




New Trends in Energy

Storage

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Introductory lecture – Energy commodities and technologies

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Motivation for energy technology research and development



Why innovate?



Energy Efficiency – Cost Efficiency

- The cheapest kWh is a kWh not generated
- Making the best out of the available resources

Energy Security

- Resilient and robust energy system
- Taking advantage of domestic energy sources leads to reduced reliance on fuel imports

Climate Change

- Transition to low-carbon economy

Health and environment

- Reduced emission of air and water pollutants that adversely affect health

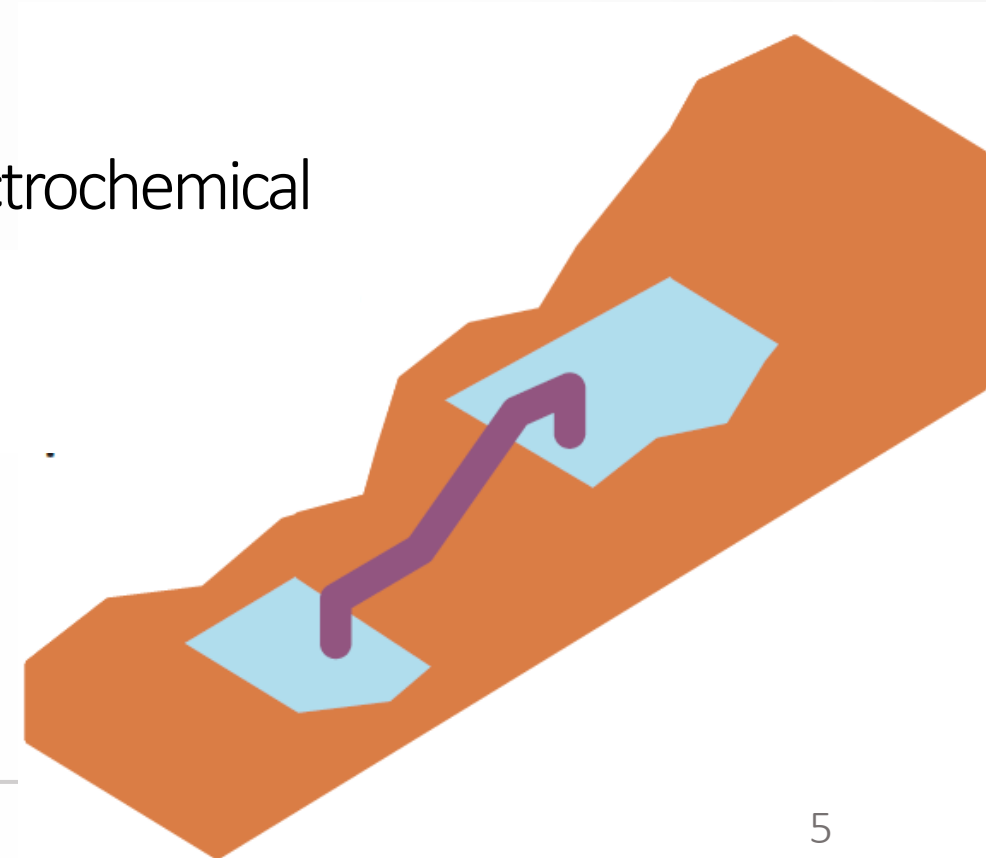


Storage

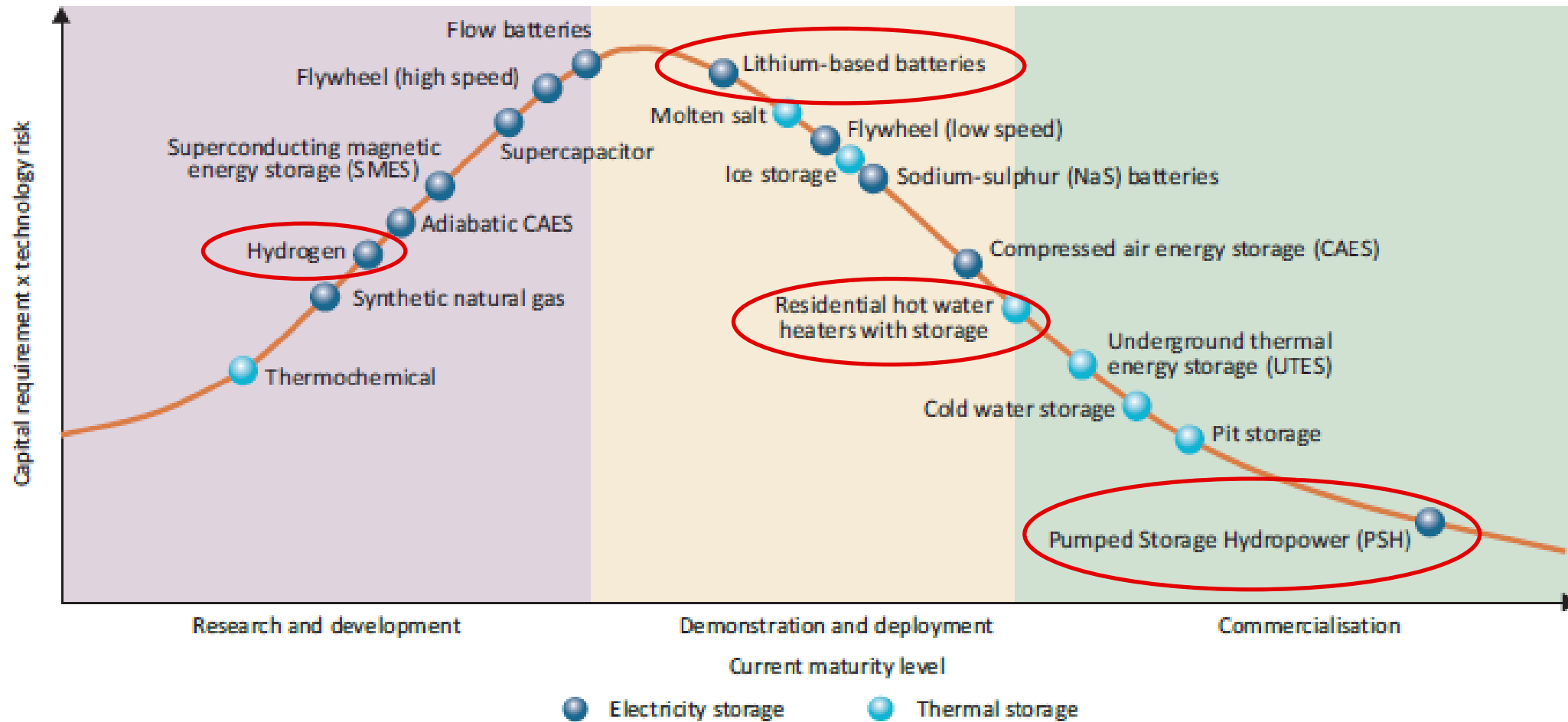
Storage – forms of storage

Energy can be stored in many forms and several media. Key examples include:

- Pumped-hydro storage >> gravitational
- Flywheels >> mechanical/rotational
- Solid state batteries (e.g. Li-ion batteries) >> electrochemical
- Compressed Air Energy Storage (CAES)
- Thermal energy storage – e.g. hot water



Maturity of energy storage technologies



Source: Decourt, B. and R. Debarre (2013), "Electricity storage", *Factbook*, Schlumberger Business Consulting Energy Institute, Paris, France and Paksoy, H. (2013), "Thermal Energy Storage Today" presented at the IEA Energy Storage Technology Roadmap Stakeholder Engagement Workshop, Paris, France, 14 February.



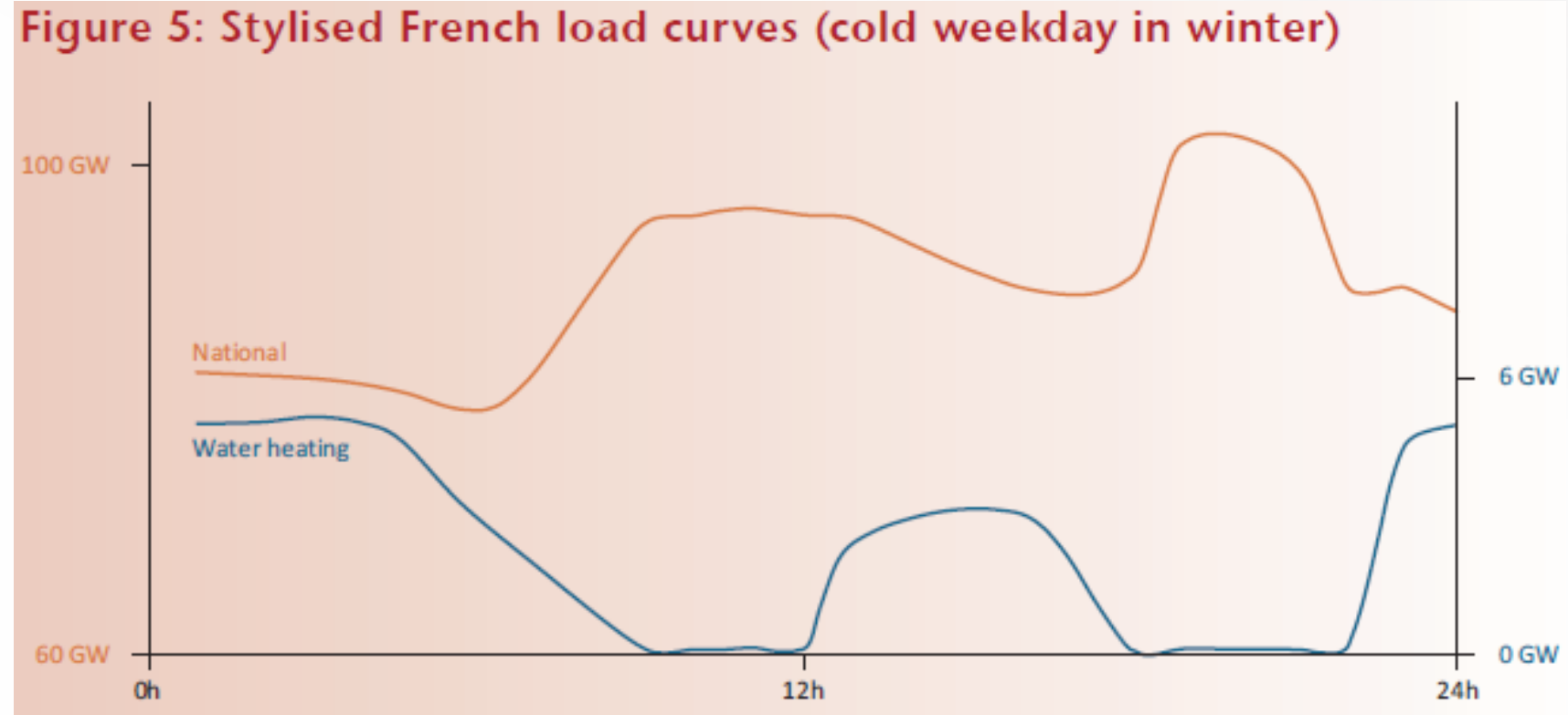
Storage – Benefits



- improving energy system resource use efficiency
- increasing use of variable renewable resources
- rising self-production and self-consumption of energy (electricity, heat/cold)
- increasing energy access (e.g. via off-grid electrification using solar photovoltaic (PV) technologies)
- facilitating in electricity grid stability, reliability and resilience
- increasing end-use sector electrification (e.g. electrification of transport sector).

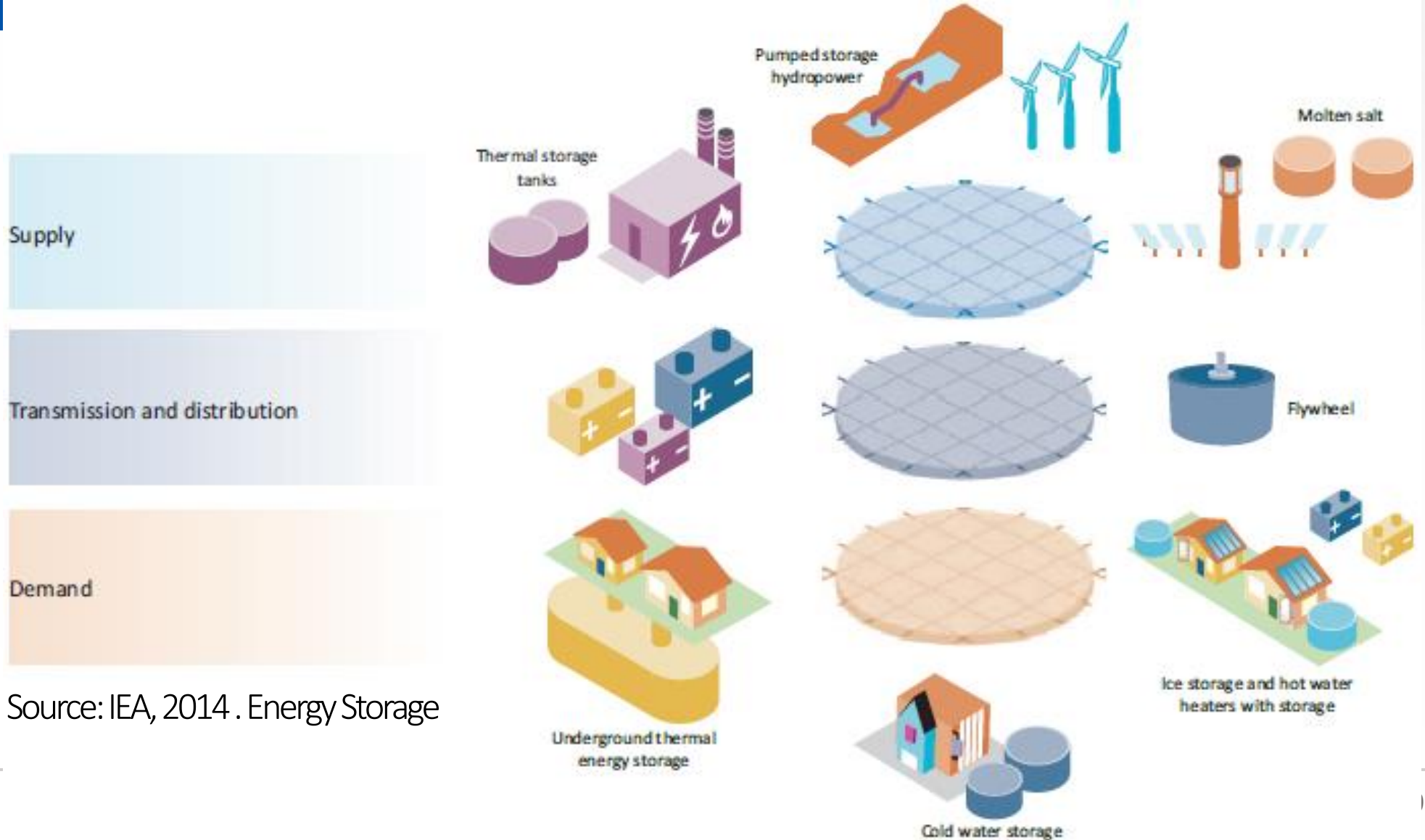
Storage applications

- Seasonal storage
- Energy arbitrage and peak demand shifting
- Ancillary services
- Black start
- Grid congestion relief
- Off-grid energy demand



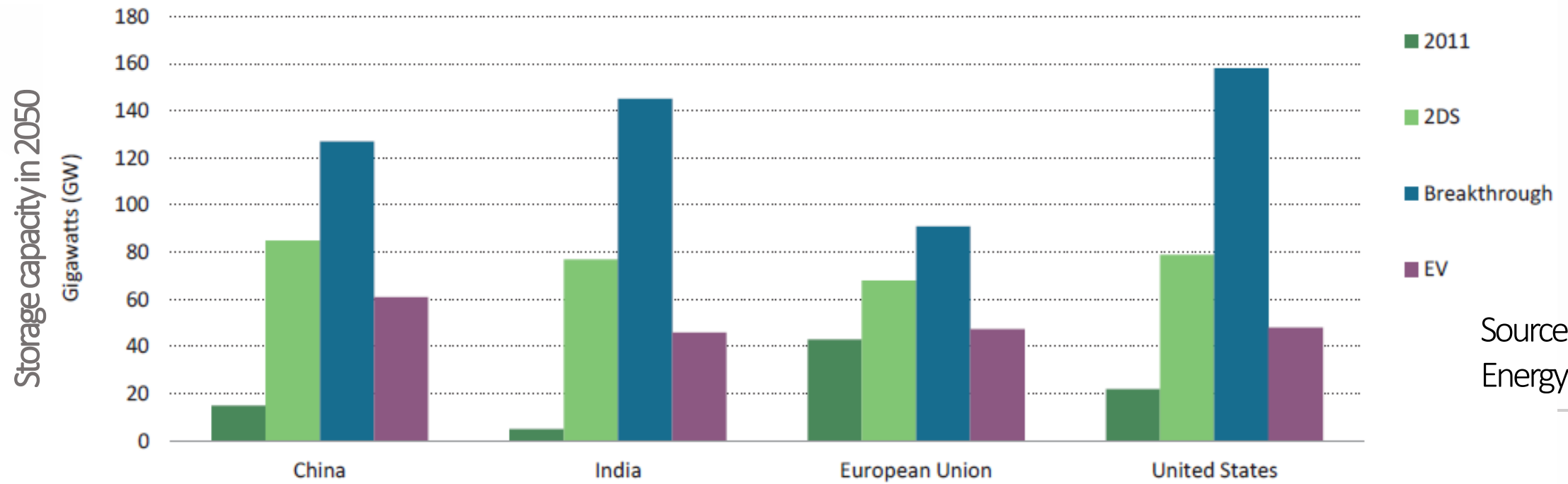
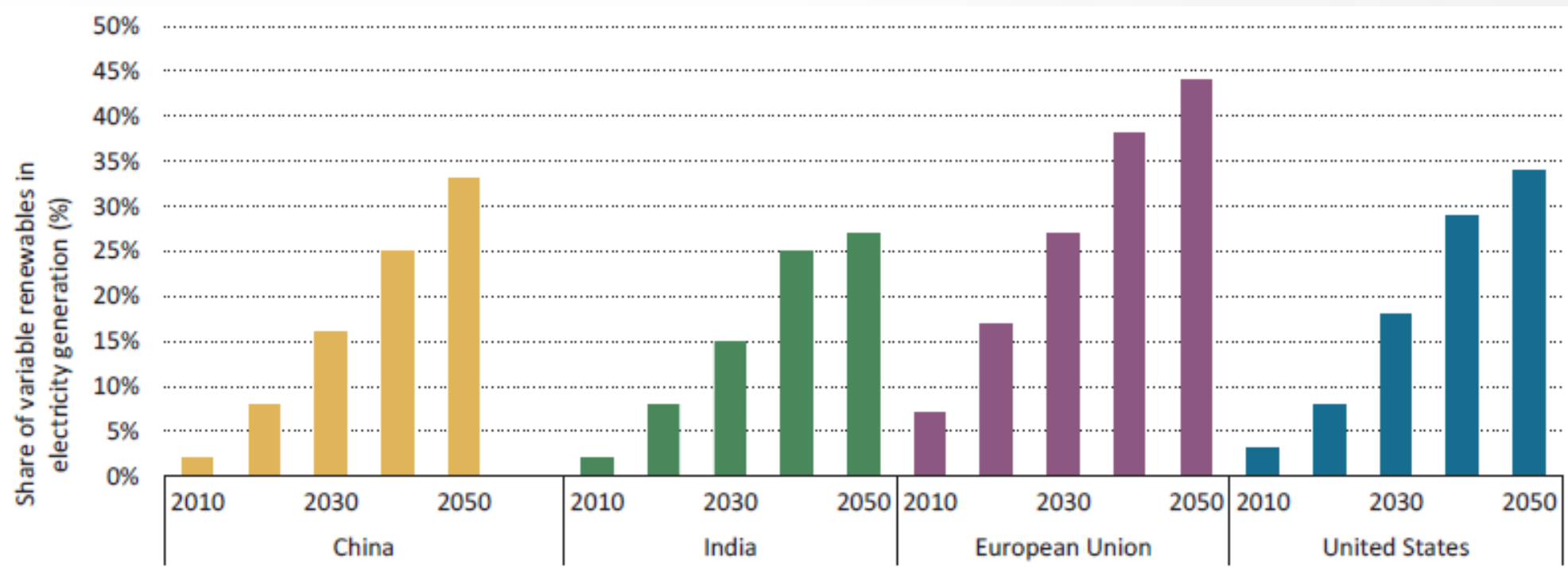
Source: IEA, 2014 . Energy Storage

Storage deployment options for electricity

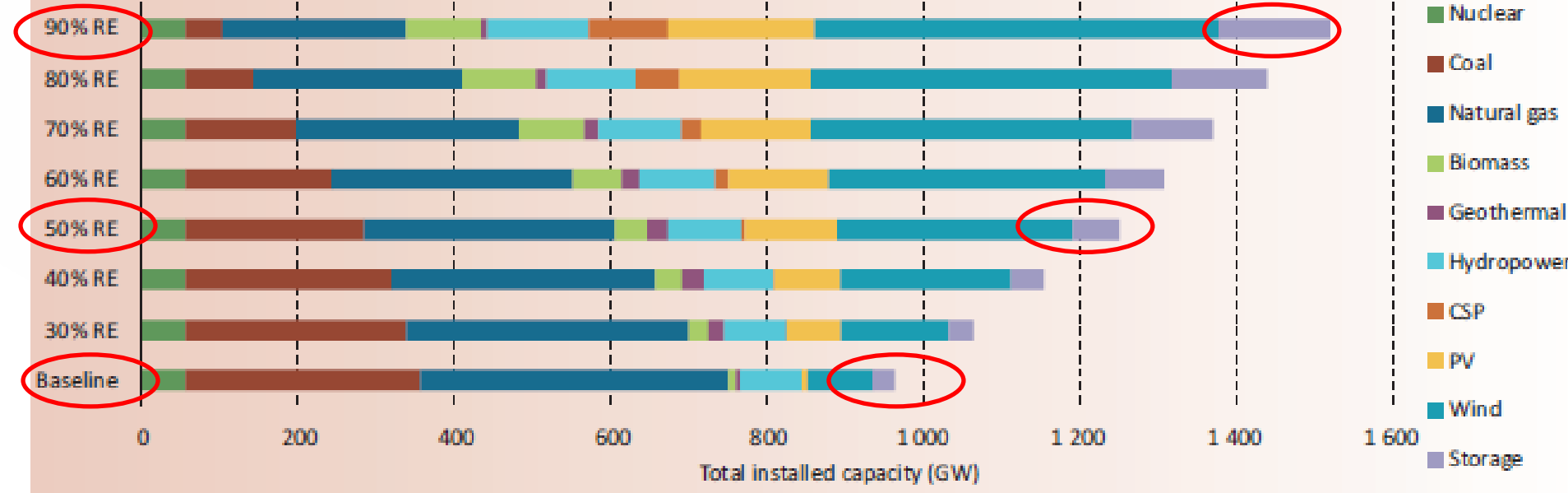
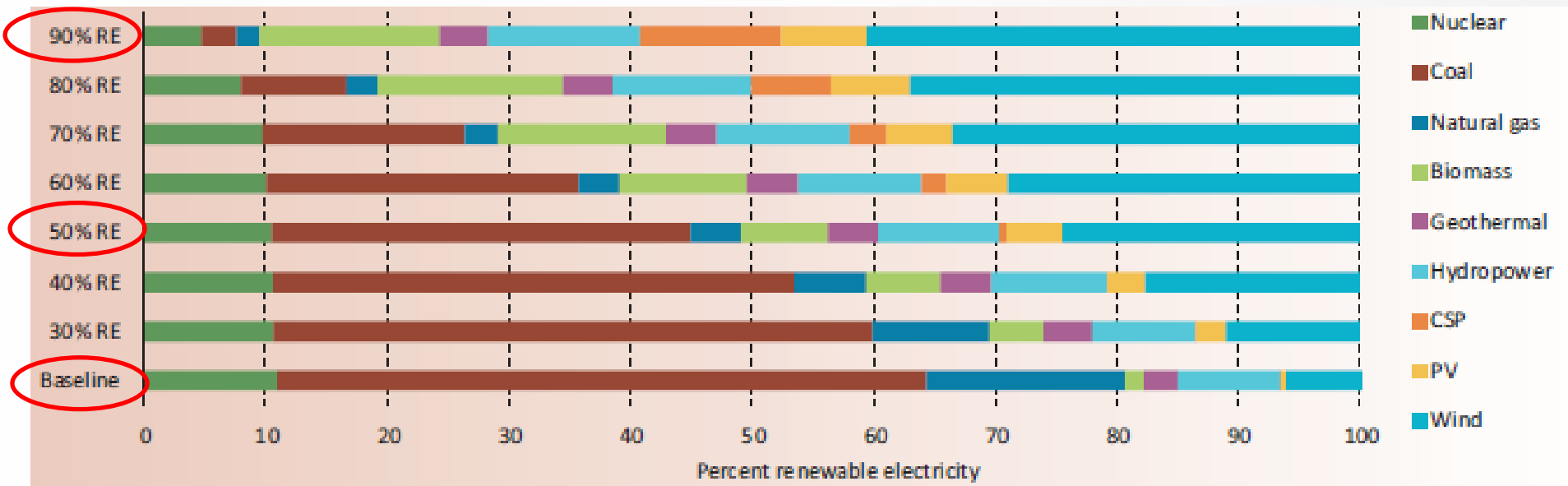


Source: IEA, 2014 . Energy Storage

IEA ETP 2DS scenario—
80% chance to limit
global temperature
increase to 2°C

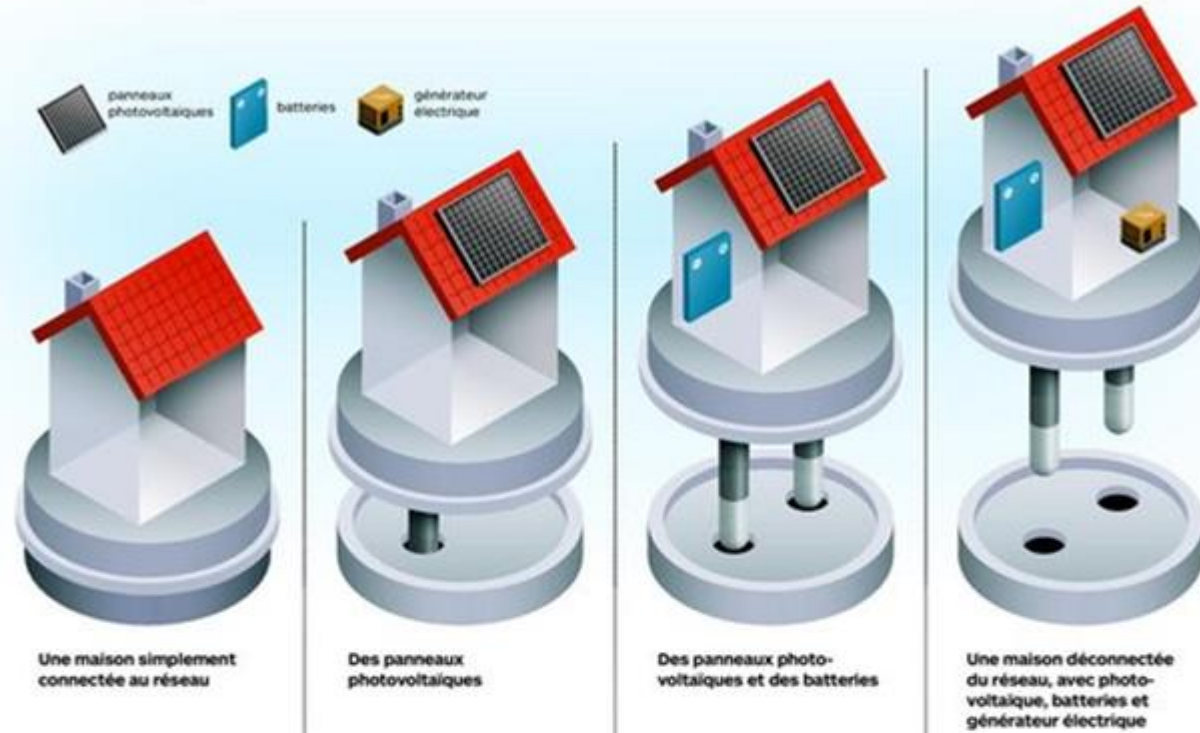


Source: IEA, 2014 .
Energy Storage



Share of renewables vs storage capacity in the United States in 2050

Source: IEA, 2014 . Energy Storage



Une maison simplement connectée au réseau

Des panneaux photovoltaïques

Des panneaux photovoltaïques et des batteries

Une maison déconnectée du réseau, avec photovoltaïque, batteries et générateur électrique

Coût annuel total

875€

Coût de l'électricité (LCOE)
25 cents par kWh

Coût de l'investissement*
0 euros

Hypothèse : le ménage consomme 3.500 kWh par an, facturé par son fournisseur.

*: un investissement rémunéré à 2% par an

Source: L'Echo/Alig
Infographie: Filip Vandenberg

336€

8,25 cents par kWh

4.800 euros

(4 kWc de panneaux photovoltaïques = 4.800 euros)

Hypothèse : les panneaux produisent 3.500 kWh par an, soit exactement la consommation du ménage, et grâce au compteur qui tourne à l'envers, la facture d'électricité en fin d'année est égale à zéro.

651€

18,6 cents par kWh

4.552 euros

(2,8 kWc de panneaux photovoltaïques = 3.360 euros et 2,98 kWh de batteries = 1.192 euros)

Hypothèse : les panneaux produisent 2.500 kWh par an, dont 400 kWh sont « perdus » et injectés gratuitement sur le réseau. Les batteries stockent 590 kWh, dont 490 sont restitués. Le ménage doit prélever 1.500 kWh par an sur le réseau pour couvrir sa consommation, au tarif normal.

808€

23,1 cents par kWh

6.340 euros

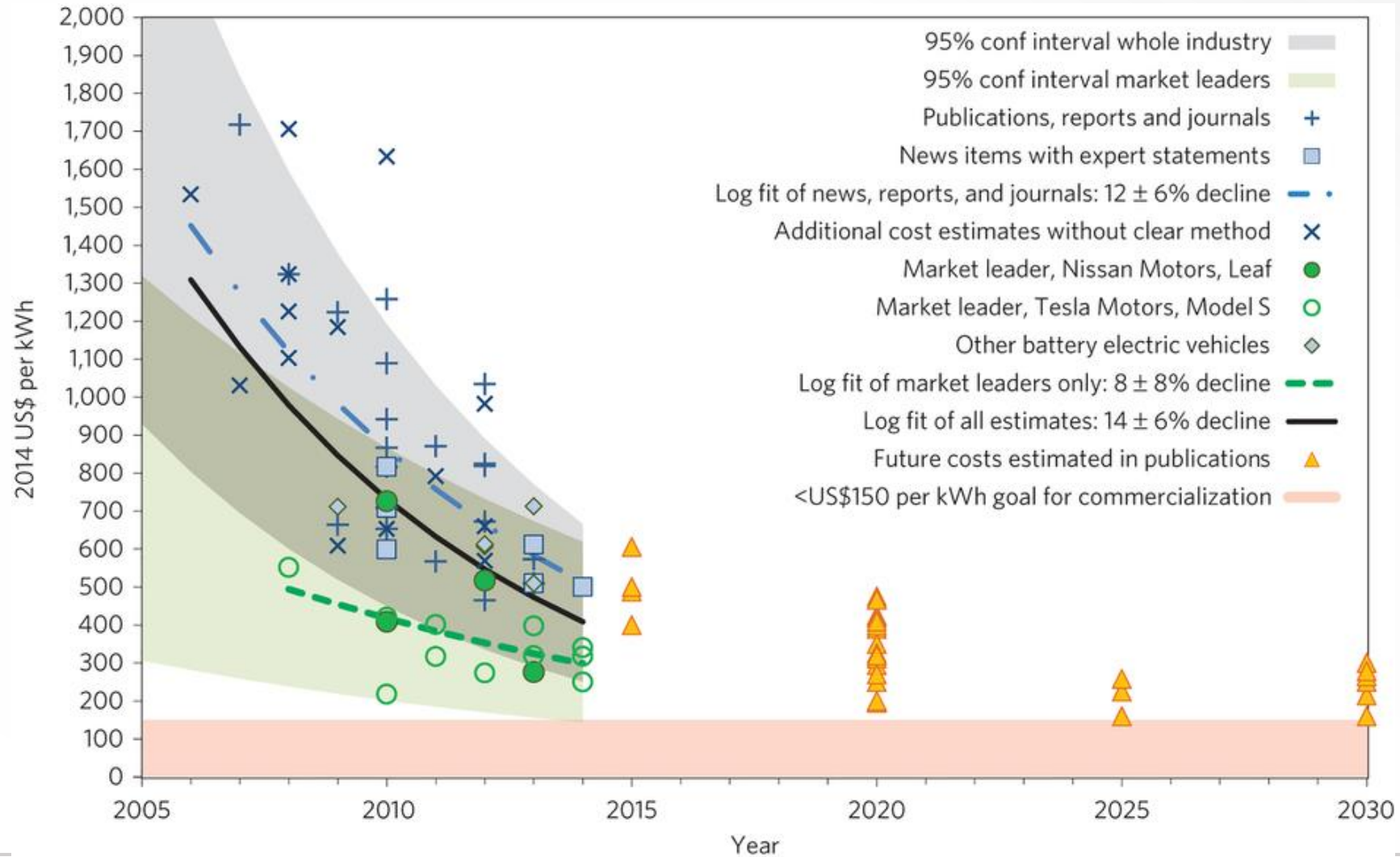
(3,2 kWc de panneaux photovoltaïques = 3.840 euros, 3,5 kWh de batteries = 1.400 euros et un générateur diesel de 5 kW à 1.100 euros)

Hypothèse : le générateur tourne au gasoil de chauffage (0,6 euro par litre). Les panneaux produisent 2.770 kWh par an, dont 500 kWh sont injectés gratuitement sur le réseau. Les batteries stockent 700 kWh, dont 570 sont restitués.

Electricity cost in Belgium and the potential for off-grid generation

Source: www.lecho.be

Cost of Li-ion battery packs in BEV



Source: Nykvist & Nilsson, 2015



Suggested further reading



- IEA Technology Roadmap: Energy Storage

http://www.oecd-ilibrary.org/energy/energy-storage_9789264211872-en



Changelog and attribution



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