

Workshop

Innovative solutions for achieving 100% renewable power systems by mid-century

Session IV – Innovative solutions for 100% renewable power systems

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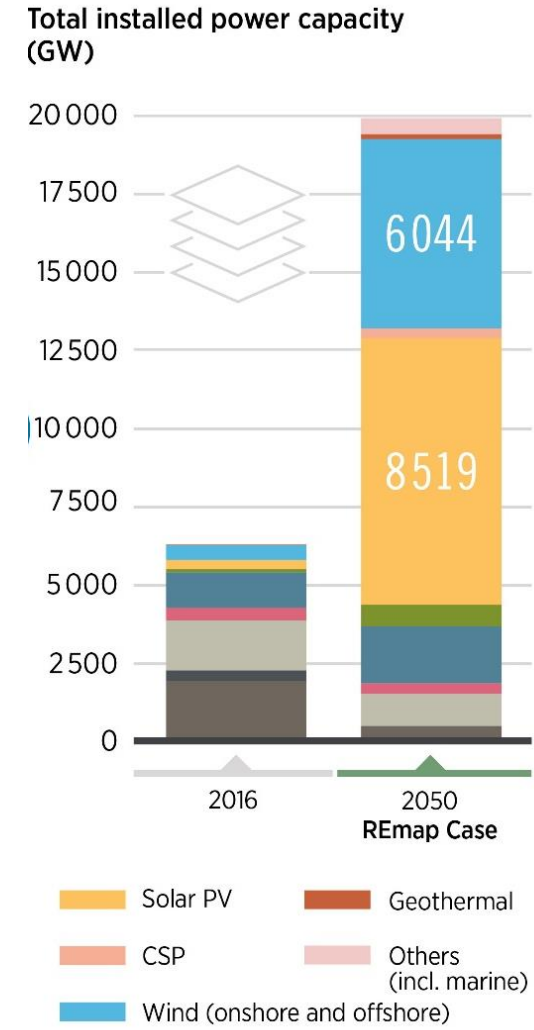
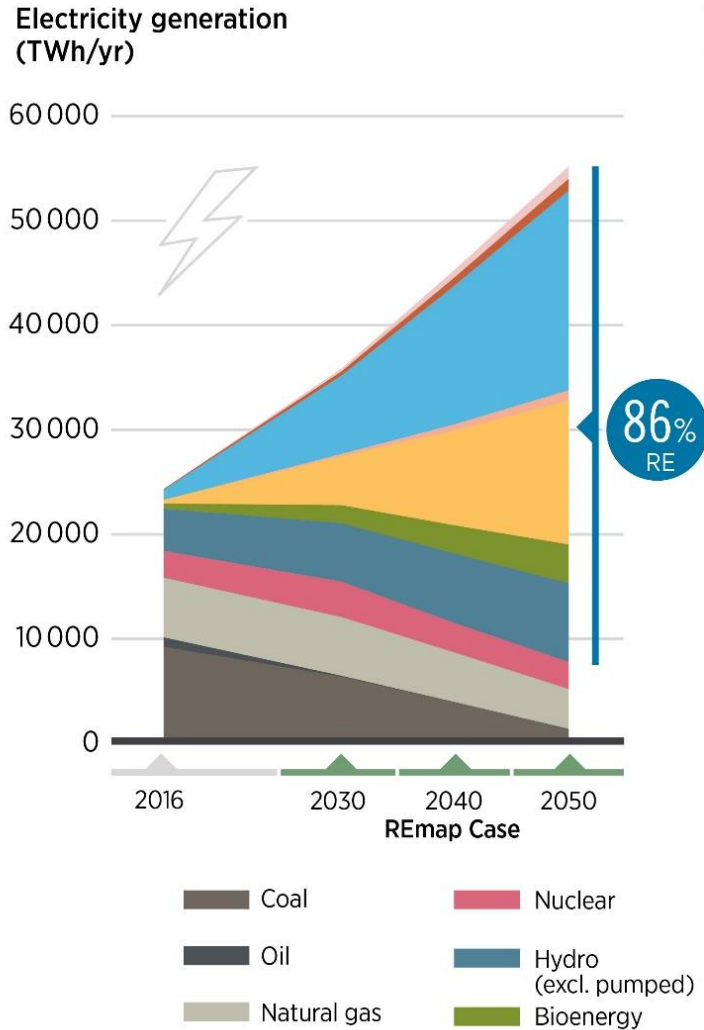


1. REmap case: pathway to meet the Paris Agreement

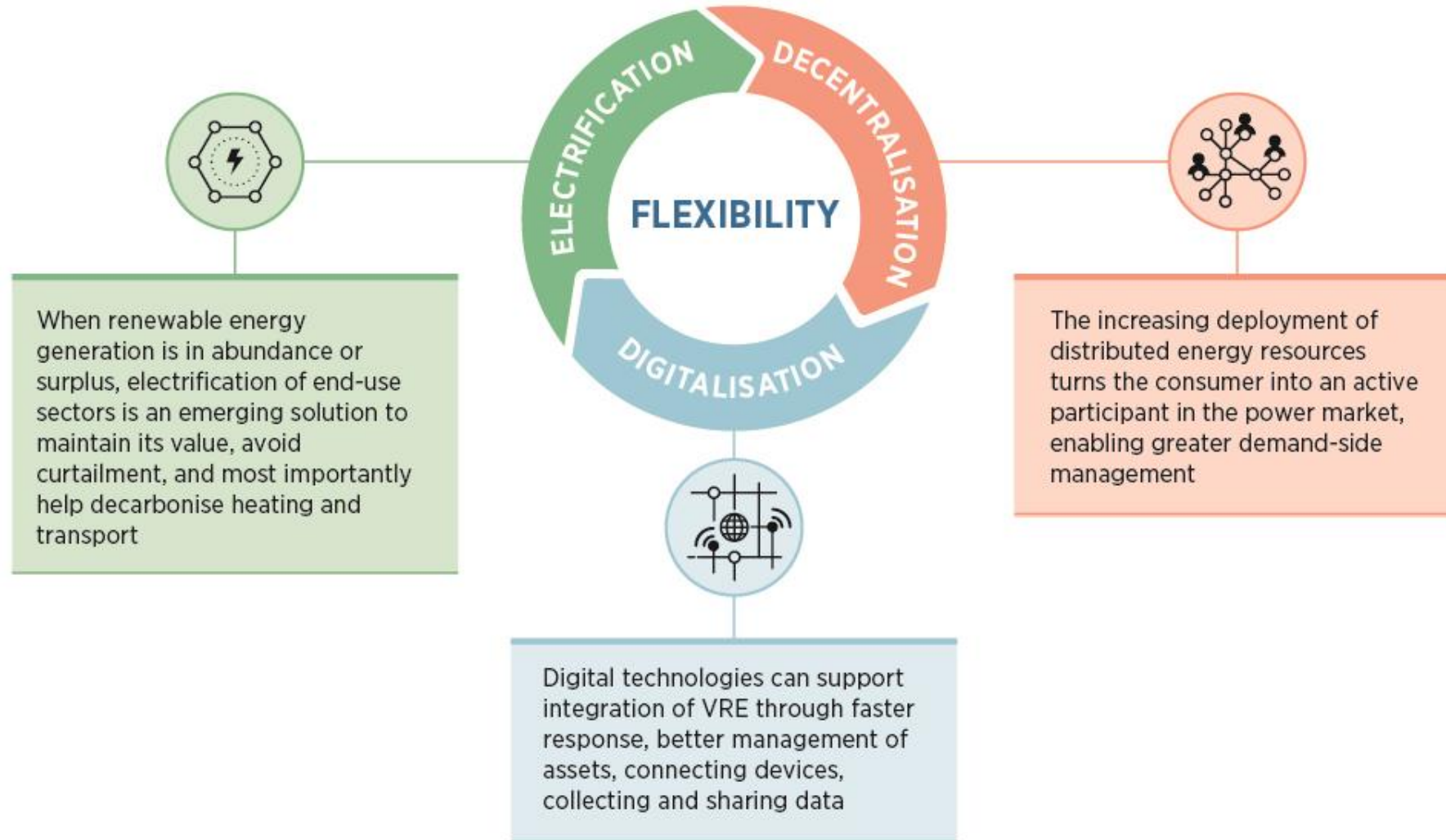
2. Innovation

- Innovation trends
- Unlocking flexibility
- New paradigm of the energy supply chain
- Innovation Landscape
- Innovations developed or implemented across Europe
- Systemic innovation approach
- Examples of solutions

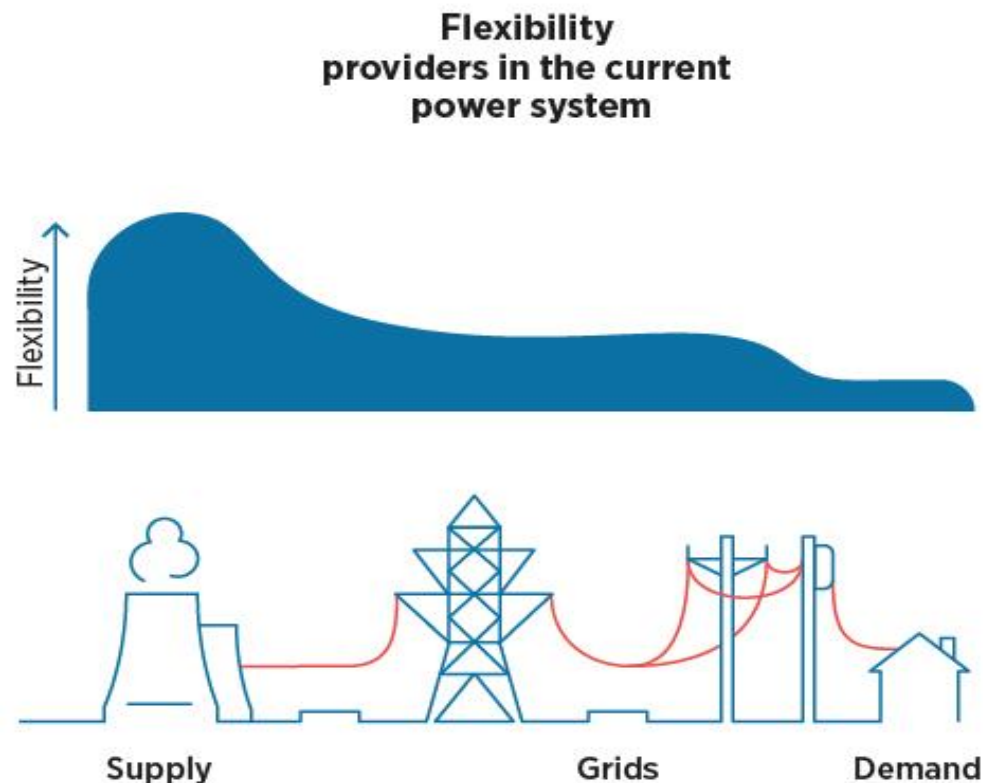
REmap case: pathway to meet the Paris Agreement



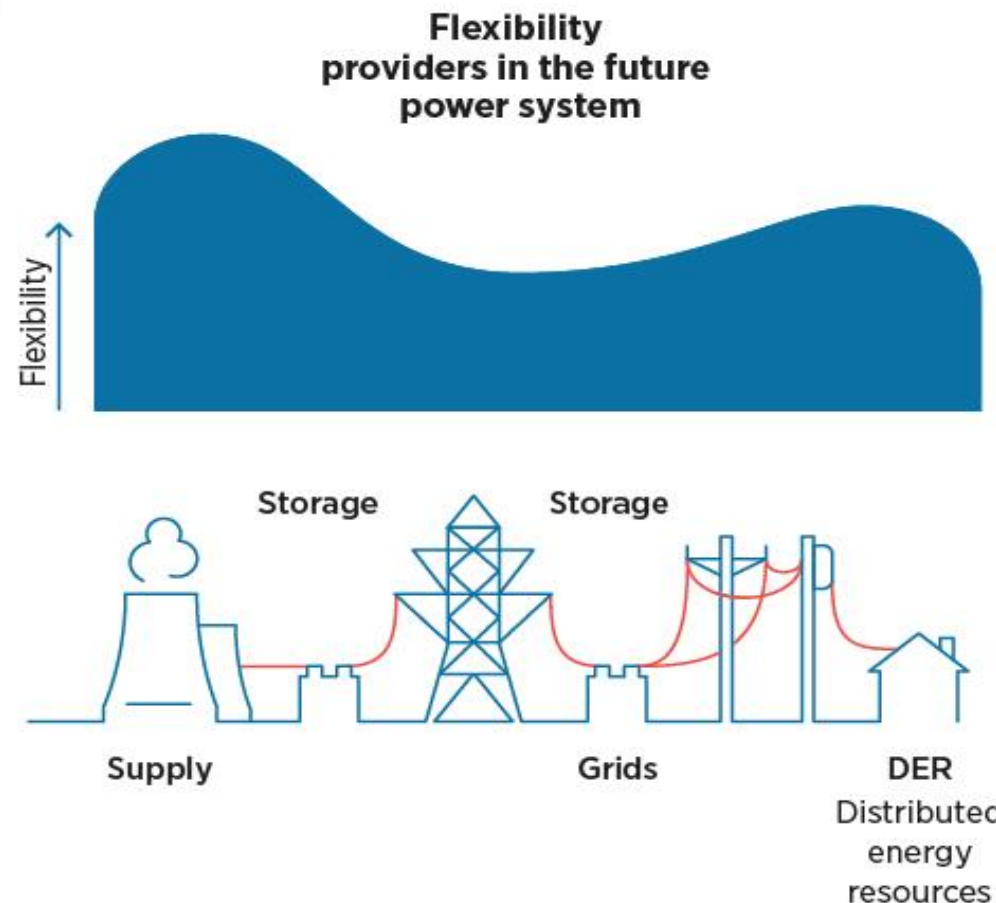
3 innovation trends



Innovation unlocks flexibility across power systems

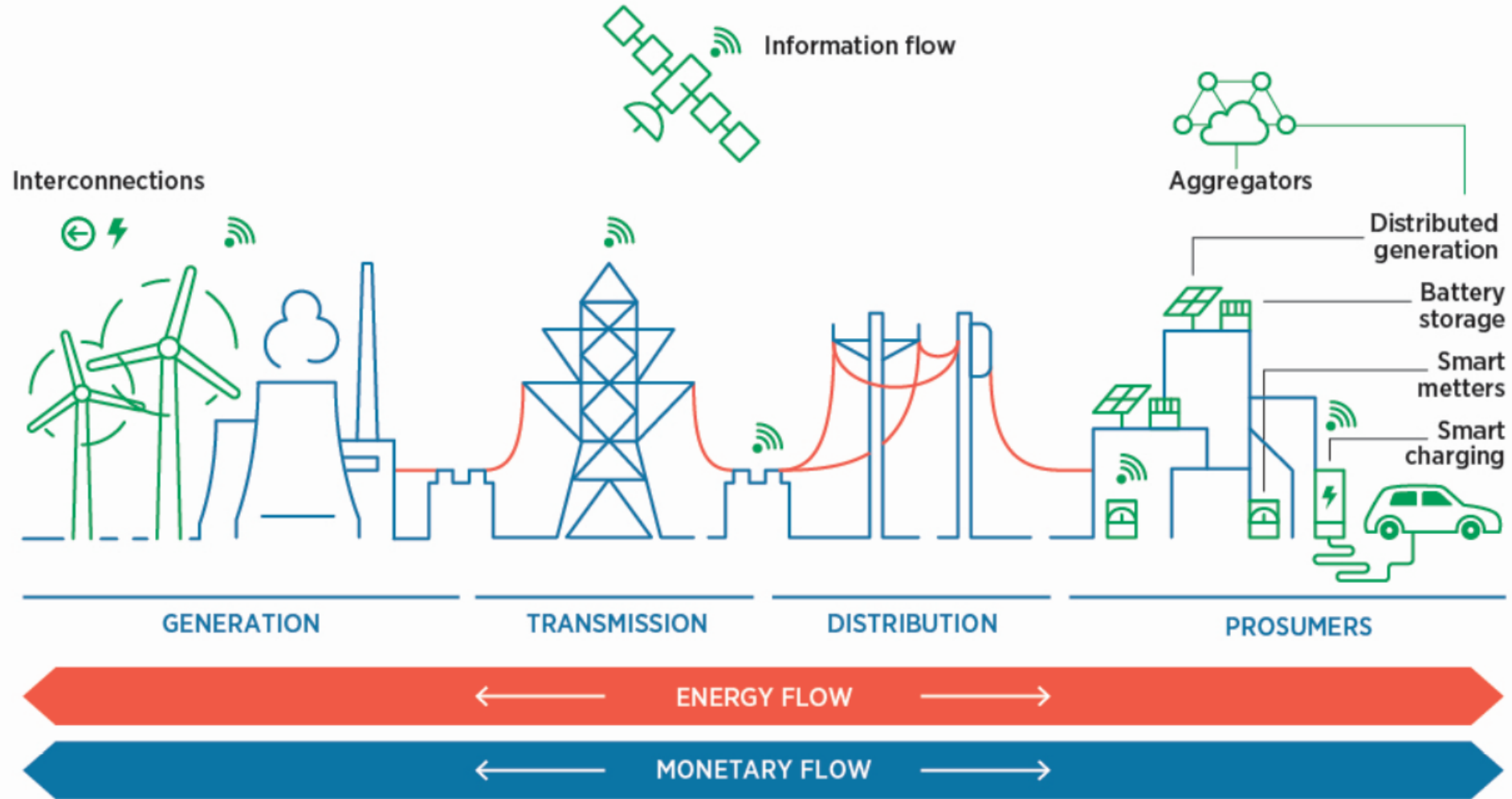


Flexibility sources: flexible generation

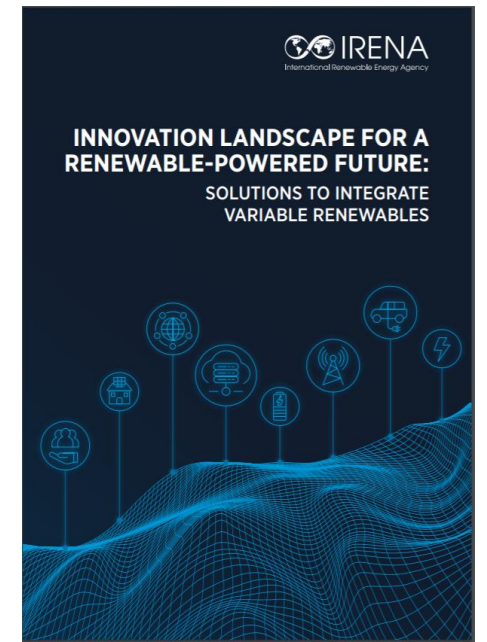
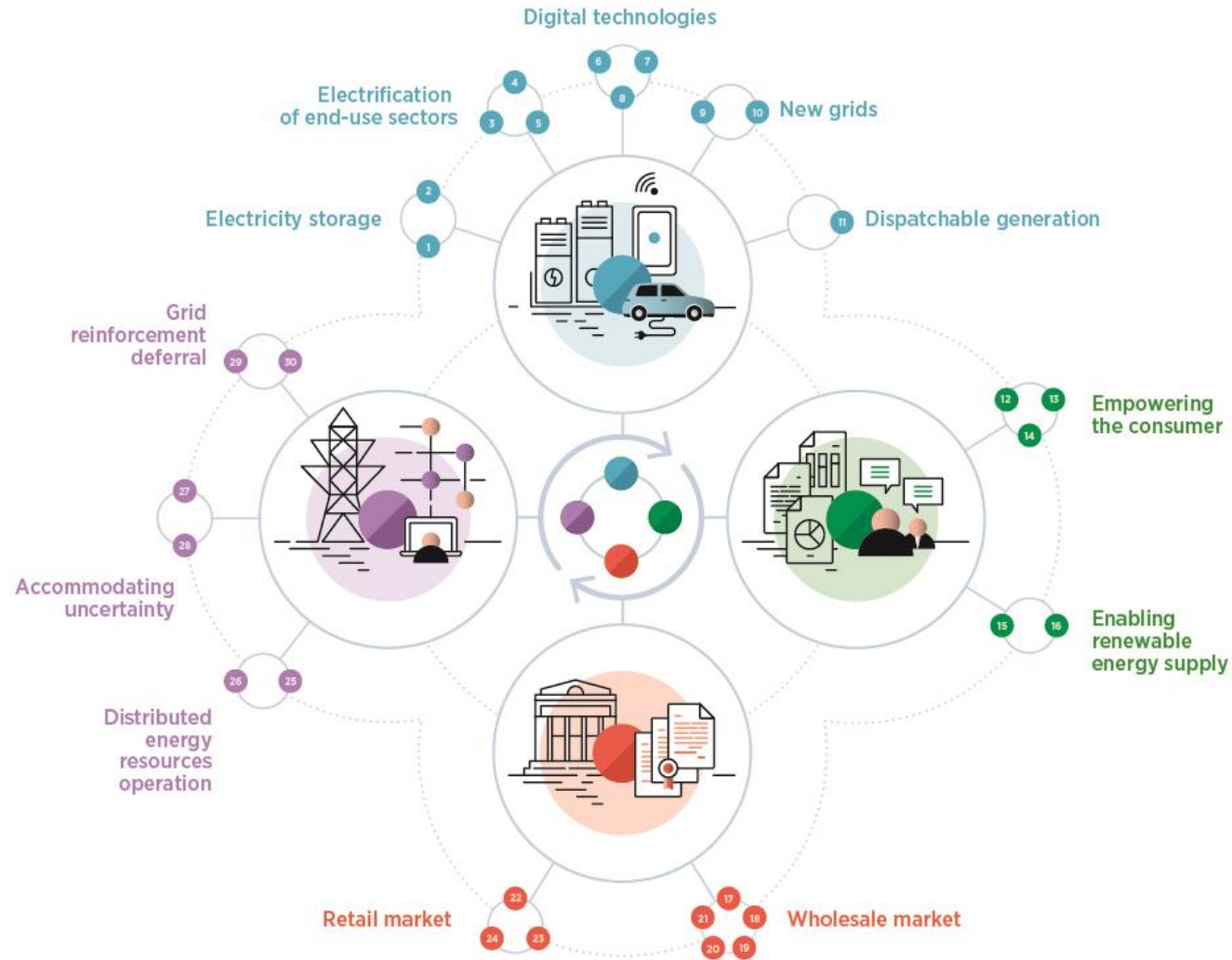


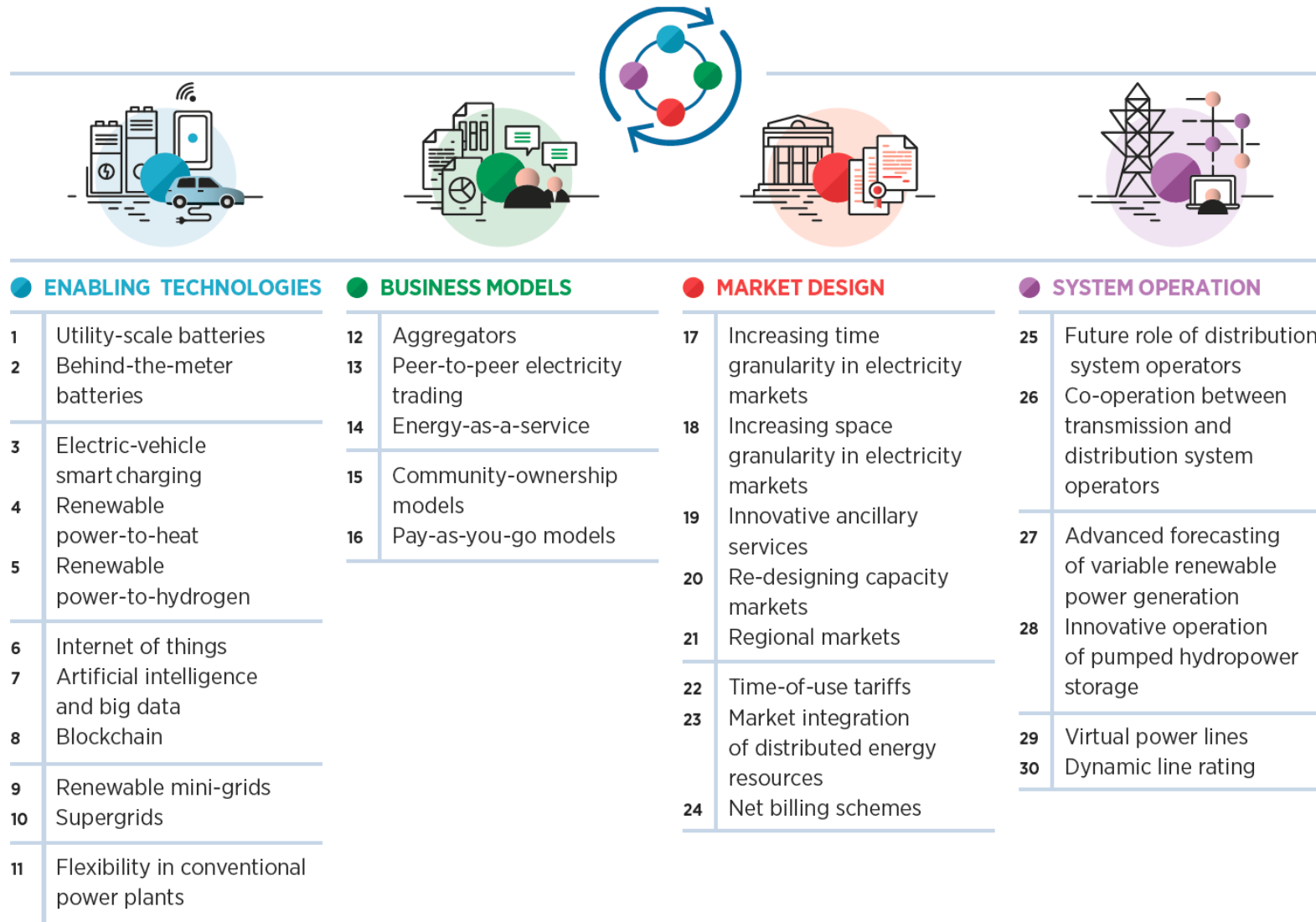
Flexibility sources: flexible generation, regional interconnections and markets, demand response, storage, power-to-X

New paradigm of the energy supply chain



Innovation Landscape

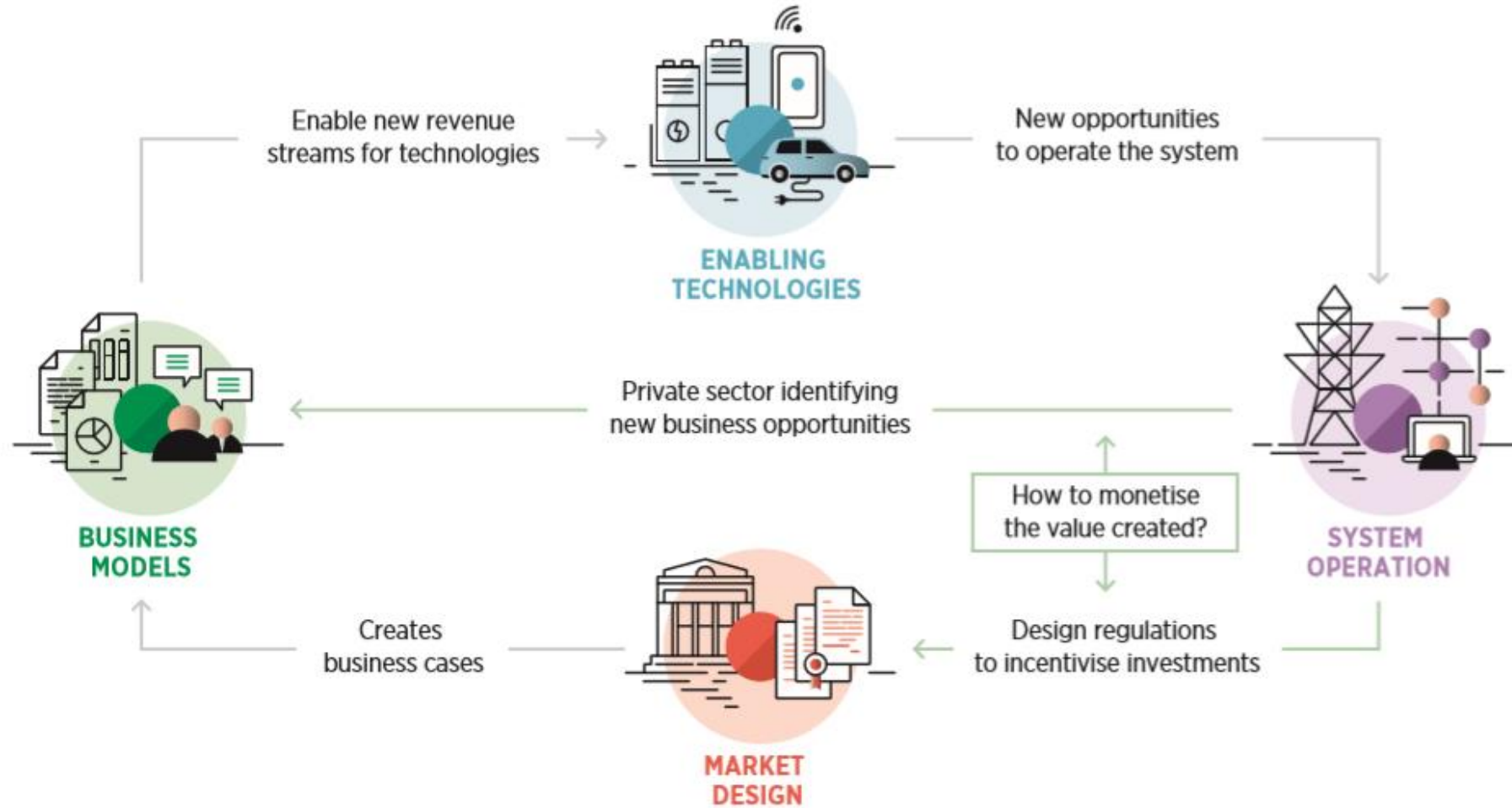




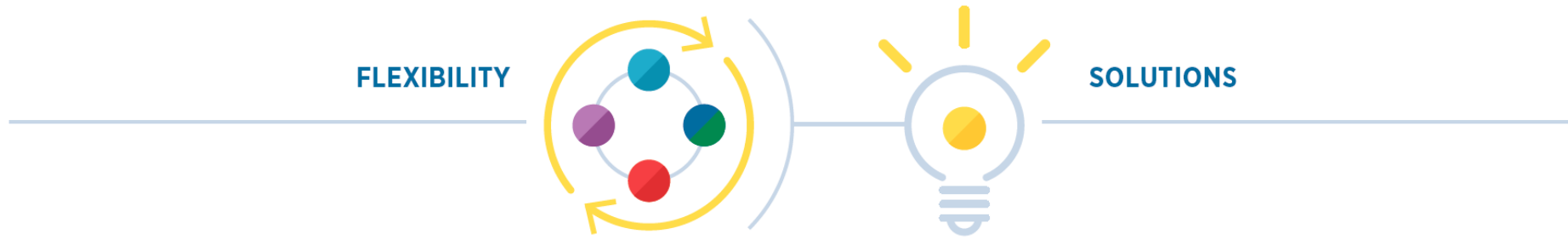
Innovations developed or implemented across Europe

Innovation category	Identified innovation	Several EU member states	AT	BE	DE	DK	FR	EE	ES	FI	IT	NL	NO	PT	SE	UK	
Enabling technologies	1. Utility-scale batteries	Yes			Yes						Yes	Yes				Yes	
	2. Behind-the-meter batteries	Yes			Yes						Yes	Yes				Yes	
	3. Electric-vehicle smart charging	Yes			Yes								Yes			Yes	
	4. Renewable power-to-heat	Yes			Yes	Yes									Yes	Yes	
	5. Renewable power-to-hydrogen	Yes															
	6. Internet of Things	Yes															
	7. Artificial intelligence and big data	Yes			Yes		Yes		Yes								Yes
	8. Blockchain	Yes			Yes								Yes				
	9. Renewable mini-grids	Yes											Yes				
	10. Supergrids	Yes			Yes												
	11. Flexibility in conventional power plants	Yes			Yes	Yes	Yes										
Business models	12. Aggregators	Yes		Yes	Yes	Yes	Yes					Yes				Yes	
	13. Peer-to-peer electricity trading	Yes			Yes			Yes				Yes				Yes	
	14. Energy-as-a-service	Yes								Yes	Yes				Yes	Yes	
	15. Community-ownership model	Yes			Yes	Yes						Yes	Yes			Yes	
	16. Pay-as-you-go model																
	17. Increasing time granularity in electricity markets	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Market design	18. Increasing space granularity in electricity markets	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	19. Innovative ancillary services	Yes			Yes											Yes	
	20. Re-designing capacity markets	Yes		Yes	Yes		Yes				Yes						
	21. Regional markets	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	22. Time-of-use tariffs	Yes					Yes		Yes	Yes			Yes		Yes	Yes	
	23. Market integration of distributed energy resources	Yes		Yes	Yes		Yes										
	24. Net billing scheme	Yes									Yes						
System operation	25. Future role of distribution system operators	Yes														Yes	
	26. Co-operation between transmission & distribution system operators	Yes	Yes	Yes		Yes		Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	
	27. Advanced forecasting of variable renewable power generation	Yes			Yes					Yes		Yes					
	28. Innovative operation of pumped hydropower storage	Yes				Yes	Yes				Yes		Yes	Yes		Yes	
	29. Virtual power lines	Yes					Yes				Yes						
	30. Dynamic line rating	Yes			Yes											Yes	

Systemic innovation for a renewable-powered future

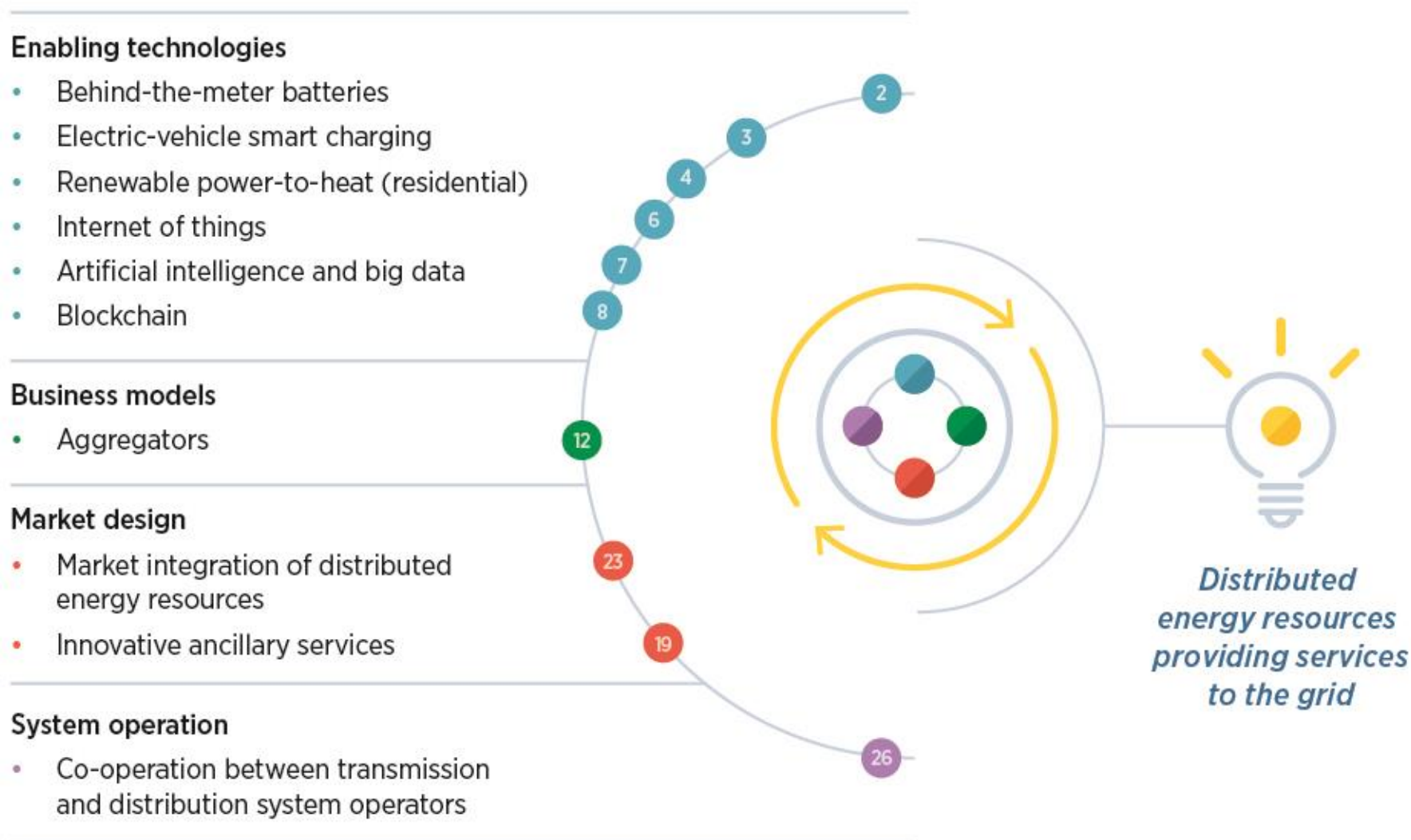


11 predefined flexibility solutions

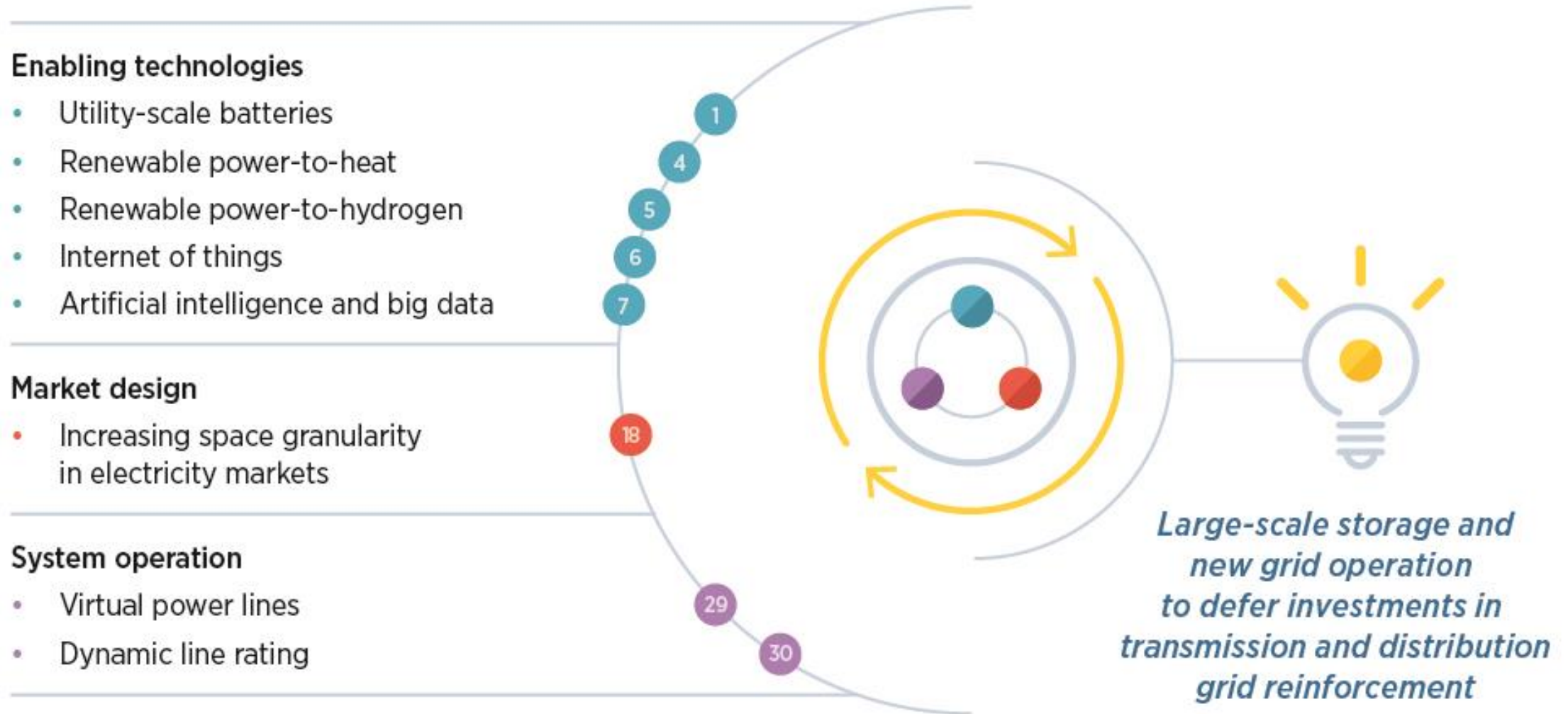


● SUPPLY-SIDE FLEXIBILITY SOLUTIONS		● GRID FLEXIBILITY SOLUTIONS		● DEMAND-SIDE FLEXIBILITY SOLUTIONS		● SYSTEM-WIDE STORAGE FLEXIBILITY SOLUTIONS	
I	Decreasing VRE generation uncertainty with advanced generation forecasting	III	Interconnections and regional markets as flexibility providers	VI	Aggregating distributed energy resources for grid services	X	Utility-scale battery solutions
II	Flexible generation to accommodate variability	IV	Matching RE generation and demand over large distances with Supergrids	VII	Demand-side management	XI	Power-to-X solutions
		V	Large-scale storage and new grid operation to defer grid reinforcements investments	VIII	RE mini-grids providing services to the main grid		
				IX	Optimising distribution system operation with with distributed energy resources		

Example of demand-side flexibility solution



Example of grid flexibility solution



Example of grid flexibility solution



Thank you for your attention!