Delft Energy Initiative

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TU Delft

TU Delft
Delft University of Technology

Delft Energy Initiative

Four main themes:

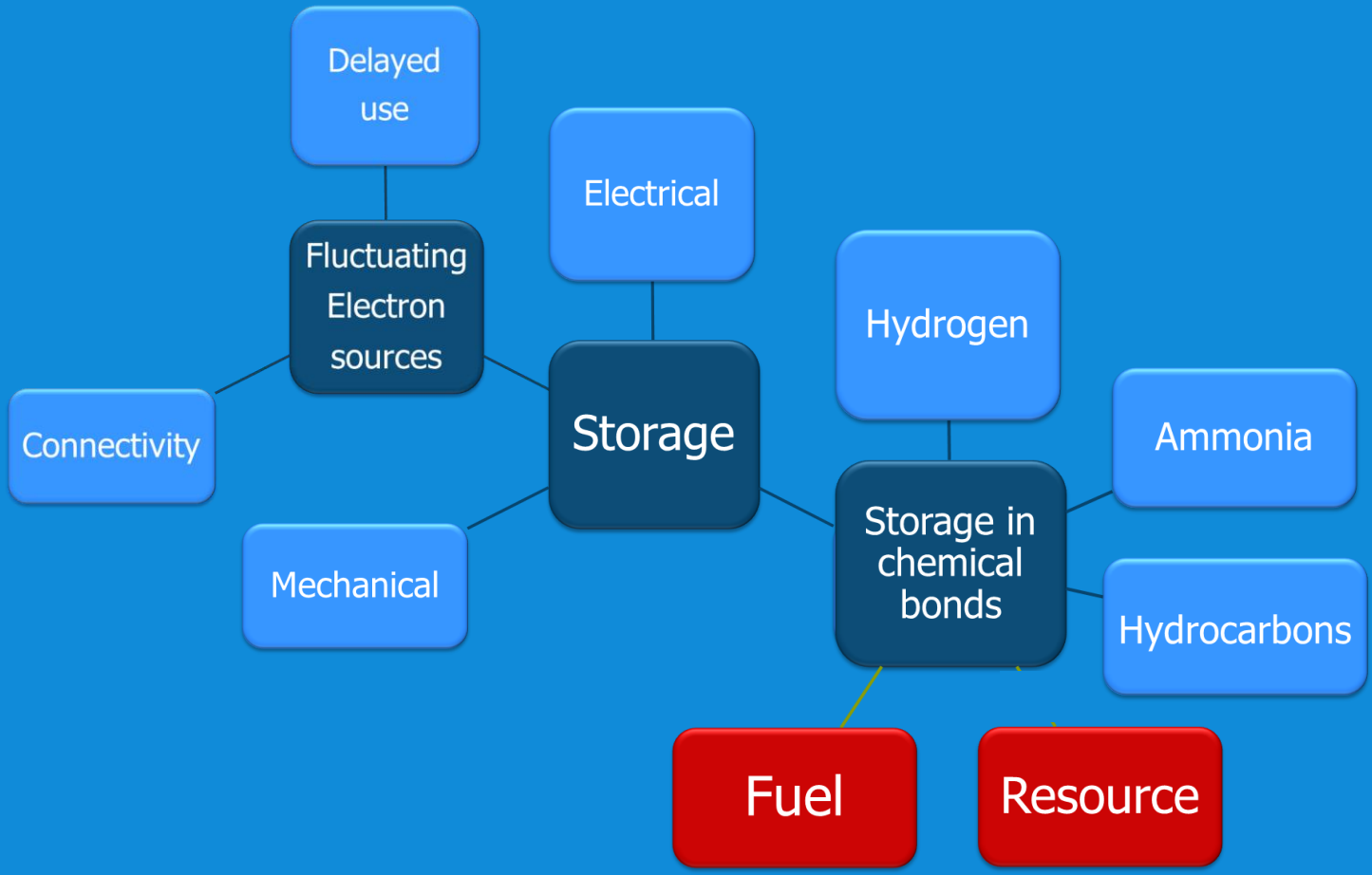
- **Urban Energy**
- **Powerweb**
- **e-Refinery**
- **Duwind**

- Education
- Entrepreneurship

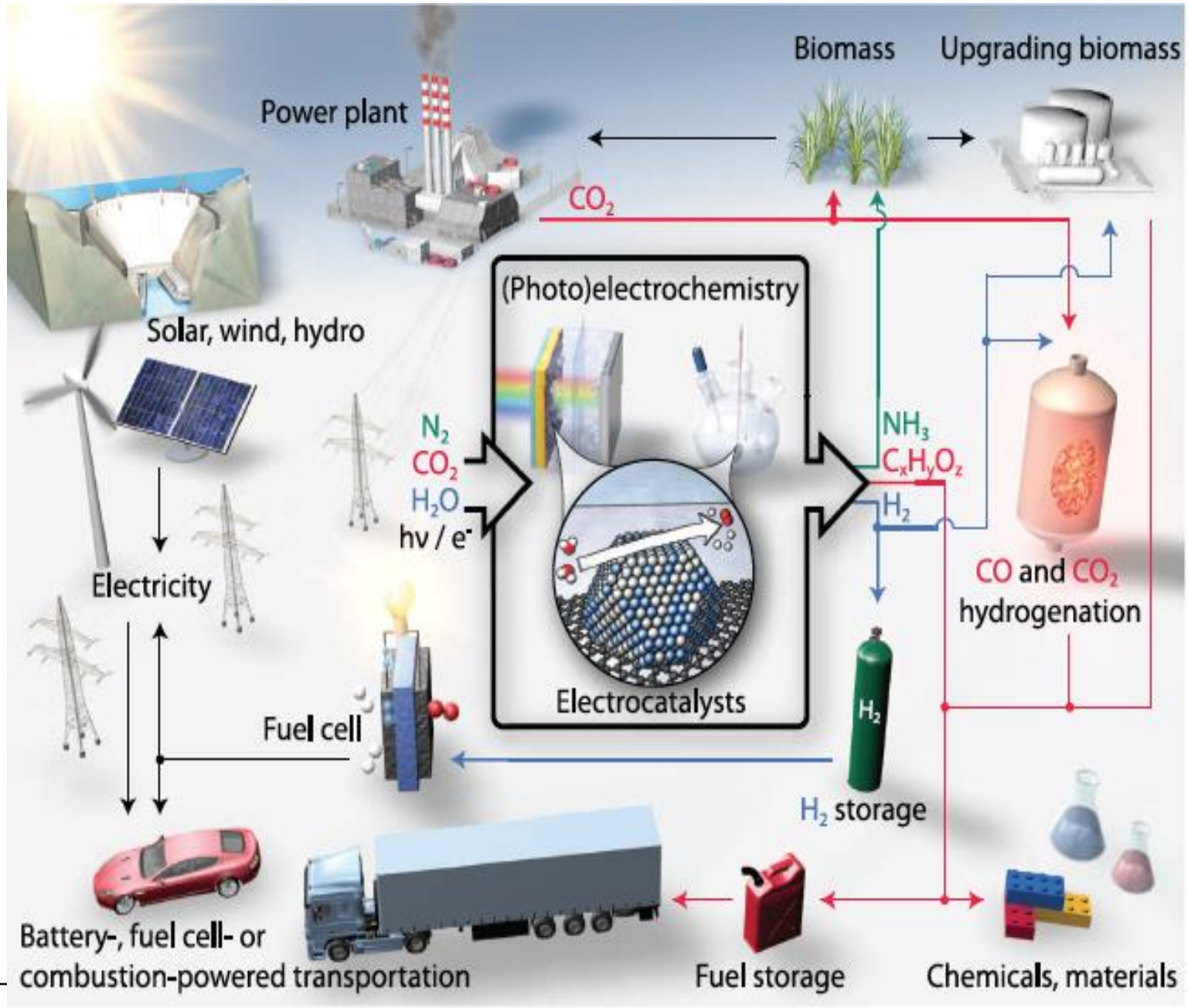
- Outreach, lectures
- Games, competitions

- about 1000 FTE

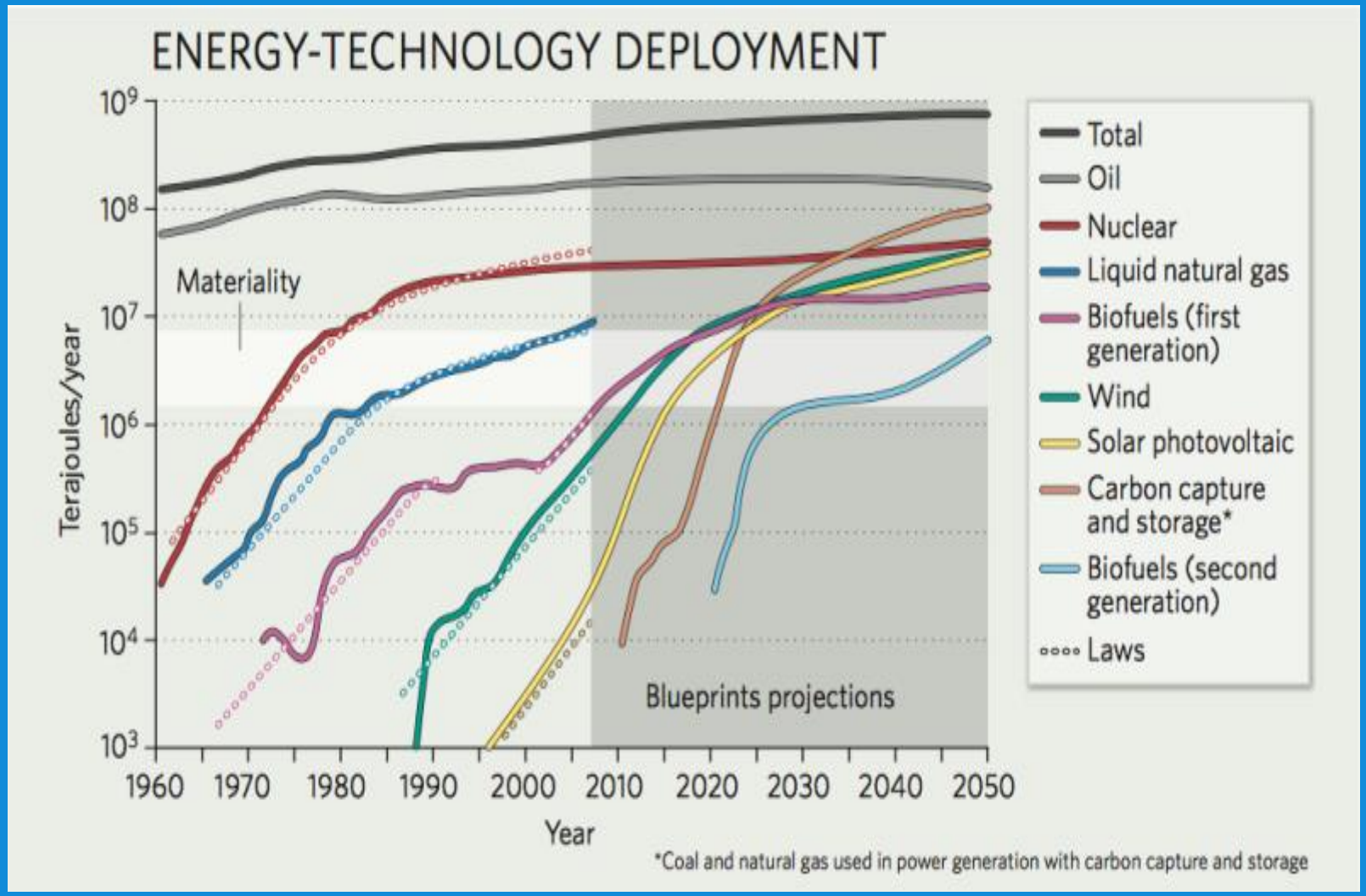
The challenge: power to chemical bonds e-Refinery



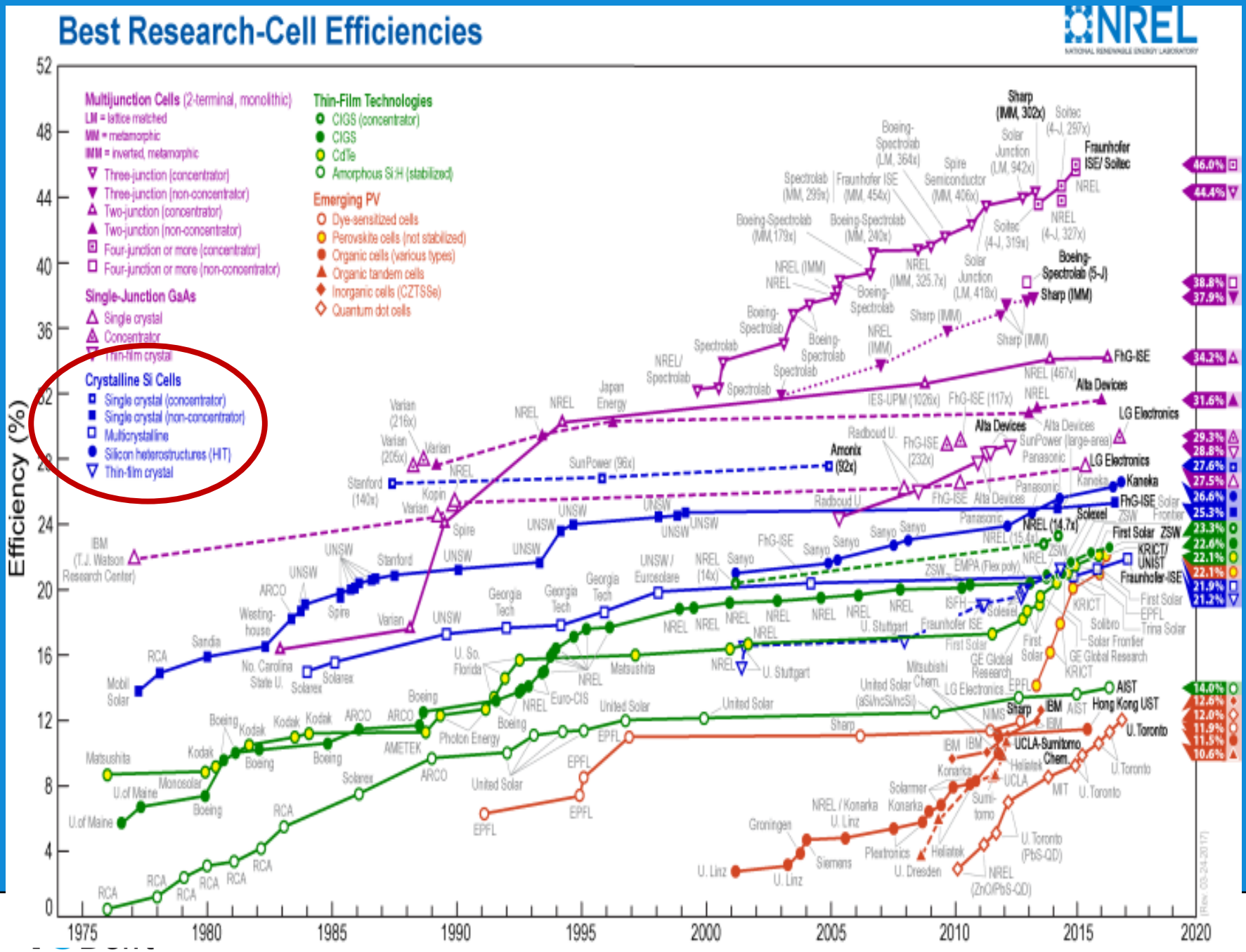
This is a TeraWatt challenge

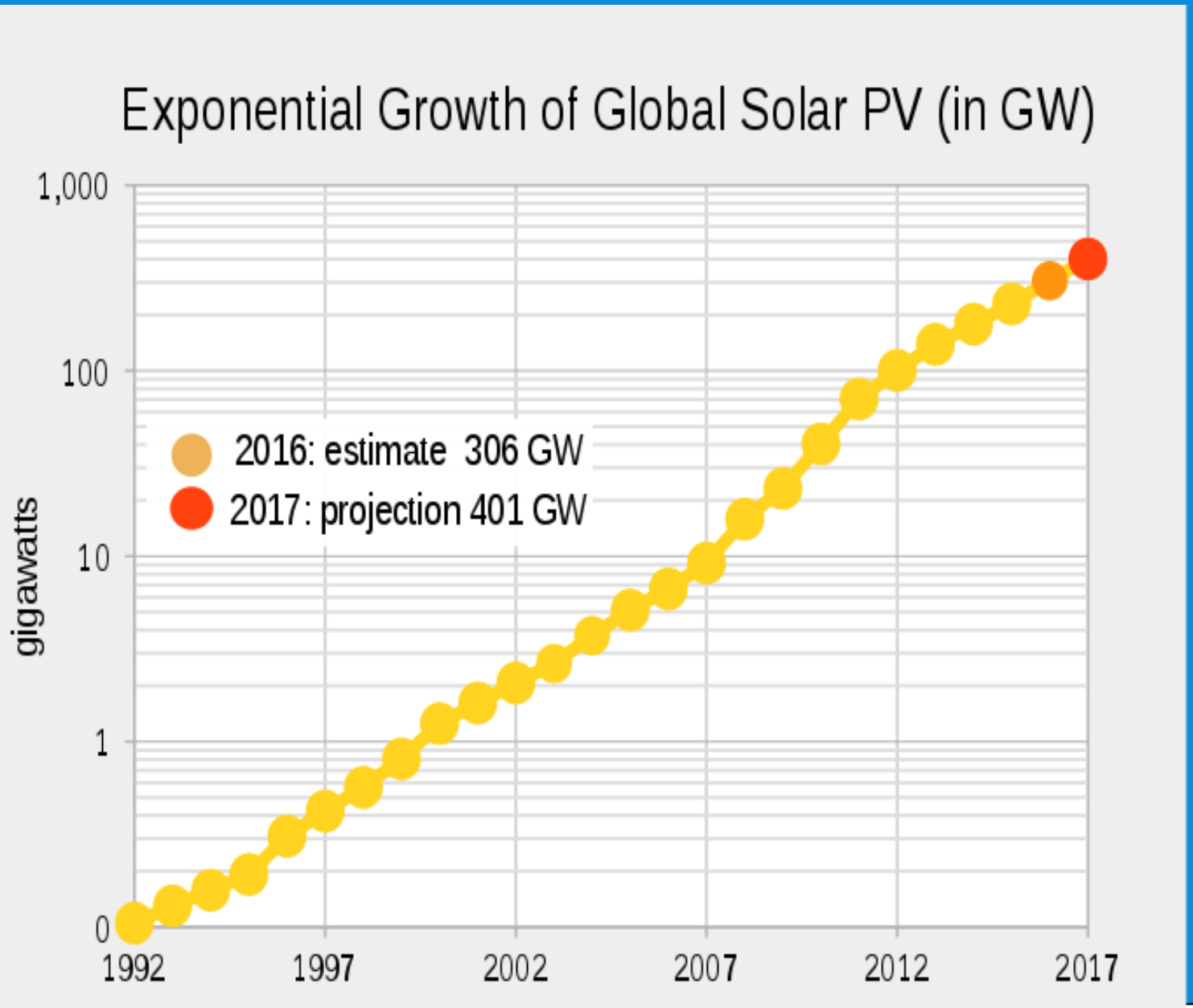


Z. She et al, Science, 355 (2017)



*Source: G.J. Kramer and M. Haigh, No quick switch to low-carbon energy, Nature **2009**, 568-569.*


Best Research-Cell Efficiencies
NREL
Efficiency (%)
Multijunction Cells (2-terminal, monolithic)
LM = lattice matched
MM = metamorphic
IMM = inverted, metamorphic
Three-junction (concentrator)
Three-junction (non-concentrator)
Two-junction (concentrator)
Two-junction (non-concentrator)
Four-junction or more (concentrator)
Four-junction or more (non-concentrator)
Single-Junction GaAs
Single crystal
Concentrator
Thin-film crystal
Crystalline Si Cells
Single crystal (concentrator)
Single crystal (non-concentrator)
Multicrystalline
Silicon heterostructures (HIT)
Thin-film crystal
Thin-Film Technologies
CIGS (concentrator)
CIGS
CdTe
Amorphous Si:H (stabilized)
Emerging PV
Dye-sensitized cells
Perovskite cells (not stabilized)
Organic cells (various types)
Organic tandem cells
Inorganic cells (CZTSSe)
Quantum dot cells
46.0%
44.4%
38.8%
37.9%
34.2%
31.6%
29.3%
28.8%
27.6%
27.5%
26.6%
25.3%
23.3%
22.6%
22.1%
22.1%
21.9%
21.2%
14.0%
12.6%
12.0%
11.9%
11.5%
10.6%
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



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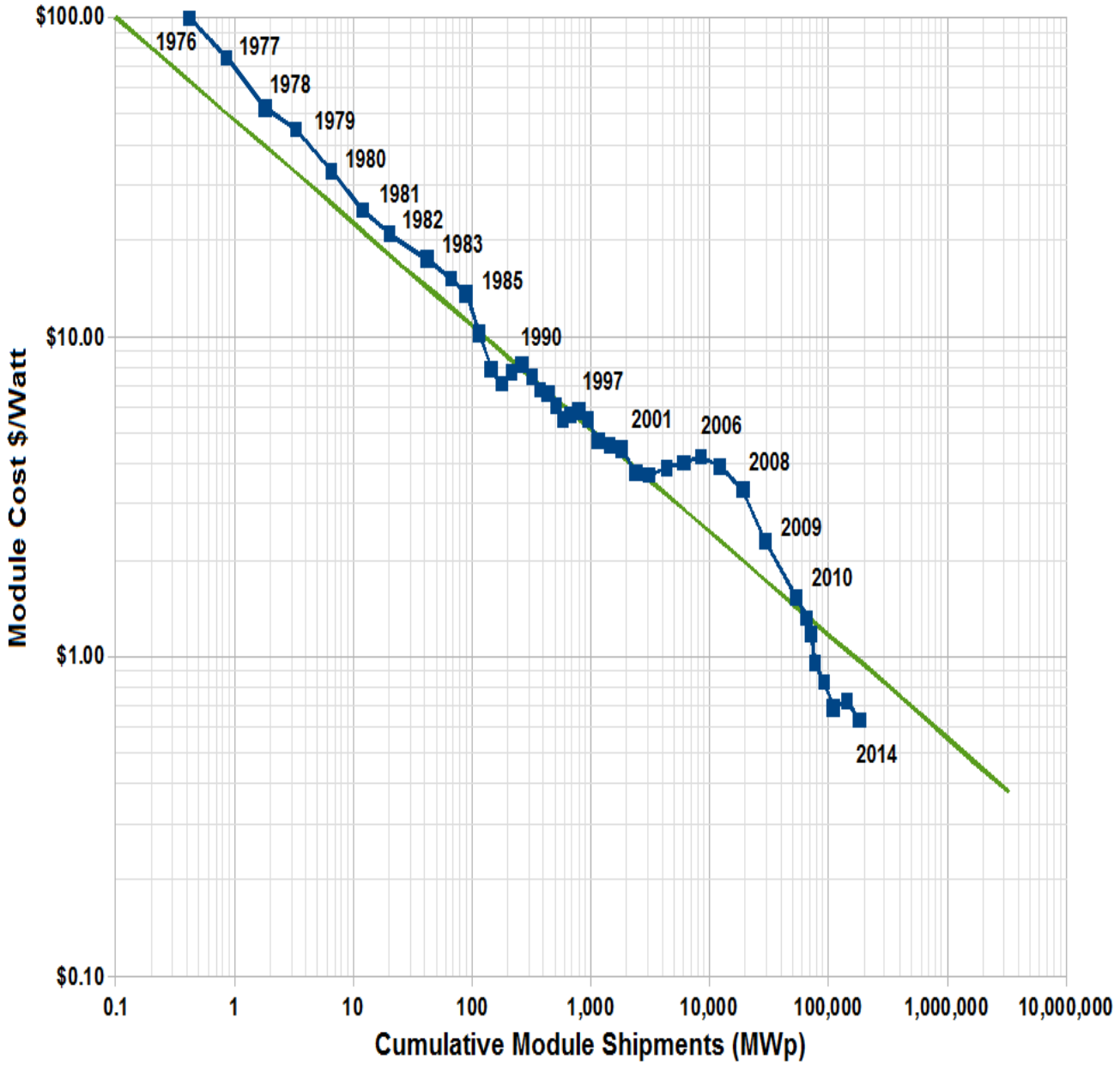
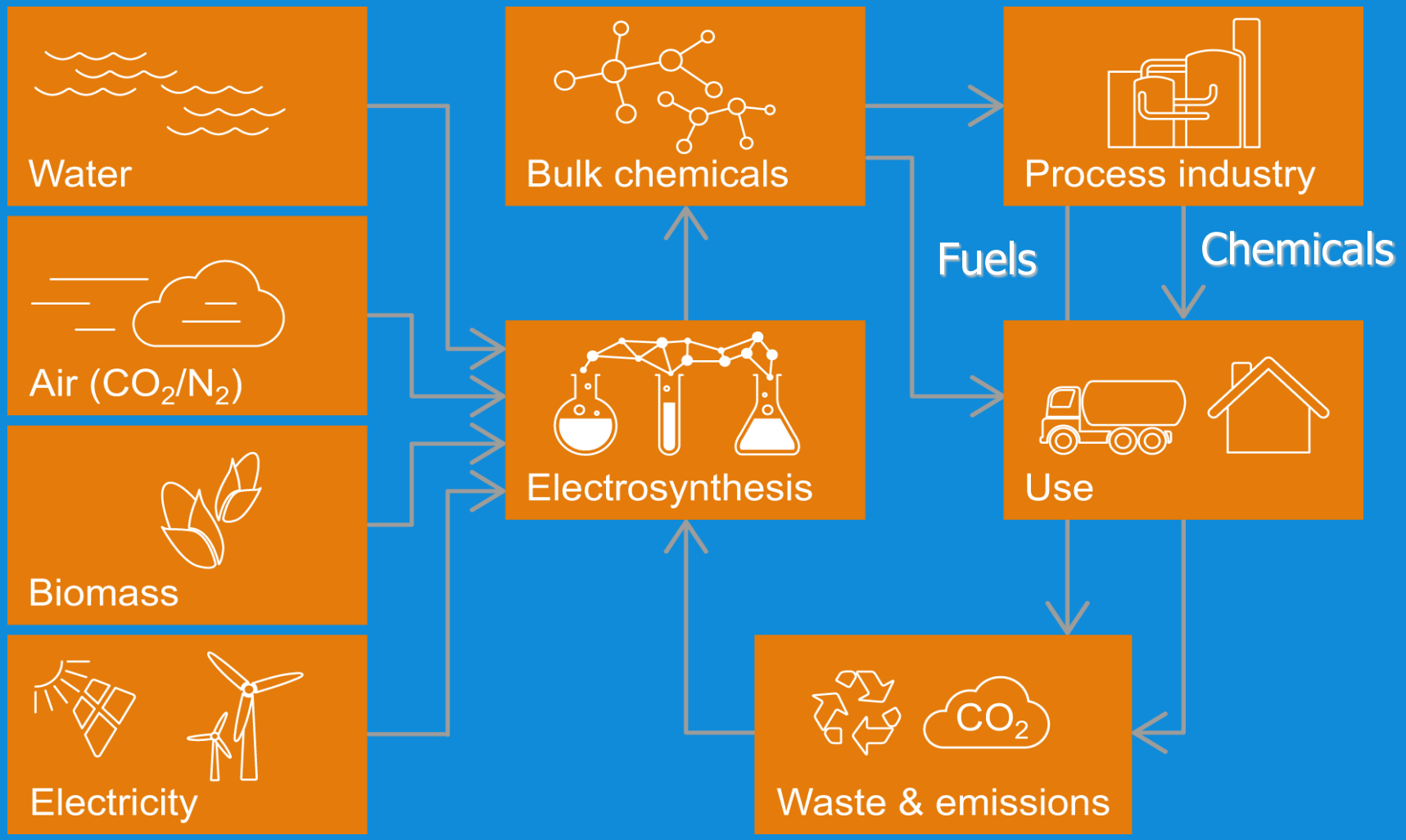
Swanson's Law

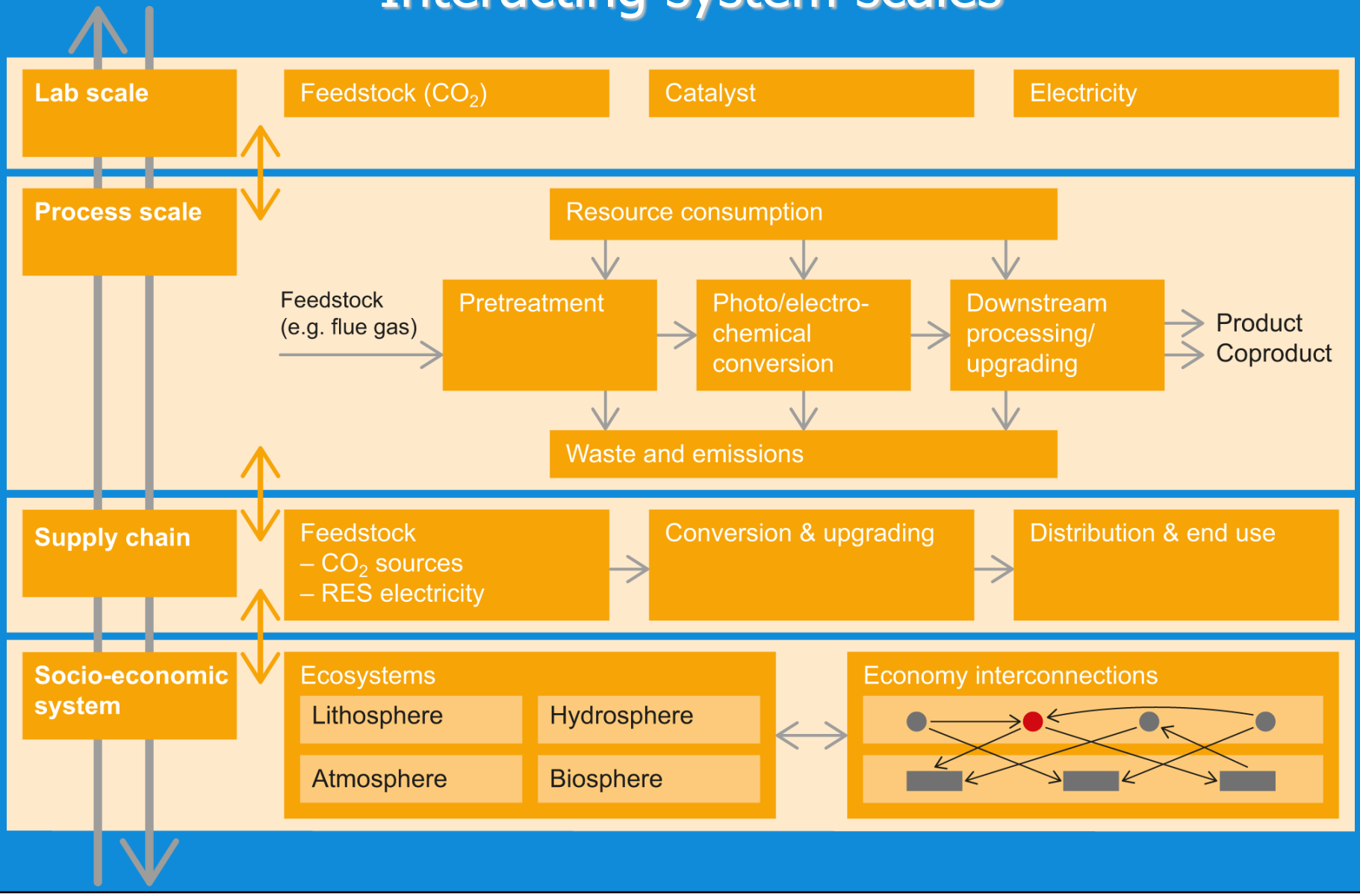


Wikipedia.com

Circular economy



Interacting system scales



Required Expertise

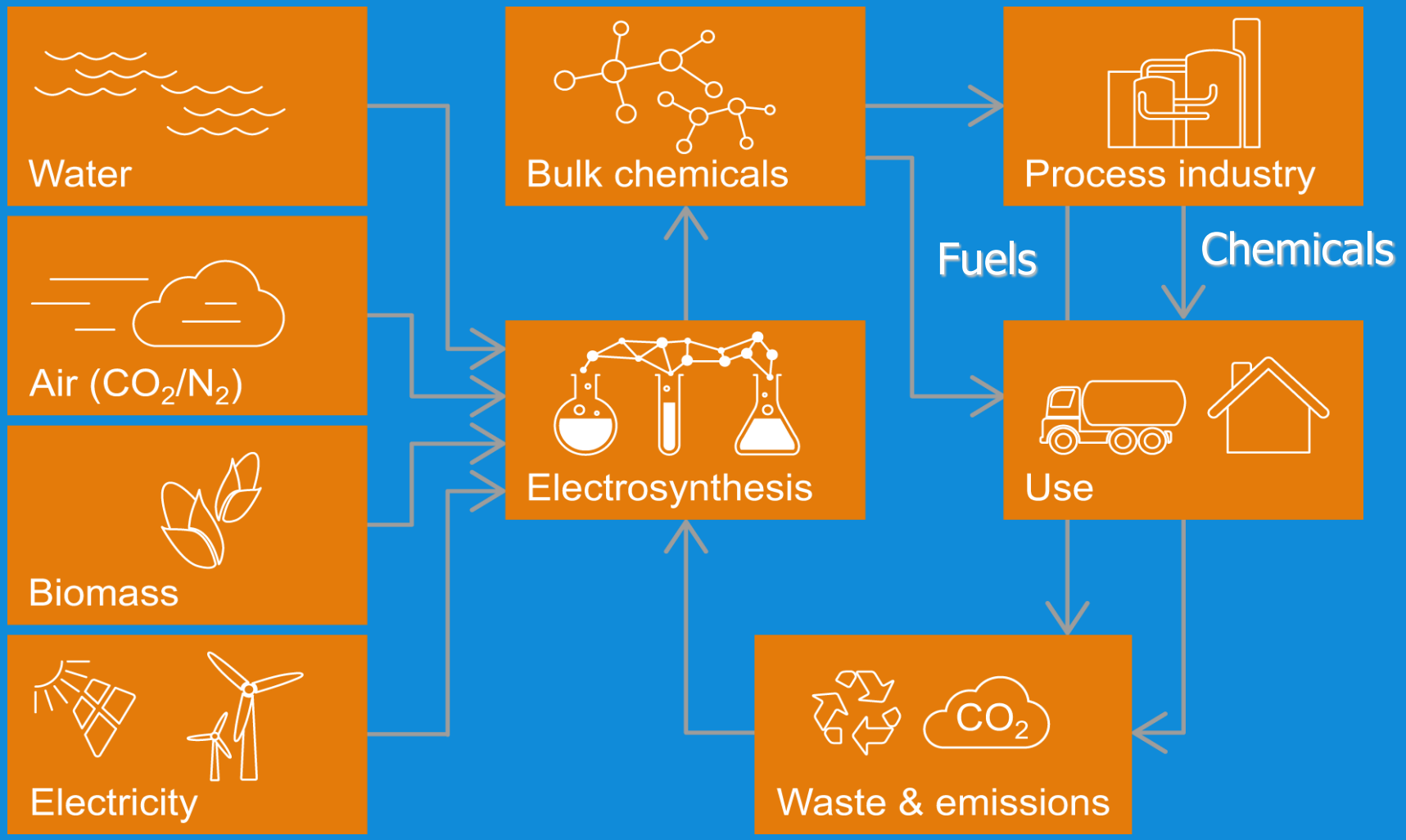
- Materials science
- Catalysis
- Electrochemistry
- Process technology
  - Transport Phenomena
  - Membrane Technology
  - Reactor Engineering
  - Process Intensification

- Energy technology and system engineering
- System integration and Value Chain Impact + institutional embedding

Required Education

- BSc and MSc level
  - Minors in BSc programmes (ChemE, Geo, MechE, SysE)
  - MSc programmes, incl 4TU
  - MSc level track, new MSc programmes?
- PhD level
  - Investment needed the Netherlands: ECCM, NWO, NWA
  - 4TU.Energy
- Life long learning
  - PDEng programmes
  - Industrial PhD programme

Towards sustainable production of chemicals and fuels



Thank you

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