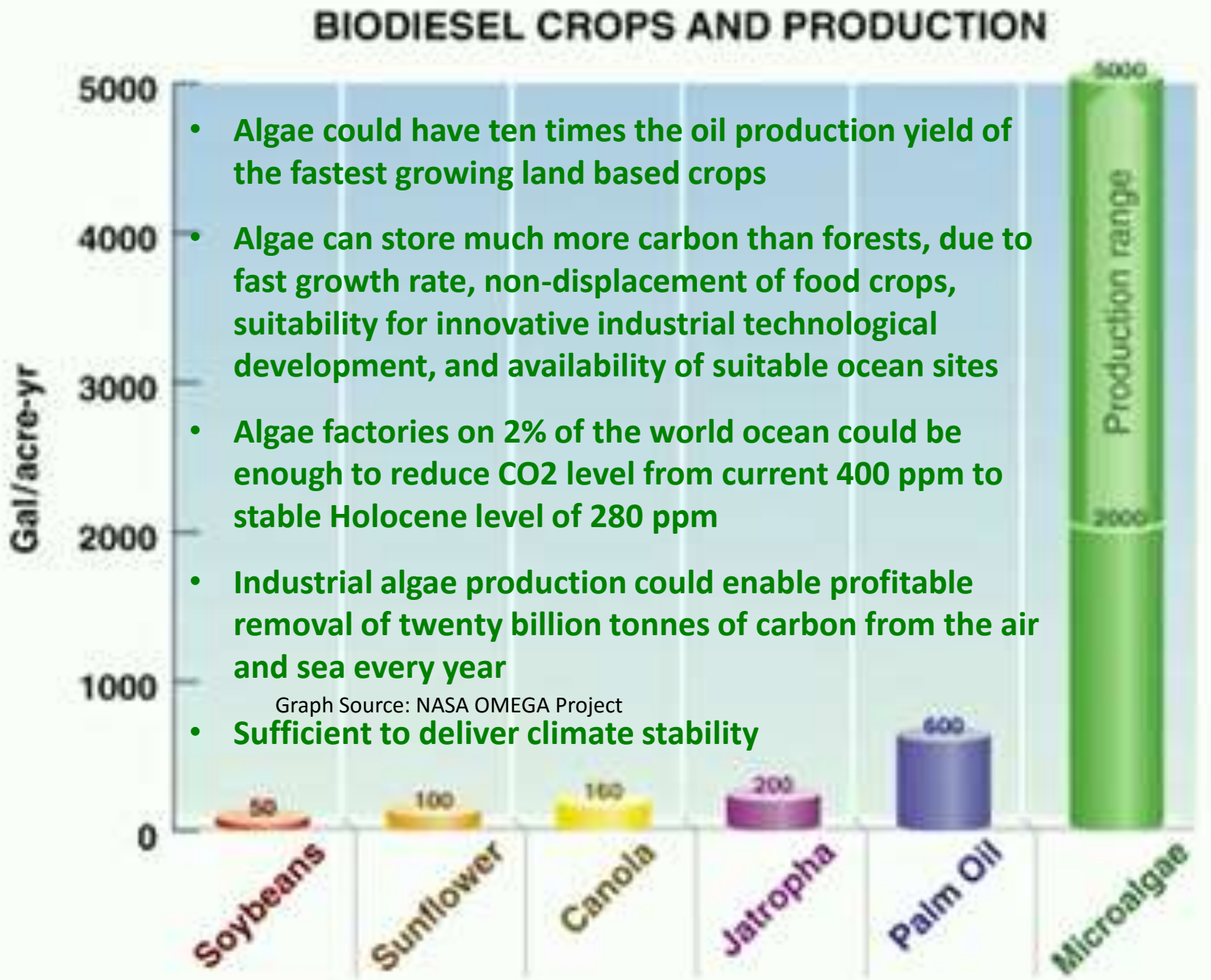
Australia's Great Barrier Reef faces high risk of collapse due to climate change

http://www.youtube.com/watch?feature=player_embedded&v=BOvrNXGJhTA Video of this map of reef topography.

How to Protect the Reef from

1. Heat?
2. Acid?
3. Nutrient?

Coral Sea - 3D view of the Project 3DGBR study area



- Algae could have ten times the oil production yield of the fastest growing land based crops
- Algae can store much more carbon than forests, due to fast growth rate, non-displacement of food crops, suitability for innovative industrial technological development, and availability of suitable ocean sites
- Algae factories on 2% of the world ocean could be enough to reduce CO2 level from current 400 ppm to stable Holocene level of 280 ppm
- Industrial algae production could enable profitable removal of twenty billion tonnes of carbon from the air and sea every year

Graph Source: NASA OMEGA Project

- Sufficient to deliver climate stability

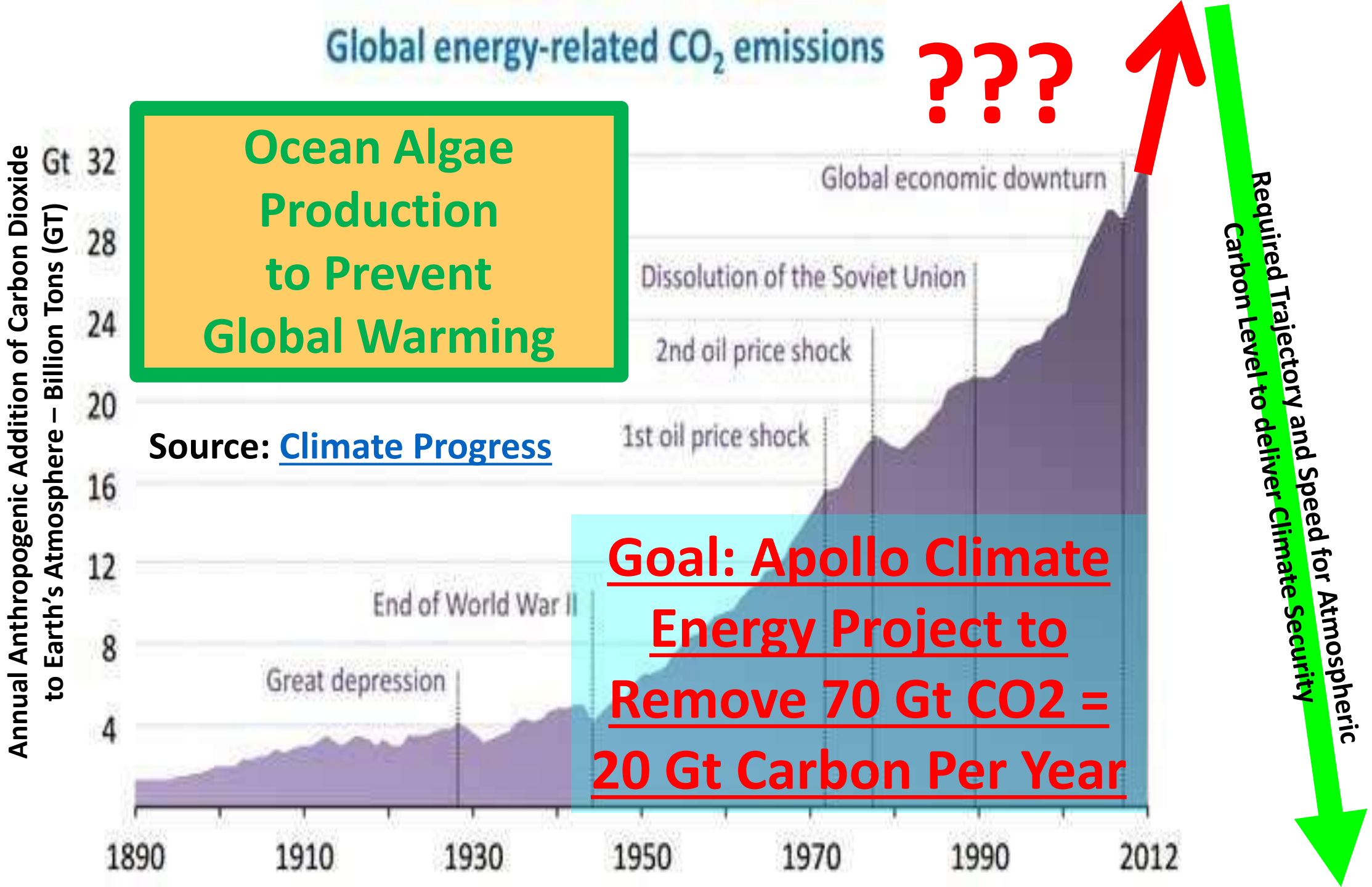
Inter-Governmental Panel on Climate Change

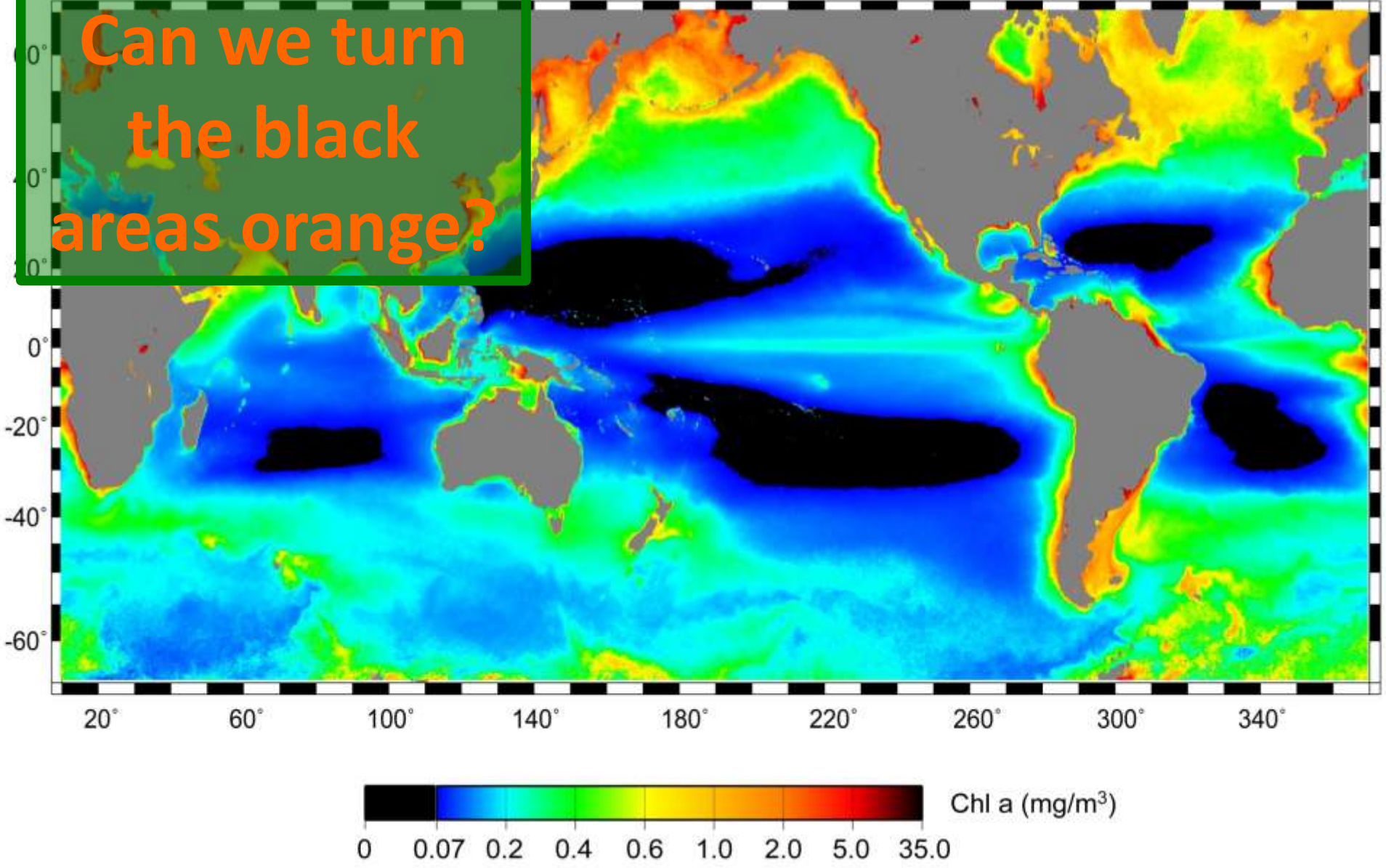
5TH ASSESSMENT REPORT, 2013

"A large fraction of anthropogenic climate change resulting from CO2 emissions is irreversible on a multi-century to millennial time scale,* **except in the case of a large net removal of CO2 from the atmosphere over a sustained period.**"

http://fixtheclimate.com/

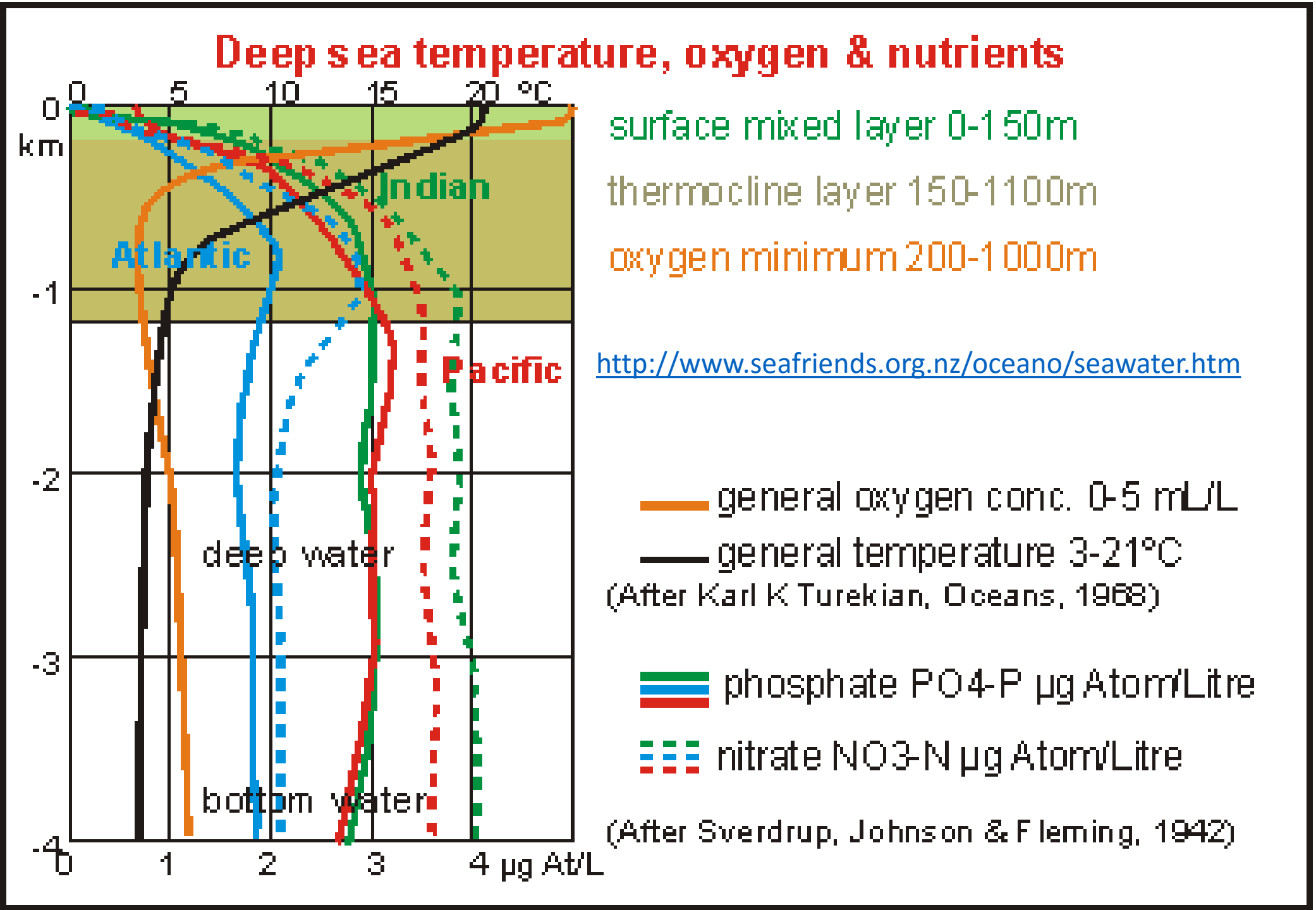
Research into Marine Cloud Whitening	Climate Engineering	01
Technology-led Policy Response	Technology	02
Research into Stra…	…ineering	03
Research into Carbon Storage	Technology	04
Planning for Adaptation	Adaptation	05
Research into Air Capture	Climate Engineering	06
Technology Trans…	…ansfers	07
Expand and Protect Forests	Forestry	08
Stoves in Developing Nations	Cut Black Carbon	09
Methane Reduction portfolio	Cut Methane	10
Diesel Vehicle Emissions	Cut Black Carbon	11
…rbon Tax	Cut Carbon	…
$0.5 Global CO2 Tax	Cut Carb…	13
$3 Global CO2 Tax	Cut Carb…	14
…l CO2 Tax	Cut Carbon	…


Global energy-related CO_2 emissions
???
Ocean Algae Production to Prevent Global Warming
Source: Climate Progress
Annual Anthropogenic Addition of Carbon Dioxide to Earth's Atmosphere – Billion Tons (GT)
Gt
32
28
24
20
16
12
8
4
Global economic downturn
Dissolution of the Soviet Union
2nd oil price shock
1st oil price shock
End of World War II
Great depression
1890
1910
1930
1950
1970
1990
2012
Goal: Apollo Climate Energy Project to Remove 70 Gt CO2 = 20 Gt Carbon Per Year
Required Trajectory and Speed for Atmospheric Carbon Level to deliver Climate Security

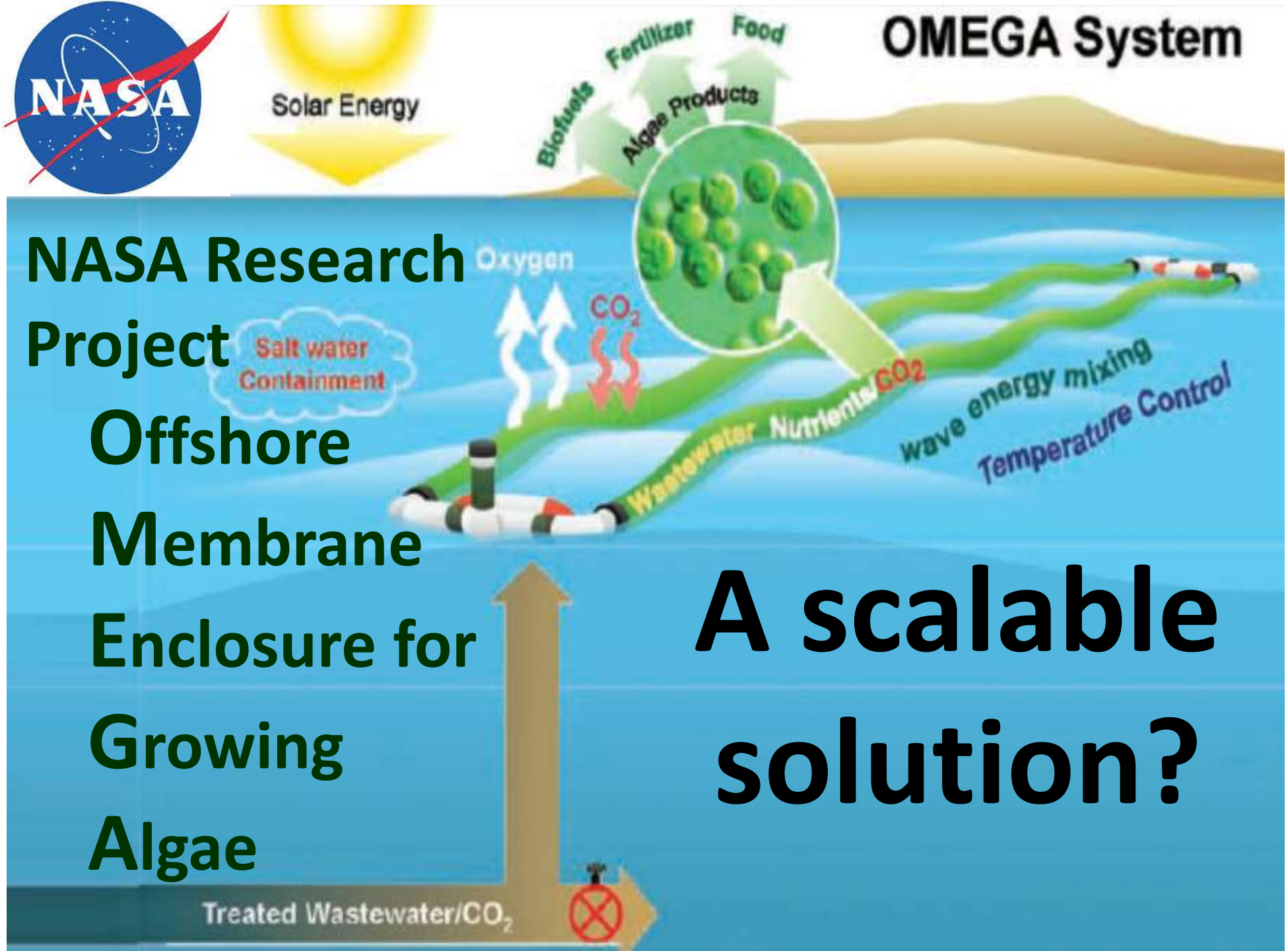


Area of low surface chlorophyll in world ocean 2009

50 million square kilometres and growing



High nutrient water (Phosphate and Nitrate) in Timor Trench (1 km depth) will be pumped to the surface by tidal array as algae biofuel feedstock



NASA Research Project

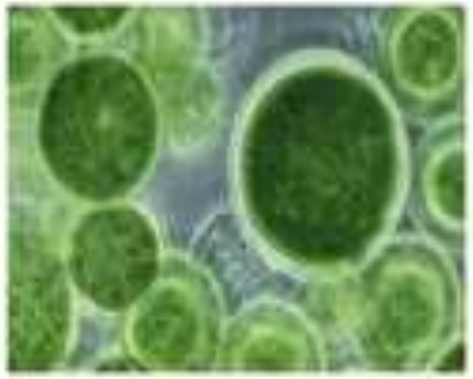
Offshore Membrane Enclosure for Growing Algae

A scalable solution?


National Aeronautics and Space Administration
NASA
http://www.nasa.gov/centers/ames/research/OMEGA/index.html
www.nasa.gov

Waste Biomass

Algae

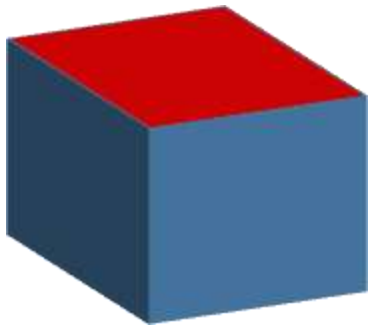


Wood

Sewage

Manure

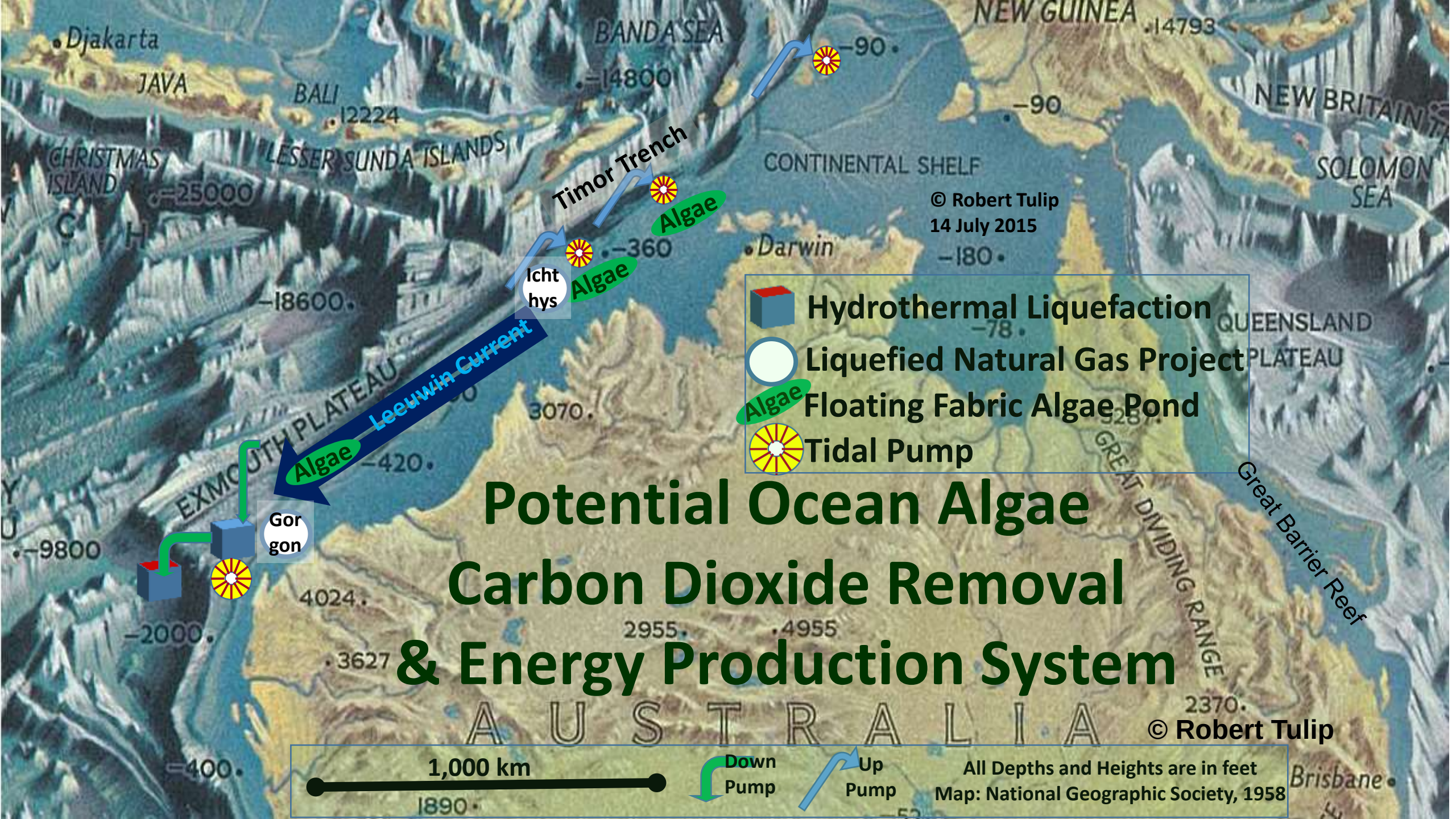
HTL



BioEnergy

Biocrude Oil

Diagram Source:
University of Illinois at Urbana Champaign
Department of Agricultural and Biological Engineering



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14 July 2015

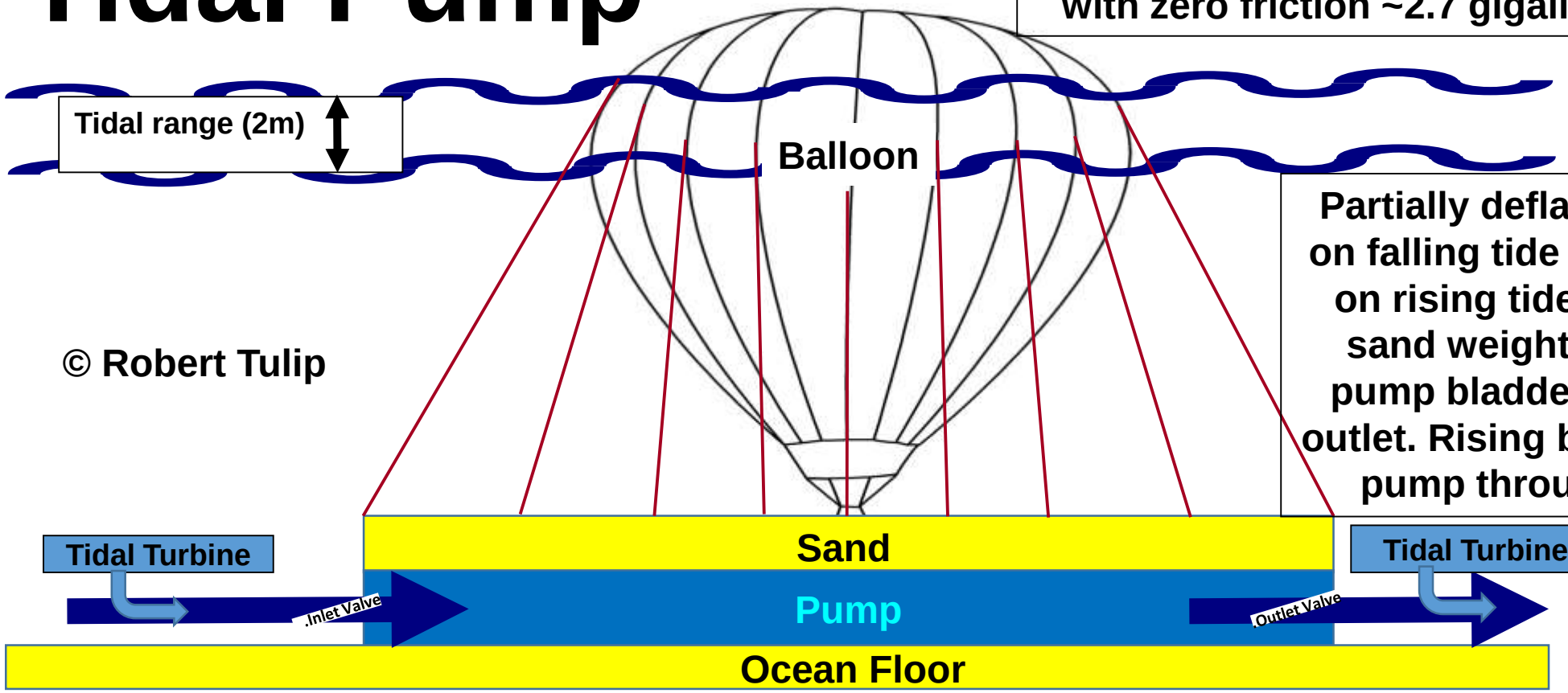
Potential Ocean Algae Carbon Dioxide Removal & Energy Production System

© Robert Tulip

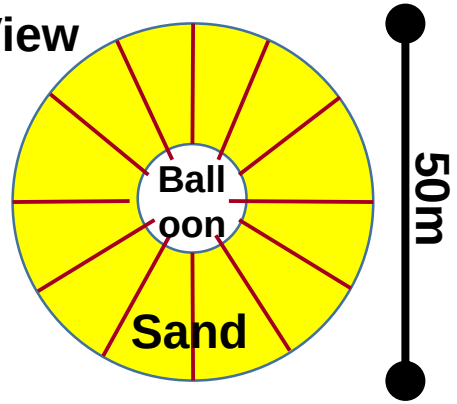
All Depths and Heights are in feet
Map: National Geographic Society, 1958

Tidal Pump

Annual Capacity of 50m model with zero friction ~2.7 gigalitres



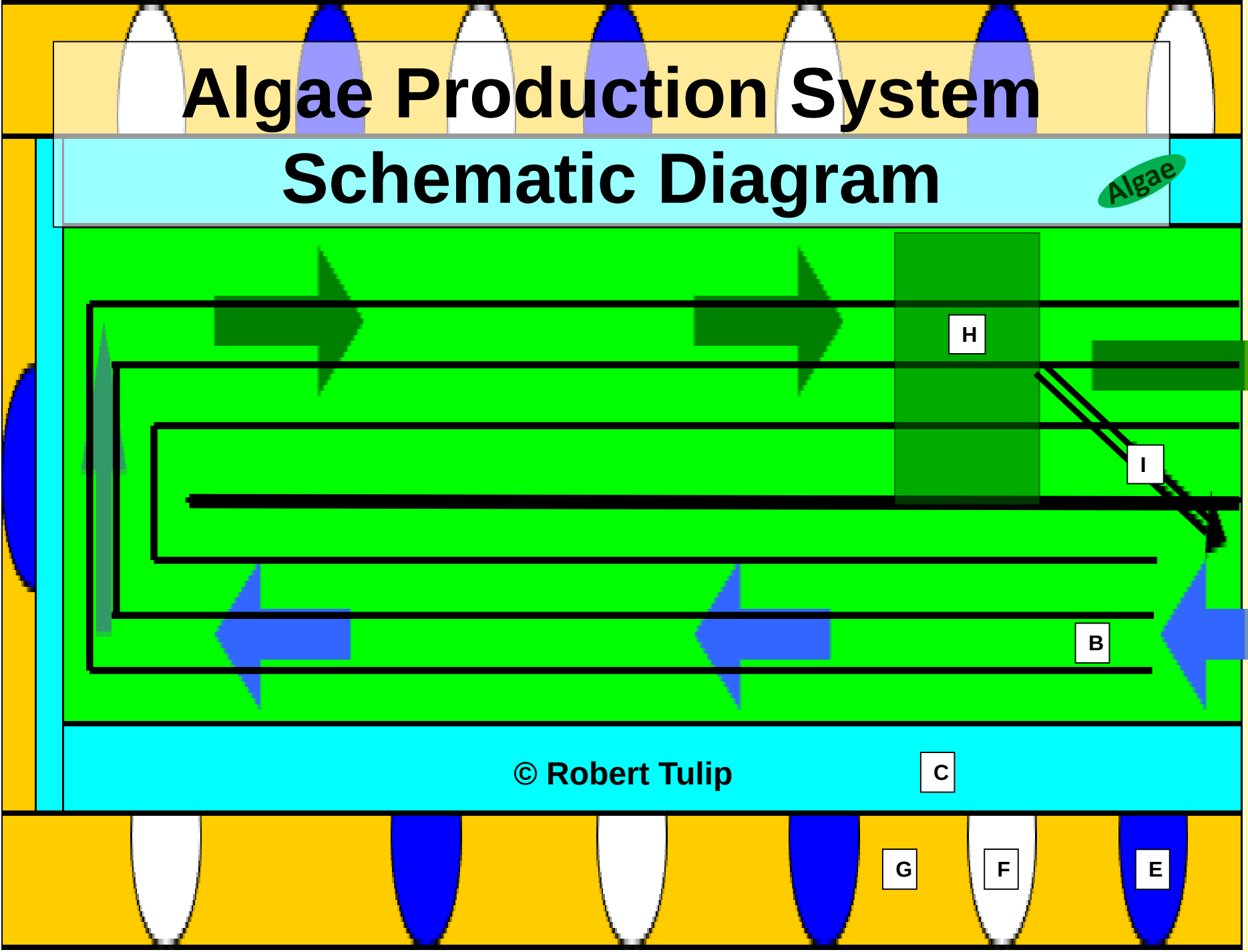
Vertical View



Dimensions (Approx)	Width metres	Height metres	Weight tonnes	Volume cubic metres	Power Lift/ Head
Balloon	20	20	8	3,800	??
Sand	50	1.3	4,000	2,600	??
Pump	50	2	4,000	4,000	??
Annual Pumping Capacity				2,775,900	??

Algae Production System

Schematic Diagram



A: Polymer bag containing water and nutrients.

B: Continuous flow algae photo-bioreactor chamber. Arrows show direction of liquid flow, divided into four parallel tracks

C: Polymer bag containing fresh water for buoyancy, pumping and stability

D: Polymer bag containing algated water output from chamber (B)

E: Submarine chamber pumping water from source (A) into chamber (B). (Note, chamber E can be replaced by a tidal pump as described in separate drawing).

F: Submarine chamber pumping air or CO_2 into chamber below chamber B as shown at side and front views

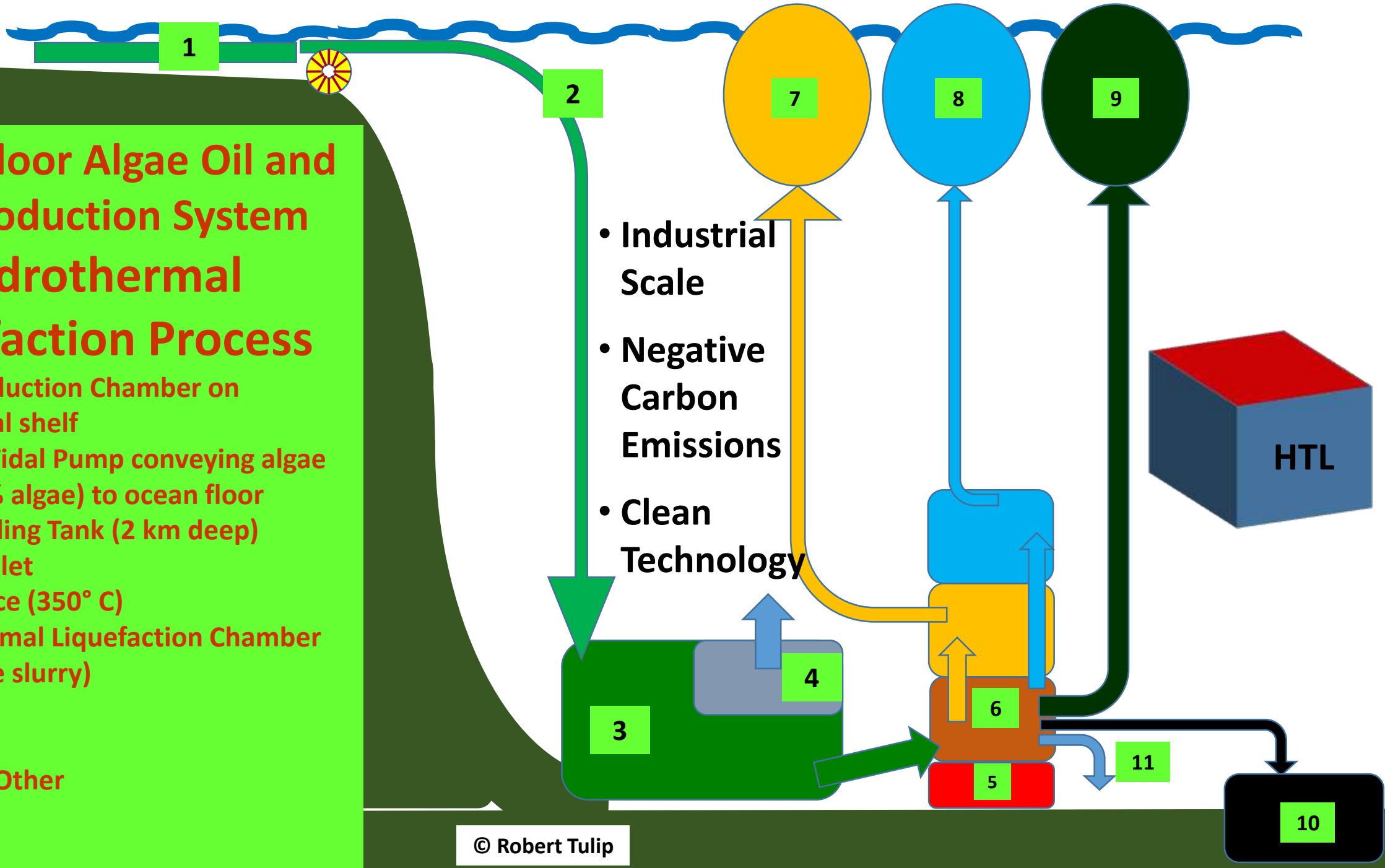
G: Rigid submarine platform at base of chambers E and F providing pumping resistance.

H: Yield Testing Point, diverting most productive track back to inlet.

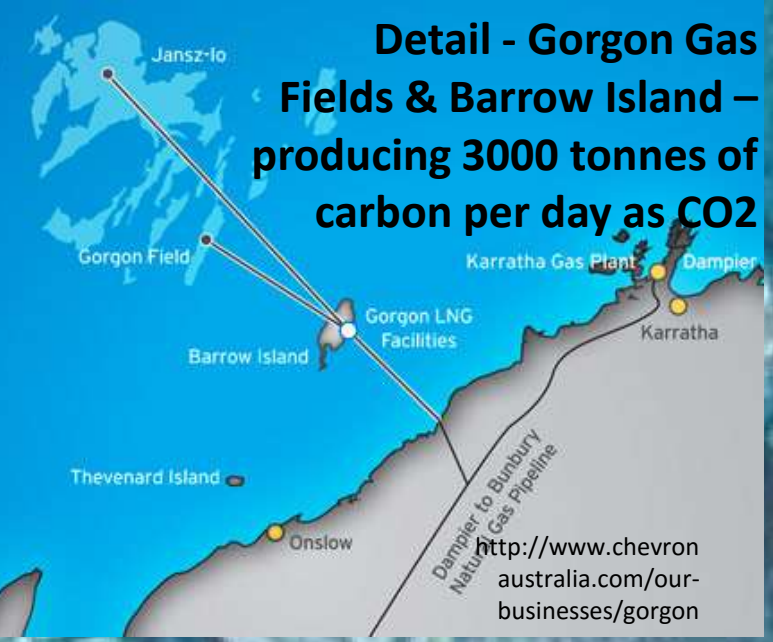
I: Return pipe transferring algated water to mix with nutrient-rich water from bag (A).

Ocean Floor Algae Oil and Gas Production System Hydrothermal Liquefaction Process

1. Algae Production Chamber on continental shelf
2. Pipe and Tidal Pump conveying algae bloom (1% algae) to ocean floor
3. Algae Settling Tank (2 km deep)
4. Water Outlet
5. Heat Source (350° C)
6. Hydrothermal Liquefaction Chamber (30% algae slurry)
7. Oil
8. Gas
9. Fertilizer/Other
10. Bitumen
11. Water



Ocean Algae Carbon Dioxide Removal & Energy Production System



Detail - Gorgon Gas Fields & Barrow Island – producing 3000 tonnes of carbon per day as CO2

http://www.chevronaustralia.com/our-businesses/gorgon

North West Shelf

Barrow Island

Leeuwin Current

Algae

Algae

© Robert Tulip
22 November 2014

−1665•
5 km deep

Algae

−1952
600 m deep

Hydrothermal Liquefaction Chamber

Tidal Pump

Western Australia

100 km

Implications of Ocean Based Algae Production for the Fossil Fuel Industry and Climate Stability

- Use emissions from coal and gas production and power stations as CO2 feedstock for large scale algae production systems at sea
- Shift from linear to cyclic paradigm, recycling burnt hydrocarbon
- Potential to transform fossil industry from wrecker to climate enabler
- Clean and protect the air and sea, funded and scaled by profit. Regulated by governments.
- Leverage assets, interests, skills and connections of the mining industry for rapid global response to carbon dioxide removal
- Adapt carbon economy for sustainable development by long term commercial use of mined carbon (roads, buildings, food, fertilizer, fuel, fabric)

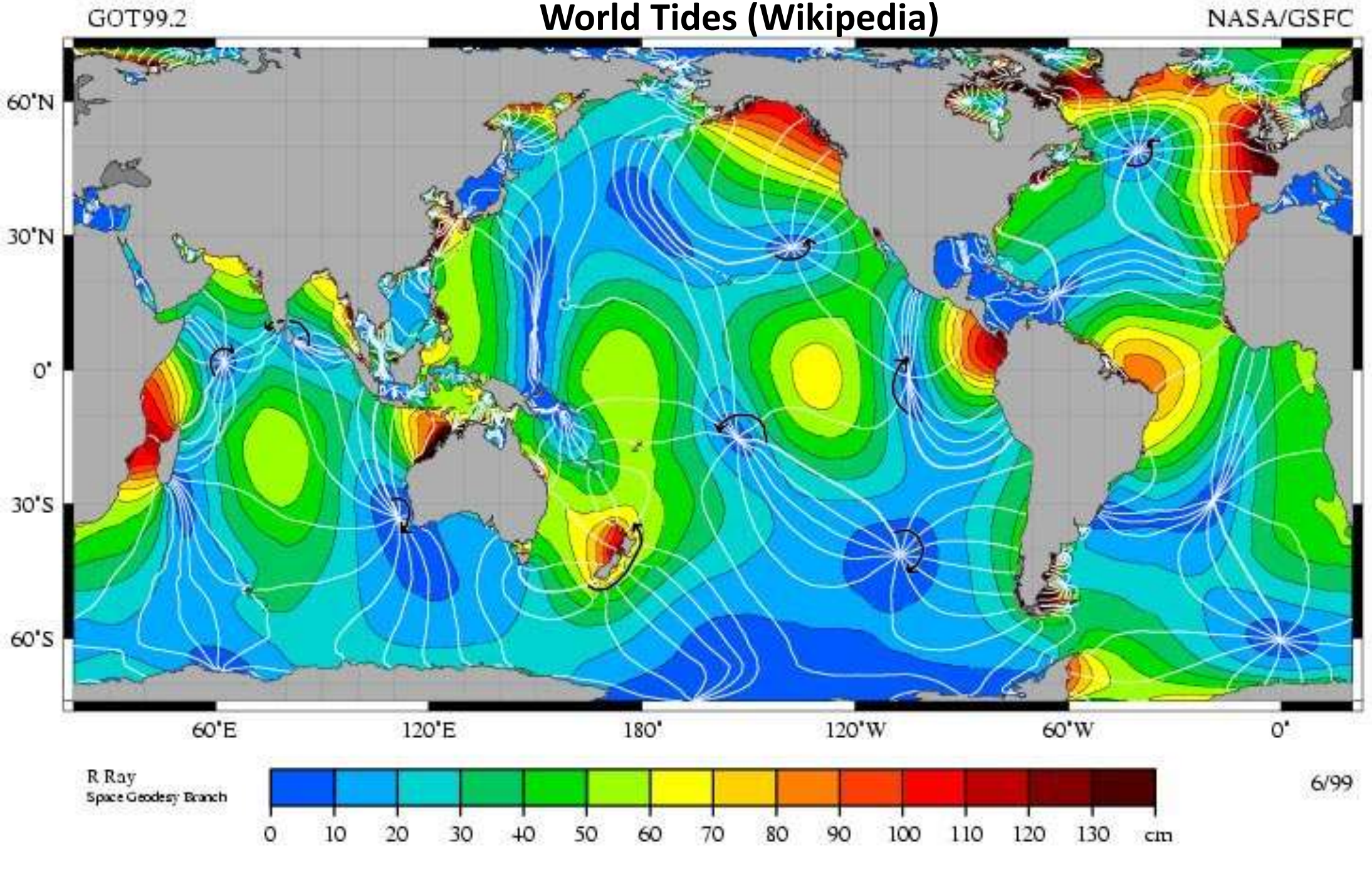
Hydrothermal Liquefaction

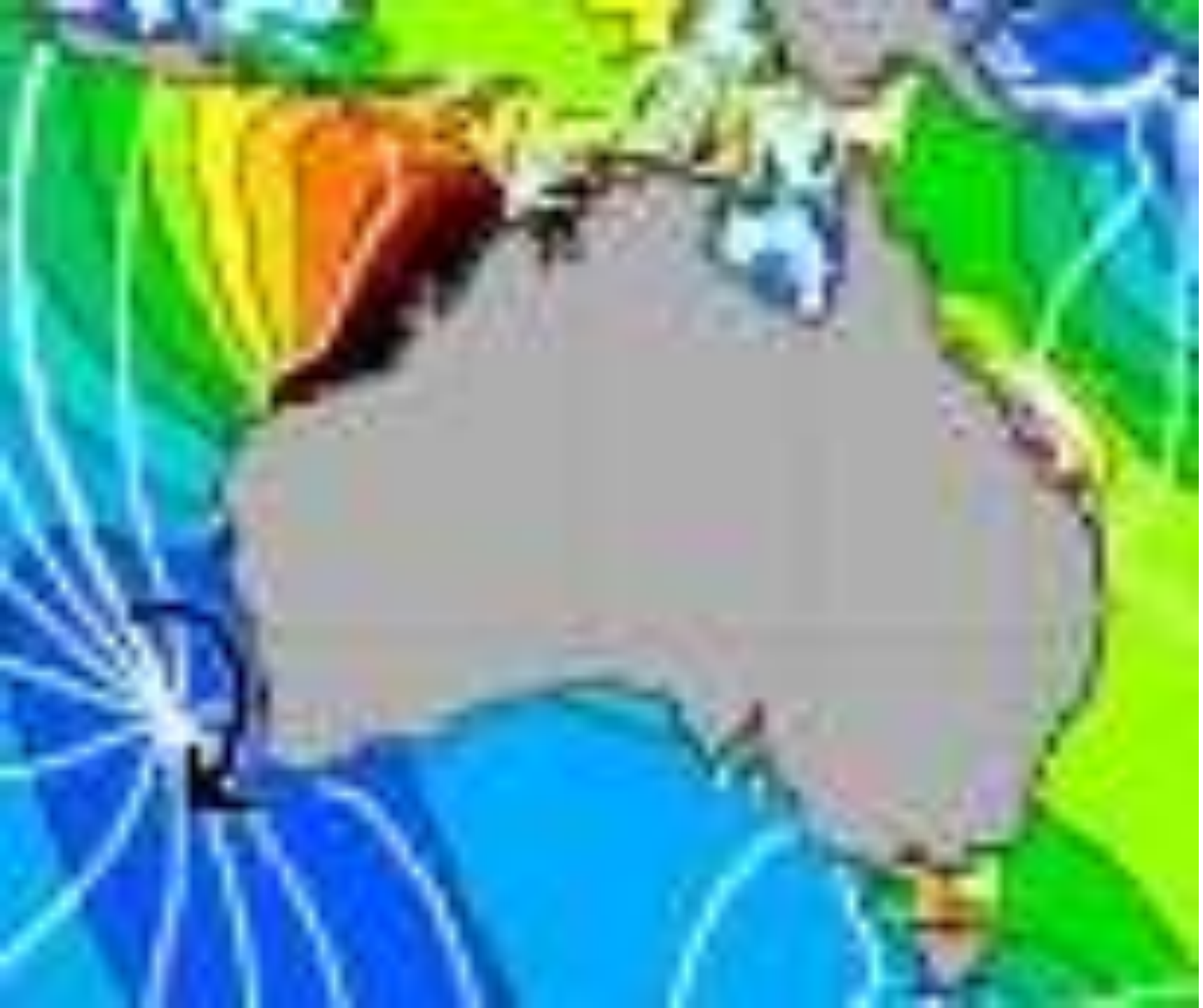
Liquefied Natural Gas Project

Floating Fabric Algae Pond

Tidal Pump

World Tides (Wikipedia)





Australian Tides

(Detail from Wikipedia Tide Map)

High tidal range on North West Shelf (up to five metres) will be tapped for this algae biofuel project.

http://wamuseum.com.au/dampier/documents/pdf/pearce%20et%20al.pdf

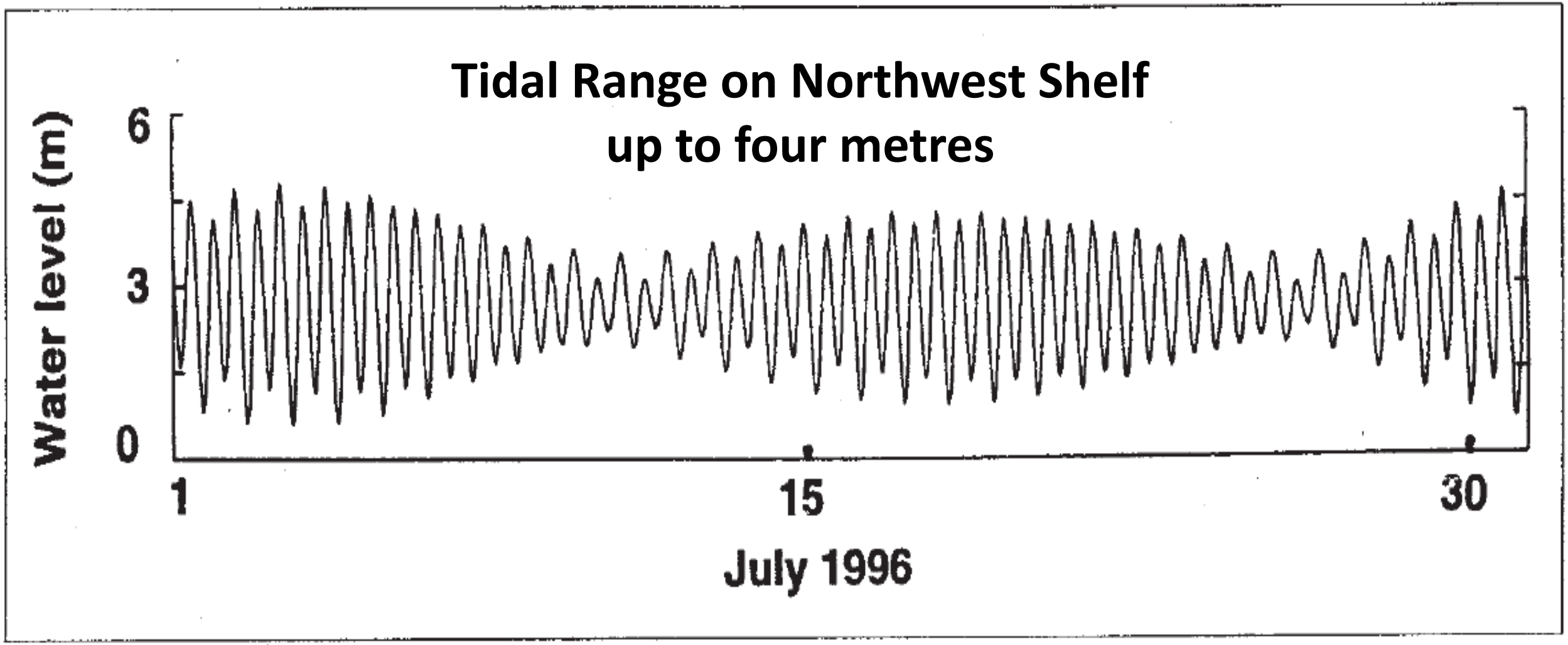


Figure 5 Typical tidal record from King Bay (Figure 1) for the month of July 1996, from Osborne *et al.* (2000).

“It always seems impossible until it's done.”

— Nelson Mandela

“Don’t believe me just watch.”

— Uptown Funk

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