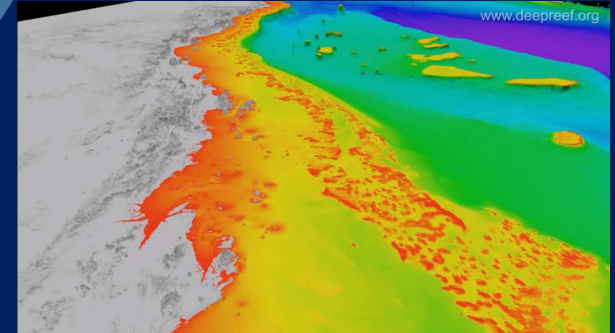
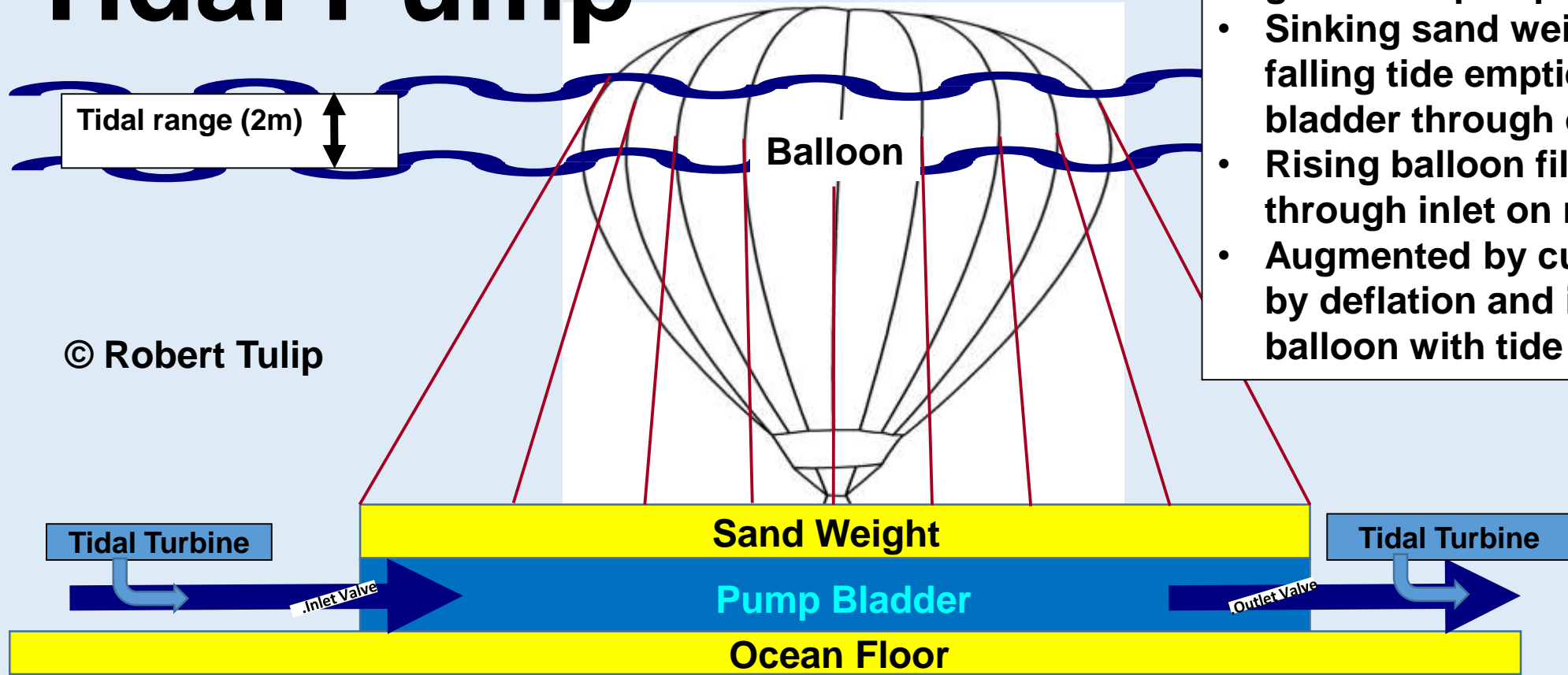


“scientists now think that the 1.5° target is needed to avoid the risk of dangerous climate change... the goal is achievable — but only with immediate, rigorous emissions reductions combined with new technologies to remove CO₂ from the atmosphere.” *





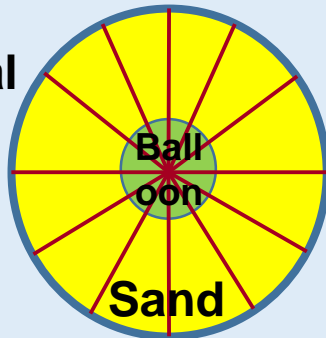
Tidal Pump



© Robert Tulip

- Falling and rising tide generates pumping energy.
- Sinking sand weight on falling tide empties pump bladder through outlet.
- Rising balloon fills pump bladder through inlet on rising tide.
- Augmented by current and by deflation and inflation of balloon with tide cycle.

Vertical View



50m

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





Proposal for **Energy-Water Nexus 2015** by Robert Tulip Tidal Pump

DESCRIPTION

IMPACT

CONTRIBUTORS **1**

COMMENTS **15**

EVALUATION

ADMIN

Show history

Pitch

The Tidal Pump, now at proof of concept, aims to shift large volumes of liquid in the ocean at lowest possible cost using new technology.



Professor Thomas Malone, Massachusetts Institute of Technology, presenting Judges Choice Winner Certificate to Robert Tulip for Energy Water Nexus Proposal on Tidal Pump

MIT October 2015

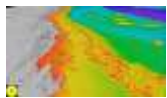


Emission Reduction
= Turn Down the Tap
= Delay Overflow

Carbon Dioxide Removal
= Negative Emission
Technology
= Drain the Bath
= Prevent Overflow

Value Proposition for University of Queensland

- COP 21 Article 5: "take action to conserve and enhance sinks and reservoirs of greenhouse gases"
 - Paris Leaders Accord on Negative Emission Technology (PLANET Accord)
- Innovative Disruptive Technology: CO2 emissions as feedstock for algae production systems at sea
- Biodiversity: Clean and protect the air and sea for insurance against climate change and extinction.
- Great Barrier Reef - Pioneer Carbon Sink to achieve <2° target
- Public Private Partnership - Leverage assets, interests, skills, duties and networks of science, government and industry at frontier of rapid global response to carbon dioxide removal
- Practical Priority Research Agenda: Shift economy to cyclic paradigm by reusing burnt fossil carbon
- Carbon Mining - air and sea as low yield orebodies (~100 grams per tonne)
 - simple robust large automated industrial systems for viable economic return and commercial replication.
- Transform old industries into climate enablers
- Adapt carbon economy for sustainable development by long term commercial use of mined carbon
 - roads, buildings, food, fertilizer, fuel, fabric



Protect the Reef



Innovative Technology



Resource and Energy PPP



Climate Stability



Large Scale Algae Production

Tidal Pump



EU says 1.5C global warming target depends on 'negative emissions' technology

EU climate chief says that aspirational 1.5C target was put into Paris climate deal at insistence of 'most exposed countries' and will require new strategies

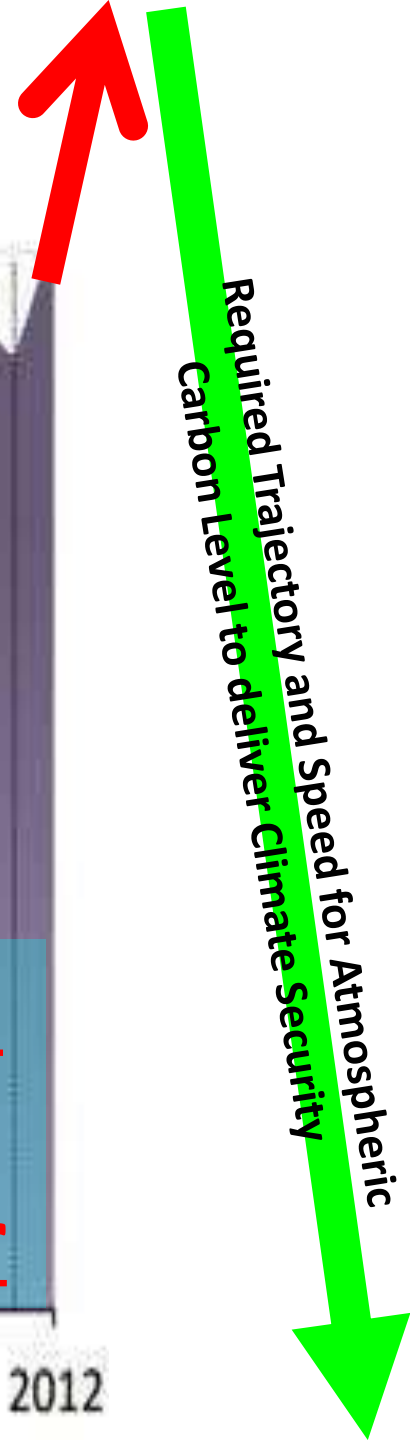


The slogan '1.5 degrees' is projected on the Eiffel Tower during the Paris climate summit. Photograph: Francois Mori/AP

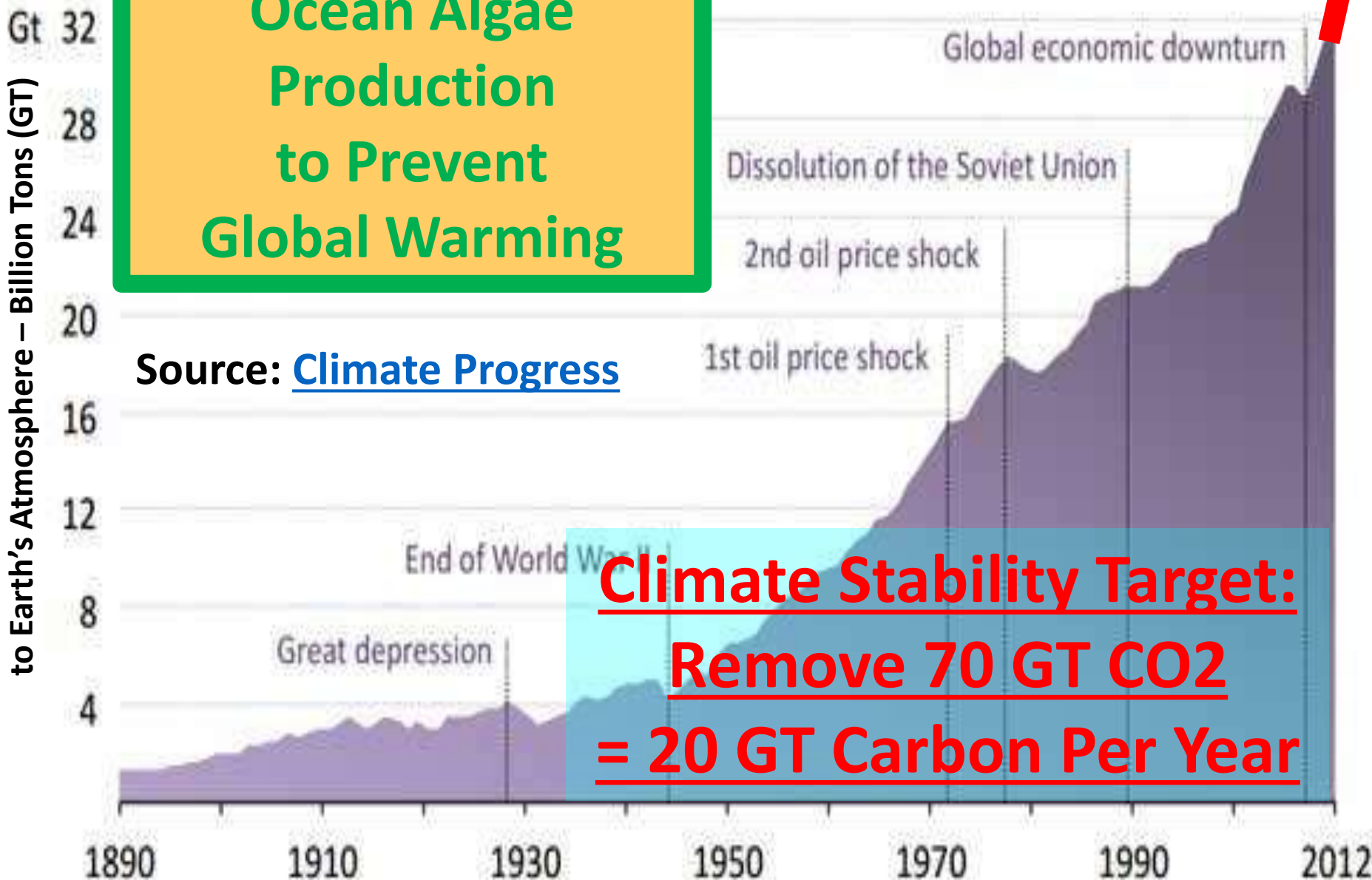
“The EU has not yet looked into the policies needed to hold global warming to 1.5C, [as agreed at the landmark Paris agreement](#), and will ask a UN climate science panel for advice involving “negative emissions” technology. **The EU negotiated at Paris with a mandate for a 2C target but were forced to accommodate more ambitious demands from “the most exposed countries”**, the bloc’s climate chief, Miguel Arias Cañete, said. Several small island states could be swallowed by rising seas if the planet warms by 2C, scientists believe. “For sure, **1.5C is a trajectory of full decarbonisation and will require accelerated strategies** and pathways,” Cañete told a Brussels press conference. Because the emissions cuts pledged in Paris [chart a journey to a world warmed between 2.7-3C](#), the only way many climate scientists can envisage saving smaller island states is with **“negative emissions” technology that sucks carbon out of the air.**”

Global energy-related CO₂ emissions

???



Annual Anthropogenic Addition of Carbon Dioxide to Earth's Atmosphere – Billion Tons (GT)

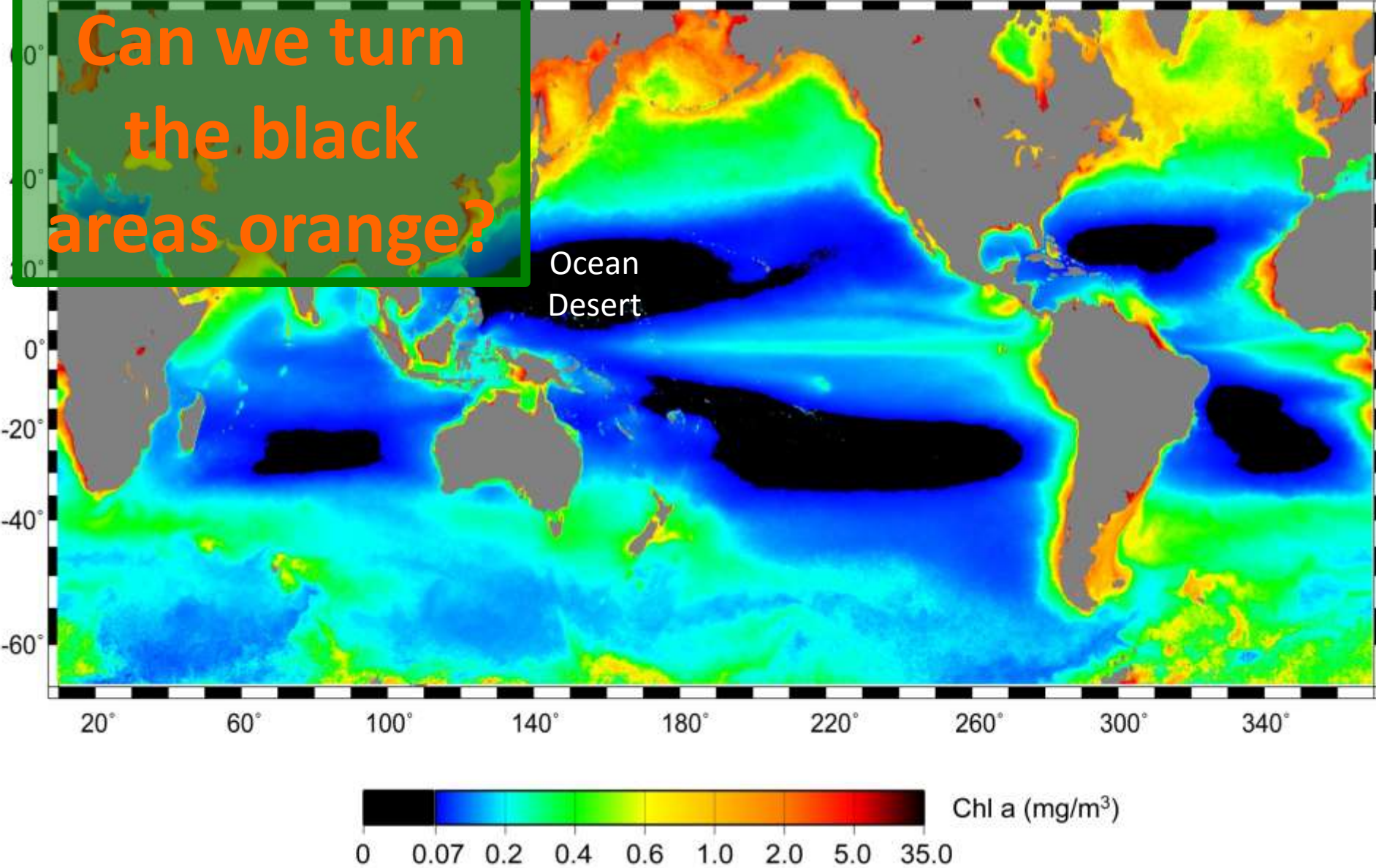


Ocean Algae Production to Prevent Global Warming

Source: [Climate Progress](#)

**Climate Stability Target:
Remove 70 GT CO₂
= 20 GT Carbon Per Year**

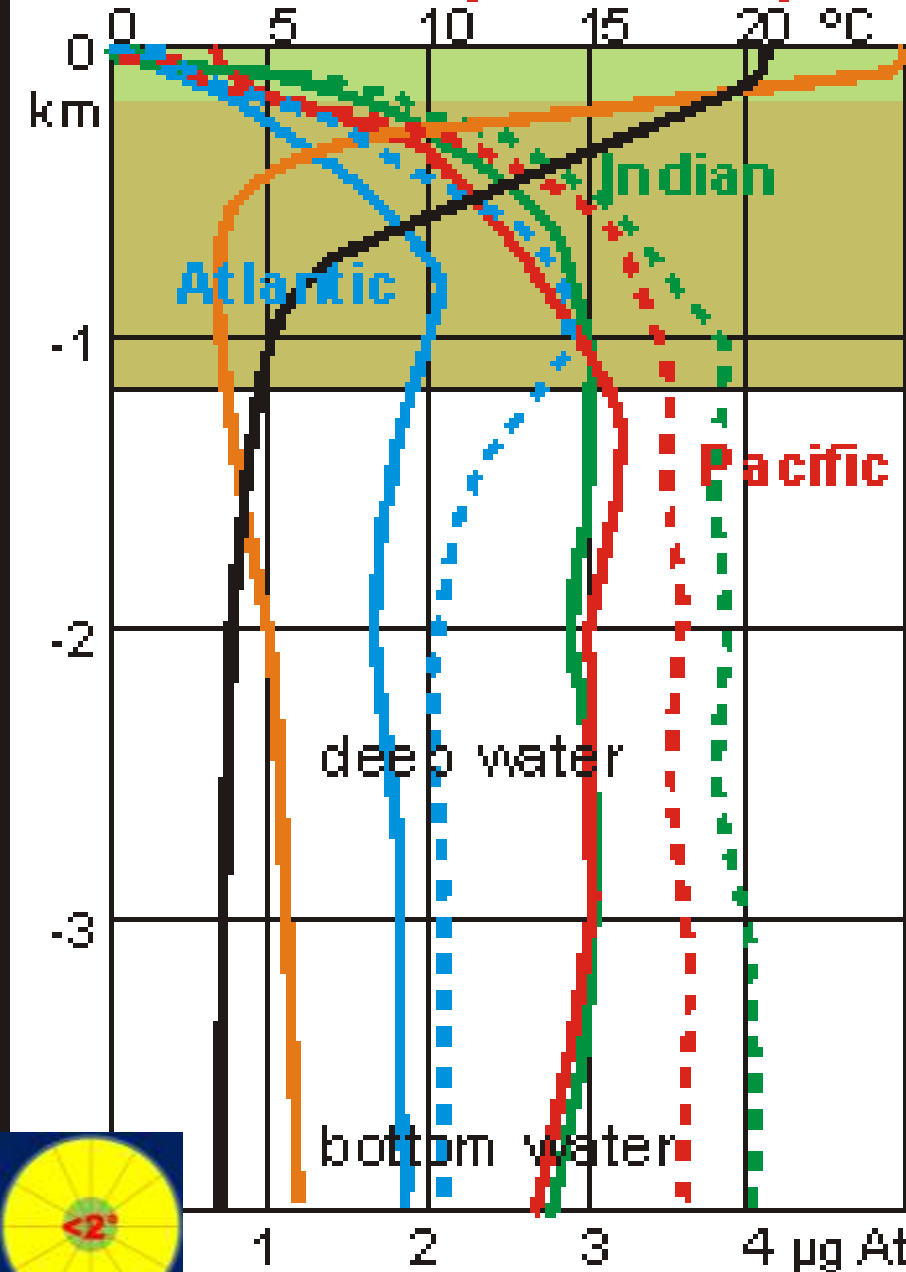




Area of low surface chlorophyll in world ocean 2009
50 million square kilometres and growing



Deep sea temperature, oxygen & nutrients



surface mixed layer 0-150m
 thermocline layer 150-1100m
 oxygen minimum 200-1000m

High-nutrient water from
 1 km deep can be
 pumped to the surface
 by tidal energy as algae
 production feedstock

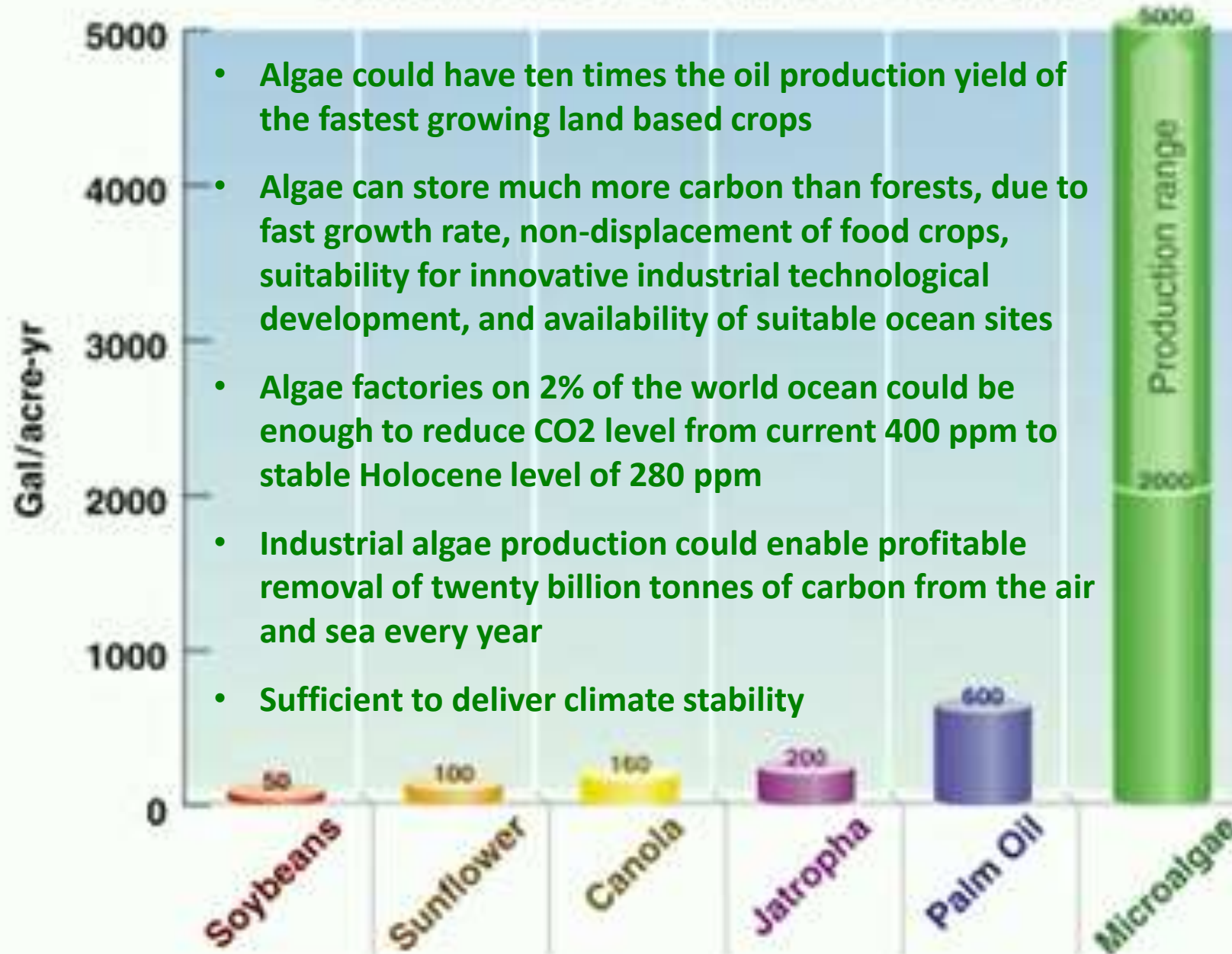
— general oxygen conc. 0-5 mL/L
 — general temperature 3-21°C
 (After Karl K Turekian, Oceans, 1968)

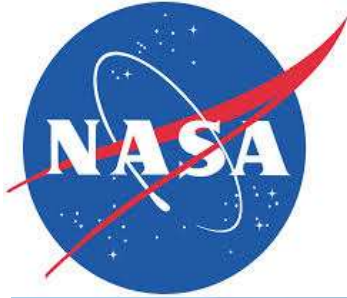
— phosphate PO₄-P µg Atom/Litre
 - - - nitrate NO₃-N µg Atom/Litre

(After Sverdrup, Johnson & Fleming, 1942)



BIODIESEL CROPS AND PRODUCTION





Solar Energy

OMEGA System

NASA Research
Project
Offshore
Membrane
Enclosure for
Growing
Algae

Salt water
Containment

Oxygen

CO₂

Biofuels

Fertilizer

Food

Algae Products

Wastewater

Nutrients/CO₂

wave energy mixing

Temperature Control

Treated Wastewater/CO₂

A scalable solution?



Simple scalable technology for carbon mining

- key to climate stability

“Drawing carbon out of the Earth’s atmosphere and oceans could make a very large difference to our climate future. The most exciting biological options involve the marine environment. Seaweed farms could absorb CO2 efficiently on a large scale.

Analysis [by Ocean Foresters] shows that seaweed farms on 9% of the ocean could:

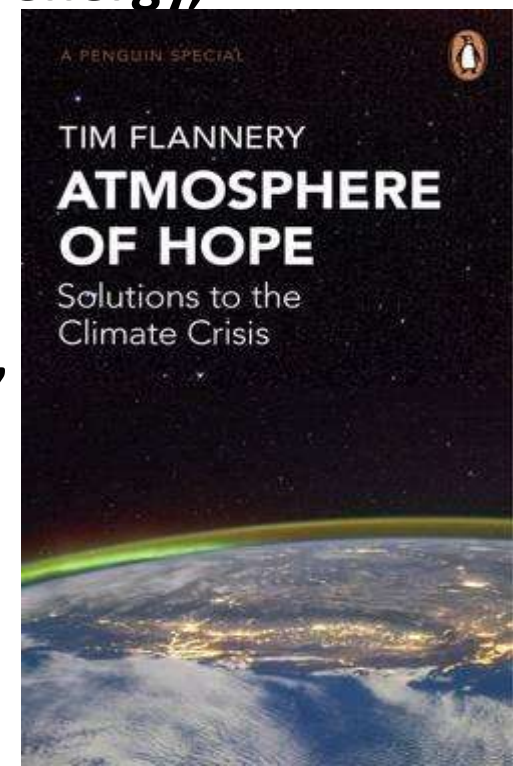
- produce enough biomethane to replace all of today’s needs in fossil fuel energy,
- remove 53 gigatonnes of CO2 per year from the atmosphere
- Produce two billion tonnes of fish per year
- Reduce ocean acidification
- Increase ocean primary productivity and biodiversity.

Many technologies required to achieve this are already in widespread use.”

Climate crisis: seaweed, coffee and cement could save the planet

Tim Flannery, The Guardian, Fri 20 November 2015

Could tidal pumping reduce the 9% estimate?





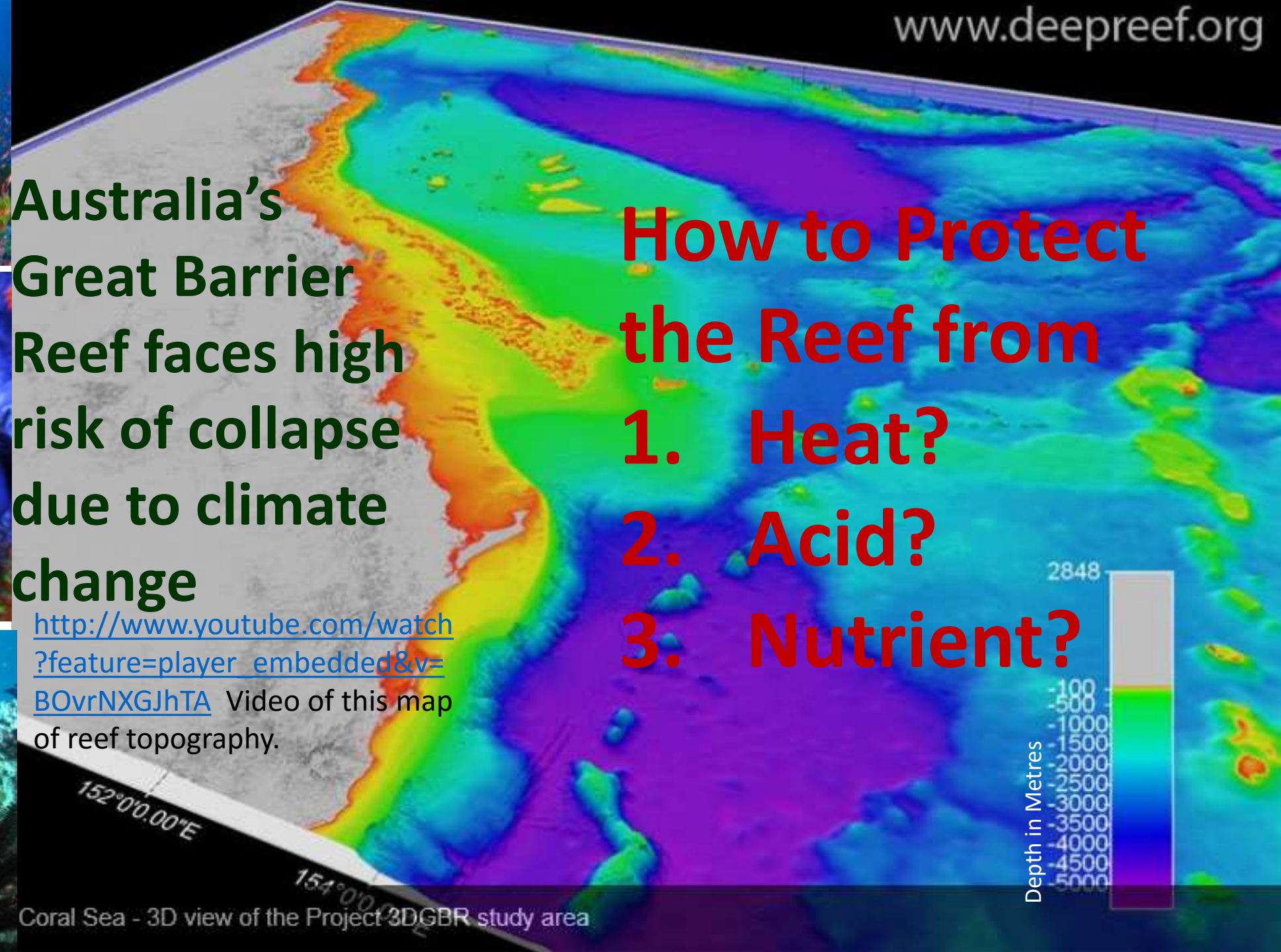
**Australia's
Great Barrier
Reef faces high
risk of collapse
due to climate
change**

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

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

**How to Protect
the Reef from**

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







Coringa-Herald National Nature Reserve & Lihou Reef National Nature Reserve

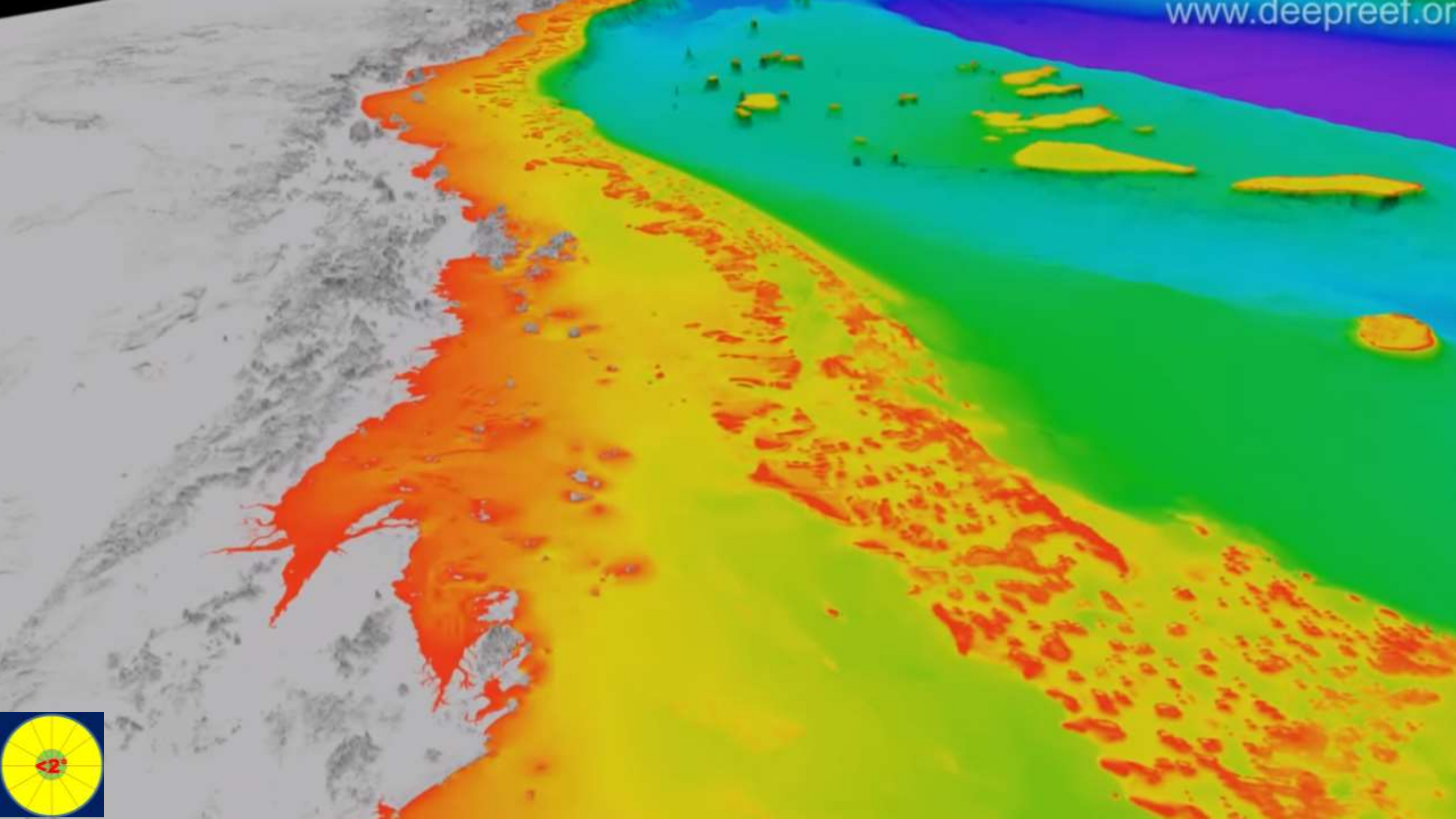
The primary objective of the Coral Sea National Nature Reserves is to maintain ecological processes and systems and to protect the habitats and biodiversity of the Reserves from the pressures associated with human use. As part of this objective the Reserves are assigned by this Plan to IUCN (World Conservation Union) protected area management category Ia — strict nature reserve: a protected area managed primarily for scientific research to ensure habitats, ecosystems, and native species are preserved in as undisturbed state as possible.

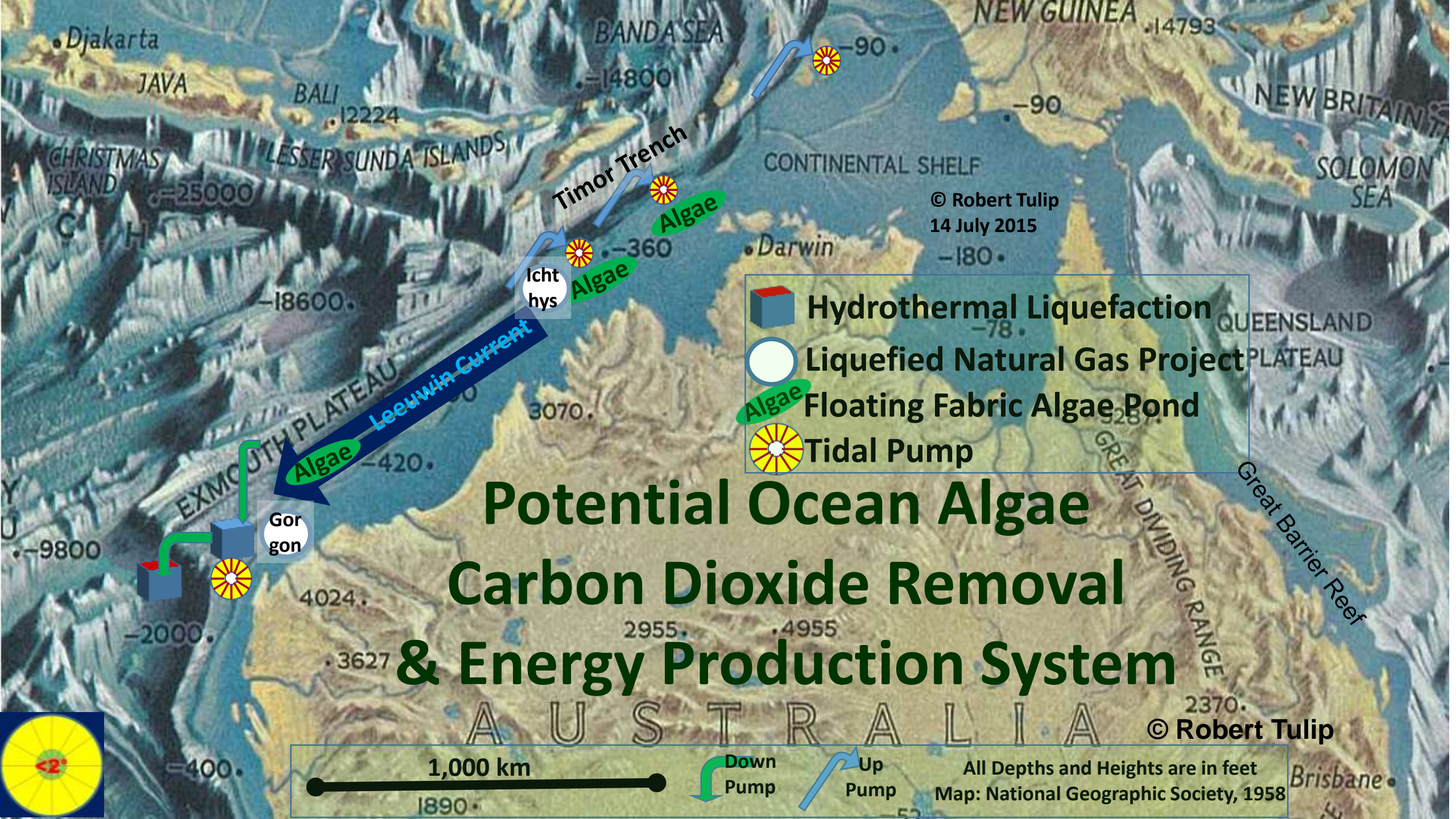


M A N A G E M E N T P L A N

Map Satellite







Djakarta

JAVA

BALI

12224

LESSER SUNDA ISLANDS

CHRISTMAS ISLAND

=25000

C H

-18600.

EXMOUTH PLATEAU

-9800

-2000.

4024.

.3627

=400.

BANDA SEA

=14800

Timor Trench

Algae

-360

Icht hys

Algae

Algae

Algae

Gor gon

3070.

2955.

.4955

A U S T R A L I A

NEW GUINEA

.14793

-90.

-90

© Robert Tulip

14 July 2015

-180.

-78.

QUEENSLAND PLATEAU





GREAT DIVIDING RANGE

Great Barrier Reef

2370.

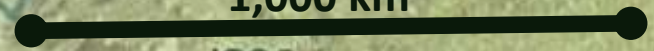
© Robert Tulip

Brisbane

-  Hydrothermal Liquefaction
-  Liquefied Natural Gas Project
-  Floating Fabric Algae Pond
-  Tidal Pump

Potential Ocean Algae Carbon Dioxide Removal & Energy Production System

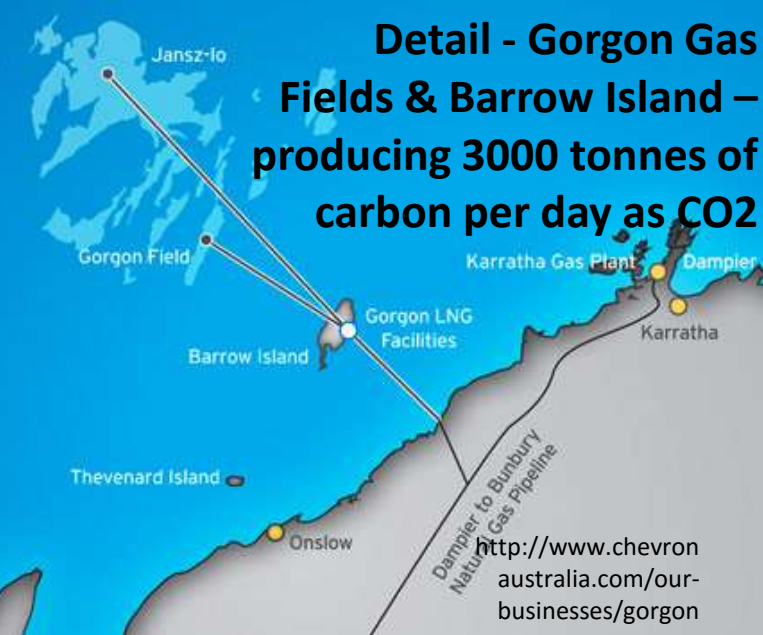
1,000 km



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



Ocean Algae Carbon Dioxide Removal & Energy Production System

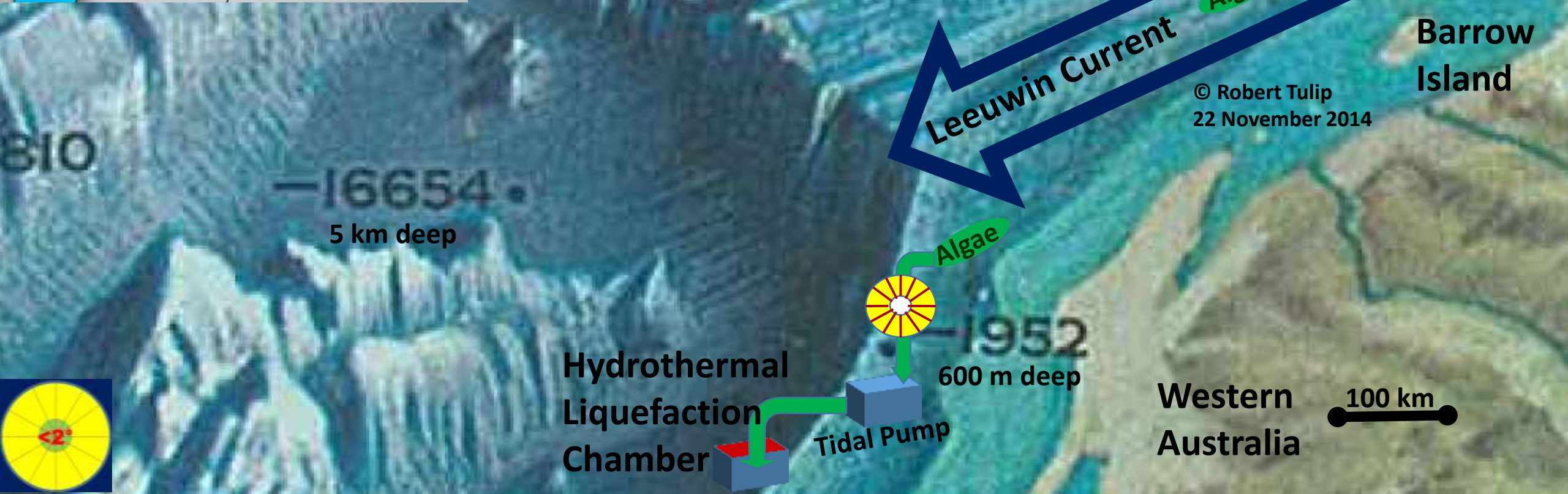


North West Shelf

Barrow Island



© Robert Tulip
22 November 2014



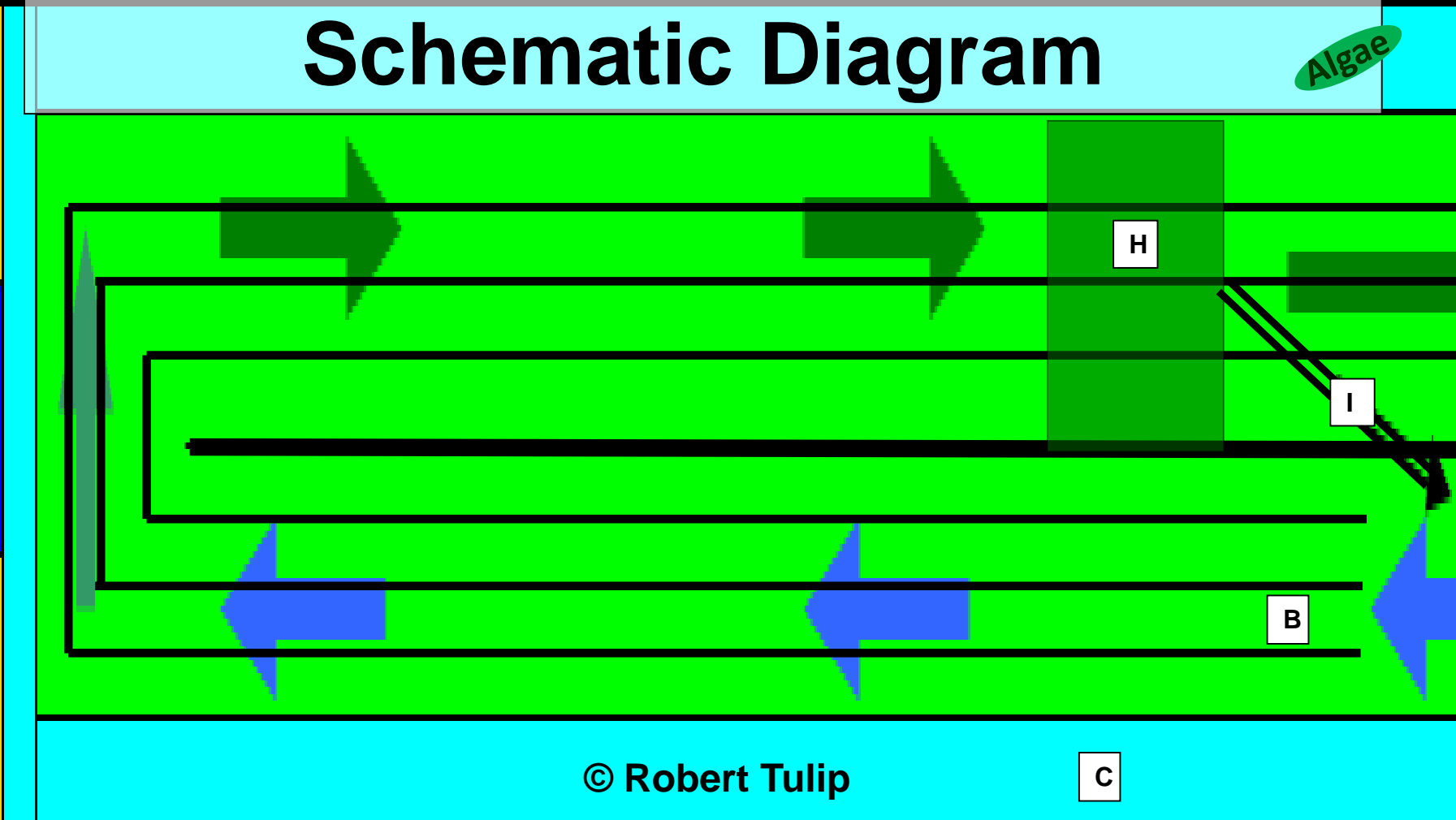
Hydrothermal Liquefaction Chamber

Tidal Pump

Algae



Algae Production System Schematic Diagram



A: Polymer bag containing water and nutrients.

B: Continuous flow algae photobioreactor 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 CO₂ 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.

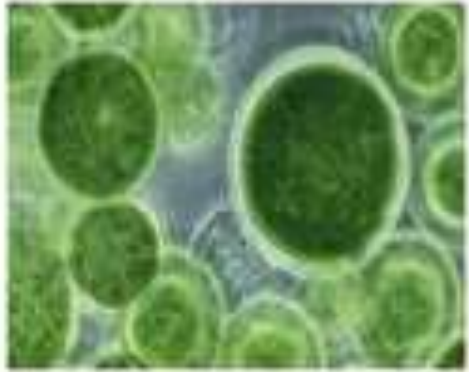
H: Yield Testing Point, diverting most productive track back to inlet.

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



Waste Biomass

Algae



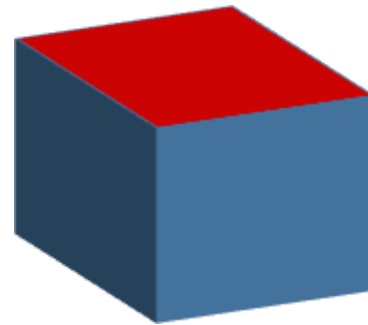
Wood



Sewage



Manure



BioEnergy

Biocrude Oil



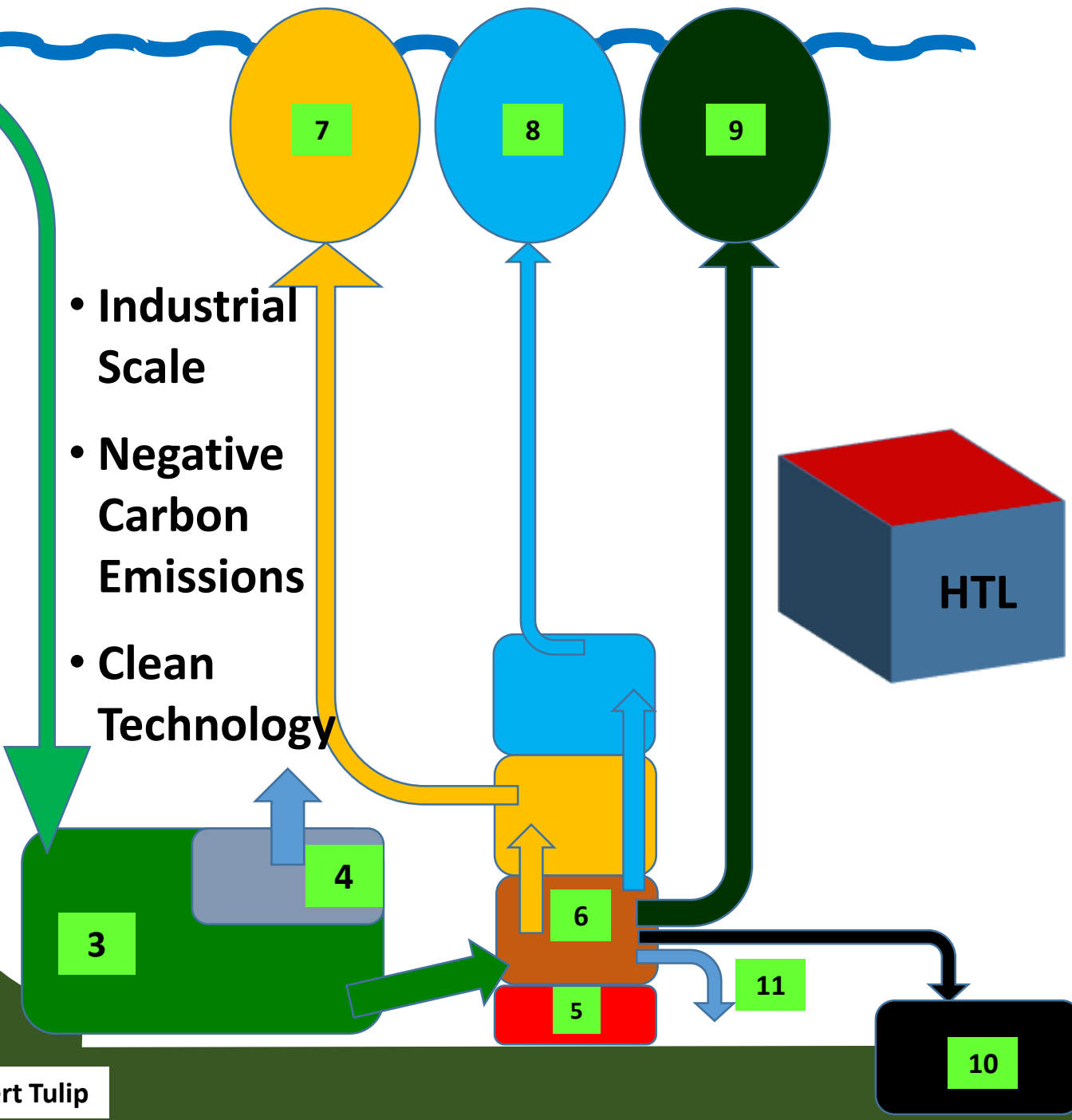
Diagram Source:
University of Illinois at Urbana Champaign
Department of Agricultural and Biological Engineering



Ocean Floor Algae Oil and Gas Production System

Hydrothermal Liquefaction Process

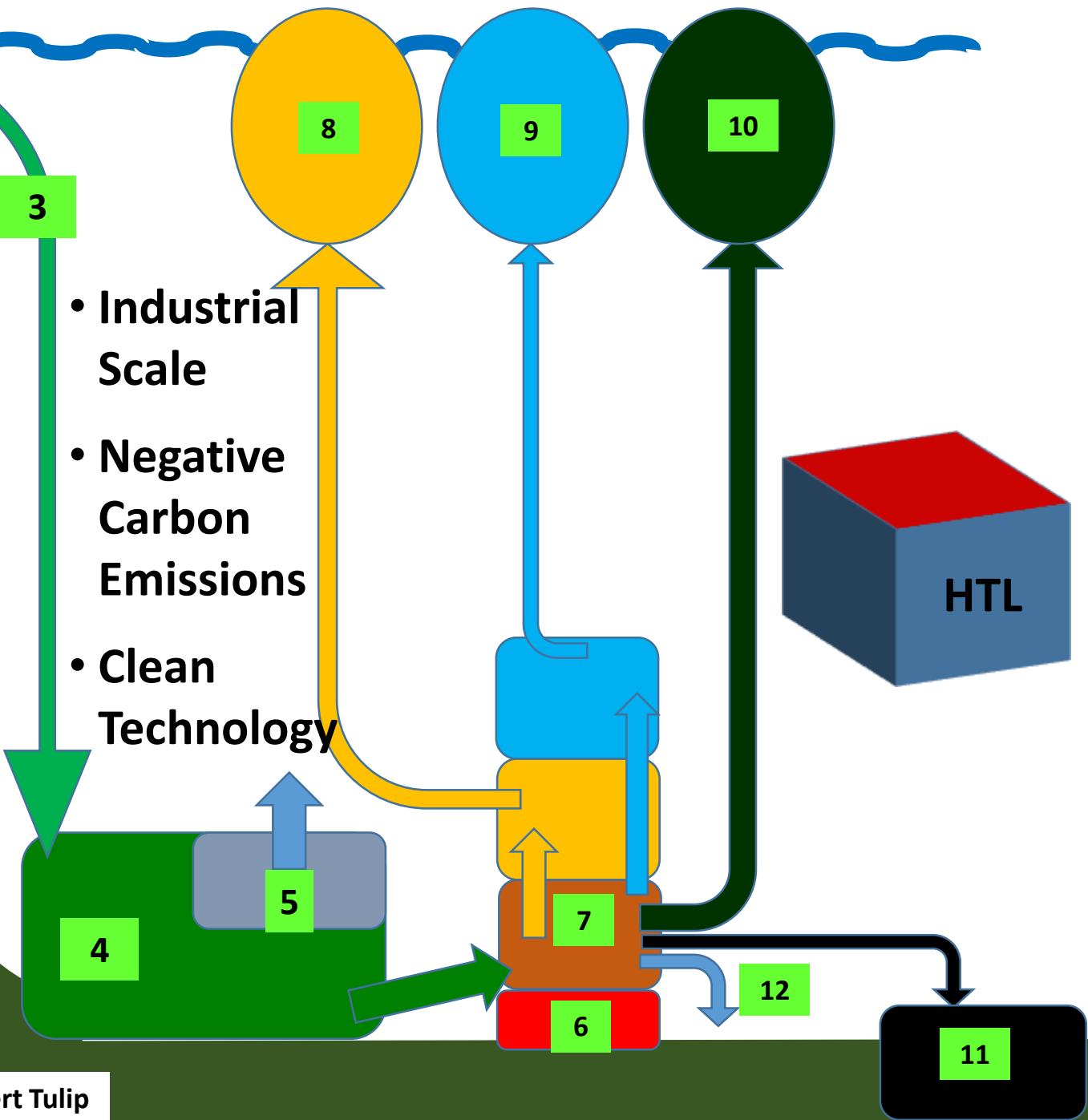
1. Algae Production Chamber on continental shelf
2. Tidal Pump piping algae bloom (1% algae) to ocean floor
3. Settling Tank (~2 km deep)
4. Water Outlet
5. Heat Source (~350° C)
6. Hydrothermal Liquefaction Chamber (~30% algae slurry)
7. Oil
8. Gas
9. Fertilizer/Other
10. Bitumen
11. Water



- Industrial Scale
- Negative Carbon Emissions
- Clean Technology

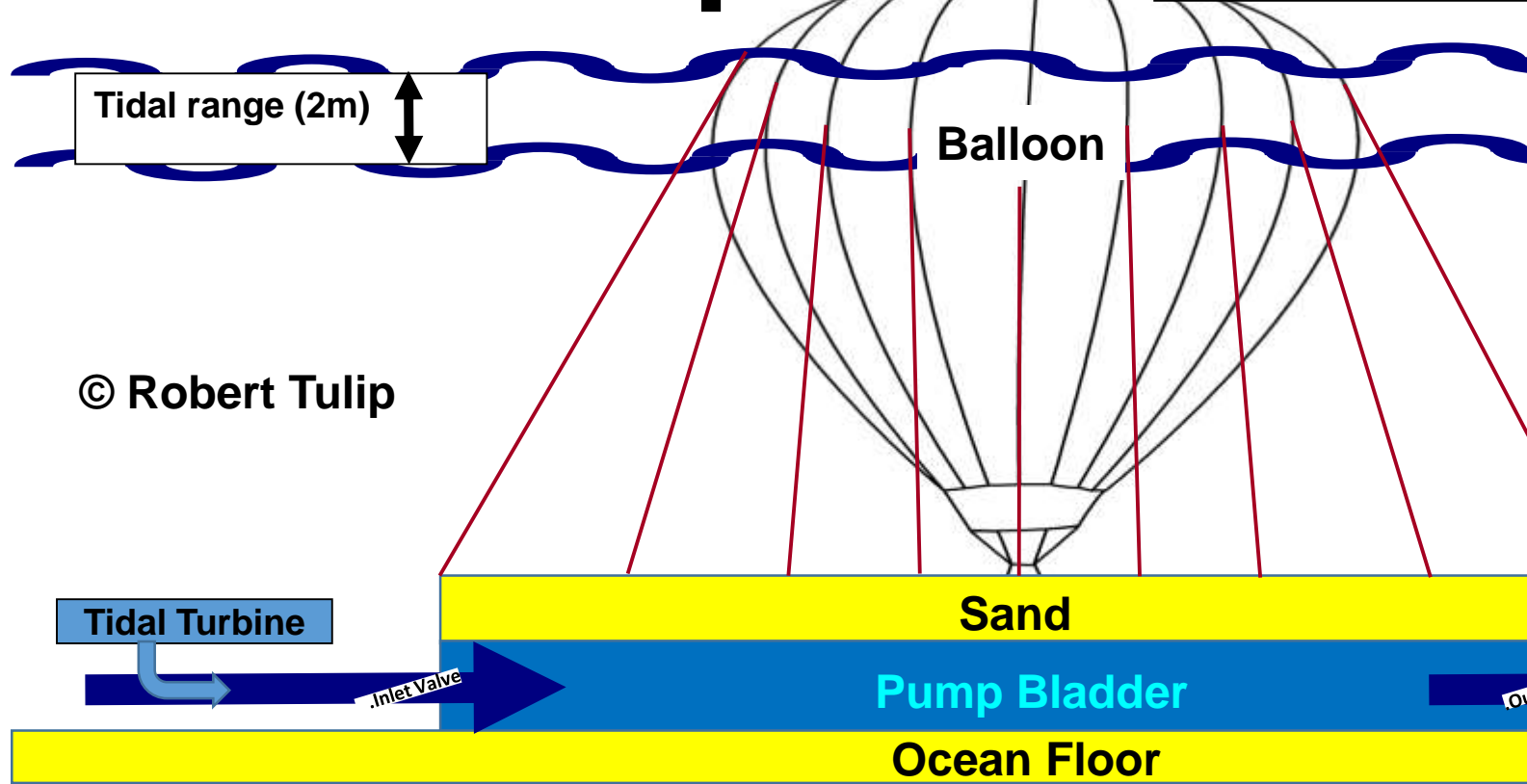
Ocean Floor Algae Fabric Production System

1. Algae Production Chamber on continental shelf
2. Tidal Pump
3. Pipe conveying algae bloom (1% algae) to ocean floor
4. Algae Settling Tank (~2 km deep)
5. Water Outlet
6. Heat Source (350° C)
7. Hydrothermal Liquefaction Chamber (30% algae slurry)
8. Fabric A
9. Fabric B
10. Fabric C
11. Fabric D
12. Water



Tidal Pump

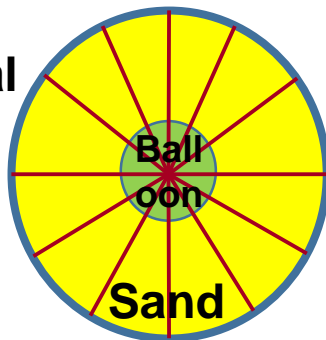
Estimated Annual Capacity 2.7 gegalitres
(50 meter diameter, less friction)



- Falling and rising tide generates pumping energy.
- Sinking sand weight on falling tide empties pump bladder through outlet.
- Rising balloon fills pump through inlet on rising tide.
- Augmented by current and by deflation and inflation of balloon with tide cycle.

© Robert Tulip

Vertical View



50m

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

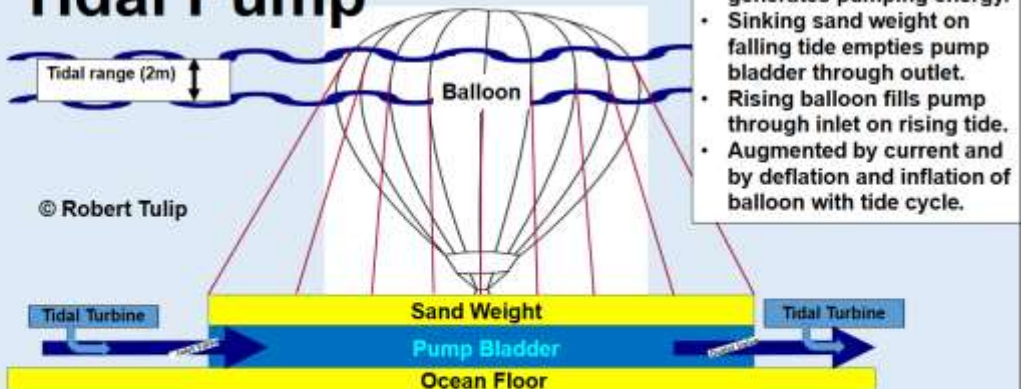


“It always seems impossible until it's done.”

— Nelson Mandela



Tidal Pump



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© Robert Tulip



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