Renewable Energy Driving the Energy Sector Transformation
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
The energy transition
We need cleaner, affordable, reliable and abundant sources of energy
Energy accounts for two-thirds of total greenhouse gas emissions

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

Annual energy-related CO₂ emissions and reductions, 2015-2050 (Gt/yr)

Energy-related CO₂ emissions (Gt/yr)

- Buildings
- Transport
- District Heat
- Power
- Industry

Reference Case: 35 Gt/yr in 2050

- Renewable energy: 41%
- Electrification w/RE: 13%
- Energy efficiency: 40%

94% CO₂ emission reductions from Renewables and Energy Efficiency

REmap Case: 9.7 Gt/yr in 2050

- Energy-emission budget:
  - 790 Gt CO₂ 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

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

Since 2012 >50% of total capacity additions

Source: IRENA statistics
Job creation from renewables deployment

Policies implemented to drive the transformation

Number of countries

Countries with Power Regulations
117
118
126

Countries with Transport Regulations
64
66
68

Countries with Heating and Cooling (H&C) Regulations
21
21
21

Power Regulations
- Feed-in tariff/premium payment
- Tendering
- Net metering
- Renewable portfolio standard (RPS)

Heating and Cooling Regulations
- Solar heat obligation
- Technology-neutral heat obligation

Transport Regulations
- Biodiesel obligation/mandate
- Ethanol obligation/mandate
- Non-blend mandate

Today’s strong business case for renewable power

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

3 The next stage
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.

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

Source: IRENA (2017) Accelerating the Energy Transition Through Innovation
Investment will need to shift to renewable energy and energy efficiency

Cumulative investment - Reference and REmap cases, 2015-2050

Reference Case energy sector investments between 2015-50 (USD trillion)
- Power grids and flexibility: 9
- Renewable energy: 9.6
- Fossil fuels: 42
- Energy efficiency: 29
- Nuclear: 3.7

Reference Case

93 USD trillion

REmap Case energy sector investments between 2015-50 (USD trillion)
- Power grids and flexibility: 18
- CCS & others: 0.5
- Fossil fuels: 22.3
- Nuclear: 3.6
- Renewable energy: 22.3
- Energy efficiency: 53

REmap Case

120 USD trillion

Source: IRENA (2018), Global Energy Transformation: A roadmap to 2050
The role of Quality Infrastructure
Quality Infrastructure to mitigate technical risk and facilitate trade

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

![Diagram of National Quality Infrastructure](image)

- **Value Chain**
  - Technical Regulations / Market Surveillance
  - RE Generation and Consumption
    - Generation
    - Storage, Transmission, Distribution
    - Consumption
- **Ministry of Energy / Regulatory Agency**
  - Construction of RE Power Stations
  - Production of Components
  - Installation

**National Quality Infrastructure**

- Accreditation
- Standardisation
- Certification
  - Products
  - Processes
  - Persons
- Metrology
  - Calibration Laboratories
- Testing Laboratories
- Inspection Bodies

**Value Chain Activities**

- Identify
- Screen
- Assess
- Select
- Pre-development
- Development
- Construct
- Operate & Maintain
- Decommission
I. Role of standards – communication and interoperability

Innovations come from different dimensions: Enabling technology, Business models, Market design and Systems operation

Digitalisation is a key enabler

Today:
- 4 million EVs
- > 500 million smart meters
- Germany
  - 2000: 30 000 power plants
  - Today: > 1.5 million
- IoT connection billions of appliances
- Big Data
II. Role of standards – accelerate global commercialisation and trading of novel technologies

Offshore Wind

- From 20 GW today to more than 500 GW in 2050
- Industry benefited from existing onshore wind and offshore oil & gas standards E.g. ISO 19900
- Technical Committees (e.g. IEC TC88) are great knowledge exchange and cooperation platforms
- Europe a front runner. Now more engagement from other regions and harmonisation of standards is required
III. Role of standards – technical risk mitigation and expansion of trade

Conditions for PV systems in GCC region

**Temperature:**
- IEC open air conditions (-40°C - +40°C)
- GCC -20°C - +55°C high humidity

**Annual irradiance:**
- Germany ~1 200 kWh/m²
- GCC ~2 300 kWh/m² – UV double

**Hail:**
- IEC 25mm Ø
- GCC 44mm Ø

**Sand:** no international test methods – different types of sand

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**PV technology**

- Future markets are in regions with different weather conditions – GCC, South East Asia, Latin America
- Current standards do not fully reflect the conditions of those regions
- Need to engage experts from those regions

Impact of the energy transition on selected countries and groupings

How renewables create new trade

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. 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.

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.

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
Thank you!

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

Record PV auction prices – what will be delivered?

Sources:
IRENA (2018), Renewable Power Generation Costs in 2017
CNE Chile
**Globalisation of PV markets - Emerging PV markets**

**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
Emerging Innovations in Power

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

System Operation
- Electric Vehicles
- Battery Storage
- Artificial Intelligence
- Internet of Things

Enabling Infrastructure
- Blockchain
- Aggregators - VPP

RE Tech
- Massive expansion of interconnections and creation of regional markets
- Value complementarities in RES
- Encourage Flexibility, pricing that supports DSM/DSR
- Decentralized system through distributed generation

Market regulation
- Electrification of end use sectors

Business Models
- Platform business model

Innovation trends for the future power system – 3D
- Digitalisation
- Decentralisation
- Demand electrification
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
QI supporting policy-makers

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

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

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

Source: TÜV Rheinland

IRENA (2017) Boosting solar PV markets: The role of quality infrastructure
It’s not about equipment cost / it’s about LCOE

Calculating the levelised cost of electricity

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

Where:
LCOE = the average lifetime levelised cost of electricity generation;

- \( I_t \) = investment expenditures in the year \( t \);
- \( M_t \) = Operations and maintenance expenditures in the year \( t \);
- \( F_t \) = fuel expenditures in the year \( t \);
- \( E_t \) = 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

International standards across the project lifecycle

<table>
<thead>
<tr>
<th>Photovoltaic Module</th>
<th>Inverter</th>
<th>Design and Installation</th>
<th>Commissioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61730 and IEC 61215, or IEC 61646 as applicable</td>
<td>IEC 62109-1, IEC 62109-2, IEC 62095 (Qualification)</td>
<td>IEC 62548 (Primary) and IEC 60364 series</td>
<td>IEC 62446</td>
</tr>
<tr>
<td>Performance and Operations</td>
<td>Grid-Code Related</td>
<td>Off-Grid Specific</td>
<td>Utility-Scale Specific</td>
</tr>
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</table>

Implementing QI

Cost/benefit ratio: ➢ 1:10

IRENA (2017) Boosting solar PV markets: The role of quality infrastructure
Informing international discussions on the energy transformation

**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

**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

**Energy Research Office, Brazil**
- Innovations for Power Sector transformation in a hydro-based system
- Opportunities for EVs

**Dialogue with Start-ups**
- Sessions with innovative entrepreneurs to learn more about emerging innovations