Energy Technology Perspectives 2012

Pathways to a Clean Energy System

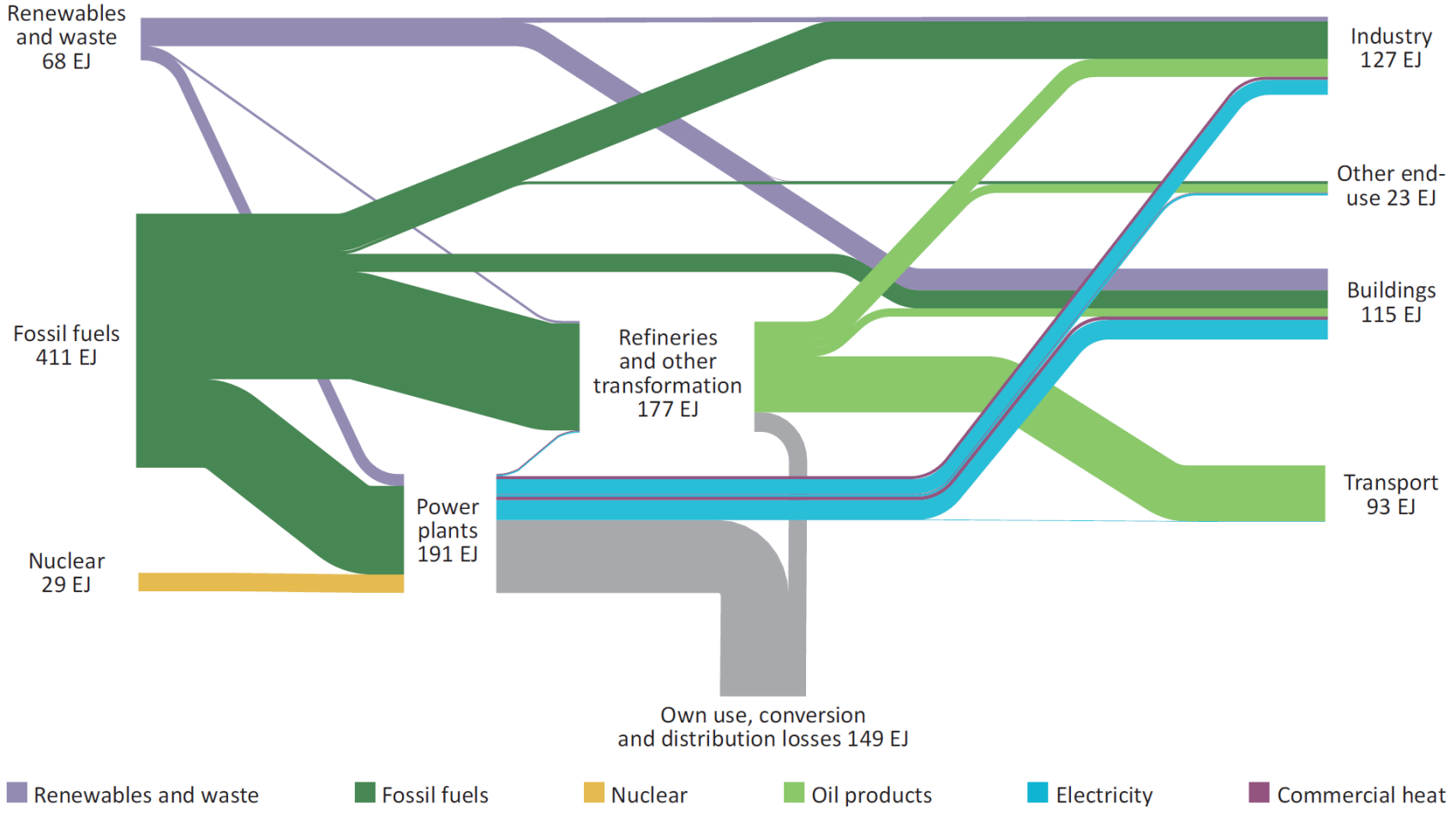
Smart Grids and Flexible Electricity Systems

2 July 2012

International Energy Agency

The Global Energy system today

ETP 2012



Dominated by fossil fuels in all sectors

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The future low-carbon energy system

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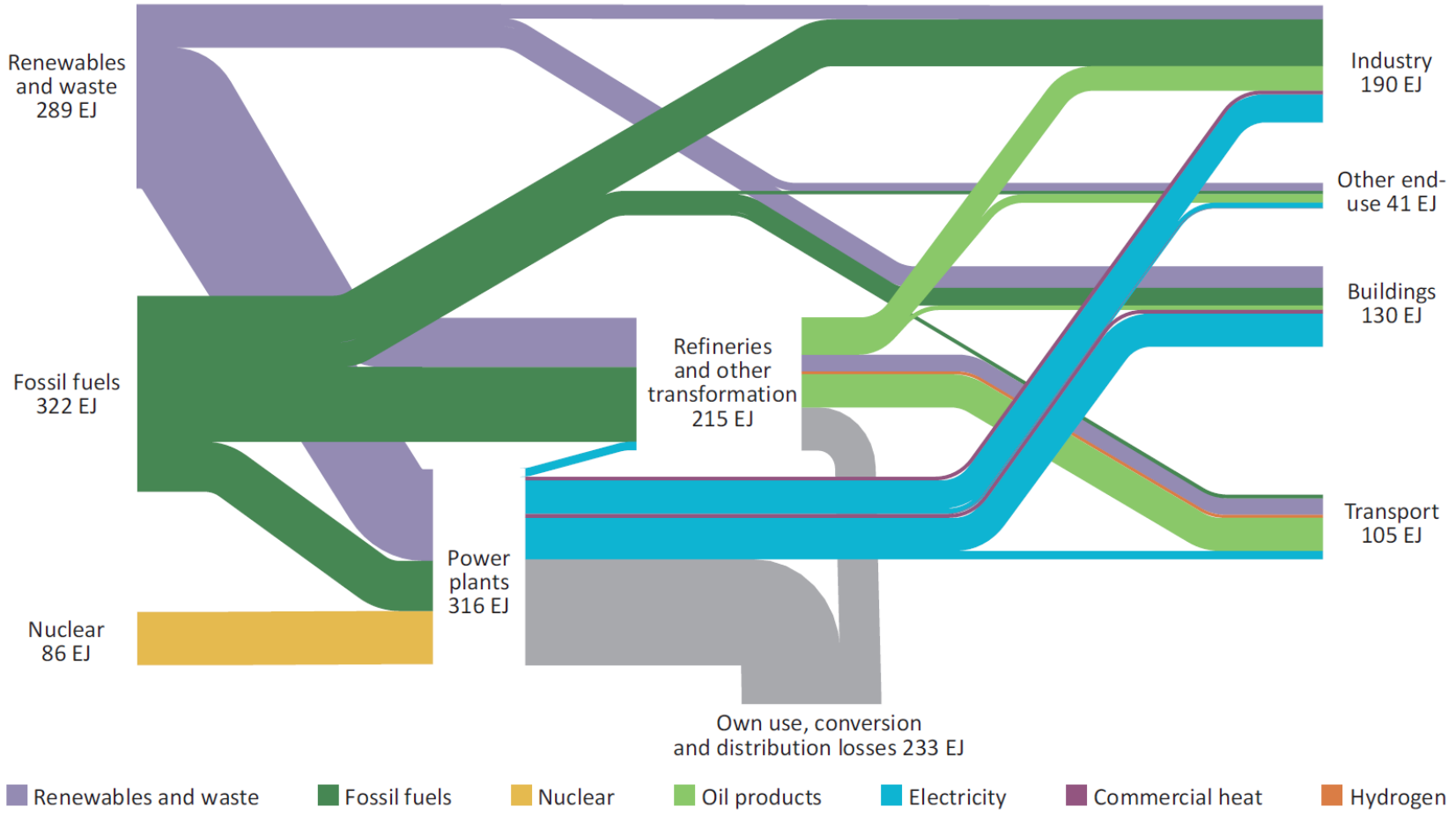

The 2DS in 2050 shows a dramatic shift in energy sources and demands

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Electricity Systems are evolving

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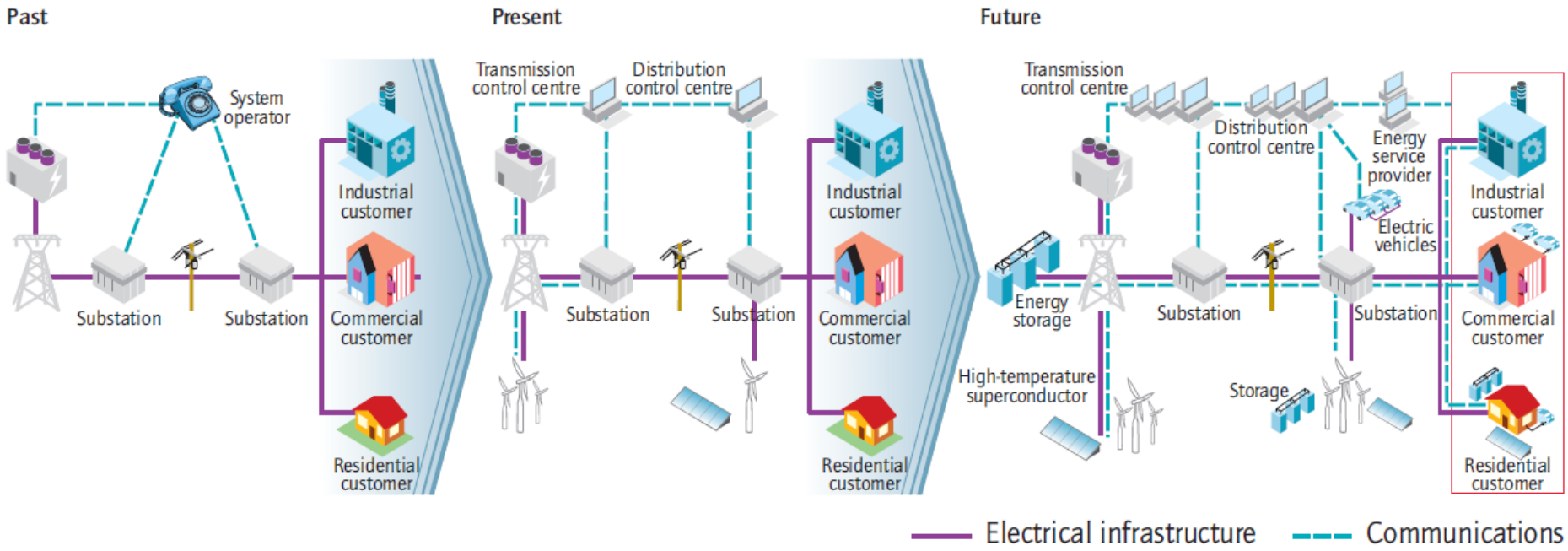

Smartening the grid is not a one time event

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Smart Grid Technologies

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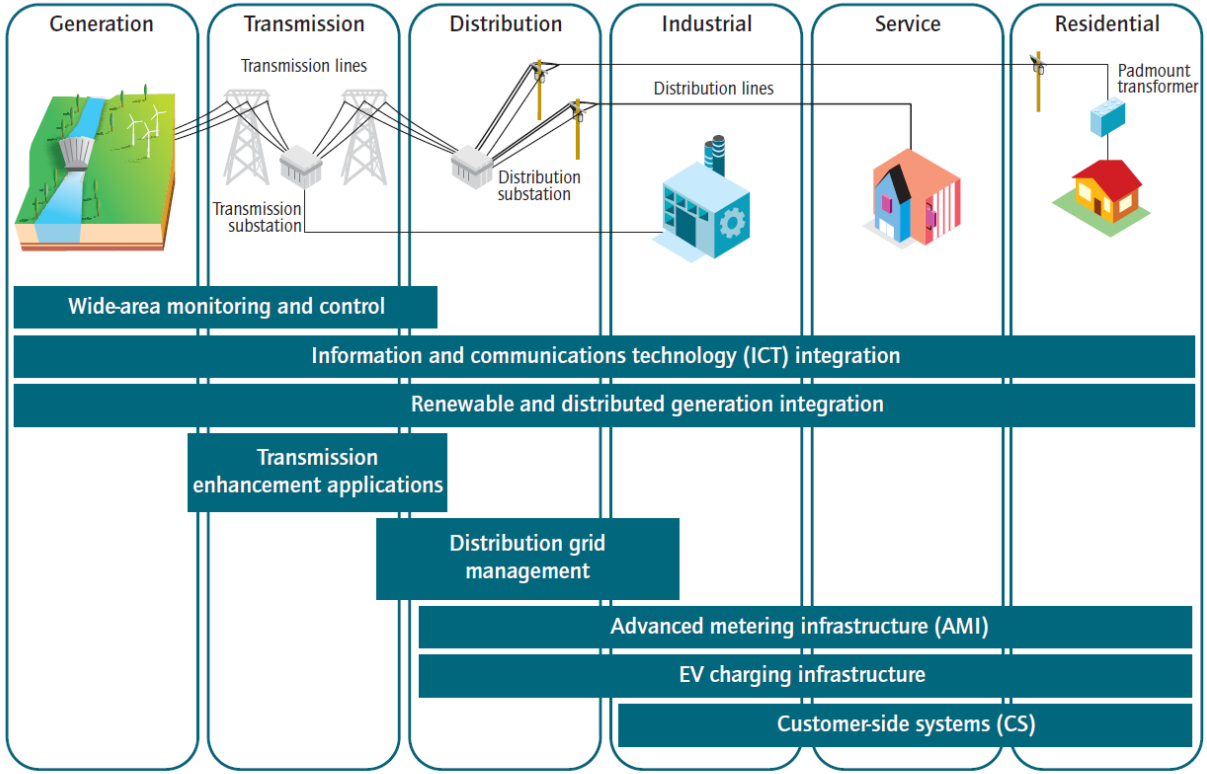

Source: Technology categories and descriptions adapted from NETL, 2010 and NIST, 2010.

Smart grid technologies are applied across the entire electricity system

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Global Electrical Energy Generation

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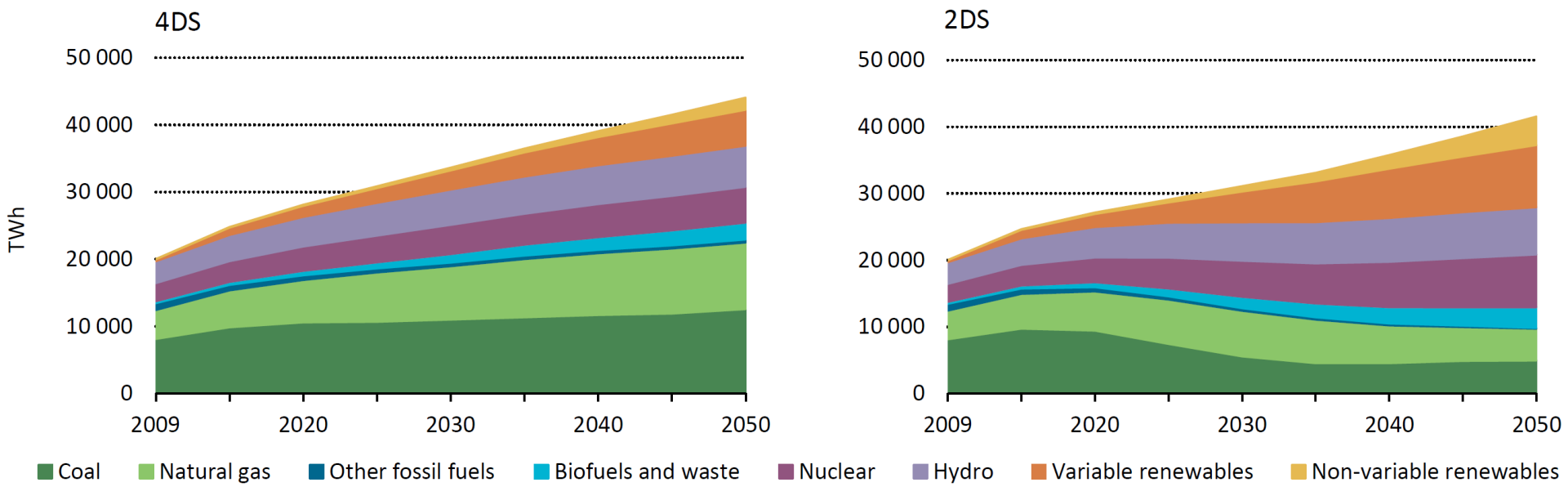

Lower electrical energy demand in 2DS even though electricity is larger proportion of overall energy demand.

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Electricity generation capacity

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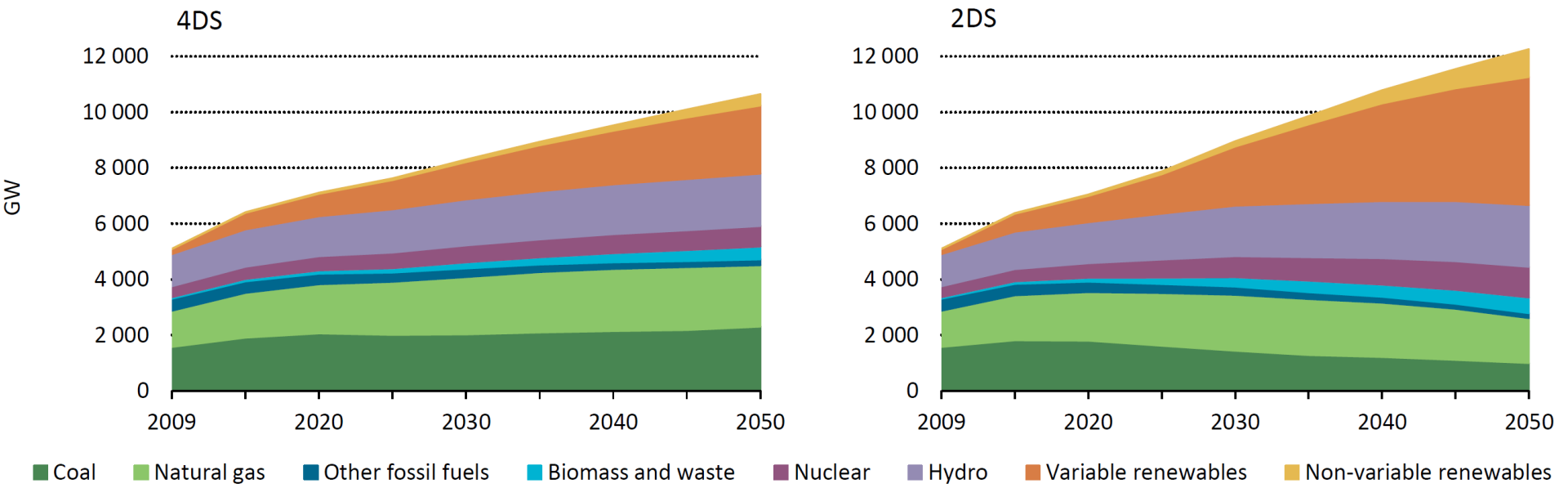

Generation capacity is higher in the 2DS due to great deployment of variable renewables with lower capacity factors.

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Electricity system flexibility

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Power system flexibility expresses the extent to which a power system can modify electricity production or consumption in response to variability, expected or otherwise.

± MW / time

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Flexibility needs and resources

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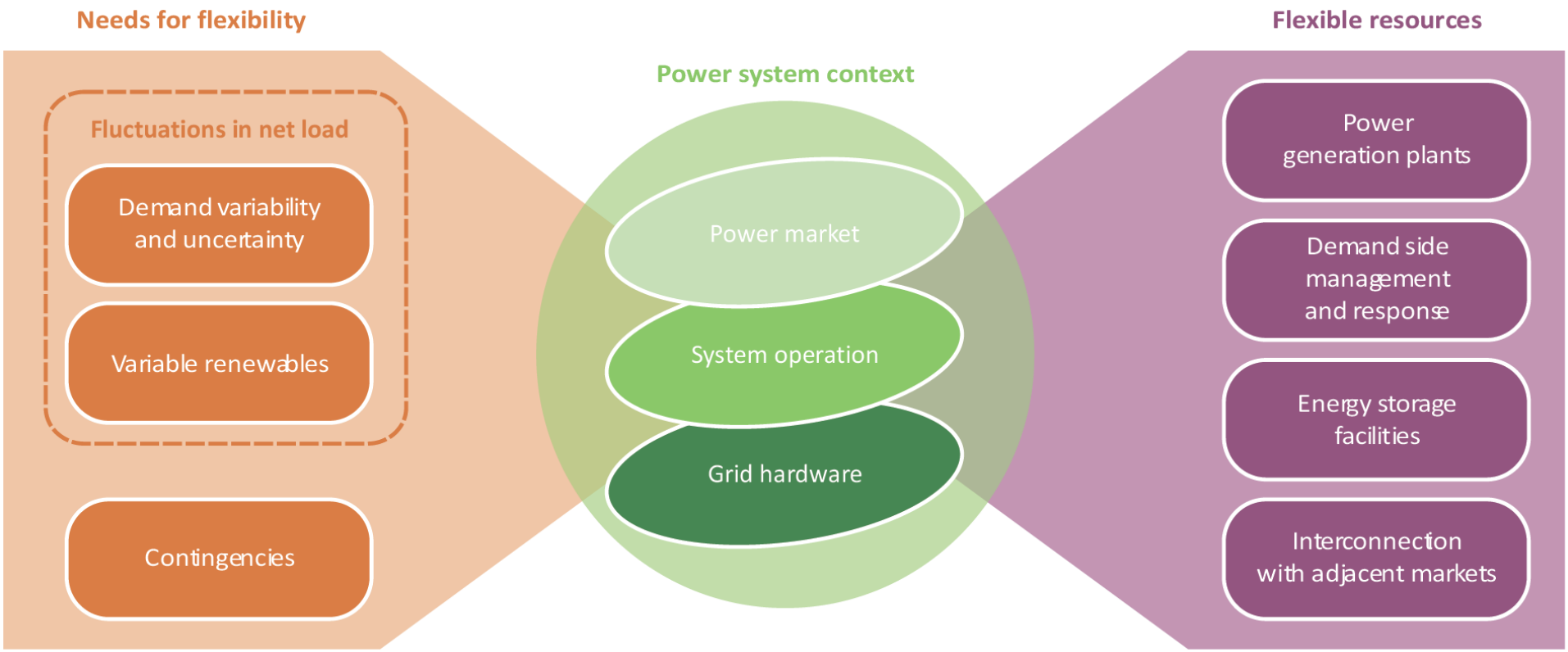

Existing and new flexibility needs can be met by a range of resources in the electricity system – facilitated by power system markets, operation and hardware.

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The need for flexibility is increasing

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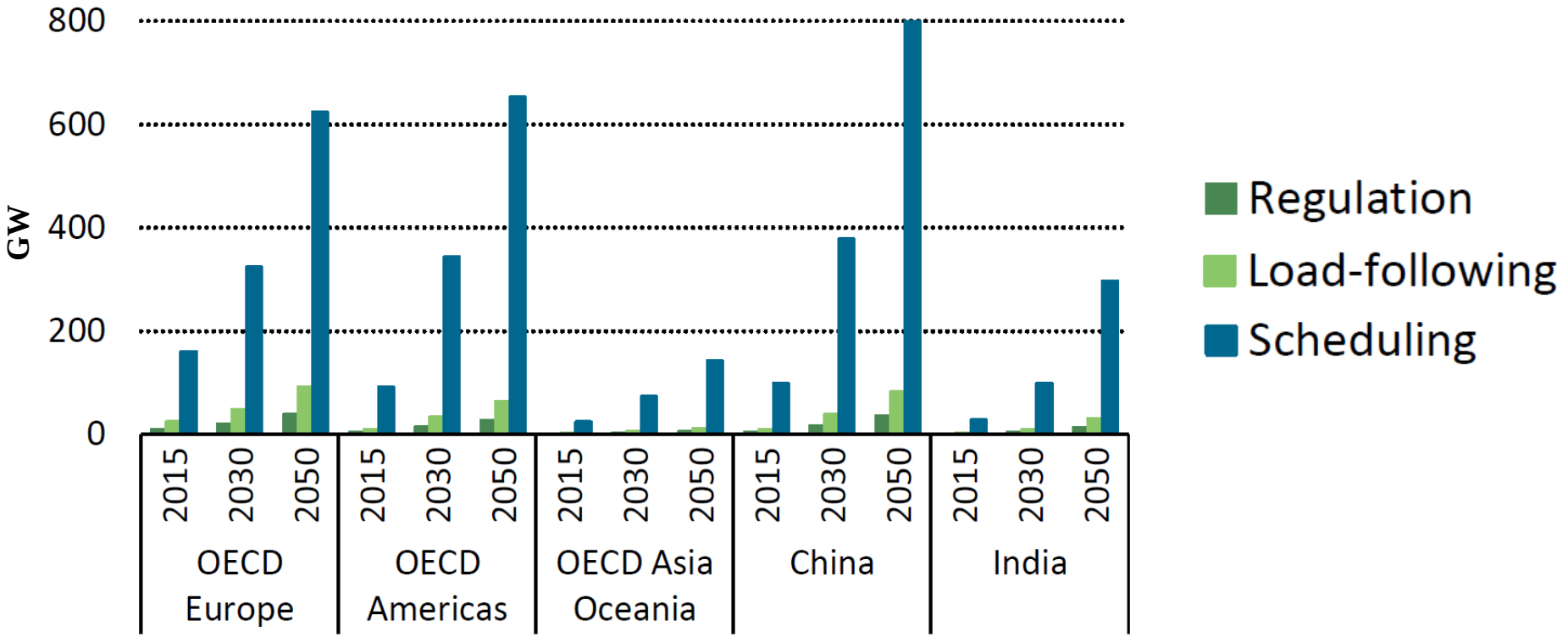

All regions under all scenarios show an increasing need for electricity system flexibility.

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The demand side flexibility resource is large and under utilised

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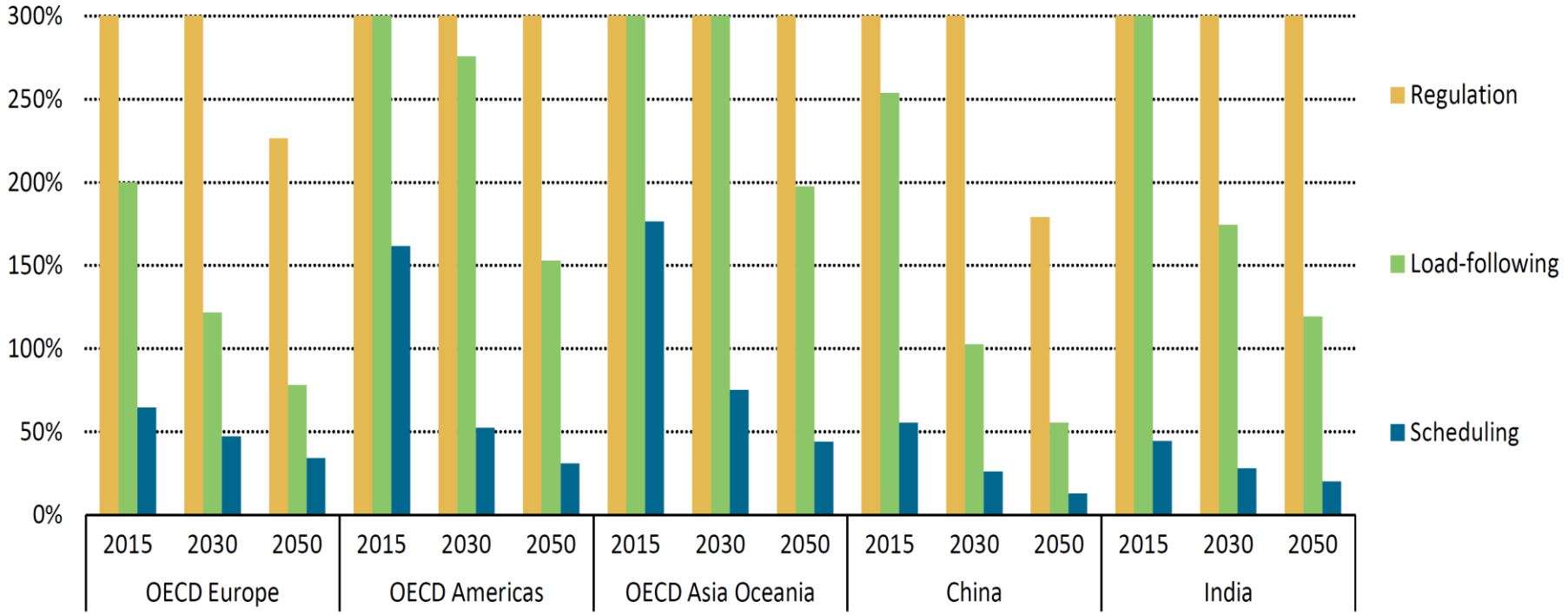

All regions exhibit a significant demand side flexibility resource – especially for regulation and load following.

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North American sectoral resource

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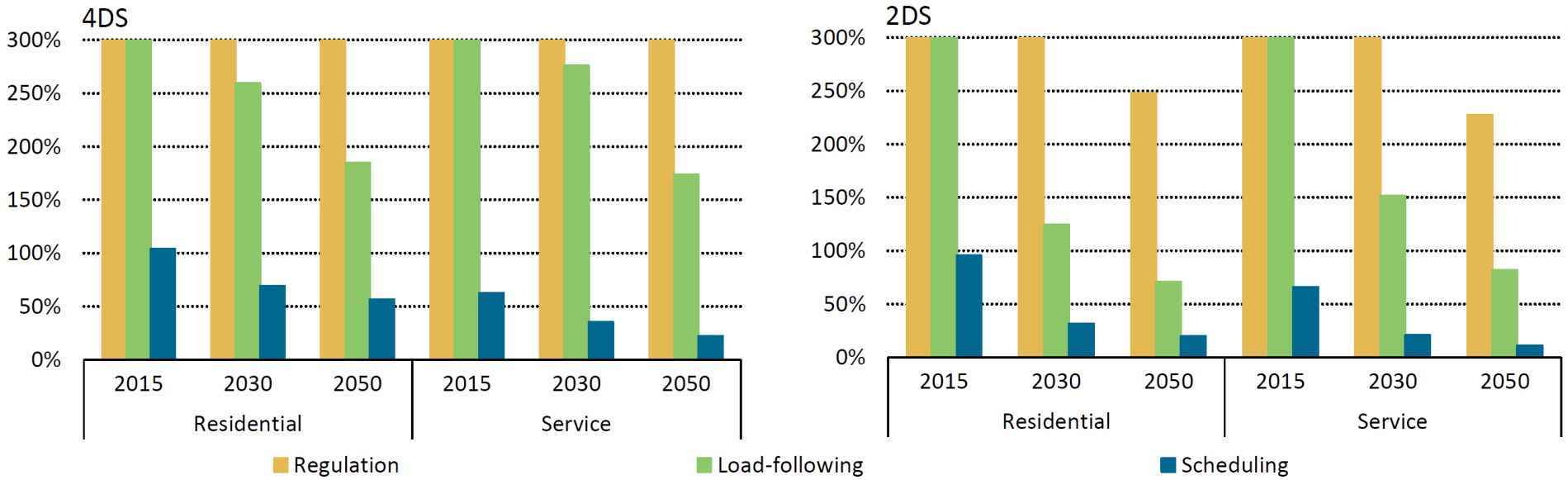

[GW]	4DS Residential			4DS Service			2DS Residential			2DS Service		
	2015	2030	2050	2015	2030	2050	2015	2030	2050	2015	2030	2050
Regulation	57.9	73.0	90.3	50.8	69.3	88.7	54.6	60.9	67.4	31.6	48.4	61.8
Load-following	32.9	42.9	54.9	17.3	24.6	30.2	31.1	36.4	42.1	9.5	14.9	18.3
Scheduling	95.8	140.4	198.5	57.7	71.2	77.9	87.4	108.3	129.2	60.6	71.8	73.5

Note: The respective regulation, load-following and scheduling balancing values of the residential, and service sectors can be added to indicate the total flexibility for each balancing type.

Demand-side energy efficiency decreases resource.

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Storage – a game changer or niche player?

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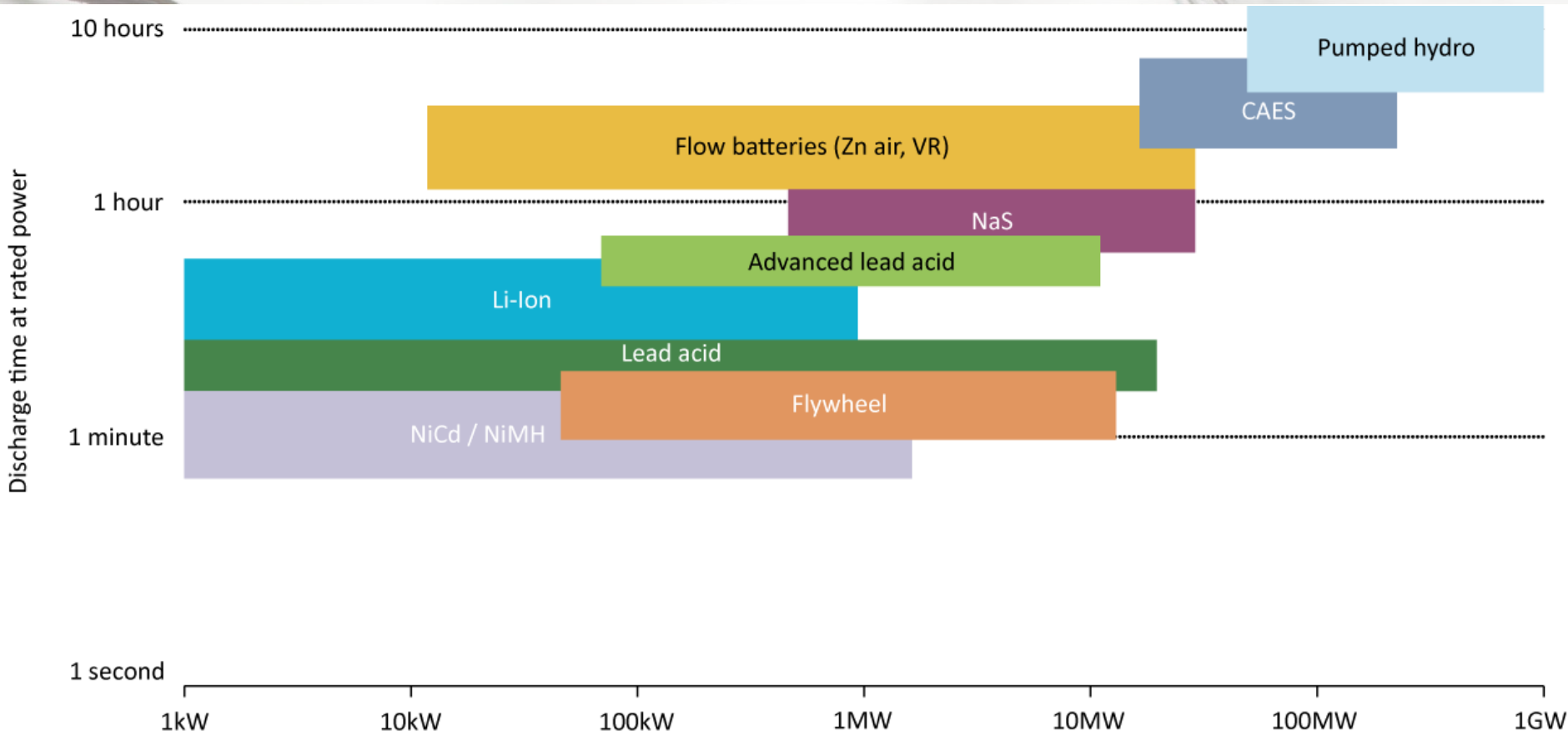

Existing installations and niche applications will play a definite role in the future, but cost concerns exist for new deployments.

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T&D infrastructure investments in the 4DS and 2DS are similar

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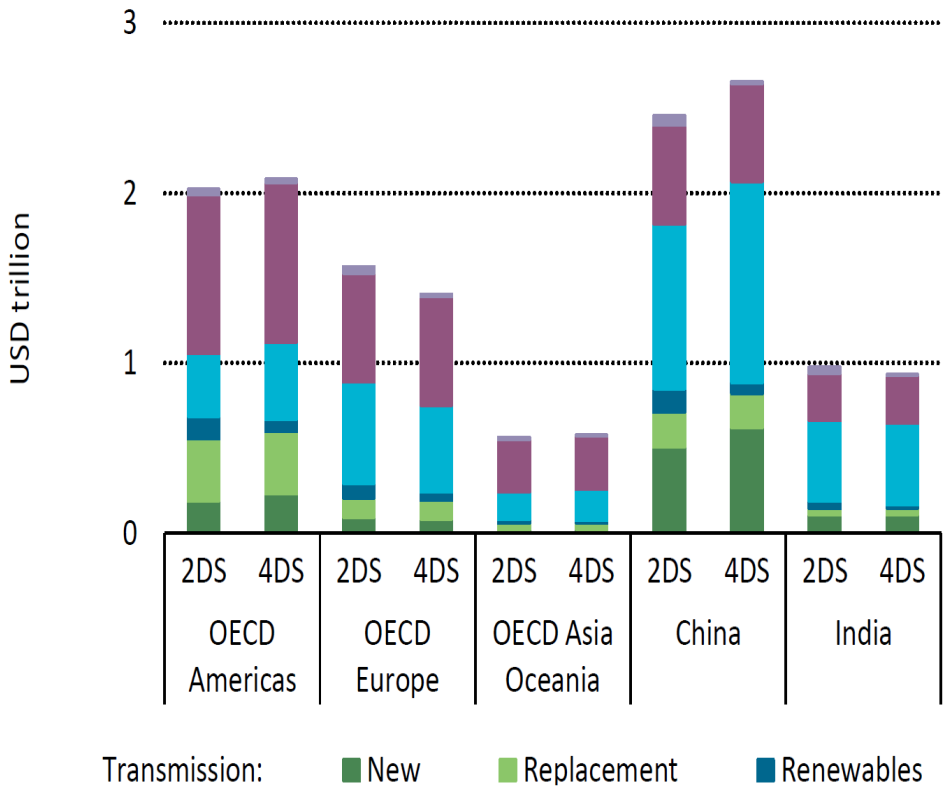

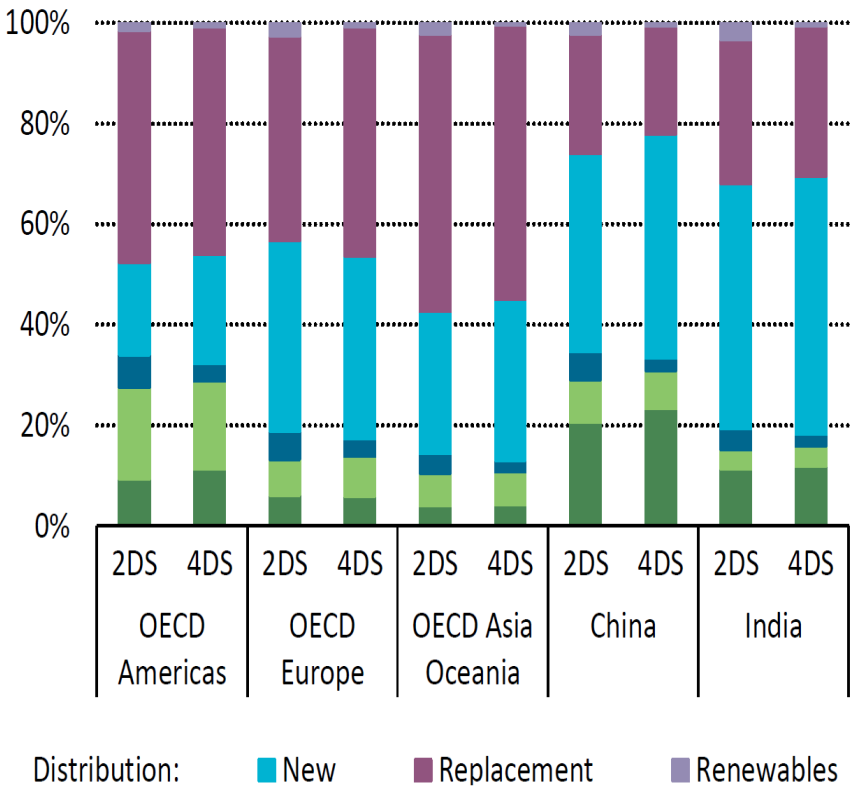

...but sectoral allocation differs

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Smart grid benefits exceed costs by a factor of between 1.5 and 4.5

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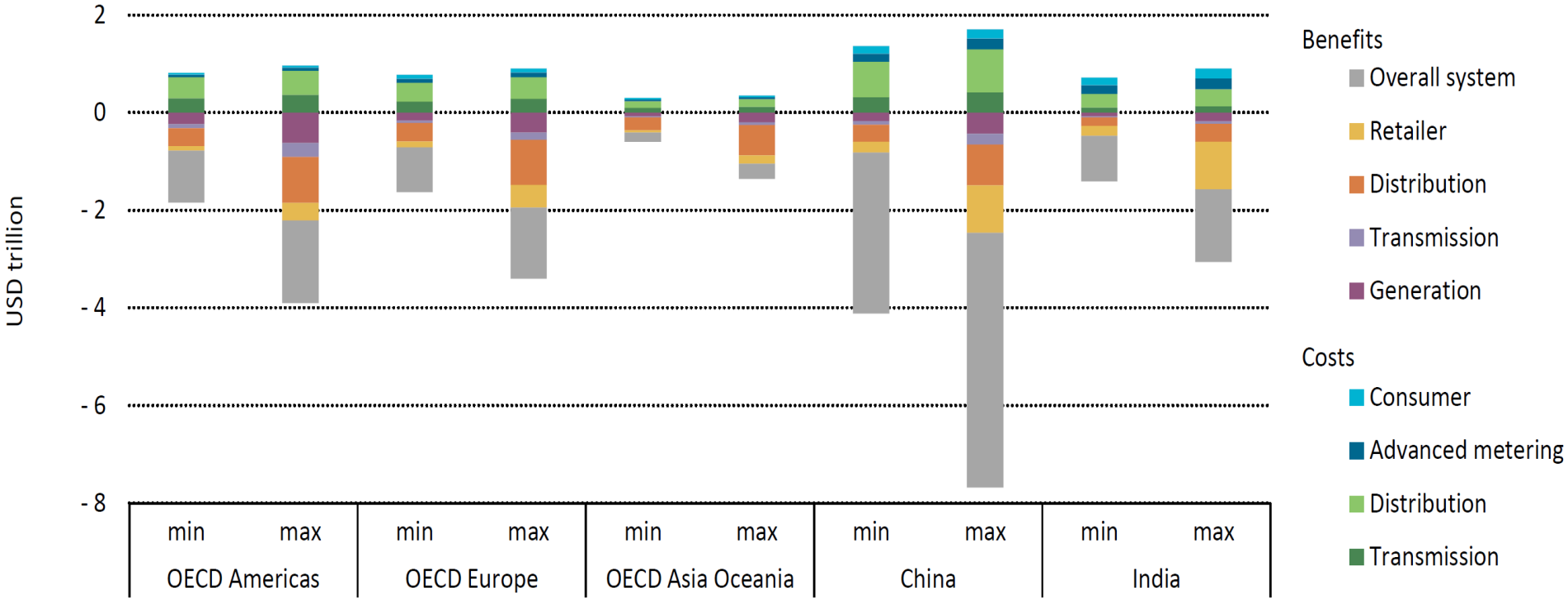

..., but direct benefits of investment in one sector may be found in other sectors.

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Technology choices in electricity system flexibility

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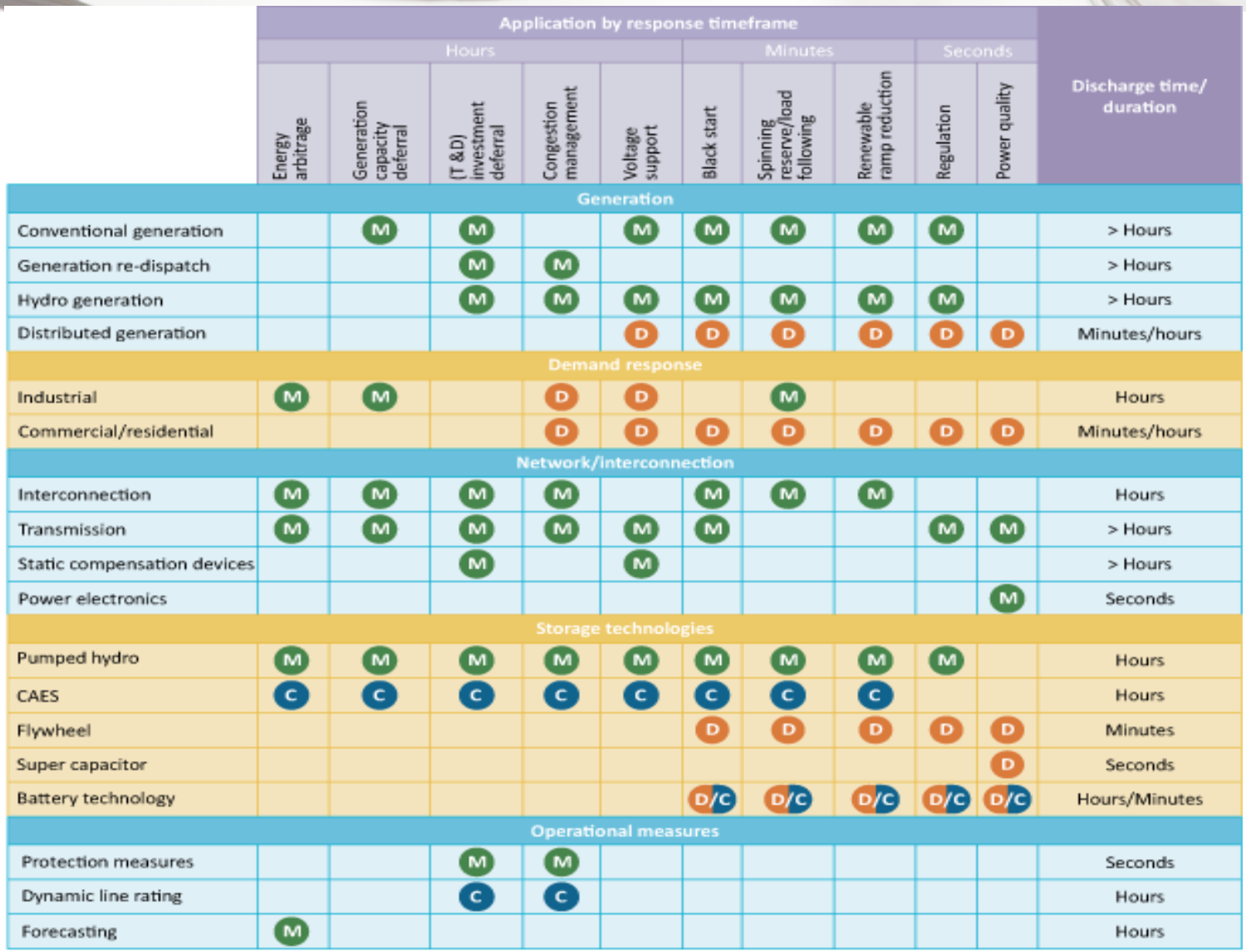

	Application by response timeframe										Discharge time/ duration
	Hours					Minutes			Seconds		
	Energy arbitrage	Generation capacity deferral	(T &D) investment deferral	Congestion management	Voltage support	Black start	Spinning reserve/load following	Renewable ramp reduction	Regulation	Power quality	
Generation											
Conventional generation		M	M		M	M	M	M	M		> Hours
Generation re-dispatch			M	M							> Hours
Hydro generation			M	M	M	M	M	M	M		> Hours
Distributed generation					D	D	D	D	D	D	Minutes/hours
Demand response											
Industrial	M	M		D	D		M				Hours
Commercial/residential				D	D	D	D	D	D	D	Minutes/hours
Network/interconnection											
Interconnection	M	M	M	M		M	M	M			Hours
Transmission	M	M	M	M	M	M			M	M	> Hours
Static compensation devices			M		M						> Hours
Power electronics										M	Seconds
Storage technologies											
Pumped hydro	M	M	M	M	M	M	M	M	M		Hours
CAES	C	C	C	C	C	C	C	C			Hours
Flywheel						D	D	D	D	D	Minutes
Super capacitor										D	Seconds
Battery technology						D/C	D/C	D/C	D/C	D/C	Hours/Minutes
Operational measures											
Protection measures			M	M							Seconds
Dynamic line rating			C	C							Hours
Forecasting	M										Hours

Technology maturity key: M Mature C Commercial D Demonstration

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What do we need to do? Barriers?

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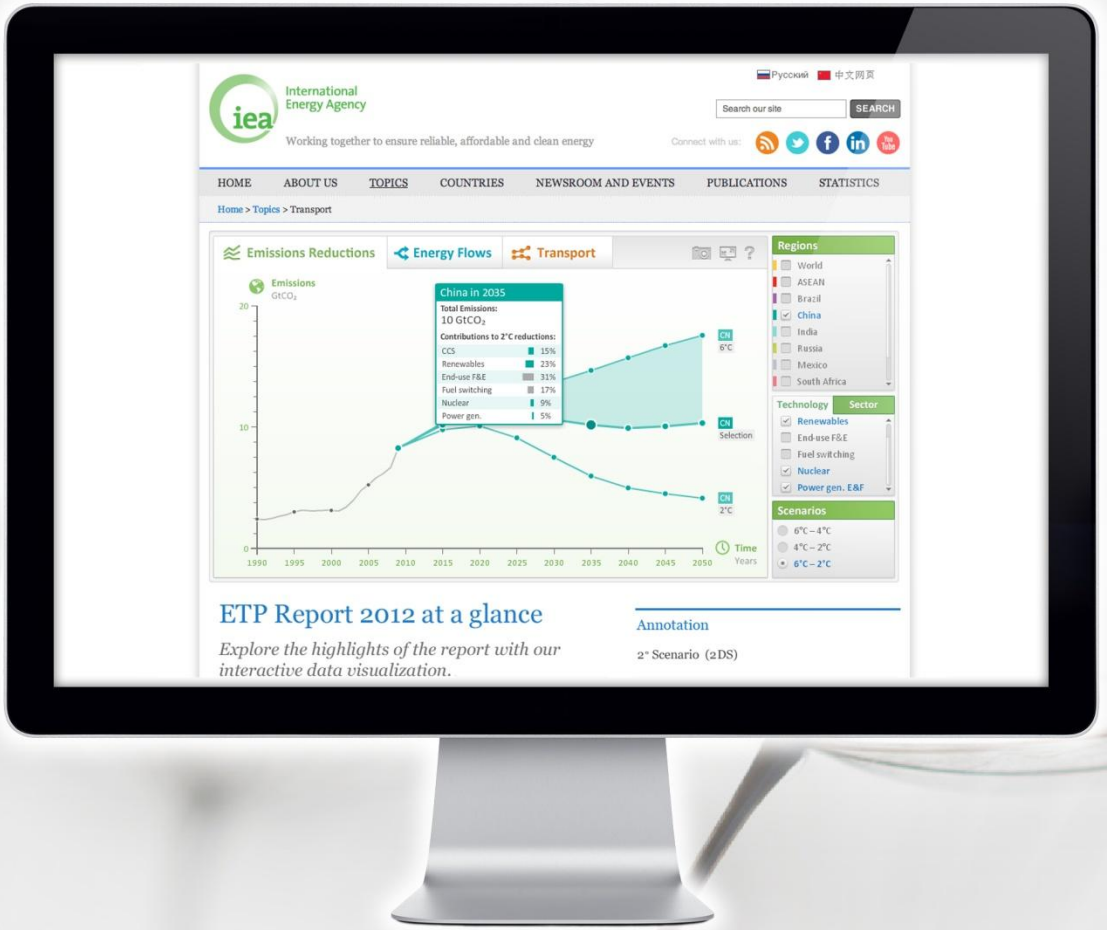
- Use systems based approaches – utilise flexibility resources from all parts of the electricity system
- Learn by doing - increased pilot and demonstration projects will enable of real-world solutions for flexibility
- Support new technology deployment – develop regulatory and market solutions that allow new technologies and new actors to support system operation
- Determine regulatory approaches that support conventional and new technologies – and adequately share costs, benefits and risks.

Explore the data behind *ETP*



www.iea.org/etp