Sol2FaS – Solar Energy to Fuel at Sea

Marinization of Energy Transition

Project idea
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Personal Introduction – Sebastian Schreier

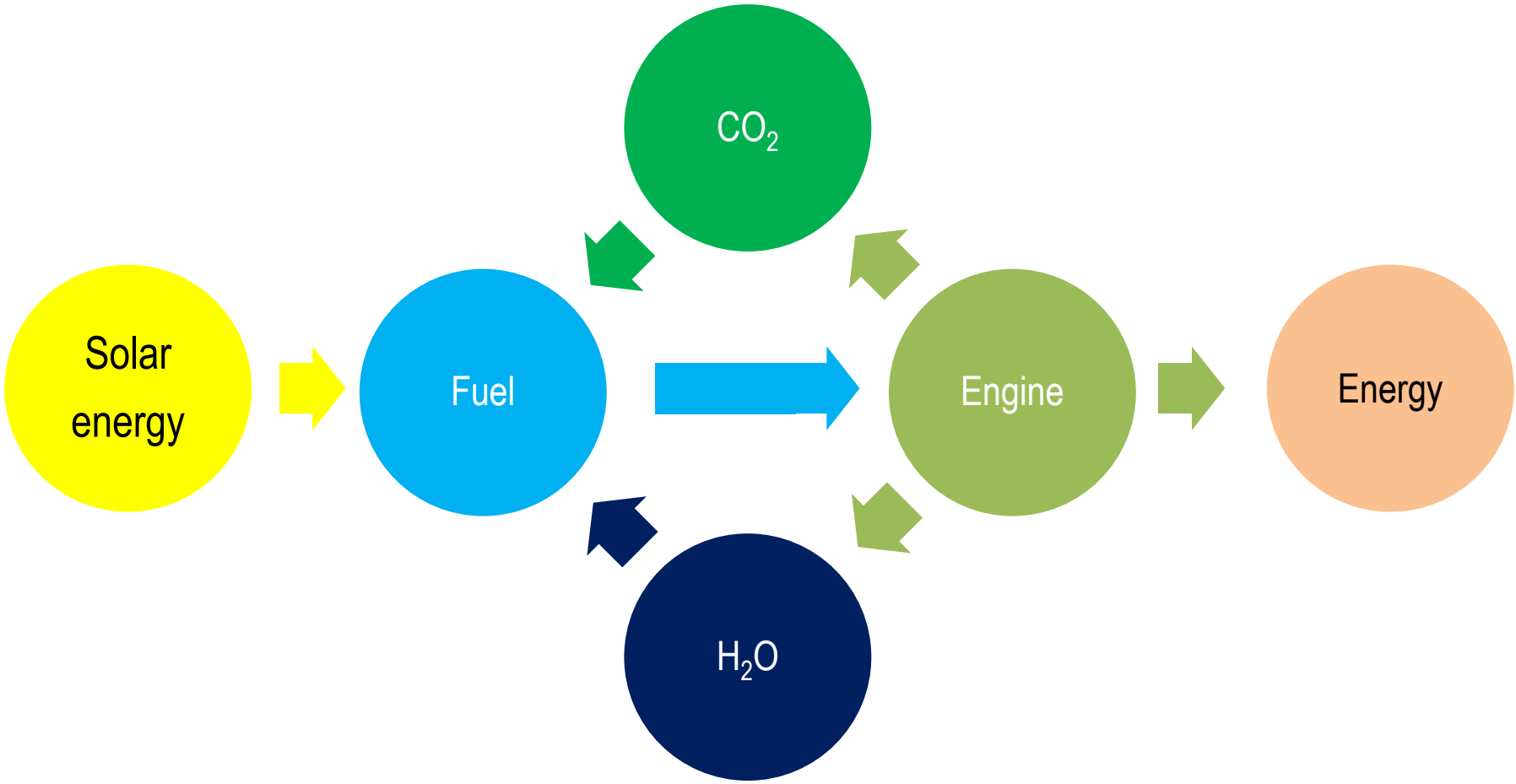
- Diploma (2005) and Doctorate (2009) in Mechanical Engineering from University of Rostock, Germany
  Focus: Naval Architecture and Ocean Engineering
  Liquid Sloshing in LNG Tanks
- 2009 – 2010: PostDoc at Kinki University, Nara, Japan
  Flow around net cages for fish farms
- 2010 – 2016: Senior Research Assistant at Chair of Ocean Engineering, University of Rostock, Germany
  Research in Liquid Sloshing and Teaching
- Since Oct. 2016: Assistant Professor in Ship Hydromechanics at 3mE, TU Delft
  Experimental Research in Fluid-Structure Interaction in (Sloshing) Impacts and Large Floating Structures
  Teaching in BSc & MSc courses

Challenges

Reduce usage of fossil fuels to reduce CO_2 output

Heavy duty transport and renewable energies require high energy density storage

A Perfect Solution



Project Goal – Sol2FaS

Marinization of the Energy Transition

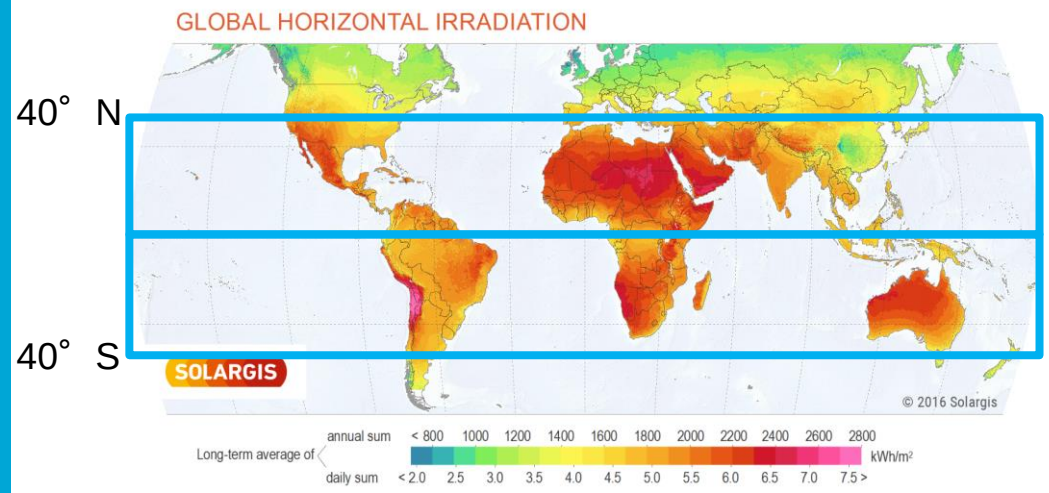
Harvesting solar energy on the open ocean and bringing clean fuel to shore to solve Earth's energy problems

Energy Considerations

Between 40° S and 40° N
→ 64 % earth surface: 0.64 * $510*10^6$ km² = $326*10^6$ km²

Average Global Horizontal Irradiation: 1 600 kWh/m² per year
→ Total solar energy: $522*10^{15}$ kWh per year

World primary energy supply 2014 (iea): $159*10^{12}$ kWh (Factor 3300)



Industrial Scale Example
1 GW conventional power plant
→ 8 TWh/a = 8000 GWh/a energy output
Bold assumption:
For same electric energy output of PV plant
5.3 GWp required → 26.5 km² (@ 0.2 kWp/m²)
10% total efficiency from electric energy to market
→ 265 km² solar panels (16.3 km)², 53 GWp

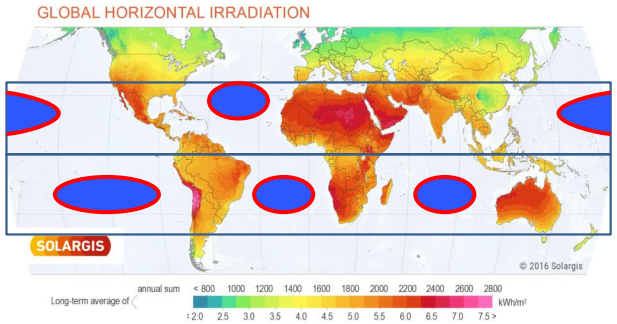
World total photovoltaic cells production capacity
→ 57 GWp per year (2015)

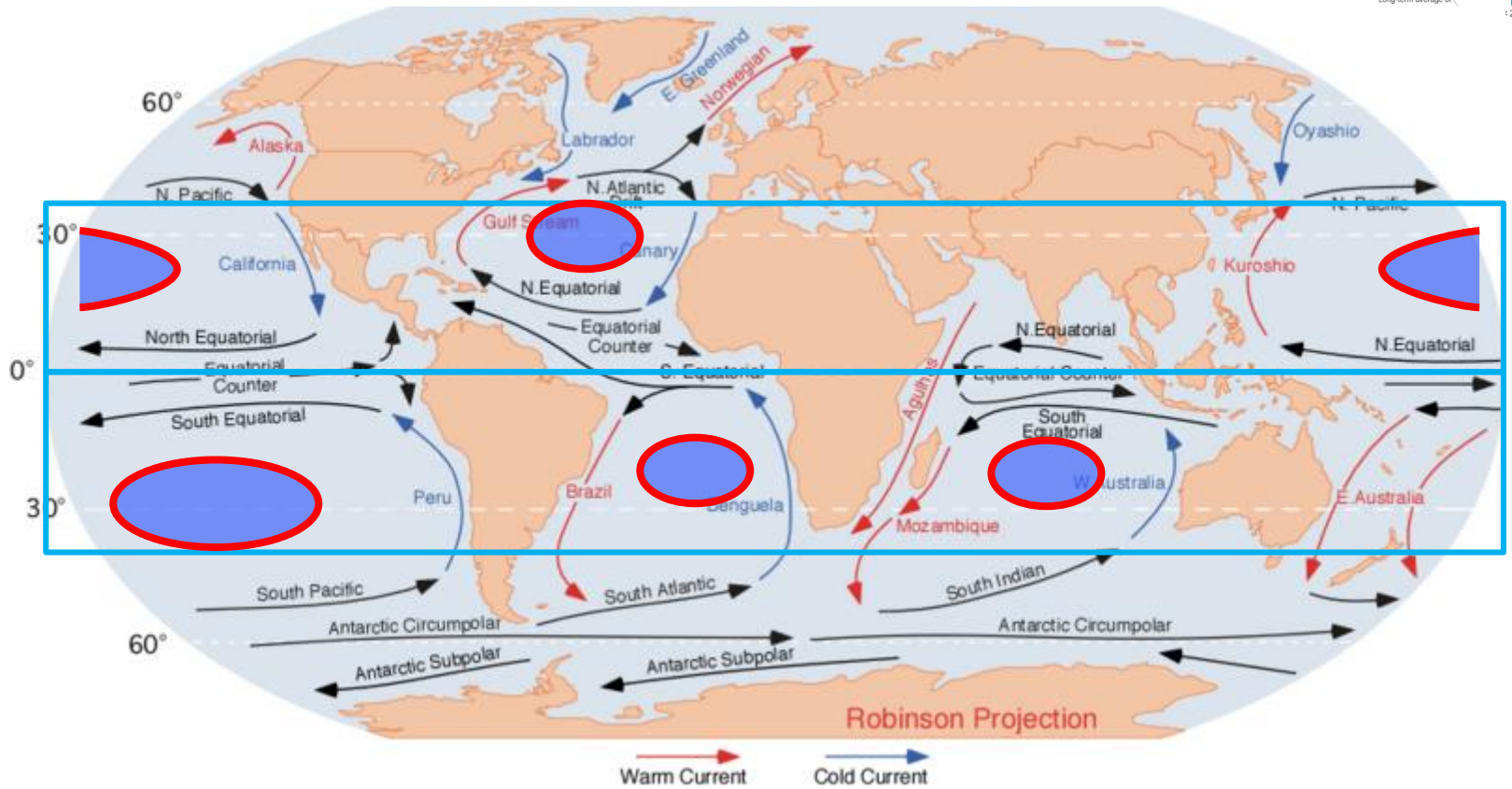
Source: GHI Solar Map © 2016 Solargis,
(http://solargis.com/assets/graphic/free-map/GHI/Solargis-World-GHI-solar-resource-map-en.png, 20161216)
PV cell prodution capacity: Fraunhofer ISE, PHOTOVOLTAICS REPORT, 2016

Ocean Gyres

From floating garbage patches to floating solar farms

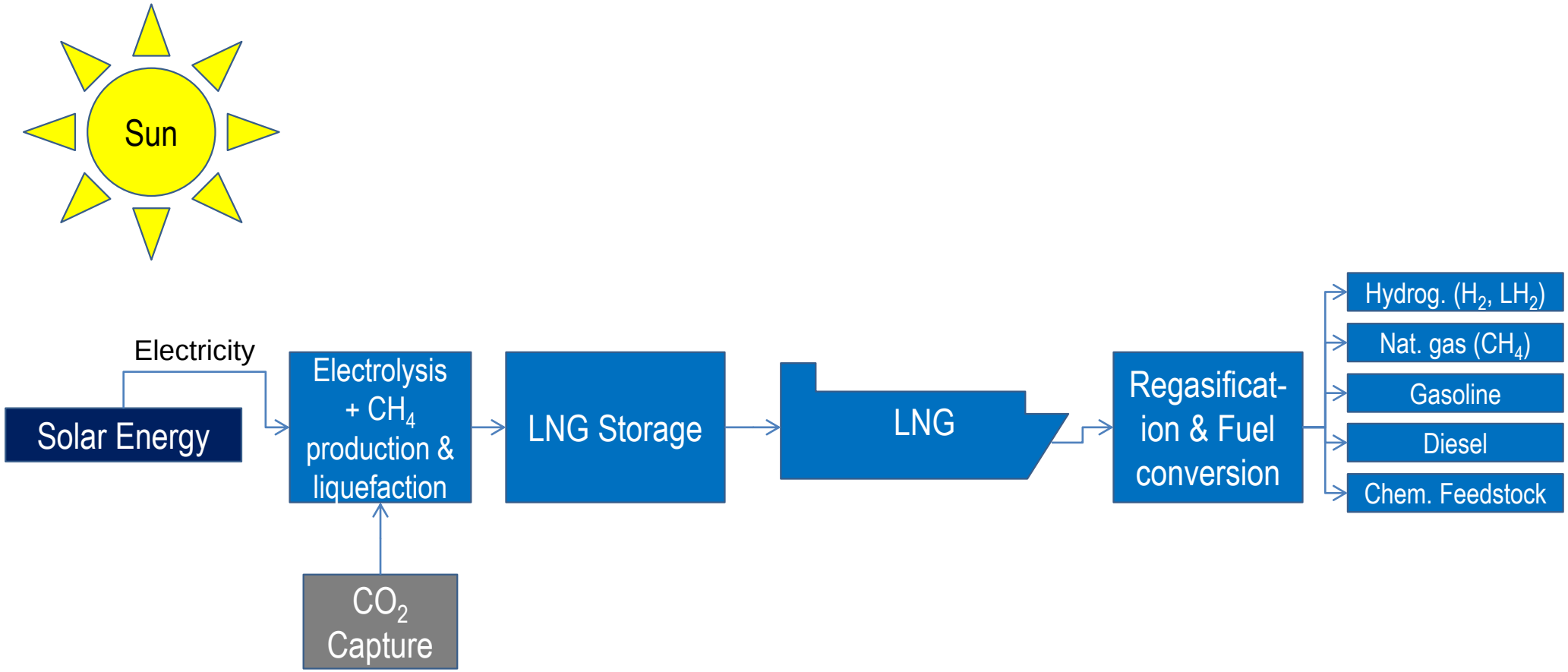
No need for mooring in centre of the great ocean gyres





Source: (large): Pidwirny, https://upload.wikimedia.org/wikipedia/commons/9/9b/Corrientes-oceanicas.png. 20161219
(small): GHI Solar Map © 2016 Solargis, (http://solargis.com/assets/graphic/free-map/GHI/Solargis-World-GHI-solar-resource-map-en.png, 20161216)

In a Nutshell



Benefits

- Energy source that has not been tapped yet
- Clean renewable energy supply
- Ocean space available, less exposed to political instabilities
- Flexible energy supply from baseload application to transport
- Existing energy infrastructure remains in use

- Freely floating (rather simple) structures
- Low maintenance due to solar cells without moving parts
- Integration of floating bunkering stations possible

Major Scientific Challenges

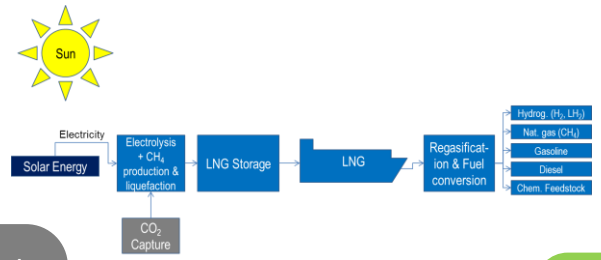
- Sustainable solar energy from large floating structures at sea
- Scale-up & marinization of relevant electrochemical processes
- Motion behaviour and fatigue of large floating structures

Research Areas and Questions

Electrochemical Processes
- Selection of media and processes
- Scale-up of processes
- Marinization of processes

Photovoltaic Cells
- Materials for marine environment
- Increase of conversion efficiency
- Monitoring and maintenance

Energy Storage and Transport
- Transport logistics
- Storage solutions



Legal/Society
- Use of international waters
- Societal impact

CO_2 Capture, Storage and Transport
- capture from atmosphere
- capture from seawater
- Large scale storage and transport

Environment
- Effects of large floating structures
- Benefits and mitigations

Large Free Floating Structures
- Motions and loading
- Structural responses, fatigue
- Construction, maintenance and repair

Invitation

Do you see areas where you can contribute?

Please join us to develop this idea!

Contact

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Next step

- NWO TTW (former STW) proposal with industry and research partner end 2017

Thank You for Your Attention!