Soluciones innovadores para integrar un mayor porcentaje de ERV

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Agenda

- IRENA's **systemic innovation** approach for VRE integration
- **Grid flexibility**: Regional markets as flexibility providers
- **Demand side flexibility**: aggregating distributed energy resources for grid services
- 8-step **innovation plan** for power sector transformation

Systemic innovation for VRE integration

IRENA
International Renewable Energy Agency

Emerging innovations for the integration of solar and wind power

SYSTEM OPERATION

Operation of a decentralised system

Electrification of end-use sectors

Value complementaries in renewable generation

Encourage flexibility

Empowering consumers

Value spatial complementaries

ENABLING TECHNOLOGIES

Digitalisation

Hydrogen

Blockchain

Storage

Electric vehicles

BUSINESS MODELS

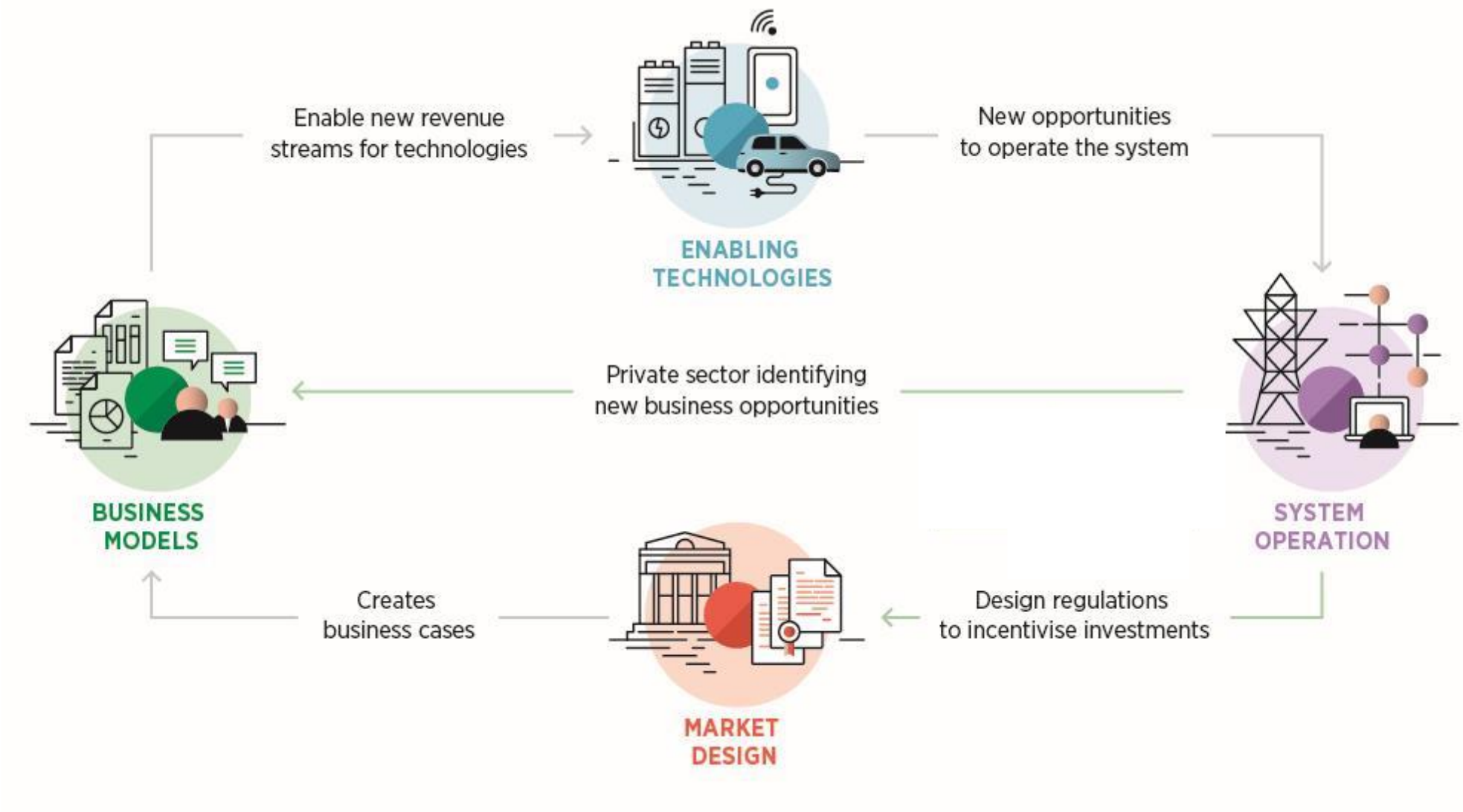
Energy as a service

Peer-to-peer electricity trading

Aggregators

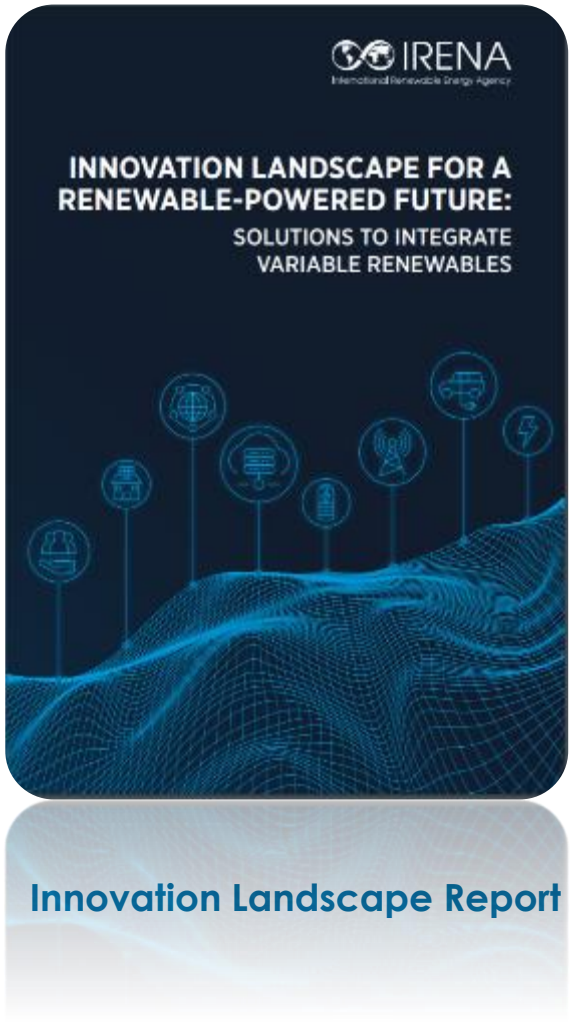
MARKET DESIGN

Systemic innovation



IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Innovations for wind and solar PV integration



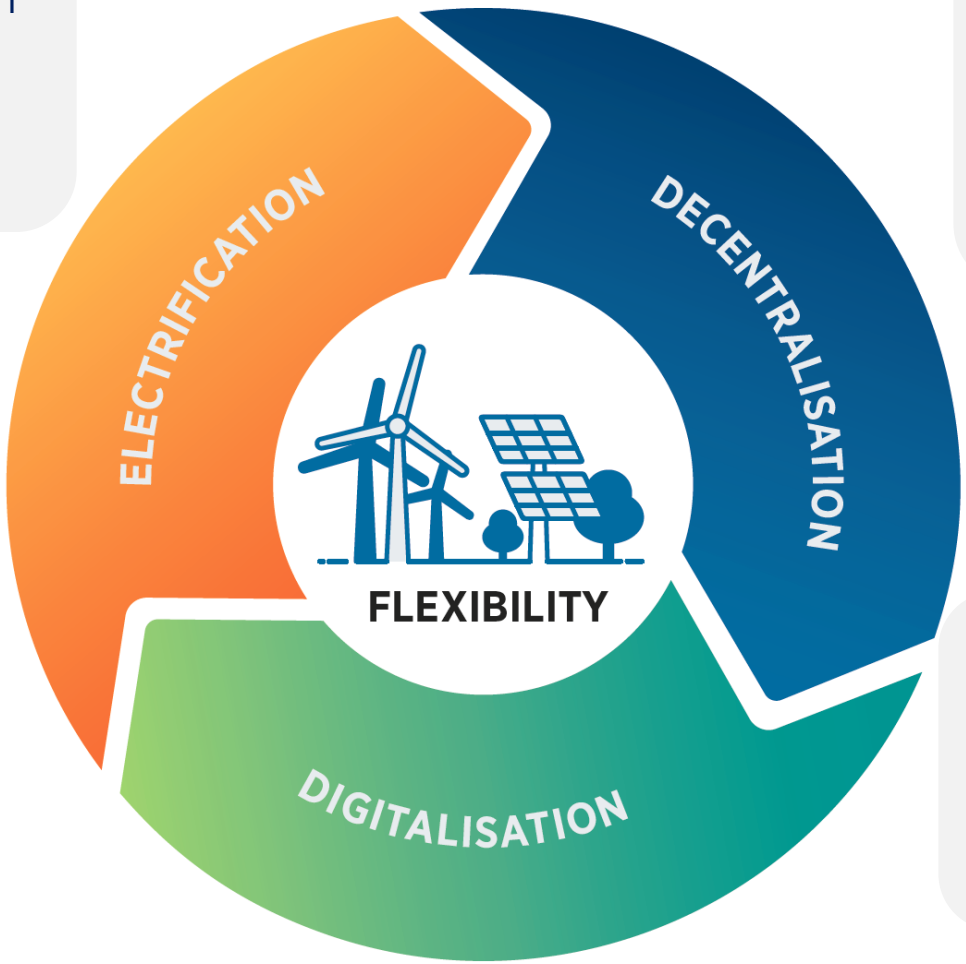
Innovation Landscape Report

ENABLING TECHNOLOGIES	BUSINESS MODELS	MARKET DESIGN	SYSTEM OPERATION
1 Utility-scale batteries	12 Aggregators	17 Increasing time granularity in electricity markets	25 Future role of distribution system operators
2 Behind-the-meter batteries	13 Peer-to-peer electricity trading	18 Increasing space granularity in electricity markets	26 Co-operation between transmission and distribution system operators
3 Electric-vehicle smart charging	14 Energy-as-a-service	19 Innovative ancillary services	27 Advanced forecasting of variable renewable power generation
4 Renewable power-to-heat	15 Community-ownership models	20 Re-designing capacity markets	28 Innovative operation of pumped hydropower storage
5 Renewable power-to-hydrogen	16 Pay-as-you-go models	21 Regional markets	29 Virtual power lines
6 Internet of things		22 Time-of-use tariffs	30 Dynamic line rating
7 Artificial intelligence and big data		23 Market integration of distributed energy resources	
8 Blockchain		24 Net billing schemes	
9 Renewable mini-grids			
10 Supergrids			
11 Flexibility in conventional power plants			

Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Power sector transformation: Innovation trends

- Electrification of end-use sectors is an emerging solution to **maintain value and avoid curtailment of VRE**, and help decarbonize other sectors

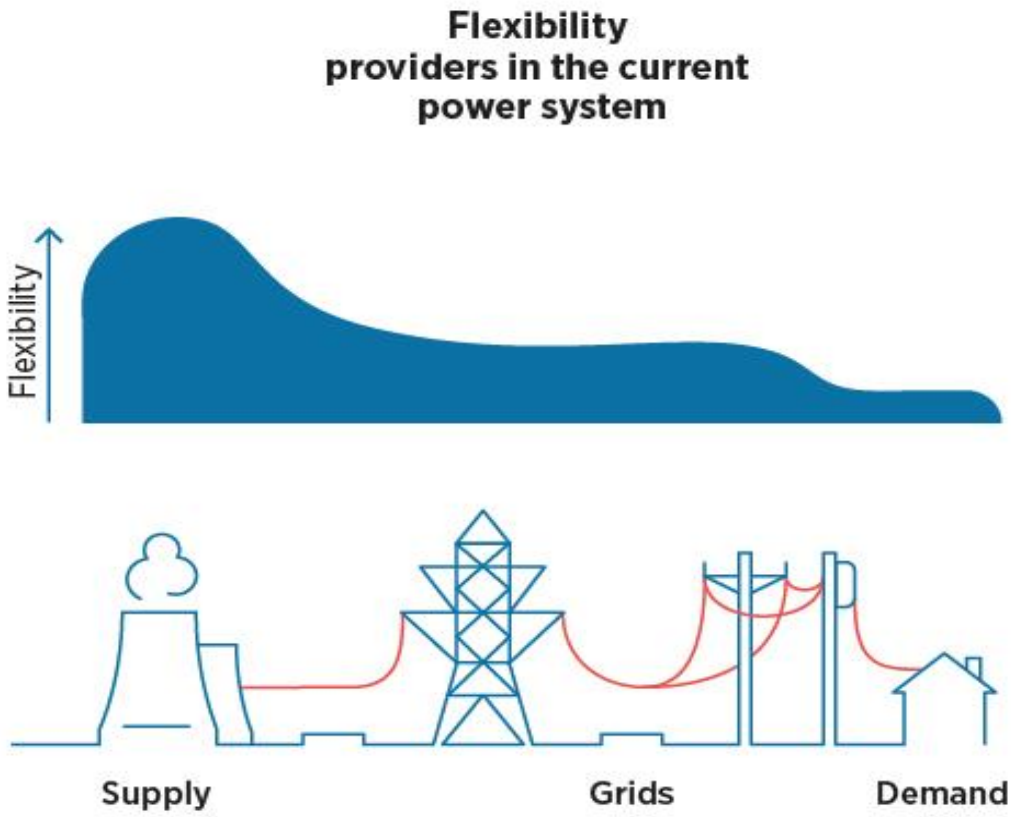


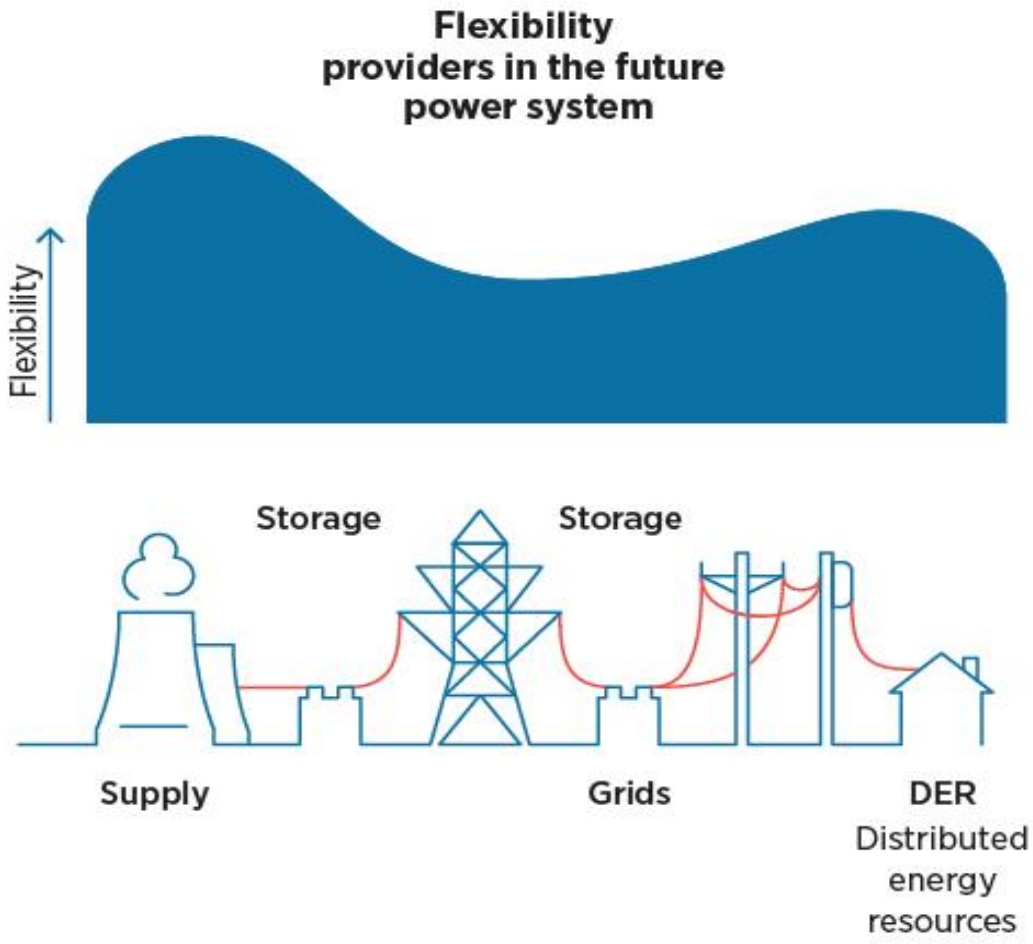
- The increasing deployment of Distributed Energy Resources (DERs) turns the consumer into an active participant, **fostering demand-side management**.

- Digital technologies enable **faster response, better management of assets, connecting devices, collecting data, monitor and control**

Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Innovation unlocks flexibility across the power system





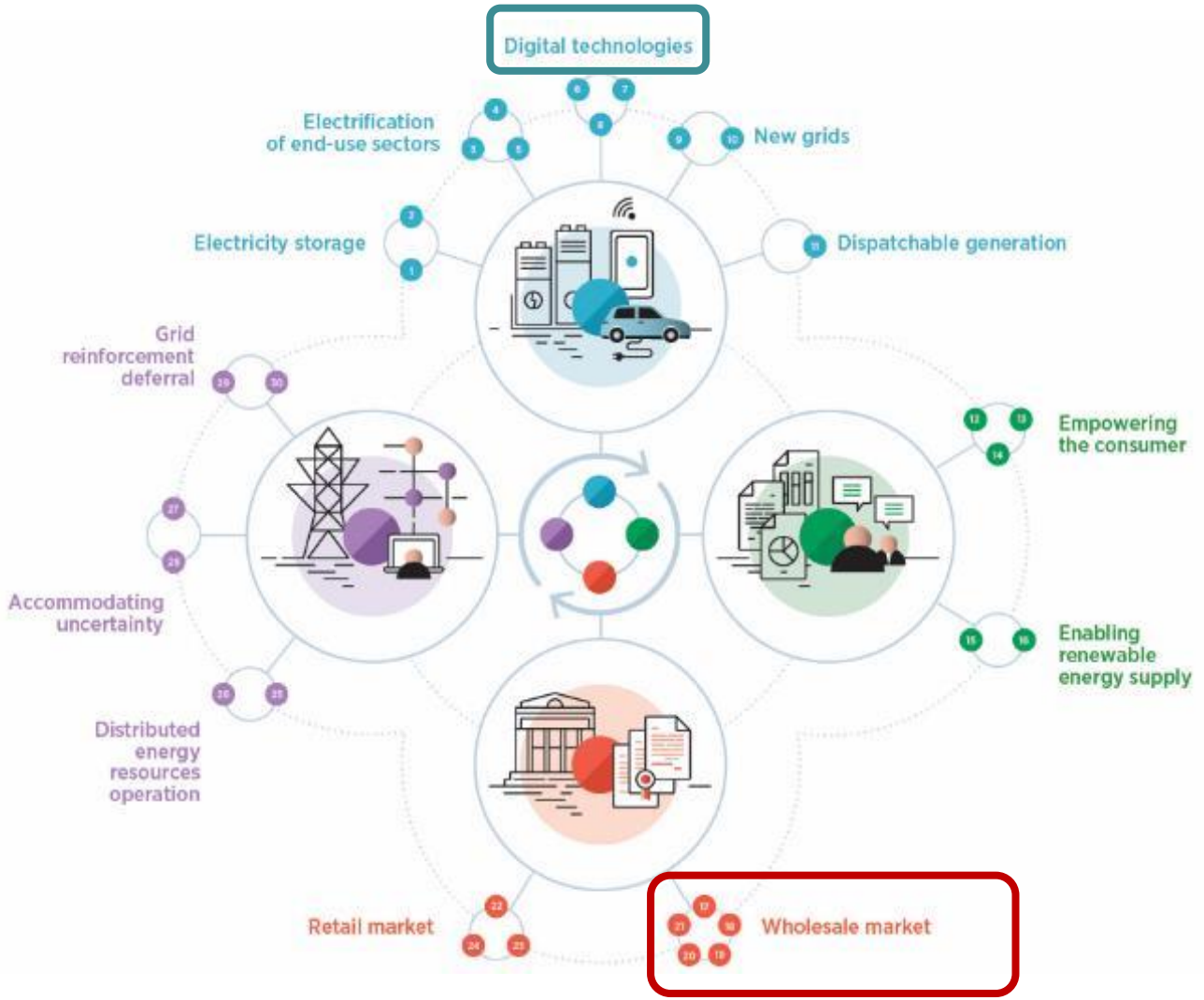
Flexibility sources: Flexible generation

Flexibility sources: Flexible generation; Regional interconnections and markets; Demand response; Storage; Power to X

Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

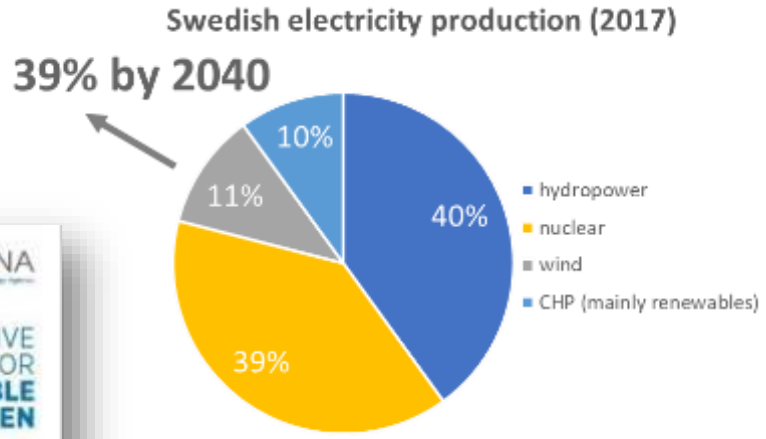
Grid flexibility: Interconnections and regional markets as flexibility providers

IRENA's innovation landscape for VRE integration



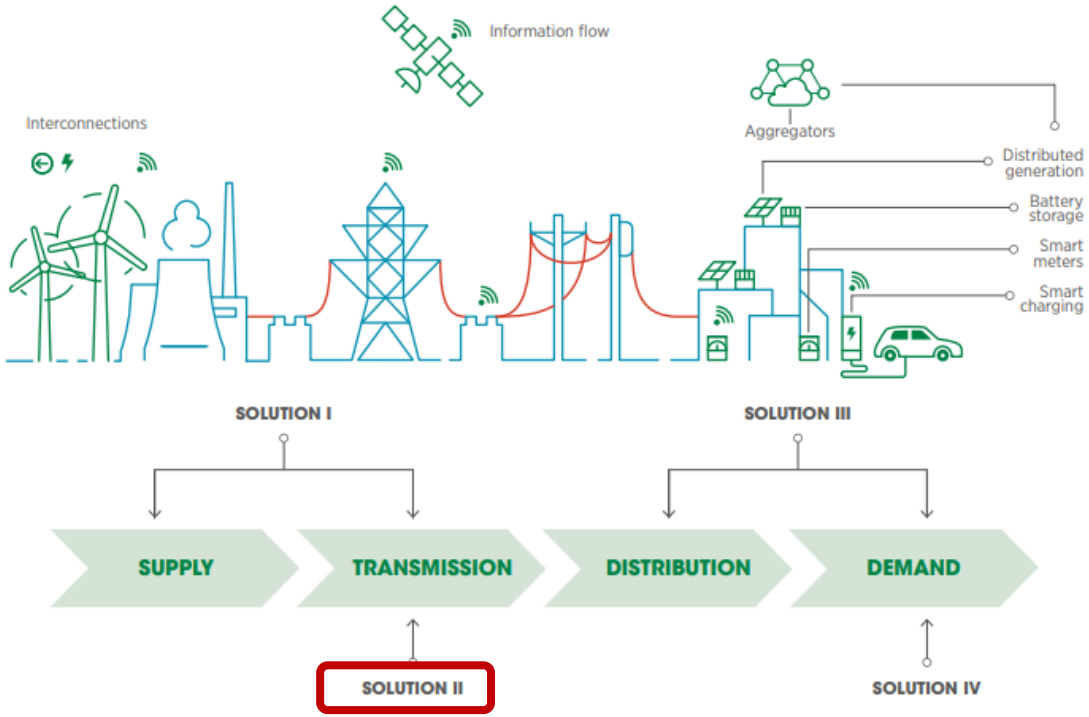
IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Each solution tackles a power sector segment



Key system operation challenges:

- **Ensuring power system stability**: annual average inertia is expected to decrease from 202 GWs (2020) to 159 GWs (2040);
- **Balancing demand and supply:** greater consumption in the South and significant hydropower generation in the North;
- **Expanding the network:** long lead times for distribution & transmission infrastructure (EUR 15 billion to be invested by 2025).



IRENA (2020), Innovative solutions for 100% renewable power in Sweden

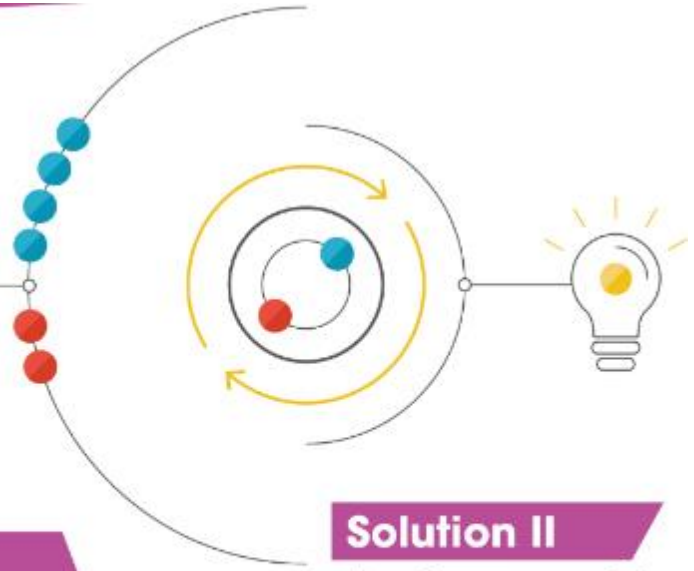
Example of solution combining innovations

Enabling technologies

- Internet of Things
- Artificial intelligence and big data
- Blockchain
- Supergrids

Market design

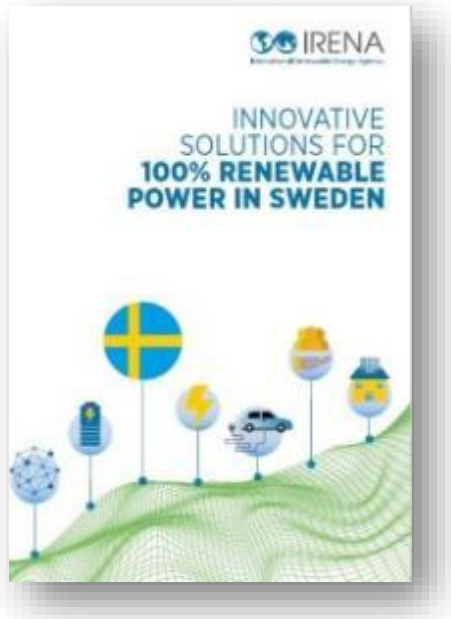
- Increasing time granularity in electricity markets
- Regional markets



Solution II

Pan-European market as flexibility provider with effective collaboration among system operators

- Improves flexibility in the existing pan-European market design;
- Fosters collaboration among system operators in Sweden, the Nordic, Baltic and wider European region;
- Ensures clear and effective division of responsibilities to manage an increasingly complex, decentralised and digitalised power system.



Europe – intraday trading between non-adjacent market areas

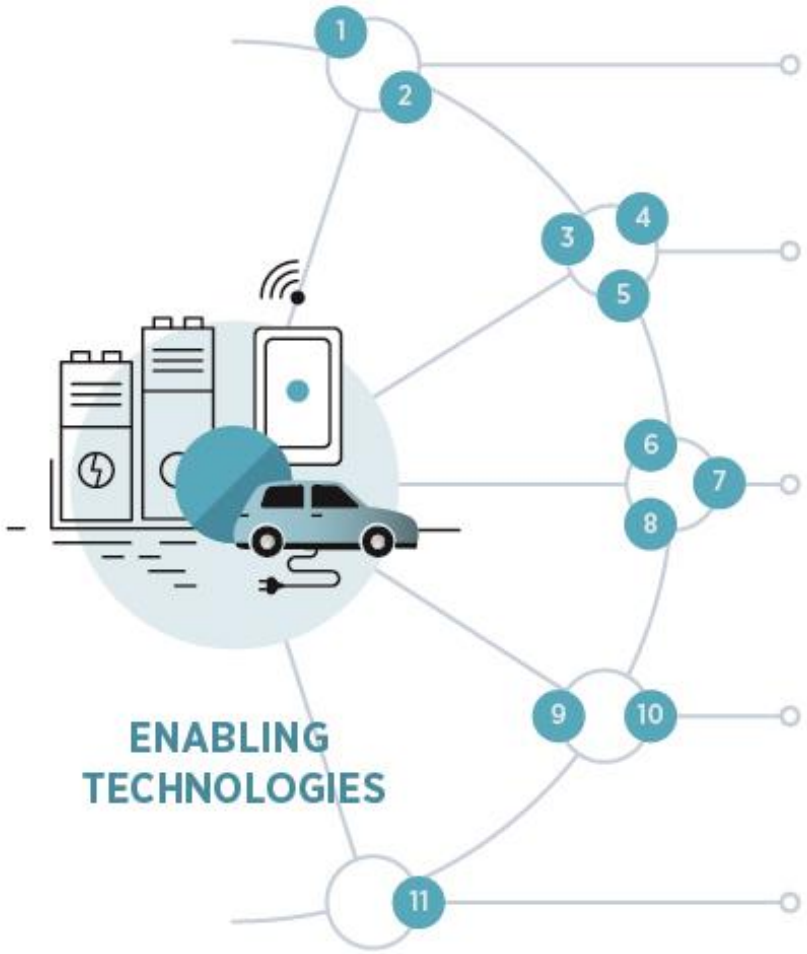
Europe – 15- and 30-minute intraday products traded closer to real-time delivery

Denmark – 53% VRE integration thanks to supergrids and regional market

European transmission system operators – pilots for a common balancing market

IRENA (2020), Innovative solutions for 100% renewable power in Sweden

Innovations in enabling technologies



Electricity storage

- **1** Utility-scale batteries
- **2** Behind-the-meter batteries

Electrification of end-use sectors

- **3** Electric-vehicle smart charging
- **4** Renewable power-to-heat
- **5** Renewable power-to-hydrogen

Digital technologies

- **6** Internet of things
- **7** Artificial intelligence and big data
- **8** Blockchain

New grids

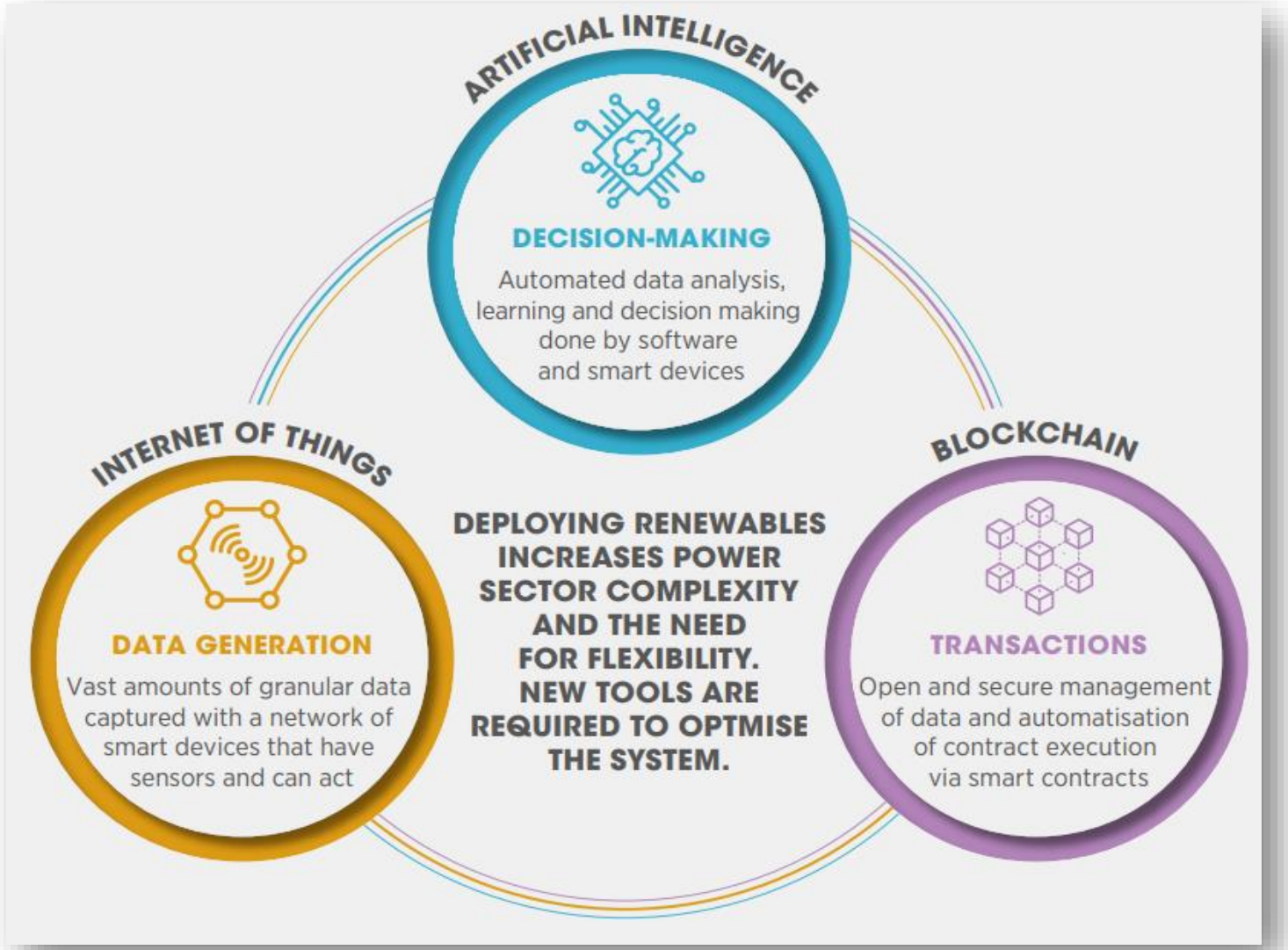
- **9** Renewable mini-grids
- **10** Supergrids

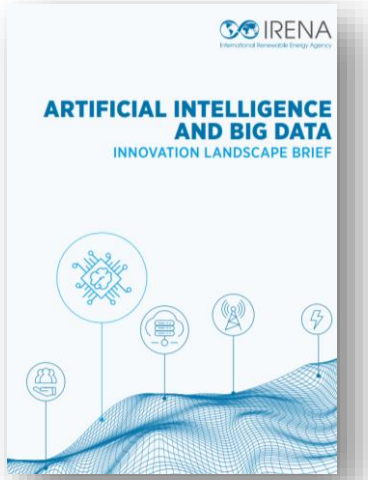
Dispatchable generation

- **11** Flexibility in conventional power plants

IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

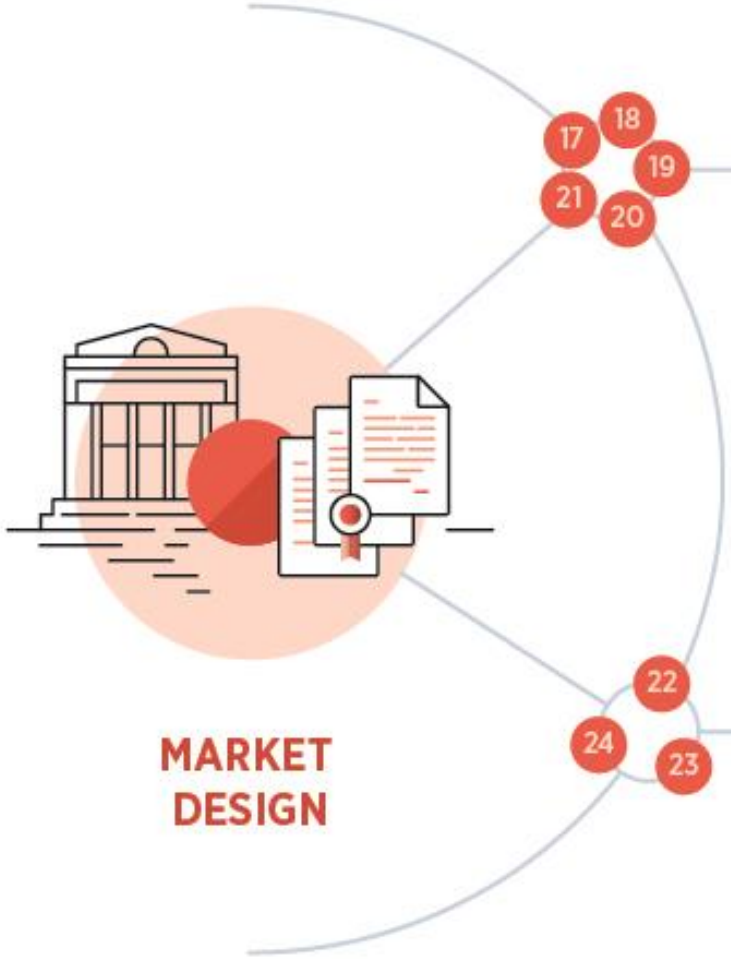
Power sector complexity requires digital innovations





IRENA (2019), Blockchain: Innovation Landscape Brief

Innovations in market design



Wholesale market

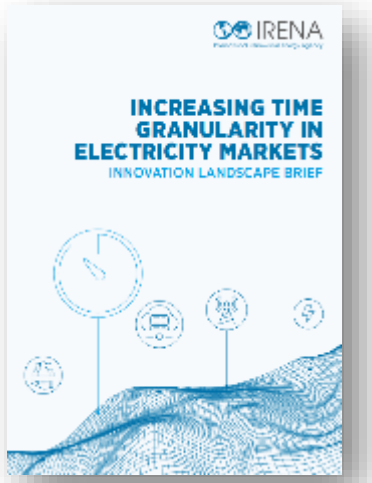
- **17** Increasing time granularity in electricity markets
- **18** Increasing space granularity in electricity markets
- **19** Innovative ancillary services
- **20** Re-designing capacity markets
- **21** Regional markets

Retail market

- **22** Time-of-use tariffs
- **23** Market integration of distributed energy resources
- **24** Net billing schemes

IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Increasing time granularity in electricity markets



How to internalize the value of flexibility in the market price?

- Reducing the **market time units** (the duration of dispatch);
- Reducing the time span between **trading gate closure** and **physical real-time delivery** of power (the lead time).

BENEFITS

Increasing time granularity in electricity markets

Short term:

Improved flexibility in operations through price signals

Long term:

Optimised investments in flexible generation capacity (through granular price signals)

Enable higher shares of VRE in the power system

SNAPSHOT

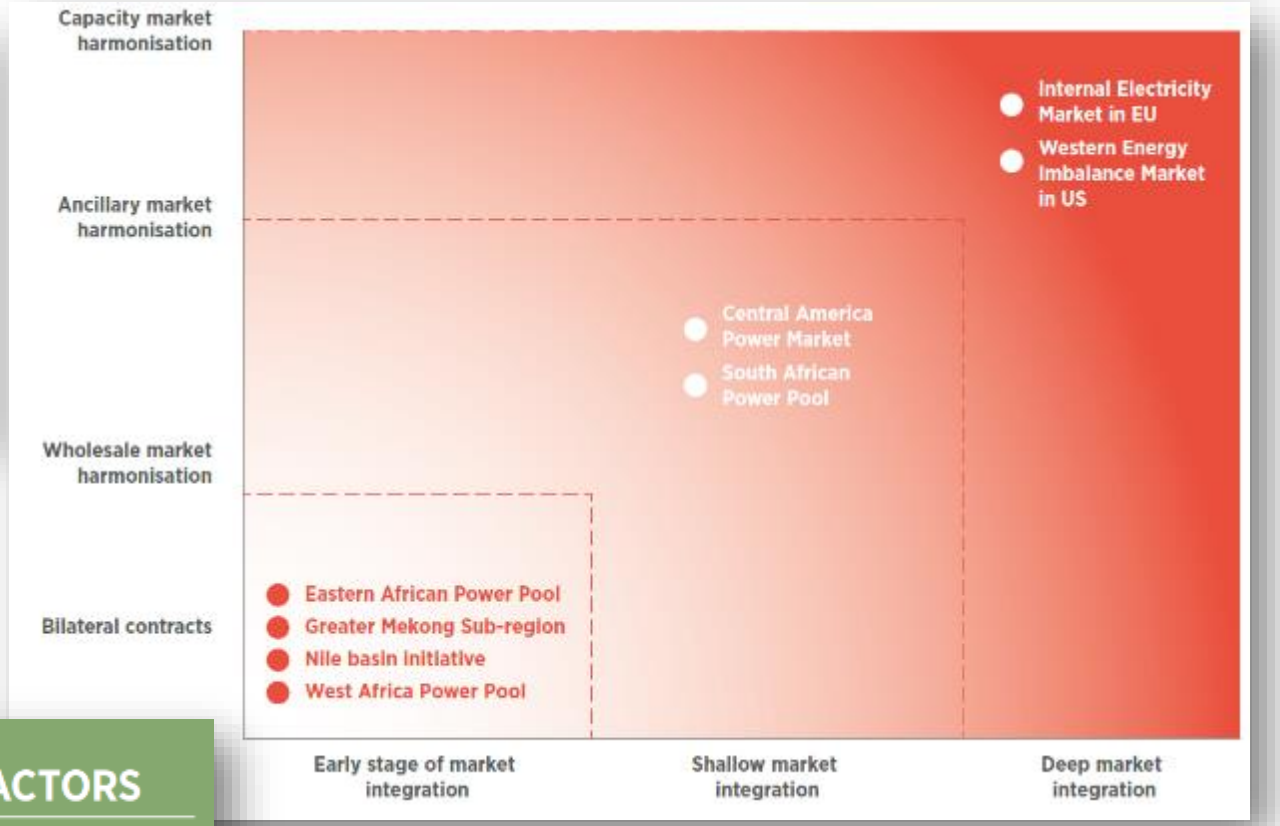
- Shorter market time units are explored in California (United States), Brazil, Germany and other European markets.
- Shorter lead times are proposed in Australia, the Nordic power market in Europe (reduced to 15 minutes), Austria, Belgium and Germany (reduced to 5 minutes).

IRENA (2019), Innovation landscape brief: Increasing time granularity in electricity markets

Regional markets as flexibility providers

1 HOW IT WORKS

Regional markets require the harmonisation of market rules for electricity to flow freely in response to market-based price signals. The deeper the integration, the more rules needs to be harmonised. There are different stages of market integration:



2 BENEFITS

- Increased flexibility through expanding balancing area
- Advantages of spatial complementarity of VRE generation
- Co-ordinate generation planning
- Reduce system operation cost

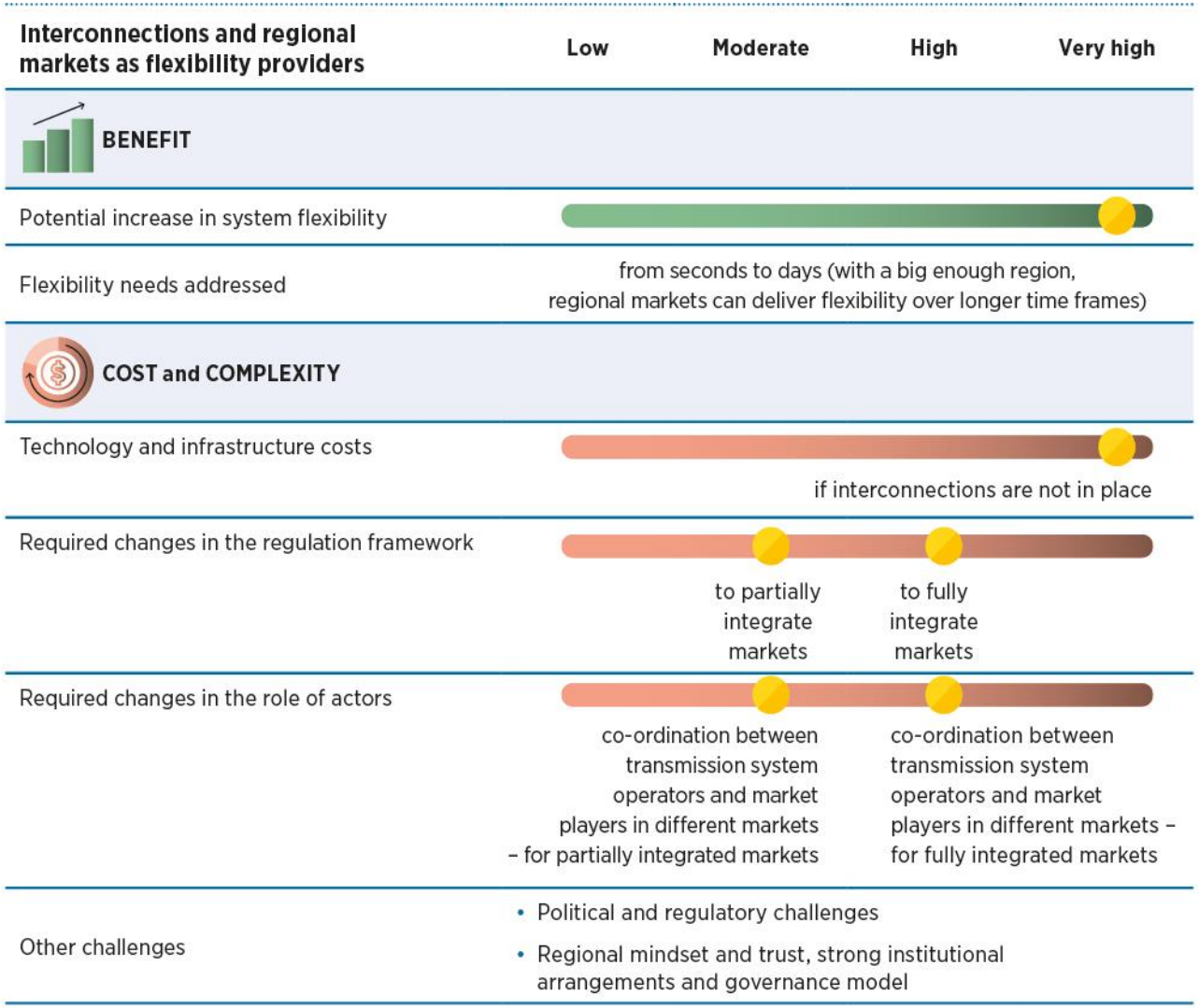
3 KEY ENABLING FACTORS

- Physical interconnections with sufficient capacity
- Regional mindset, strong institutional arrangements and governance model
- Robust IT system for market operation

IRENA (2019), Innovation landscape brief: Regional markets

Regional markets as flexibility providers

Benefits
&
costs

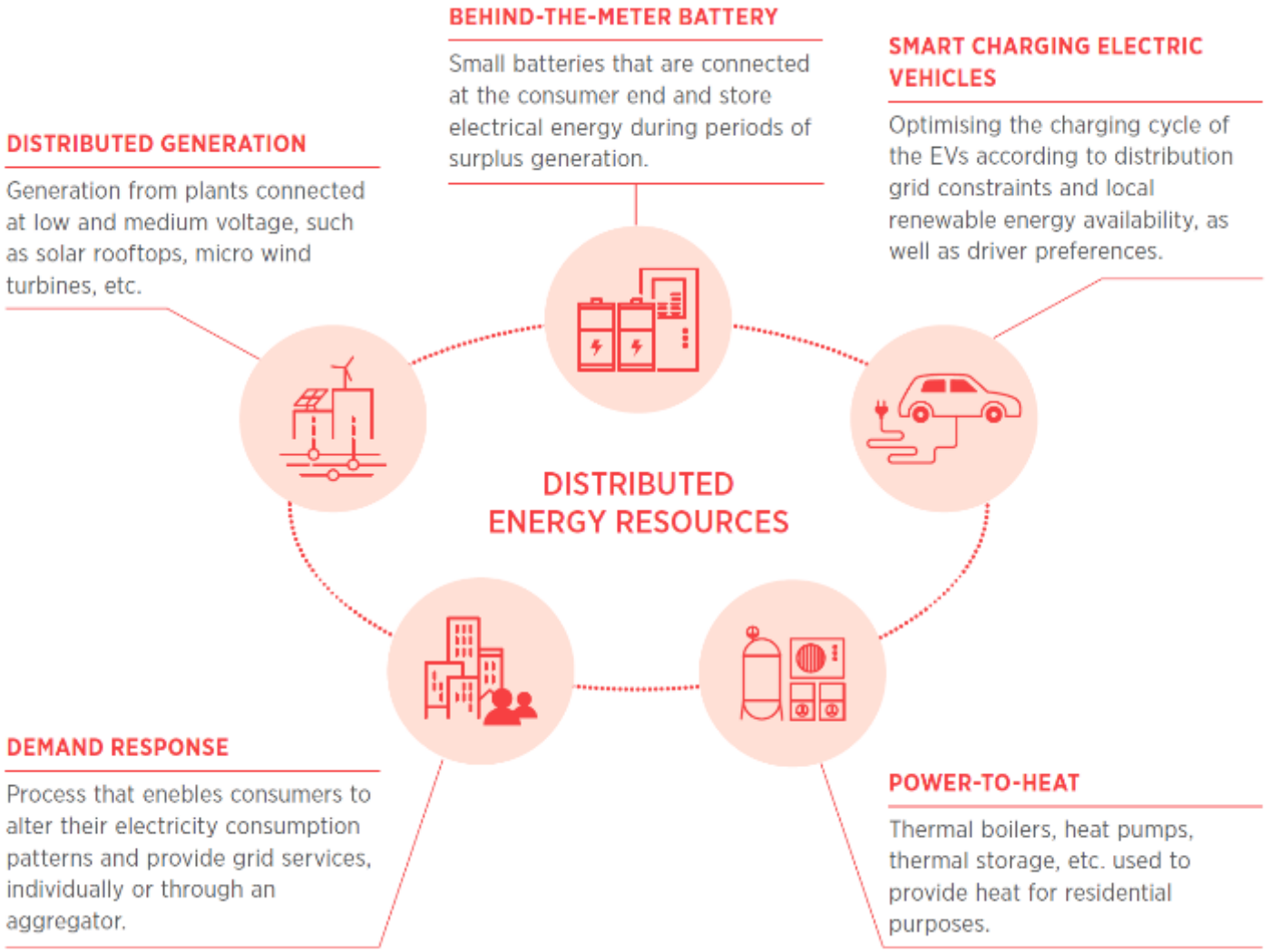


IRENA (2019), Innovation landscape brief: Regional markets

Demand side flexibility: Aggregating distributed energy resources for grid services

Decentralisation and digitalisation

The new consumer is also producing, storing, trading energy and managing own load



Internet of things

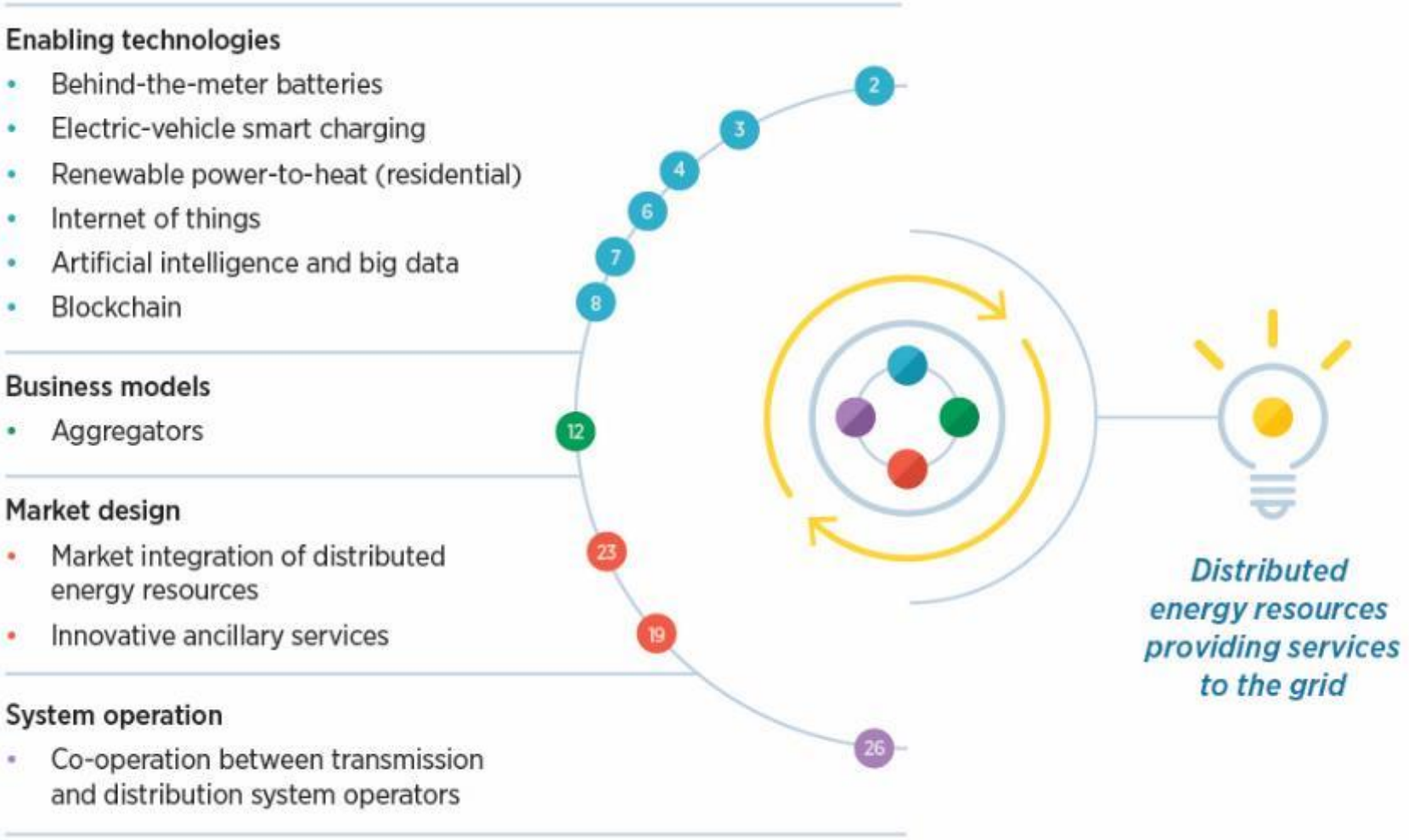
Artificial intelligence

Blockchain

Source: IRENA (2019) Innovation landscape brief: Market integration of distributed energy resources

Demand-side flexibility solutions

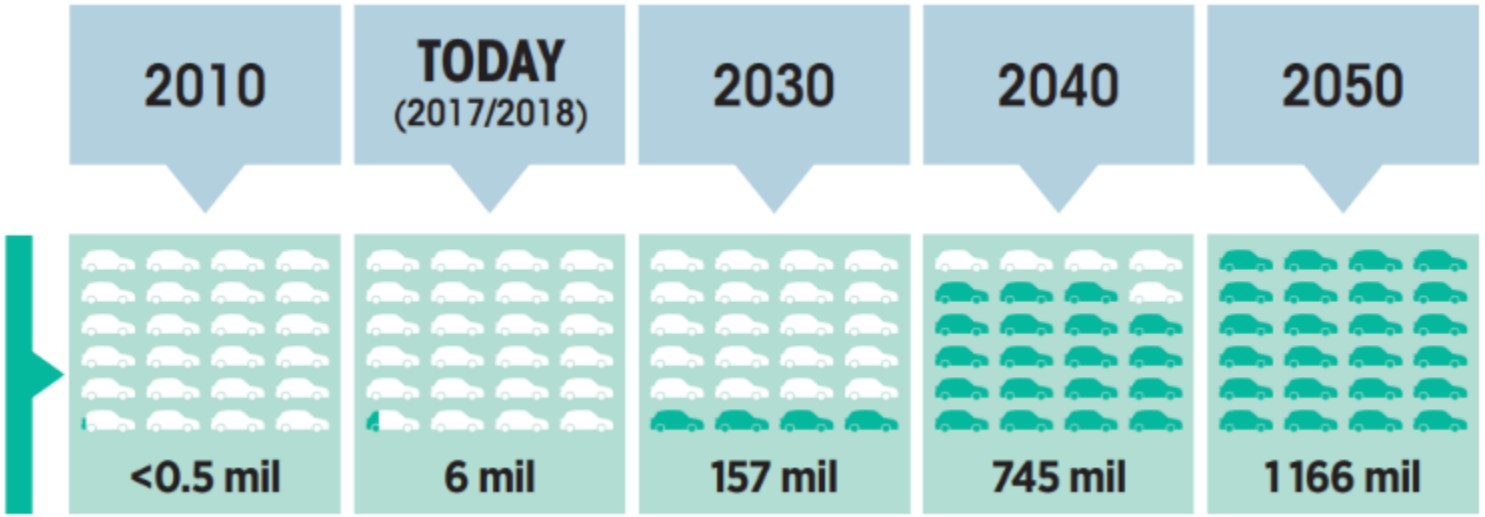
Aggregating distributed energy resources for grid services



Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

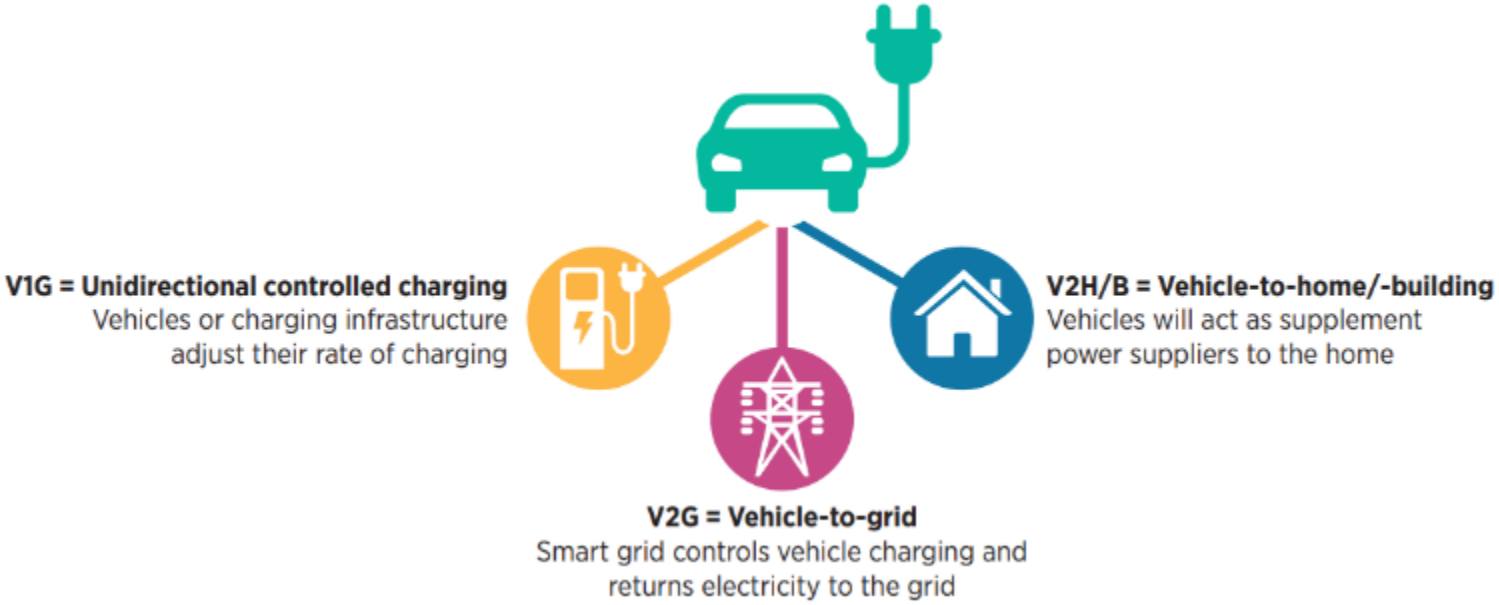
Innovative technology: EV smart charging

Electric vehicles



Smart charging for electric vehicles (EVs) holds the key to unleash synergies between clean transport sector and low-carbon electricity.

It minimises the load impact from EVs and unlocks the flexibility to use more solar and wind power.



Innovative technology: Internet of Things

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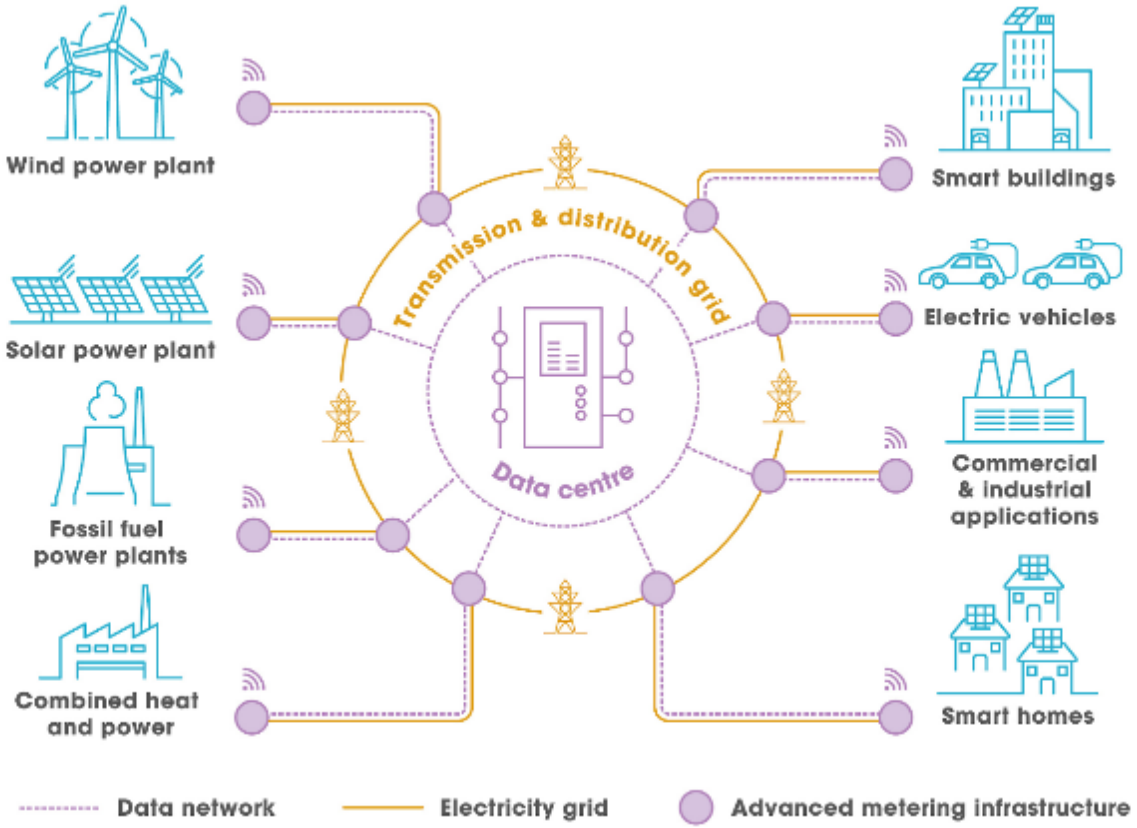
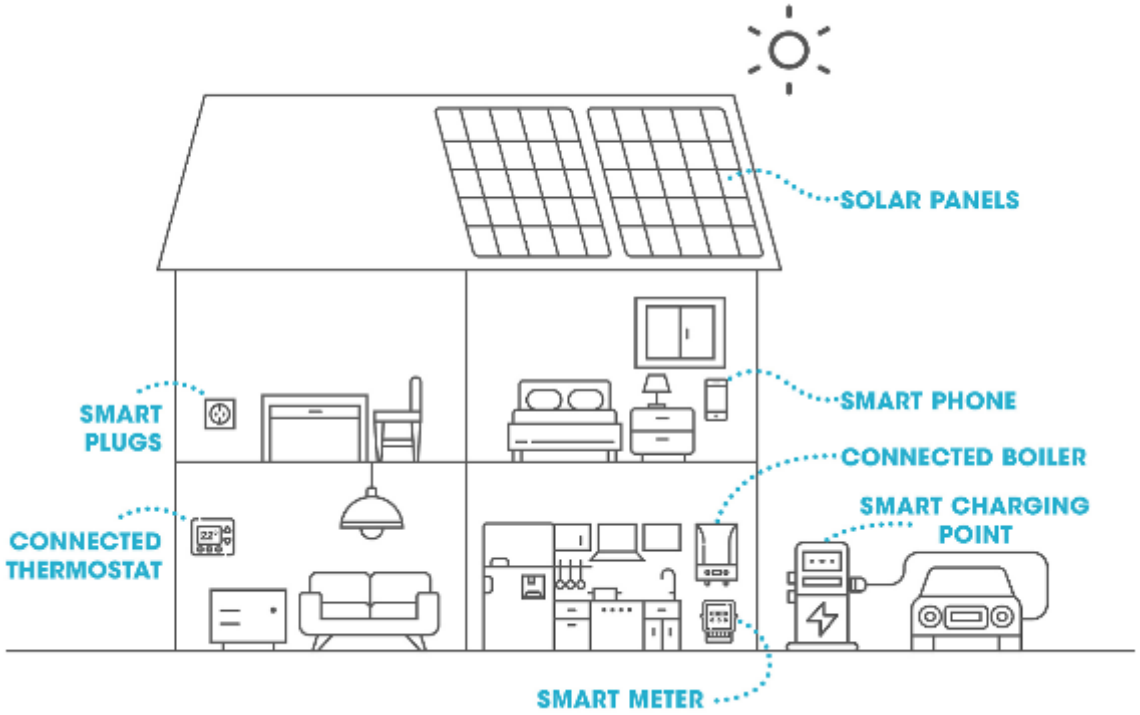
IoT transforms physical objects into 'smart' devices to

collect, communicate, monitor and interpret information from their surroundings in real time

Smart grids



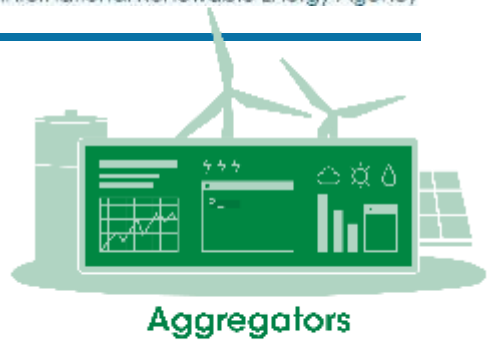
Smart homes

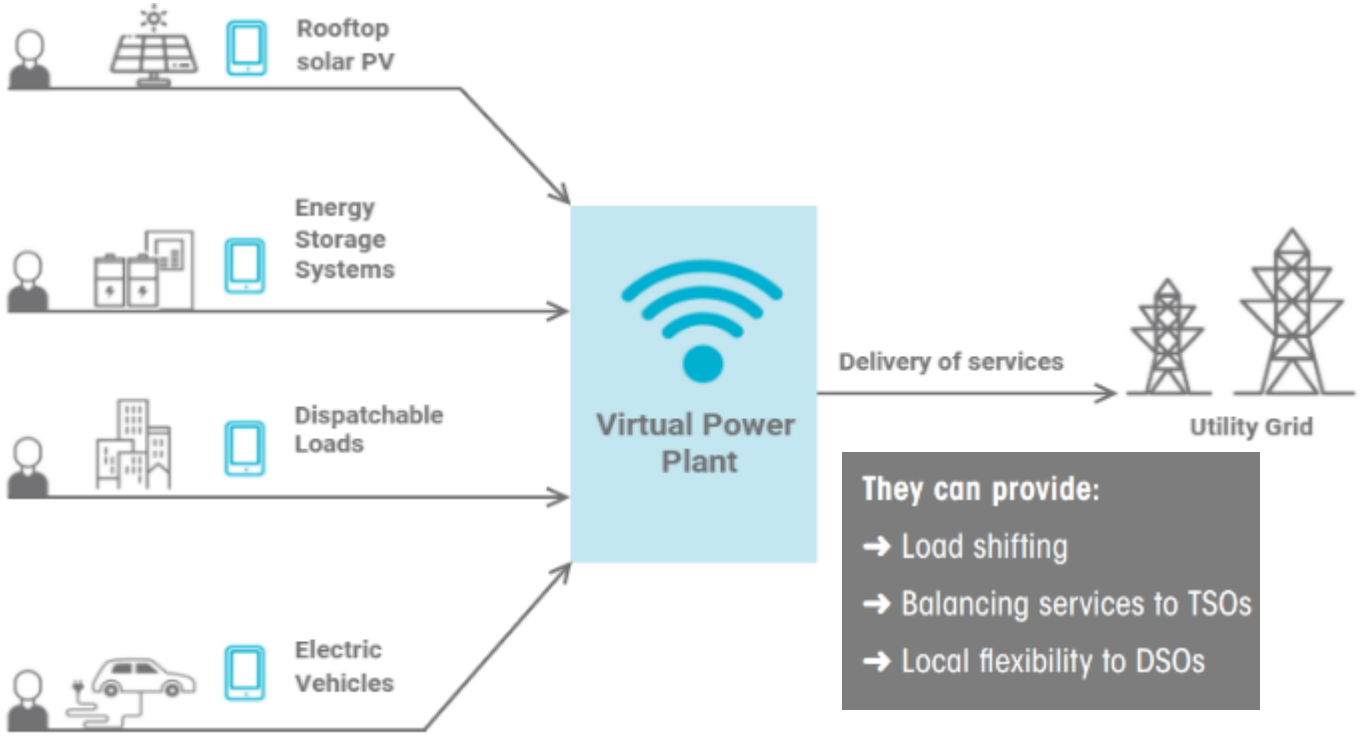


Source: IIRENA (2019), Innovation landscape brief: internet of things, International Renewable Energy Agency, Abu Dhabi.

Innovative Business Models: Aggregators

Aggregators bundle DERs to engage as a single entity – a virtual power plant (VPP) – in power or service markets.
Aggregators are a new market player that can optimise the use of distributed energy resources.





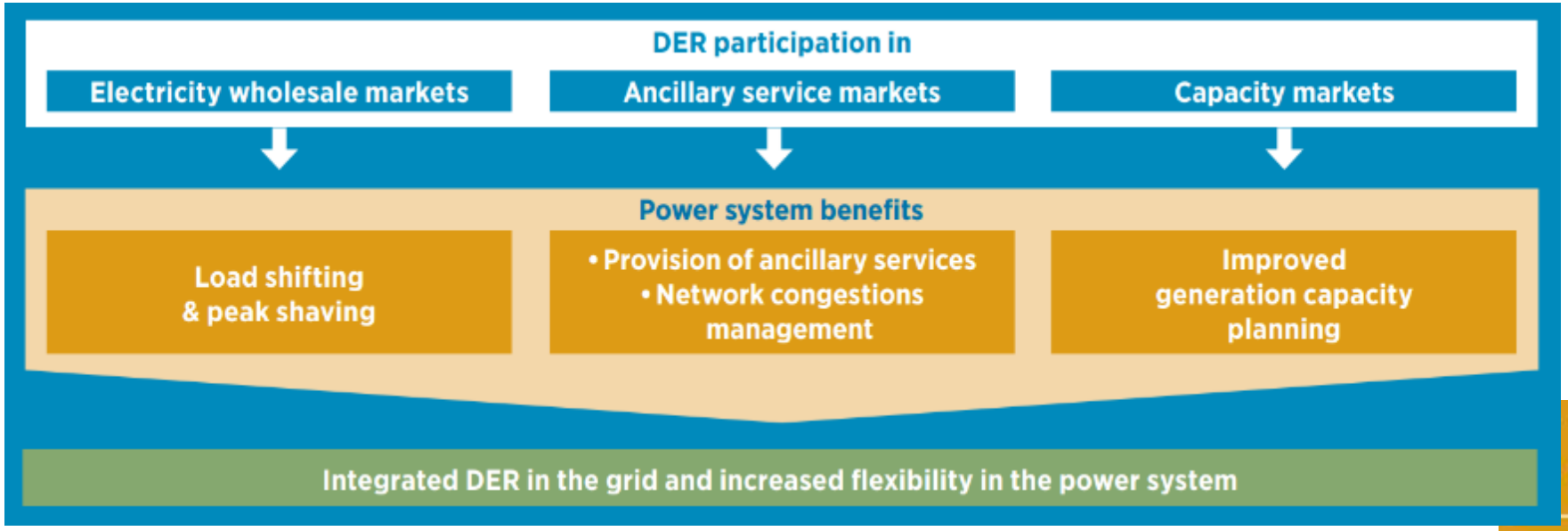
3 SNAPSHOT

- Global market value of USD 762 million in 2016, expected to reach USD 4 597 million in 2023
- World's Largest VPP is expected to connect DERs in 50,000 homes to meet 20 % of South Australia's daily power demand.
- Projects in Netherlands, Germany and Australia are aggregating behind the meter batteries to provide grid services.

Source: IRENA (2019) Innovation landscape brief: Aggregators

Innovative Market Design

Participation in wholesale and ancillary service markets exposes DERs to market prices and enable demand-side flexibility



Encourage flexibility

Empowering consumers

SNAPSHOT

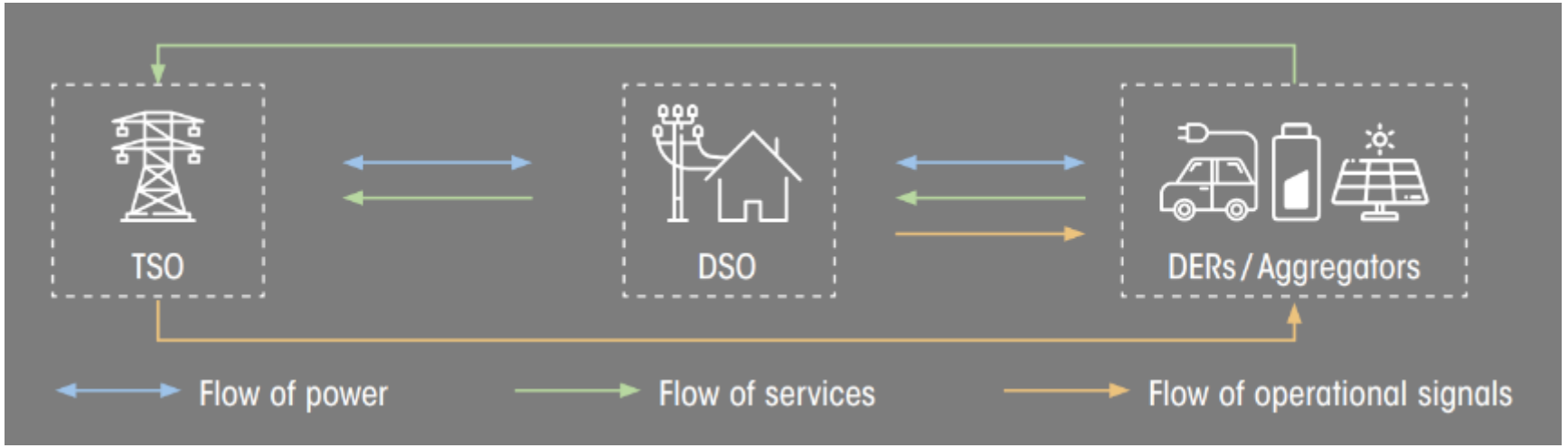
- In EU, DERs can offer 100 GW of demand response potential.
- New York's ISO (NYISO) is planning to enable DER participation in Day-Ahead Demand Response Program and Demand Side Ancillary Services Program.
- By 2050, DERs would supply 30–45 % of Australia's electricity needs

Source: IRENA (2019) Innovation landscape brief: Market integration of distributed energy resources

Innovative System Operation

Operation of a decentralised system

Improved co-ordination between transmission and distribution system operators becomes essential to integrate distributed energy resources and gain maximum system flexibility



3 SNAPSHOT

- Various TSO-DSO co-operation projects have been piloted in the European Union
  - SmartNet project includes Denmark, Italy and Spain
  - CoordiNet project includes Greece, Spain and Sweden
- Colombia is also looking at increasing TSO-DSO co-operation in the context of increased distributed generation

2 KEY ENABLING FACTORS

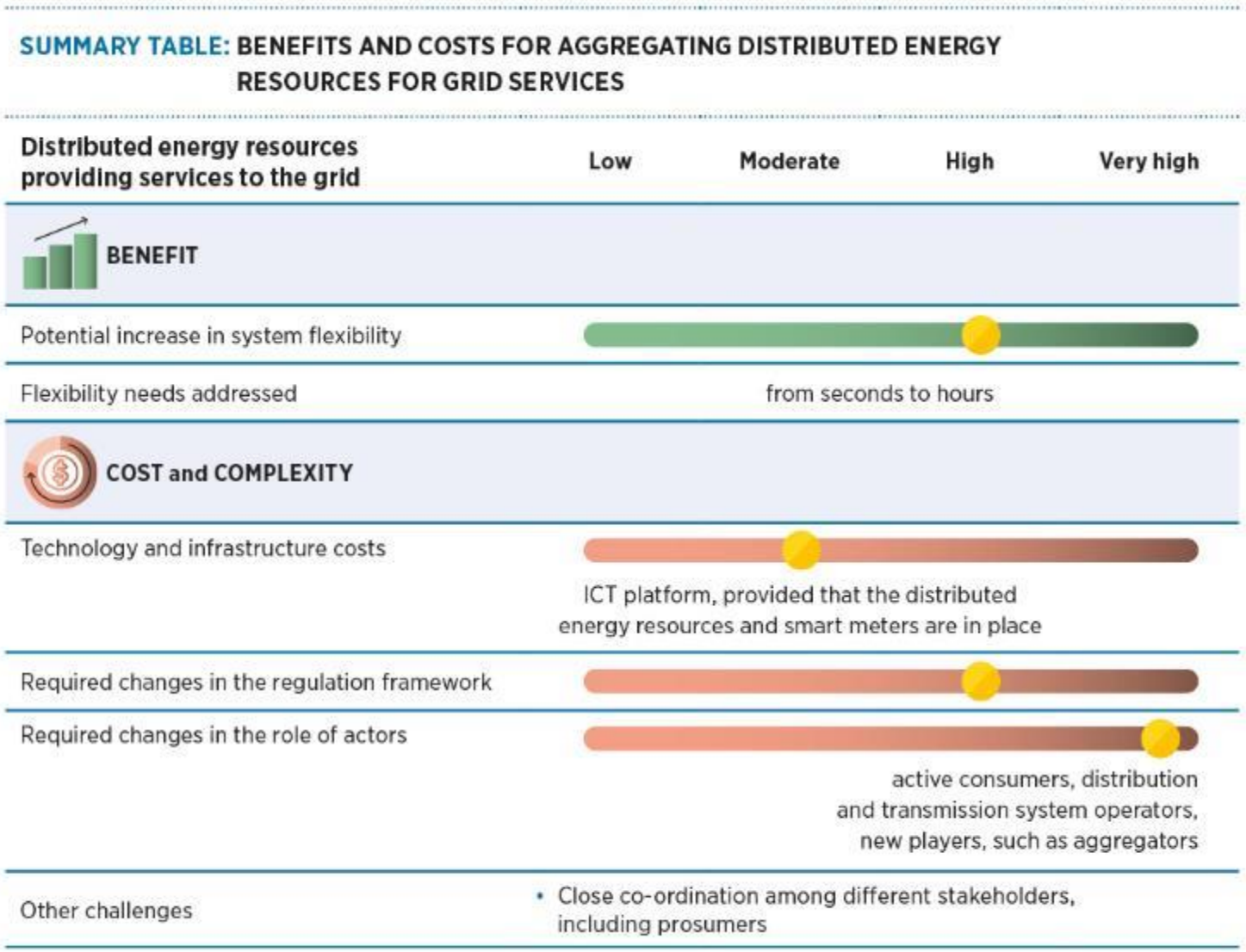
- Introduction of data exchange platforms
- Digitalisation
- Clearly defining the new role of DSOs

Source: IRENA (2019) Innovation landscape brief: Market integration of distributed energy resources

DERs providing services to the grid

Implemented solution:

- The VPP Next Kraftwerke providing grid services to Elia (Belgium)
- Sonnen Baterie Provides grid services in Germany
- Tesla's VPP contributes to renewable energy integration and system stability in South Australia

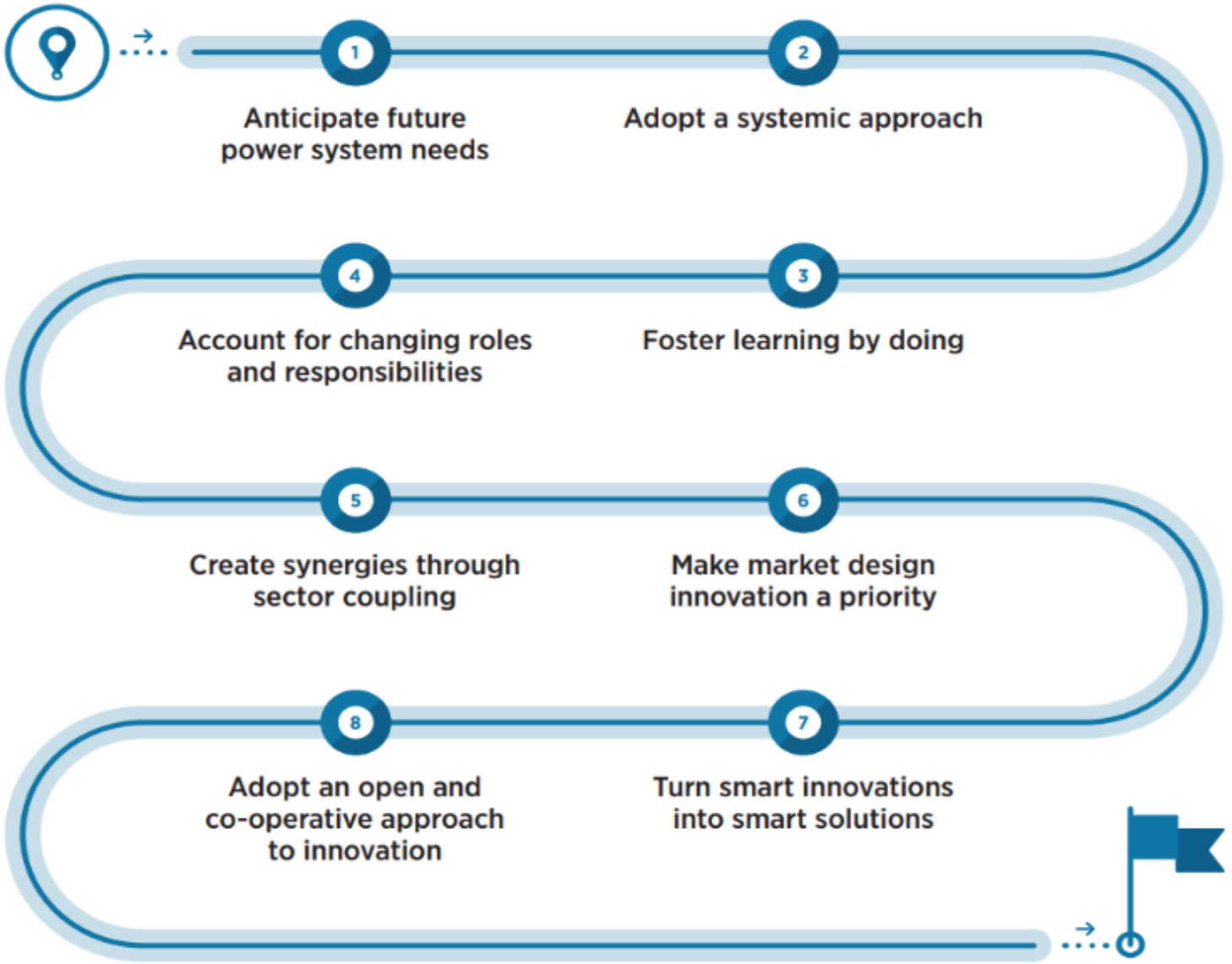


SUMMARY TABLE: BENEFITS AND COSTS FOR AGGREGATING DISTRIBUTED ENERGY RESOURCES FOR GRID SERVICES

Distributed energy resources providing services to the grid	Low	Moderate	High	Very high
BENEFIT				
Potential increase in system flexibility				
Flexibility needs addressed	from seconds to hours			
COST and COMPLEXITY				
Technology and infrastructure costs				
	ICT platform, provided that the distributed energy resources and smart meters are in place			
Required changes in the regulation framework				
Required changes in the role of actors				
	active consumers, distribution and transmission system operators, new players, such as aggregators			
Other challenges	• Close co-ordination among different stakeholders, including prosumers			

8-step innovation plan

8-step innovation plan for power sector transformation



Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

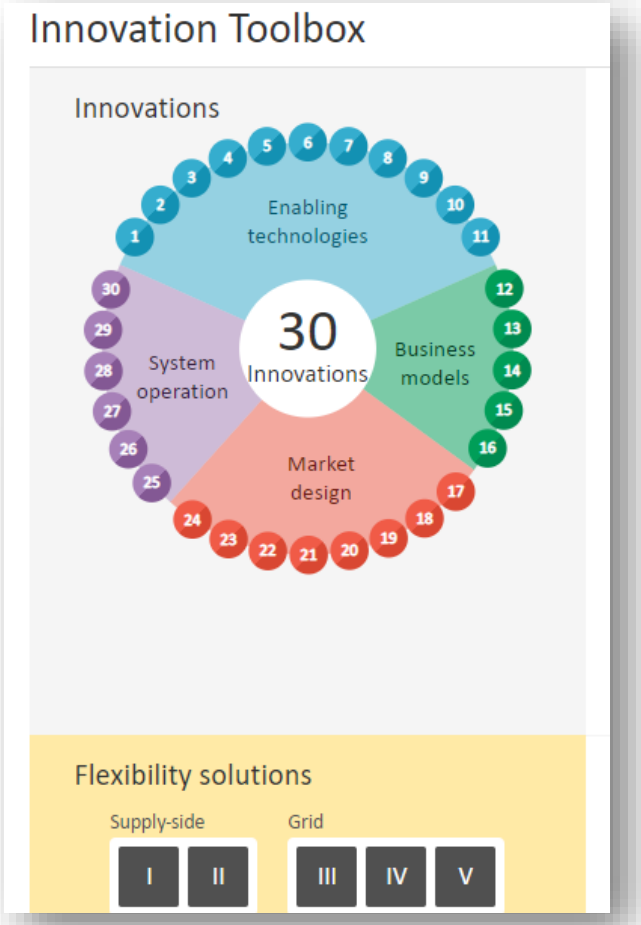
Further reading

- **IRENA (2019), Innovation Landscape for a renewable-powered future:** *Solutions to integrate variable renewables:* **Link**

- **IRENA (2019), Innovation Landscape Briefs:**
  - ✓ Market design briefs: **Link**
  - ✓ Enabling technologies**: Link**
  - ✓ Business models: **Link**
  - ✓ System operation: **Link**

- **IRENA Innovation Toolbox: Link**

- **IRENA (2020), Innovative solutions for 100% renewable power in Sweden: Link**



Further reading

https://www.irena.org/publications/2019/Feb/Innovation-landscape-for-a-renewable-powered-future

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