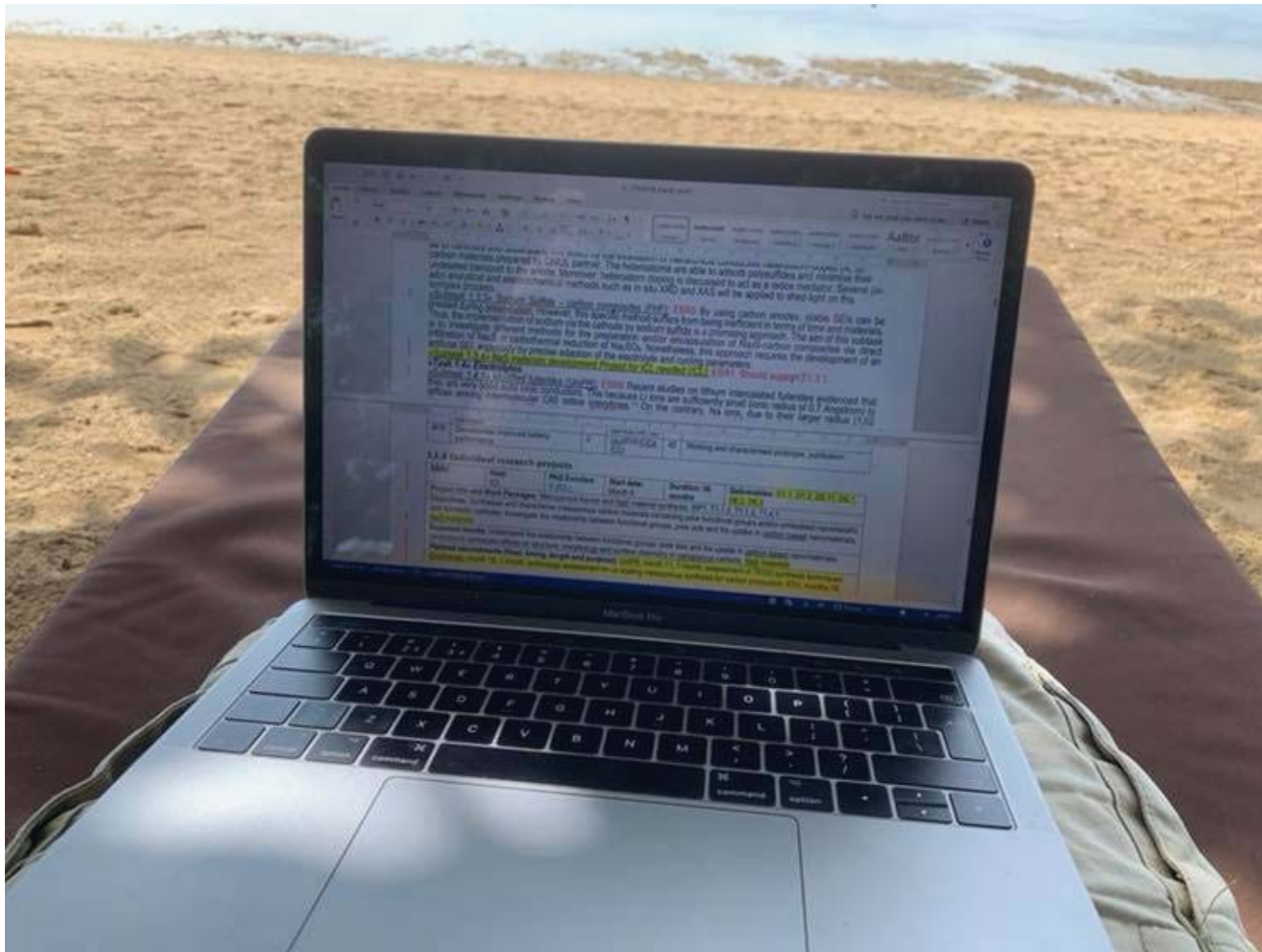


London-Indonesia joint battery project

(plus some solar generation and water purification)

Prof Alan Drew

My first experience of Indonesia....



My second experience of Indonesia....

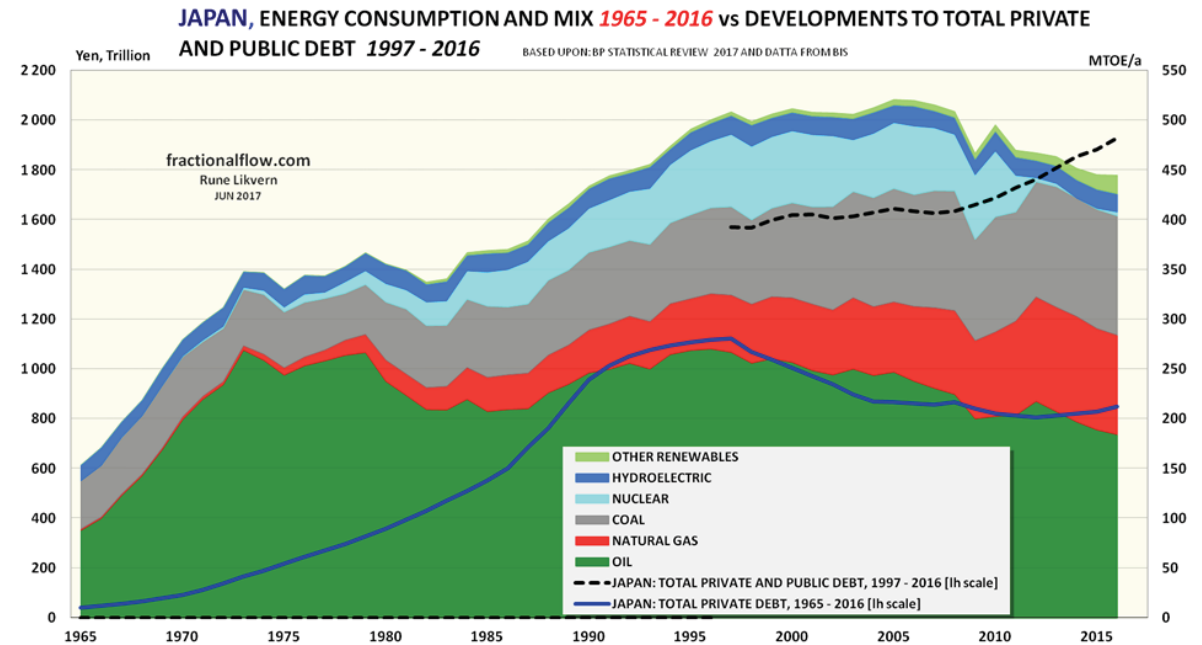
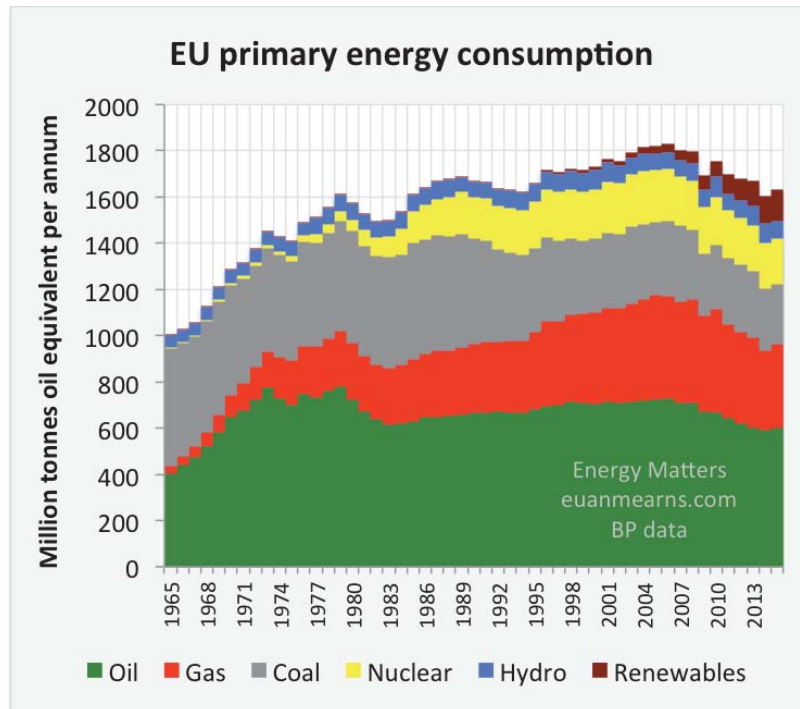


My third experience of Indonesia....



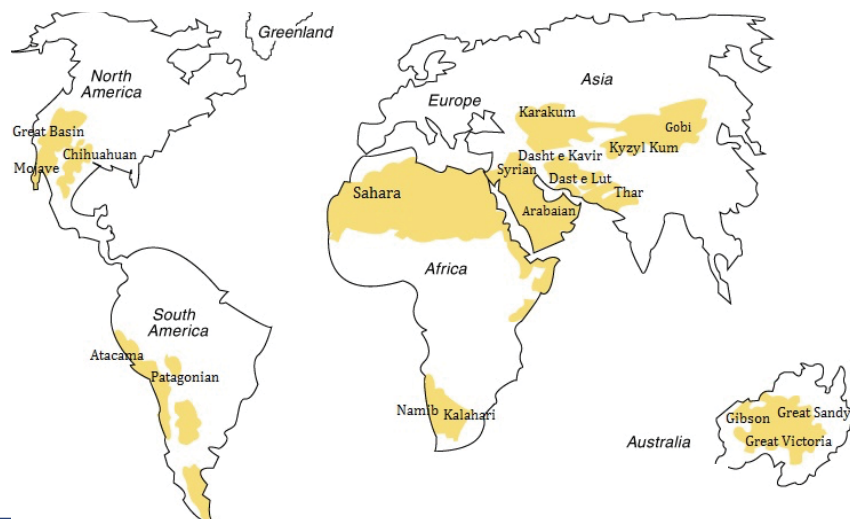
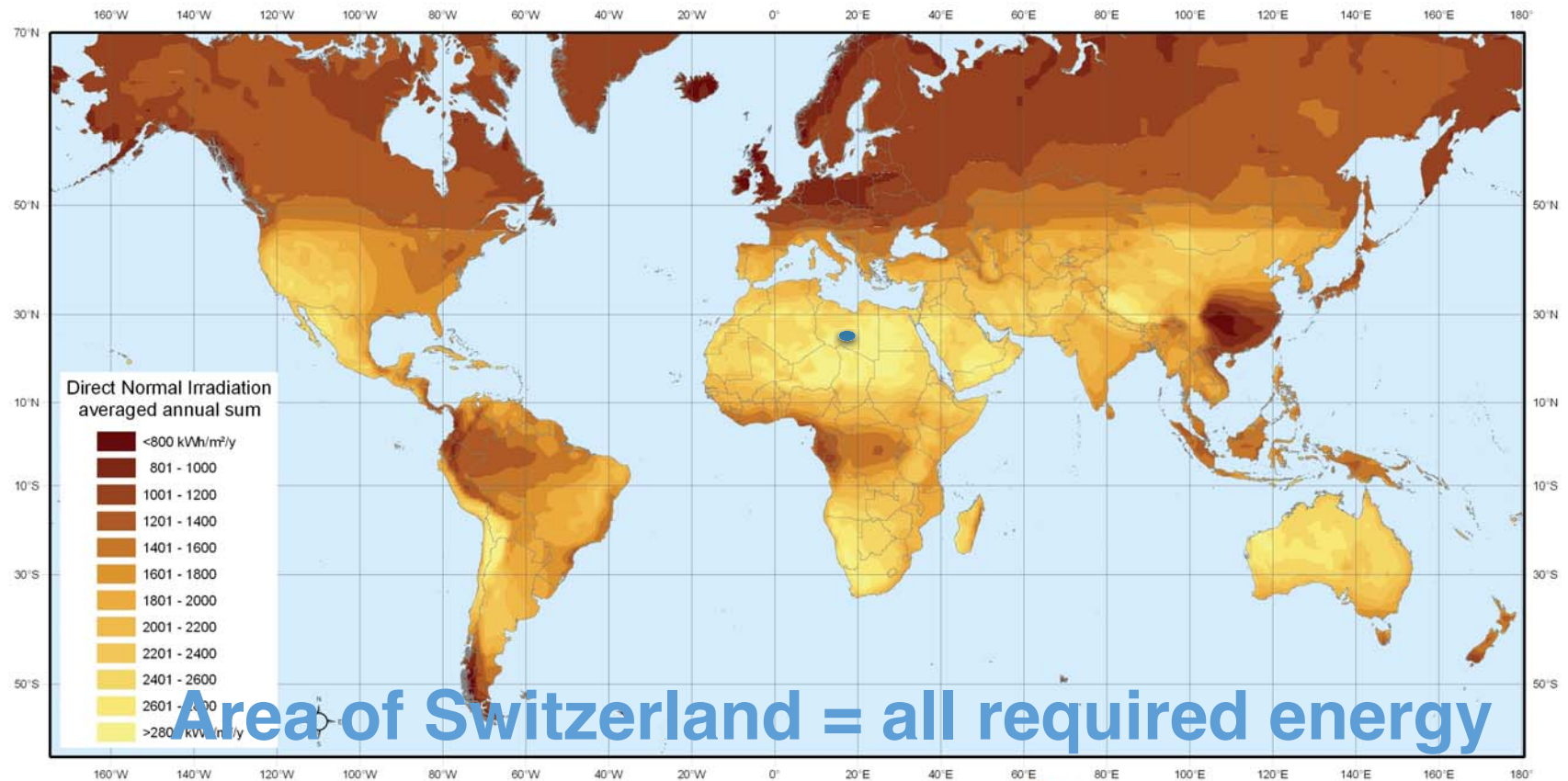
Energy production in the world

The world's energy production



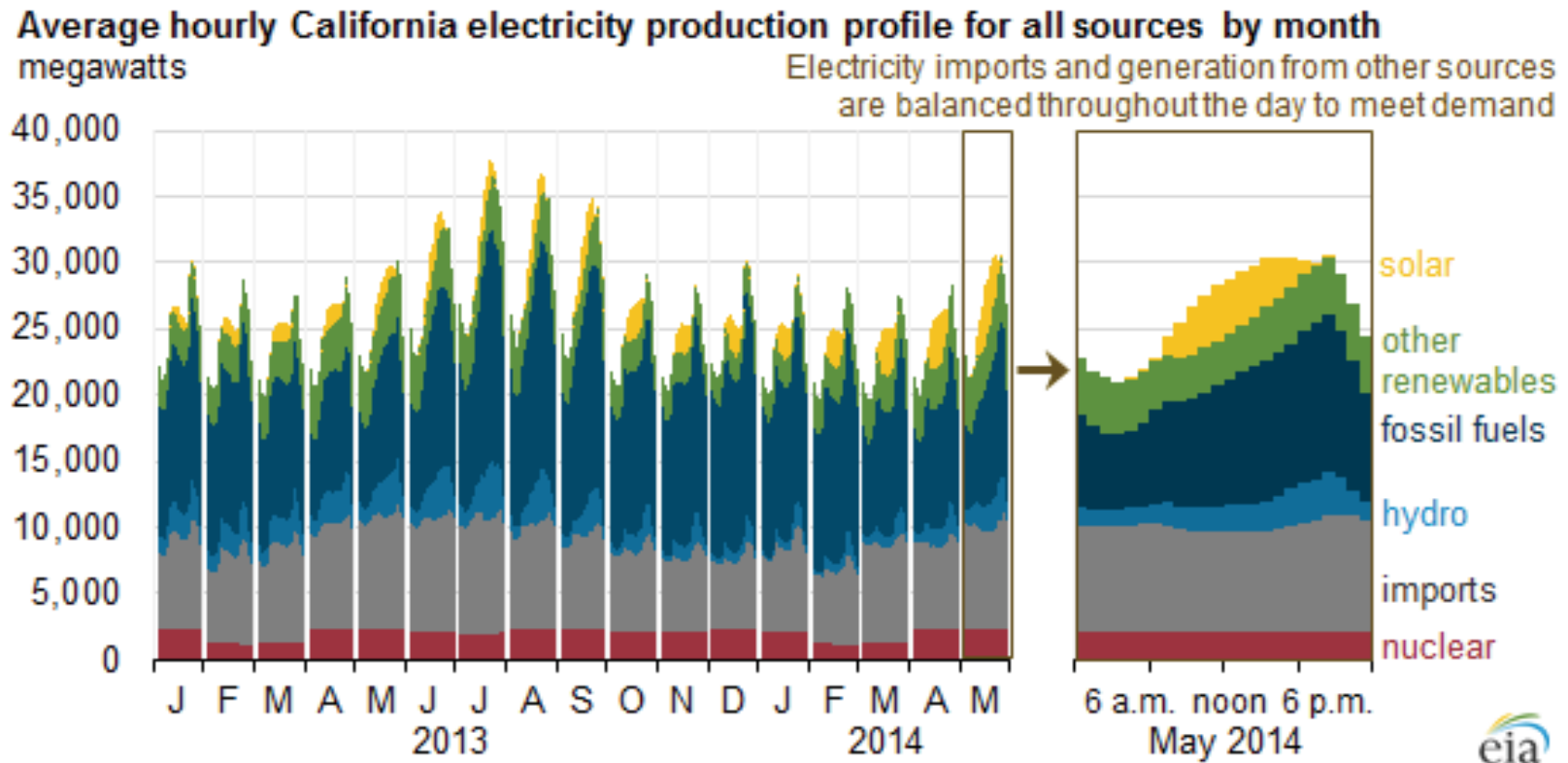
3/4 of the electricity generation comes from fossil fuels
A small proportion from nuclear

Direct Normal Irradiation (DNI)



Solar generation has potential

The details.....



Peak renewable generation: around lunchtime

Peak usage: 7 pm

12 hours of solar generation, 24 hours usage

We need a way of storing solar generation!

Tesla - the most expensive car in the world...



Caught fire October
2013 in Seattle

Tesla Motor Company
shares plunged by
\$600M



NATIONAL FIRE PROTECTION ASSOCIATION

The leading information and knowledge resource on fire, electrical and related hazards

“U.S. fire departments responded to an estimated average of **152,300** automobile fires per year in **2006-2010**.”

9

Safety aside.....

My Kia Carens

To drive 800 km:

45 kg of diesel

2 kg of fuel tank

5 minutes to refuel



2. We need better batteries!

Nissan Leaf

To drive 160 km:

1 kg cell

192 cells

190 kg battery

fast charging (80%) = 30 minutes

To drive 800 km = 3 hours of charging



10

Korean cars are not better than Japanese cars

And the supply of the raw materials?

Energy use for battery manufacturing with is ~500 MJ/kWh battery.
150-200 kg CO₂/kWh battery

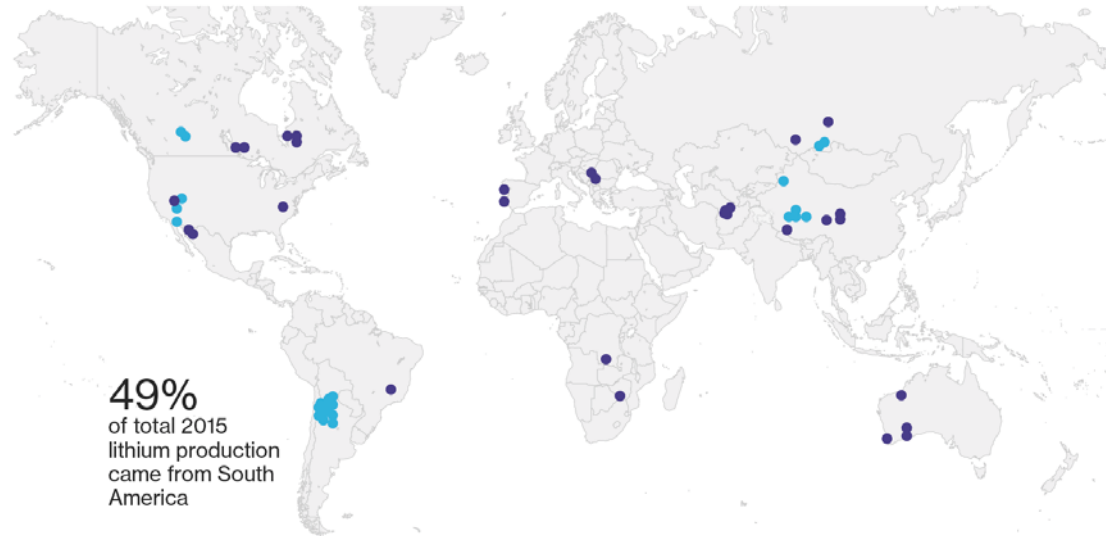
Li: extracted from a limited number of countries (Argentina, Chile, Bolivia)

Co: shortages of natural resource (limited number of countries, also S America), extracted from rock (environmentally damaging)

Cu: Used as an electrode/current collector. High energy demands to extract.

Graphite: Natural graphite from mines (45%) and synthetic graphite from petroleum coke

Major lithium deposits by type
● Brine ● Hard rock



11

We need more environmentally friendly batteries!

Na batteries

AI current collectors (less energy needed for production)

Na ions are everywhere, and easy to extract

~~Li: extracted from a limited number of countries (Argentina, Chile, Bolivia)~~

~~Co: shortages of natural resource (limited number of countries, also S America), extracted from rock (environmentally damaging)~~

~~Cu: Used as an electrode/current collector. High energy demands to extract.~~

~~Graphite: Natural graphite from mines (45%) and synthetic graphite from petroleum coke~~



Major lithium deposits by type
● Brine ● Hard rock

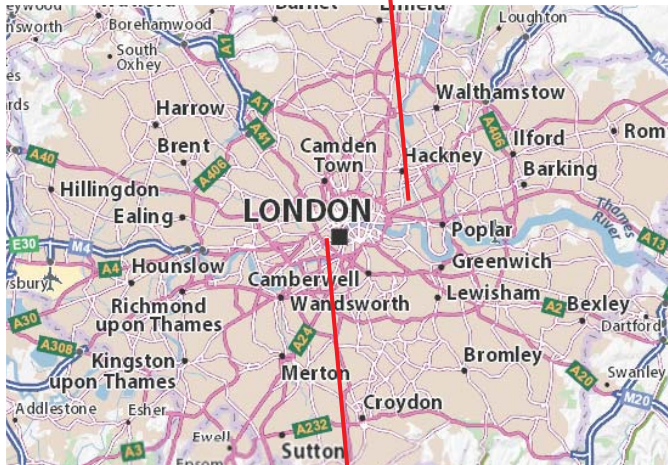


Sodium-ion based systems have the potential to provide energy at \$23/kWh/annum, less than half the cost of lithium-ion batteries.



UK-Indonesia collaboration

Our proposal



Imperial College
London



UNIVERSITAS
INDONESIA
Veritas, Probitas, Iustitia
EST. 1849

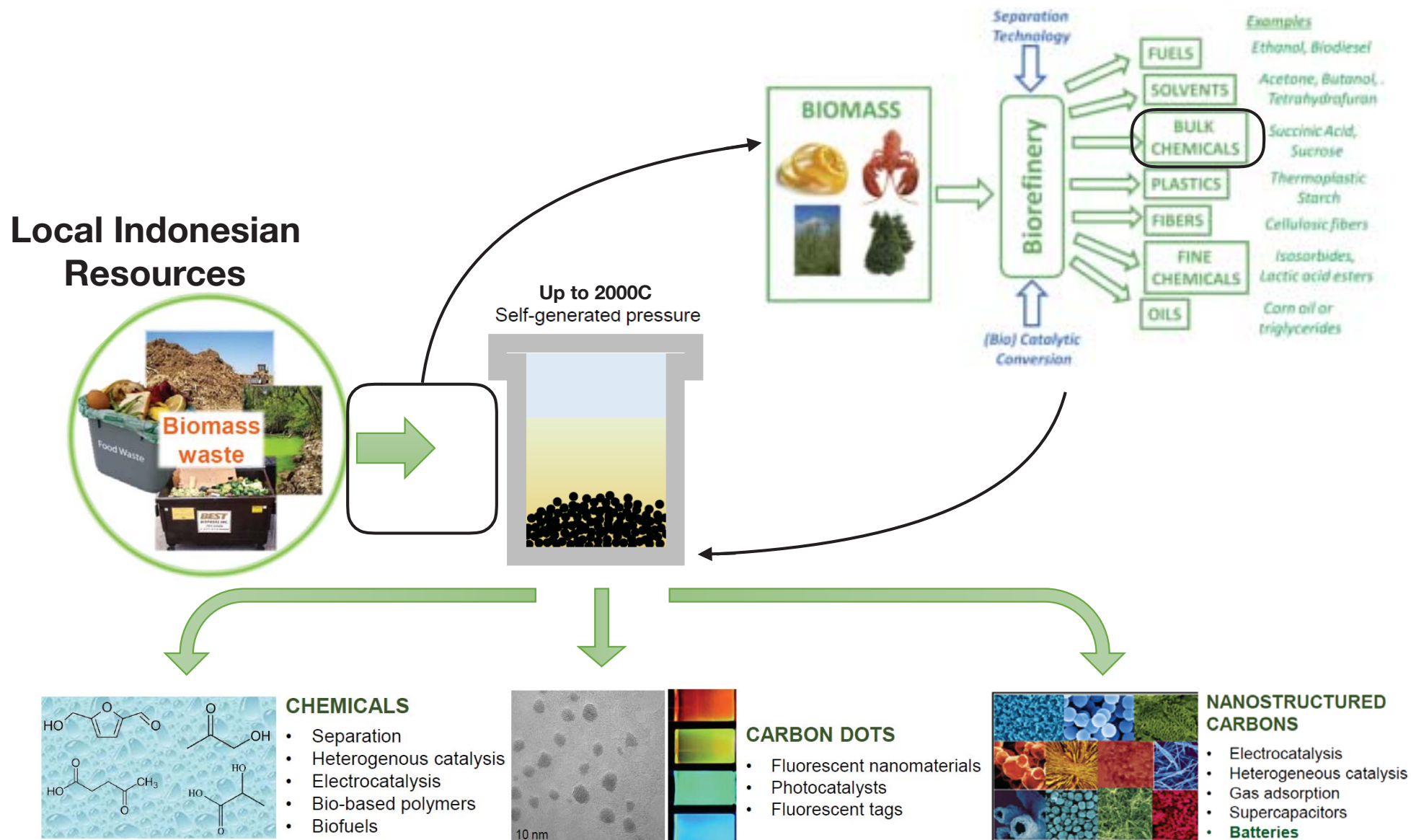


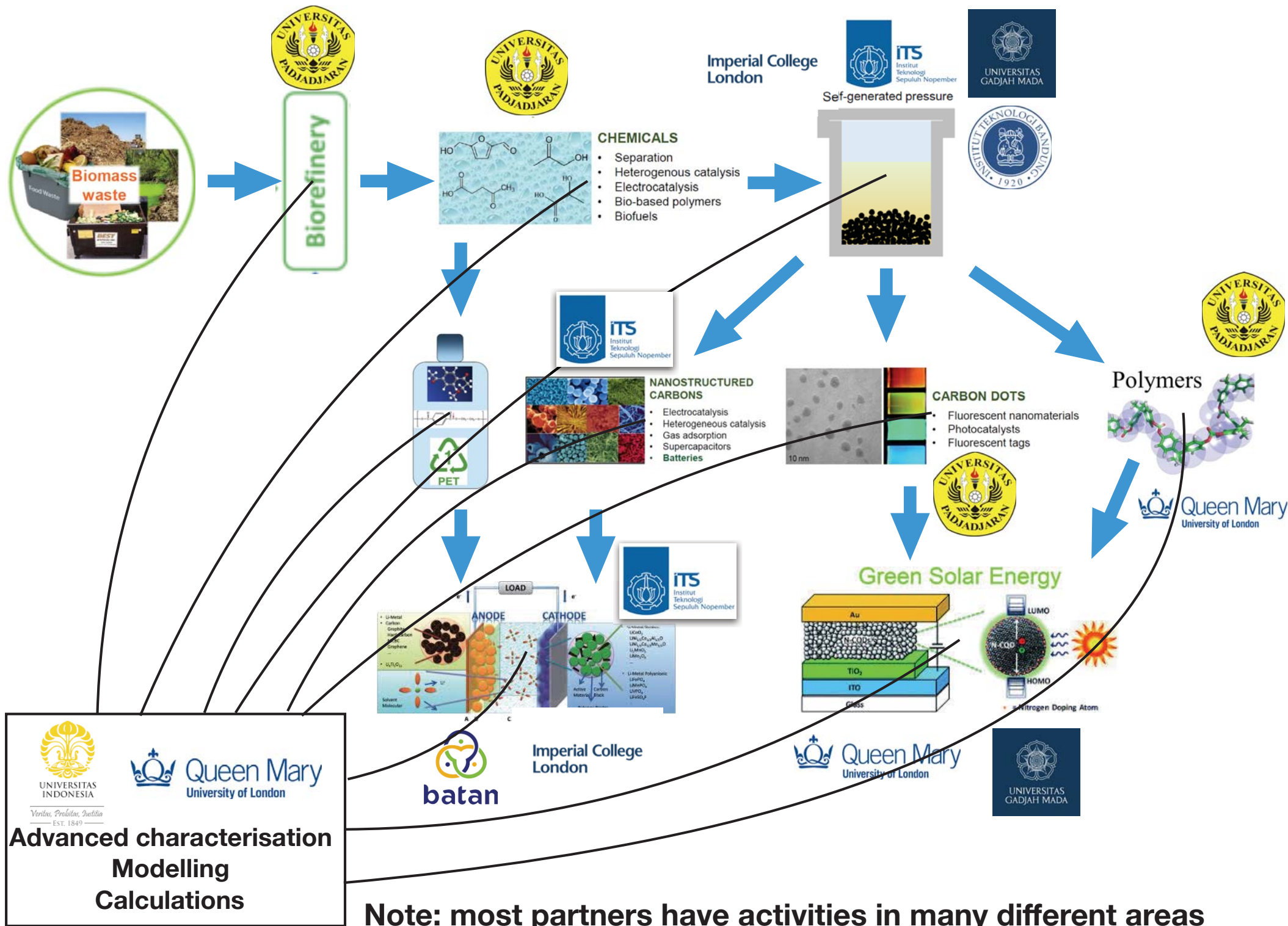
batan



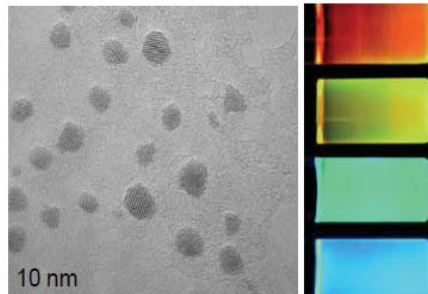
ITS
Institut
Teknologi
Sepuluh Nopember

Our proposal





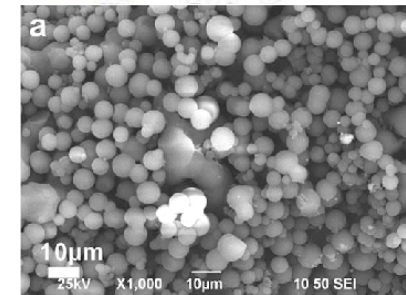
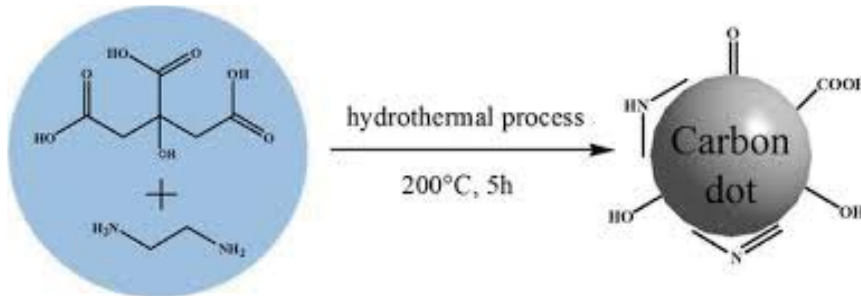
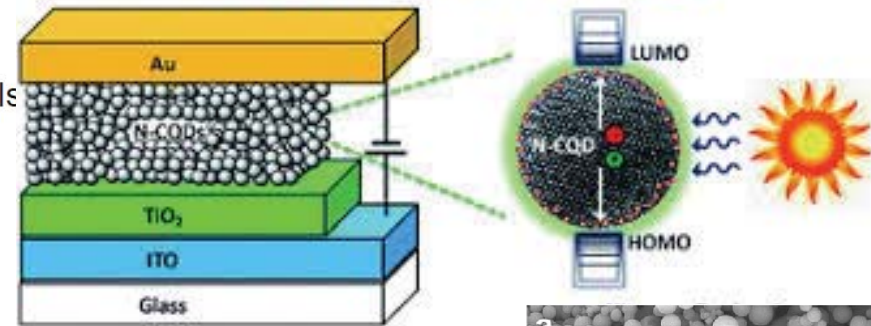
Solar cells



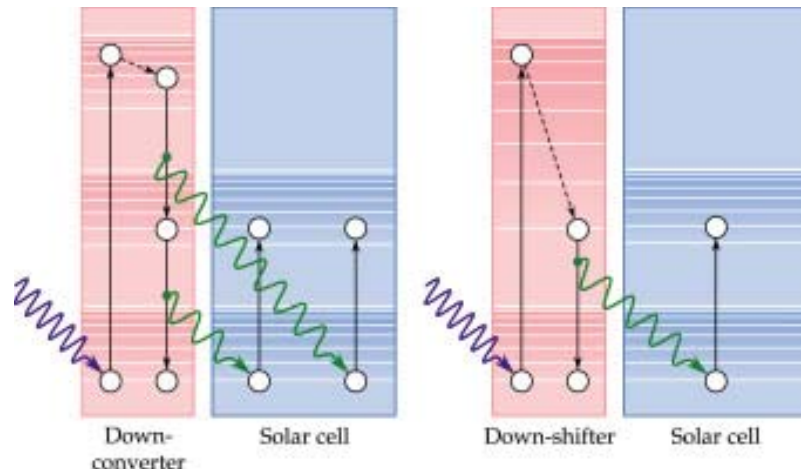
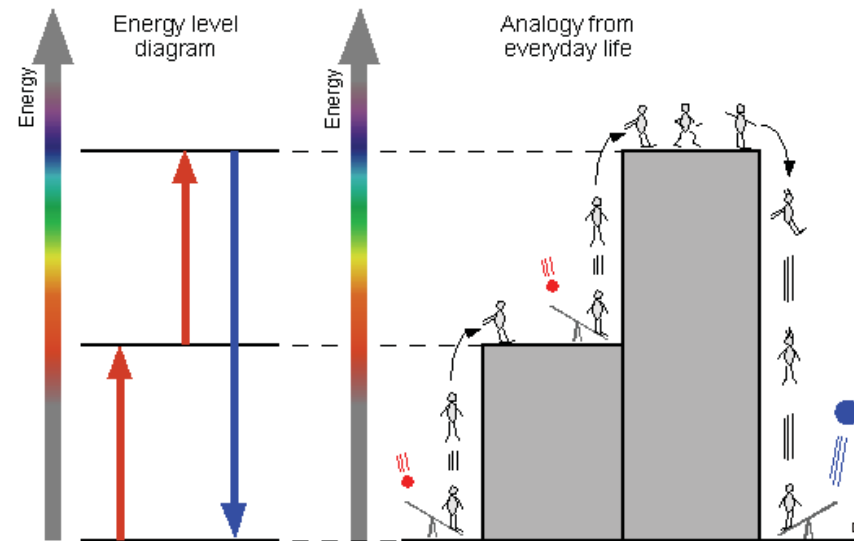
CARBON DOTS

- Fluorescent nanomaterials
- Photocatalysts
- Fluorescent tags

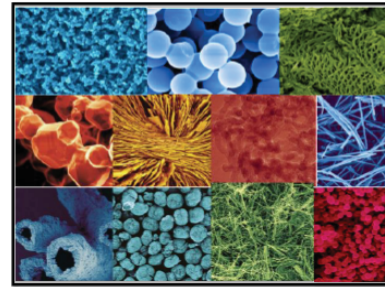
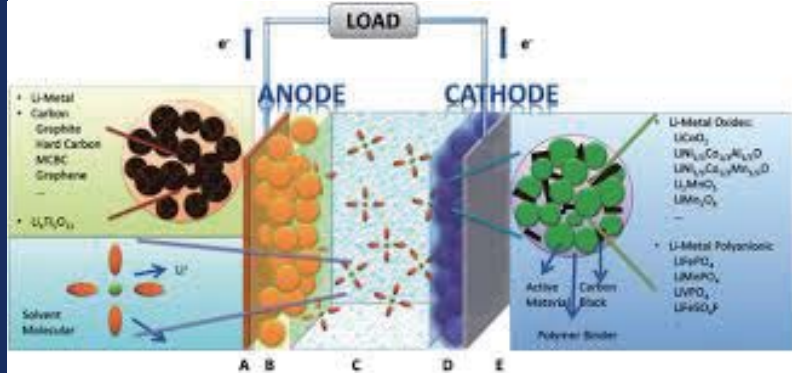
Green Solar Energy



Upconversion Making 1x blue out of 2x red



Na/Li ion battery anodes



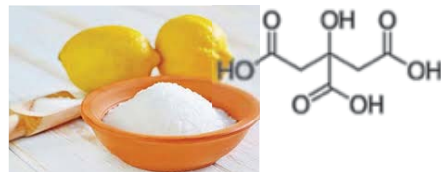
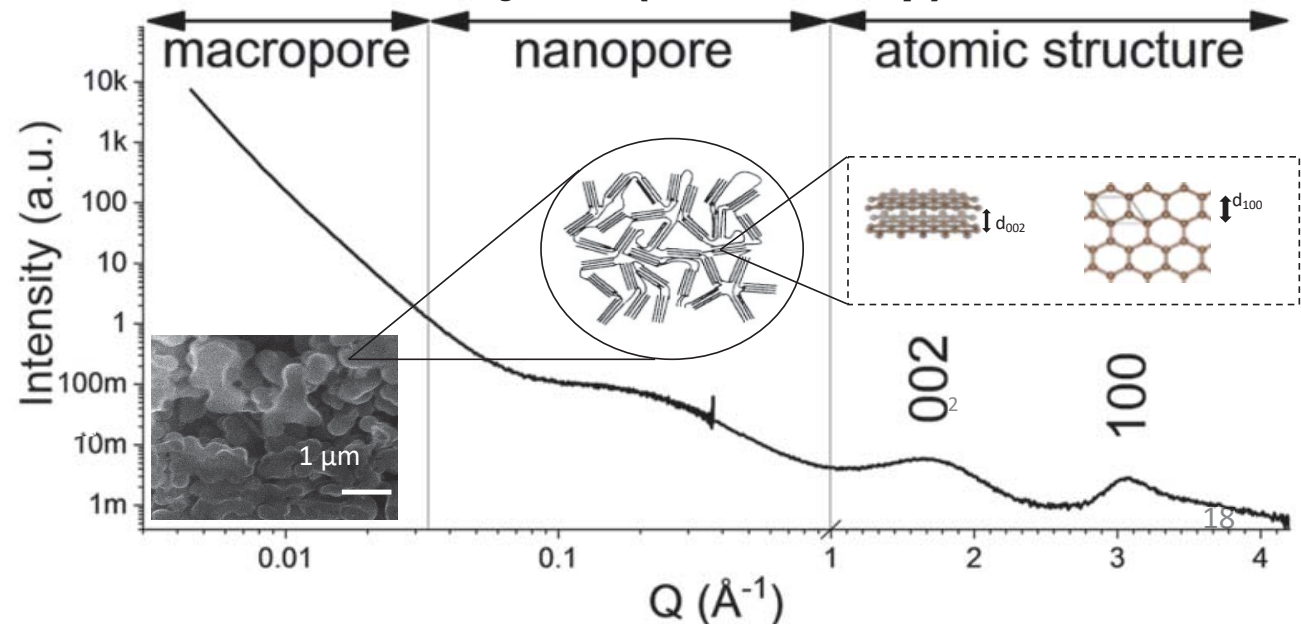
NANOSTRUCTURED CARBONS

- Electrocatalysis
- Heterogeneous catalysis
- Gas adsorption
- Supercapacitors
- **Batteries**

4

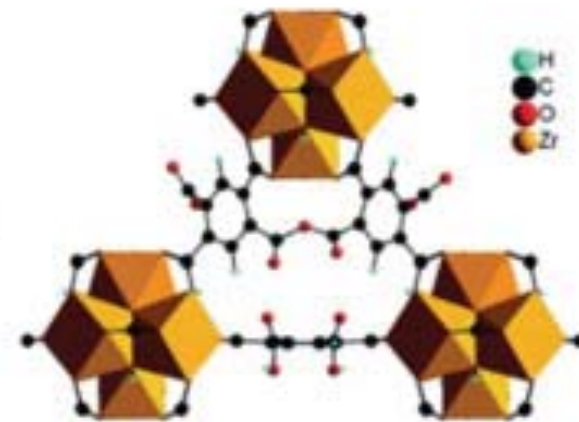
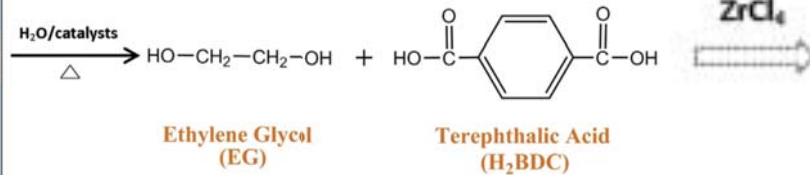
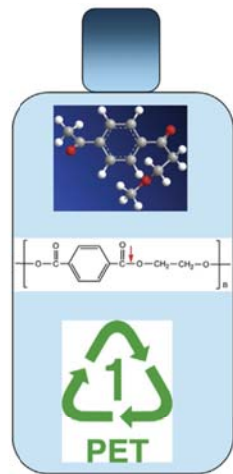


Physics (Drew Group)

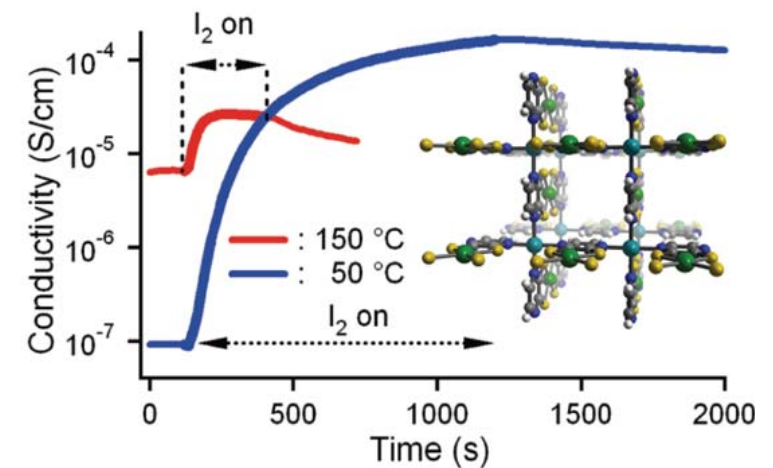
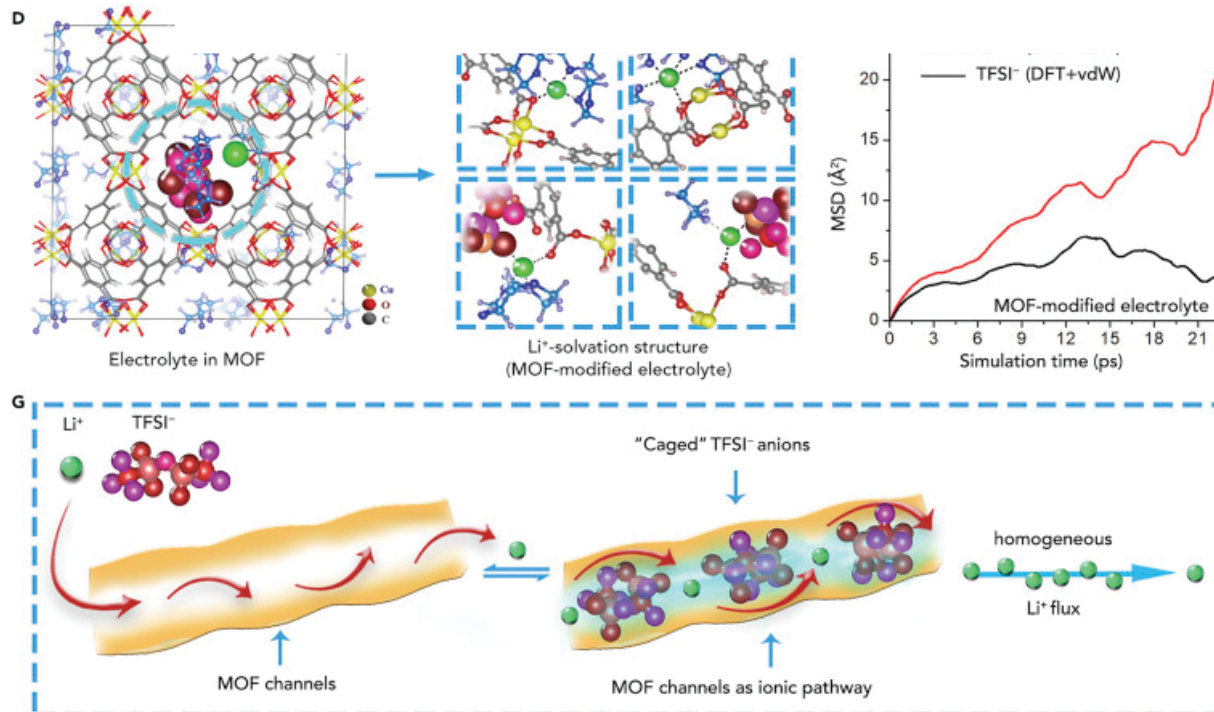


Chemistry (Titirici Group)

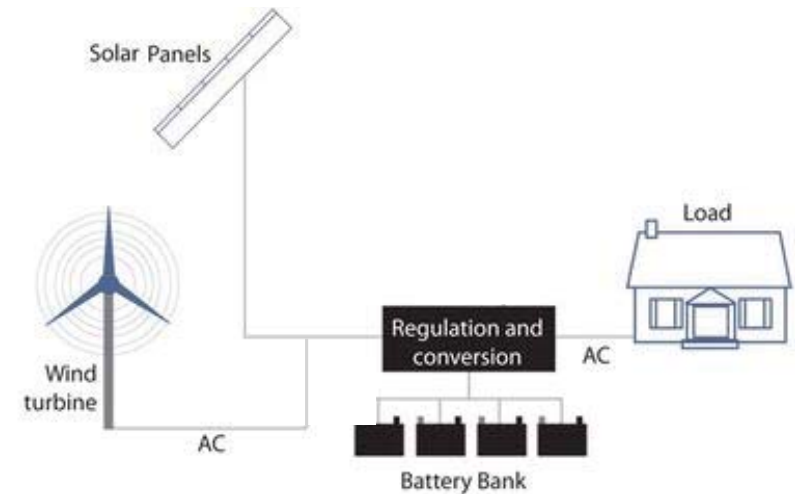
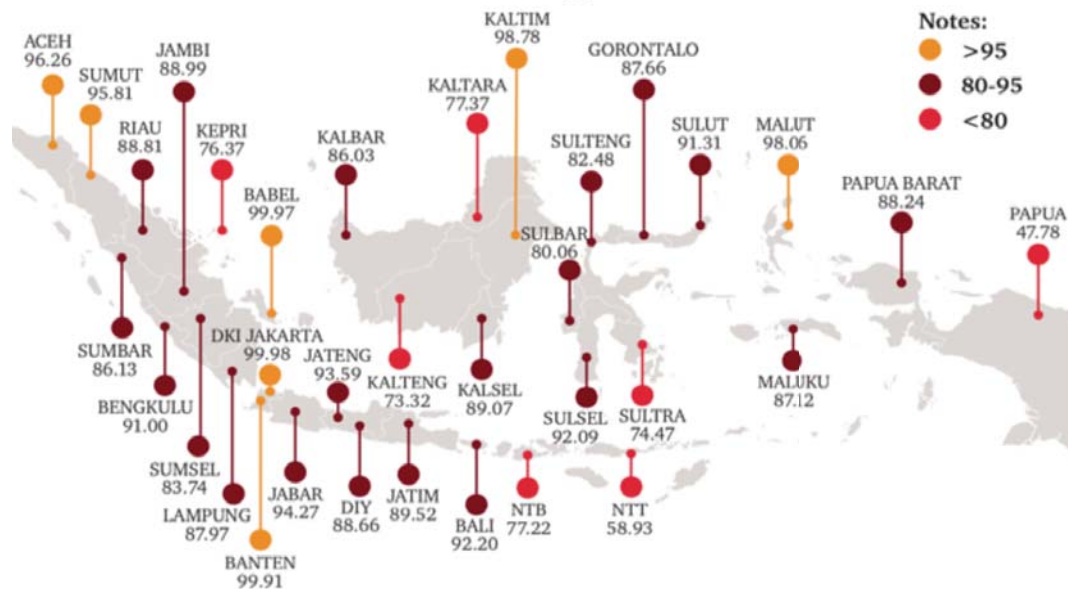
Na/Li ion battery electrolytes



UiO-66(Zr)



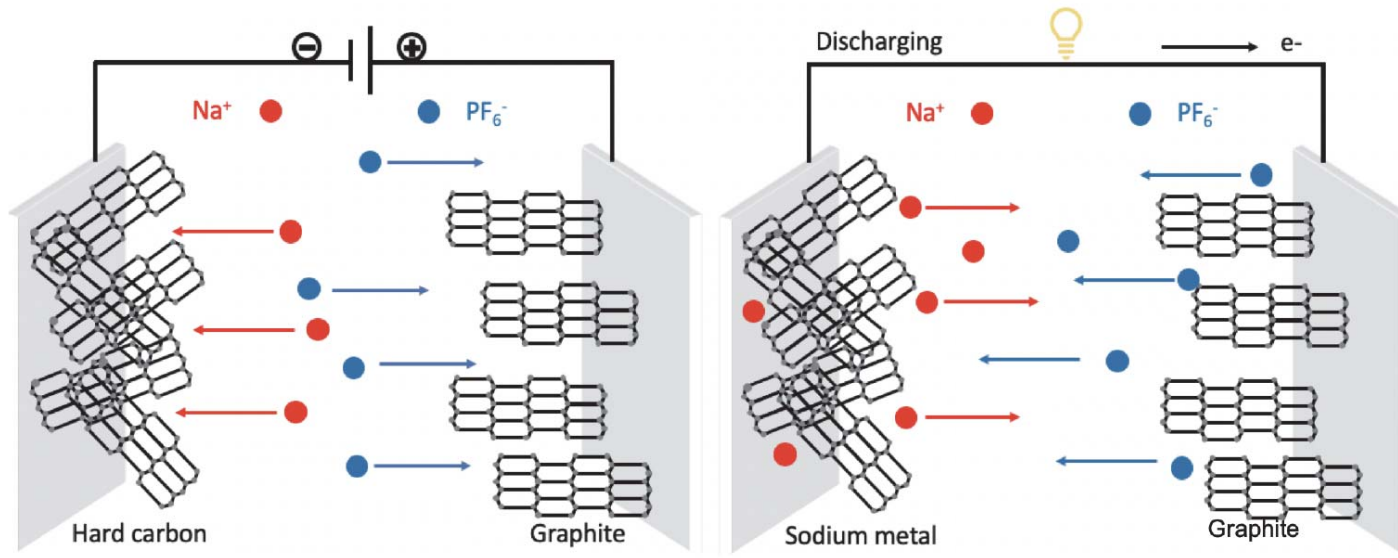
Battery / solar cells combined



Microgeneration and storage

- Cheap **Current: £1.5k / kW**
- Readily available locally sourced resources **Current: Li not available in Indonesia**
- Lasts 10,000 cycles (~25 years) **Current: 3,000 cycles**
- Produces enough for small settlement (100kW) or individual house (1-2kW)

All carbon batteries?

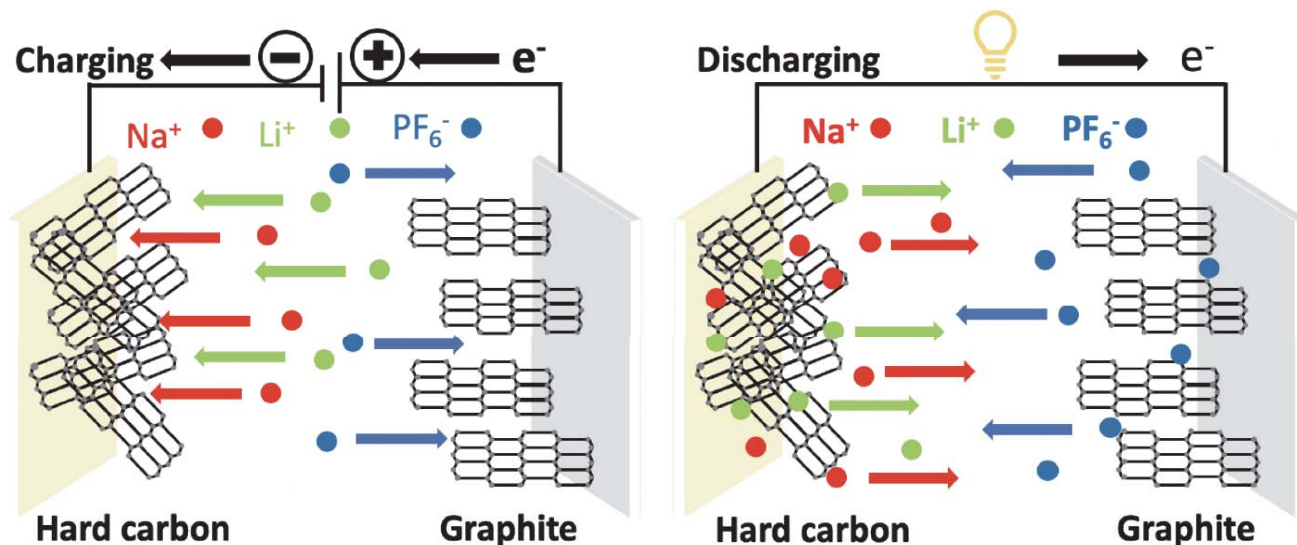


Dual ion Advantages

- Higher energy/power density
- Higher working voltage
- All carbon system possible
- Fast charging

Disadvantages

- Relatively low capacity
- Limited cathode choice



Multi ion Advantages

- Higher energy/power density
- Higher working voltage
- All carbon system possible
- Fast charging
- Higher capacity than dual ion

Disadvantages

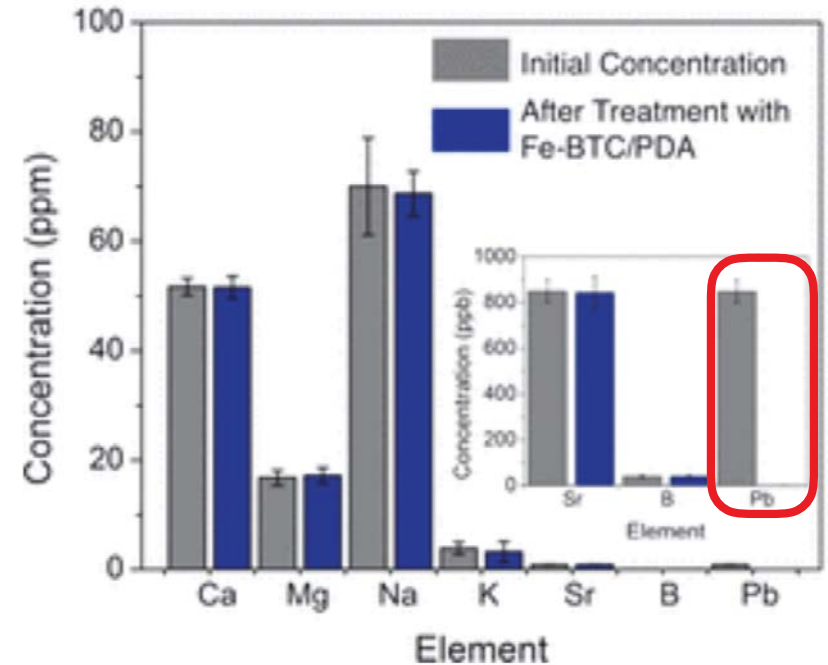
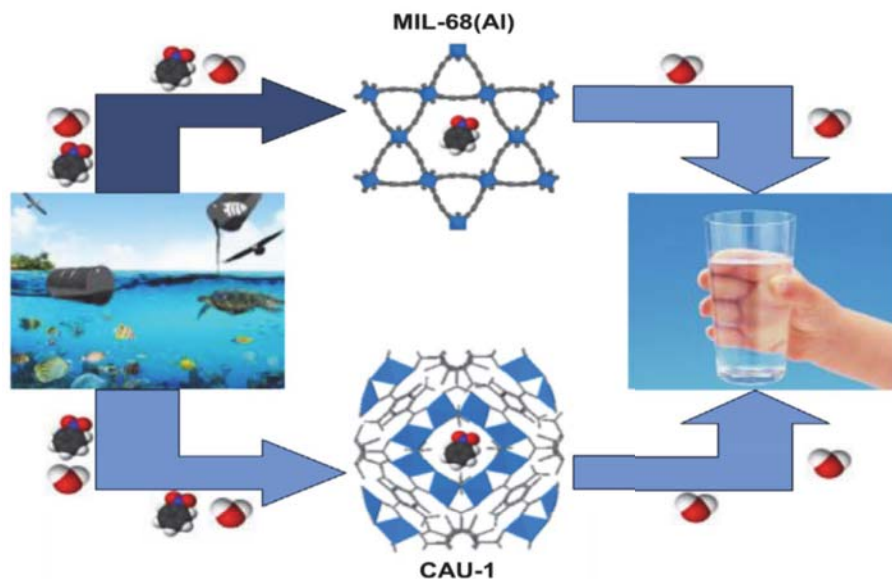
- Limited cathode choice

Other areas of collaboration

Not batteries but still cool

MOFs

- Ion selectivity
- 99.9% of contaminants removed
- 1634 mg of Hg^{2+} and 394 mg of Pb^{2+} per gram of MOF/polymer composite

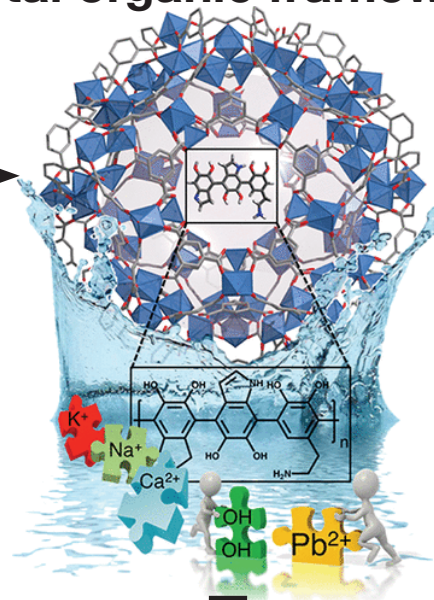
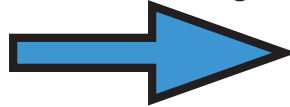


Plastic pollution



Metal organic framework

Chemistry



Using pollution to
solve pollution

Materials Science
and Engineering



Heavy industry pollution



+



=



Drinking water²⁴

Conclusion

