RENEWABLE ENERGY

International Energy Agency

Electrification, vector for further renewables deployment

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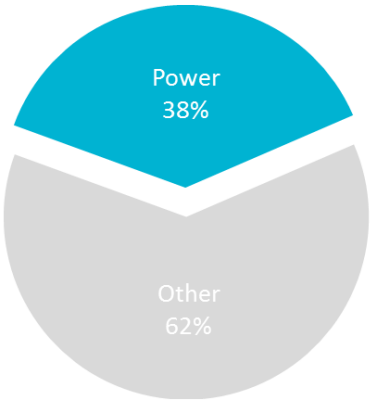
Electricity can power sustainable growth

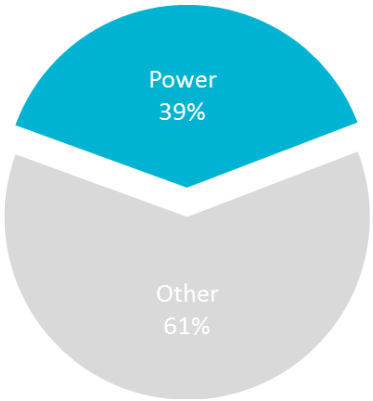
ETP 2014

2011

Primary energy use 550 EJ

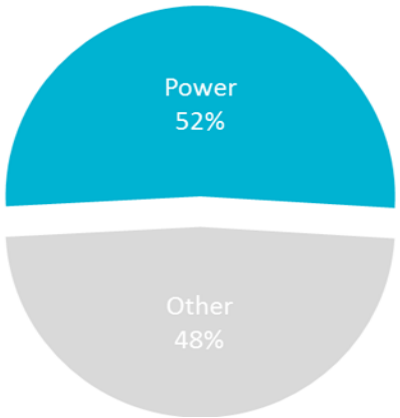


CO_2 emissions 33.8 Gt

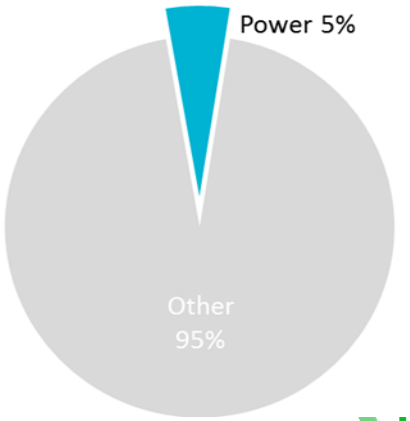


2050 2DS

Primary energy use 695 EJ

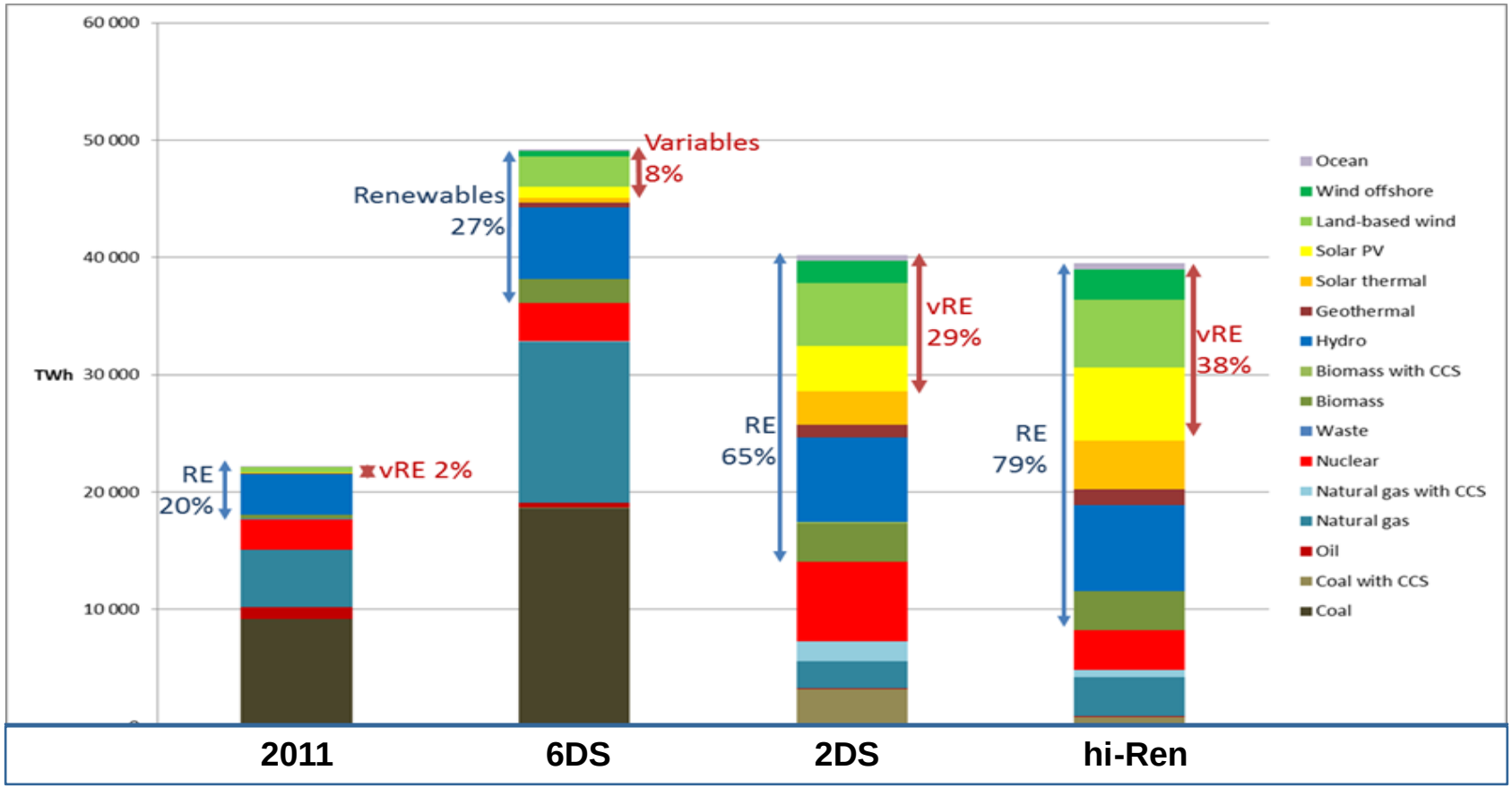


CO_2 emissions 15.0 Gt



Electricity Generation: a share reversal

ETP 2014



- **Generation today:**
  - **Fossil fuels: 68%**
  - **Renewables: 20%**
- **Generation 2DS 2050:**
  - **Renewables: 65 - 79%**
  - **Fossil fuels: 20 - 12%**

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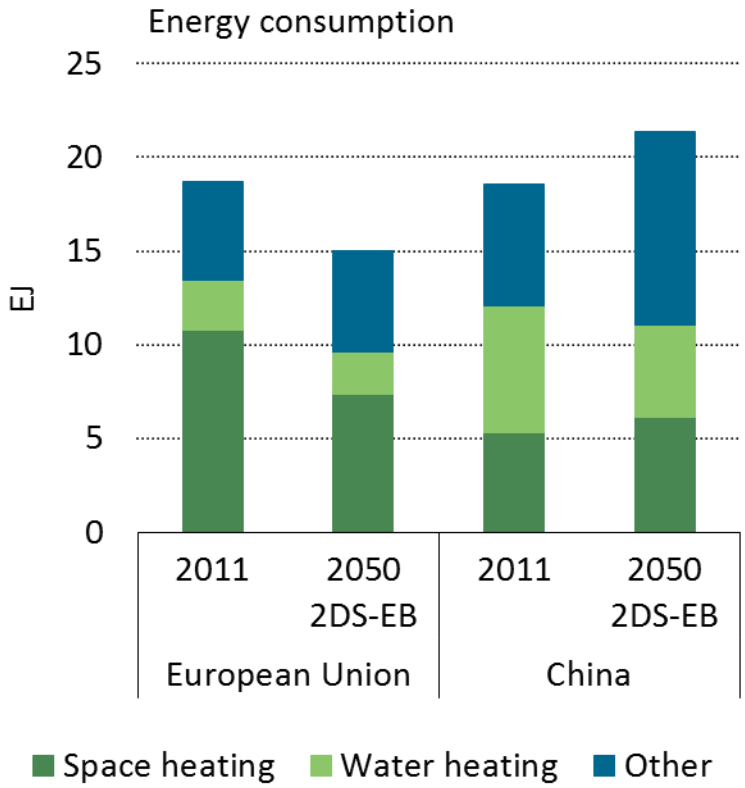
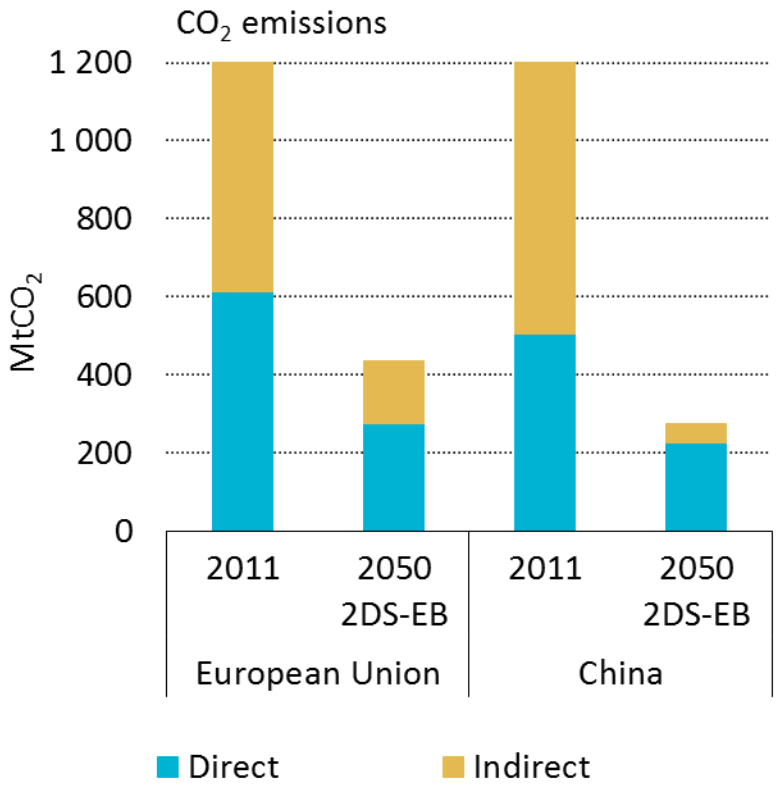
Building sector benefits most from decarbonisation of power generation

ETP 2014





Source: ETP 2014

Increasing electricity use also helps to reduce natural gas demand in buildings

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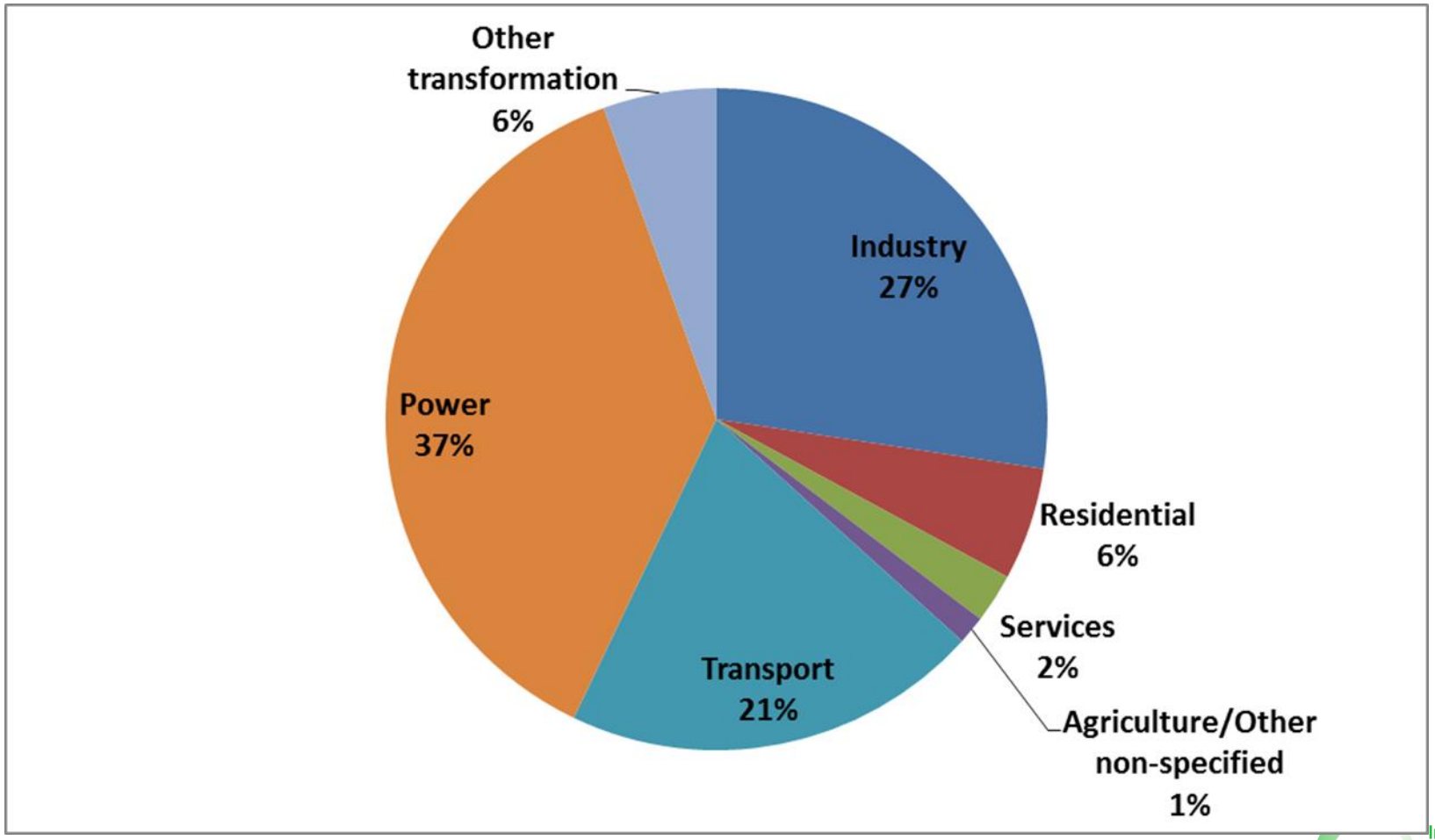
Direct « end-use » CO2 emissions

ETP 2014

Industry and transport dominate non power sectors



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Markets: Transports

Plug-in hybrid Golf GTE: the VW that doesn't cheat?

- Urban density favors shift towards public transports
- Renewable power and biofuels best options to substitute fossil fuels
- Electric and plug-in hybrid vehicles
- On-road electrification of trucks on highways

Renewables for manufacturing industries – ongoing work

- Manufacting industries use ~ 30% of global energy
  - 40% including feedstock, blast furnace and coke oven
- Demand would grow until 2050
  - by 83% in the 6DS scenario (ETP 2014)
  - By 40% in the 2DS scenario
- Some substitution would occur
  - Biomass would grow from 6% to day to 13% in 2050 (2DS)
  - Electricity would grow from 24% today to 32% in 2050 (2DS)

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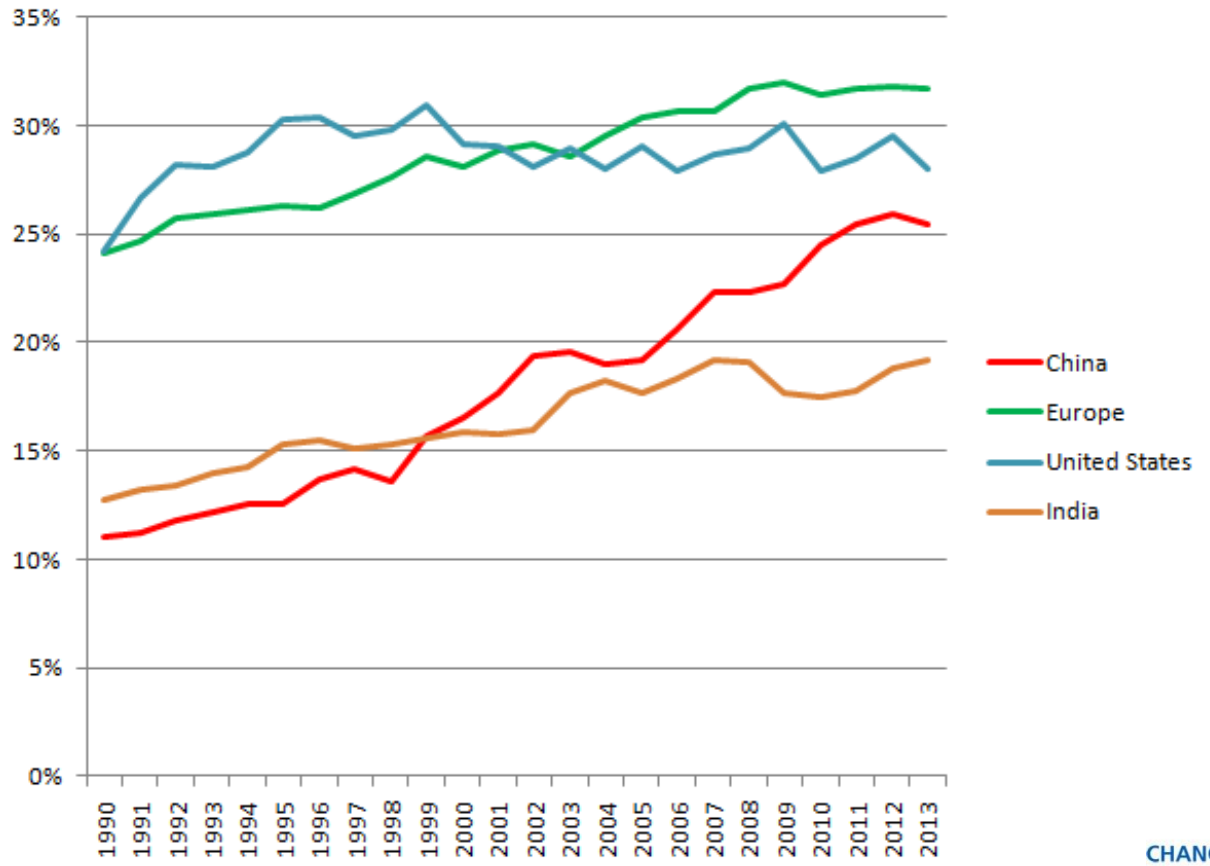
How to increase the use of RE in manufacturing industries?

- How to increase the use of RE as in 2DS or beyond?
  - For energy, feedstock, process agents…
  - Using biomass, solar heat, geothermal…
  - Hydrogen from renewables
  - (mostly) Renewable power, self-generated or from the grid
  - Electrification of industry help integrate more variable RE

Rising electricity demand from industry

Share of electricity in the total industrial energy consumption
Evolution for China, Europe, US and India between 1990 and 2013



Source : ENERDATA

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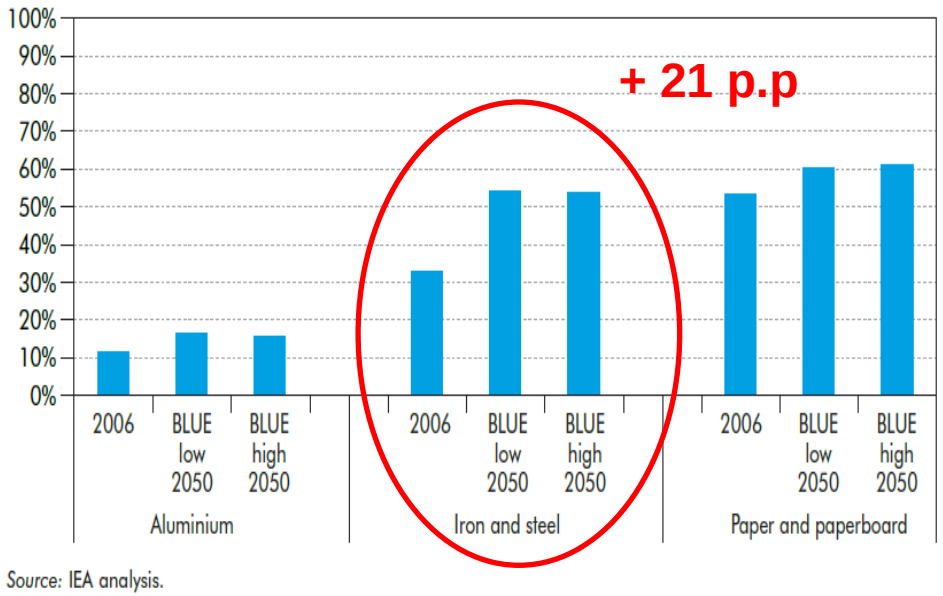
Current electrification trends

- Ferrous metal recycling
  - Energy-efficient
- Advanced manufacturing
  - Smart sensors
  - Further automation
  - Robotics & cobotics
- Additive manufacturing
  - 3-D printing save feedstock

Figure 7.12 ▶ Share of recycled materials by industry



Source: IEA analysis.

Source : Energy Energy Transitions for Industry (IEA, 2009)

CHANGER L'ÉNERGIE ENSEMBLE

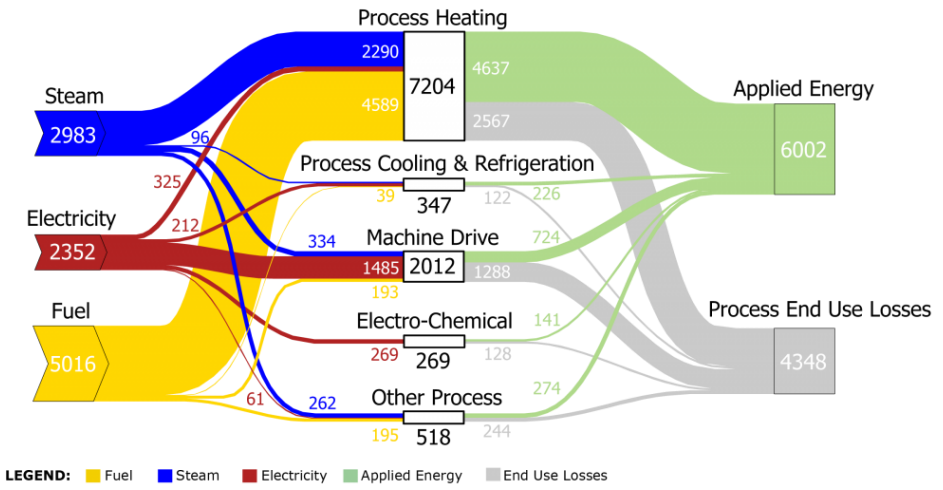
But process heating is the big fish (e.g. in the US)

Process Energy = 10 350 TBtu
88 %

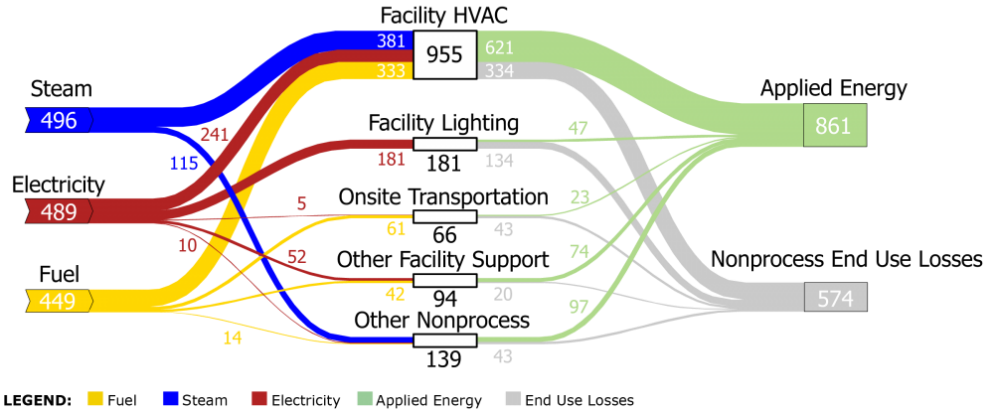
Process Heating Energy = 7 204 TBtu
61 %

Non Process Energy = 1 434 TBtu
12%

rocess Energy (TBtu), 2010



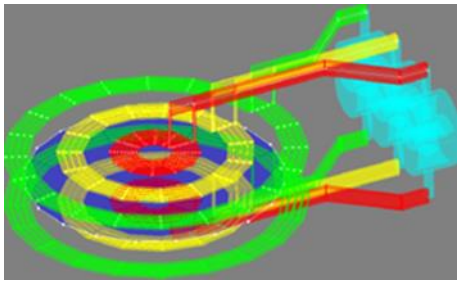
Nonprocess Energy (TBtu), 2010

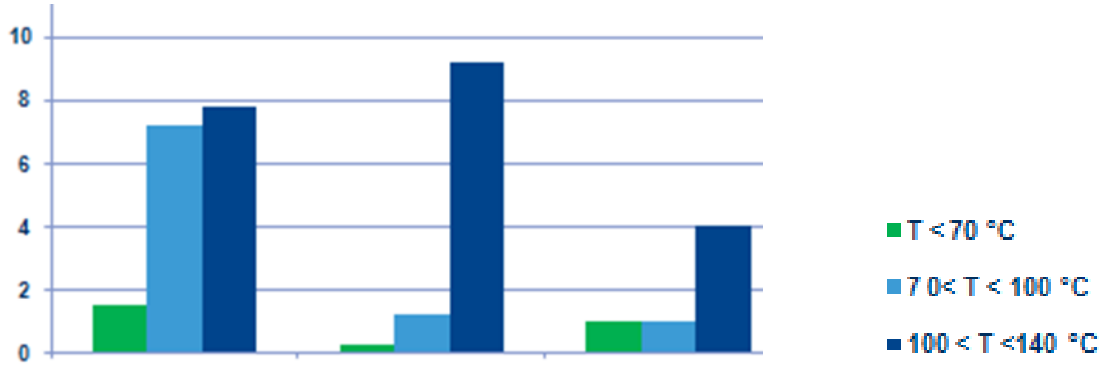


Source : D.O.E., Office of Energy Efficiency & Renewable Energy (from MECS 2010)

Efficient electric heating technologies

- Industrial heat pumps
  - Commercially available to 100°C output
  - Reaching 140°C output would double potential
- Induction heating and smelting
- Microwaves (food, rubber, plastics)…





Source : Energy Energy Transitions for Industry (IEA, 2009)

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Photo Credit : SAIREM

Hydrogen as an energy carrier and process agent

- Water electrolysis
  - <5% of the world global hydrogen production
  - no carbon emission, pure H_2
- In sunny countries, H_2 from concentrating solar-assisted CH_4 steam-reforming with easy CO_2 capture feasible
- Or solar heat-assisted electrolysis
- Process agent for, e.g., direct iron reduction

Electrowinning cell demonstrator (ULCOwin, 2011)

Switching to electricity : a lot of solutions in all sectors

- Gas compressors to electricity compressors in Oil & Gas and chemicals
- Electrification of mineral transportation in Mining & Minerals
- Drying using micro waves in Minerals
- Industrial heat pumps in Food and beverage and Pharmaceuticals

Economic Enablers-Barriers

- Price of electricity versus fossil (subsidies)
- Price for flexibility - TOU tariffs
- Price of CO2 and other externalities
- Energy Efficiency
- LCC versus up front investment

Technology Enablers - Barriers

- Process technology evolution (exp. heating)
- Load and peak management
- Storage (electricity & heat)
- Cogeneration

Schneider Electric

The hidden potential of the Pulp & Paper Industry

RES-E (TWh)	2013
PV	81
Wind	234
TOTAL	315

PPI electricity purchased from the grid (TWh)	2013
TOTAL	50

This is what the electricity system sees…

PPI on-site energy generation (TWh)	2013
Electricity	52
Heat	138
TOTAL	190

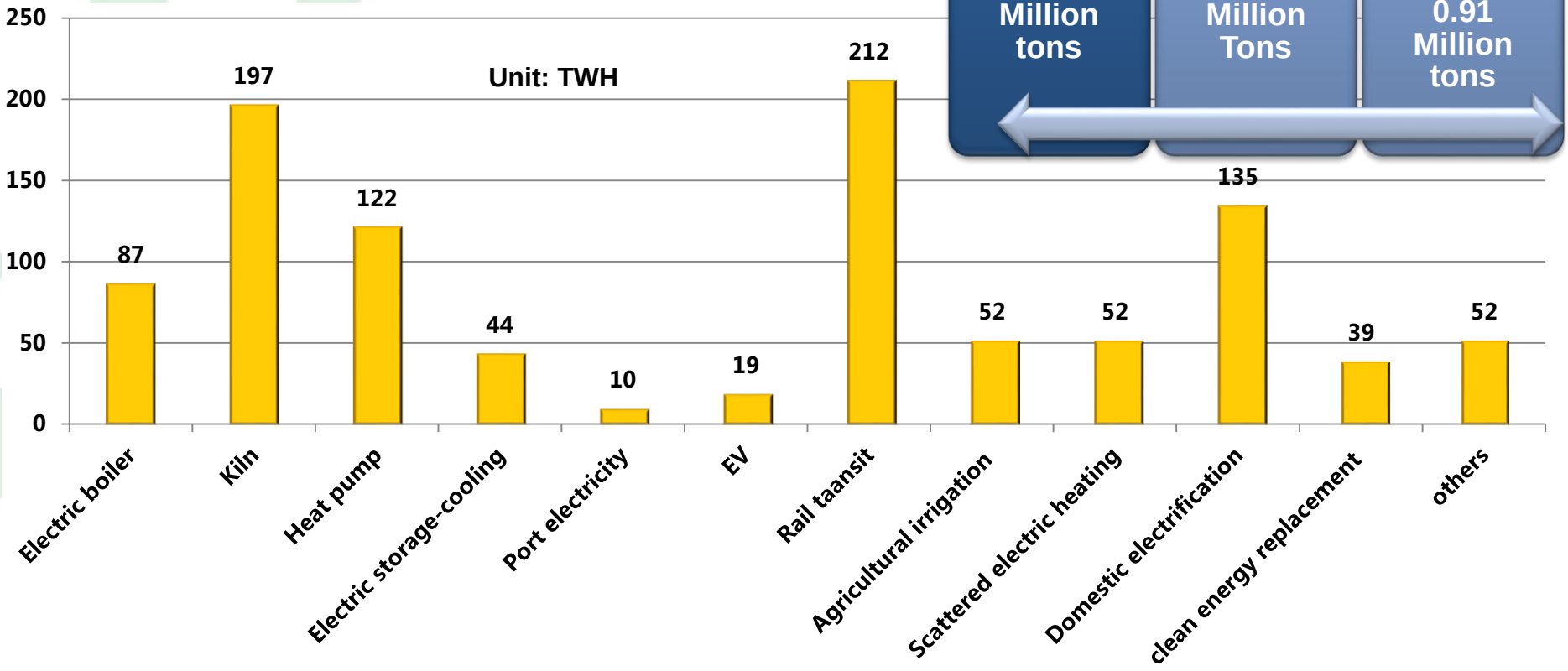
… but this is what the electricity system DOES NOT see!!!

Sources: EuObserv'ER, CEPI

Electricity replacement of SGCC

2014

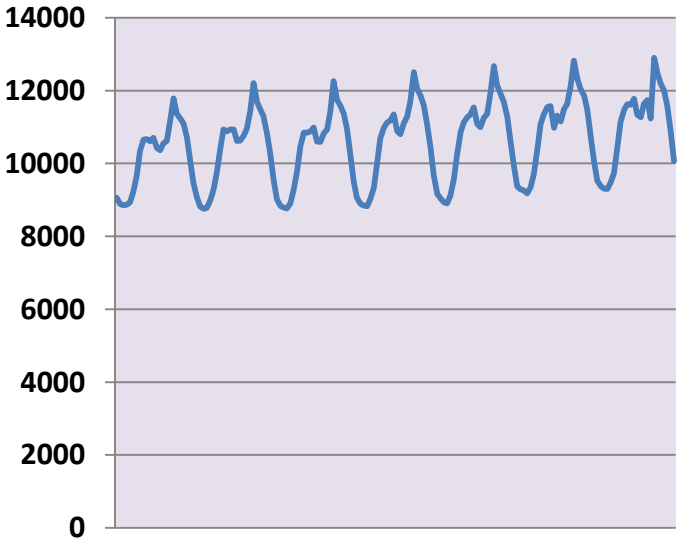
- Electricity replacement projects: 13000
- Number of related policies：121



Opportunities Brought by Industries Electrification

- Industries electrification will result in the growth of electricity demand which brings opportunities for RE grid integration.
  - Growth of industrial electricity provide a large **market for RE;**
  - Increase of the share of industrial load **changes the load profile** and **decrease the peak-valley ratio (peak-valley difference/ total load)** of load.

peak-valley ratio: 31.70%

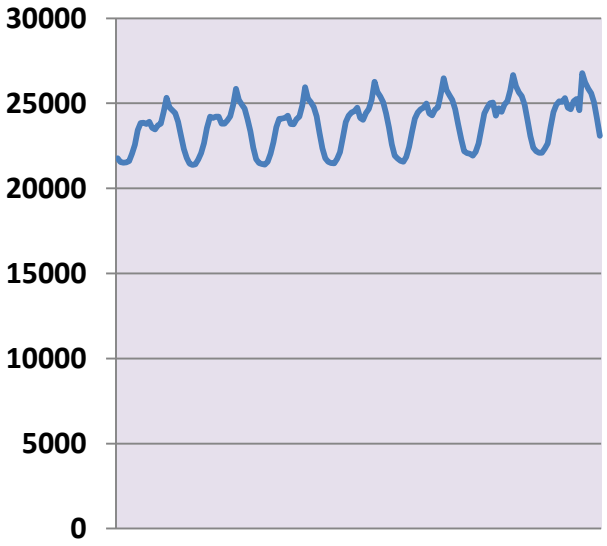


Residential load grow

Industrial load grow

Peak-valley ratio decrease

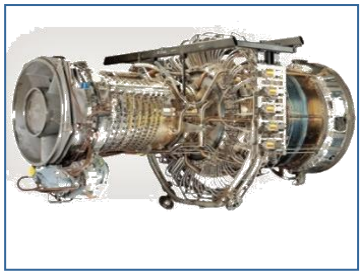
peak-valley ratio: 20.13%



Flexible power systems are key

More variables require more flexible power systems

Demand Side | Grids | Generation | Storage



Flexible power systems increase both **energy source diversification** and **system resilience**

Demand Flexibility as Storage Facility

The « Storage » Solution by Energy Pool

- **A Storage Facility can be:**
  - A electrochemical battery (Li-Ion or so on) at minimum 350$/kWh (Tesla)
  - « A existing consumer able to store energy with a low cost instrumentation »
  - …
- **What kind of consumers could store energy?**

Cold Storage Plant

Building

More than 5GW of consumers able to store energy is already existing in France!!

Thermal Energy Stored

Data-center

Ice Rink

Chemistry

Water

Potential Energy Stored

Some Economics

Comparison Battery/ Consumers

Battery

Battery Cost: 3500$/10kWh (Tesla annoucement)

Cost for a 1MW/1MWh Battery:

350k$

Water Supply
Distribution System

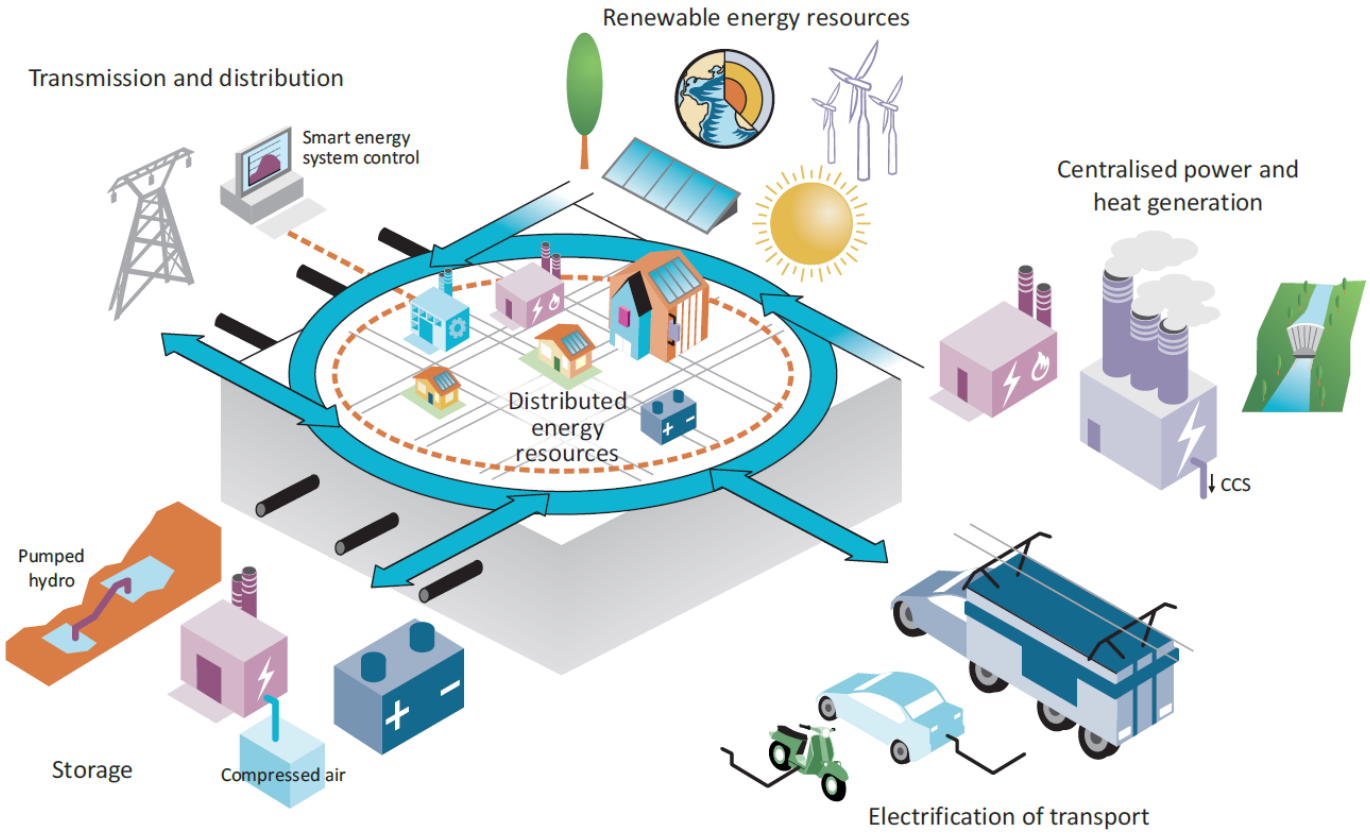
Instrumentation cost for a 1MW Flexibility at the consumer side:

35k$

Store Energy in existing consumers is 10 times cheaper than the cheapest battery!!

Systems thinking and integration

ETP 2014



A sustainable electricity system is a smarter, multidirectional and integrated energy system that requires long-term planning for services delivery

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Useful links

- **Renewable energies and manufacturing industries – first workshop, Paris, May 2015**
  - **https://goo.gl/3mFzHt**
- ***Energy Technology Perspectives 2014 – Harnessing Electricity's Potential***
  - ***http://www.iea.org/bookshop/472-Energy_Technology_Perspectives_2014***
- ***The Power of Transformation – Wind, Sund and the Economics of Flexible Power Systems***
  - ***http://www.iea.org/bookshop/465-The_Power_of_Transformation***
- ***Solar Energy Perspectives* (2011)**
  - **http://goo.gl/uIU0N6**