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WEBINAR SERIES

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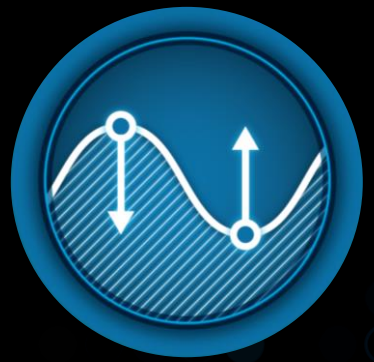
Unlocking Demand-Side Flexibility to Transform the Power Sector

Presenter:

- Carlos Fernandez, Power Sector Transformation Strategies Team



WEDNESDAY, 1 APRIL 2020 • 10:00 – 10:30 CET

Agenda

1. Introduction

2. Solutions to provide demand-side flexibility
   a) Power-to-hydrogen
   b) Smart appliances and industrial demand response

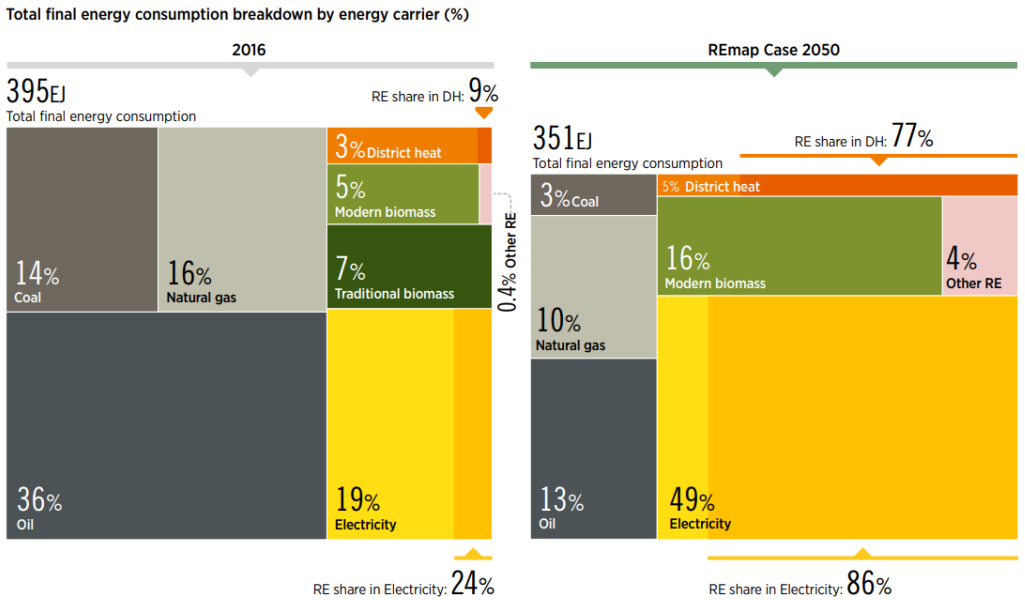
3. Examples of demand-side flexibility in actual practice
   a) Industrial demand response providing reserves
   b) Demand-side flexibility using hydrogen production

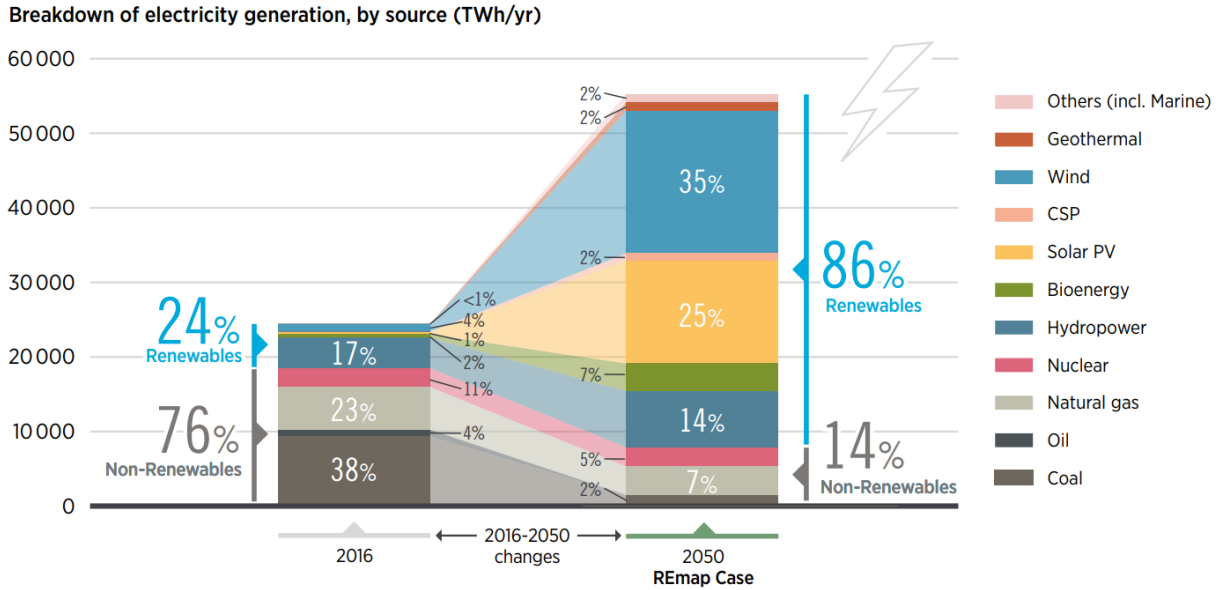
4. Innovations that enable demand-side flexibility applications

5. Conclusions

Electrification and dominance of VRE in the future electricity mix are key for the energy transition

REmap Case, 2016-2050





- REmap analysis suggests the share of electricity in global final energy demand will double by 2050 (from 19% to 49%)
- Renewable energy will generate 86% of total electricity worldwide
- Variable renewables like solar and wind power will supply more than 60% of total electricity
  - This practically means many countries will have VRE shares more than 60% into their power mix
  - System flexibility issues need to be assessed and necessary grid investments identified

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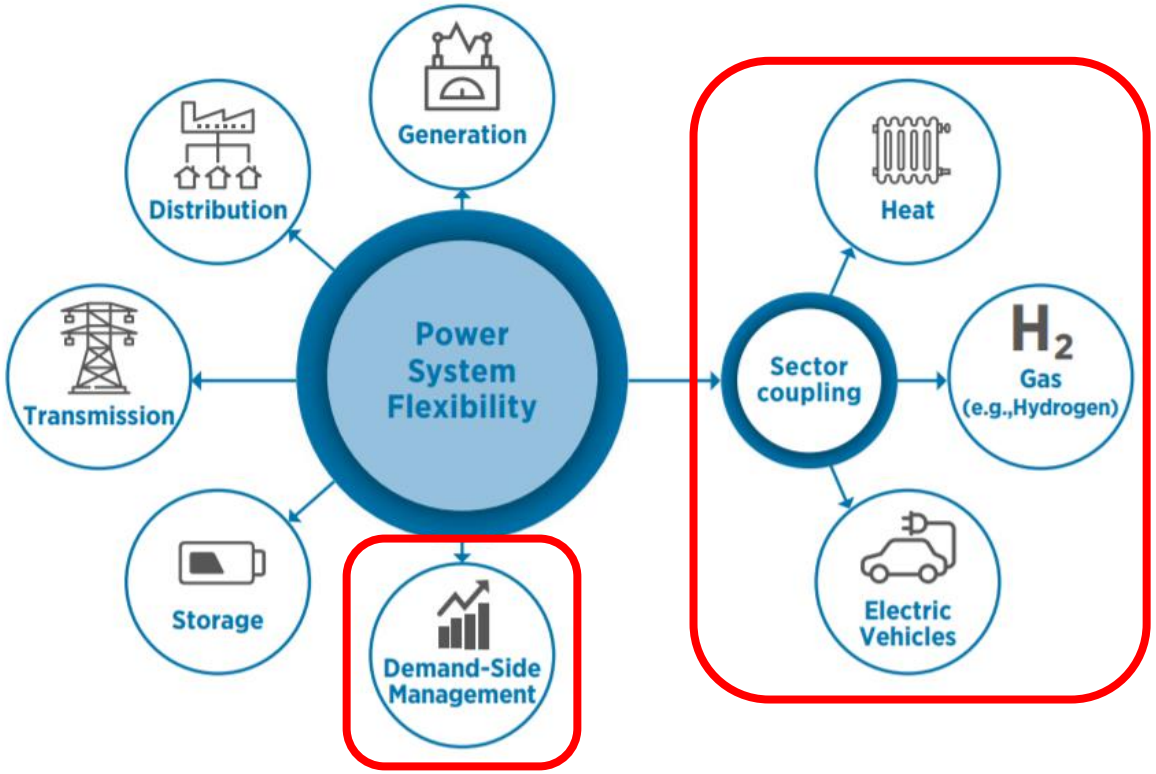
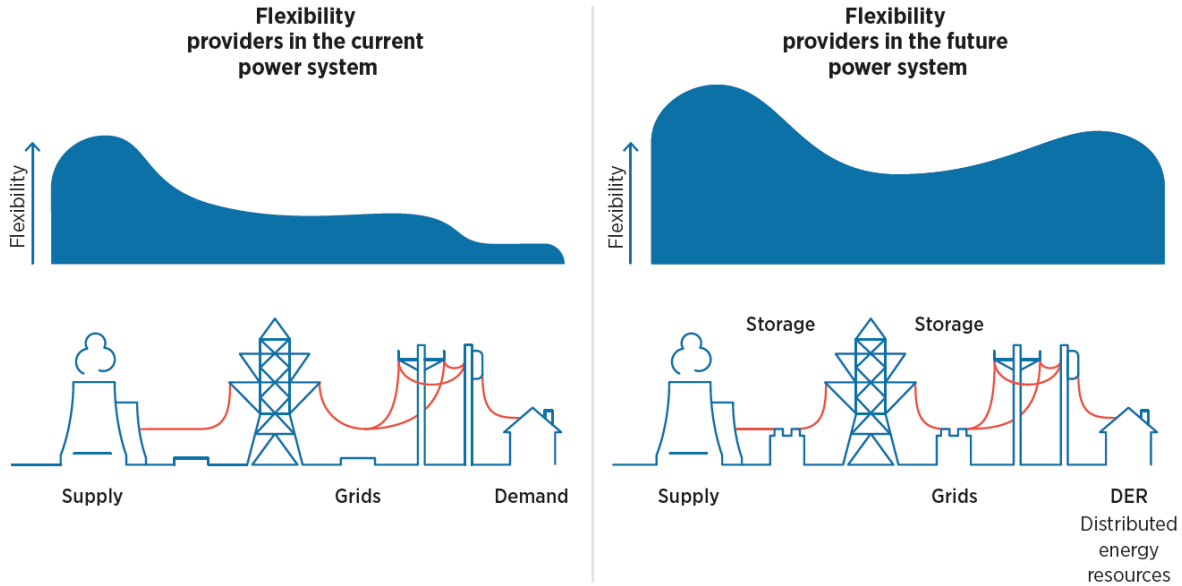
Source: Global Energy Transformation: A Roadmap to 2050, IRENA, 2019

Flexibility needs to be harnessed in all sectors of the energy system

Flexibility according to IRENA (2018):

"Flexibility is the capability of a power system to cope with the variability and uncertainty that VRE generation introduces into the system at different time scales, from very short to the long term, avoiding curtailment of VRE and reliably supplying all the demanded energy to customers"





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Source: *Power System Flexibility for the Energy Transition, IRENA, 2018*

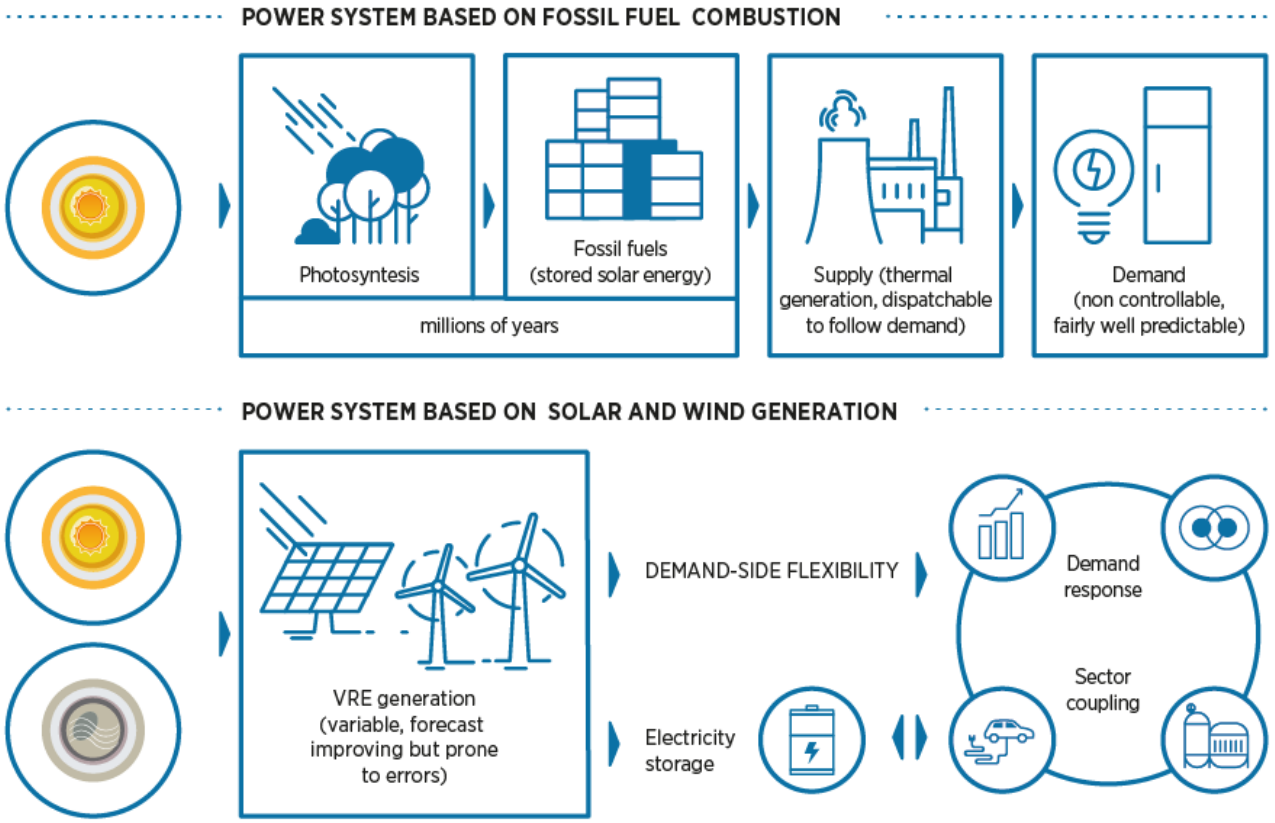
Demand side flexibility for power sector transformation

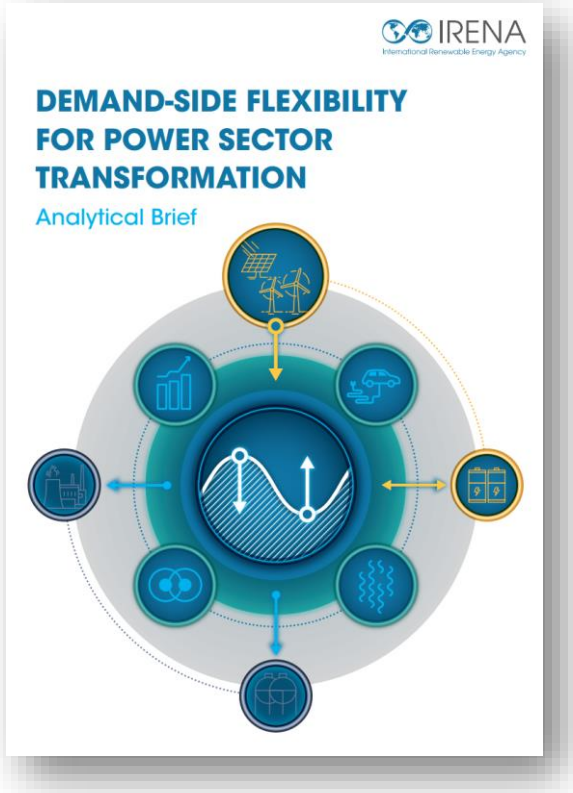
"Demand side flexibility can be defined as a part of the demand, including that coming from the electrification of other energy sectors (i.e. heat or transport via sector coupling), that could be reduced, increased or shifted in a specific period of time to:

(1) Facilitate integration of VRE by ***reshaping load profiles to match VRE generation***

(2) ***Reduce peak load and seasonality***

(3) ***reduce electricity generation costs*** *by shifting load from periods with high price of supply to periods with lower prices."*





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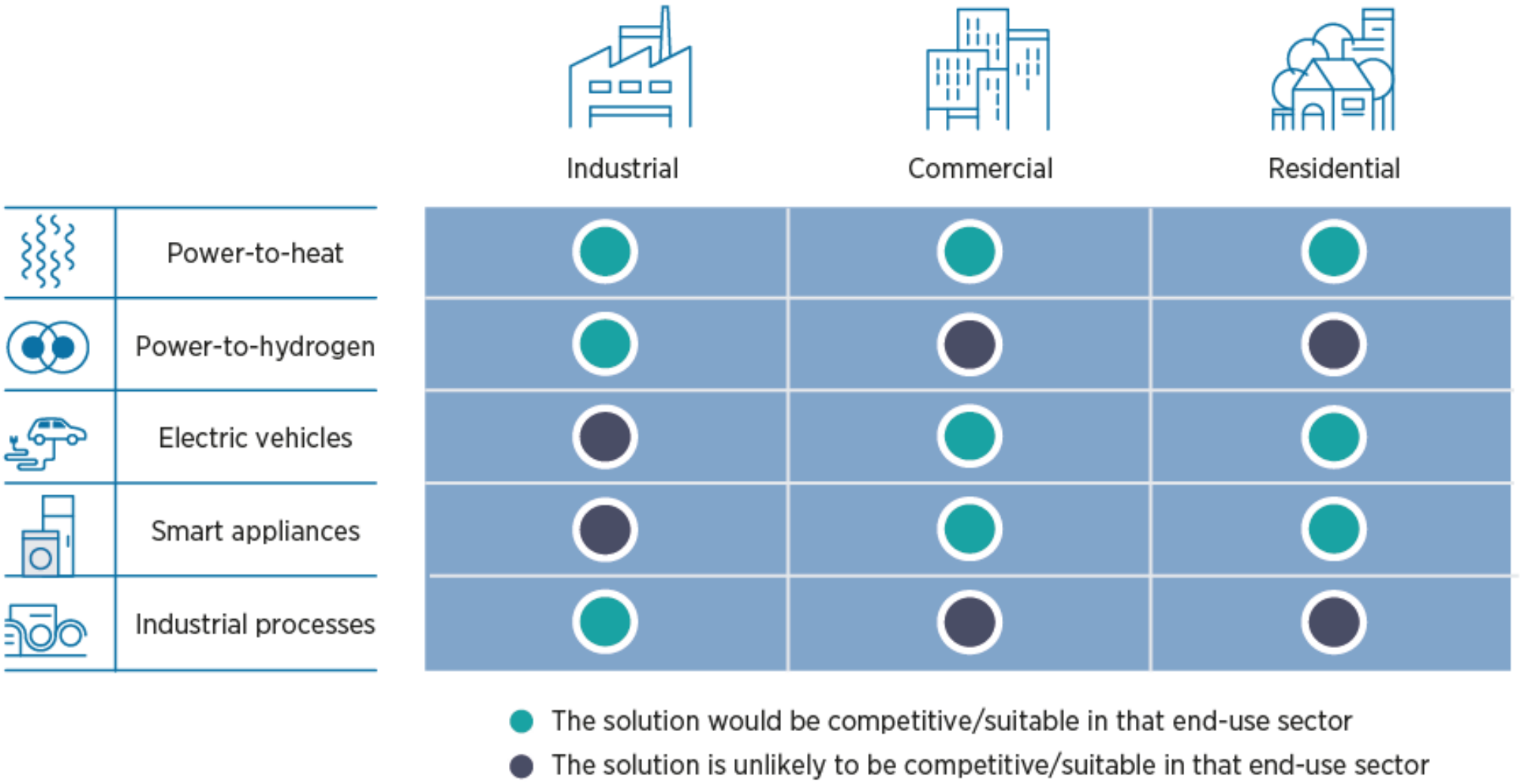
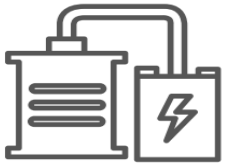
Solutions to provide demand side flexibility



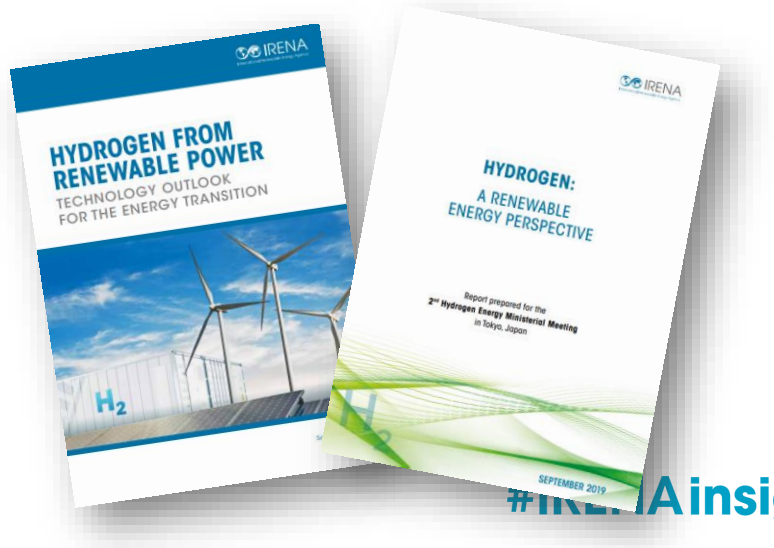
Power-to-hydrogen

- Hydrogen is an energy carrier, that is raising interest across different countries and institutions worldwide
- Hydrogen can be used in parallel with electricity to absorb the energy contained in sun and wind and reach consumers that otherwise would not be reachable
- Hydrogen from renewable power is expected to raise to 3 EJ by 2030 and **19 EJ by 2050**, accounting for more than half od the hydrogen demand (29 EJ)
- Power-to-hydrogen is mostly suitable/competitive for the industrial sector
- Can be stored in natural gas networks or dedicated storage facilities in the long-term (seasonal storage)



Electrolysers

- Use electricity to split water into hydrogen and oxygen
- Can provide demand-side flexibility by:
  - Adjusting hydrogen production to follow wind and solar generation profiles in periods of high resource availability
  - Provide grid balancing services



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Example 1 – Demand-side flexibility using hydrogen production

- **H21 North of England** project, which aims to convert all of the gas networks in the north of England to hydrogen by 2034.
- The project will imply a **125 GW hydrogen transmission** system with **12.5 GW of hydrogen production capacity and 8 TWh of storage** (equivalent to 62 Hornsdale Power Reserve battery systems – the Tesla 100 MW/129 MWh battery in South Australia), which will be **capable of providing seasonal demand-side flexibility**
- Consider hydrogen production through steam methane reforming, however if it proves to be technically and economically feasible in the future electrolysis can be considered as an alternative

- Electrolysers can also provide some ancillary services like Frequency Containment Reserves (FCR) or Frequency Restoration Reserve (FRR)
- **Thysenkrupp** has proven that electrolysers has enough fast ramping capabilities to enable them to provide FCR

Smart appliances and industrial demand response

Smart appliances

- Appliances can be used to provide demand-side flexibility is the right ICT infrastructure is in place
- **Most relevant appliances:** electric dryers, washing machines, dishwashers, fridges and freezers
- The use of these depend on consumer's behavior and the idea is that they will react to price signals and use these during low-price periods
- Suitable in the commercial and residential sectors

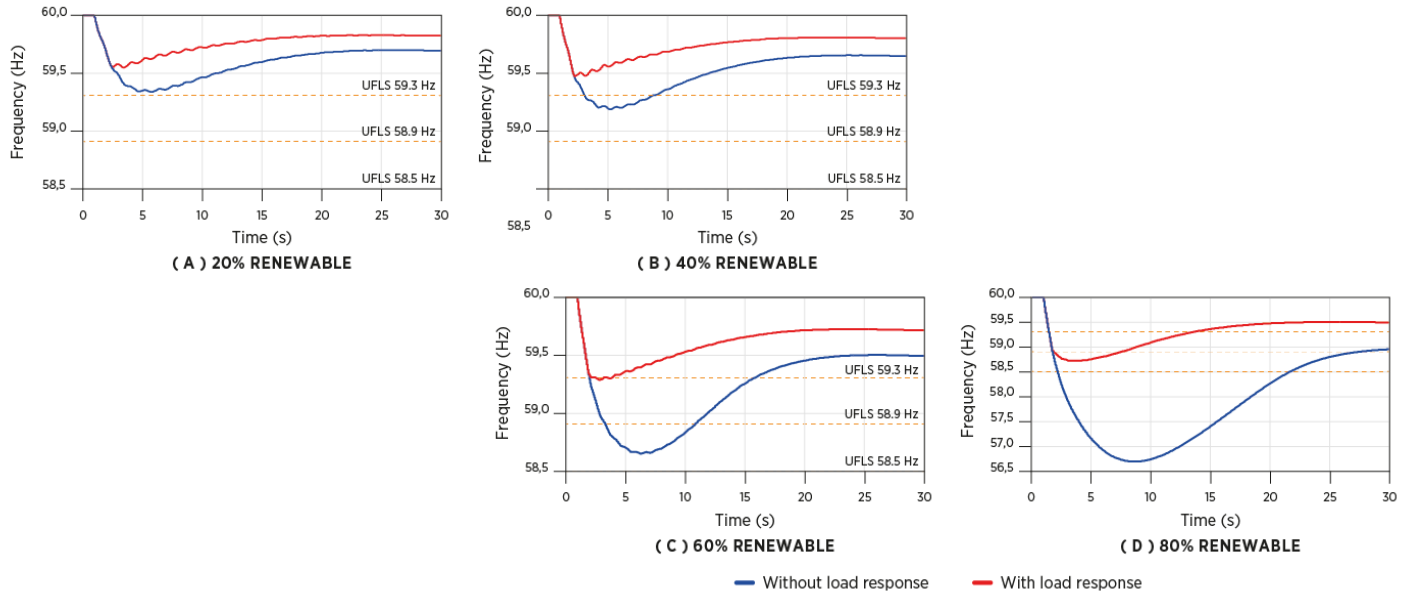
Industrial demand response

- Industries have a set of processes that require electricity besides power-to-heat or power-to-hydrogen processes
- These could also provide demand-side flexibility by shifting load, if required
- **Examples:** cement production, electric arc furnaces, electric ovens, aluminium production, wood pulp production, paper manufacturing
- Only suitable/competitive in the industrial sector

Example 2 – Industrial demand response providing reserves

- The Electricity Reliability Council of Texas (ERCOT) has allowed the participation of demand in ancillary services since 2002
- Initially the maximum share of participation of demand in **the responsive reserve service (RRS)** was 25% and increased to 60% in 2018 (VRE share was 19%)
- Most of the demand resources participating in RRS were from the industrial sector and **in 2018 ERCOT had a total of 4200 MW** that could participate

- From 2019 a **fast frequency response (FFR)** service was included in ERCOT where load resources will be able to participate too
- Figures shows how these load resources would perform delivering FFR



Innovations that enable demand-side flexibility applications

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	ENABLING TECHNOLOGIES	BUSINESS MODELS	MARKET DESIGN	SYSTEM OPERATION
Industrial demand response providing reserves	• Renewable power-to-heat • Renewable power-to-hydrogen • Behind-the-meter batteries • Artificial intelligence and big data	• Aggregators	• Innovative ancillary services	
Electric water heaters responding to prices	• Renewable power-to-heat • Internet of things • Artificial intelligence and big data	• Aggregators	• Time-of-use tarifs	• Co-operation between transmission and distribution system operators • Future role of distribution system operators
Aggregators enabling demand-side flexibility	• Behind-the-meter batteries • Electric vehicle smart charging • Renewable power-to-heat • Internet of things • Artificial intelligence and big data	• Aggregators • Energy-as-a-service	• Market integration of distributed energy resources	• Co-operation between transmission and distribution system operators • Future role of distribution system operators • Virtual Power Lines
Electric vehicles with smart charging	• Electric vehicle smart charging • Internet of things • Artificial intelligence and big data • Blockchain	• Aggregators • Pay-as-you-go models	• Time-of-use-tariffs • Innovative ancillary services • market integration of distributed energy resources	• Co-operation between transmission and distribution system operators • Future role of distribution system operators • Virtual Power Lines
District heating networks	• Renewable power-to-heat	• Community ownership models	• Increase time granularity in electricity markets	
Hydrogen for seasonal demand-side flexibility	• Renewable power-to-hydrogen		• Innovative ancillary services	• Advanced forecasting of variable renewable power generation

Enabling technologies: Technologies that play a key role in facilitating the integration of renewable energy

Business models: Innovative models that create the business case for new services, enhancing the system's flexibility and incentivizing further integration of renewable energy technologies

Market design: New market structures and changes in the regulatory framework to encourage flexibility and value services needed in a renewable-based power energy system, stimulating new business opportunities

System operation: Innovative ways of operating the electricity system, allowing the integration of higher shares of variable renewable power generation

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Conclusions

- Under a high penetration of Variable Renewable Energy flexibility becomes key for the power system operation

- This flexibility must be harnessed not only on the supply-side by also on the demand-side, which is refererred to as **demand-side flexibility**

- Demand side flexibility fulfils several important aims:
  - Facilitates VRE integration by **shaping load profiles to match VRE generation**
  - Facilitates system-wide electrification by **reducing peak load and managing seasonality**
  - **Reduces production costs** by shifting load from periods with high prices to periods with low prices

- Various solutions already exist to provide demand-side flexibility: power-to-heat, power-to-hydrogen , electric vehicles, smart appliances and industrial demand response

- Today there are already several commercial projects that use these solutions to provide demand side flexibility. Two examples have been presented.

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Questions & Answers

Please use the 'Questions' feature on the webinar panel

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- THURSDAY, 16 April 2020 • 3:00pm – 3:30pm CET
  "The IRENA Electricity Storage Valuation Framework"

- TUESDAY, 28 April 2020 • 10:00 – 10:30 CET
  "Renewables for refugee settlements: Sustainable energy access in humanitarian situations"

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Thank you!

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