



EIRES

EINDHOVEN INSTITUTE
FOR RENEWABLE
ENERGY SYSTEMS

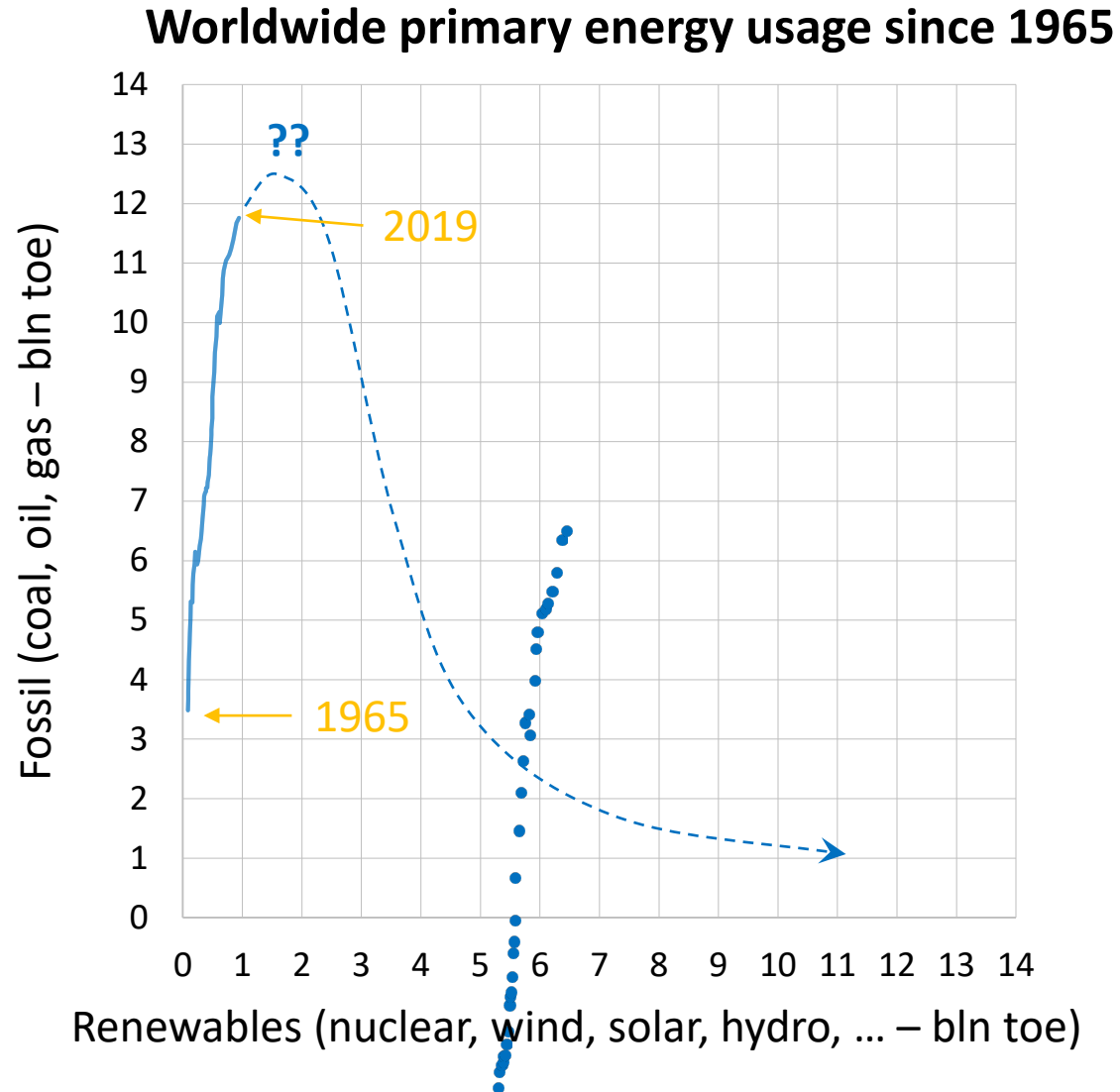
TU/e

DRIVING THE ENERGY REVOLUTION

Mark Boneschanscher
NL IL minisymposium 13 January 2021

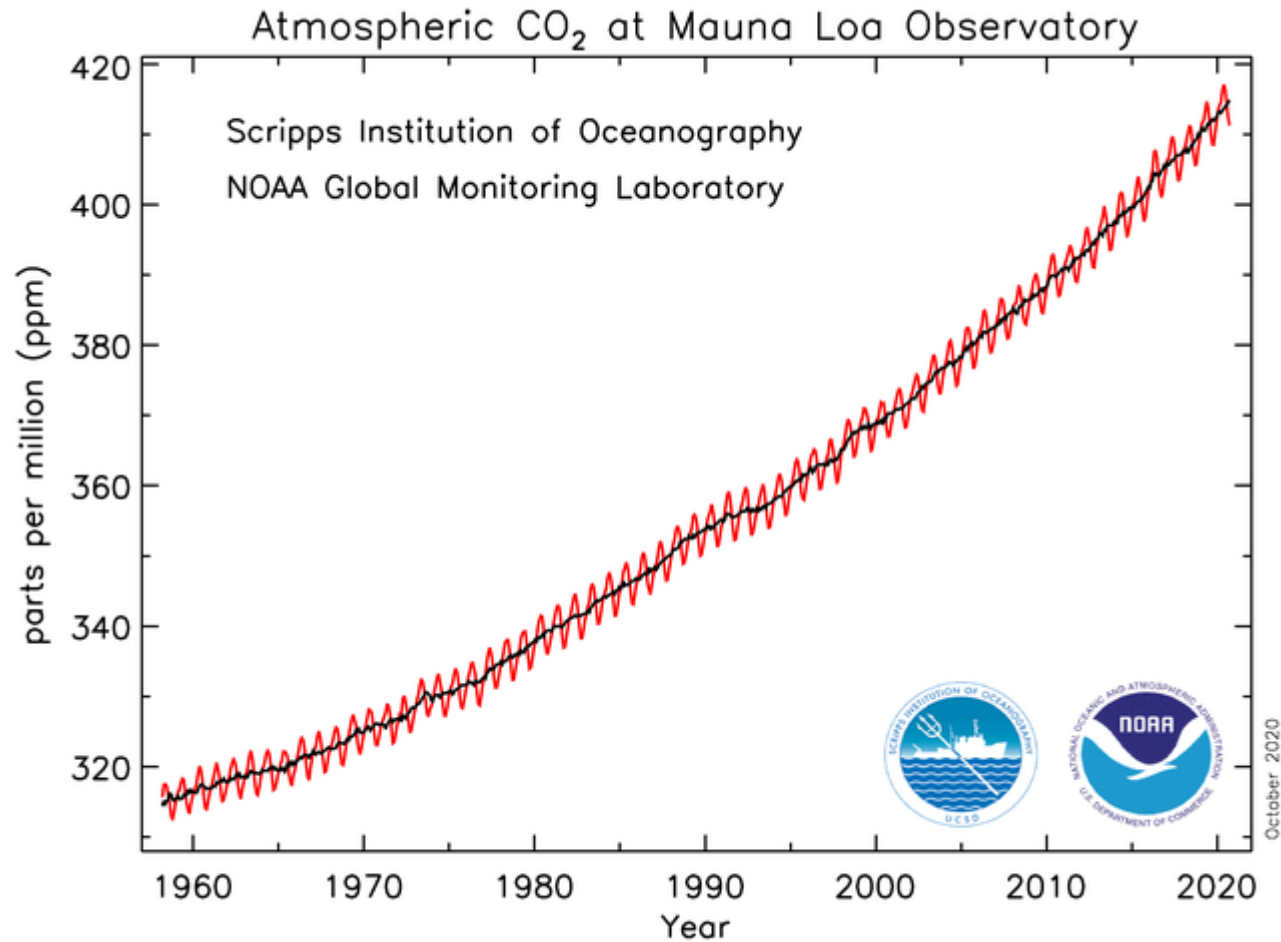
more info: www.tue.nl/eires | eires@tue.nl

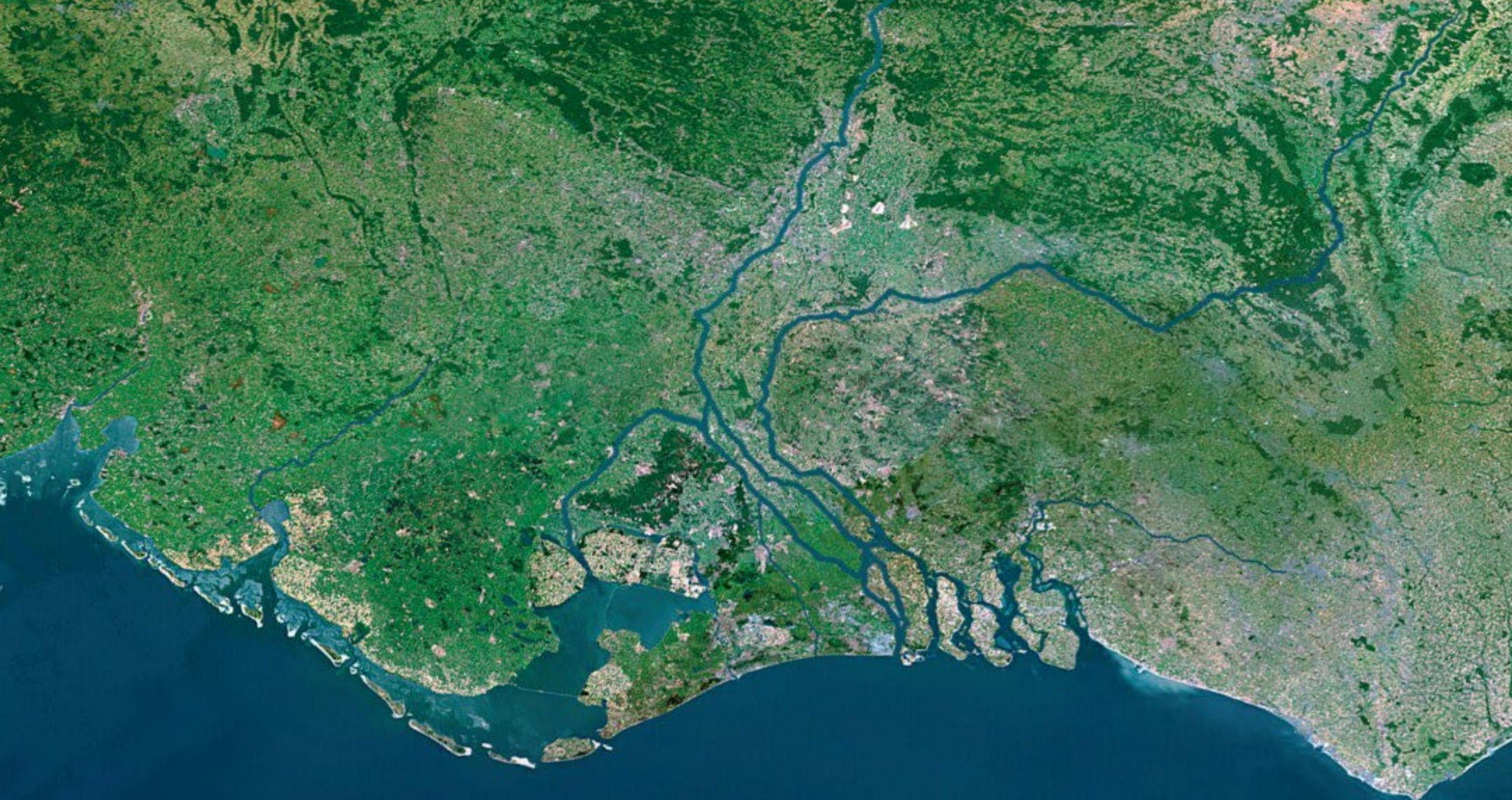
The energy transition requires a giant acceleration



Based on prof.dr. Vianney Koelman
Data: Hannah Ritchie, OurWorldInData.org, 2020

The energy transition requires a giant acceleration

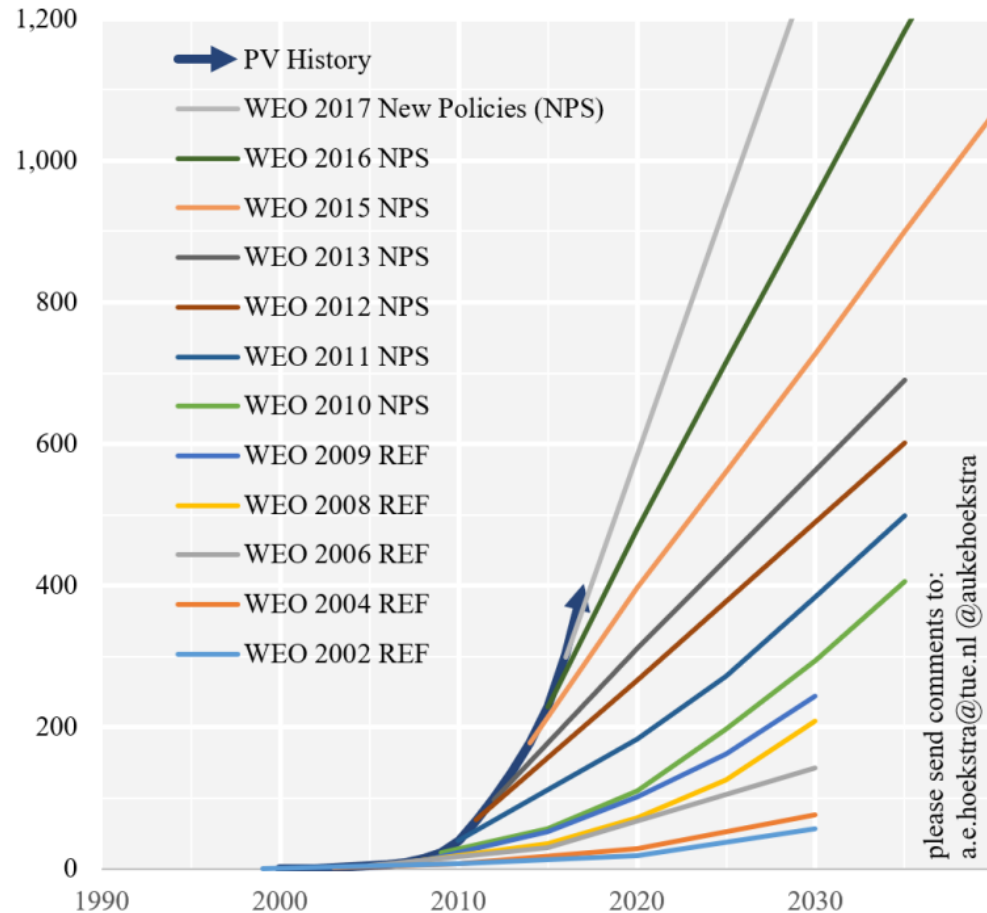




How to accelerate?

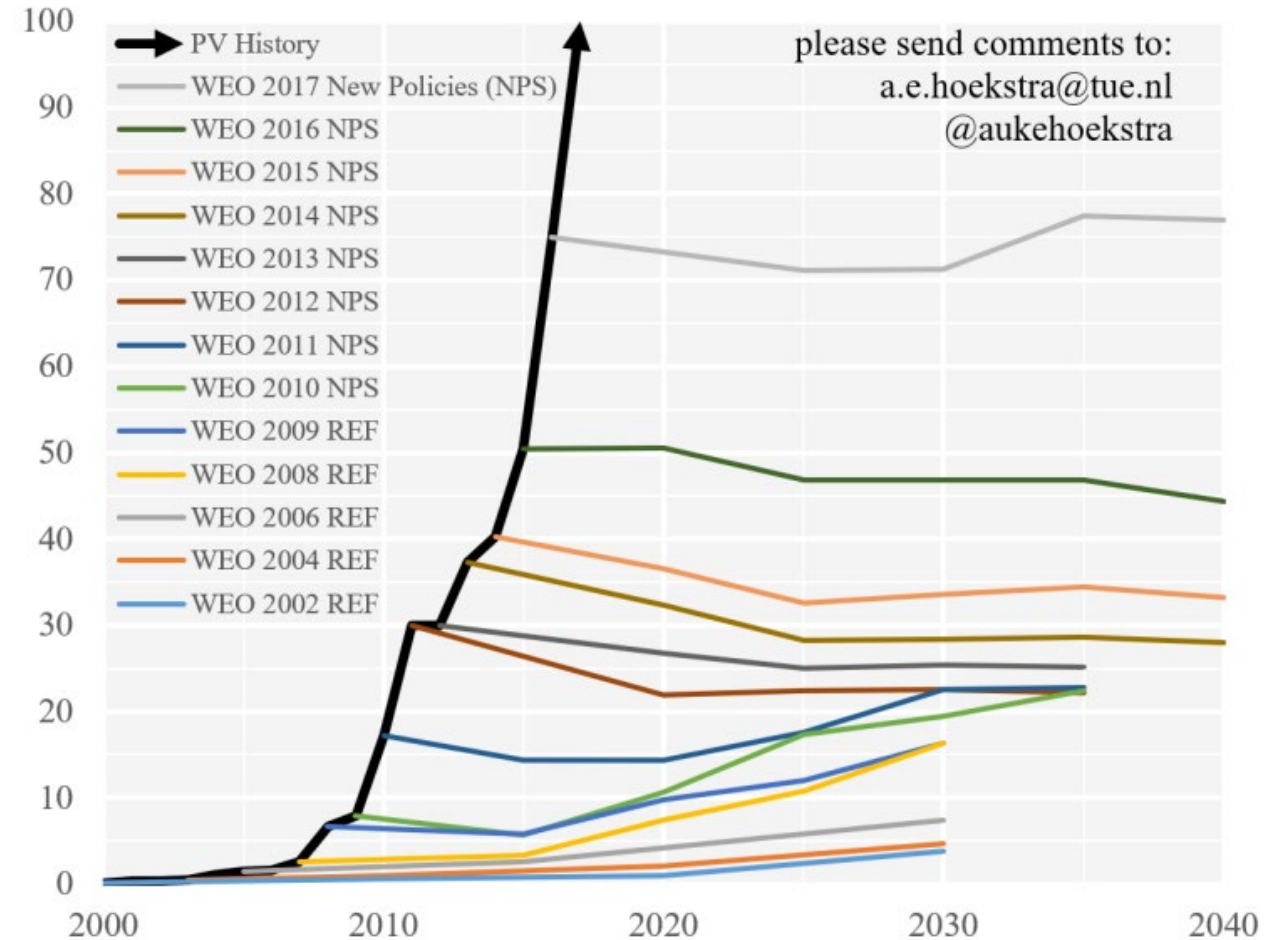
Cummulative PV capacity: historic data vs IEA WEO predictions

In GW of total installed capacity - source International Energy Agency - World Energy Outlook



Annual PV additions: historic data vs IEA WEO predictions

In GW of added capacity per year - source International Energy Agency - World Energy Outlook



How to accelerate?

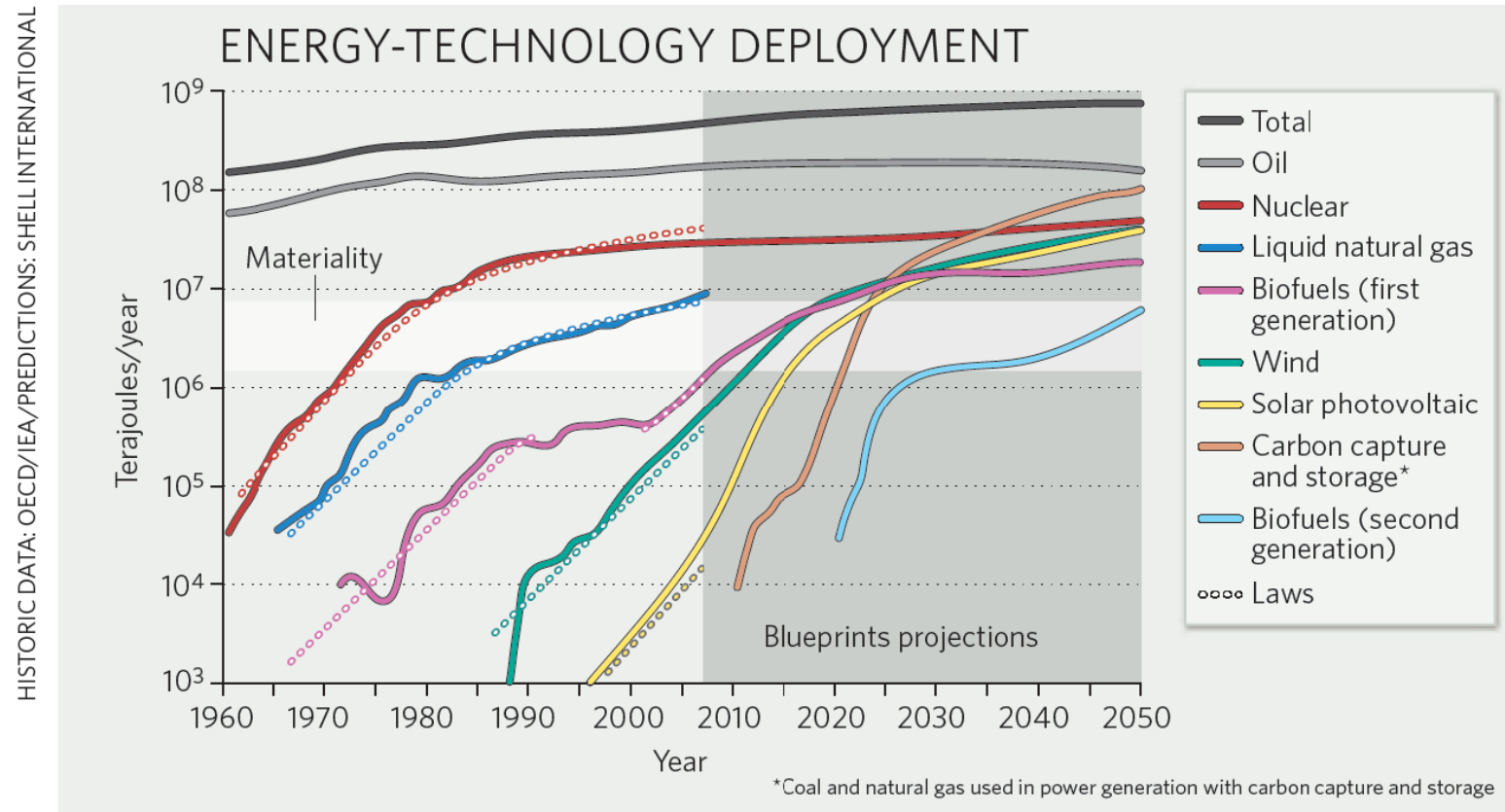
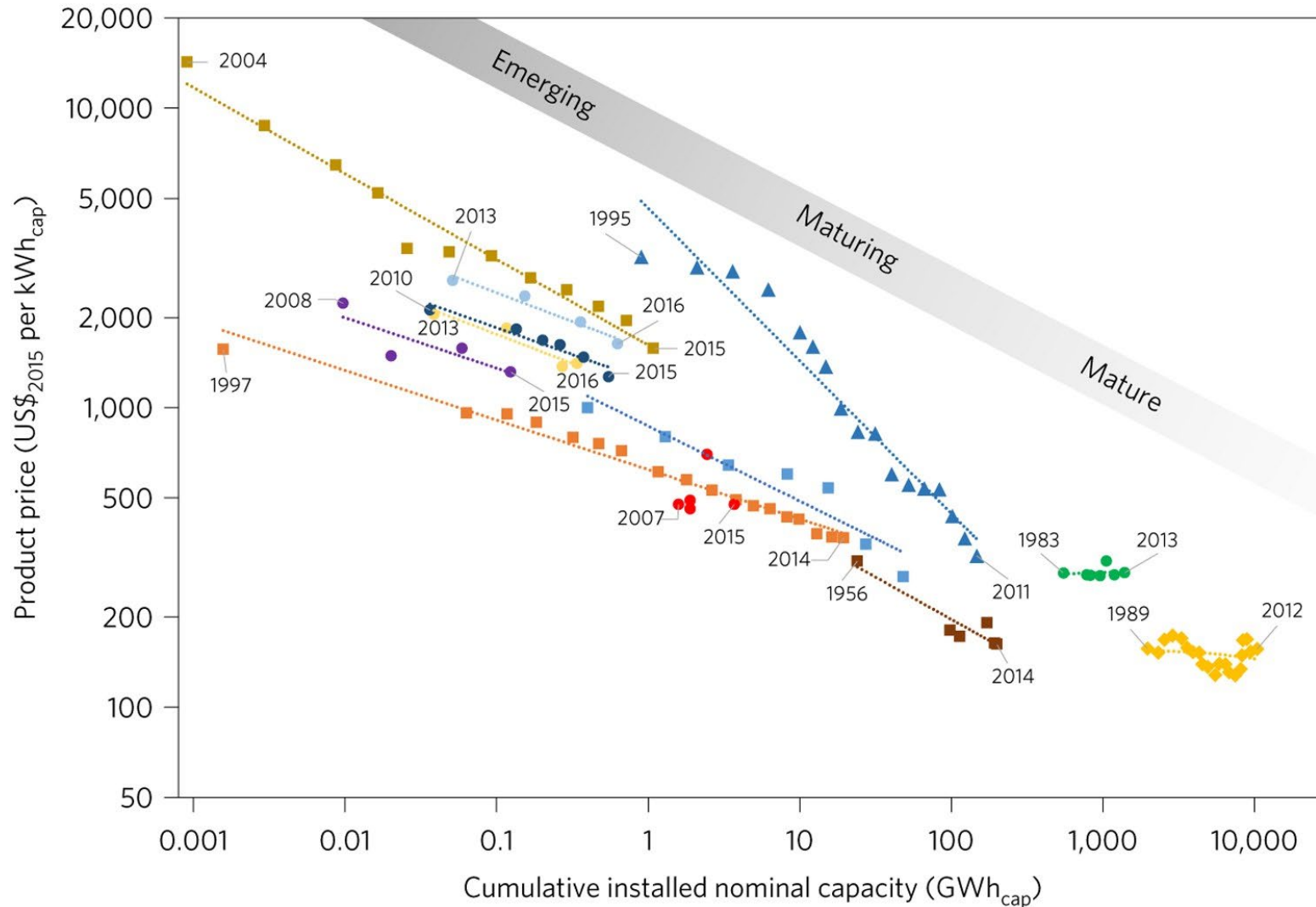


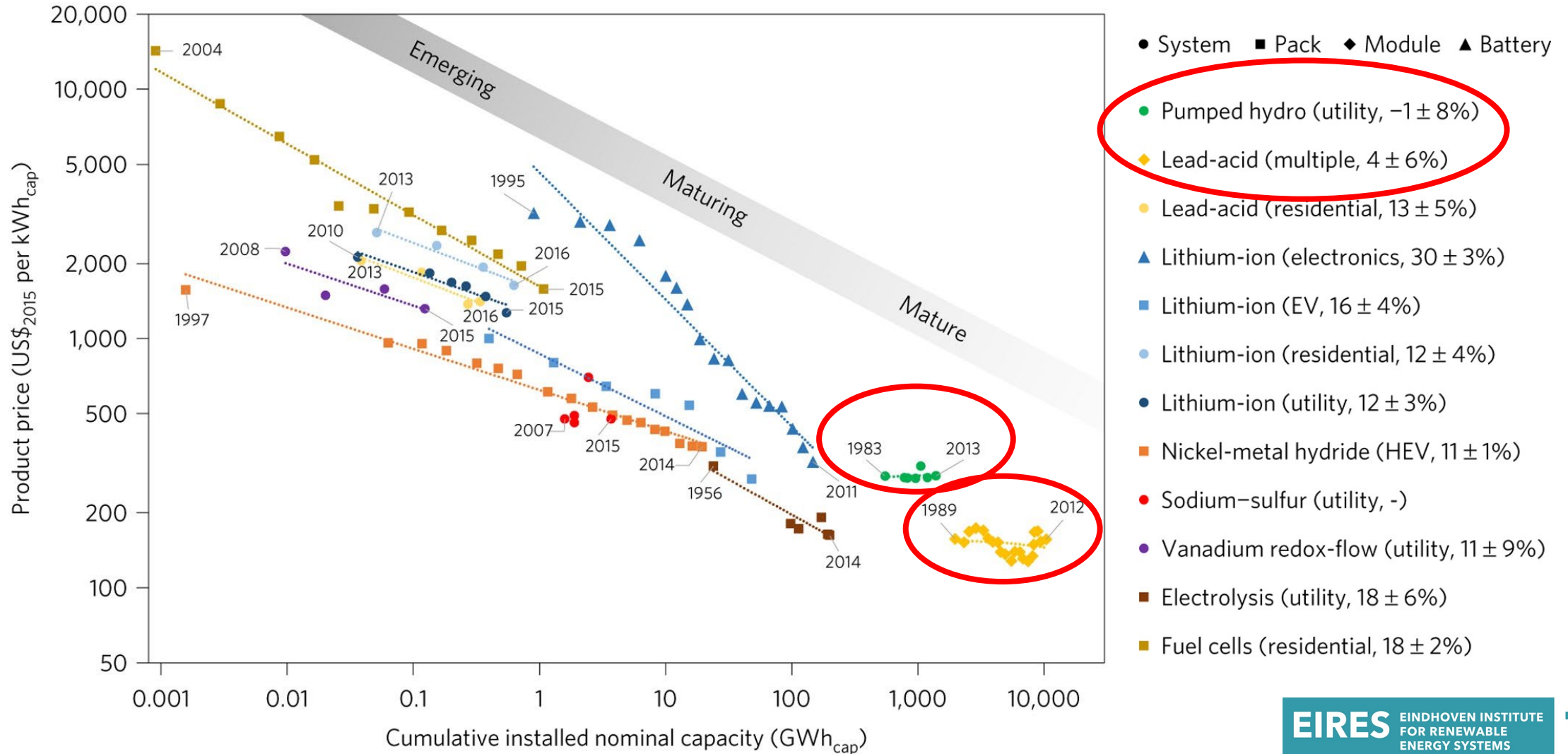
Figure 1 | Global production of primary energy sources. When a technology produces 1,000 terajoules a year (equivalent to 500 barrels of oil a day), the technology is 'available'. It can take 30 years to reach materiality (1% of world energy mix). Projections after 2007 taken from Shell's Blueprints scenario³.

How to accelerate?



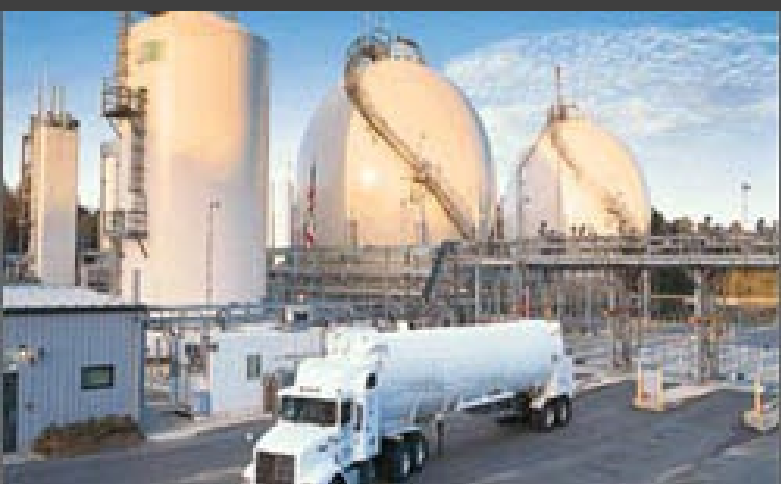
- System ■ Pack ◆ Module ▲ Battery
- Pumped hydro (utility, $-1 \pm 8\%$)
- ◆ Lead-acid (multiple, $4 \pm 6\%$)
- Lead-acid (residential, $13 \pm 5\%$)
- ▲ Lithium-ion (electronics, $30 \pm 3\%$)
- Lithium-ion (EV, $16 \pm 4\%$)
- Lithium-ion (residential, $12 \pm 4\%$)
- Lithium-ion (utility, $12 \pm 3\%$)
- Nickel-metal hydride (HEV, $11 \pm 1\%$)
- Sodium-sulfur (utility, -)
- Vanadium redox-flow (utility, $11 \pm 9\%$)
- Electrolysis (utility, $18 \pm 6\%$)
- Fuel cells (residential, $18 \pm 2\%$)

How to accelerate?



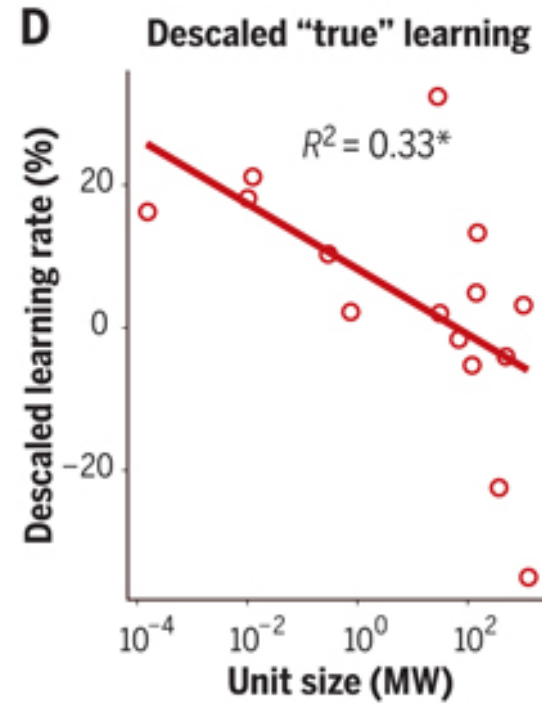
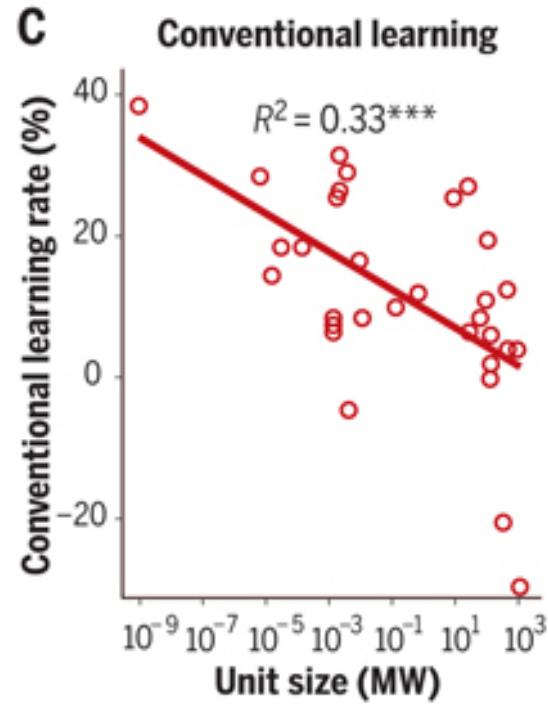
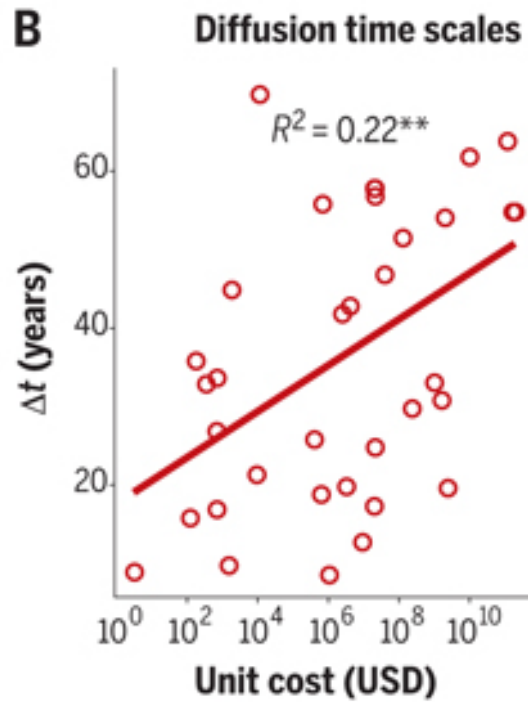


The role of granularity

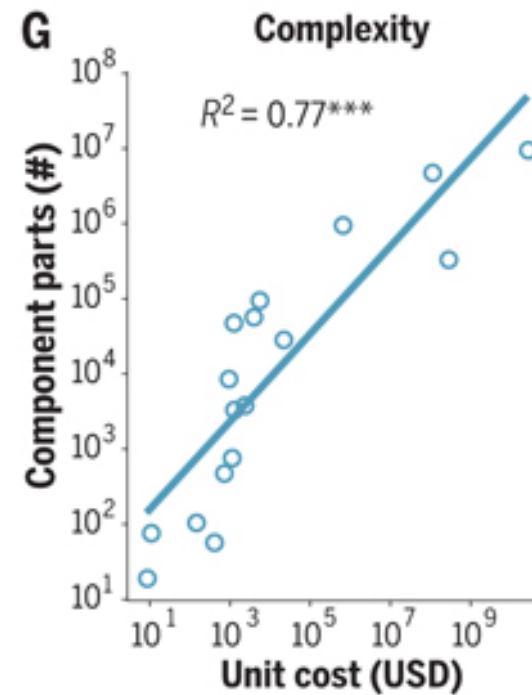
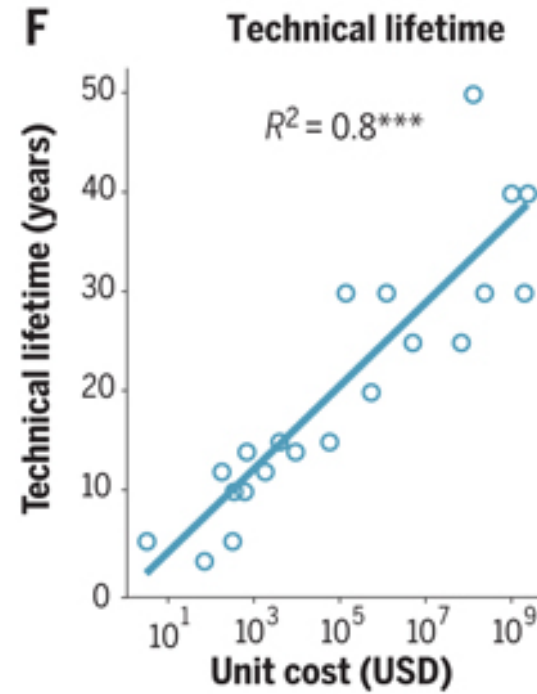
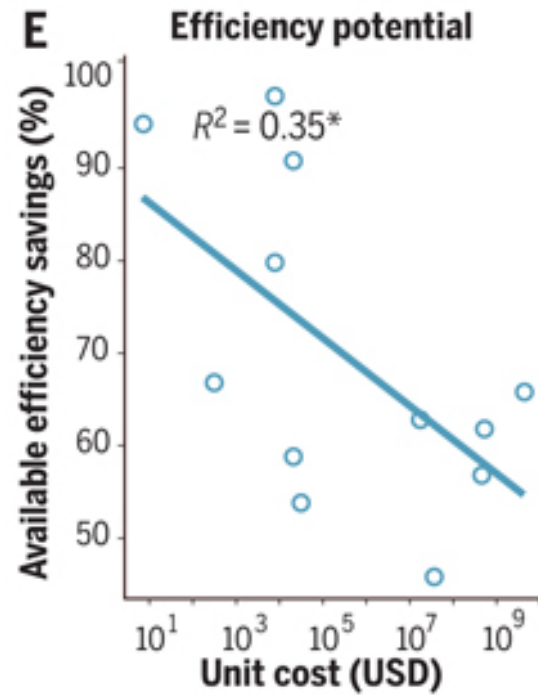


C Wilson *et al.*, Science **368**, 6486 (2020)
images taken from Wikipedia

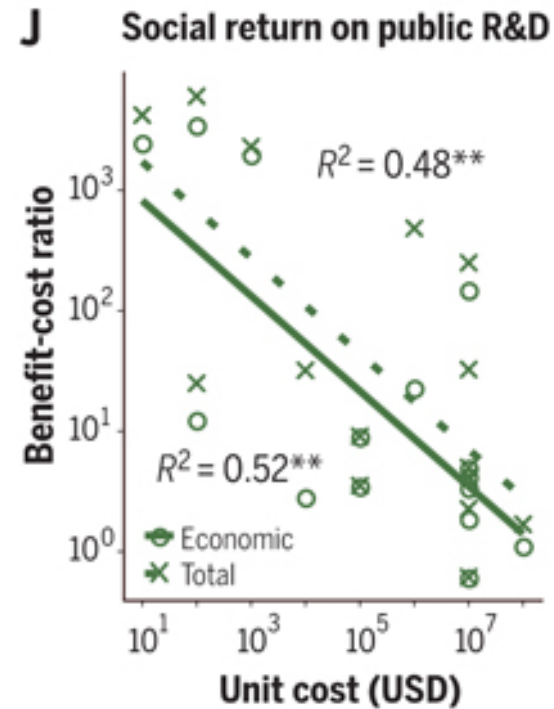
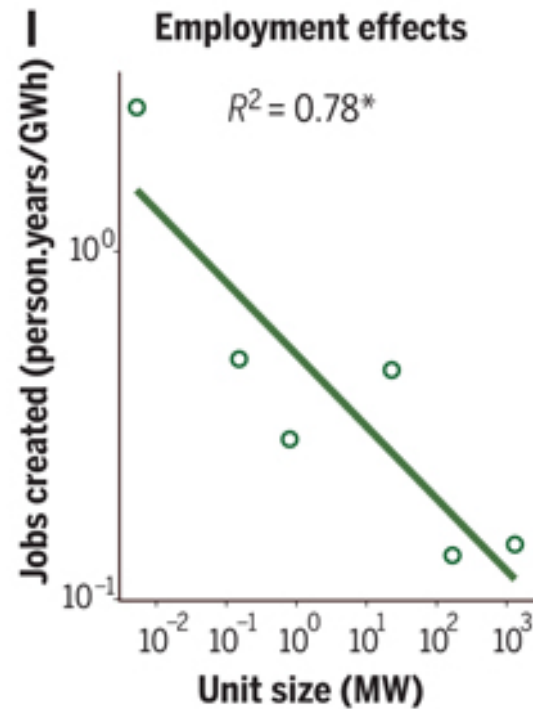
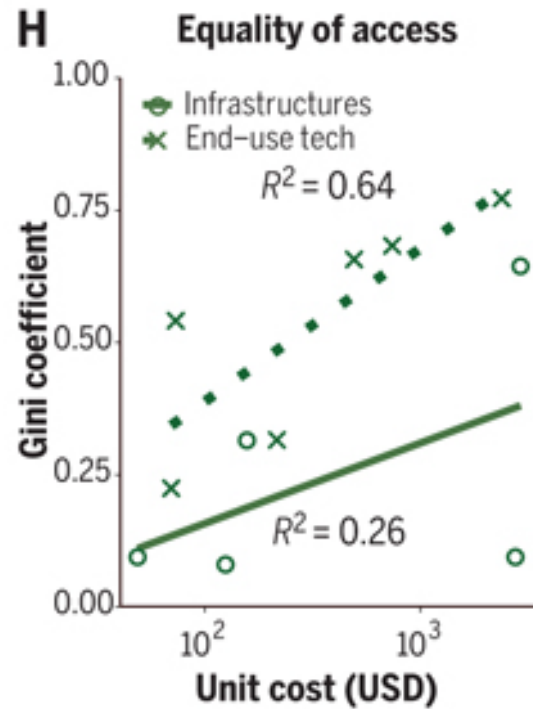
The role of granularity



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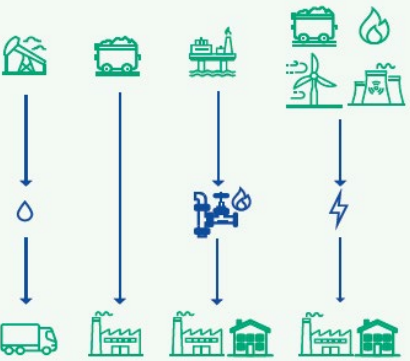
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- Opening 31 August 2020 by state secretary Van Veldhoven
- Signing of MoU with VDL
- Bringing together TU/e research aimed at systems for energy conversion and storage
- Development of icon systems together with the high-tech manufacturing industry

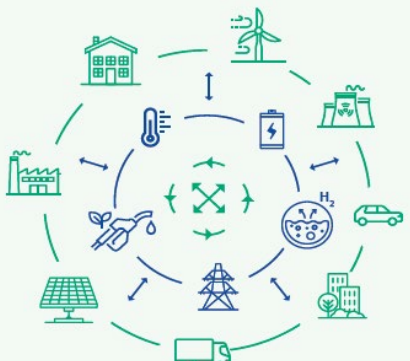


Renewables bring new challenges

The energy system today : linear and wasteful flows of energy, in one direction only

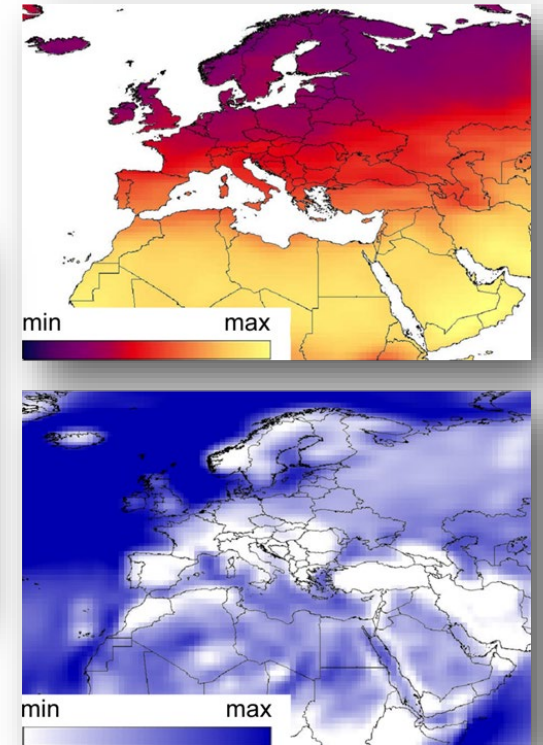
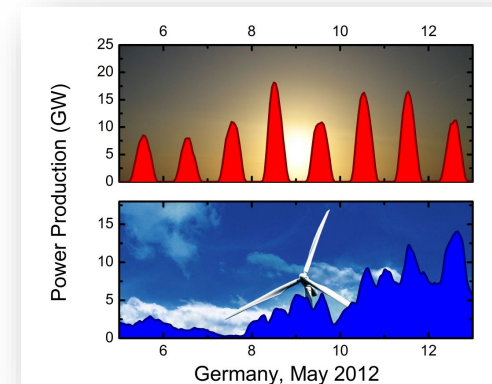


Future EU integrated energy system : energy flows between users and producers, reducing wasted resources and money



An Integrated EU Energy System will have **three main characteristics**:

- A more **efficient and “circular” system**, where waste energy is captured and re-used
- A **cleaner power system**, with more direct electrification of end-use sectors such as industry, heating of buildings and transport.
- A **cleaner fuel system**, for hard-to-electrify sectors like heavy industry or transport



Supply and demand: a mismatch in time and place

→ Transport, conversion and storage of renewable energy is key!

Systems for Sustainable Heat

- Chairs: Silvia Gaastra-Nedea and Henk Huinink
- Focus on development of new materials and systems for heat storage and transport
- Icon project heat battery
- Partners:

TNO innovation for life

 **CALDIC**

 **EVONIK**
Leading Beyond Chemistry

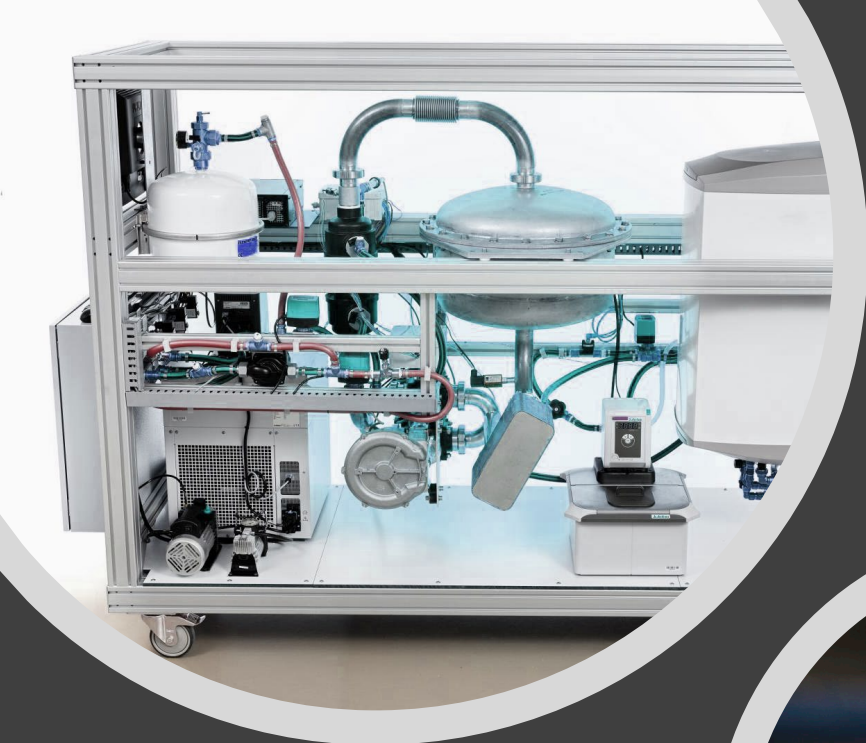
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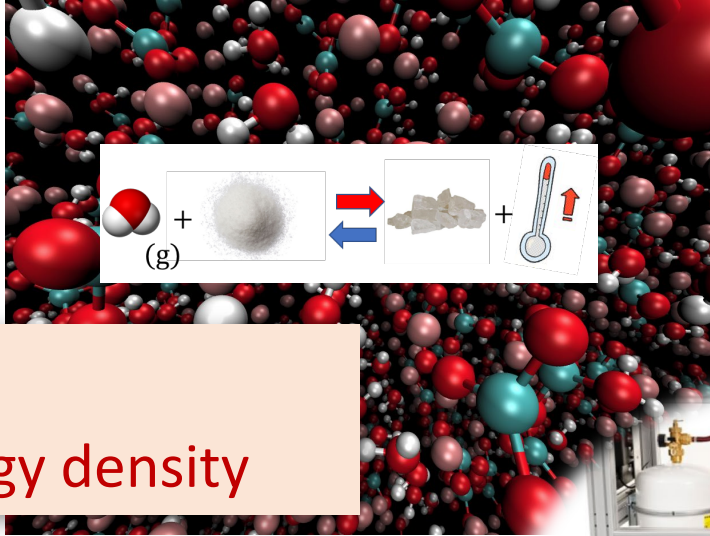
TRUDDO

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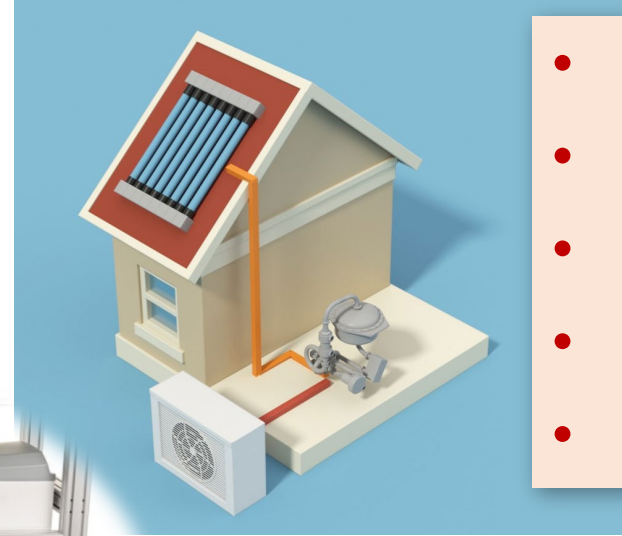


The thermochemical principle



- loss-free
- high energy density

En route to applications

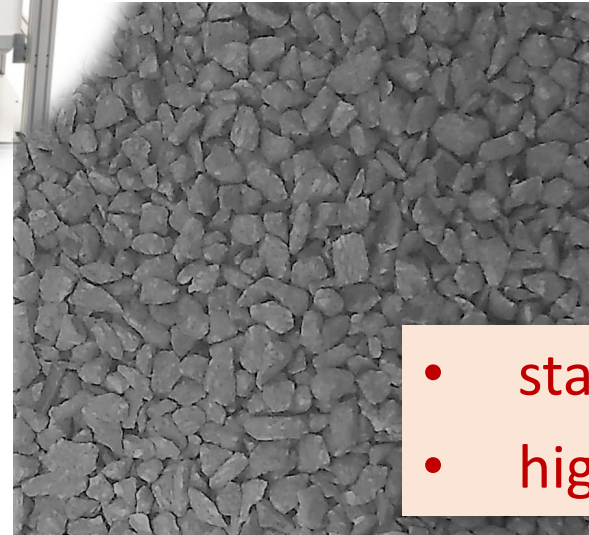


- affordable
- compact
- scalable
- silent & safe
- option: cooling



- simplicity:
4 components

new device principle



- stable
- high power

K₂CO₃-composite

Chemistry for Sustainable Energy Systems

- Chairs: Marta Costa Figueiredo and Adriana Creatore
- Focus on materials and structures to improve the performance of (electro)catalysts

- Icon project Dutch Electrolyzer

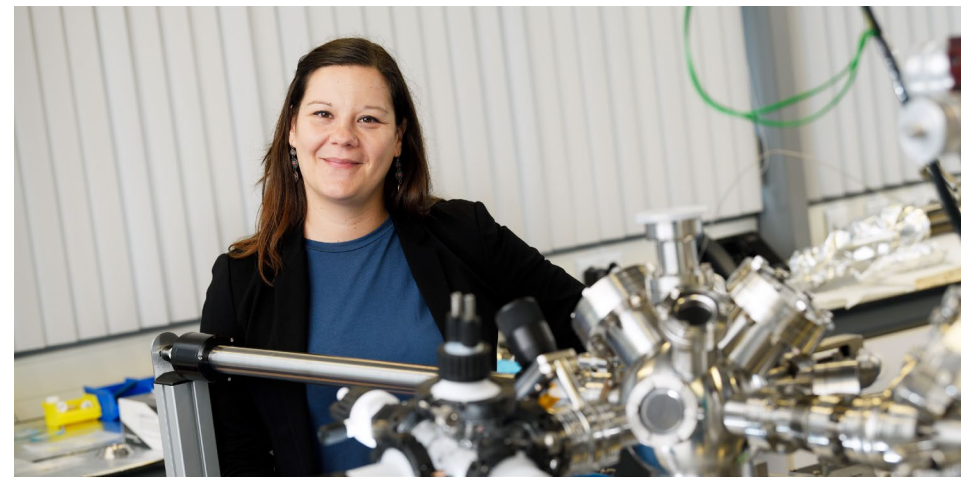
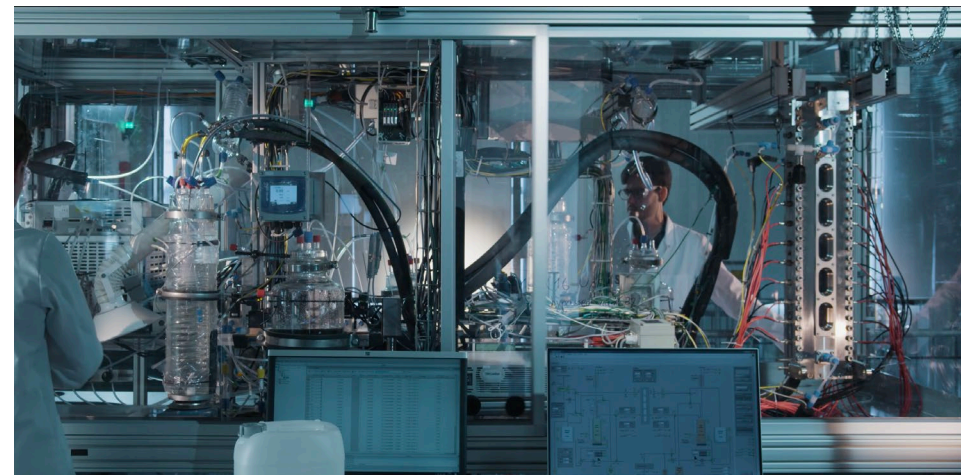
- Partners:



Provincie Noord-Brabant



Institute for Sustainable Process Technology





Systems Integration

- Chairs Lisanne Havinga and Guus Pemen
- Focus on modeling the production, conversion, and storage of renewable energy
- Icon project Deep Digit (tbc)
- Partners:

WOONinc.



alliander



ENEXIS
ENERGIE IN GOEDE BANEN



TRUDO



Energiedak®

ennatuurlijk

TU Delft



CONICO
VALVE TECHNOLOGY

VoltaSolar

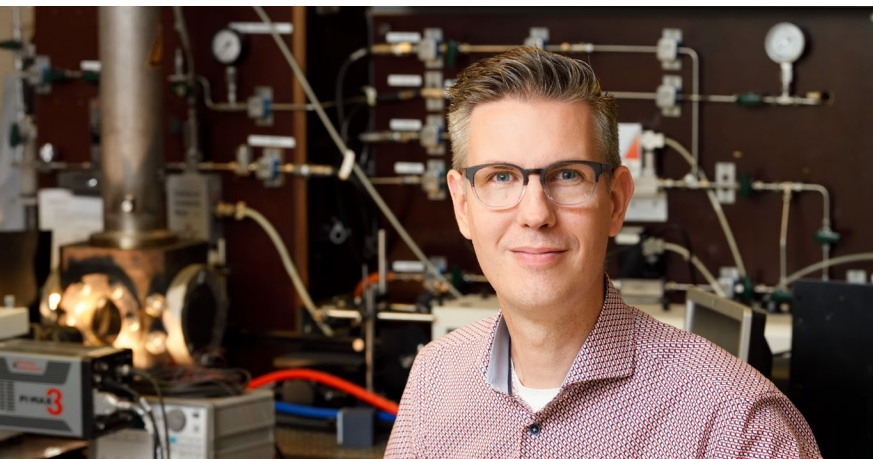
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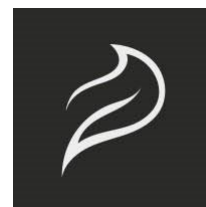
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Engineering for Sustainable Energy Systems

- Chairs Niels Deen and John van der Schaaf
- Focus on the design and testing of technical solutions for sustainable energy storage and conversion
- Icon project metal fuels
- Partners:



Provincie Noord-Brabant

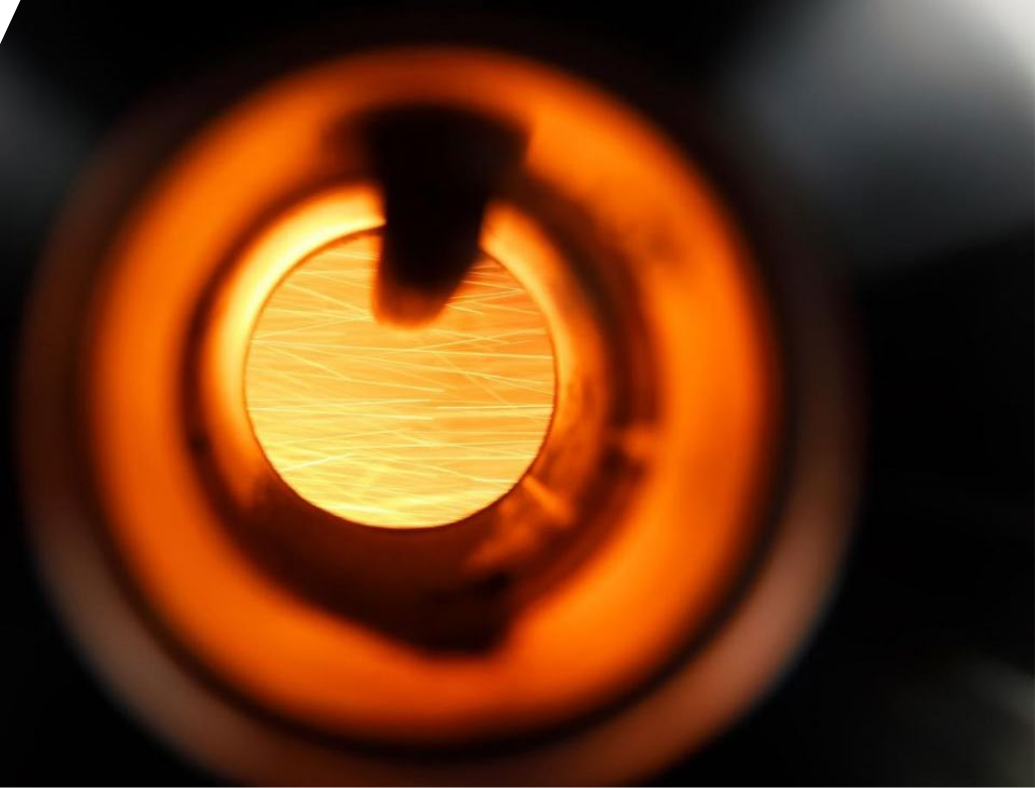


Foto credits Bart van Overbeeke and Mees van den Ekart



Conclusions

- The energy transition requires a giant acceleration
- Transport, conversion and storage of sustainable energy is key
- EIRES focus is therefore on small, modular scalable systems
- Research is organized around icon systems defined with industry



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Questions or comments?

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