

MINERAL RAW MATERIALS AND ENERGY

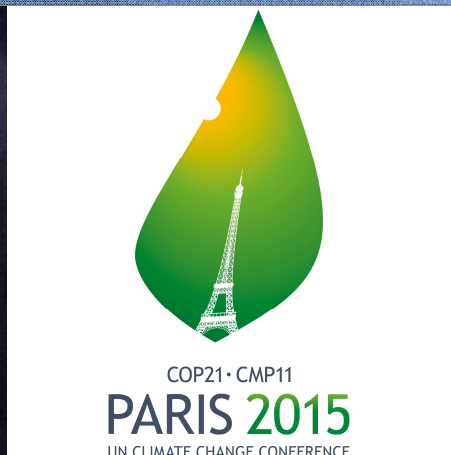
Selected facts and figures from the report produced by the French Alliance for Energy Research Coordination (ANCRE)

Presented by co-author Patrice Christmann (BRGM) on behalf of the Coordination Olivier Vidal (CNRS)

COP 21 – COMES Side-event – Paris, December 7th, 2015

Report available here (In French):











http://www.mineralinfo.fr/sites/default/files/upload/ancre_rapport_2015-ressources_minerales_et_energie_0.pdf



Most elements in the periodic table are essential to the innovative technologies required to address mankind's energy problems

H																	He
Li	Be	RAW MATERIALS NEEDED FOR ENERGY SECTOR APPLICATIONS (MOST ARE FROM MINING ACTIVITIES)										B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Uut	Uuq	Uup	Uuh		Uuo

Lanthanides	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Hm	Er	Tm	Yb	Lu
(Rare Earth)														
Actinides	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

	Energy storage		Electricity generation and storage		Lighting
	Connectivity		Elements specific to nuclear electricity generation		Supraconductors
	Energy saving		Photovoltaics		
	Catalysis (fuel cells)		Permanent magnets for windmills and electrical/ hybrid cars		



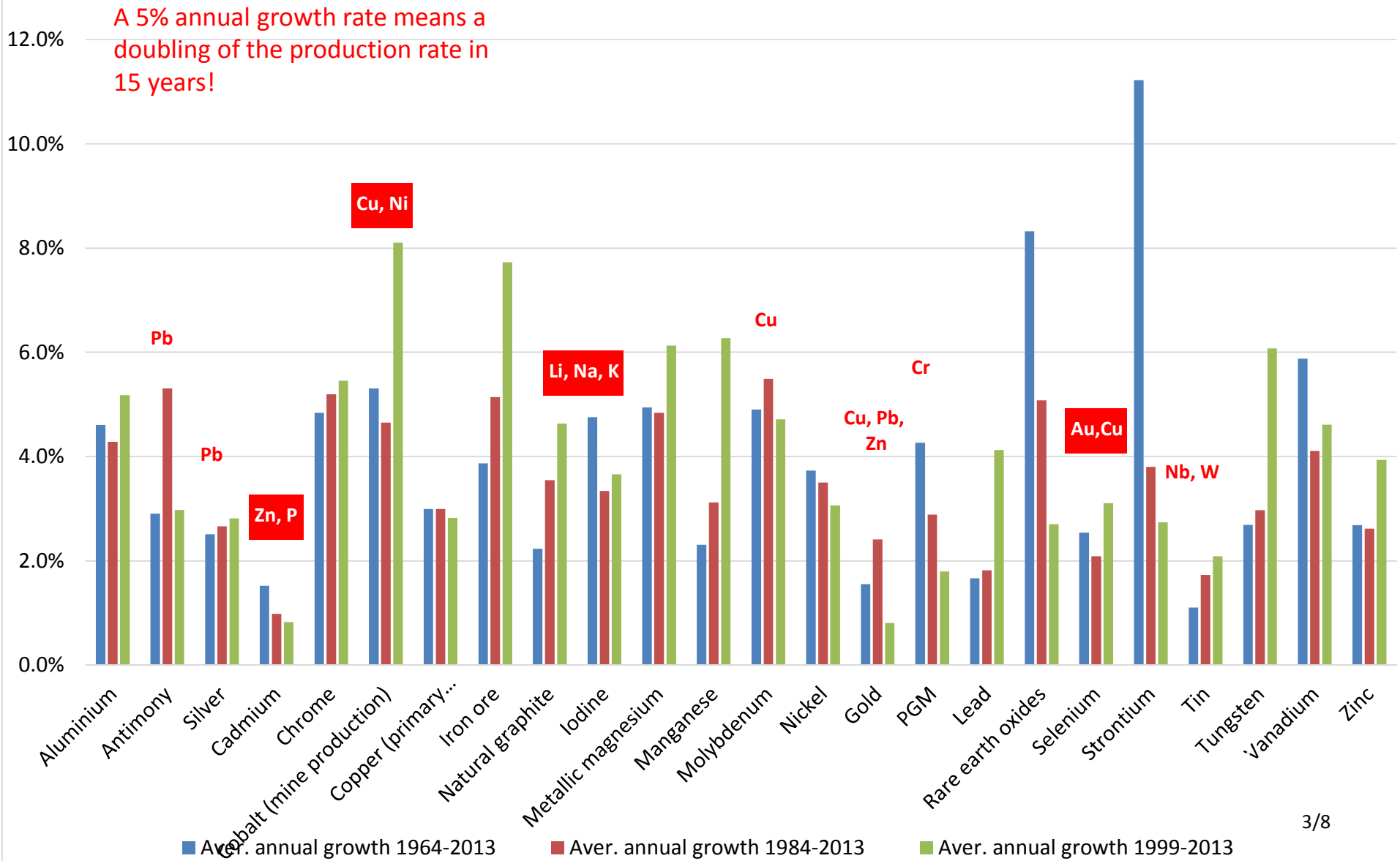
The energy sector contributes to the rapid demand growth for a wide range of minerals and metals.

The production of minerals and metals requires in turn an important share of the global energy production (currently about 10.5%) and generates related emissions (CO₂, sulfur and nitrogen oxides, particulate matter, mercury from coal production, radionuclides from coal combustion and rare earth production...).

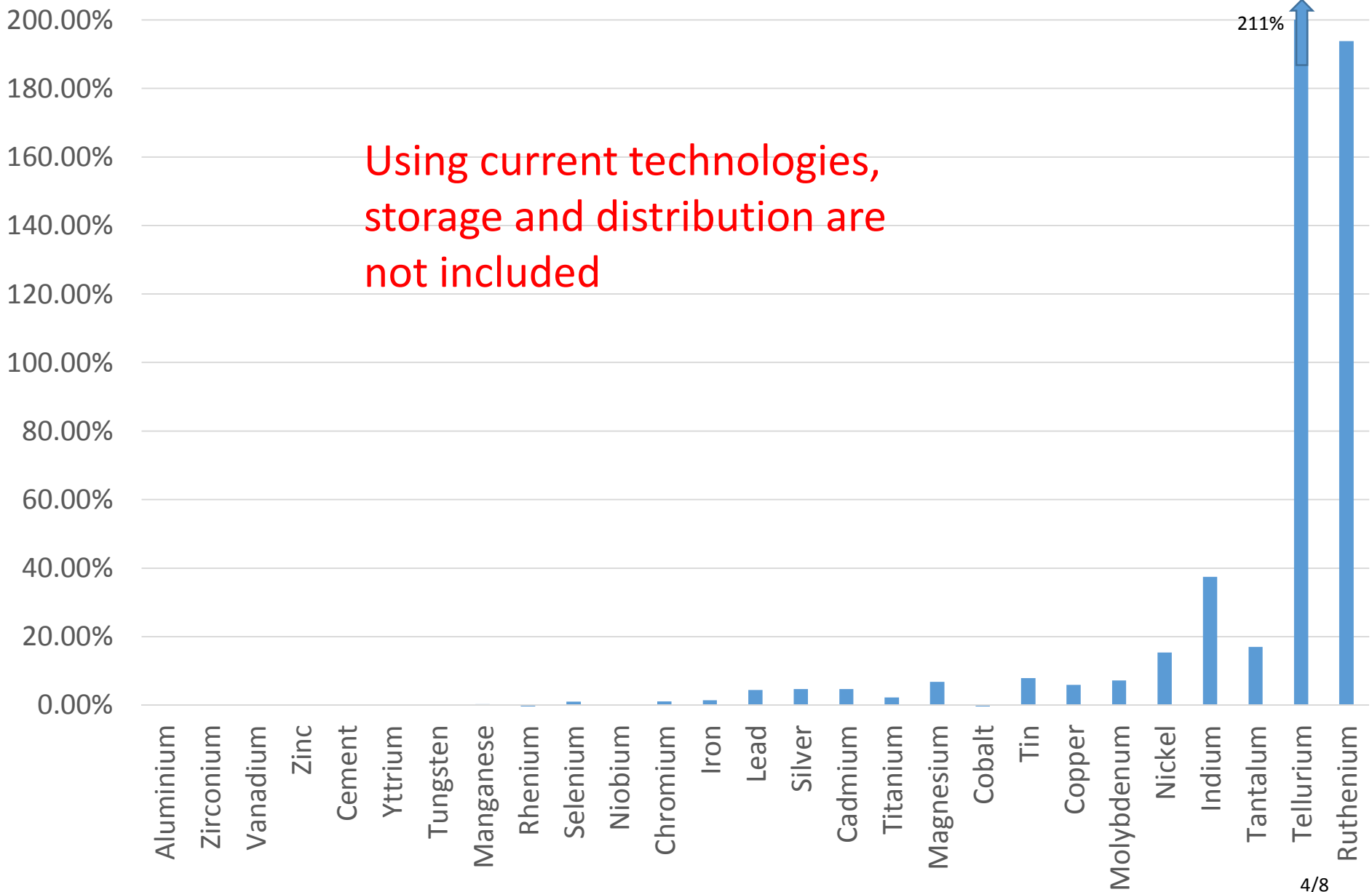
Some renewable energy production systems such as windmills allow to recover in 4-6 months the energy invested in their production, with a lifetime of 10-20 years.



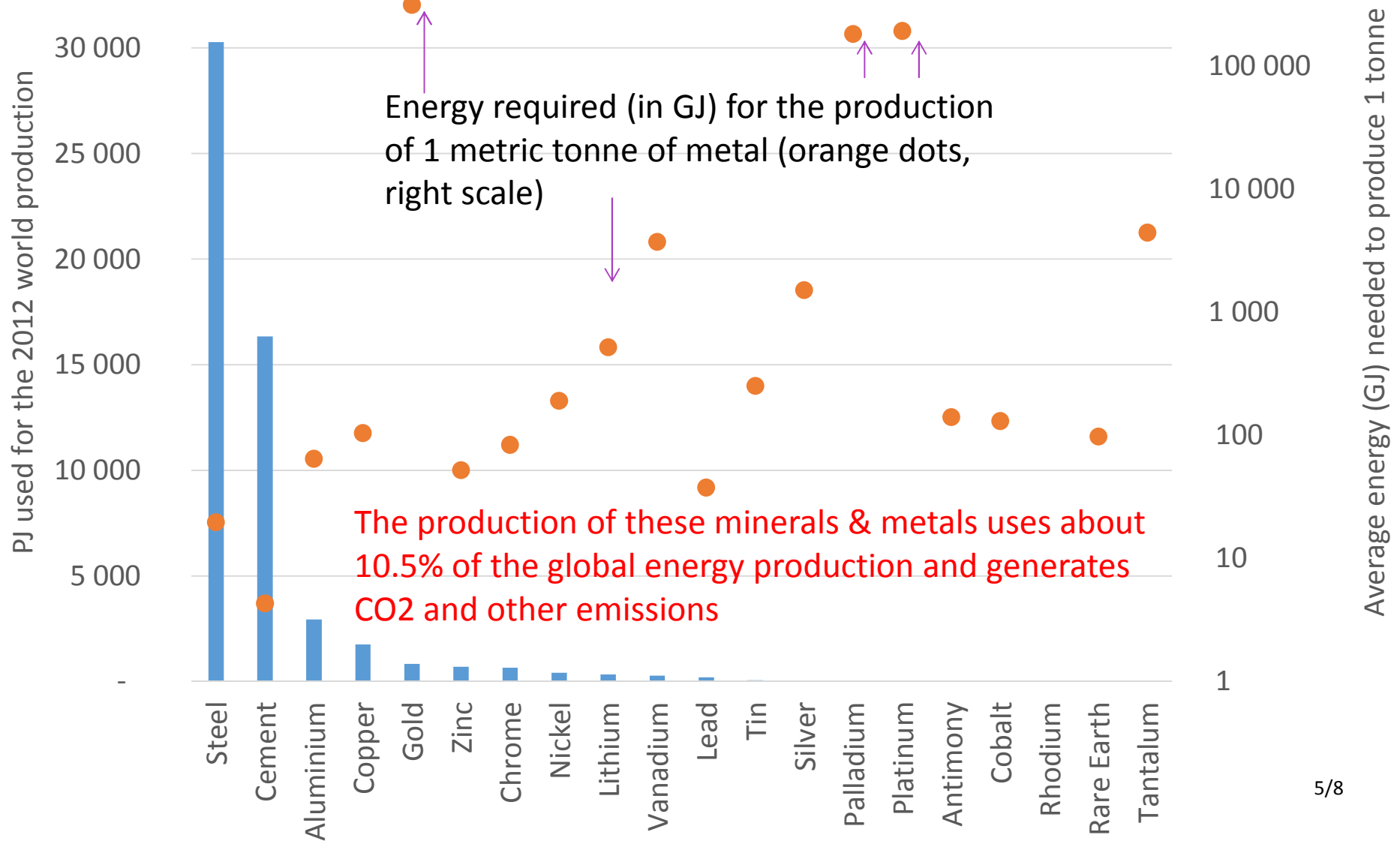
Average annual world production growth rate observed for a selection of metals over a 50, 30 and 15 years period



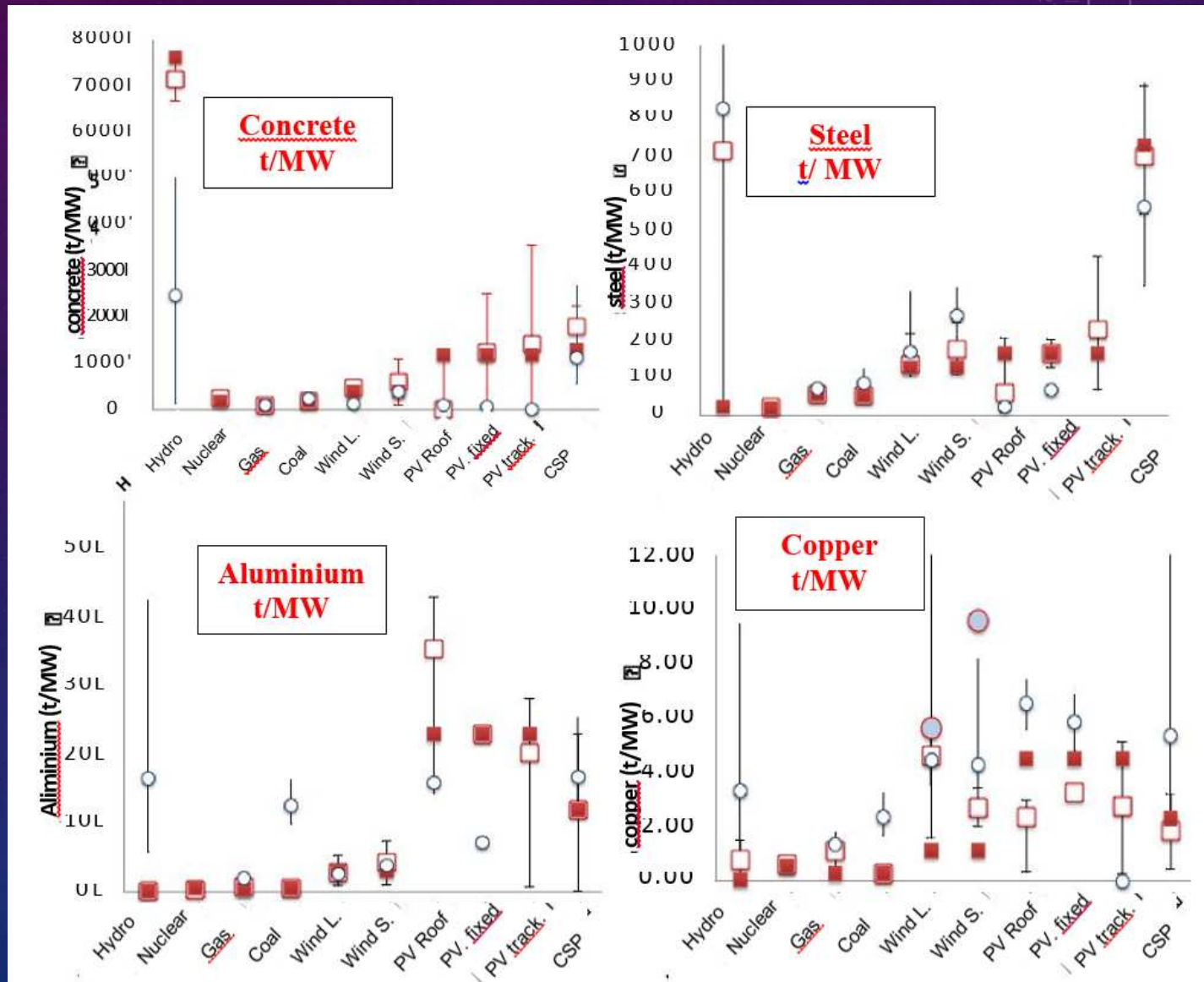
Average additional annual amount of metals (in % of 2012 world production) required by the International Energy Agency 450 scenario



Average energy required for the production of 1 tonne (in GJ per tonne, right scale, orange dots) and total energy required for the 2012 world production of a selection of metals (in PJ, left scale, blue bars)

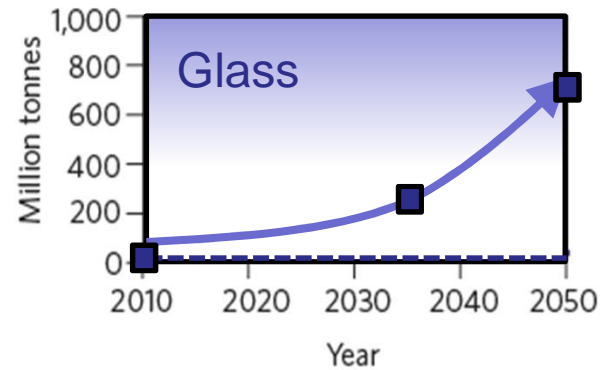
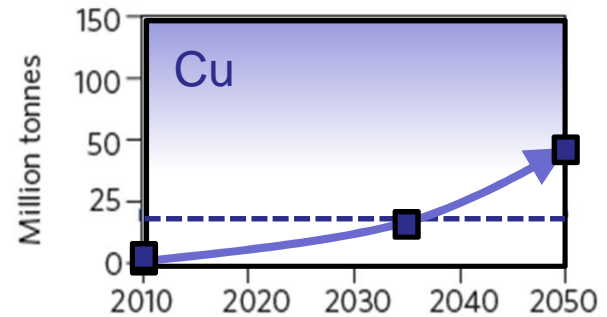
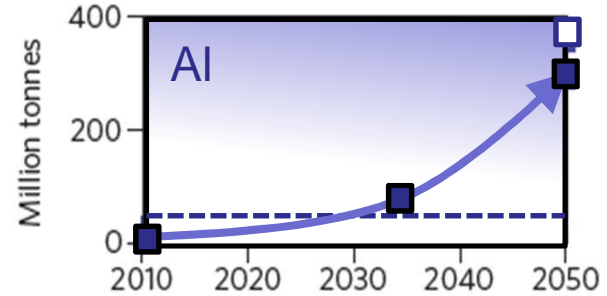
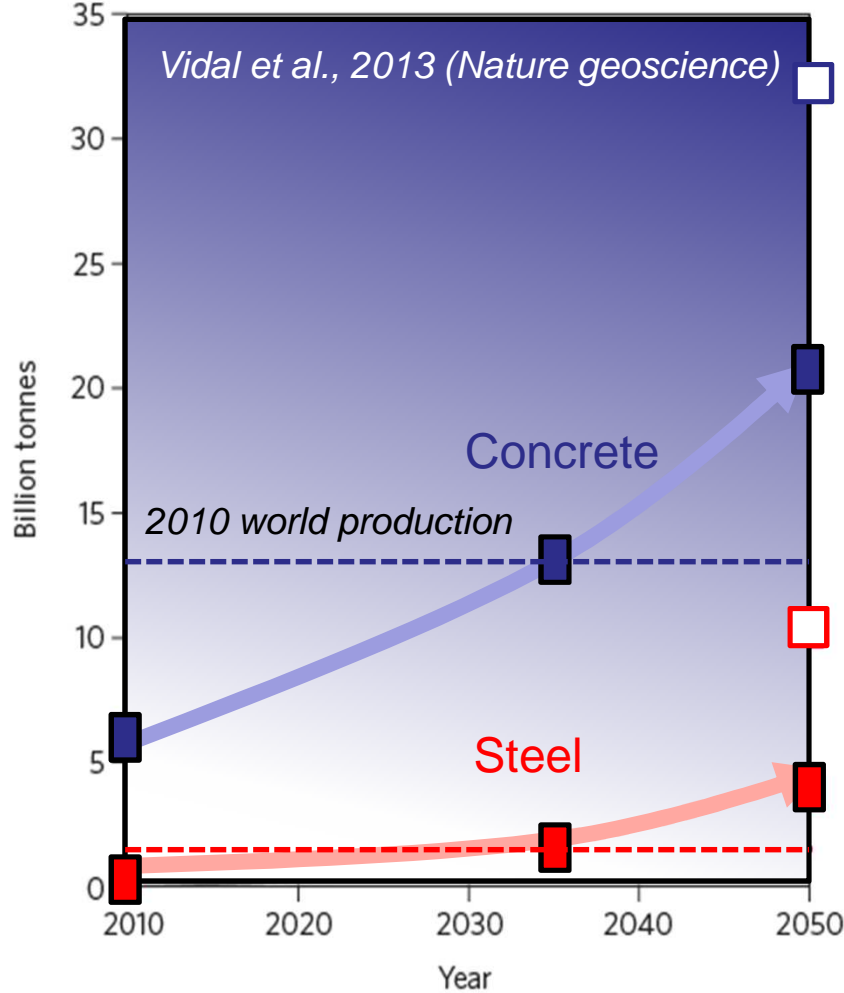


Average annual amount of metals (in metric tonnes per MW) required by different energy production technologies



Materials requirements for wind and solar energy production facilities

facilities



In 2050, the **cumulative** amount of concrete, steel, Al, Cu and glass sequestered in wind and solar facilities will be 2 to 8 times the 2010 world production. This comes in addition to all the requirements of 10 billion terrestrians in 2050!

Circular economy: absolute decoupling between desired growth and its negative impacts. A long-term objective and many obstacles in its way

