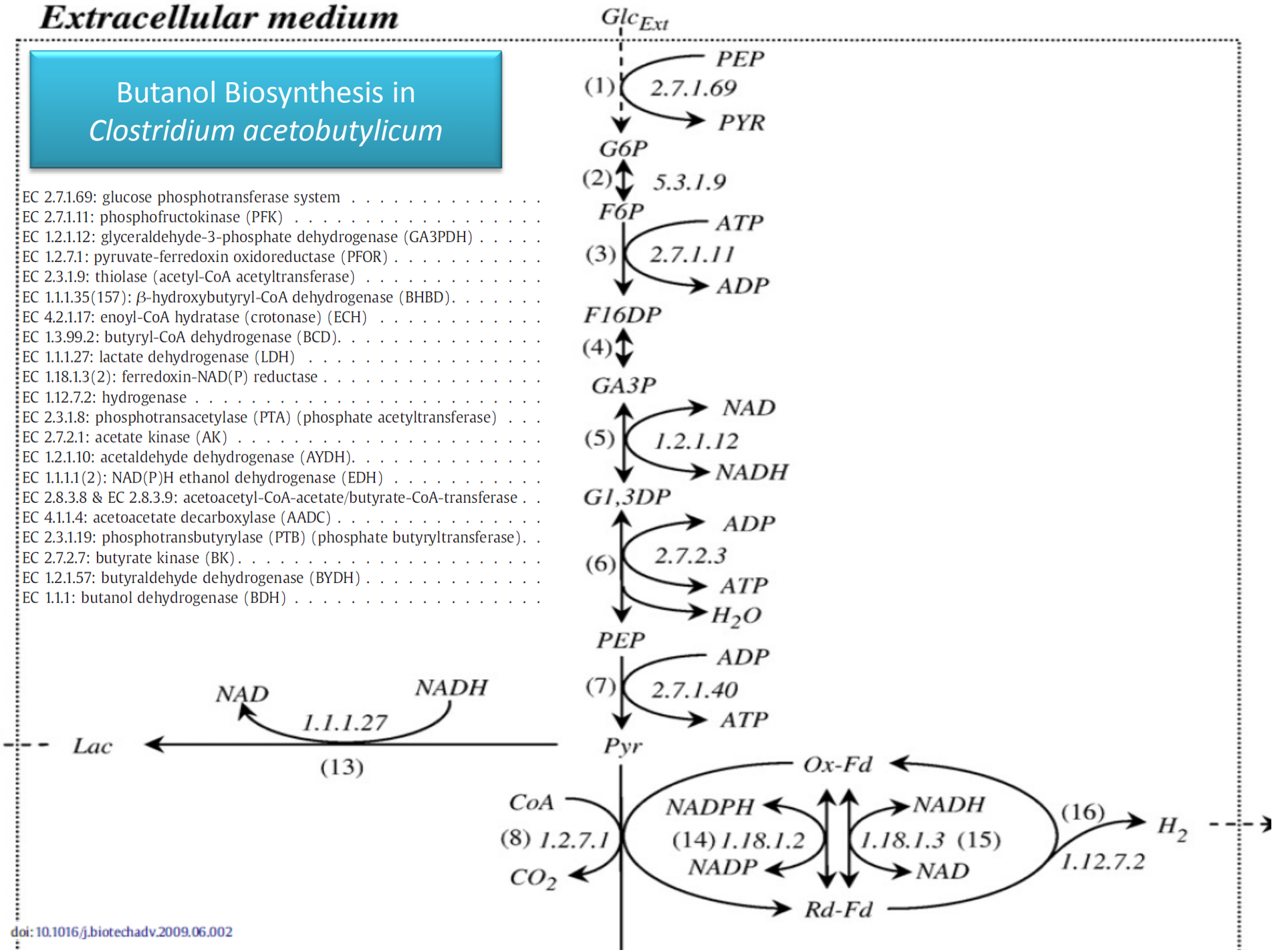
C 6

Low Insolation Commodity


Butanol Synthesis : Cut & Paste
Metabolic Biotech Engineering


Value Network of Energy
Purine Biosynthesis
AMP
GMP
ATP
ADP
Adenosine
dATP
dADP
Adenine
GTP
GDP
Guanosine
dGTP
dGDP
Guanine
Glucuronate Metabolism
Vitamin C
Glucuronate
Pentose Interconversions
Histidine
Histidine Metabolism
Serine
Methionine
Cysteine
Aspartate Amino Acid Group Synthesis
Tryptophan
Aromatic Amino Acid Synthesis
Threonine
Asparagine
Other Sugar Metabolism
Ribulose-5P
Aspartate
Lysine
Inositol
Inositol Metabolism
Lactose
Galactose
Fructose
Tyrosine
Pentose Phosphate Pathway
Porphyrine and Corrinoids Metabolism
Fumarate
Succinate
Haemaglobin
Vitamin B12
Cytochromes
Chlorophyll
Aerobic Sugar Respiration
Oxaloacetate
Citric acid cycle
2-oxo glutarate
Sucrose
Cellulose
Glucose-1P
Glucose-6P
Fructose-6P
GAD-3P
Pyruvate
Acetyl-CoA
Cellulose and Sucrose Metabolism
Anaerobic Sugar Respiration
Glycolysis and Gluconeogenesis
Pyruvate Decarbox.
Glucose
Pyruvate Metabolism
Amylose
Glycogen
Starch and Glycogen Metabolism
Glucosamine
Chitin
Amino Sugars Metabolism
Glutamine
Glutamate Amino Acid Group Synthesis
Lactate
Ethanol
Fats
Glycine
Serine
Alanine
Small Amino Acid Synthesis
Glutamate
Proline
Fatty Acid Metabolism
Urea Cycle
Pyrimidine Synthesis
Valine
Threonine
Leucine
Iso-leucine
Branched Amino Acid Synthesis
Fatty Acid
Urea
Arginine
Aspartate
Uridine
Cytidine
Uracil
UTP
Thymine
dTTP
Cytosine
CTP
CDP
dCTP

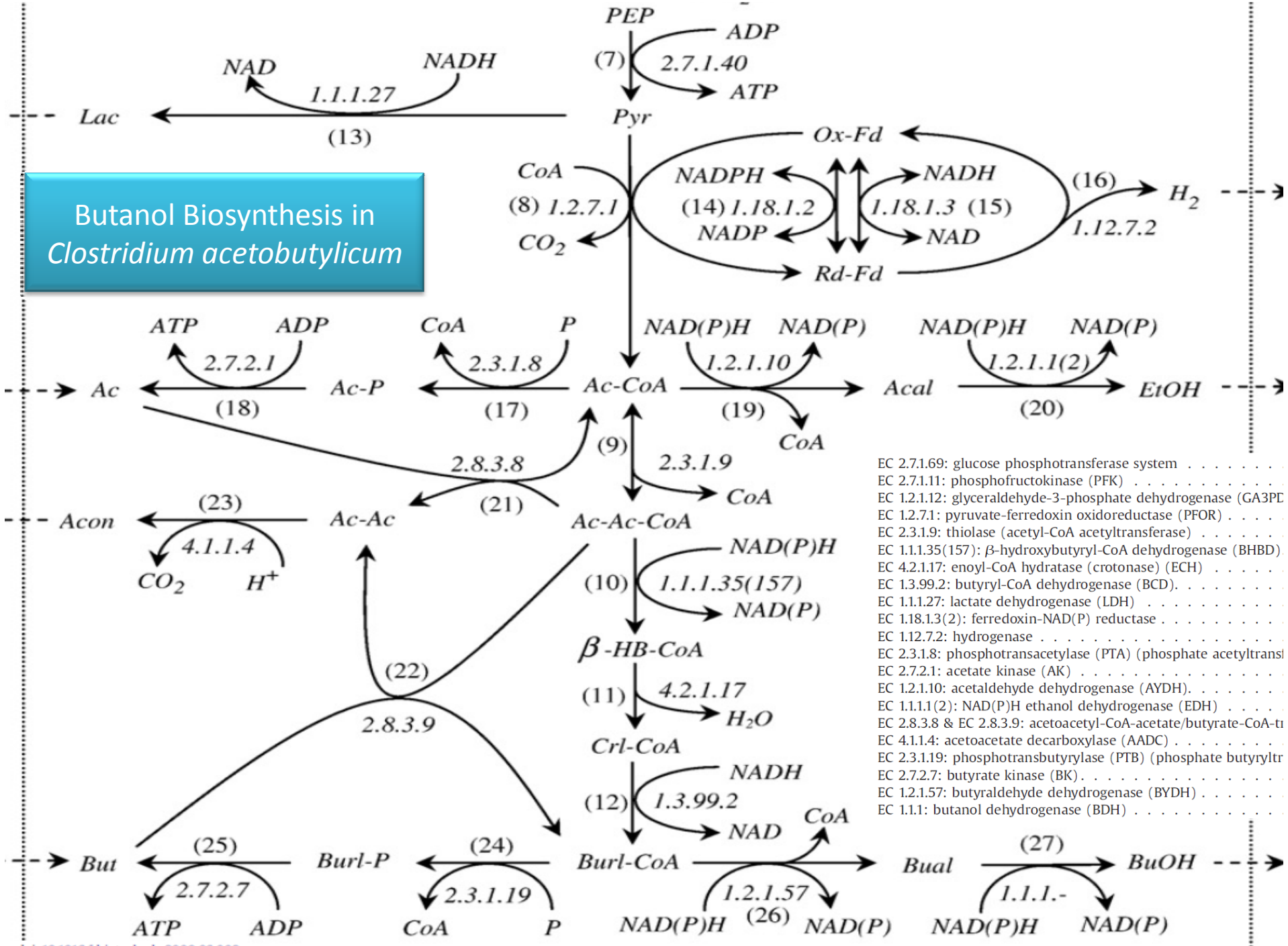
Butanol Biosynthesis in *Clostridium acetobutylicum*



EC 2.7.1.69: glucose phosphotransferase system . . . . . .
EC 2.7.1.11: phosphofructokinase (PFK) . . . . . .
EC 1.2.1.12: glyceraldehyde-3-phosphate dehydrogenase (GA3PDH) . . . . .
EC 1.2.7.1: pyruvate-ferredoxin oxidoreductase (PFOR) . . . . . .
EC 2.3.1.9: thiolase (acetyl-CoA acetyltransferase) . . . . . .
EC 1.1.1.35(157): β-hydroxybutyryl-CoA dehydrogenase (BHBD). . . . . .
EC 4.2.1.17: enoyl-CoA hydratase (crotonase) (ECH) . . . . . .
EC 1.3.99.2: butyryl-CoA dehydrogenase (BCD). . . . . .
EC 1.1.1.27: lactate dehydrogenase (LDH) . . . . . .
EC 1.18.1.3(2): ferredoxin-NAD(P) reductase . . . . . .
EC 1.12.7.2: hydrogenase . . . . . .
EC 2.3.1.8: phosphotransacetylase (PTA) (phosphate acetyltransferase) . . .
EC 2.7.2.1: acetate kinase (AK) . . . . . .
EC 1.2.1.10: acetaldehyde dehydrogenase (AYDH). . . . . .
EC 1.1.1.1(2): NAD(P)H ethanol dehydrogenase (EDH) . . . . . .
EC 2.8.3.8 & EC 2.8.3.9: acetoacetyl-CoA-acetate/butyrate-CoA-transferase . .
EC 4.1.1.4: acetoacetate decarboxylase (AADC) . . . . . .
EC 2.3.1.19: phosphotransbutyrylase (PTB) (phosphate butyryltransferase). .
EC 2.7.2.7: butyrate kinase (BK). . . . . .
EC 1.2.1.57: butyraldehyde dehydrogenase (BYDH) . . . . . .
EC 1.1.1: butanol dehydrogenase (BDH) . . . . . .

doi: 10.1016/j.biotechadv.2009.06.002

Butanol Biosynthesis in *Clostridium acetobutylicum*



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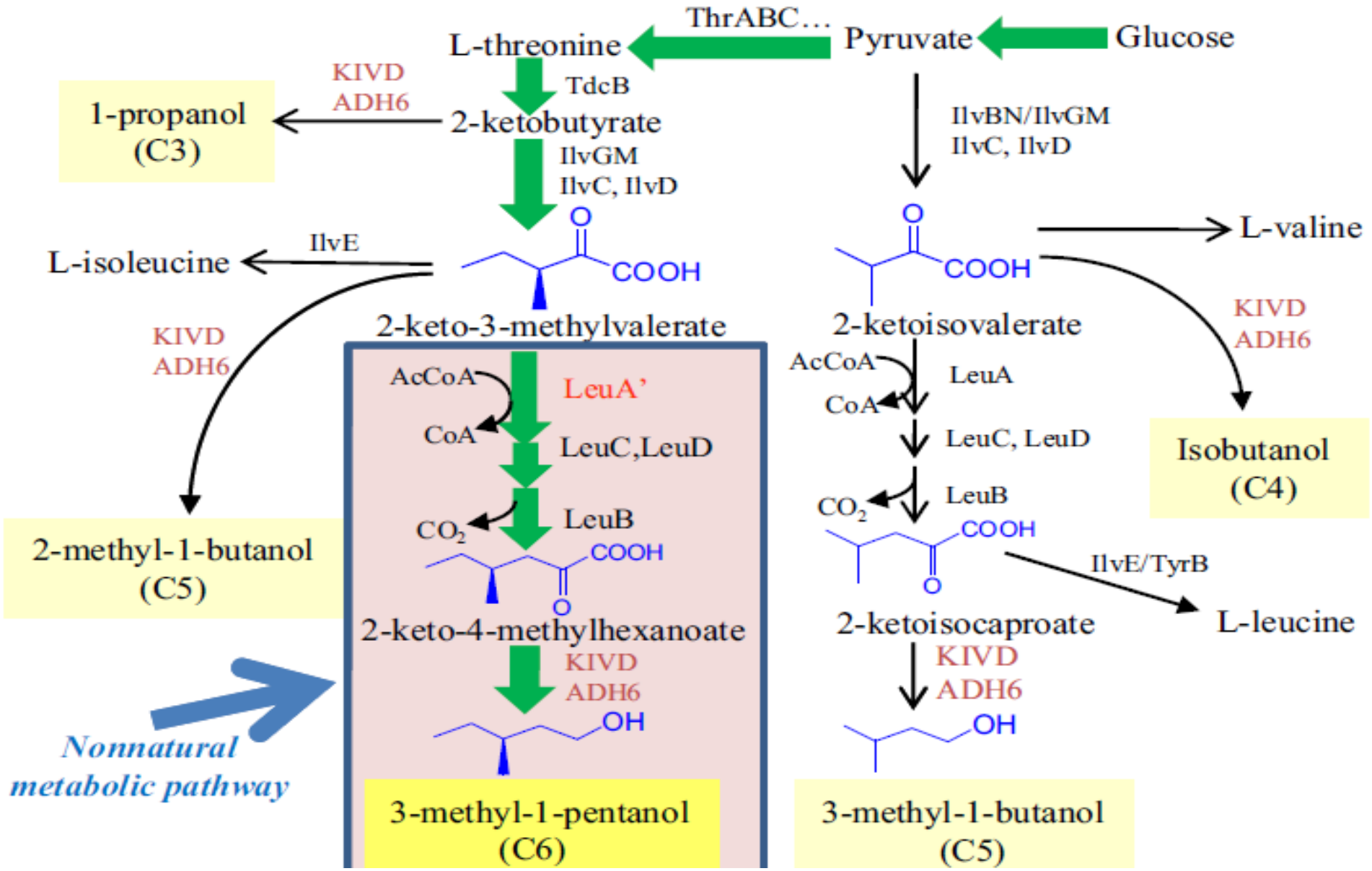
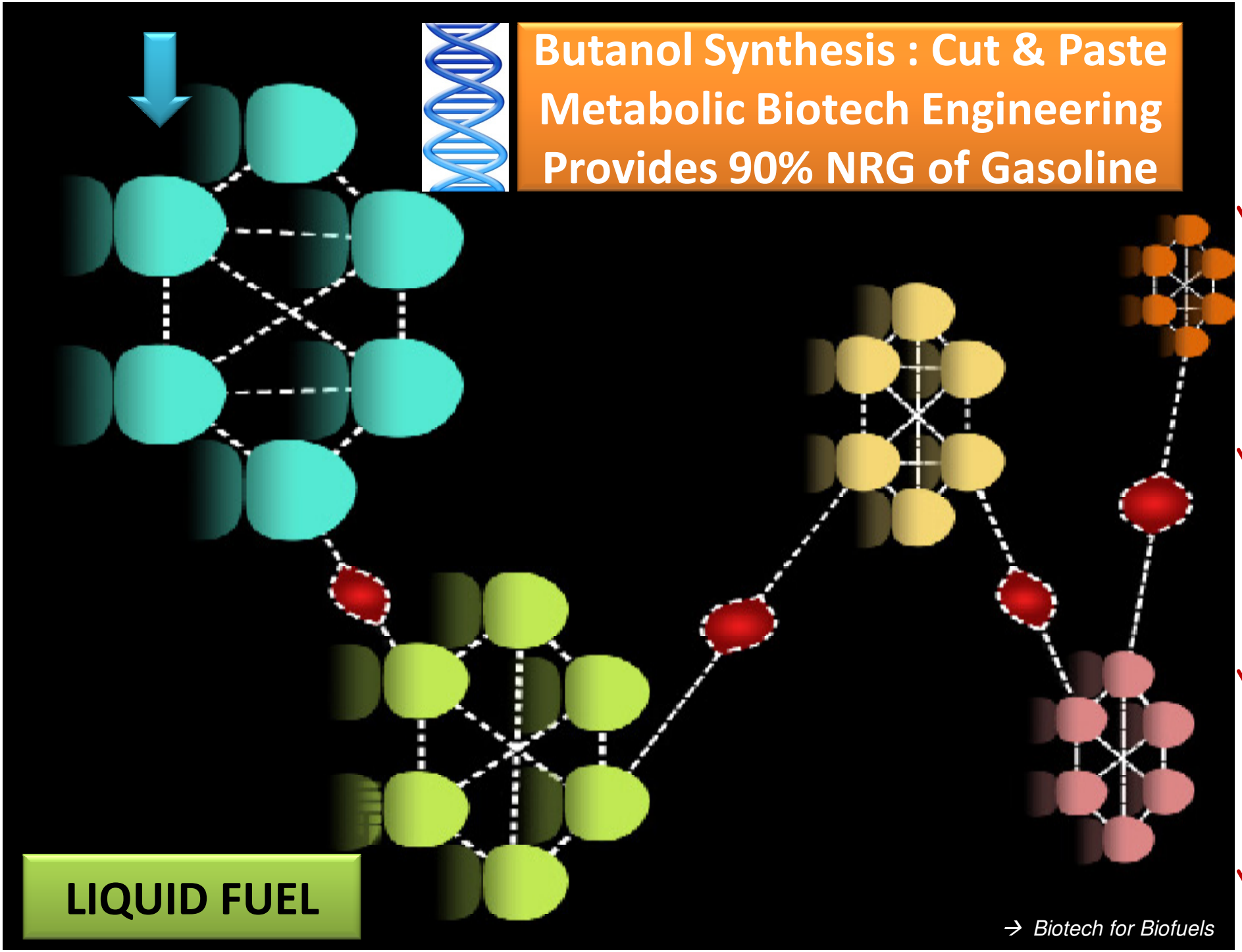
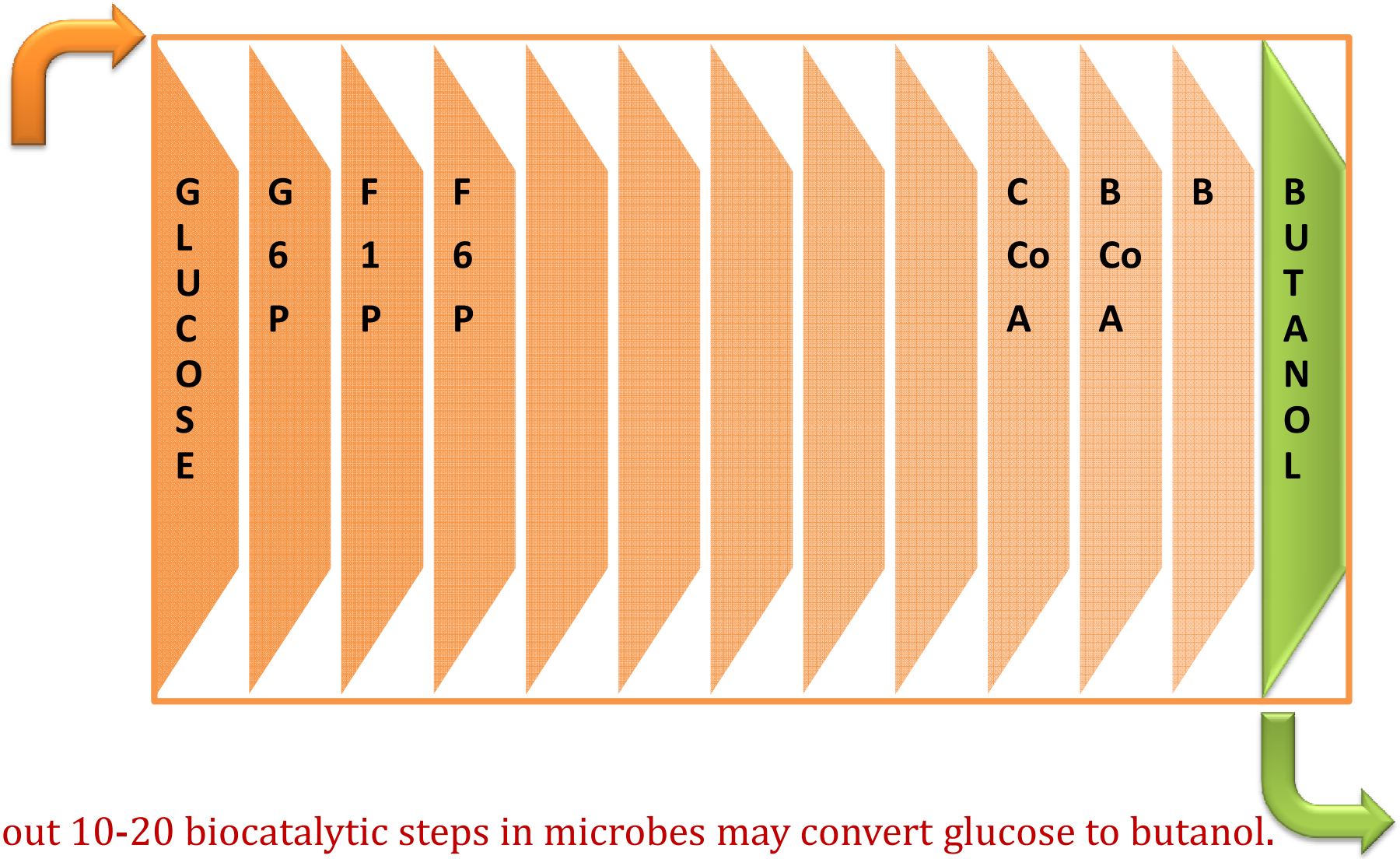
Energy Supply Chain: Metabolic Engineering of Supply Network Planning



www.pnas.org/content/suppl/2008/12/08/0807157106.DCSupplemental/0807157106SI.pdf

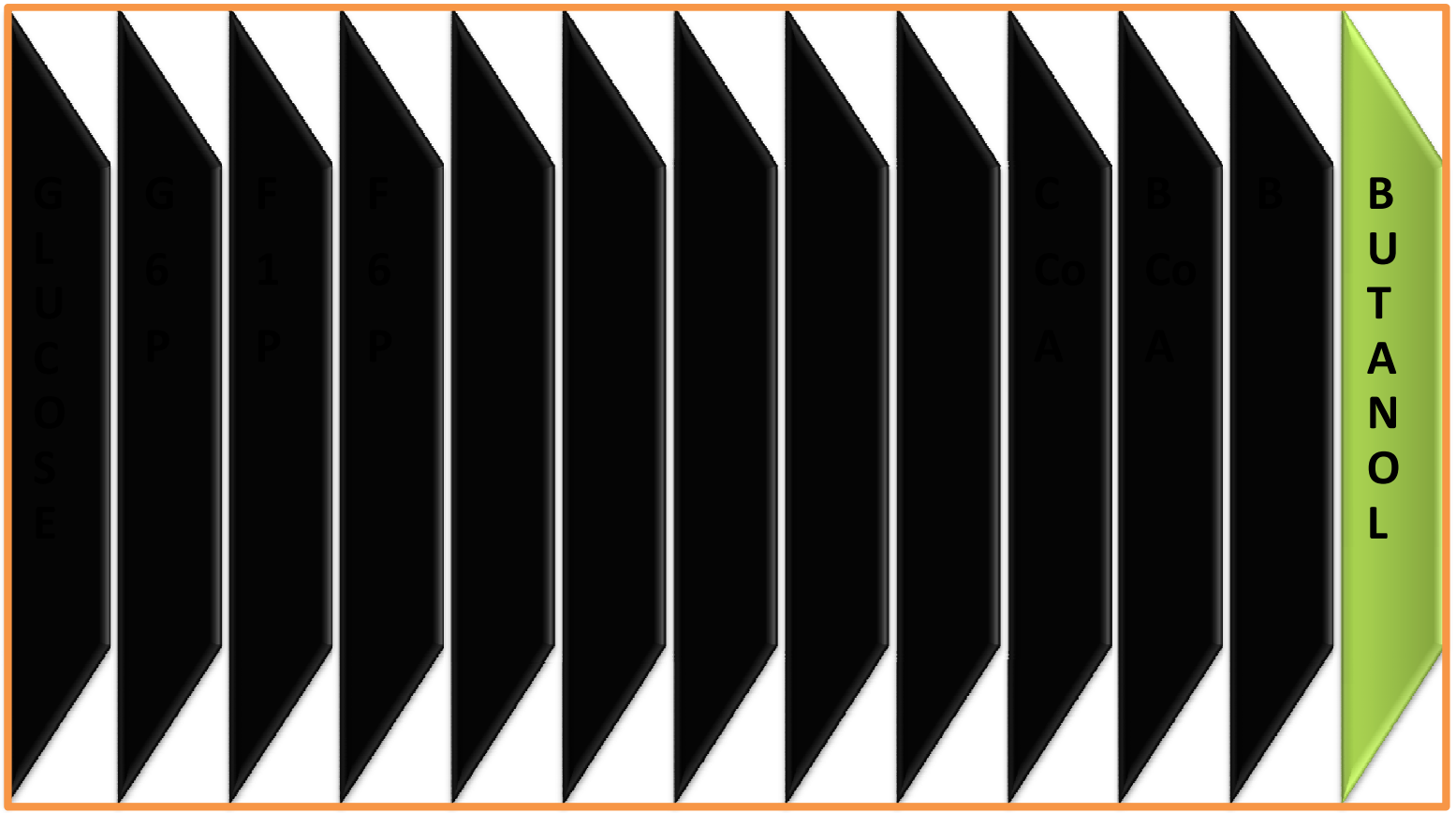

Butanol Synthesis : Cut & Paste
Metabolic Biotech Engineering
Provides 90% NRG of Gasoline
LIQUID FUEL
→ Biotech for Biofuels

Hypothetical Immobilized Enzymatic Catalysis of Glucose to Butanol
Butanol Battery 2020



About 10-20 biocatalytic steps in microbes may convert glucose to butanol. These enzymes immobilized on substrates may form a multi-layer cube. If functional, the cascade may convert glucose (commodity) directly to butanol.

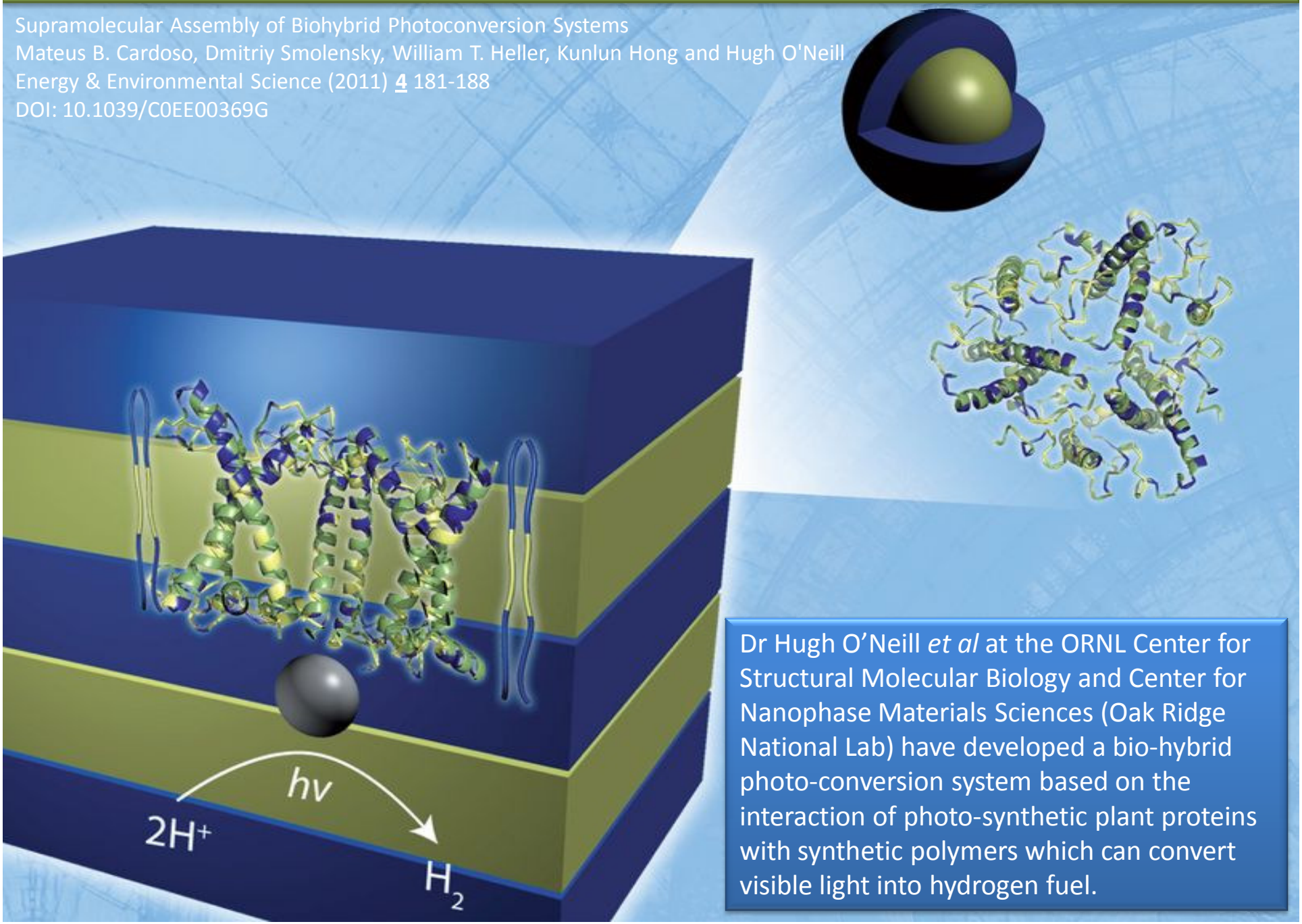
Hypothetical Immobilized Enzymatic Catalysis in Nano-Chloroplasts 2100 AD



Light-dependent (photosystem I and II) and light-independent reactions of photosynthesis may be difficult (but not impossible) to functionalize *(as above)* due to the vast number of integral proteins in thylakoids in chloroplasts.

Hypothetical Immobilized Enzymatic Catalysis in Nano-Chloroplasts ?

Supramolecular Assembly of Biohybrid Photoconversion Systems
Mateus B. Cardoso, Dmitriy Smolensky, William T. Heller, Kunlun Hong and Hugh O'Neill
Energy & Environmental Science (2011) **4** 181-188
DOI: 10.1039/C0EE00369G



Dr Hugh O'Neill *et al* at the ORNL Center for Structural Molecular Biology and Center for Nanophase Materials Sciences (Oak Ridge National Lab) have developed a bio-hybrid photo-conversion system based on the interaction of photo-synthetic plant proteins with synthetic polymers which can convert visible light into hydrogen fuel.

Based on proven gross inefficiencies of the internal combustion engine in converting chemical energy to mechanical energy (about 15%) it is clear that the future is electric. Then, why pursue scaling production of liquid fuel (C4, C5) from bacteria?

The answer is not simple but at least one simple answer is that predictions are difficult, especially when the question at hand requires one to forecast when rapid-charge car batteries will commence mass production. Reducing the re-charge time from 30-60 minutes to 5-10 minutes may be the disruptive factor that catalyzes or inhibits mass adoption of electric vehicles.

Can liquid fuel alternatives stand the economic stress test?

CHANGES

Electric Vehicles (EV)

- Automobile Engineering
- Charging Infrastructure
- Repair - Maintenance

Flex Fuel Vehicles (FFV)

- Liquid Fuel Production

TOO MANY PARALLEL CHANGES NECESSARY FOR SUCCESSFUL ADOPTION OF EV

Why liquid fuel may fare better in an economic stress test.

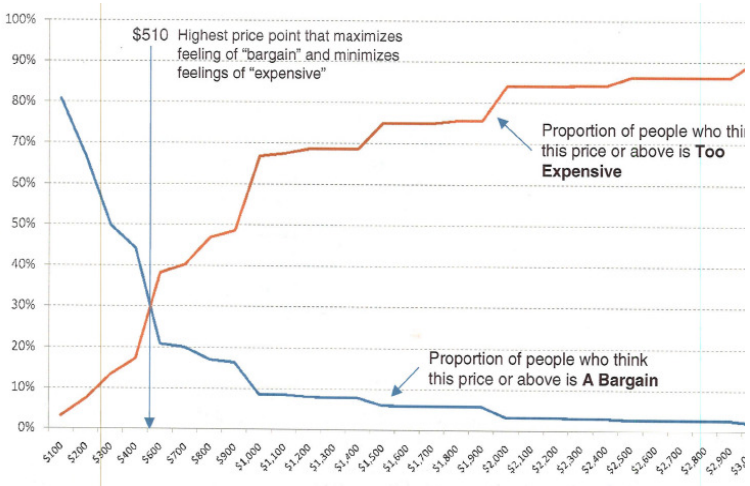
Investment

Electric Vehicle (Low Carbon / Neutral)

- Vehicle Engineering
- Charger Units (220V & 440V)
- Charging Stations
- Loss of 160,000 gas stations in US
- Loss of distribution assets
- Jobs lost versus created
- 1 source dependence - power grid
- Home chargers & remote control
- Wireless sensor data to phones

Flex Fuel Vehicle (Low Carbon / Neutral)

- Production scalability
- Photo bio-reactors / bioreactors
- Wireless sensor data to phones



Is liquid fuel still necessary when Lithium ion nano-phosphate batteries become standard?

DISRUPTIVE INNOVATION – A123 Systems

Electric Vehicles (looks good)

- 90% efficiency from electric motors
- About 5-10 minutes for full charge
- RoboTrespa for short use/commute
- Diminished range anxiety and cost
- Vehicles as grid energy storage (peak)

Flex Fuel Vehicles (looks bad)

- 15% efficiency (chemical-mechanical)
- Alternate fuel for emergency vehicles
- Jet and bunker fuel (unless nuclear)

Non-fossil carbon-neutral renewable liquid fuel from photosynthetic microorganisms can be used for power generation for domestic users as well as grid based electricity distribution in countries where nuclear fission or fusion power is less readily available.

Is infrastructure disappointment imminent for early EV users?

IS THE CART BEFORE THE HORSE ?

Electric Vehicle Adopters

- Believe in the cause
- Aware of the pros/cons
- Extract marketing benefits
- A123 Systems - Tesla, Prius, Volt

Electric Vehicle "wait & see"

- Frugal types "Wal-Martians"
- Fleet owners: GE, DHL, FedEx, UPS
- Developing countries
- Price drop / subsidies

Forecast Risk - mass adoption and domestic charge of rapid-charge batteries.

One Billion Vehicles in 2020

2010 Automobiles

- 800 million vehicles in current use

2020 Automobiles

- 200 million vehicles to be added
- Conservative estimate : China , India
- Lacks systemic initiatives for EV
- Biofuel generates low paying job
- Carbon-neutrality controls GHG
- Wait & See : grid / battery innovation

Non-fossil liquid fuel may be a solution for several decades.
Fossil fuel will still be available but at what economic cost?
Other non-fossil possibilities include methanol & biodiesel.

Action Plan

Progressive Entrepreneurial Innovation
Yes, we can!

- Connect with or create collaborative infrastructure (laboratory)
- Source or develop fuel generating microorganism
- Adapt or re-tool photo-bioreactor
- Produce butanol and establish metrics
- END OF PRE-PHASE (intellectual property)
- START OF PHASE 1 – scale to 1 L / hr
- Phase 1a – small scale reactor (new product)
- START OF PHASE 2 – scale to 10 L / hr
- Phase 2b – medium scale reactor (product)
- Net energy vs insolation analysis / optimize
- START OF PHASE 3 – scale to 100 L / hr
- Phase 3b – large scale reactor (plant)
- Local and global production/distribution
- Significant new job creation / grow economy
- Fossil fuel independence reduces GHG

Risk Averse Cautious Analysis and Study
Why we cannot …

- There are at least five famous groups who have patents on fuel producing bacteria.
- Producing bio-tech butanol is not new.
- Photo-bioreactor re-engineering requires chemical and mechanical engineers.
- May need 1-2 years to arrive at Phase 1.
- Uncertainty and risk in scalability estimates.
- 2 million dollars over 2-3 years is too much.
- This is different from our mandate / remit.
- ROI will take 2-5 years and that is too long.
- Who will hire the experts and the students?
- Who will manage this complex project?
- We will wait for universities to do the work.
- We don't want any genetic engineering.
- Corn ethanol will suffice as the liquid fuel .
- We have enough fossil fuel for 150 years !

Short Term Focus for Scalable Photo-Production of Liquid

C4

Demonstrate

- Bench-top reactor
- 1 liter per hour
- 1-2 years

→

- Garden reactor
- 10 liters per hour
- 2-3 years

Current Oil Use 5 trillion L per year

Scenario - Photo bio-reactor scalability plateau - 10 L / hour

Global C4 Demand Doubles to 10 trillion L / yr

Single Unit Production

- 10 L / hour
- 50% efficiency
- 50% insolation
- Yield ~ 20,000 L / yr

Distributed Production

- 500 million users
- Garden reactor
- 500 million products
- Yield 10 trillion L / yr

The Cautious

- I don't want fuel in my house
- My GM Volt uses A123 battery
- I don't want to buy these products - we have the grid
- Really what does this achieve?
- Is this sustainable?
- There are other solutions.
- What about electricity from sewer sludge?
- Is there a market for this product?

The Optimist

- Animal Farm, Server Farms and now C4-ward Farms at remote locations.
- Generator converts C4 to electricity and feeds GM Volt or sell to the grid.
- Utilities can also own C4-ward Farms as the source of electricity to the grid.
- Independence from fossil fuels using non-vegetative (not food) source.
- It is sustainable and carbon neutral which helps stabilize/reduce GHG.
- C4 is not a panacea but when combined with C6 offers a global solution which uses C6 as a non-perishable, non-exhaustible commodity for the supply chain of energy agnostic global economy.
- Good idea from Craig Venter but do you want sewer sludge in your house?
- Sales over 10-20 years for 500 million units at $1,000 per unit = $500 billion. Maintenance micro-payment at 50 c per day = $90 billion pa for services.

Temporary Conclusion (this is not a panacea)

At this time (01/11) it appears feasible to partially reduce GHG emissions by rapidly gearing toward manufacturing of vegetation-independent non-fossil carbon-neutral C4-C5 renewable liquid fuel from photosynthetic cyano-bacteria (microalgae) using sunlight and carbon dioxide.

It is one solution that may be closer at hand than others. The risk in this manufacturing process is scalability of production volume to make a sufficient contribution as fuel source for global use. The risk may also be a reward. If cost or technology for scalability is unsuitable then production volume may remain low. The low volume product may be suitable and affordable for domestic or small businesses. If each home or small business owned its independent energy manufacturing appliance (liquid fuel generator), it may significantly reduce demand for grid distributed power.

Fuel (C4, C5) produced in high insolation zones will be useful locally but transportation is costly. Hence, the emergence of glucose (C6) as a driver of the future liquid energy supply chain. High insolation zones in developing nations can produce C6 and sell the product to industrialized nations in low insolation zones. Glucose may be converted by a variety of microbial or other methods to C4,C5 fuels without sunlight or the need to source vegetation or waste. Inventory of glucose may provide nations with energy security and partially reduce the uncertainty from energy prices which often segues to volatility in economic development.

Production of C6 from embedded photosynthetic enzymatic components immobilized on chips is a possible extension of the convergence of bio and nano-technology for renewable energy. In a manner similar to present-day solar panels, 22nd Century may expect “nano-chloroplast” panels for manufacturing glucose-on-a-chip or C4/C5 chips. The latter harnesses solar energy in chemical bonds and used on demand rather than directly generating electricity from photo-voltaic cells where energy may rapidly perish if unused unless storage technology significantly improves. In the interim, glucose from microbes may become an important energy commodity.

“I cannot believe that it ever make economic sense for an individual to make the capital expenditure for his own electric generation unless that individual cannot connect to the grid. Thus I do not believe in the assumptions about the future that your paper is based upon.” – *Bob Curl 11/10/2010*

"Where a calculator on the ENIAC is equipped with 18,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and weigh only 1.5 tons." -- *Popular Mechanics, 1949*

"I have traveled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year." -- *The editor in charge of business books for Prentice Hall, 1957.*

"But what...is it good for?" -- *Engineer at the Advanced Computing Systems Division of IBM, 1968, commenting on the microchip.*

"There is no reason anyone would want a computer in their home." -- *Ken Olson, president, chairman and founder of Digital Equipment Corp., 1977.*

"This 'telephone' has too many shortcomings to be considered as a means of communication. The device is inherently of no value.“ - *Western Union 1876.*

"The Americans have need of the telephone, but we do not. We have plenty of messenger boys." -- *Sir William Preece, chief engineer of the British Post, 1876.*

"The wireless music box has no imaginable commercial value. Who would pay for a message sent to nobody in particular?" -- *David Sarnoff's associates in response to his urgings for investment in the radio in the 1920s.*

"While theoretically and technically television may be feasible, commercially and financially it is an impossibility." -- *Lee DeForest, inventor.*

"The concept is interesting and well-formed, but in order to earn better than a 'C', the idea must be feasible." -- *A Yale University management professor in response to Fred Smith's paper proposing reliable overnight delivery service. (Smith went on to found Federal Express Corp.)*

"Who the hell wants to hear actors talk?" -- *H. M. Warner, Warner Brothers, 1927.*

"I'm just glad it'll be Clark Gable who's falling on his face and not Gary Cooper." -- *Gary Cooper on his decision not to take the role in "Gone With the Wind."*

"A cookie store is a bad idea. Besides, the market research reports say America likes crispy cookies, not soft and chewy cookies like you make." -- *Response to Debbi Fields' idea of starting Mrs. Fields' Cookies.*

"We don't like their sound, and guitar music is on the way out." -- *Decca Recording Co. rejecting the Beatles, 1962.*

"Radio has no future. Heavier-than-air flying machines are impossible. X-rays will prove to be a hoax." -- *William Thomson, Lord Kelvin, British scientist, 1899.*

"So we went to Atari and said, 'Hey, we've got this amazing thing, even built with some of your parts, and what do you think about funding us? Or we'll give it to you. We just want to do it. Pay our salary, we'll come work for you.' And they said, 'No.' So then we went to Hewlett-Packard, and they said, 'Hey, we don't need you. You haven't got through college yet.'" -- *Steve Jobs on attempts to get Atari and HP interested in his and Steve Wozniak's PC.*

"If I had thought about it, I wouldn't have done the experiment. The literature was full of examples that said you can't do this." -- *Spencer Silver on the work that led to the unique adhesives for 3-M "Post-It" Notepads.*

"It will be years -- not in my time -- before a woman will become Prime Minister." -- *Margaret Thatcher, 1974.*

"I see no good reasons why the views given in this volume should shock the religious sensibilities of anyone." -- *Charles Darwin, The Origin Of Species, 1869.*

"With over 50 foreign cars already on sale here, the Japanese auto industry isn't likely to carve out a big slice of the U.S. market." -- *Business Week, Aug 2, 1968.*

"That Professor Goddard with his 'chair' in Clark College and the countenancing of the Smithsonian Institution does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react--to say that would be absurd. Of course, he only seems to lack the knowledge ladled out daily in high schools." -- *1921 New York Times editorial about Robert Goddard's revolutionary rocket work. The remark was retracted July 17, 1969.*

"You want to have "Drill for oil? You mean drill into the ground to find oil? You're crazy." -- *Workers whom Edwin L. Drake tried to enlist to drill for oil in 1859.*

"Stocks have reached what looks like a permanently high plateau." -- *Irving Fisher, Professor of Economics, Yale University, 1929.*

"There is not the slightest indication that nuclear energy will ever be obtainable. It would mean the atom would have to be shattered at will." -- *Einstein, 1932.*

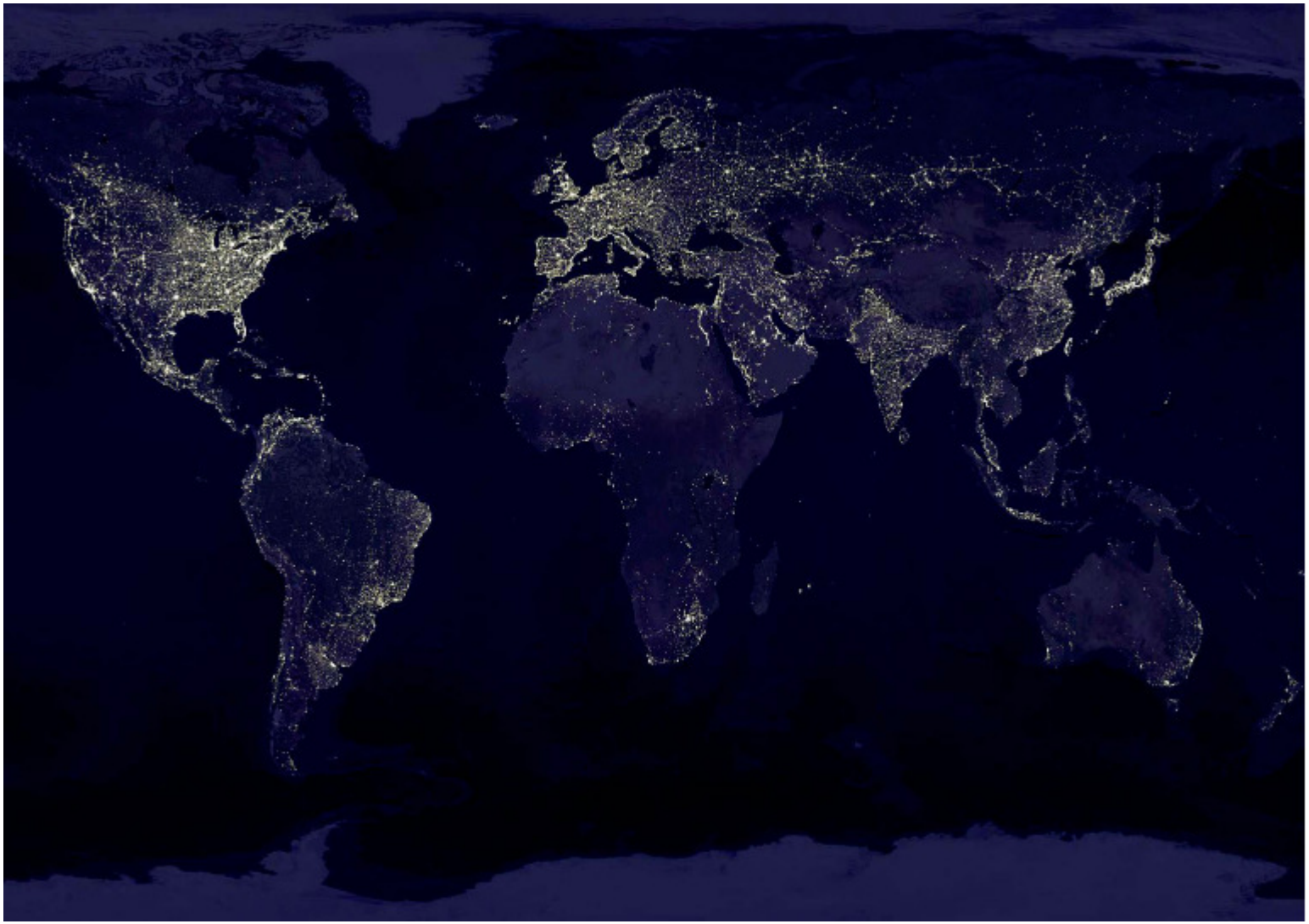
"The bomb will never go off. I speak as an expert in explosives." -- *Admiral William Leahy, U.S. Atomic Bomb Project.*

"Airplanes are interesting toys but of no military value." -- *Marechal Ferdinand Foch, Professor of Strategy, Ecole Superieure de Guerre.*

"There will never be a bigger plane built." -- *A Boeing engineer, after the first flight of the 247, a twin engine plane that holds ten people.*

"Louis Pasteur's theory of germs is ridiculous fiction." -- *Pierre Pachet, Professor of Physiology at Toulouse, 1872.*

"The abdomen, the chest, and the brain will forever be shut from the intrusion of the wise and humane surgeon." -- *Sir John Eric Ericksen, British surgeon, 1873.*



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