IRENA
International Renewable Energy Agency

Renewable Energy Trends and Prospects

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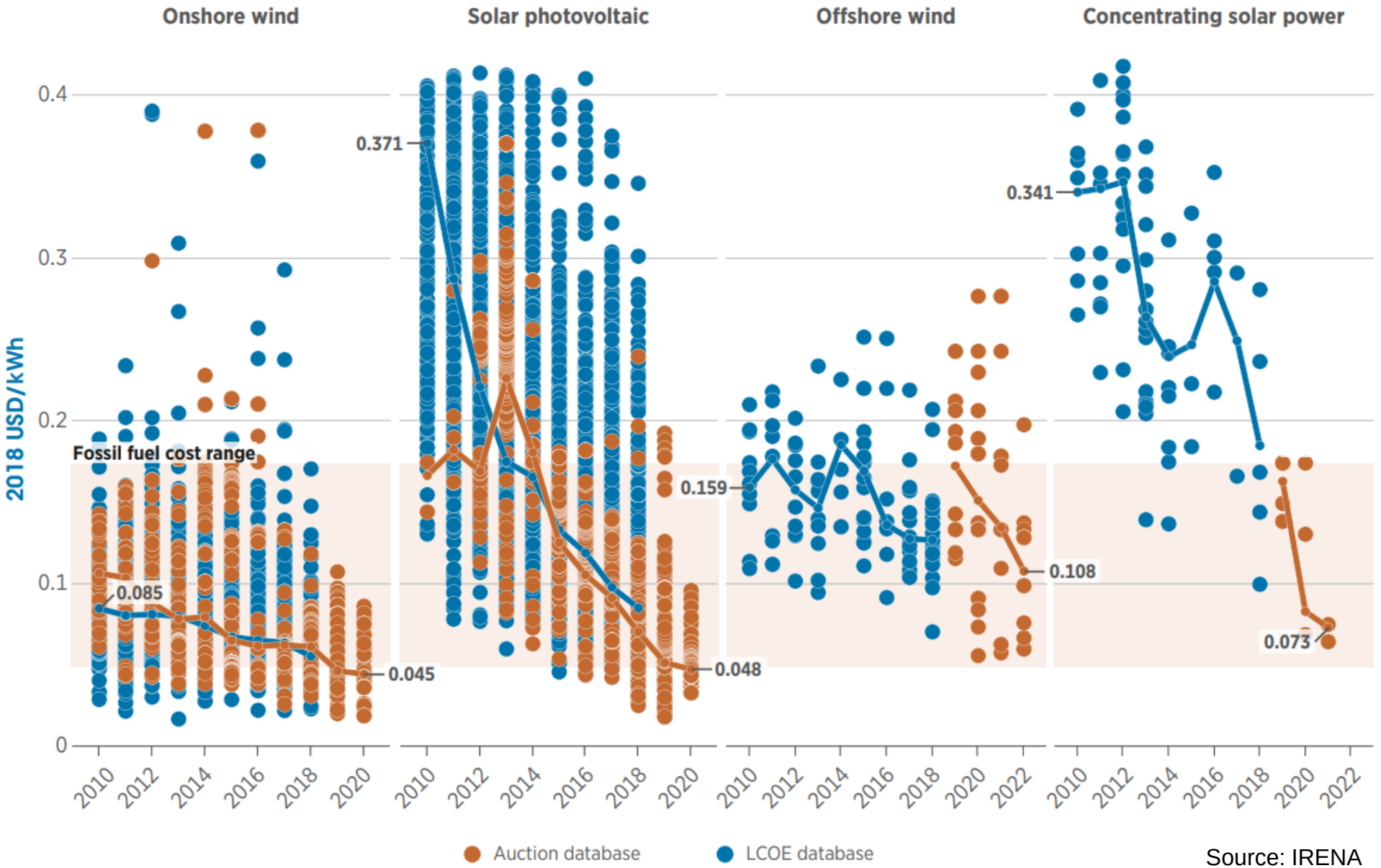
Solar & Wind: LCOE/auction price evolution overview - Continued rapid cost reduction in the coming years

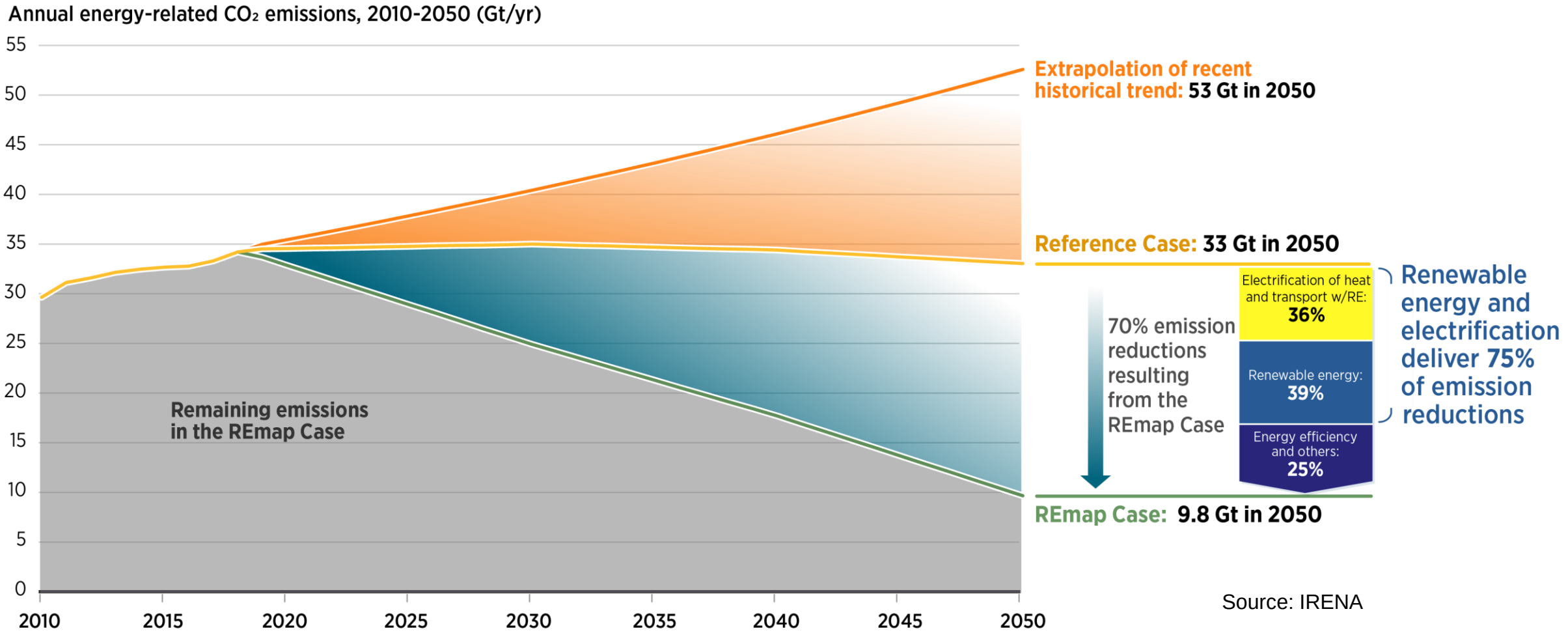


IRENA costing database of 15,000 large scale RE power projects and 1.5 million rooftop PV systems

Covering half of all existing and planned RE capacity

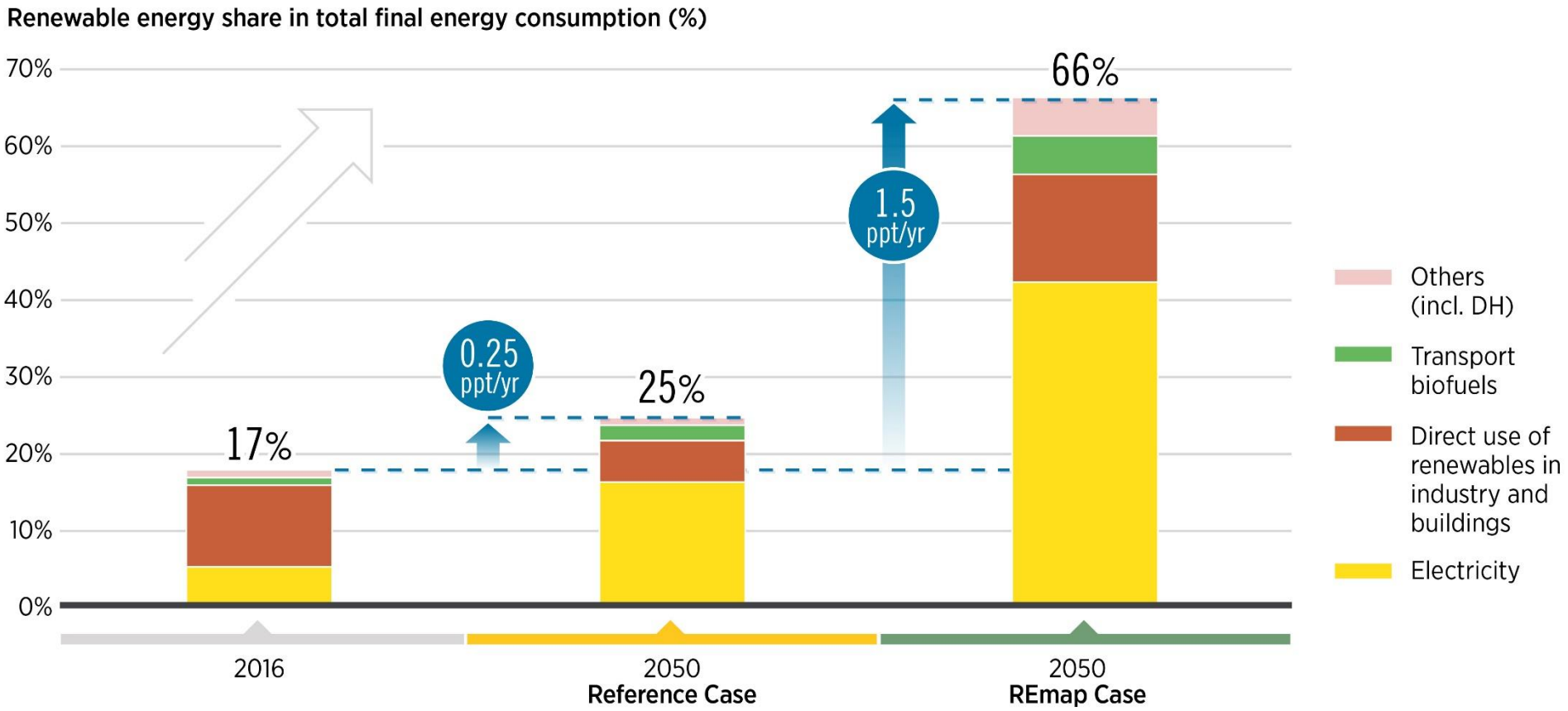
Source: IRENA

Renewables & electrification can deliver 75% of energy-related CO_2 emission reductions needed



Source: IRENA

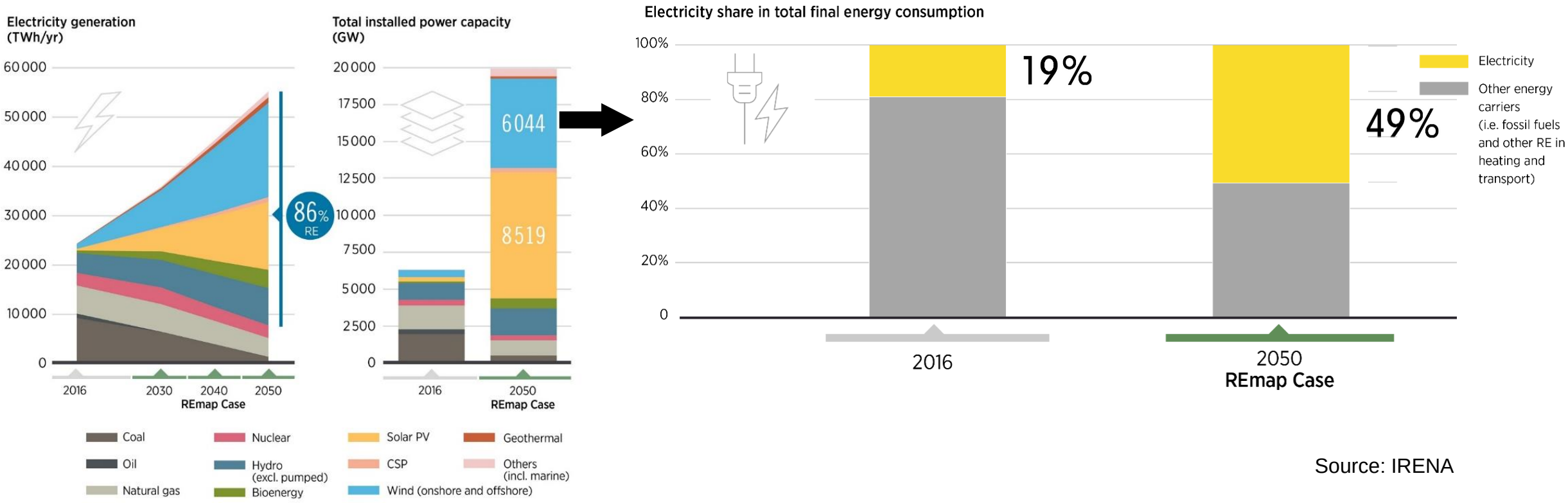
Growing share of renewables in final energy consumption – RE power and electrification are key



Source: IRENA

The share of renewables in total final energy consumption (TFEC) needs to **ramp up six-fold** – from a historical average of 0.25 percentage points per year to almost 1.5 percentage points per year.

Electrification paired with renewables is a major solution for decarbonisation



Source: IRENA

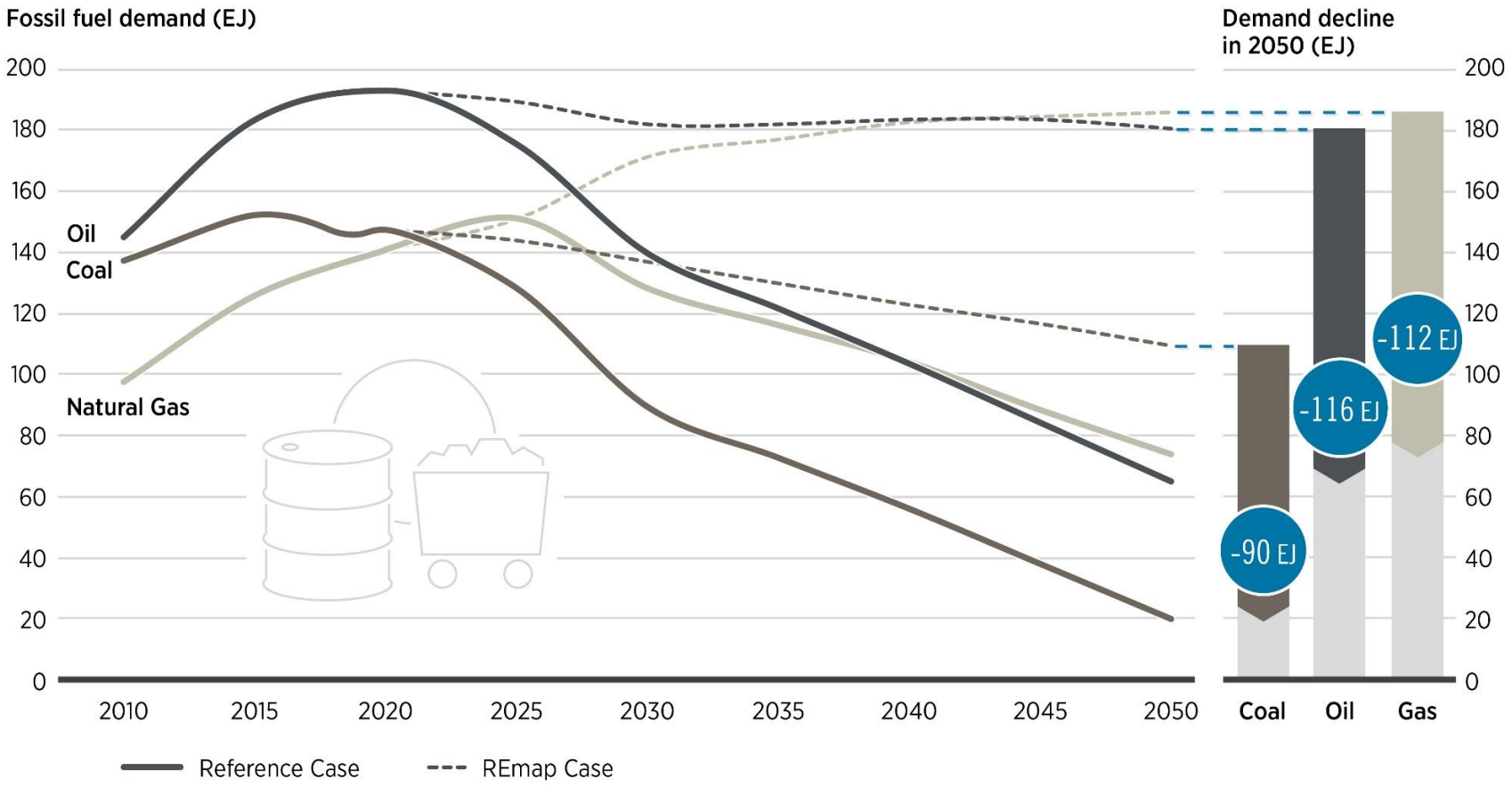
By 2050,

- Electricity becomes the central energy carrier
- 86% of electricity generation will come from renewables

A transformed energy system: Scaling up renewables not just for power, but also for heat and transport

Declining global demand for fossil fuels

Fossil fuel use (left, PJ/yr), 2015-2050; decline in fossil fuel usage by sector REmap Case relative to Reference Case (right, in 2050)



Source: IRENA

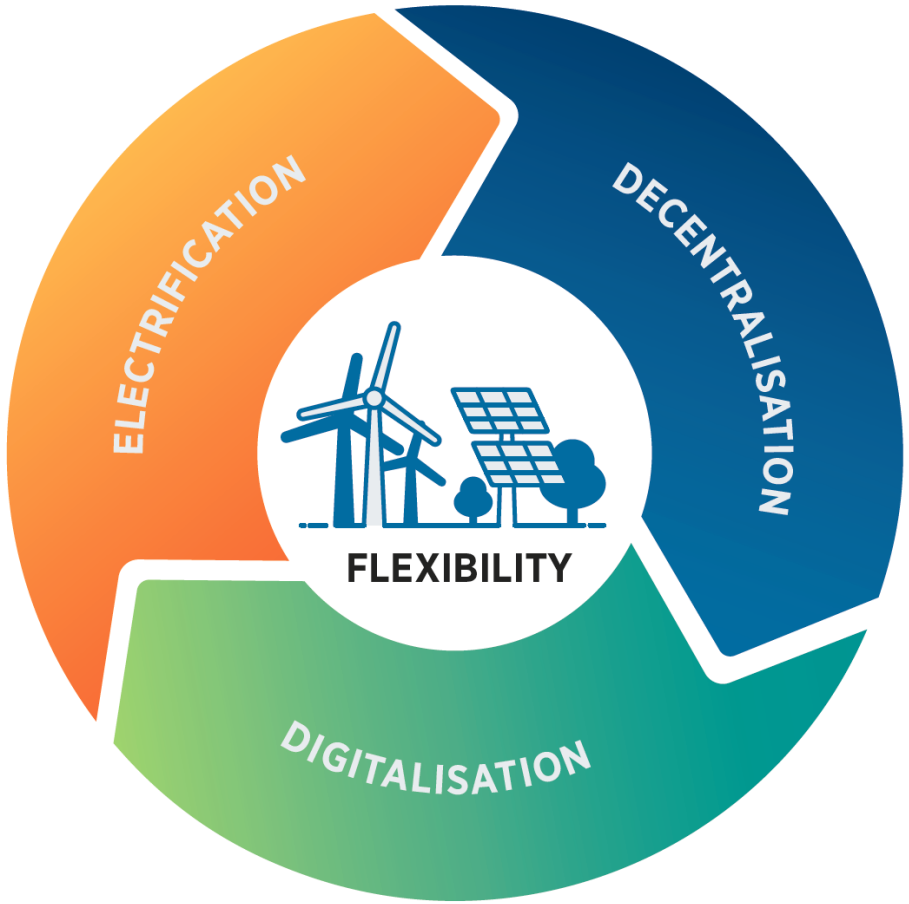
With accelerated uptake of renewables, both oil and coal demand decline significantly and continuously, with natural gas demand peaking around 2025. Natural gas would be the largest source of fossil fuel in 2050.

Three key power systems trends

Decentralisation -impact on supply side-. Wind and PV is largely centralised today but distributed generation, notably rooftop PV, is growing, bringing new flexibility opportunities at the demand side.

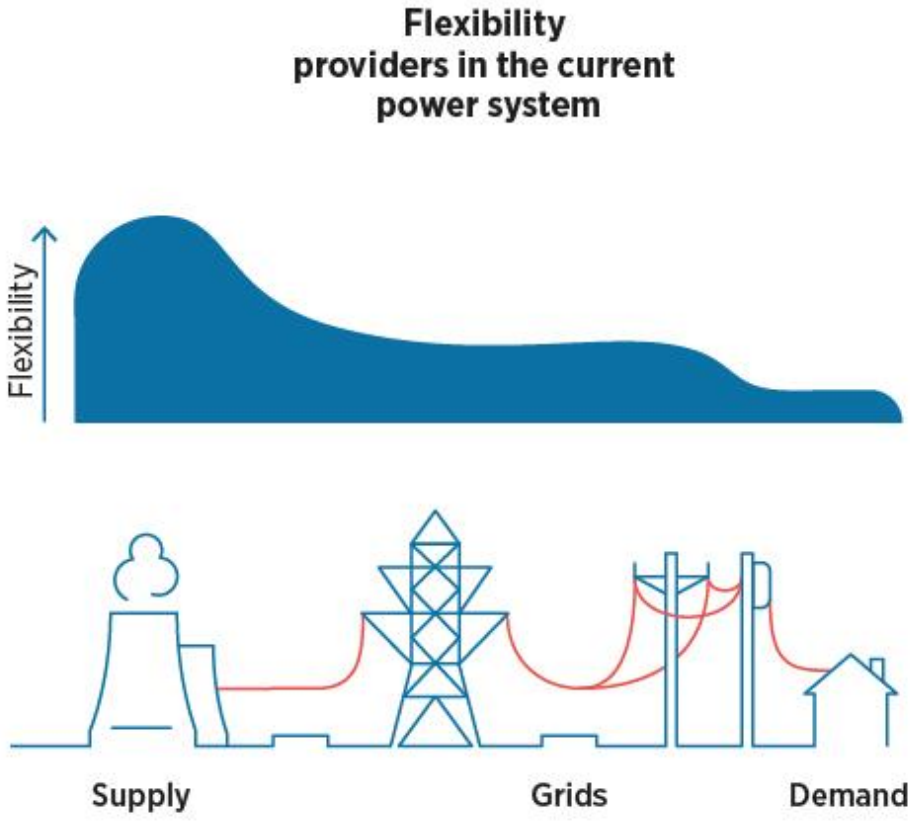
Electrification -impact on demand side-. It may decarbonise end-use sectors through renewable electricity and, if done in a smart way, become a flexibility source to integrate more renewables in power systems.

Digitalisation -impact on system integration-. Key enabler to amplify the energy transformation by managing large amounts of data and optimising systems with many small units

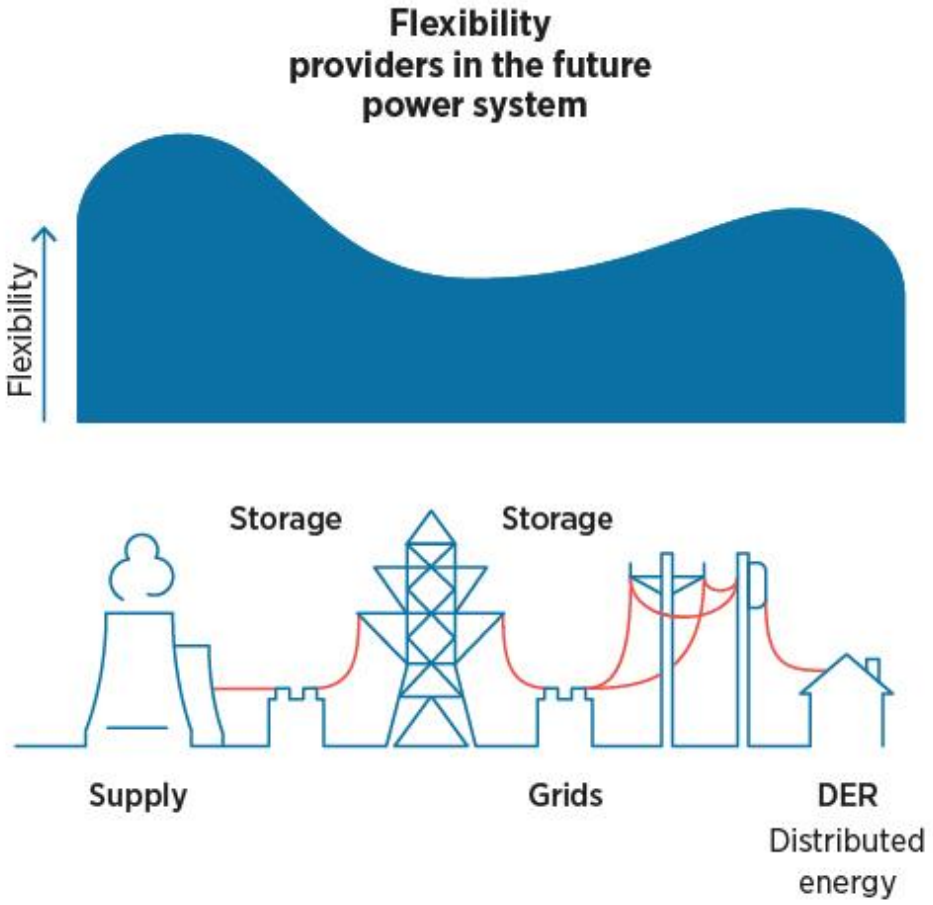


Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Unlocking flexibility across the whole power system



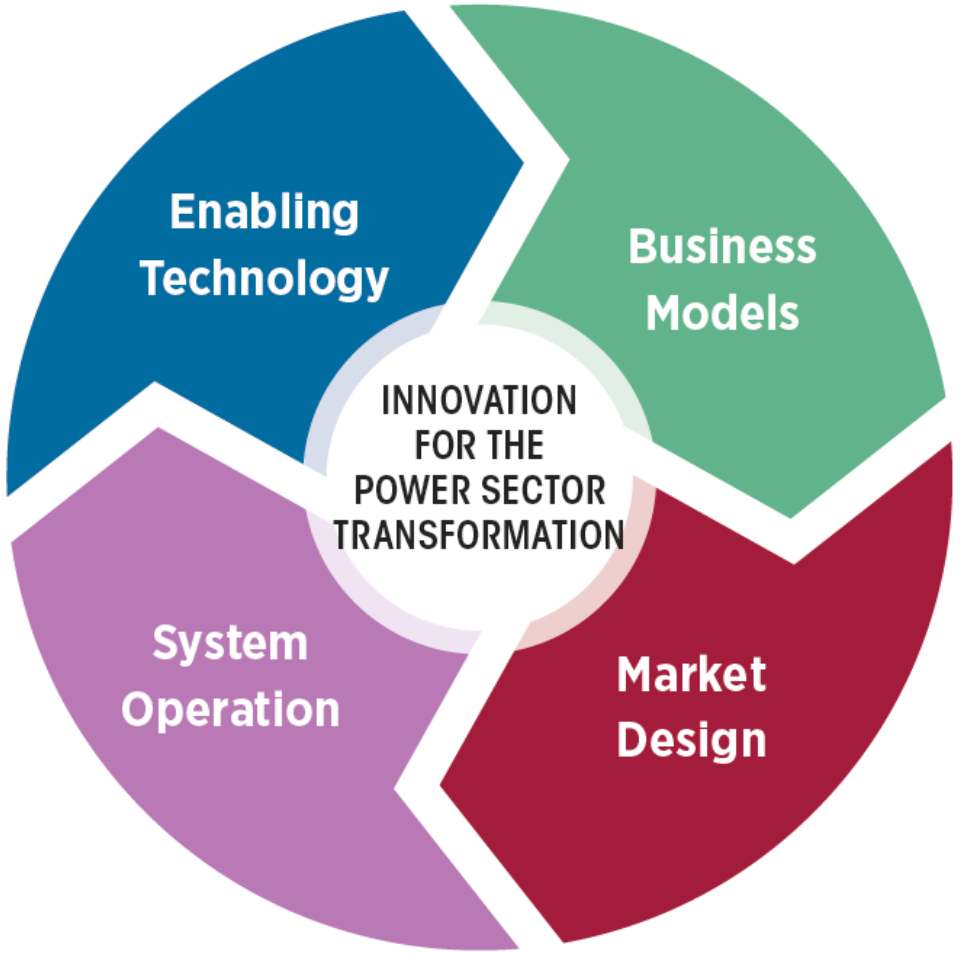
Flexibility sources: Flexible generation



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

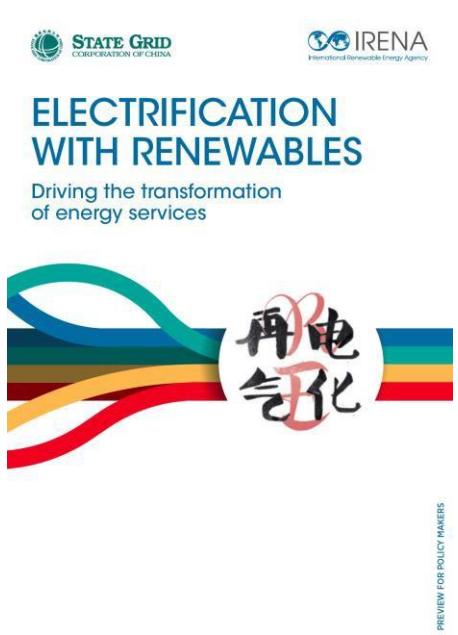
Four dimensions of power system innovation



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

Flexibility as an enabler for the integration of VRE

Flexibility and sector coupling

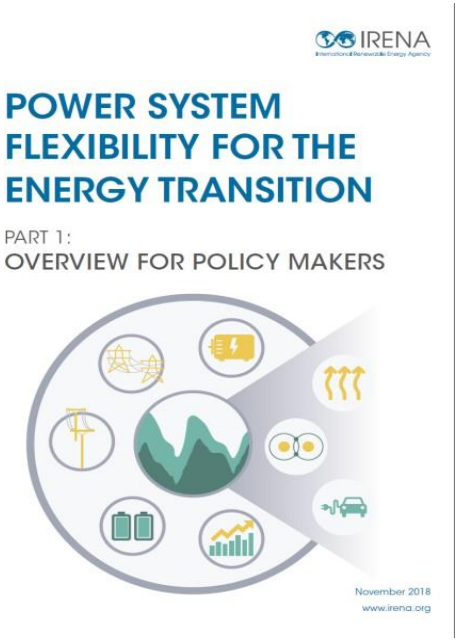


Electricity more than 45% of final energy use by 2050

Up to 62% of energy CO_2 emission reduction from RE-electrification

Smart systems and solutions are key

Flexibility concepts and policies

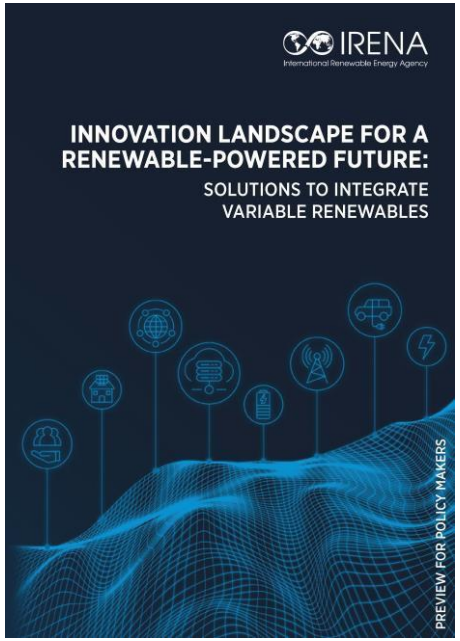


Flexibility is key for power system transformation

Flexibility concepts and strategies are changing

New strategies are increasingly being adopted

Flexibility innovation toolbox



Many innovations are emerging that can increase flexibility

Innovations combine to create real-world solutions

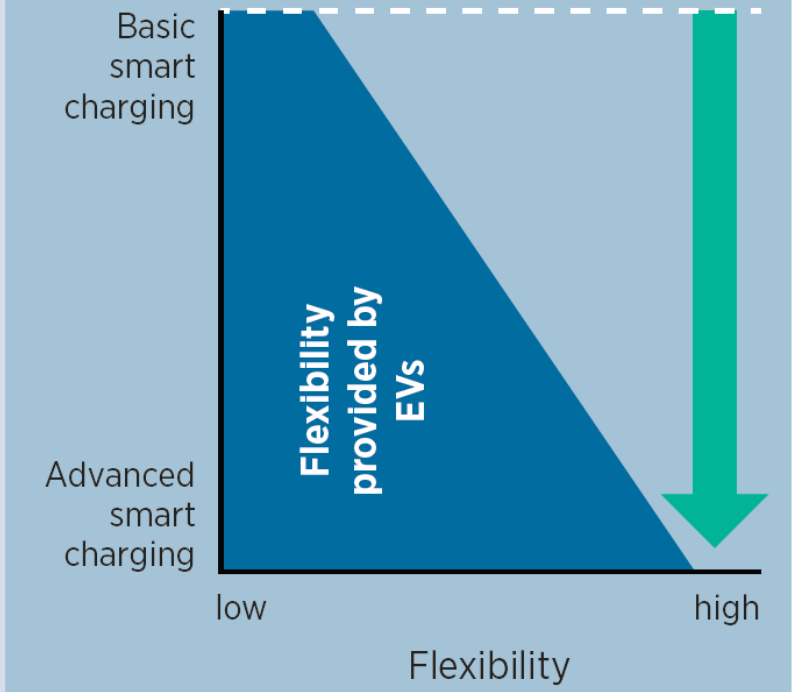
Decisionmakers can find solutions that fit their needs

Smart charging makes EVs a source of flexibility for power systems - facilitating integration of VRE

Current concepts of smart charging include

- **Time-of-use pricing without automated control**
- **Basic controlled (on/off)**
- **Unidirectional controlled (V1G)**
- **Bidirectional controlled (V2G, V2H, V2B)**
- **Dynamic pricing with automated control**

Smart charging enables EVs to provide grid services



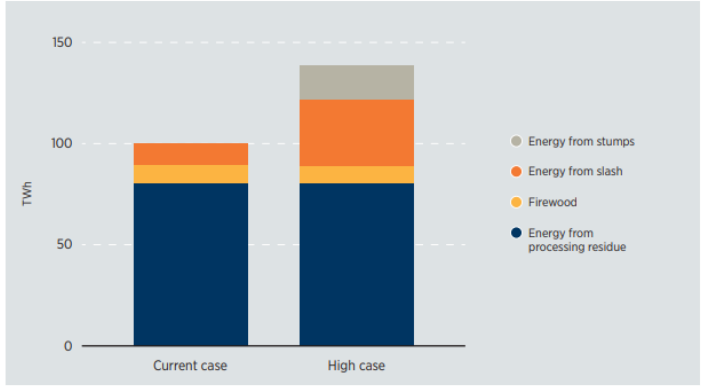
Source: IRENA (2019) Innovation Outlook: Smart charging for Electric Vehicles

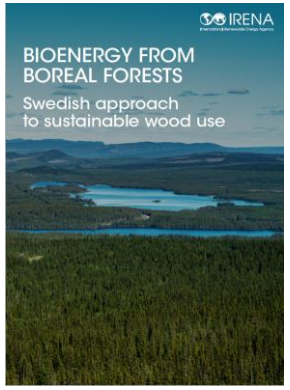
Sustainable Forest Management – Swedish case

Wood flow element	Current residue shares	Enhanced residue use
Forest biomass growth in 2015	**436 TWh**	**436 TWh**
(Left in forest growing)	107 TWh	107 TWh
Cut (75% of growth increment)	**329 TWh**	**329 TWh**
Stemwood (55% of cut)	**181 TWh**	**181 TWh**
• Pulpwood (including bark)	87 TWh	87 TWh
· use for energy (DH)*	9 TWh	9 TWh
· use for energy (mills, other)	48 TWh	48 TWh
· use for energy (biofuel)	1 TWh	1 TWh
• Saw logs (including bark)	**80 TWh**	**80 TWh**
· sawnwood in construction	**22 TWh (60% of sawnwood)**	**22 TWh (60% of sawnwood)**
· other sawnwood use	14 TWh (40% of sawnwood)	14 TWh (40% of sawnwood)
· use for energy (DH)	6 TWh	6 TWh
· use for energy (mills, other)	12 TWh	12 TWh
• Firewood	9 TWh	9 TWh
• Discarded wood (DH)	5 TWh	5 TWh
Slash (20% of cut)	**66 TWh**	**66 TWh**
• Use for energy (DH)	**10 TWh (15% of slash)**	**33 TWh (50% of slash)**
• Left in forest rotting	56 TWh	33 TWh
Stumps (25% of cut)	**82 TWh**	**82 TWh**
• Use for energy (DH)	**0 TWh (0% of stumps)**	**17 TWh (20% of stumps)**
• Left in forest rotting	82 TWh	66 TWh
Total bioenergy use	**99 TWh**	**139 TWh**

* Fuel oil boiler efficiency – 80%, modern wood furnace – 87%, DH – appox. 100%

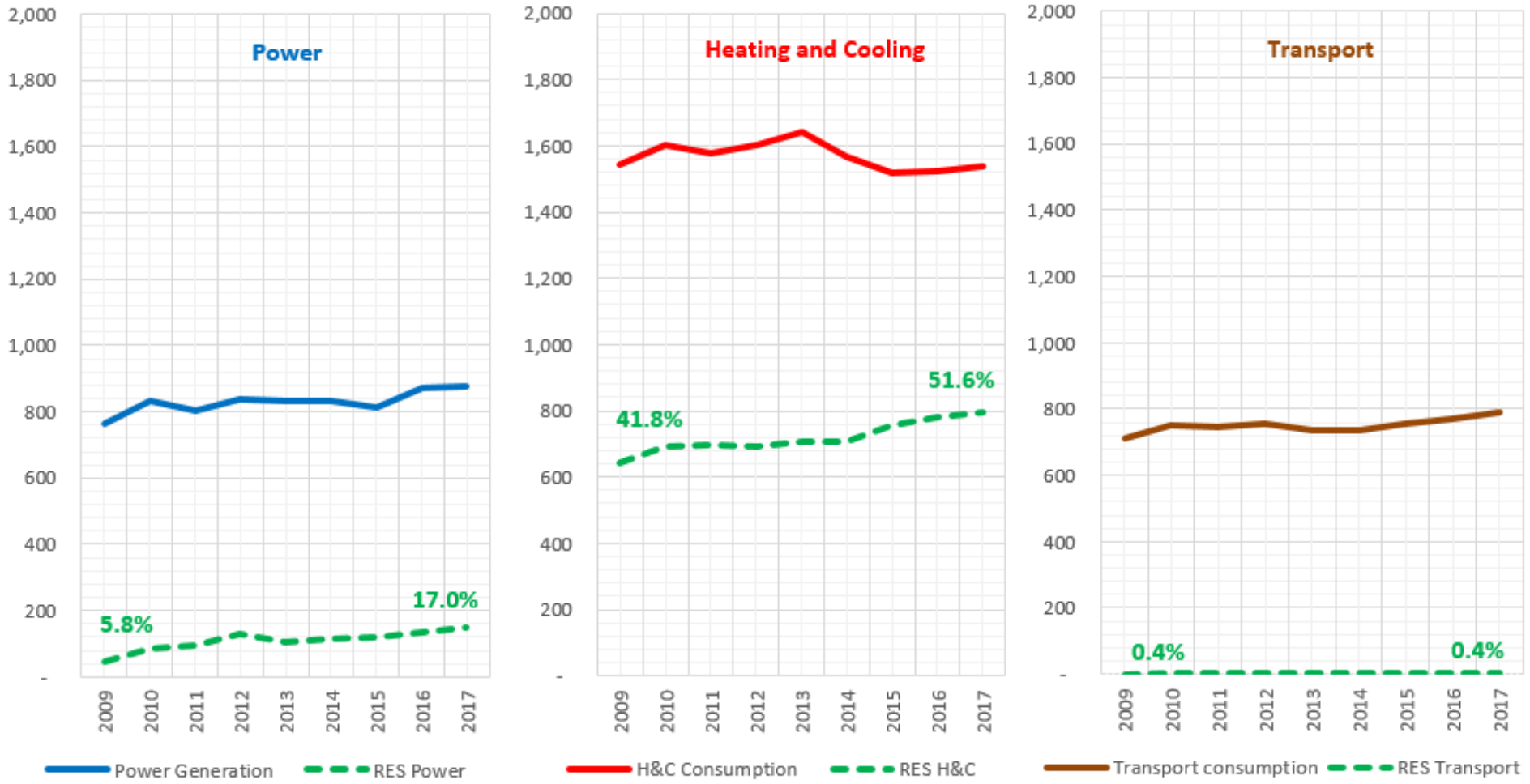
- ***Harvest less wood than grows each year***
  - Swedish forests have been growing around 1% per year
  - Largely because 25% of annual growth is left growing
  - Also because management replaces older, slower-growing trees with younger, faster-growing trees
- ***Substitute wood for carbon-intensive building materials***
  - Approximately 2.8 t of carbon dioxide emissions are avoided for every tonne of wood used in buildings
  - Around 60% of Swedish wood logs are used in buildings
- ***Use wood residues instead of fossil fuel for energy***
  - Wood displacing coal and fuel oil for process heat, DH
  - (Current residue use) 99 TWh of wood for process heat and DH – 32.8 MtCO2 displacement of fuel oil*
  - (Enhanced residue use) 138 TWh of wood for process heat and DH - 46.8 $MtCO_2$ displacement of fuel oil





Estonia has made progress in renewables over the last 10 years

> Overall share grew from 23% in 2009 to 29% in 2017



Rising bioenergy exports

Estonia vs European Union in 2030

European Union 2030 Targets	
Greenhouse Gases Emissions (GHG)	- 40 %*
Energy Efficiency (Final Energy Consumption - FEC)	- 32.5 %**
Renewable Energy (Renewable Energy share - RES)	32 %***

Estonia's NECP

GHG Emissions

- Binding target to reduce greenhouse gas (GHG) emissions by 13% of 2005 levels by 2030 under the Effort Sharing Regulation.
- Target to reduce GHG emission by 80% compared to 1990 levels by 2050

Energy Efficiency

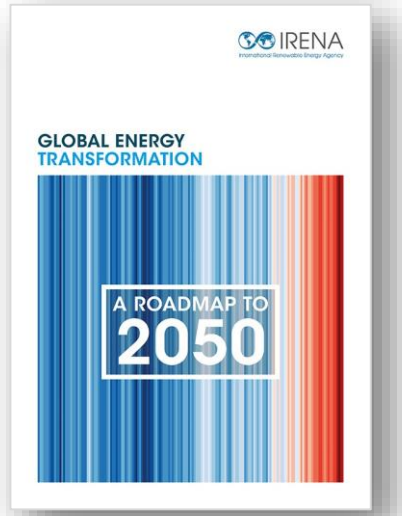
- Primary energy consumption in 2030 will be 10% less than in 2012
- Improvements through more energy efficient buildings, reduction of district heating losses, co-generation

Renewable Energy

- To increase Renewable Energy Share to 42.0% in FEC by 2030
- 30% renewable power
- 80% heat
- 14% transport

** Compared to overall emissions in 1990; ** Compared to the reference case projection for 2030 made in 2007 as extracted from the Revised Energy Efficiency Directive 2018/2002; *** Share of gross final energy consumption*

Thank you!



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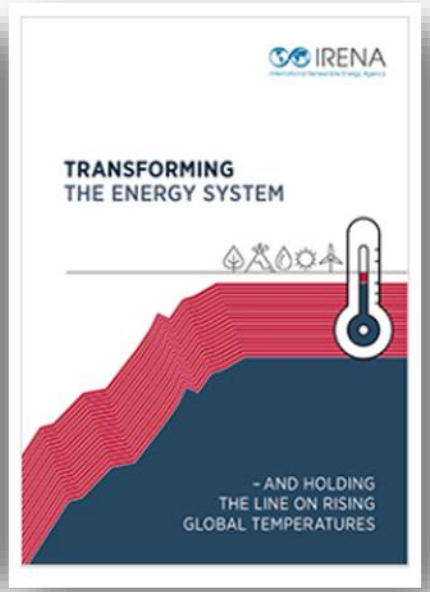

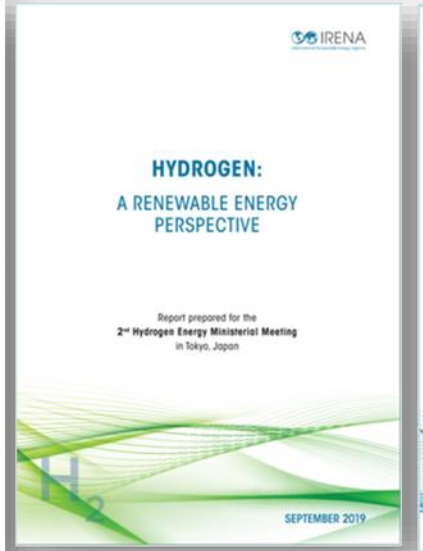

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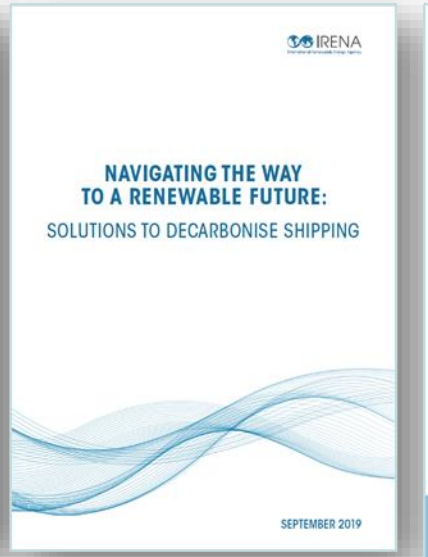

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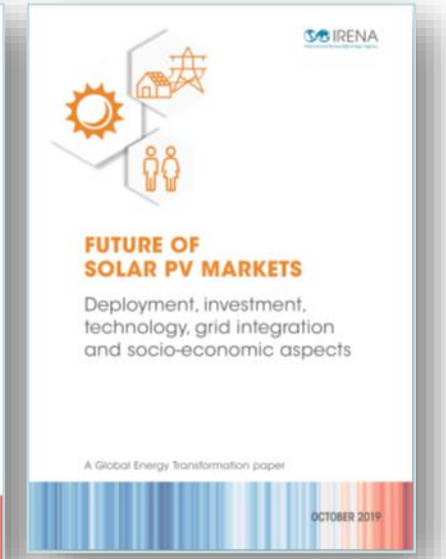

November

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