

Renewables in the energy transition

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Le Bourget, 7 December 2015*

www.iea.org

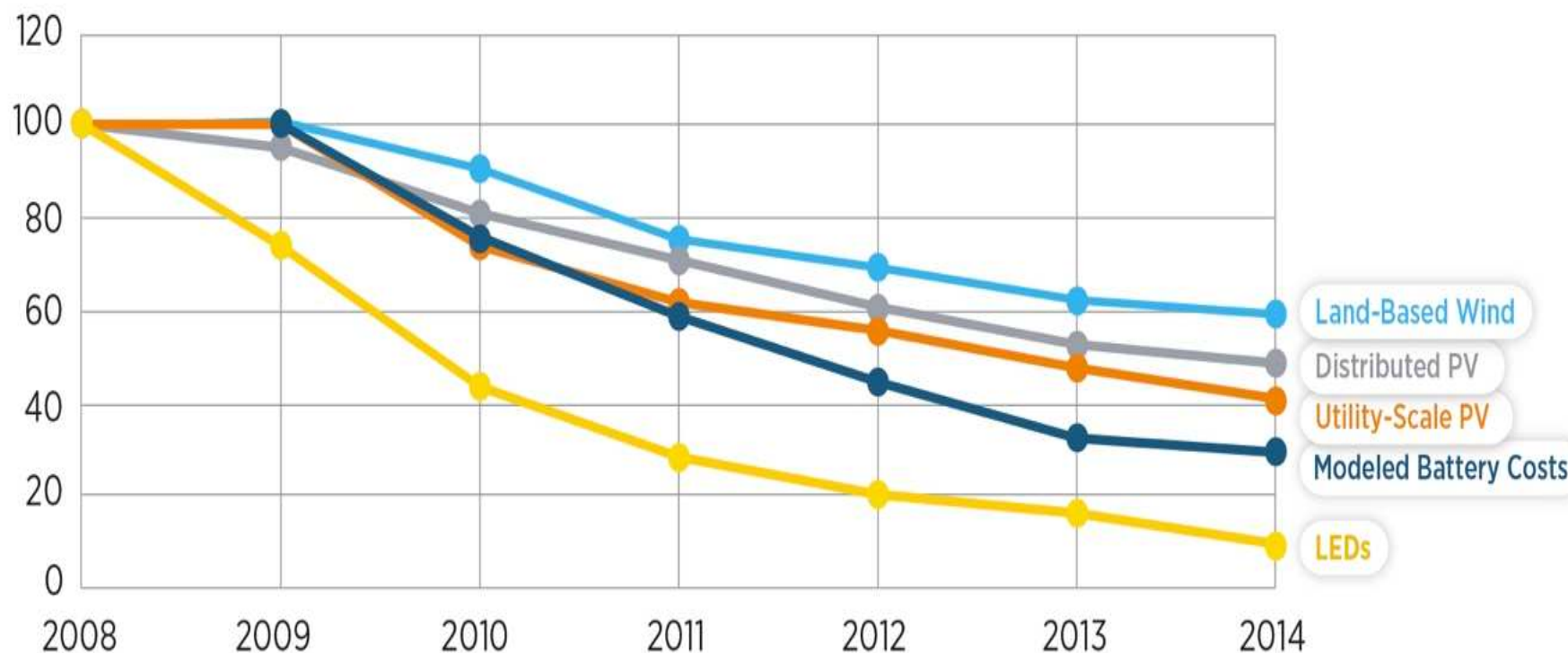
Innovation is driving costs down



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Indexed Cost Reductions Since 2008



Source: Ernest Moniz, US Secretary of Energy, IEA Ministerial, 18 November 2015

The future arrives for Five Clean Energy Technologies. Changes since the time of COPENHAGEN are facilitating COP talks in Paris.

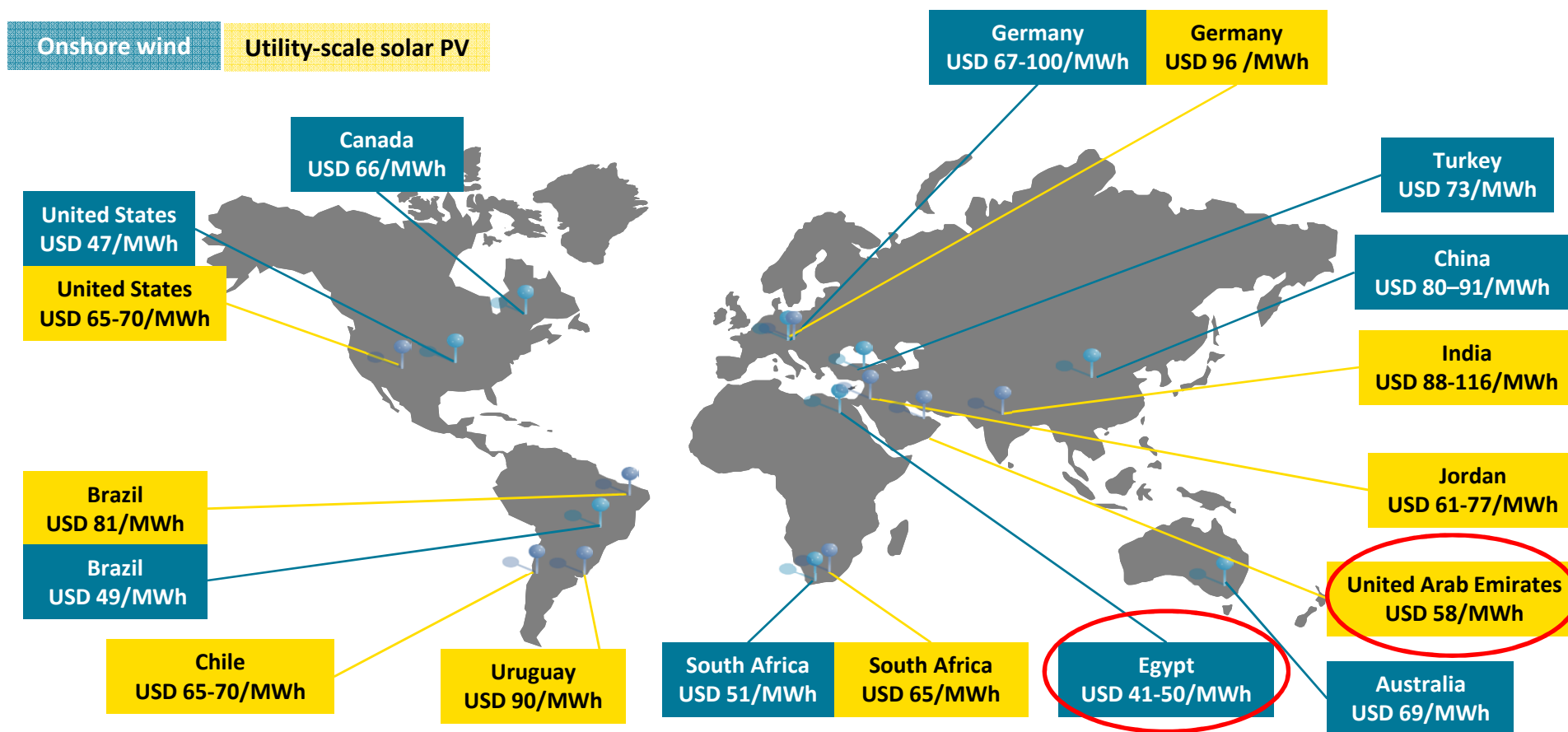
Wind and solar costs reach new lows



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Recent announced long-term contract prices for new renewable power



This map is without prejudice to the status or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

Price competition, long-term contracts, good resources and financial de-risking measures create deployment opportunities in newer markets at lower costs

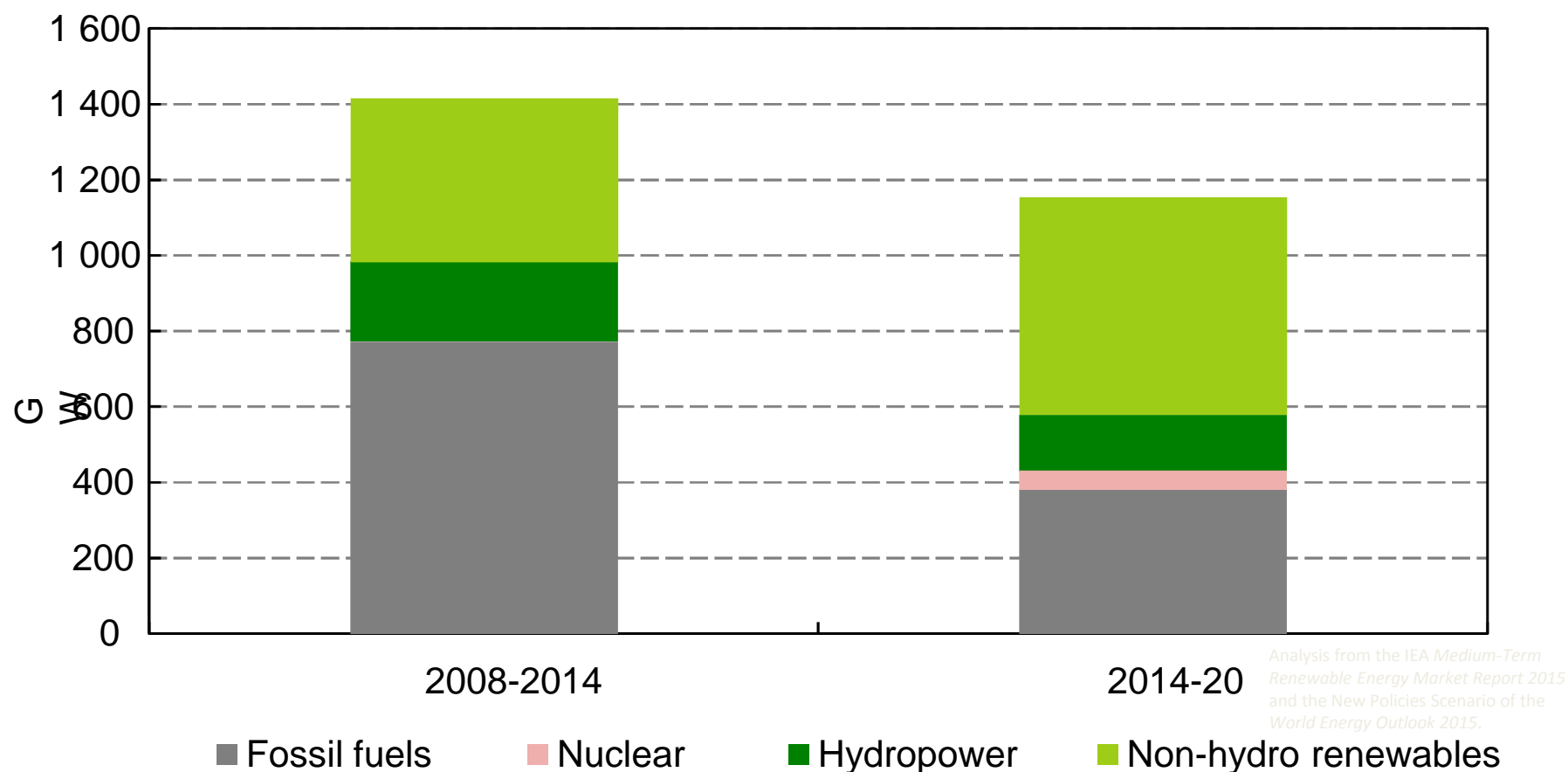
Renewables, the largest source of new power generation capacity



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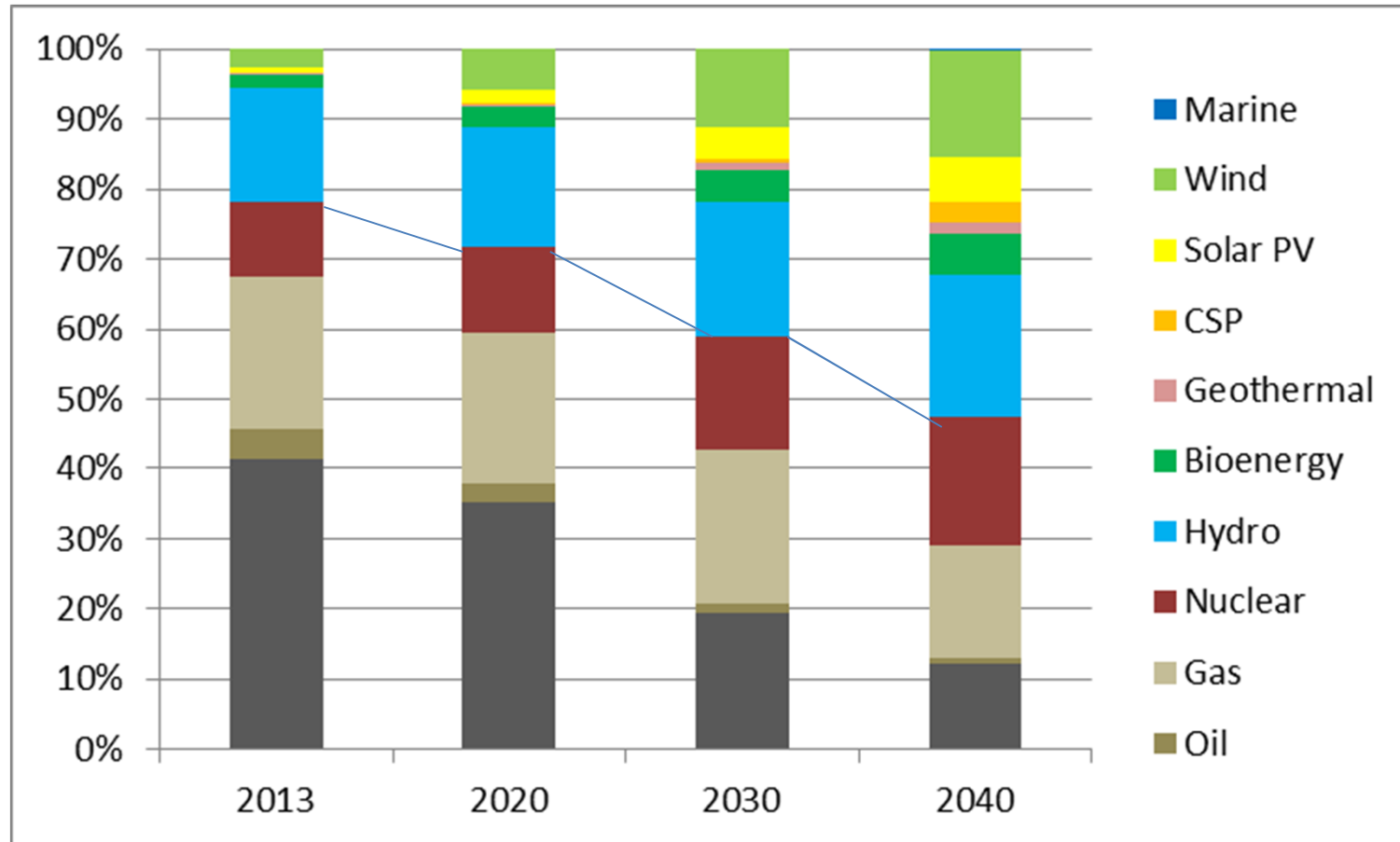
World net additions to power capacity



The share of renewables in net additions to power capacity continues to rise with non-hydro sources reaching nearly half of the total

Power mix: a shift reversal

Evolution of the global power mix in the 450 Scenario



Renewables should account for over 50% of global electricity generation by 2040

Capacities in climate-friendly scenarios (GW)



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	2013	2020	2040	2050		Beyond...
				2 DS	Hi-Ren	
<i>Source Technology</i>		<i>MTMR 2015 Main case</i>	<i>WEO 450 Scenario</i>	<i>ETP 2015</i>	<i>ETP 2014</i>	<i>Solar Energy Perspectives</i>
Bioenergy	88	125	378	465	560	
Geothermal	12	16	78	113	216	
Hydropower	1 136	1 326	2 042	1 947	1 980	1 600
Ocean	1	1	36	109	241	
Solar PV	136	429	1519	2 755	4 626	12 000
Solar thermal	4	9	256	716	954	6 000
Wind	303	631	1 908	2 583	3 098	10 000
<i>Storage</i>	<i>150</i>			<i>259</i>	<i>607</i>	

Three pillars of system transformation



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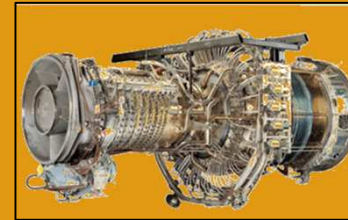


Technology
spread

Geographic
spread

Design
of power
plants

System
friendly
VRE



Investments



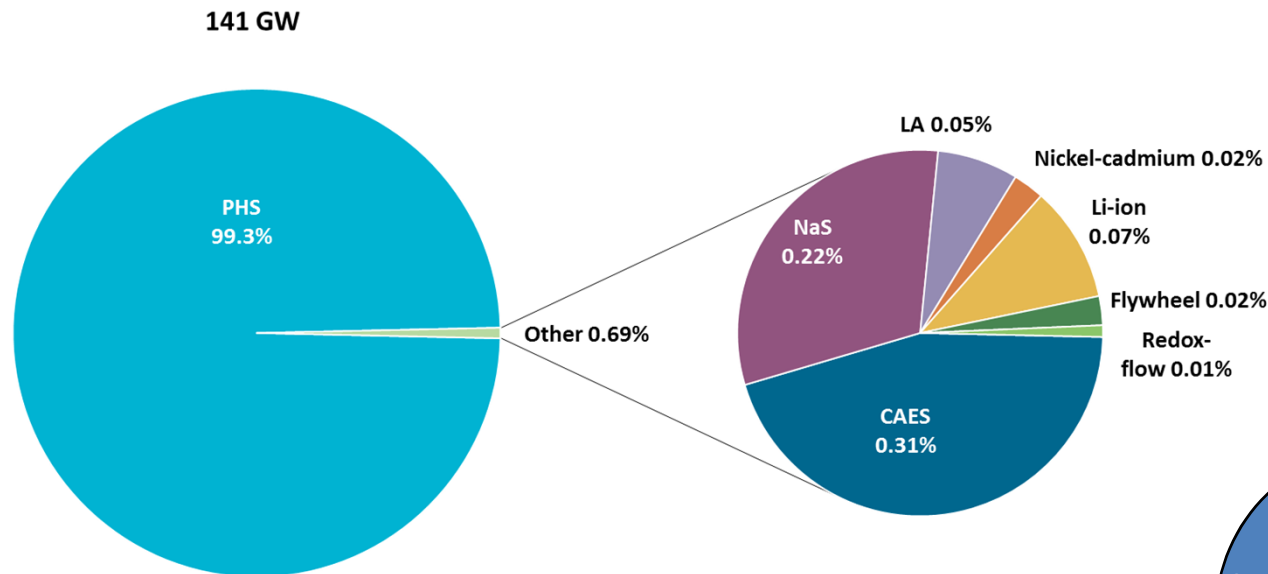
Operations

*More flexible systems increase both diversification and resilience
→ increase energy security*

Pumped-storage hydropower makes it all - almost



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- Arbitrage
- Weekly storage
- Black start
- « Flexing » power system w. variable RE after nuclear power...

Thermal storage in CSP plants
~1500 MW

Reservoir hydropower
~ 500 GW?

Availability of materials?



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- **Steel and cement seem to be no-brainers**
 - *But implied GHG emissions must be reduced*
- **Silicon unlimited, perovskites abundant...**
 - *Some PV technologies require less abundant materials*
- **Rare earths are not rare, but not concentrated in geology**
 - *And exploitation is concentrated in China, at least for now*
 - *Substitutes exist but some advantages would be lost*
- **Lithium? Battery storage not a prerequisite for renewables in power, if for part of electric mobility**