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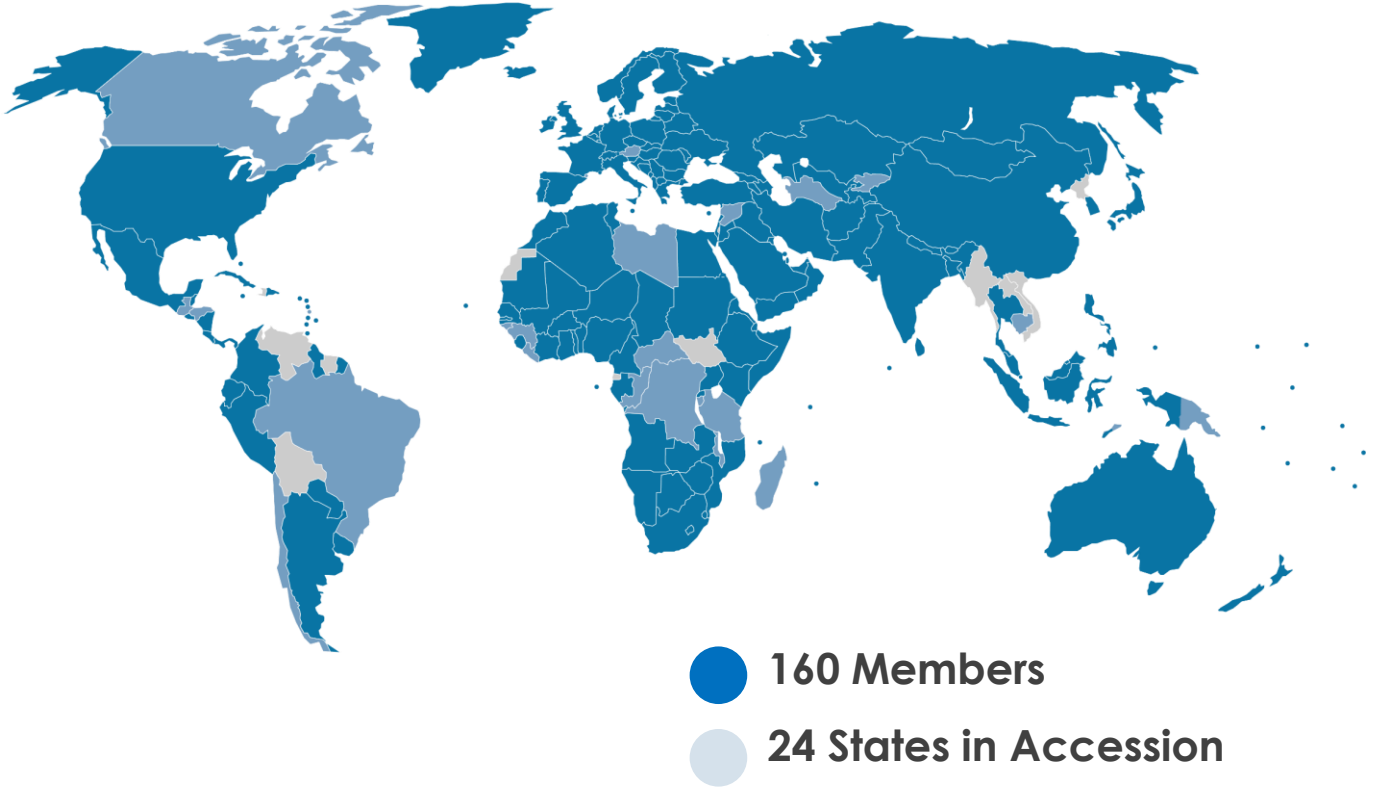
International Renewable Energy Agency

Renewable Energy Driving the Energy Sector Transformation

Sustainable Development and the green economy
5 February 2019
Geneva, Switzerland

About IRENA

- Inter-governmental agency established in 2011
- Headquarters in Abu Dhabi, UAE
- IRENA Innovation and Technology Centre – Bonn, Germany
- Permanent Observer to the United Nations – New York



Mandate: Assist countries to accelerate renewable energy deployment

1 The energy transition

Development and welfare for all

UN Sustainable Development Goals (SDGs)

Source: IRENA (2017) Rethinking Energy

We need cleaner, affordable, reliable and abundant sources of energy

Energy accounts for two-thirds of total greenhouse gas emissions

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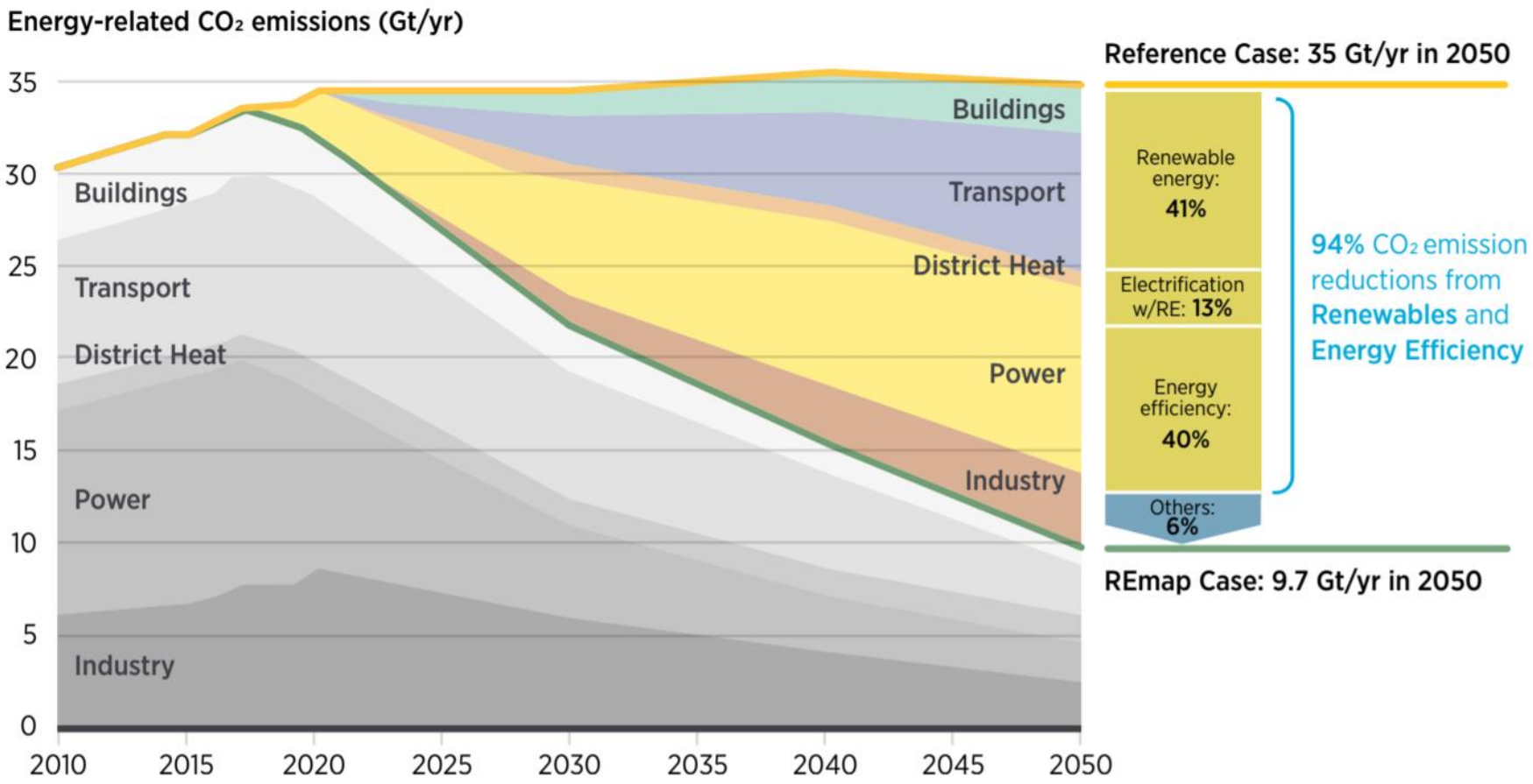
To meet 2°C climate target set at COP 23 in Paris 2015

Annual energy-related CO_2 emissions and reductions, 2015-2050 (Gt/yr)

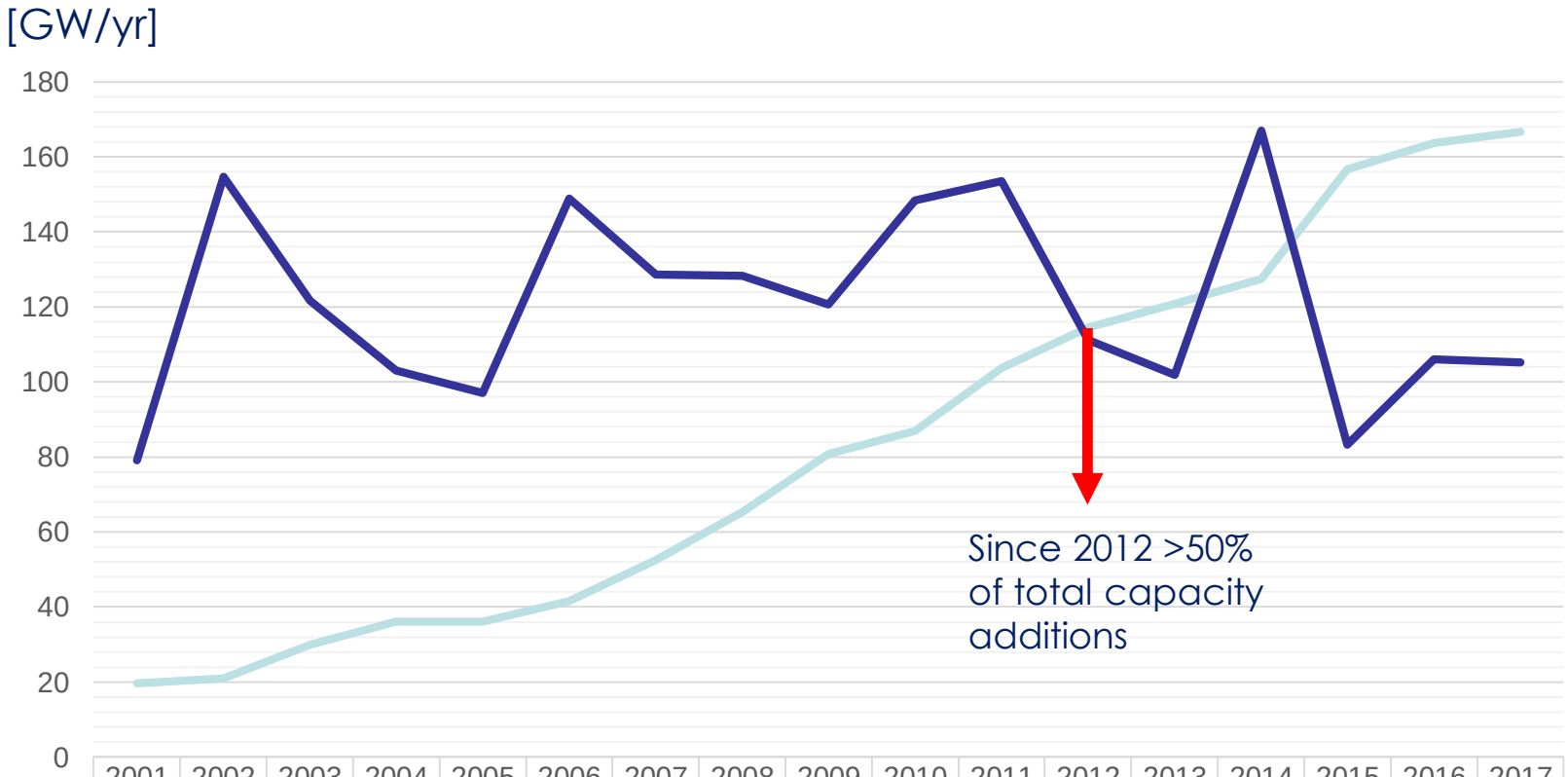


- Energy-emission budget:
  - 790 Gt CO_2 from 2015 till 2100
  - *At current emissions rate, carbon budget would be consumed by 2040*
  - RE and EE can achieve 94% of emission reductions needed by 2050

Source: IRENA (2018), Global Energy Transformation: A roadmap to 2050

2 The progress

Global capacity additions – Electricity generation



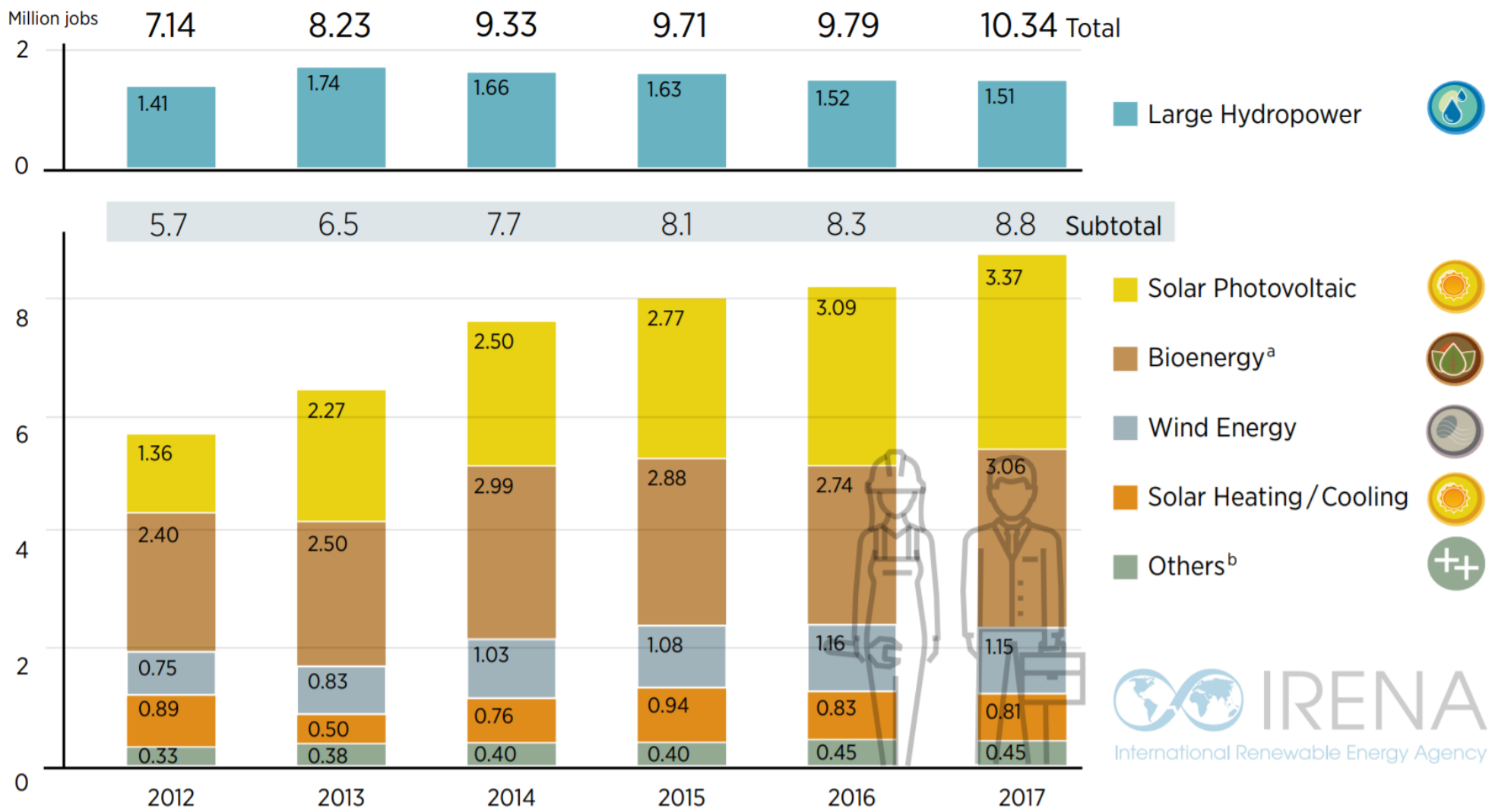
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Renewables (GW)	20	21	30	36	36	42	53	65	81	87	104	114	121	127	157	164	167
Non-renewables (GW)	79	155	122	103	97	149	129	128	121	148	154	111	102	167	83	106	105

2017 a record year:

- >160 GW of RE installed – lead by *93 GW solar, 47 GW wind, 20 GW hydro*
- RE cumulative capacity > 2,000 GW
  - Despite low oil prices
- 280 USD billion. Solar PV and wind leading

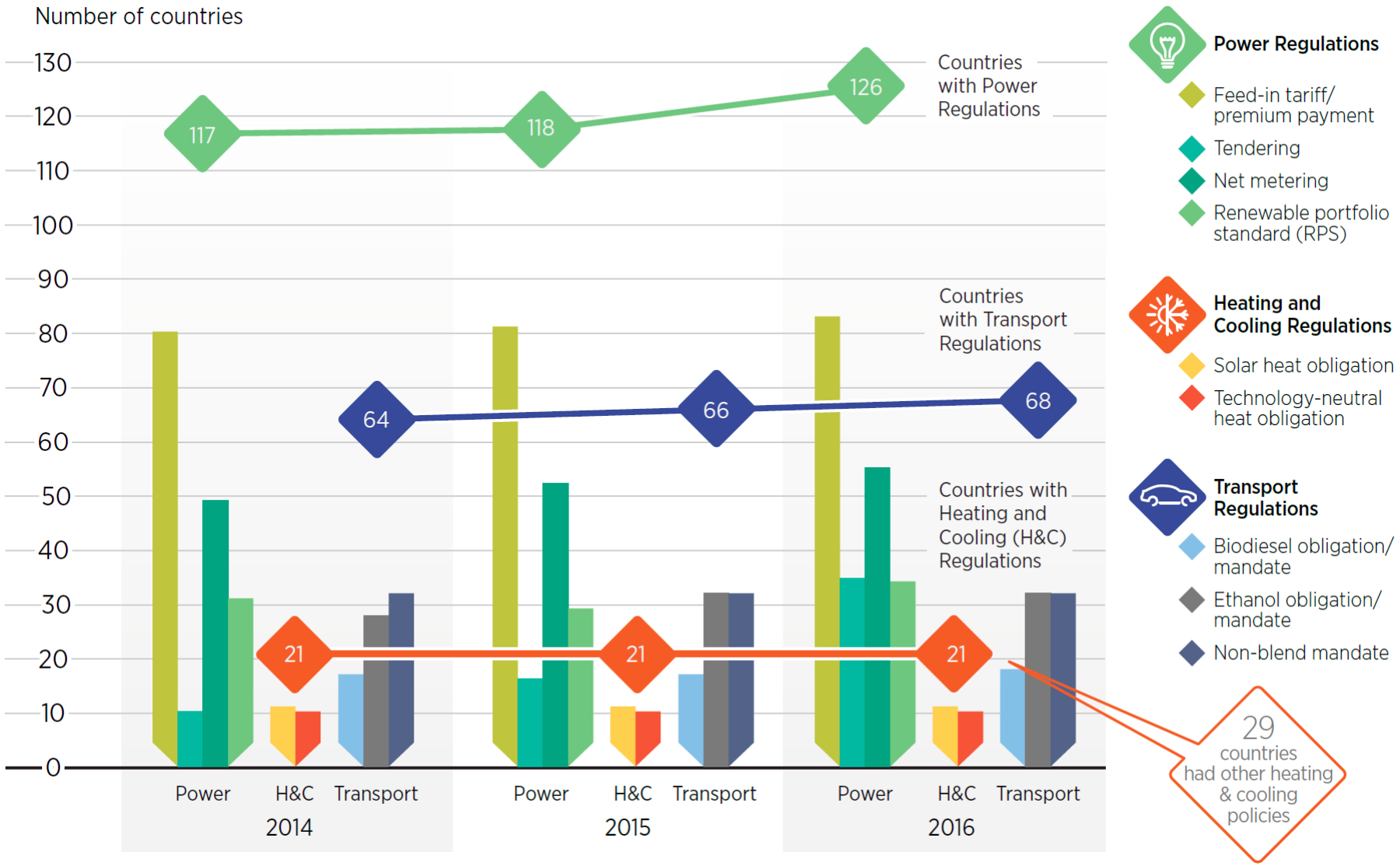
Source: IRENA statistics

Job creation from renewables deployment



Source: IRENA, IEA and REN21 (2018), 'Renewable Energy Policies in a Time of Transition'. IRENA, OECD/ IEA and REN21

Policies implemented to drive the transformation



Number of renewable energy regulatory incentives and mandates, by type, 2014-16

Source: IRENA, IEA and REN21 (2018), 'Renewable Energy Policies in a Time of Transition'. IRENA, OECD/ IEA and REN21

Today's strong business case for renewable power

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Cost reduction in the period 2010 - 2017

73%
Solar PV

23%
Onshore Wind

Expected cost reduction in the period 2015 - 2025

54%
Solar PV

37%
CSP

15%
Offshore Wind

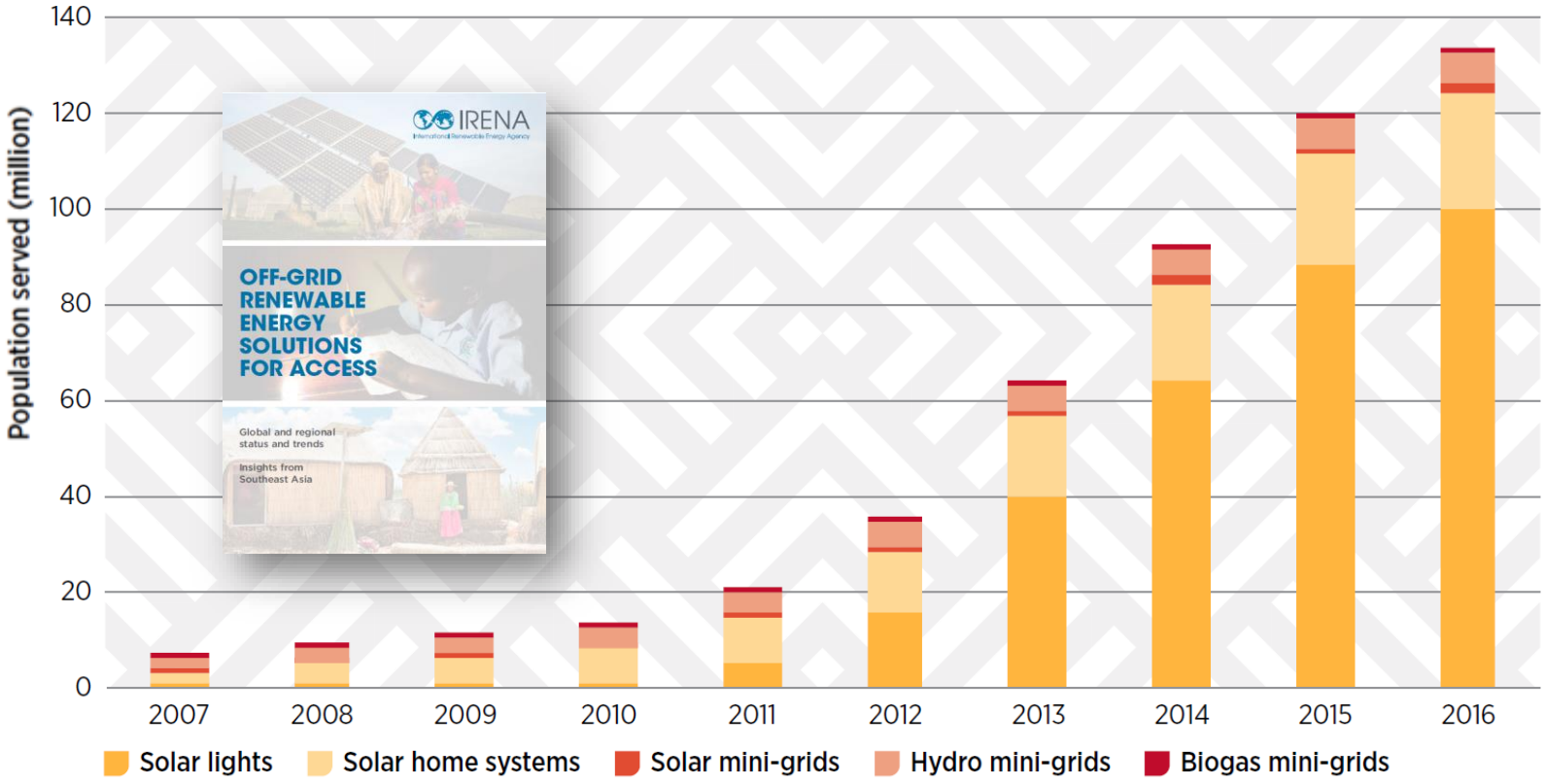
12%
Onshore Wind

- All renewable power options will compete with fossil fuels on price by 2020
- Wind and PV are abundant and available in most countries

Source: IRENA (2018), Renewable Power Generation Costs in 2017, International Renewable Energy Agency

Renewable solutions for energy access

- Some one billion people without electricity access today
- ~ 130 million served by RE systems:
  - 100 M solar lights
  - 24 M solar home systems
  - 9 M through mini-grids
  - *Around 300 MW are estimated from trade stats**
- 50 – 250 GW potential to hybridise existing diesel generator capacity, 12 GW on islands
- 1 million telecom towers in South Asia and Sub-Saharan Africa



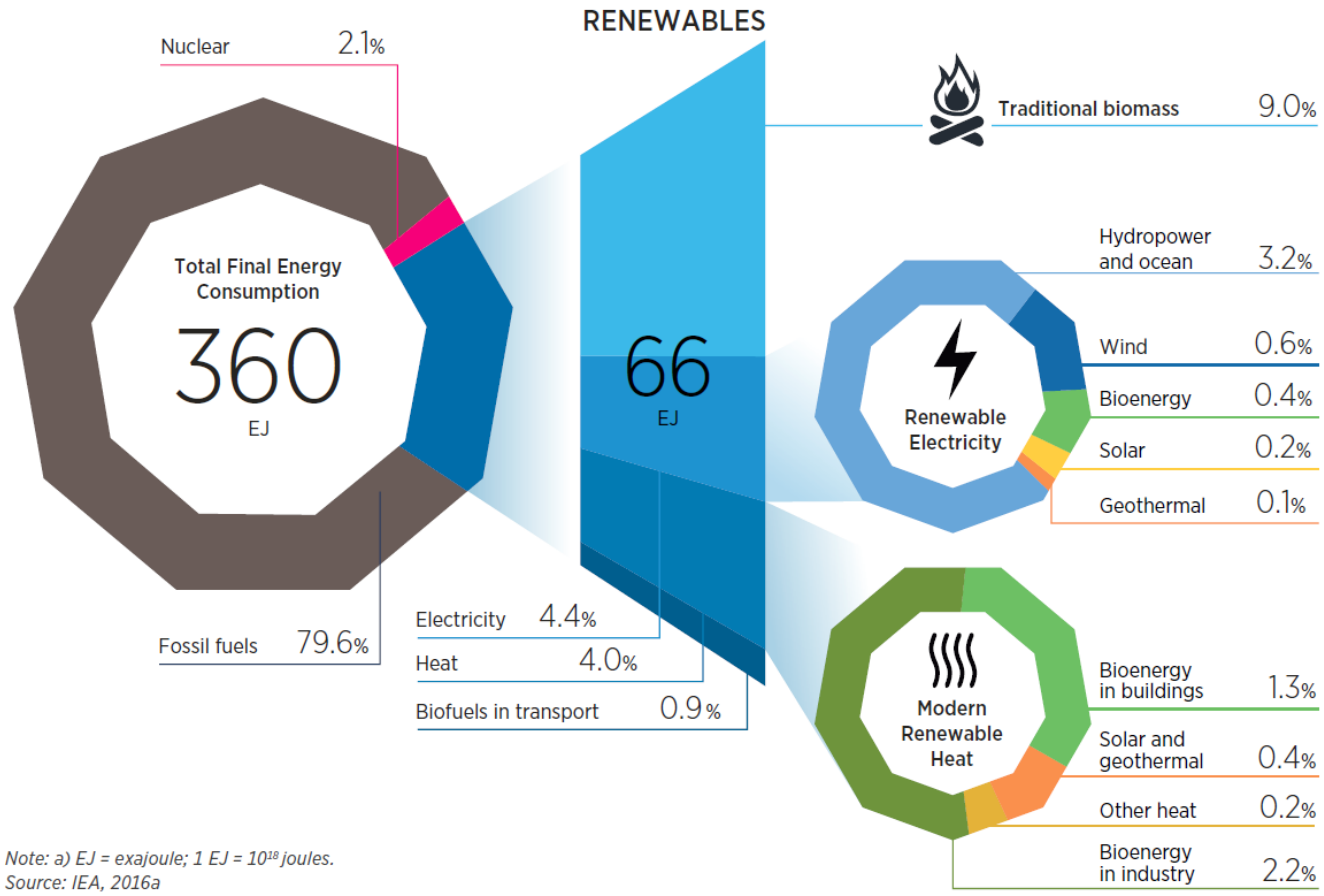
IRENA (2018) OFF-GRID RENEWABLE ENERGY SOLUTIONS Global and regional status and trends

*IRENA (2018), Measurement and estimation of off-grid solar, hydro and biogas energy, International Renewable Energy Agency (IRENA), Abu Dhabi

But energy continues to be a fossil fuels based sector

The growth rate in terms of **renewable share per year will need to increase six-fold** over past rates

Total final energy consumption (EJ) and renewable shares in 2014



Note: a) EJ = exajoule; 1 EJ = 10^{18} joules.
Source: IEA, 2016a

Source: IRENA (2017) Rethinking Energy

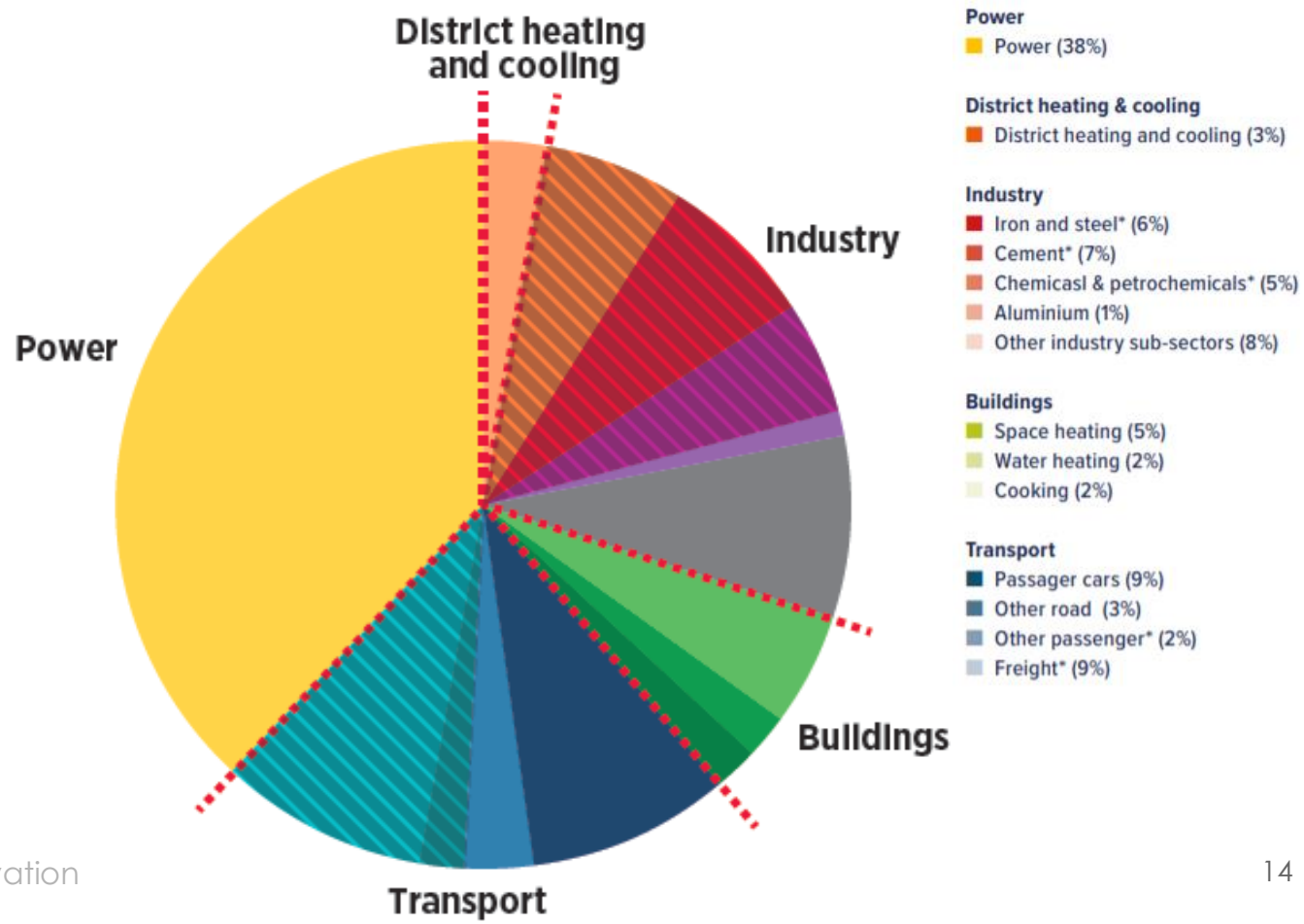
3 The next stage

Tracking innovation pace and needs

- **On track:** Power sector. *Innovation focus – system integration*

- **Lagging behind:** Transport and industry sector. *Innovation focus – electrification, new processes, bioenergy*

Global CO2 emissions by sector 2015



Source: IRENA (2017) Accelerating the Energy Transition Through Innovation

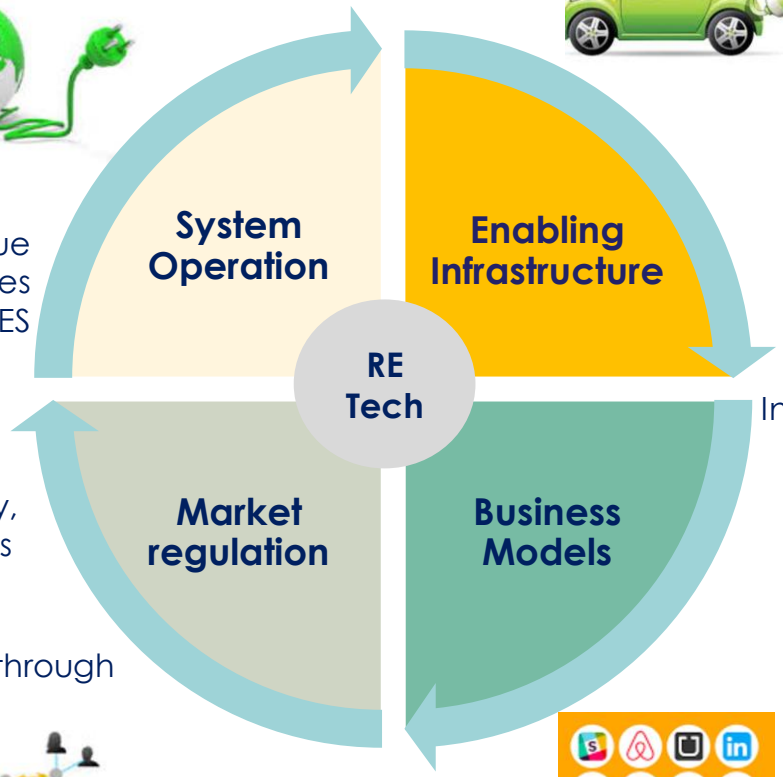
Emerging Innovations in Power

A Combination of Affordable RE Technologies, Digitalisation and Climate Change Policies is driving change – IRENA Innovation Landscape Assessment ongoing

Electrification of end use sectors

Massive expansion of interconnections and creation of regional markets

Value complementarities in RES



Electric Vehicles

Battery Storage

Artificial Intelligence

Internet of Things

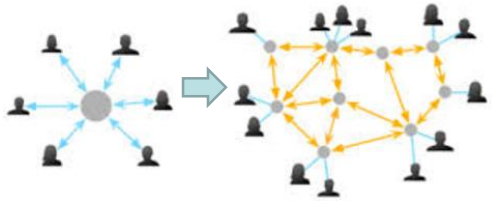
Blockchain

Aggregators- VPP

Platform business model

Encourage Flexibility, pricing that supports DSM/DSR

Decentralized system through distributed generation



Innovation trends for the future power system – 3D

Digitalisation

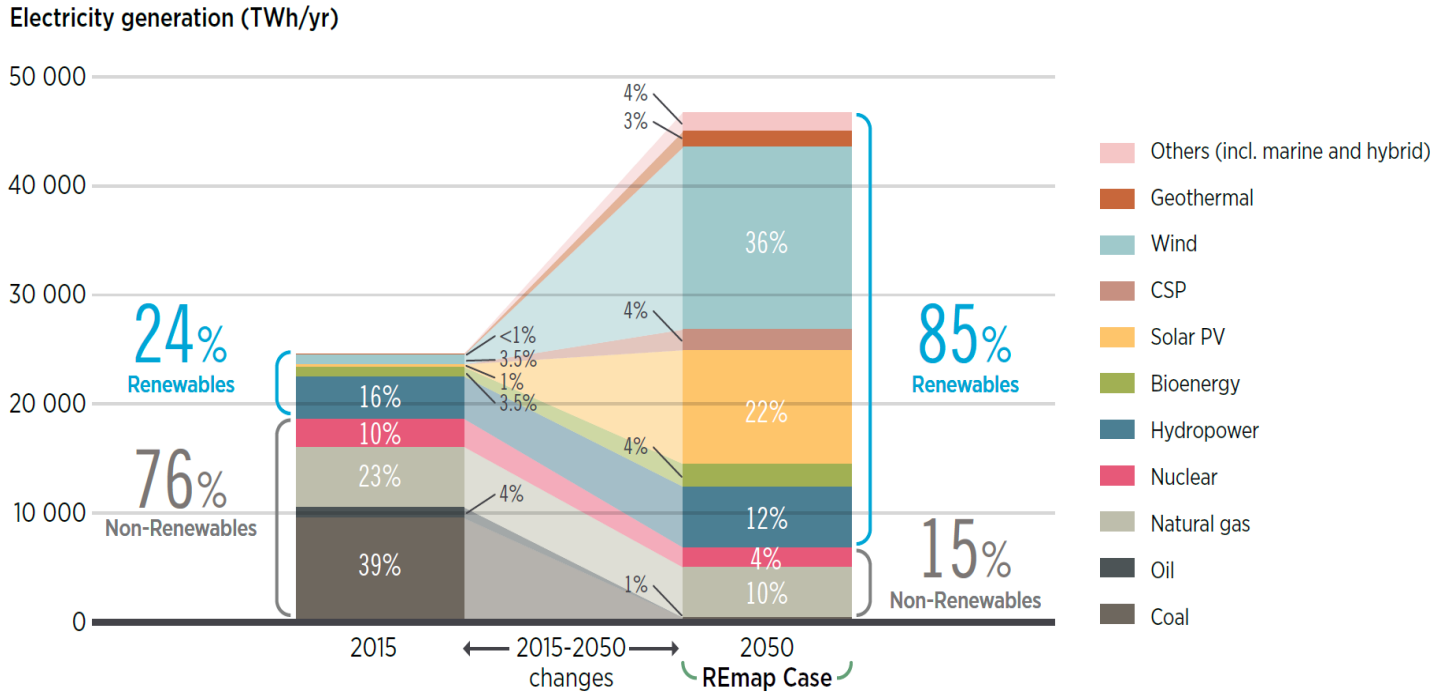
Decentralisation

Demand electrification

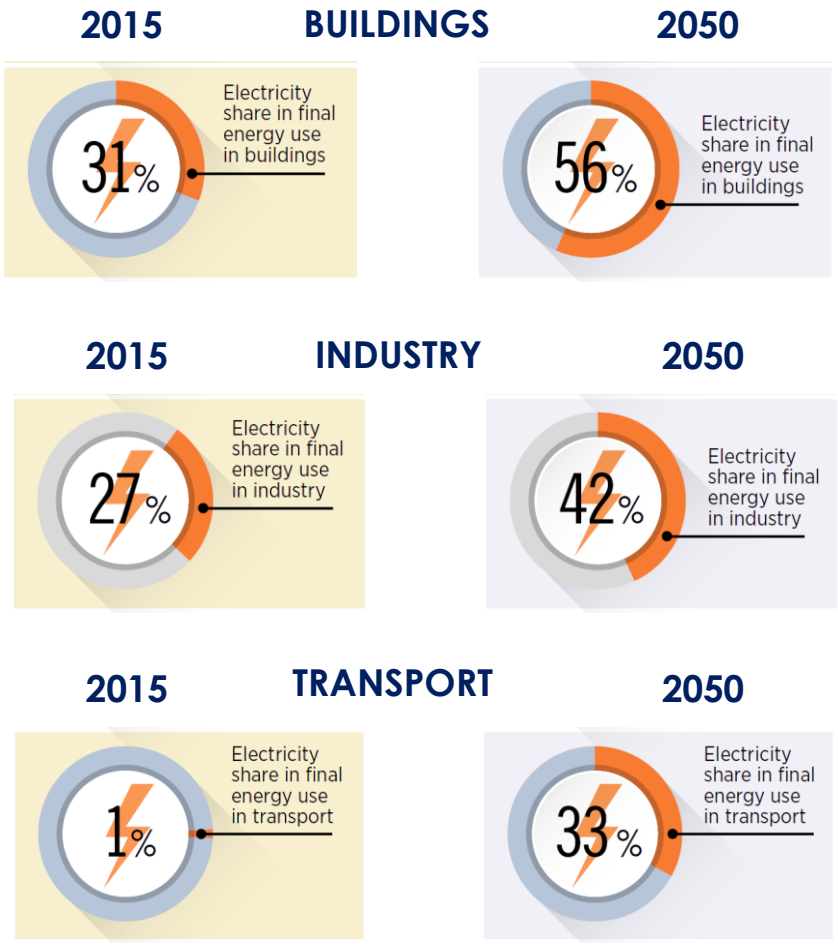
Renewable electricity generation and electrification are cornerstones of energy transformation

Gross power generation will almost double between 2015 and 2050, with renewables generating 85%, 60% VRE and 40% electrification of end use

Breakdown of electricity generation by source



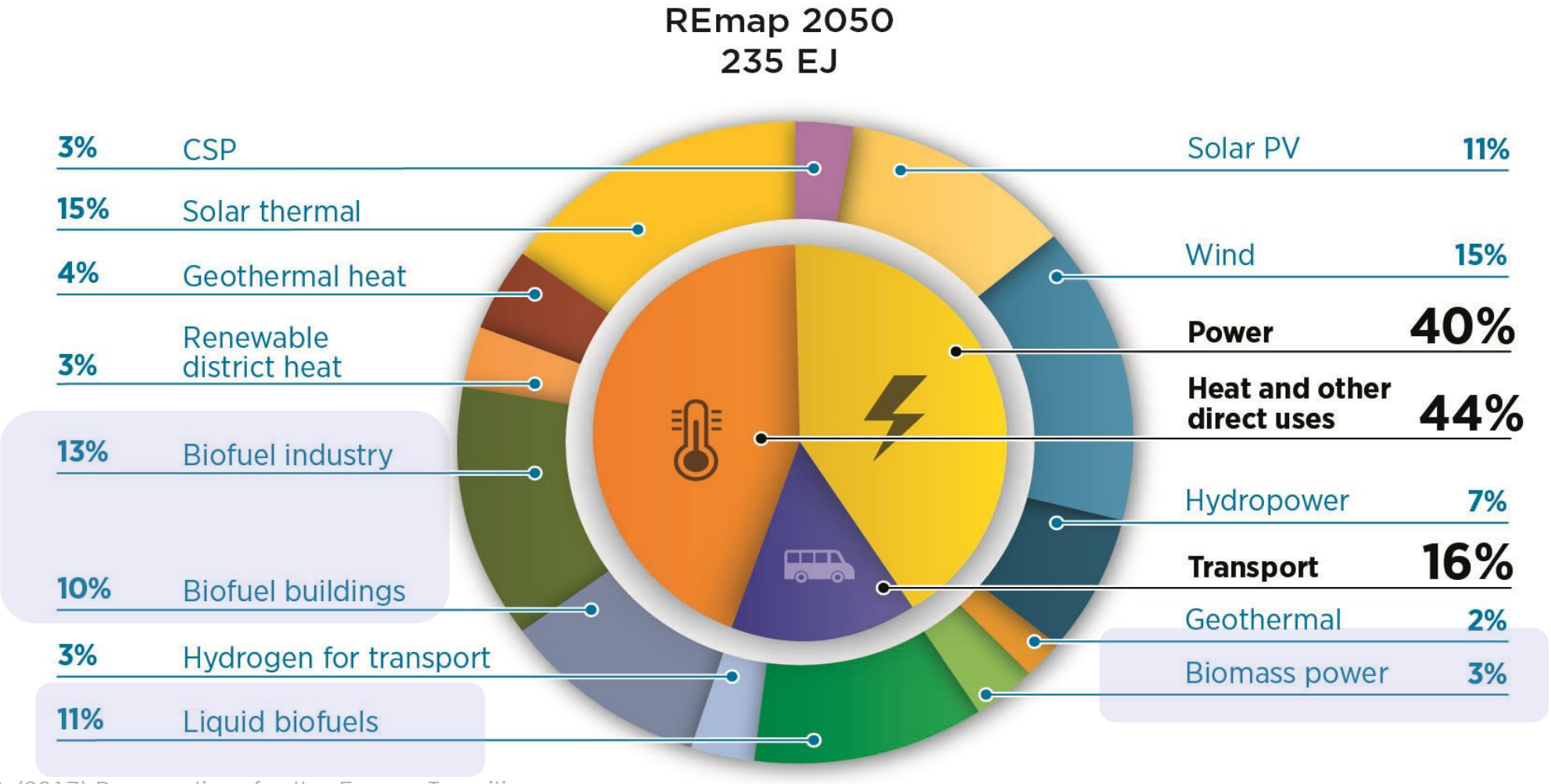
325 GW pumped hydro, 175 GW stationary batteries, 12 380 GWh EV battery capacity



Source: IRENA (2018), Global Energy Transformation: A roadmap to 2050

Major Modern Bioenergy Needs in 2050

More than a third of the total final energy consumption from renewables in 2050 should come from modern bioenergy mainly in end-use sectors



Source: IEA/IRENA (2017) Perspectives for the Energy Transition

Investment will need to shift to renewable energy and energy efficiency

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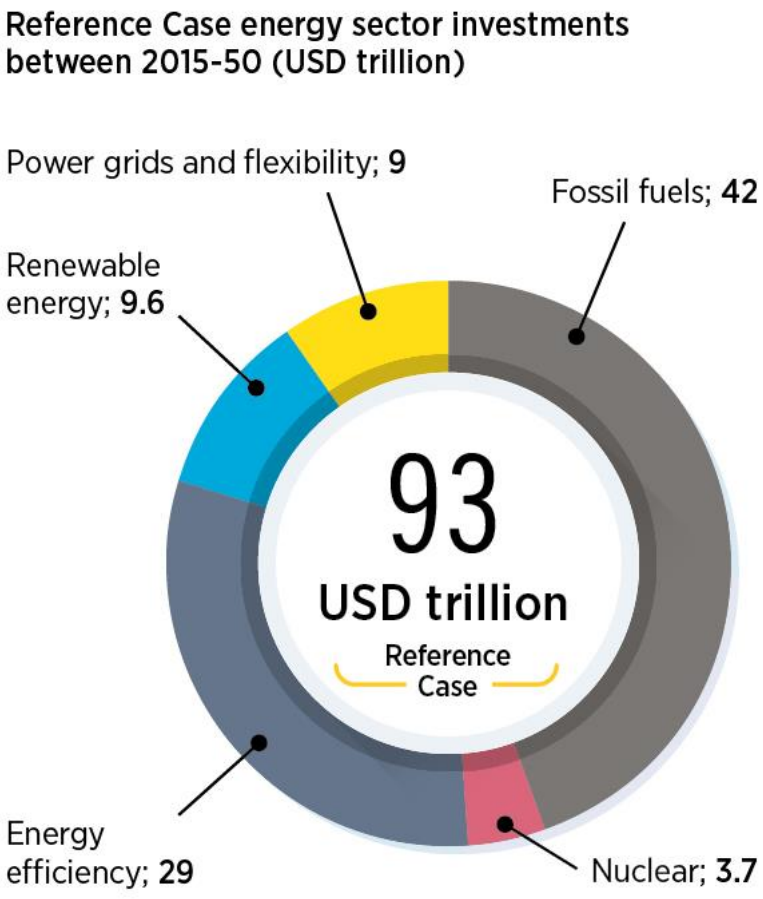
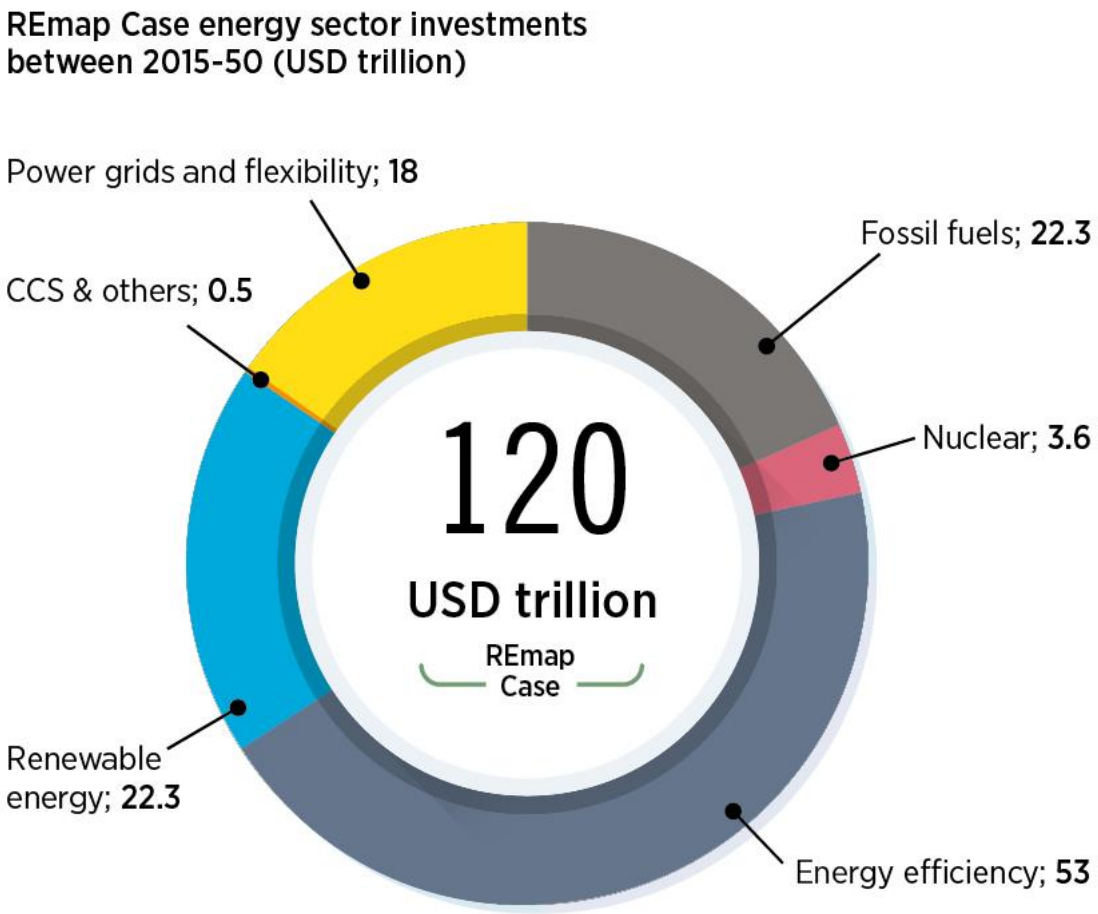
Cumulative investment - Reference and REmap cases, 2015-2050





Source: IRENA (2018), Global Energy Transformation: A roadmap to 2050

4 The role of Quality Infrastructure

Record PV auction prices – what will be delivered?

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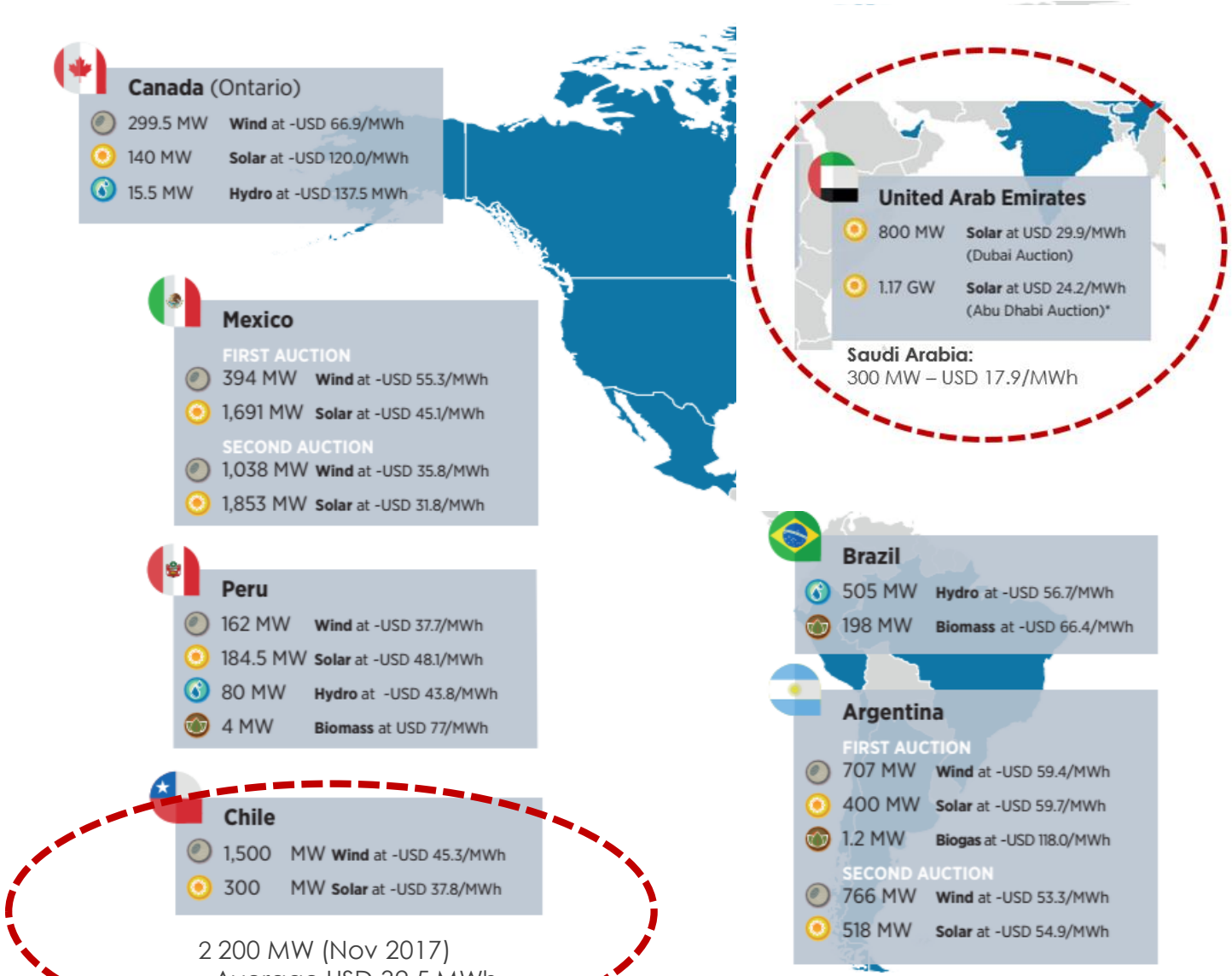

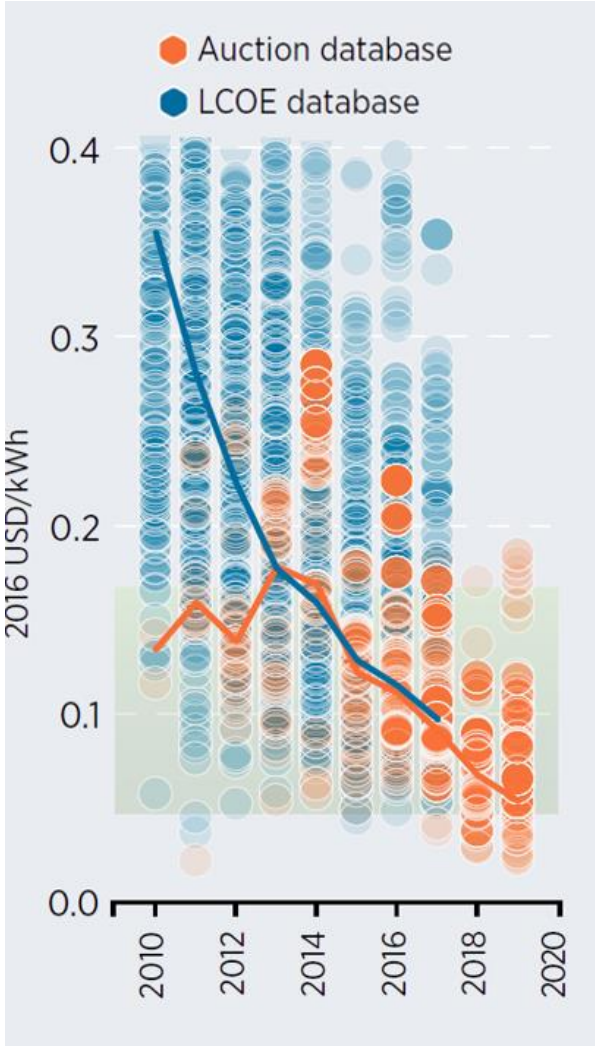

Sources:
IRENA (2018), Renewable Power Generation Costs in 2017
CNE Chile

Quality Infrastructure to mitigate technical risk and facilitate trade

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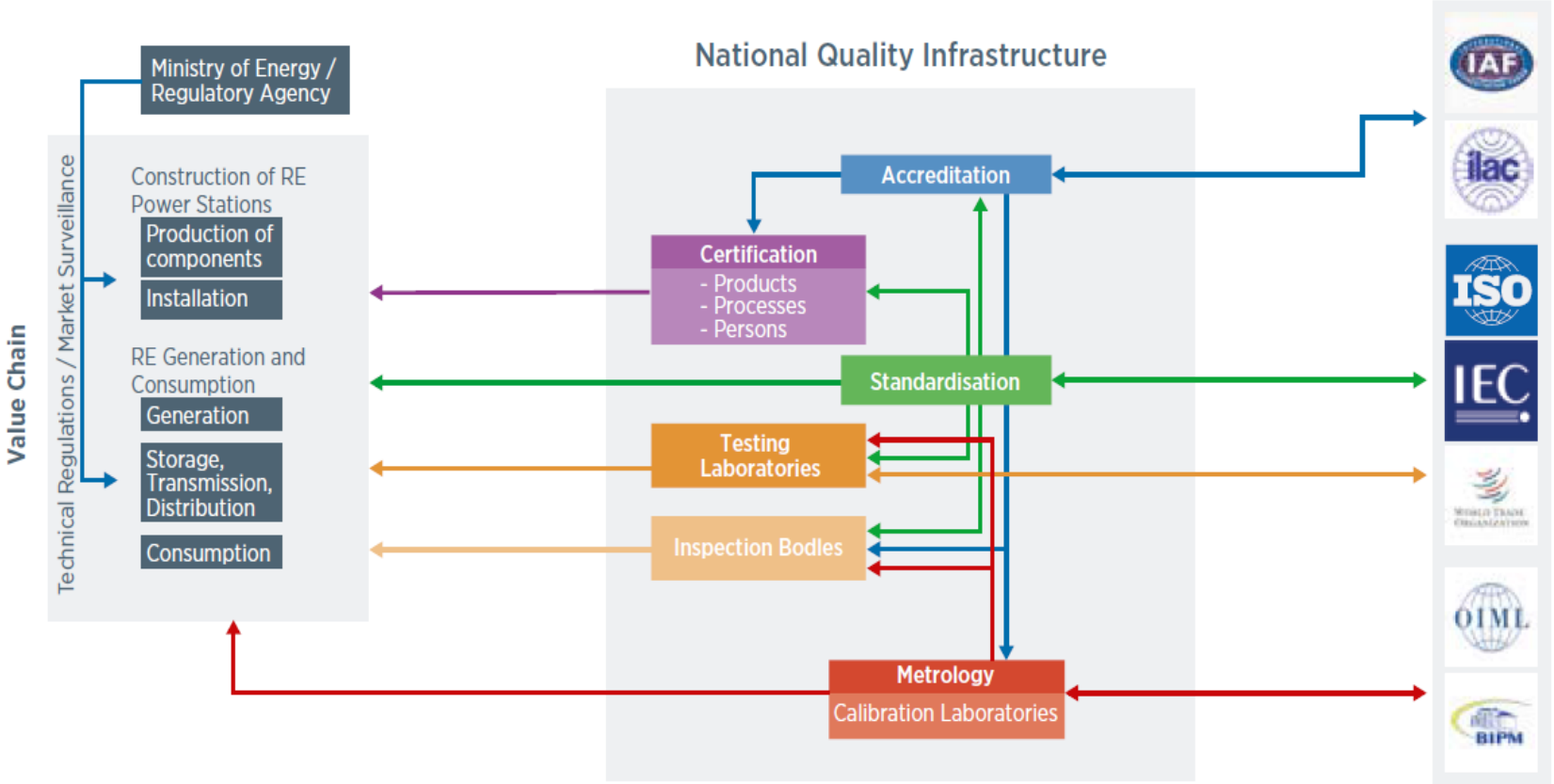
Which **instruments** do we have to mitigate technical risk and harmonise requirements in Globalised RET Markets worth USD trillion?



Identify → Screen → Assess → Select → Pre-development → Development → Construct → Operate & Maintain → Decommission

QI supporting policy-makers

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1 POLICY OBJECTIVES

- Economic and affordable photovoltaic systems
- Support development goals
- Reliable photovoltaic systems
- PV integrated in power systems

2 HOW QUALITY INFRASTRUCTURE SUPPORTS THE POLICY OBJECTIVES

- Attracts investment through risk mitigation
- Increases public acceptance
- Encourages efficient services
- Fosters good practices
- Promotes consumer protection

3 WHERE TO APPLY QUALITY INFRASTRUCTURE

- White papers
- Guidelines
- Regulations
- Incentives
- Industry guidebooks
- Vocational training

IRENA (2017) Boosting solar PV markets: The role of quality infrastructure

Overview of measures to scale up renewable solutions for energy access

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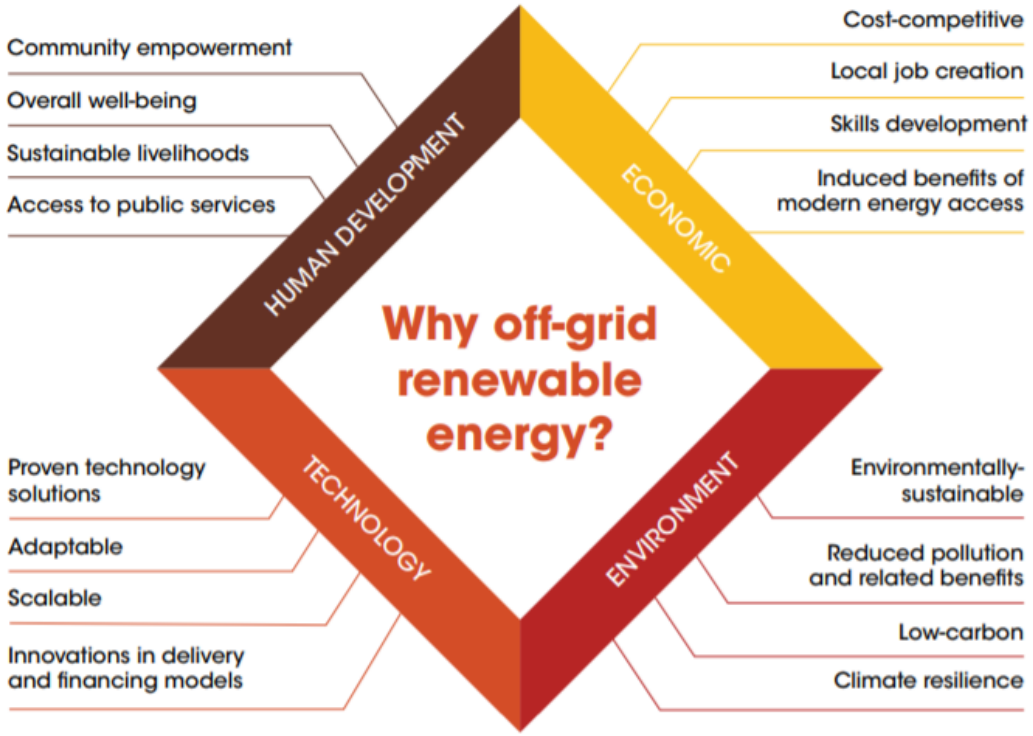
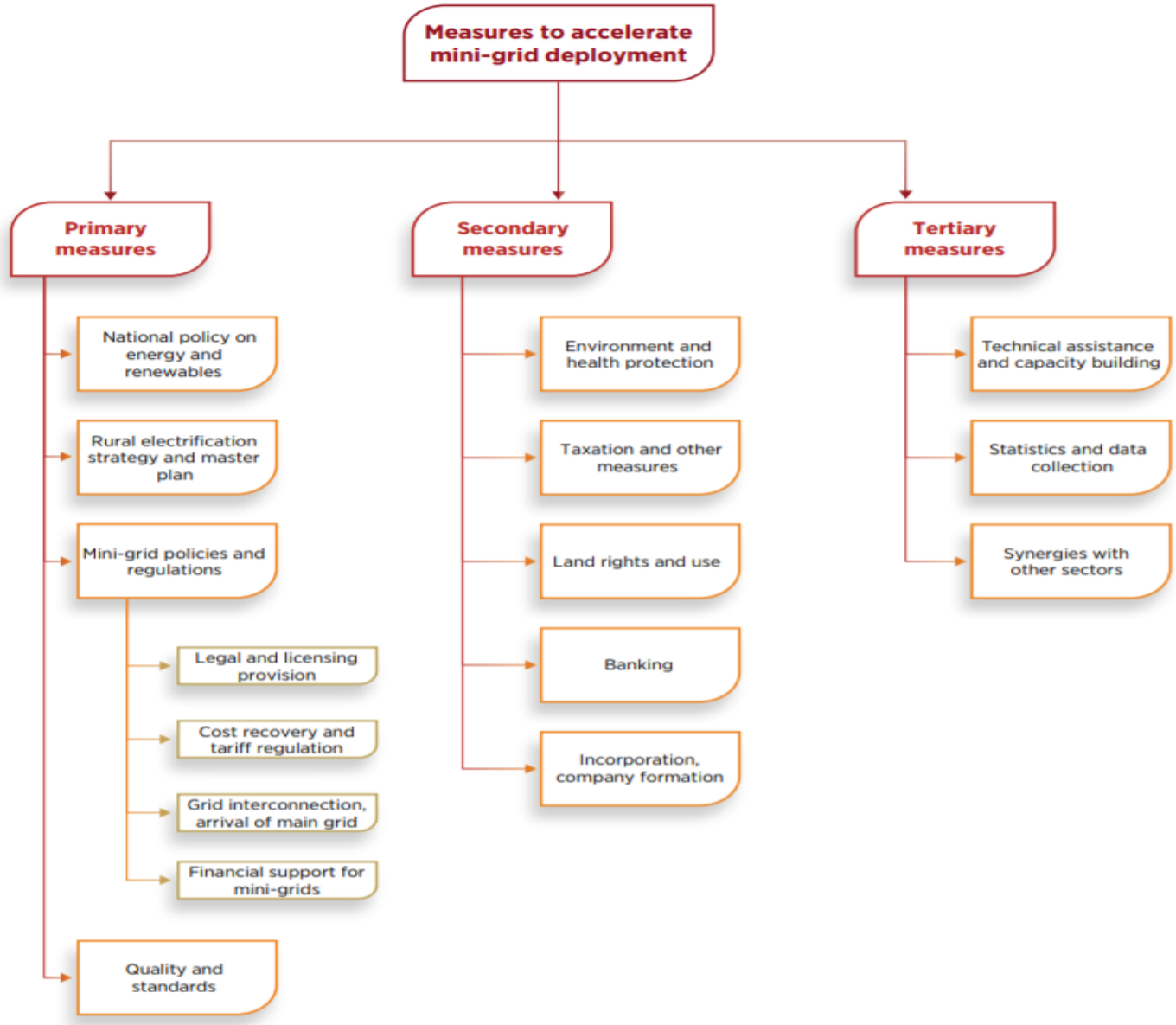




IRENA (2018) Policies and regulations for renewable energy mini-grids

Using QI in country regulations for mini-grids

USA National Electrical Code: new article about DC mini grids.

California and Hawaii: new installations require inverters to provide grid support or smart inverter functions. (UL Test Standards)

Tanzania Energy and Water Utilities Regulatory Authority: Latest mini grid regulatory framework allows:

-Mini-grids at multiple locations can acquire a **single license** (> 1 MW) **or registration** for mini-grids using the same technology (<1 MW);

- Allow grid-connected mini-grids to **operate in islanded** mode when power to a previously isolated mini-supply is not available from the main grid;

- **Clarity and credibility on the compensation calculation** for distribution assets when the main grid connects grid.

Source: NFPA, 2018; CEPR, 2018, WRI 2017, Magnaray International, African enterprise investor

Using QI in country regulations for mini-grids

Puerto Rico Regulation on Microgrids.

After hurricane Maria in 2017, Puerto Rico looked to implement more resilient energy systems in their communities.

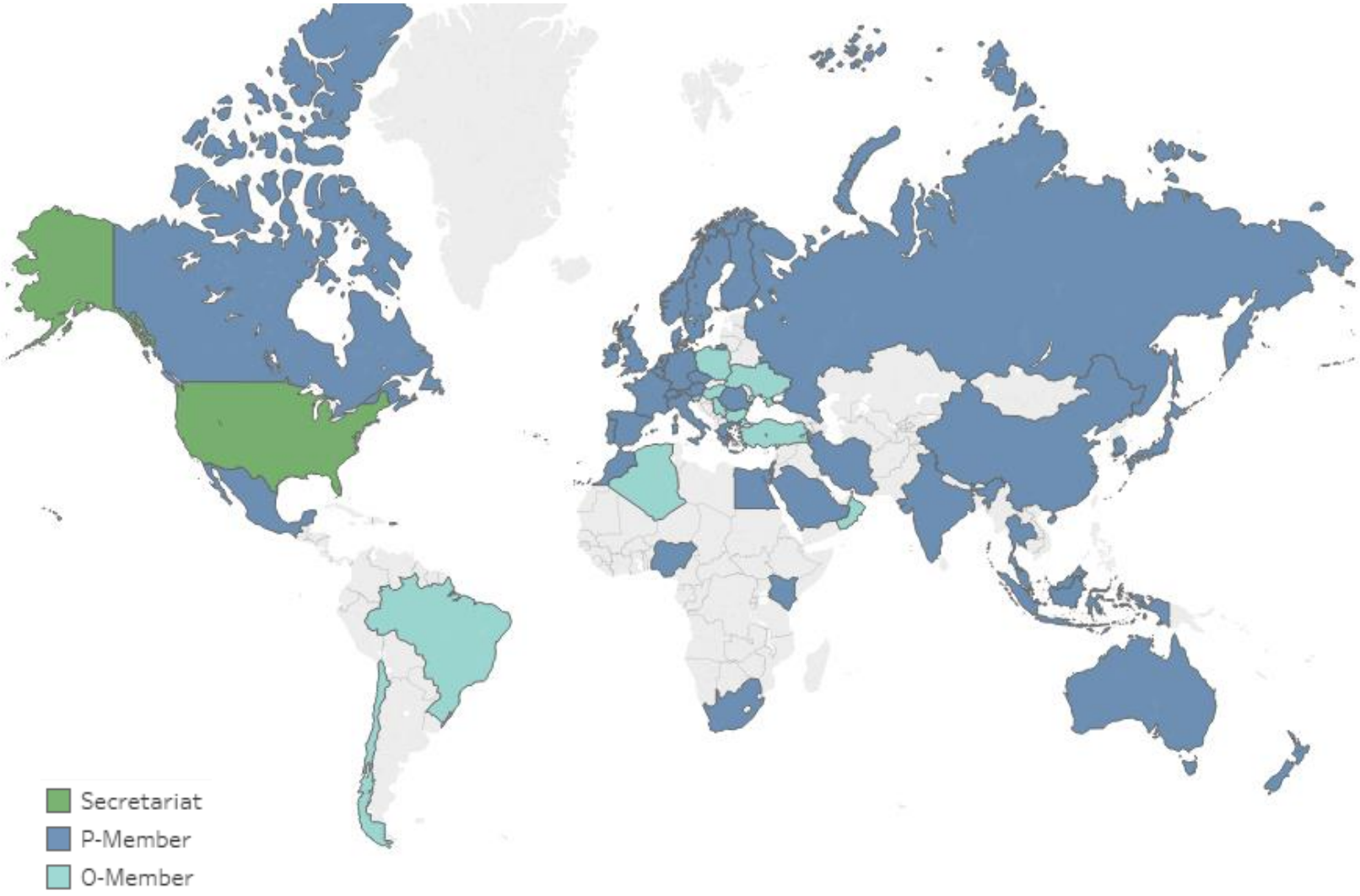
The 2018 regulation defines 'renewable microgrids' as those that can generate 75 % of their energy from renewables. It identifies the applicable codes and standards.

Below, the Commission establishes the list of Codes and Standards with which all microgrids must comply. It remains the responsibility of each microgrid owner and operator to ensure that its microgrid system is in compliance with any and all Codes and Standards that may be applicable to it.

1. Latest National Electrical Code;
2. Latest National Electrical Safety Code;
3. IEEE Standard 1547-2014;
4. IEEE P2030.2, P2030.7;
5. IEC 61850-7-420; Power Utility Automation
6. IEC/TS 62898-1 and 62898-2; Guidelines for microgrid projects planning and specification

Source: NFPA, 2018; CEPR, 2018, WRI 2017, Magnaray International, African enterprise investor

Engagement in international standardization – e.g. PV: IEC TC82



-Limited engagement from emerging markets

-Need for engagement in relevant international platforms

- IEC / IECRE
- PVQAT
- IEA PVPS (T13, T12)
- IRENA
- Others

-Work together

- Industry (SolarPower Europe – SolarBankability, SolarUnited)
- R&D institutes
- Financial institutions
- Commercial banks
- Insurance companies
- Policy-makers and regulators
- Communities and final consumers

Source: http://inspire.irena.org/Pages/default.aspx

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Backup slides

Globalisation of PV markets - Emerging PV markets

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Chile

According the government of Chile and four groups of the Chilean Association of Electricity Producers, "solar will become the primary source of electricity in the country as early as **2030, with expectations that it will cover more than 30% of demand.**

India

India has quadrupled its renewables target. It is planning **100 GW of solar power by 2022.**

Mexico

Target addition of **5.4GW of Solar PV by end of 2019.** In 2017 closed with 0.57 GW.

Saudi Arabia

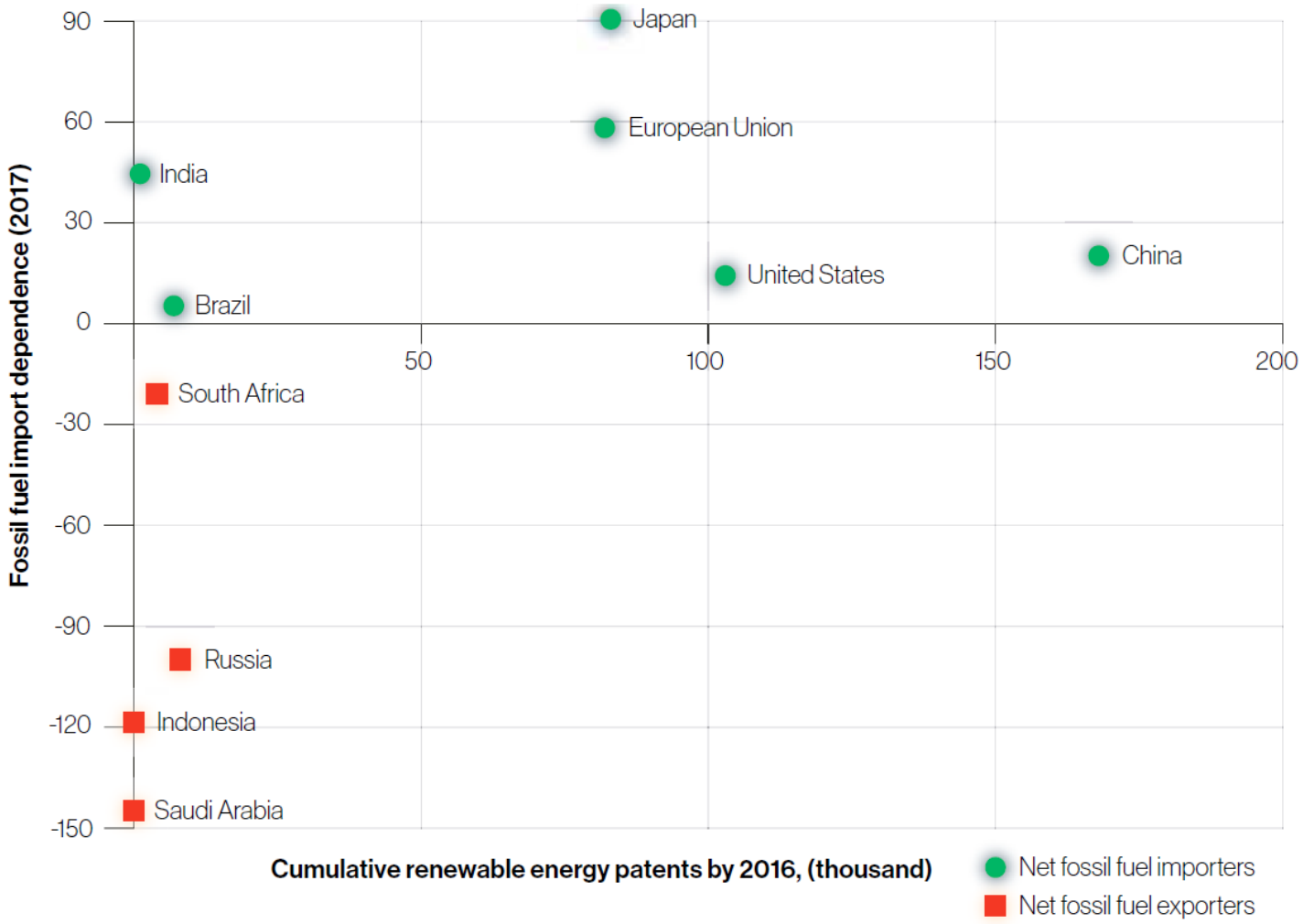
Saudi Arabia and Japanese financial giant SoftBank have pledged to spend about $200 billion through 2030 to **build 200 gigawatts of solar PV,** a move that could upend the global solar landscape — if it comes to fruition.

South Africa

South Africa's **target of building 8.4 gigawatts (GW) of solar photovoltaic (PV) capacity by 2030,** currently operates with 1.7 GW of solar energy capacity.

Source: Daily Maverick, PV Magazine, Business Times, CNBC, Maritime Executive, IHS Market

Impact of the energy transition on selected countries and groupings



Source: BP, IRENA.

Source: IRENA (2019) A New World: The Geopolitics of the Energy Transformation

How renewables create new trade

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The transition to renewable energy will create new trade patterns. While trade in fossil fuels will decline, trade in at least three other areas will grow:

1. **Trade in renewable energy-related goods and technologies.** These include a wide range of goods and technologies, from solar PV panels to smart meters and batteries, as well as their components and parts (for example, blades for wind turbines or water wheels for hydropower) and related services (for example, engineering and installation services).
2. **Electricity trade** will increase because additional interconnections make grids more stable and resilient. Variable renewables, such as solar and wind power, require flexible and interrelated power systems that can balance supply and demand in real time. Electricity interconnections can be made between neighbouring countries, at a regional scale and possibly even inter-continentally.
3. **Trade in renewable energy fuels** may also grow significantly.[100] An example is hydrogen formed by electrolysis in regions that possess an abundant supply of renewable energy, such as Patagonia or the Australian desert. Besides hydrogen, a host of synthetic fuels may also be generated from renewable electricity, including ammonia, methane and methanol. Such fuels permit seasonal storage of renewable electricity (which only pumped hydro has been able to do to date), and use existing infrastructure (such as natural gas pipelines). They also have the potential to reduce emissions in hard-to-electrify sectors such as aviation and some industrial processes.[101]

While the potential to increase trade exists, the number of trade disputes related to renewable technologies has grown in recent years. Trade in renewable energy goods may be hampered by tariffs, discriminatory subsidies, and conflicting technical standards. Members of the WTO have started negotiations to open trade in environmental goods and services further. In the future, consideration will need to be given to governance issues, particularly standards and rules, to ensure a level-playing field in renewable energy trade.

Source: IRENA (2019) A New World: The Geopolitics of the Energy Transformation

Holistic View - Quality Covers the Whole System, not Hardware only

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TÜV Rheinland

"Every other fault that we detect is due to incorrect installation."

Source: TÜV Rheinland

Licensing Installers

USA

NABCEP™
Raising Standards. Promoting Confidence.

Australia

CLEAN ENERGY COUNCIL
SOLAR ACCREDITATION SCHEME

UK

MCS
The Certification Mark for Onsite Sustainable Energy Technologies

Netherlands

ZONNEKEUR

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It's not about equipment cost / it's about LCOE

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Calculating the levelised cost of electricity

$$\text{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

LCOE = the average lifetime levelised cost of electricity generation;

It = investment expenditures in the year t;

Mt = Operations and maintenance expenditures in the year t;

Ft = fuel expenditures in the year t;

Et = electricity generation in the year t;

r = discount rate; and

n = life of the system.

Commonly a major criterion for investment

But not only relevant criteria:
- Installation and services
- System performance
- Durability

QI aims to minimise the LCOE and maximise profit

Photo-voltaic Module	Inverter	Design and Installation	Comm-issioning
IEC 61730 and IEC 61215, or IEC 61646 as applicable	IEC 62109-1, IEC 62109-2, IEC 62093 (Qualification)	IEC 62548[1] (Primary) and IEC 60364 series	IEC 62446
Perform-ance and Operations	**Grid-Code-Related**	**Off-Grid Specific**	**Utility-Scale Specific**
IEC 61724 Future IEC 62446-2 (2017)	Country specific, but grid function testing per IEC 62116, IEC 62910	IEC 62257 Series for off-grid and rural electrifica-tion	Future IEC 62738 (2016)

International standards across the project lifecycle

Implementing QI

Cost/benefit ratio:
- 1:10

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Informing international discussions on the energy transformation

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Ministerial RoundTable E-mobility

- Synergies between VRE and EVs
- Smart charging is crucial

European Commission

- Technology options for EU decarbonisation
- Political roadmap for doubling RE in energy mix cost effectively

Mission Innovation

- Priorities in RD&D
- Need for a systemic approach

Dialogue with Start-ups

- Sessions with innovative entrepreneurs to learn more about emerging innovations

European Utility Week

- Role of Utilities in the Power sector transformation
- Emerging of new active players in the sector

Clean Energy Ministerial

- Offshore wind
- Innovative Energy Planning

epe

Energy Research Office, Brazil

- Innovations for Power Sector transformation in a hydro-based system
- Opportunities for EVs