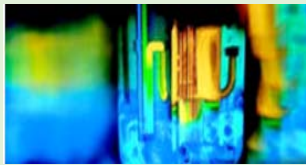


Energy decarbonation and nanotechnology

Challenges for Energy Systems decarbonation
Opportunities for nanotechnology
Transfer to industrial scale



EURO NANO FORUM

BUCHAREST JUNE 12TH 2019

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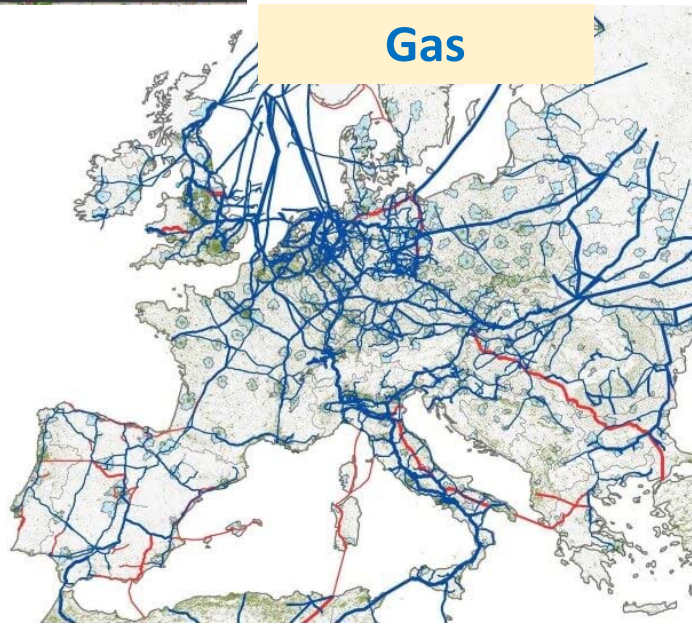
Networks for Energy Safety

Electricity



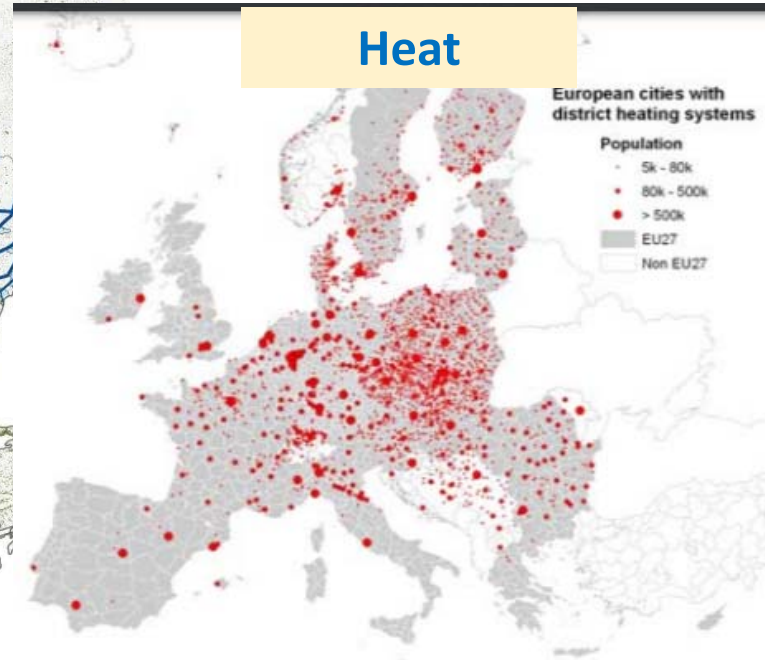
- Historically : Co-development with production sites
- High power electronics, new insulators, power electronics

Gas



- Long distance transportation
- Electricity / Gaz conversion
- Pipelines protection

Heat



- Long term cost-effective storage
- Energy efficiency
- Gaz / Heat conversion



Key technical elements for decarbonised reliable energy

- « Not all MWh have the same Customer value »
- **Time scale**
 - (ms, s), min , hour, week, month
 - multi-decenal Investments
- **Spatial scale**
 - « do it yourself » household energy system => continental scale
- **Comprehensive life cycle analysis.**



Required « flexibilities »

Productions

- Intermittents (wind, solar, ...)
- Intermediate (hydro, bio-sourced, ...)
- Dispatchable (nuclear, gaz, geothermal, ...)

Consumption

- Efficiency
- Smart consumption management
- Mobility and transportation

Storage

Multi Energy vector integration

Smart Network management

Power electronics

Networks and energy transportation





In Europe : Energy Security Need

Electric Network Static Equilibrium

Production = Consumption

New paradigms ?

- Auto-consumption, auto production
- Energy storage
- Suppressed or delayed consumption
- Importation/exportations
- New market rules
- Smart grid ,...

Prod. + Import – Eff_{prod} + Destorage = Cons + Export – Eff_{cons} + Storage

(space & time)

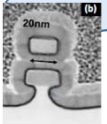
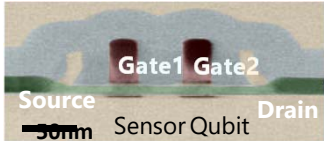
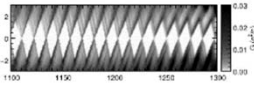
Anytime
everywhere
All scales,
Any “business model”,

+ **dynamic equilibrium**
 (“network service”)

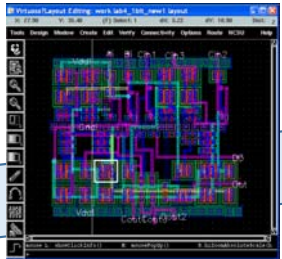


From research to industrial deployment

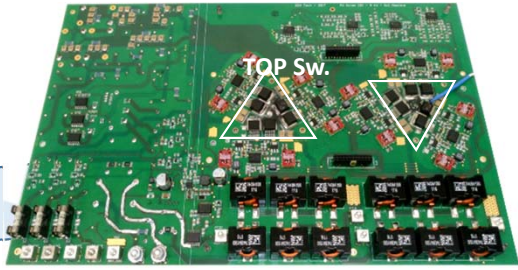
S&T Research



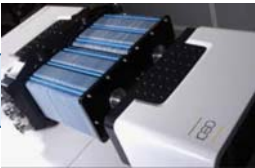
Key Enabling Technologies



Full scale Demonstrations



Cost-effective Volume Production





Spares



A few Challenges for advanced materials and nanotechnology towards cost effective and safe Decarbonised Energy

Digital

- Energy effective microelectronics
- Smart sensors
- ...

High power electronics

- Gan / SiC
- ...

Advanced Materials and advanced mechanics

- Trade offs
 - Optimise efficiencies / Reduce rare materials
 - Optimize materials / Allow recycling
- Safe and flexible Nuclear fuel
- Better electric machines (Magnets, 3D printing, ...)
- Higher temp. Heat resistant material
- Lighter structural material
- Optimised tribology
- Nanoporous insulating materials
- Switchable glasses
- New lighter copperless conducting materials
- ...

Advanced fluidics

- Thermal exchangers
- nano-fluids, nano-additives
- Nano-filtering (CO₂ separation?)

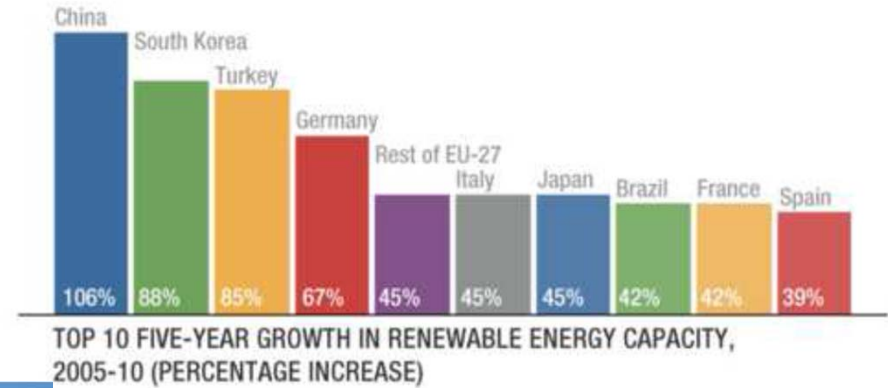
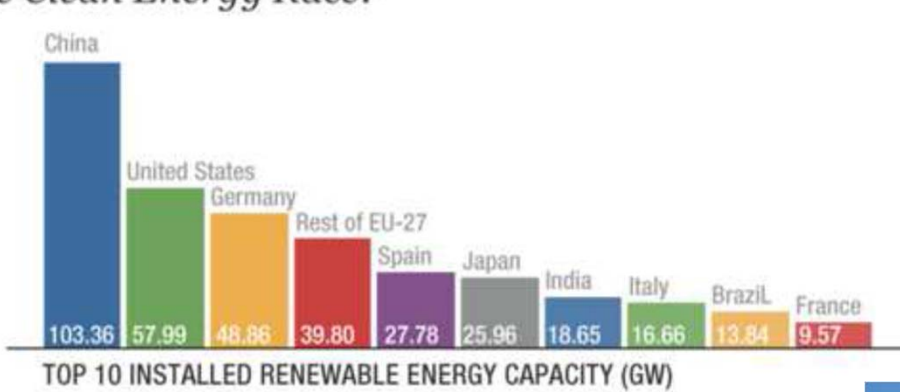
Energy storage

- Battery new electrodes
- Nano catalysis (H₂ FC)
- New hydrogen tanks
- Phase change materials
- ...

S&T Revolution needed in Energy Storage !!

World Energy : an ongoing revolution ?

The Clean Energy Race?



Saint Herblain FR 7,2 MW 2018 ?

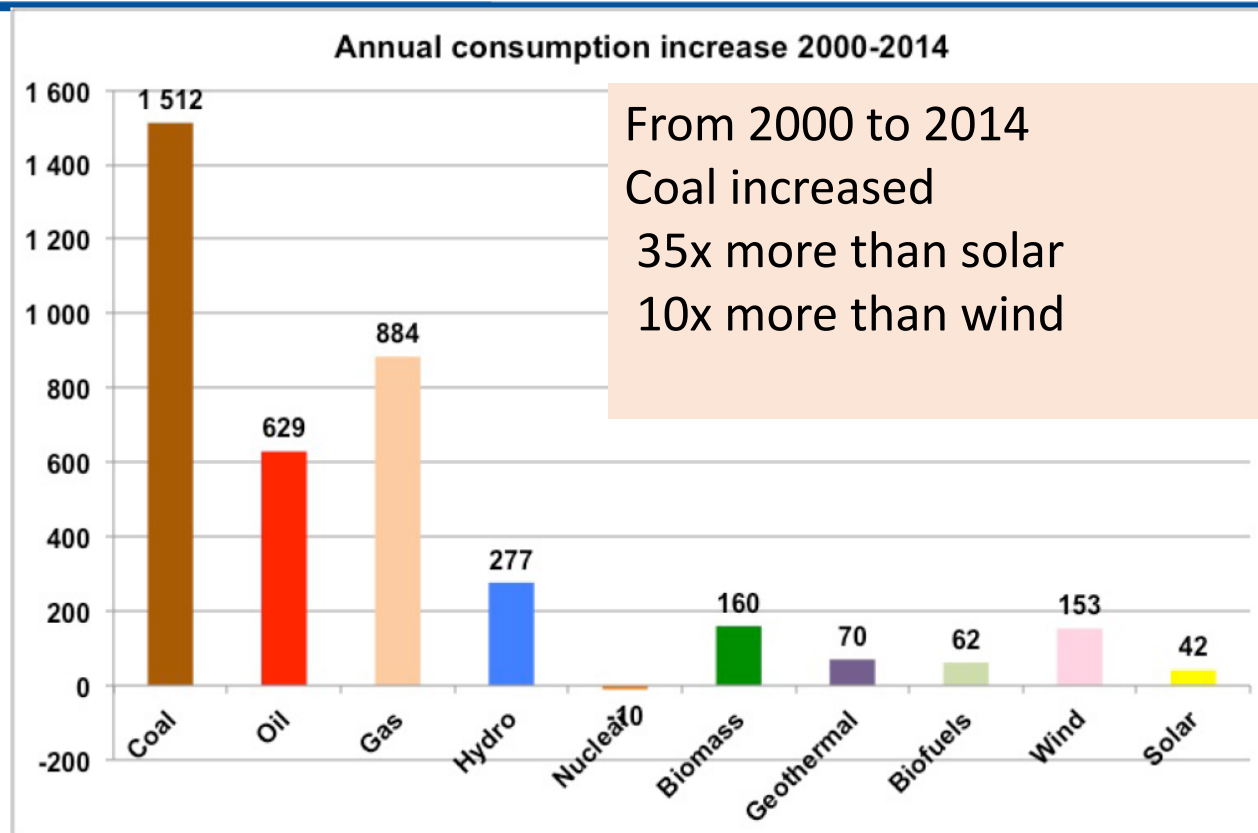


2016 France :
Typical : 3kWc
10-12k€
Energy return : 2,5y



Walney UK 0,367 => 0.66 GW 2018

Detectable revolution?

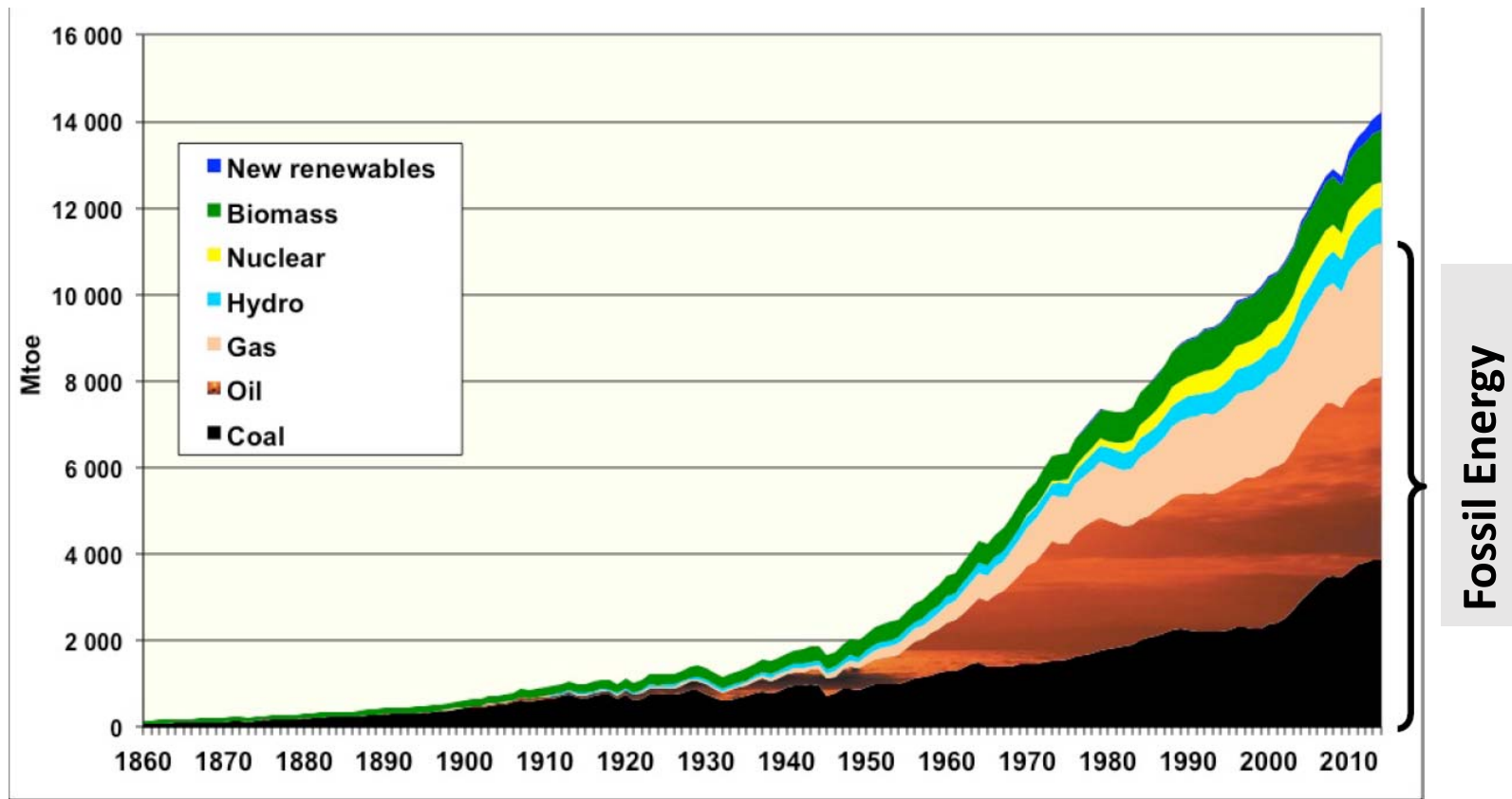


World consumption increase by energy between 2000 and 2014.

Jancovici from BP Statistical Review 2015 and others



World Energy: starting point 2015



Energy used by mankind since 1860. From Jancovici.