CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# WEBINAR

# Dynamic regulation and digitalisation for a renewable-powered future

---


**Presenters:**
**Annegret Groebel, CEER | Francisco Boshell, IRENA | Elena Ocenic, IRENA**

**Moderated by:**
**Arina Anisie, IRENA**


**Monday, 20 July 2020 • 16:00 – 17:00 CEST**

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# SPEAKERS

Annegret Groebel
CEER

Francisco Boshell
IRENA

Elena Ocenic
IRENA

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# AGENDA

## Dynamic regulation and digitalisation for a renewable-powered future

Opening Address

1. **Digitalisation for a Renewable-Powered Future**, Francisco Boshell, IRENA
2. **Dynamic Regulation to Enable the Transition of the Energy System**, Annegret Groebel, CEER
3. **Systemic Innovation for Solar PV and Wind Integration**, Elena Ocenic, IRENA

Q&A

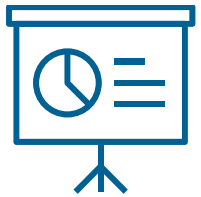
CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

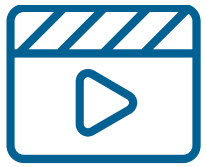
All of you are **muted** and will remain so throughout the webinar

Use the **Chat** feature to introduce yourself and talk to other attendees

If you have **Questions** to the speaker please use the **Q&A**



The slides will be shared via email after the end of the webinar



A recording of the webinar will be available within 48 hours

Tell us how we did in the survey to help us improve

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# OPENING ADDRESS

**Arina Anisie, IRENA**

CEER
Council of European Energy Regulators

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

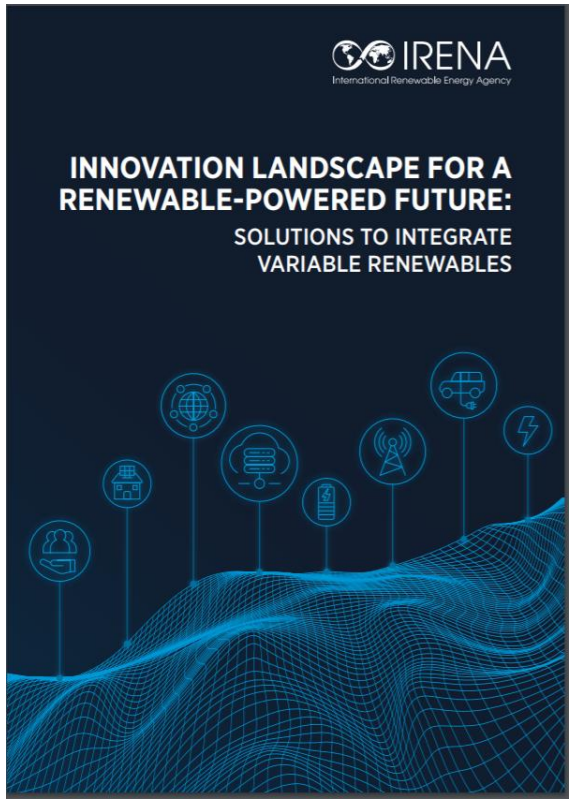
- Digitalisation
- Hydrogen
- Blockchain
- Storage
- Electric vehicles

## BUSINESS MODELS

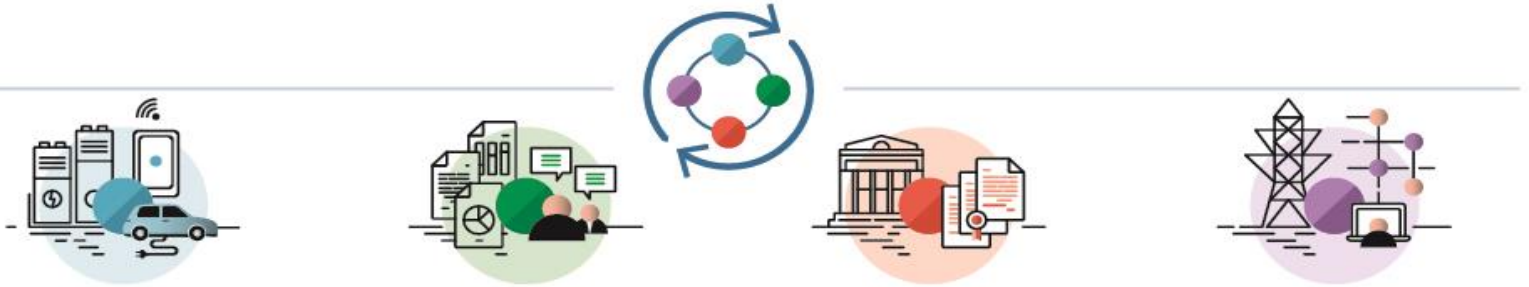
- Energy as a service
- Peer-to-peer electricity trading
- Aggregators

## MARKET DESIGN

# Emerging innovations for wind and solar PV integration




**Innovation Landscape Report**



## ENABLING TECHNOLOGIES

| | |
|---|---|
| 1 | Utility-scale batteries |
| 2 | Behind-the-meter batteries |
| 3 | Electric-vehicle smart charging |
| 4 | Renewable power-to-heat |
| 5 | Renewable power-to-hydrogen |
| 6 | Internet of things |
| 7 | Artificial intelligence and big data |
| 8 | Blockchain |
| 9 | Renewable mini-grids |
| 10 | Supergrids |
| 11 | Flexibility in conventional power plants |

## BUSINESS MODELS

| | |
|---|---|
| 12 | Aggregators |
| 13 | Peer-to-peer electricity trading |
| 14 | Energy-as-a-service |
| 15 | Community-ownership models |
| 16 | Pay-as-you-go models |

## MARKET DESIGN

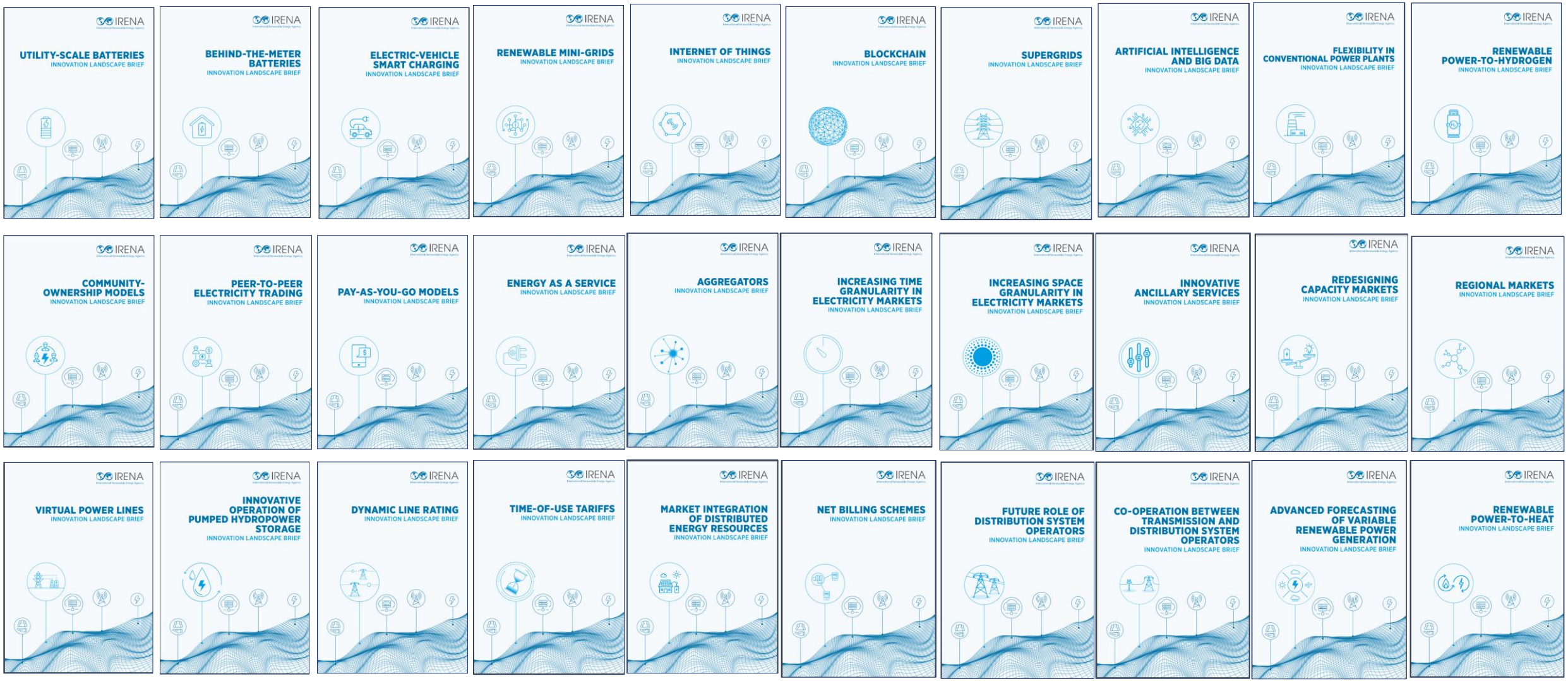
| | |
|---|---|
| 17 | Increasing time granularity in electricity markets |
| 18 | Increasing space granularity in electricity markets |
| 19 | Innovative ancillary services |
| 20 | Re-designing capacity markets |
| 21 | Regional markets |
| 22 | Time-of-use tariffs |
| 23 | Market integration of distributed energy resources |
| 24 | Net billing schemes |

## SYSTEM OPERATION

| | |
|---|---|
| 25 | Future role of distribution system operators |
| 26 | Co-operation between transmission and distribution system operators |
| 27 | Advanced forecasting of variable renewable power generation |
| 28 | Innovative operation of pumped hydropower storage |
| 29 | Virtual power lines |
| 30 | Dynamic line rating |

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

# 30 Innovation Briefs




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

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# Digitalisation for a renewable-powered future

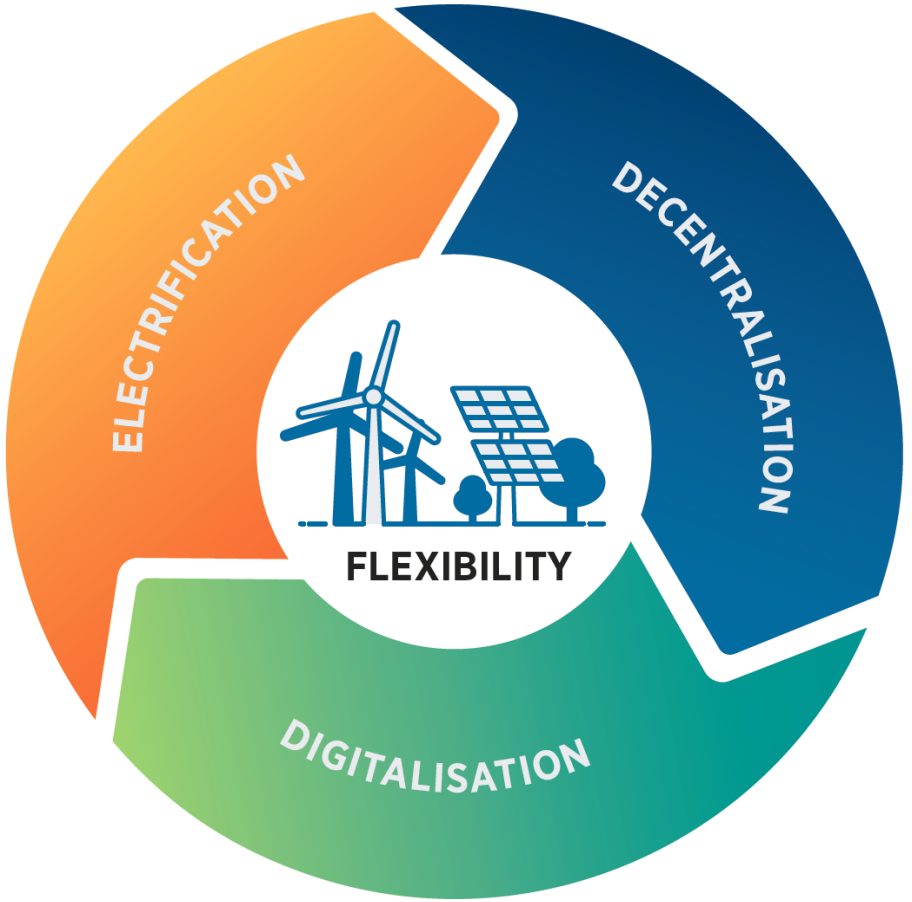
**Francisco Boshell, IRENA**

# Power systems flexibility propelled by three trends

I. **Decentralisation –supply side.** Wind and PV is largely centralised today but distributed generation - notably rooftop PV, ~ 1% of all electricity generation today – is growing, bringing new flexibility opportunities at demand side

II. **Electrification –demand side.** It plays in two ways, may decarbonise end-use sectors through renewable electricity and, if done in a smart way, become a flexibility source to integrate more renewables in power systems

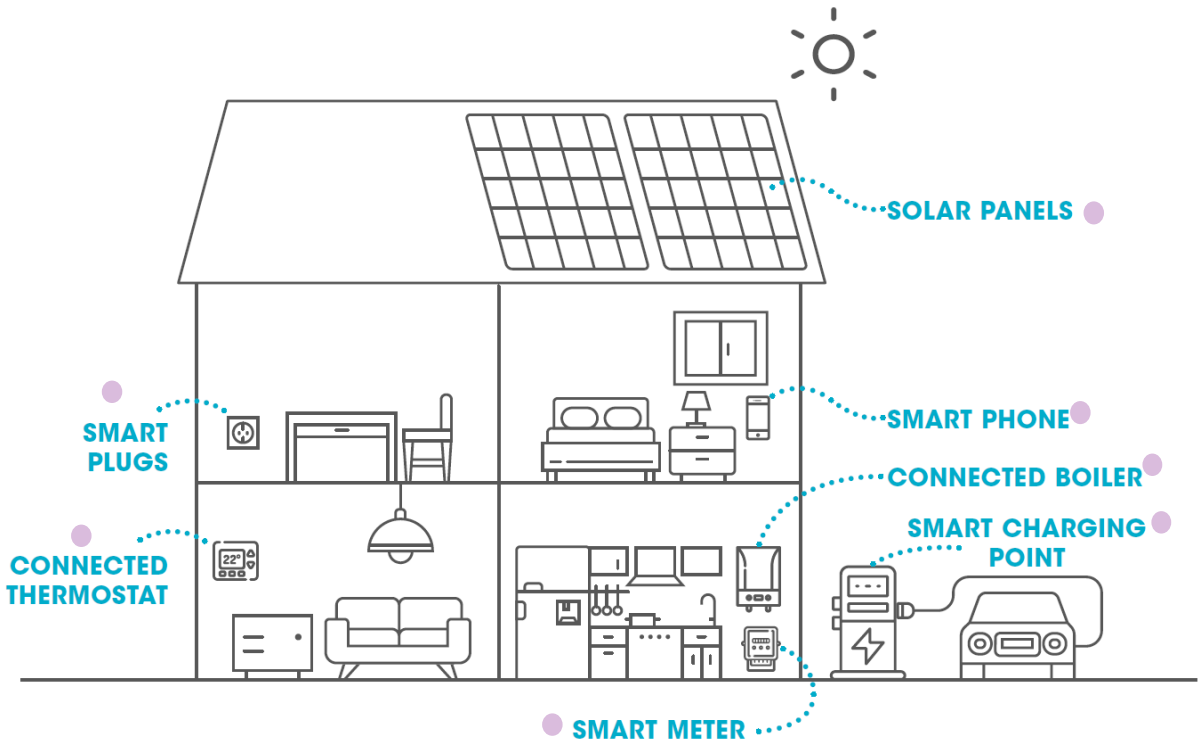
III. **Digitalisation –system integration.** Covert data into value by optimising complex systems with more actors involved, many small generation units and new type of loads




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

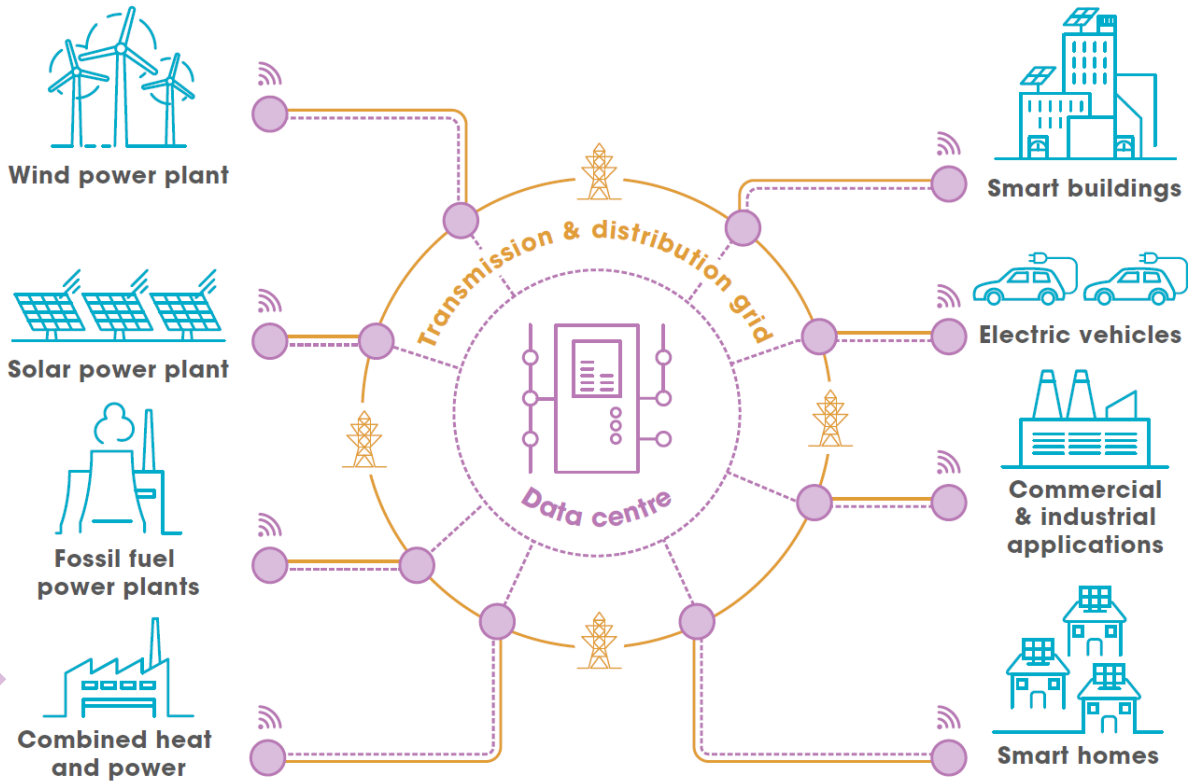
# 1. 'Internet of Things' - applications for RE power systems

## >> *DATA COLLECTION AND TRANSFER*




## At Demand Level

## At System Level



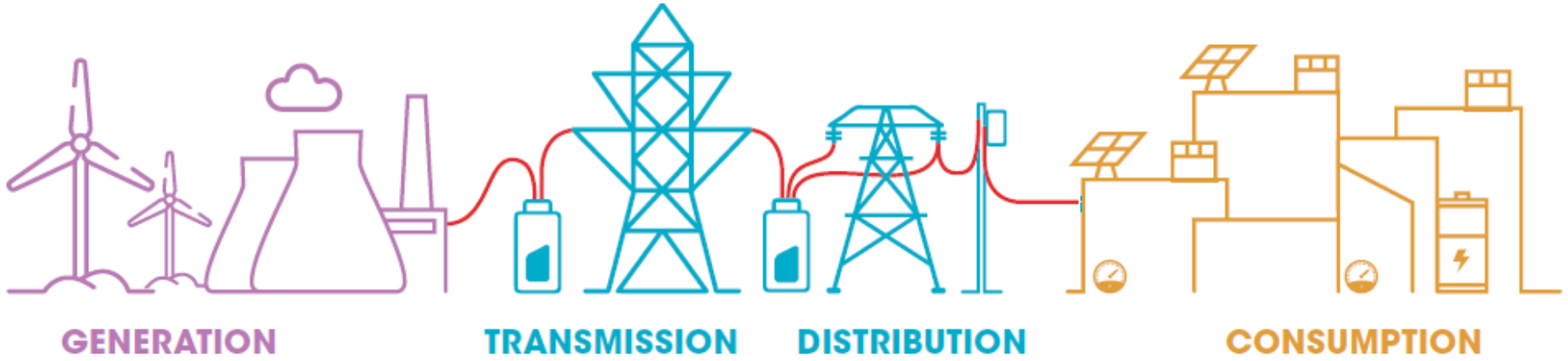

Source: IRENA (2019), Innovation landscape brief: Internet of Things

CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

# 2. 'Artificial Intelligence' - applications for RE power systems

## >> *DECISION MAKING*

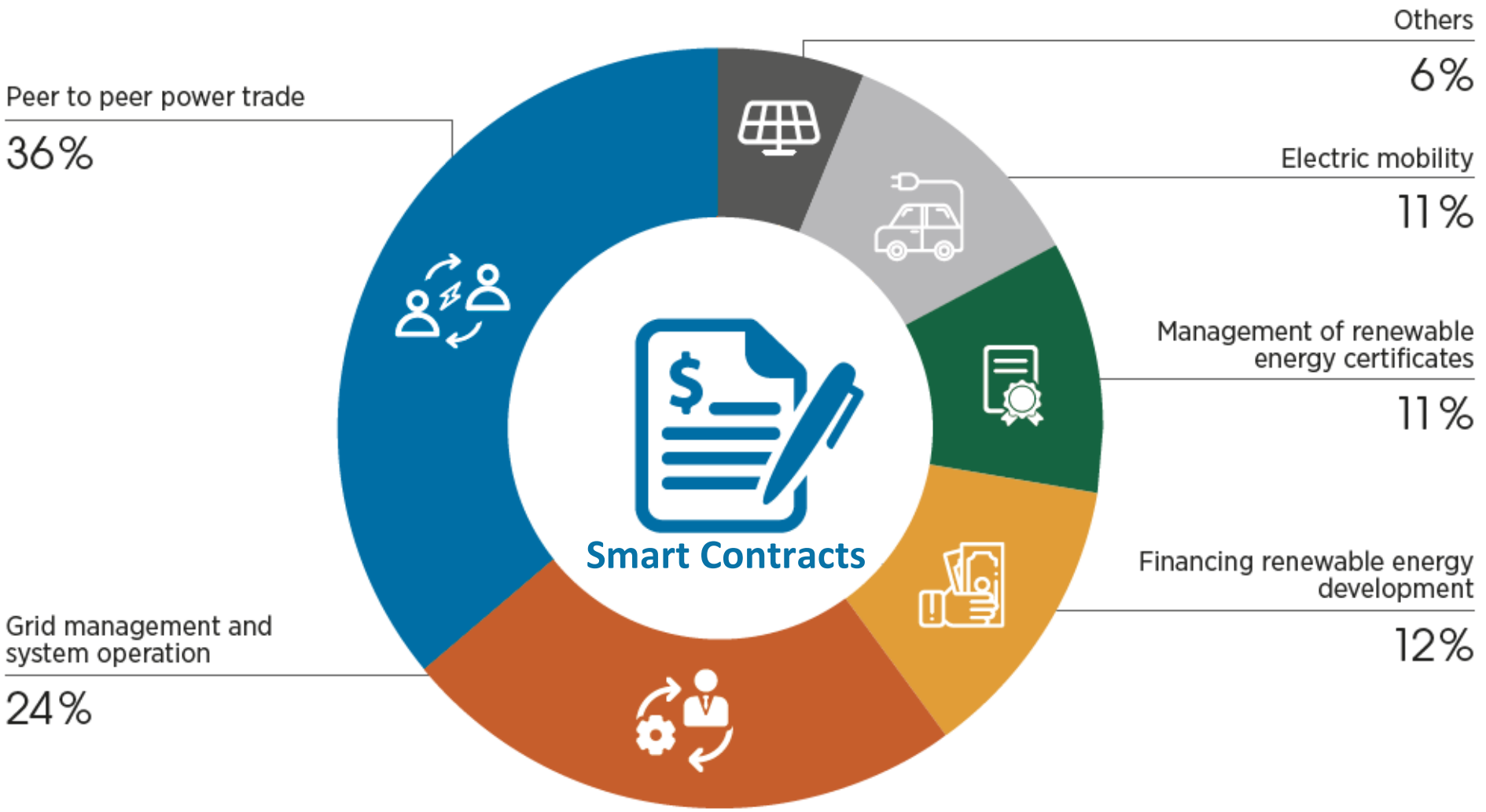



1. Improved wind and solar generation forecast
2. Maintain grid stability and reliability
3. Improved demand forecast
4. Efficient demand-side management
5. Optimised energy storage operation
6. Optimised market design and operation

Source: IRENA (2019), Innovation landscape brief: Artificial intelligence and big data

# 3. Blockchain (DLT) – Decentralised RE with smart contracts at the core

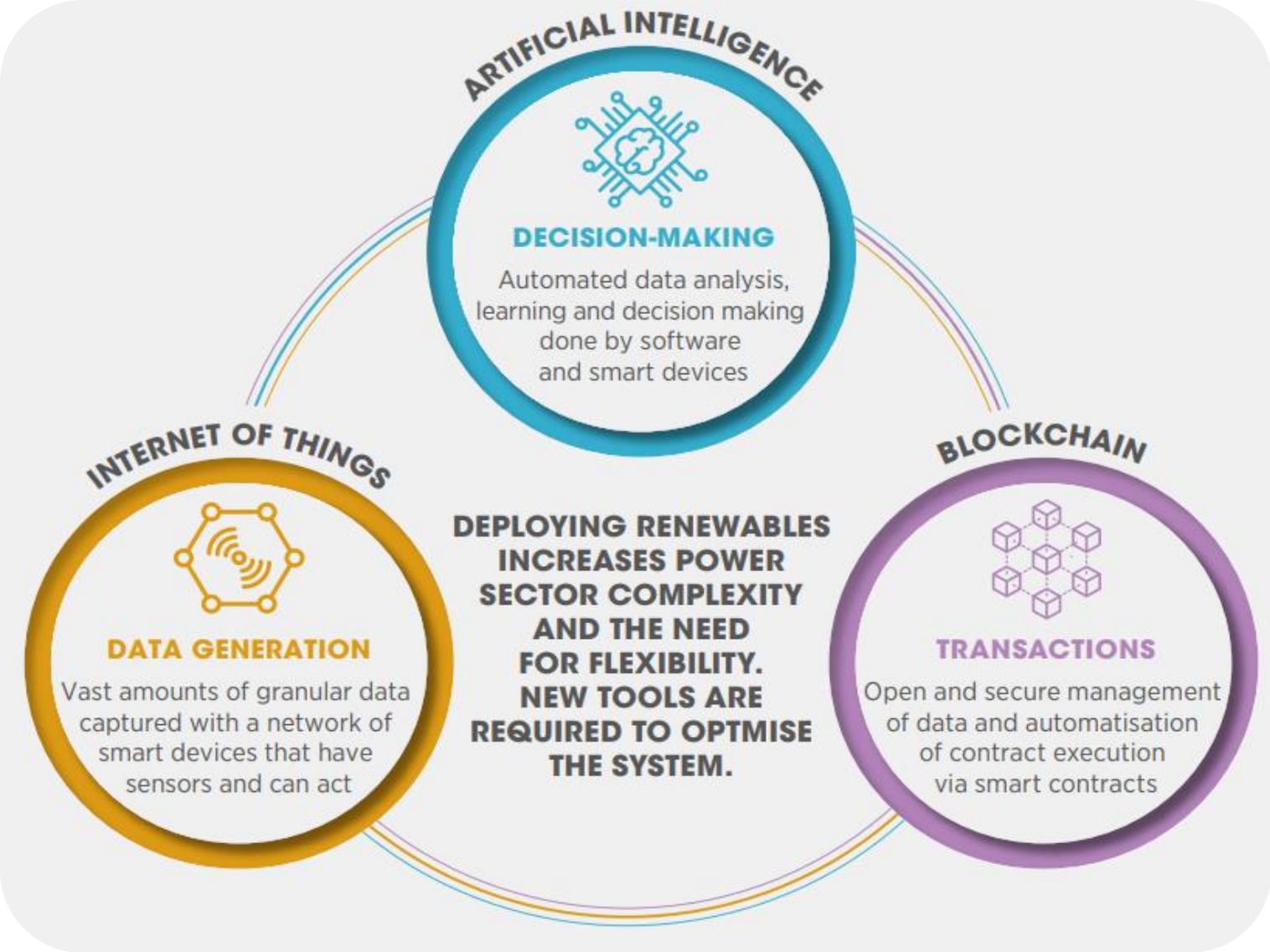
## >> *TRANSACTIONS*




*Note: Data as of July 2018.*
*Based on: Livingston et al. (2018), Applying Blockchain Technology to Electric Power Systems.*

Source: IRENA (2019), Innovation landscape brief: Blockchain

# Increased power sector complexity requires a combination of digital innovations




Source: IRENA (2019), Innovation landscape brief: Blockchain

# Progress in using digital technologies for RE applications

## >> *EXAMPLES FROM IRENA's INNOVATION LANDSCAPE*

| Project (company) | Service provided | Description |
|---|---|---|
| **BeeBryte (France, Singapore)** | **Demand forecast and demand-side management** | BeeBryte aims to minimise utility bills with AI algorithms and automated control of heating-cooling equipment (*e.g.* HVAC), pumps, electric vehicle charging points or batteries. Using advanced weather forecasts, occupancy, consumption and electricity price signals, BeeBryte maintains processes and temperature within an operating range set by the customer, resulting in up to 40% savings. |
| **DCbrain (France)** | **Grid stability and reliability** | DCbrain enables the optimisation of flows and consumptions, the identification and prevention of network anomalies and the simulation of network evolution. |
| **DeepMind, Google (United States)** | **Demand forecast and demand-side management** | DeepMind develops programs that can learn to solve complex problems without needing to be taught how. DeepMind has tested its machine-learning algorithms at Google's data centres in an effort to reduce power consumption. |
| **DeJoule, Smart Joules (India)** | **Demand forecast and demand-side management** | DeJoule is an air conditioning optimisation platform with a built-in software that uses AI to facilitate demand-side management and enhance the efficiency and performance of air conditioning systems while decreasing costs for consumers. |
| **EUPHEMIA, N-SIDE (Europe)** | **Optimised market operation** | EUPHEMIA is a coupling algorithm that integrates European day-ahead energy markets to determine spot prices and volumes. It covers 25 European countries (Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom). |
| **EWeLiNE (Germany)** | **Renewable energy generation forecasting** | EWeLiNE uses AI to predict the supply of renewable energy days in advance. EWeLiNE takes real-time data from solar power plants and wind turbines around Germany and feeds it into an algorithm that calculates the renewable energy output for the next 48 hours. This algorithm uses machine learning, and the researchers compare real data with EWeLiNE predictions to refine the algorithm and improve its accuracy. |

Source: IRENA (2019), Innovation landscape brief: Artificial intelligence and big data

- **75 billion devices** could be connected worldwide by 2025
- Most IoT projects focus on **demand-side applications** (smart homes)
- Global investment in blockchain in energy markets would grow to over **6 billion USD by 2025**
- Interesting new applications in electricity markets, e.g. EUPHEMIA using **AI to integrate 25 EU day-ahead markets**
- Projects are **emerging in all continents** - EU a front runner
- TSOs looking into applications to **increase visibility of distributed assets** as a source of flexibility
- ***(~ 100 projects documented in IRENA's Innovation Briefs)***

Disclaimer: The mention of specific companies or certain projects or products does not imply that they are endorsed or recommended by IRENA in preference to others of a similar nature that are not mentioned

# Key factors to enable deployment of digital technologies in power systems

| Unlock benefits for regulators | Increase performance and Reduced power consumption | Implement infrastructure and standards | Address cybersecurity and data privacy |
|---|---|---|---|
| • Regulator with access to real-time data and analytics for dynamic decision making<br>• Increased involvement of more actors and ensure transparency<br>• Properly compensate services to the systems (digital and physical) | • Increased number of transactions<br>• Bitcoin 300 kWh per transaction, 2018 3.4 GW (proof of work) | • Connection between wet and dry world<br>• Advanced metering infrastructure<br>• Interoperability based on harmonised standards and protocols | • E.g. DLTs increase data security, but any vulnerable point?<br>• Data management, analytics and PRIVACY (private data on public chains)<br>• Input data quality: Garbage in garbage out |

***Value from demonstration projects and regulatory sandboxes**

Source: IRENA (2019) Blockchain: Innovation Landscape Brief

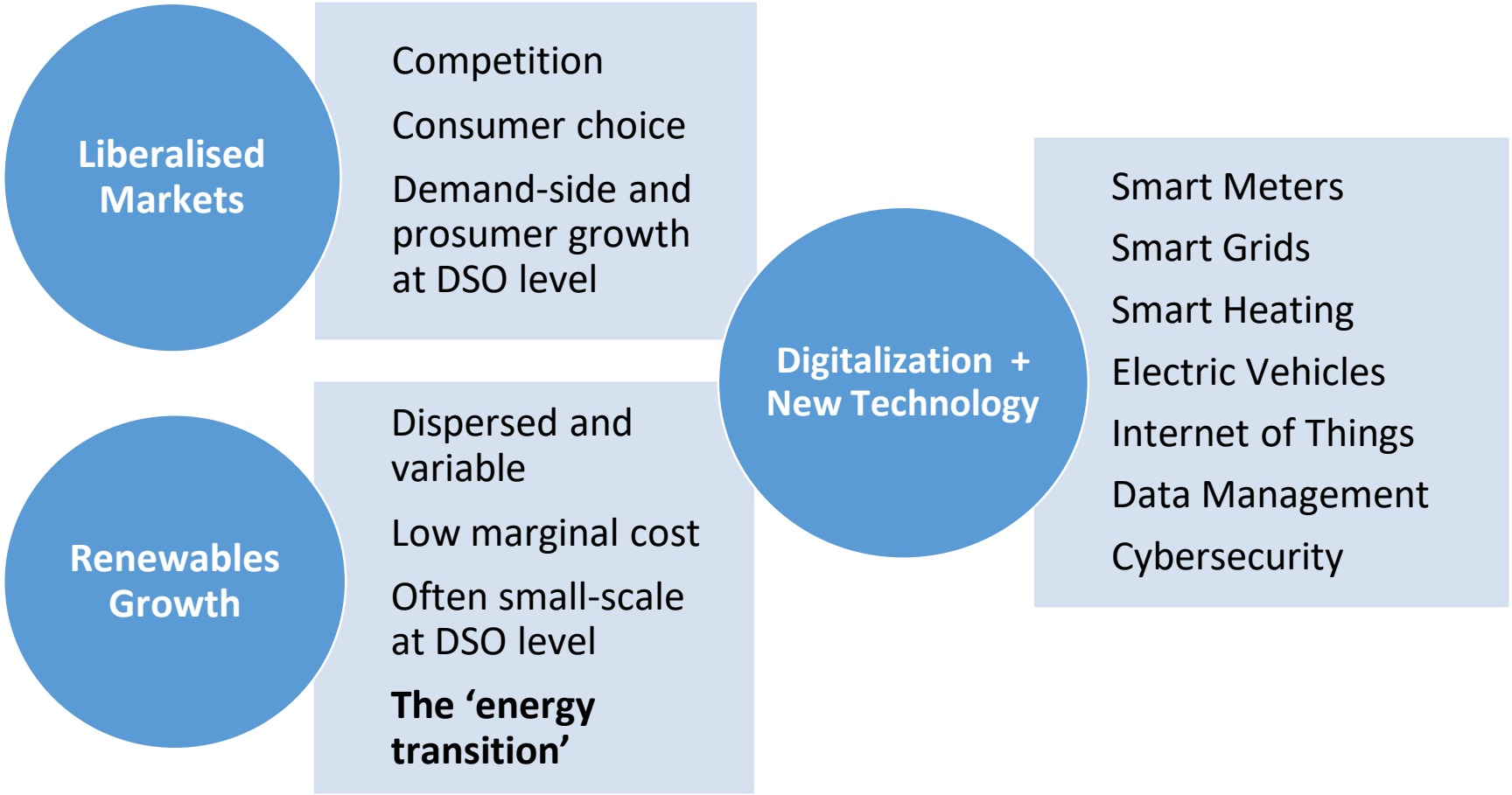
CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# Dynamic Regulation to Enable Digitalisation of Energy System

**Annegret Groebel, CEER**

# New Responsibilities for Regulators




CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

# Regulatory principles to foster innovation contributing to the energy transition

- **Fundamental regulatory principles have proven to work well and Europe's energy system remains stable and strong based on the internal energy market legislation in place**
- **The regulator has to ensure that a market based approach is implemented properly and that the targets are achievable, mainly to ensure the transition towards a flexible energy system where renewables are fully integrated in both the grid and markets without price distortions;**
- **Regulators have more tasks now as they have to ensure that the interplay between markets and regulation functions properly in order to contribute to the energy transition. This also implies that regulators have the responsibility to implement REMIT, which means ensure that energy wholesale trading functions properly and prevent market manipulation and insider trading by assuring market integrity and transparency for the benefit of consumers;**
- **It is extremely important that all market participants including consumers are involved in order to ensure the energy system becomes flexible, in particular it is important to integrate renewables in both the grid and the markets and to empower consumers so that they can both benefit from the new chances and contribute to the system by e.g. contributing to grid stability with demand side management.**
- **This requires dynamic regulation going hand-in-hand with well functioning markets fostering innovations relying on digitalization. This comprises a whole system approach ensuring benefits are passed on to consumers.**

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# CEER's 3D Strategy (2019- 2021)

## Digitalisation (in consumer interest)

- Protect and empower consumers
- Cost saving opportunities
- New business models

## Decarbonisation (at least cost)

- Promotion of flexibility, integration of renewables fully into the grid and the market
- Whole system approach
- Market based solutions

## Dynamic regulation

- Coherent and adaptive regulatory framework with European solutions oversight to ensure trust in the market
- Future proofed regulatory framework that enables the energy transition and digitalisation
- Cross-sectoral cooperation

CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

# Core elements of a sustainable regulatory strategy on digitalisation in the energy sector

CEER Conclusions Paper on Dynamic Regulation to Enable Digitalisation of the Energy System published on 10 Oct. 2019:

Digitalisation in the consumer interest is one of the three key strategic policy areas in CEER's 3D Strategy:

> To facilitate competition that benefits active energy consumers whilst protecting the more vulnerable in society leaving no one behind.

- Giving the right price-signals
- Enabling market based flexibility
- Encouraging Distribution System Operators (DSOs) to use flexibility
- Empowering consumers for demand side flexibility
- Generating the right sort of data
- Making data accessible, useful and secure
- Fostering innovation through digitalization of the energy system

CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

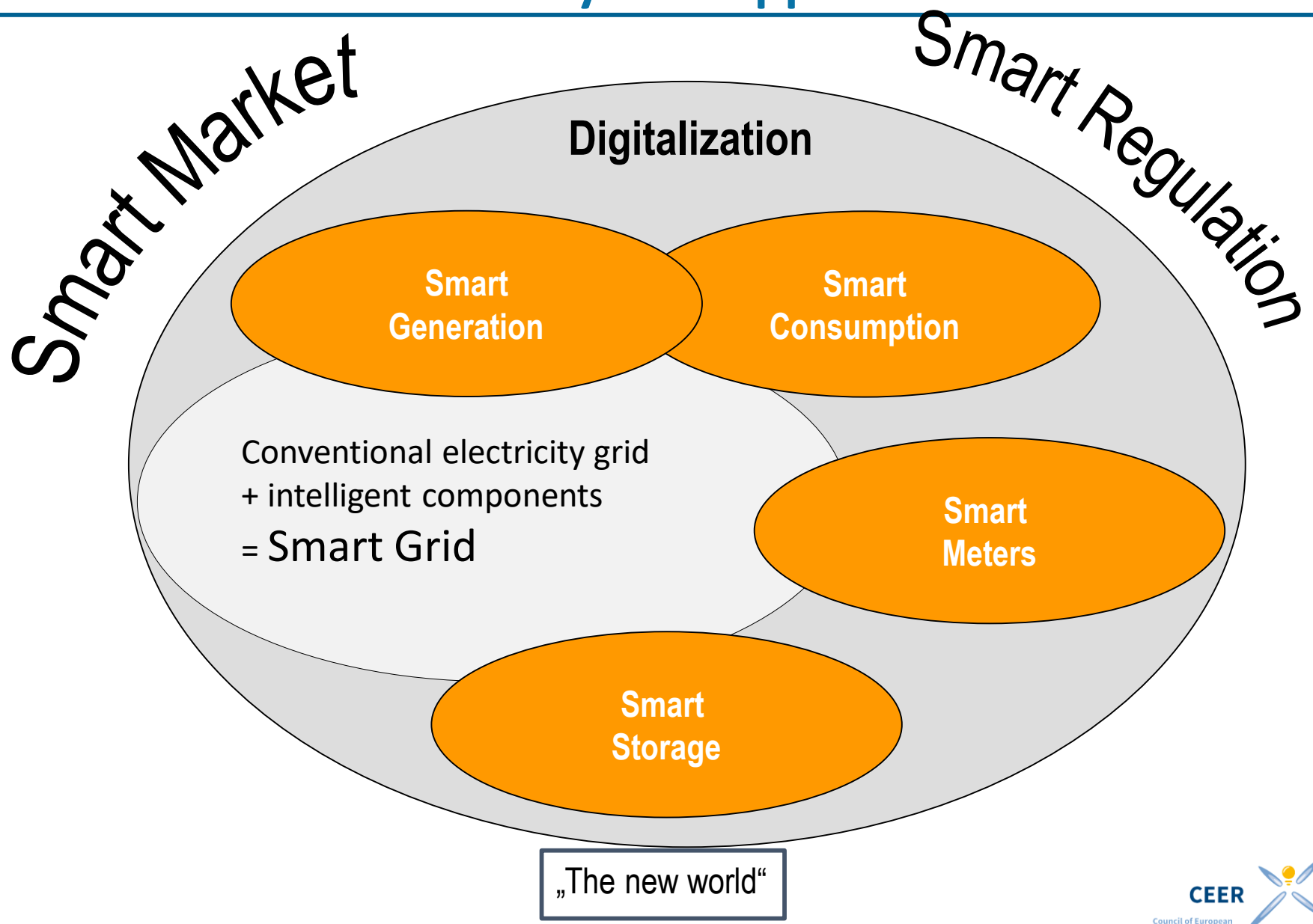
# Changing role of the regulator

- Increasing share of RES to reach climate targets is inevitable, but creates new challenges both for the grid (new dimensioning and restructuring due to decentralised / distant generation) and markets
- ➡ The regulators get more responsibilities to support the energy transition and ensure RES grid and market integration
- More interaction between the generation level and the grid and more players require a more flexible energy system relying on digitalization
- More flexibility requires adaptive/dynamic regulation using a market-based approach to reflect the closer interaction between the generation level and the grid as well as the supply/retail side (DSR, prosumers etc.) ensuring markets work well in a system based on a natural monopoly (grid) and adapt swiftly to new developments without however forgetting predictability
- Define roles of all players and rules ex-ante to ensure a level playing field so that well-functioning markets send efficient price signals so that the right mixture of technologies and flexibility solutions result for the benefit of consumers
- Conclusion: „smart“ regulatory oversight needed with a market-based whole system customer-centric approach fostering innovation

CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

# Smart market and smart regulation: Whole system approach




CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

# Relevant and recent CEER Publications

- CEER's 3D Strategy (2019 – 2021) – Digitalisation, Decarbonisation, Dynamic Regulation: CEER's 3D Strategy to foster European energy markets and empower consumers (2019)
- Conclusions paper on Dynamic Regulation to Enable Digitalisation of the Energy System (2019)
- CEER Paper on Electricity Distribution Tariffs Supporting the Energy Transition (2020)
- CEER Paper on DSO Procedures of Procurement of Flexibility (2020)
- CEER Paper on Whole System Approaches (2020)
- CEER Paper on Unsupported RES (2020)
- CEER Paper on Cybersecurity in the Clean Energy for All Europeans Package (2020)
- ACER/CEER Position Paper on the Revision of the TEN-E Regulation and Infrastructure Governance (2020)
- CEER's Input on the EU Strategy for Smart Energy Integration (2020)
- CEER's Input on the Roadmap for an EU Strategy for Hydrogen (2020)
- CEER Recommendation on Dynamic Price Implementation (2020)
- All publications are available on the CEER website: www.ceer.eu.

# Systemic innovation for solar PV and wind integration

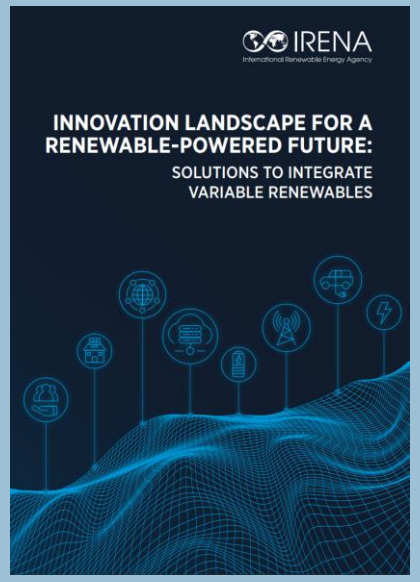
**Elena Ocenic, IRENA**

# IRENA's systemic innovation concept for solar PV and wind integration

## Innovation Landscape Report for VRE integration

### + 30 Innovation Landscape Briefs

### + Swedish case study




Link

Link

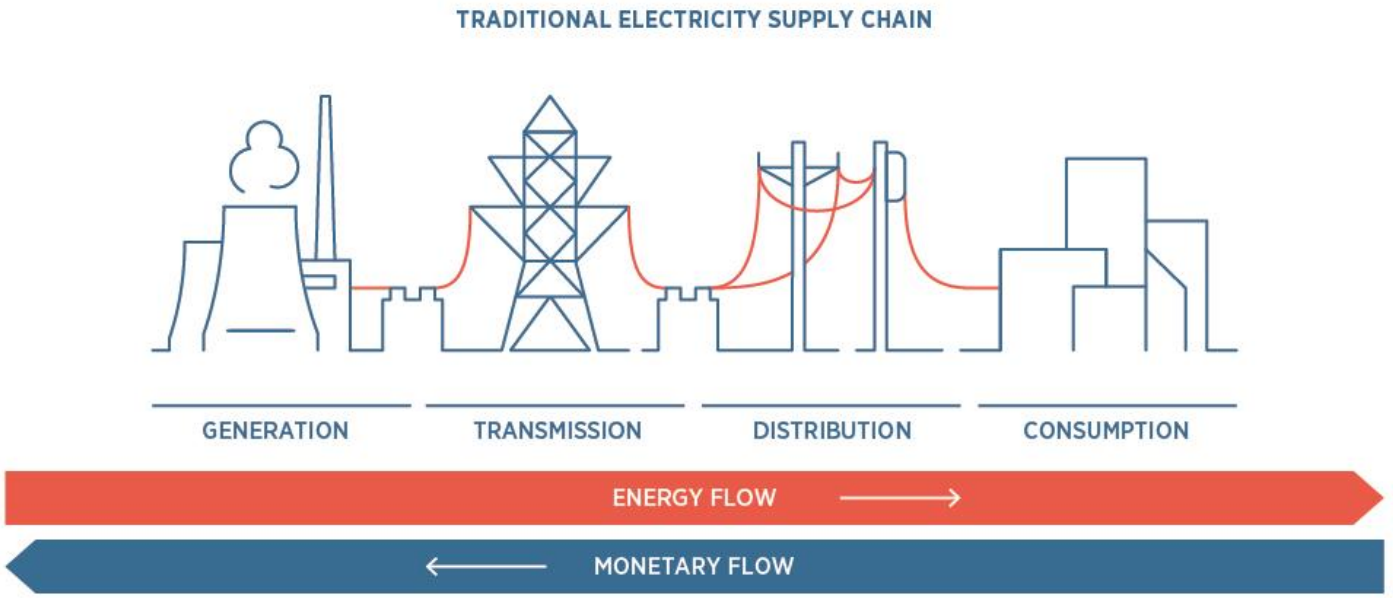
- Market design: **Link**
- Enabling technologies**: Link**
- Business models: **Link**
- System operation: **Link**

### + 5 African case studies ongoing

IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables
IRENA (2020), Innovative solutions for 100% renewable power in Sweden

CEER Council of European Energy Regulators
IRENA International Renewable Energy Agency

# Innovation unlocks flexibility across entire power system

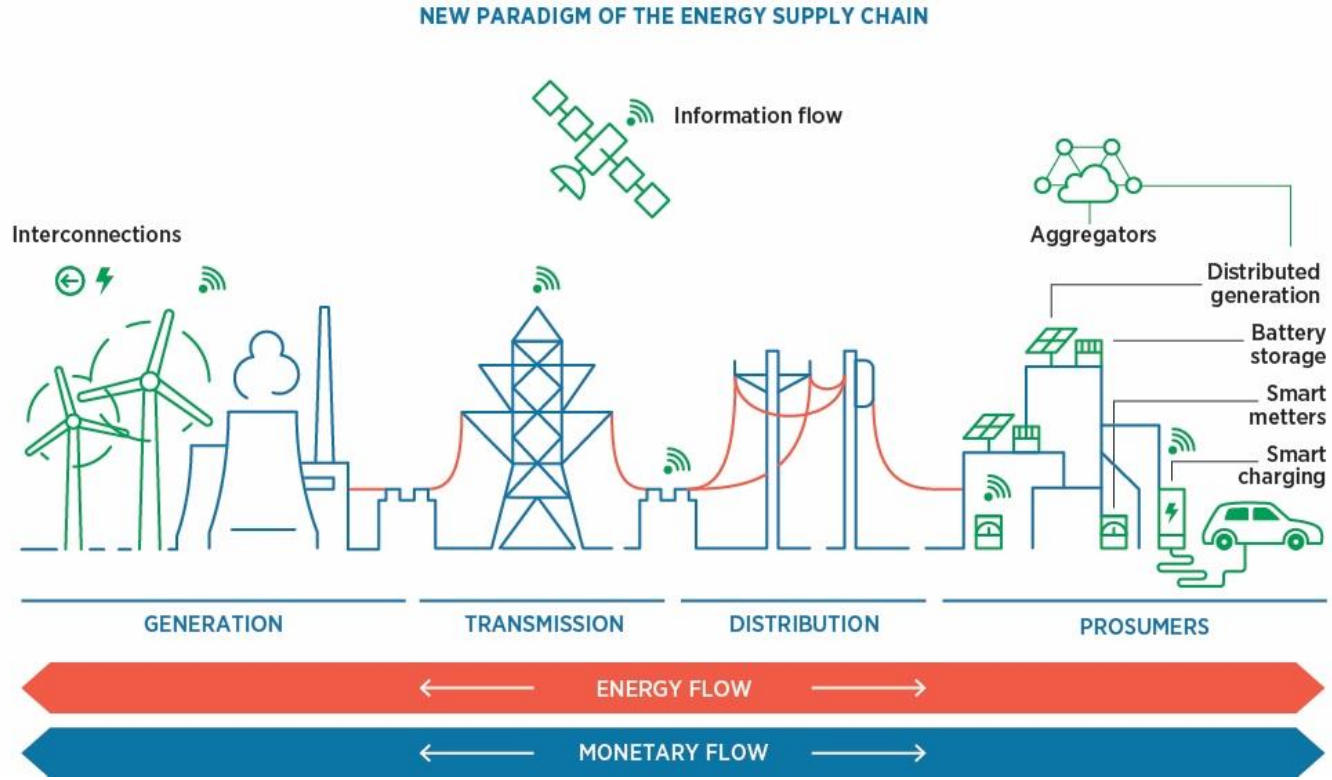



**Flexibility providers in the current system:**

Flexible generation

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

# Innovation unlocks flexibility across entire power system

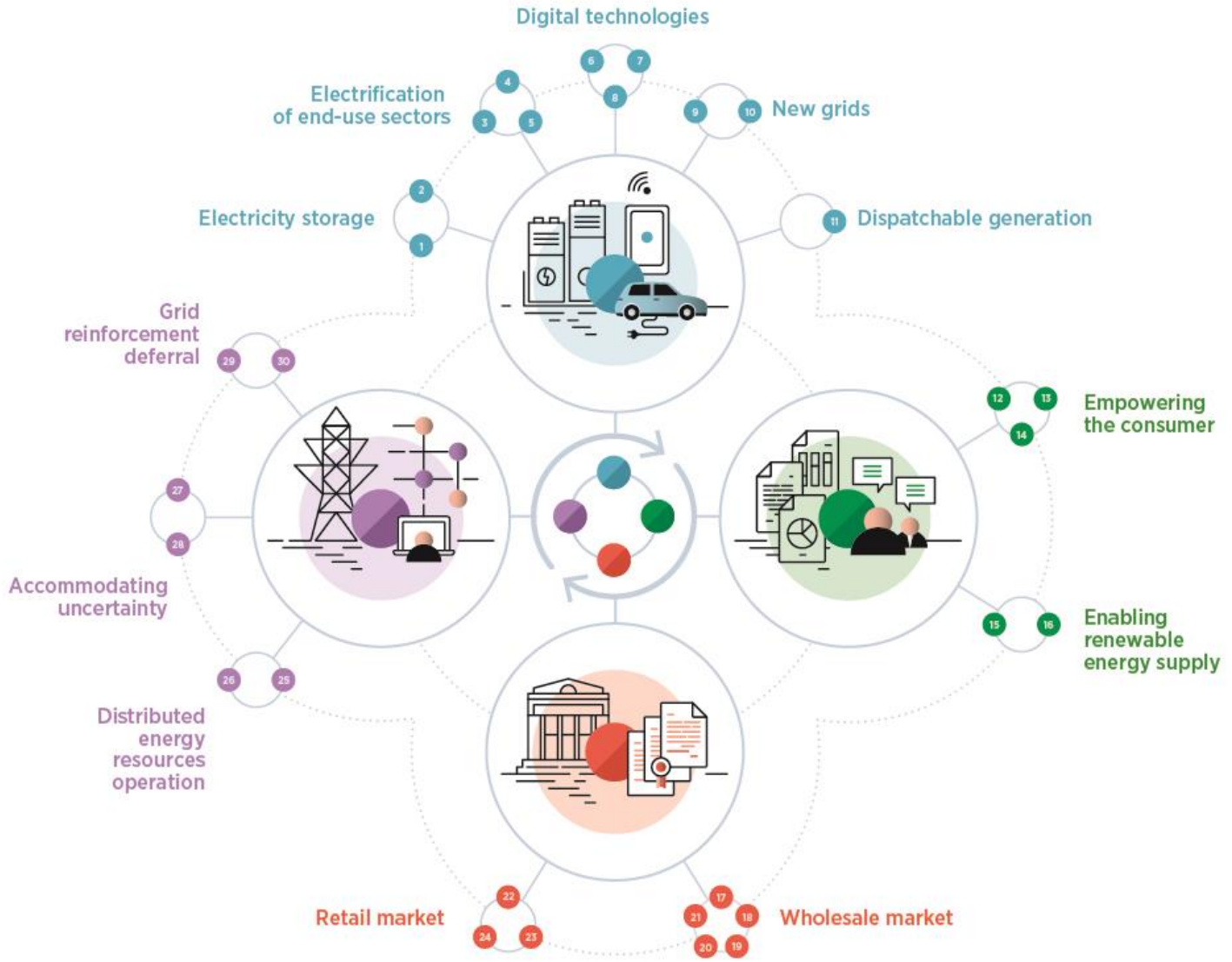



**Flexibility providers in tomorrow's system:**

Flexible generation,
Regional markets,
Demand response,
Storage, Power-to-X.

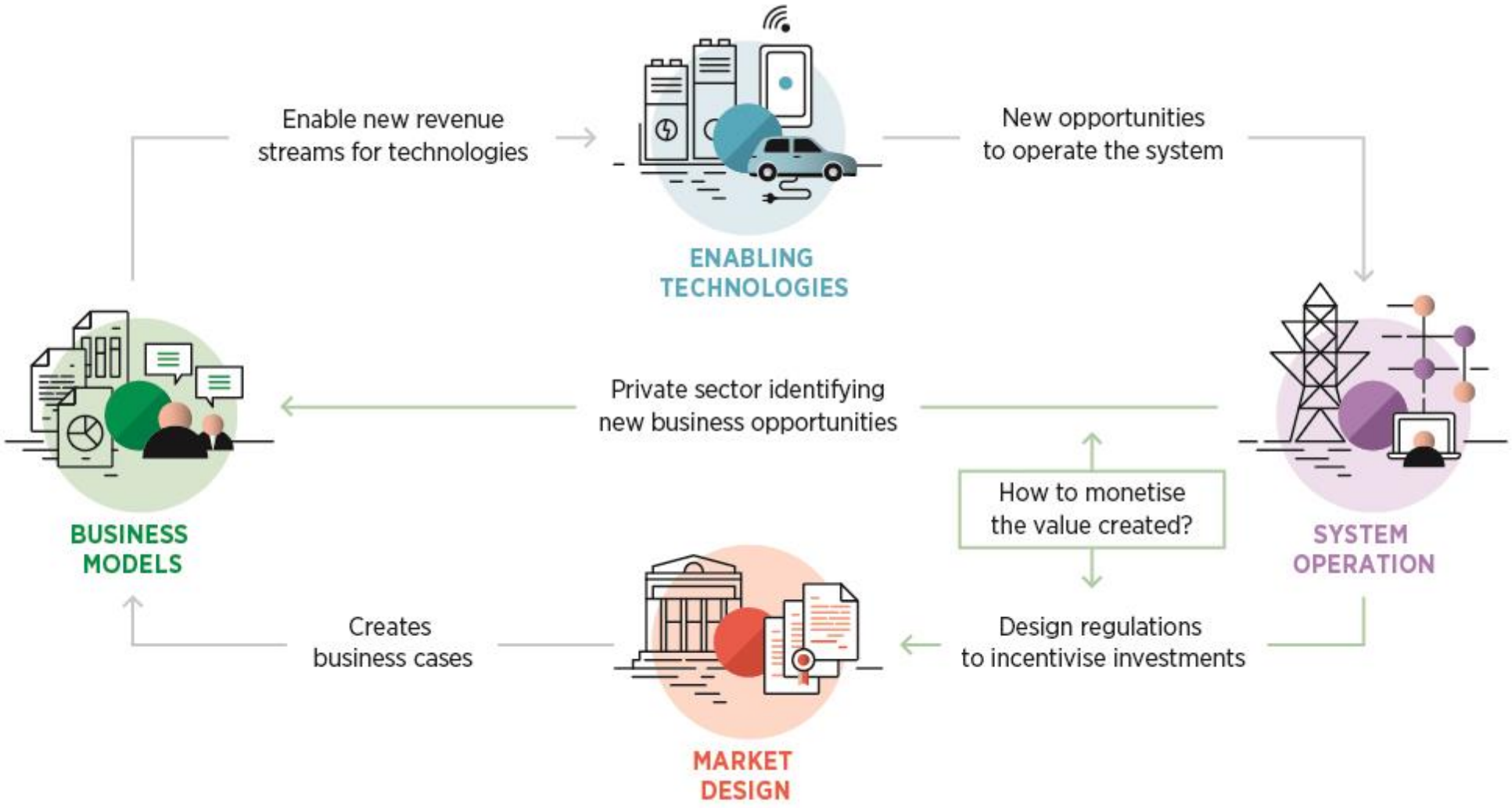
IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

# The innovation landscape for variable renewable power integration




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

# Systemic innovation approach for an integrated renewable energy system




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

# Example of an innovative solution with relevance for Sweden and elsewhere

## Enabling technologies

- Behind-the-meter batteries
- EV smart charging
- Renewable power-to-heat
- Internet of things
- Artificial intelligence and big data
- Blockchain

## Business models

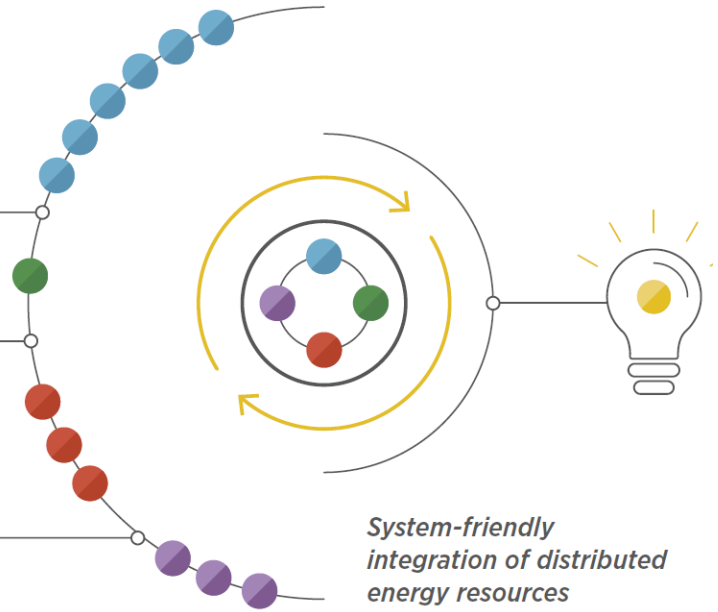
- Aggregators

## Market design

- Time-of-use tariffs
- Innovative ancillary services
- Market integration of distributed energy resources

## System operation

- Future role of distribution system operators
- Co-operation between transmission and distribution system operators
- Virtual power lines



*System-friendly integration of distributed energy resources*

**Sweden – Time-of-use tariffs**

**Sweden – Smart Heat Grids**

**Sweden – CoordiNet project**

**Netherlands – EV batteries for grid stability**

**Denmark – Parker Project**

**Germany – Aggregator providing grid services to the transmission system operator**

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

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# PANEL DISCUSSION

# Q&A

IRENA
International Renewable Energy Agency

# NEXT WEBINAR #IRENAinsights

## Reaching zero with renewables in transport and industry

---

**Tuesday, 18 August 2020 • 15:00 – 15:30 CEST**

***Registration link:***

https://register.gotowebinar.com/register/9114595560879011599

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# NEXT JOINT WEBINARS

Sustainable Energy Development Authority seda MALAYSIA

IRENA
International Renewable Energy Agency

# Innovations for a decentralised, renewable-powered system: Peer-to-peer electricity trading

**Tuesday, 25 August 2020 • 10:00 – 11:00 CEST**

https://www.irena.org/events/2020/Aug/IRENA-SEDA-Joint-Webinar

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# NEXT JOINT WEBINARS

Enlit Europe

IRENA
International Renewable Energy Agency

## Thirty innovations for a renewable-powered future

**Wednesday, 26 August 2020 • 17:00 – 18:30 CEST**

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# IRENA VIRTUAL EDITION INNOVATION WEEK 2020

## Renewable solutions for transport and industry

**5 - 8 October**

https://www.irena.org/events/2020/Oct/IRENA-Innovation-Week-2020

CEER
Council of European Energy Regulators

IRENA
International Renewable Energy Agency

# THANK YOU FOR JOINING US!

## SEE YOU IN OUR NEXT WEBINARS

## www.irena.org