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

M mandate: Assist countries to accelerate renewable energy deployment
The energy transition
Development and welfare for all

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-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
Since 2012 >50% of total capacity additions

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

Policies implemented to drive the transformation

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

Today’s strong business case for renewable power

Cost reduction in the period 2010 - 2017

- Solar PV: 73%
- Onshore Wind: 23%

Expected cost reduction in the period 2015 - 2025

- Solar PV: 54%
- CSP: 37%
- Offshore Wind: 15%
- Onshore Wind: 12%

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

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
But energy continues to be a fossil fuels based sector

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

\textbf{Total final energy consumption (EJ) and renewable shares in 2014}

- **Fossil fuels**: 79.6%
- **Electricity**: 4.4%
- **Heat**: 4.0%
- **Biofuels in transport**: 0.9%
- **Modern Renewable Heat**: 13%
- **Bioenergy in buildings**: 1.3%
- **Solar and geothermal**: 0.4%
- **Other heat**: 0.2%
- **Bioenergy in industry**: 2.2%
- **Traditional biomass**: 9.0%
- **Hydropower and ocean**: 3.2%
- **Wind**: 0.6%
- **Bioenergy**: 0.4%
- **Solar**: 0.2%
- **Geothermal**: 0.1%

Note: a) EJ = exajoule; 1 EJ = 10^9 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

- System Operation
  - Massive expansion of interconnections and creation of regional markets
  - Electrification of end use sectors
  - Value complementarities in RES

- Enabling Infrastructure
  - Electric Vehicles
  - Battery Storage
  - Artificial Intelligence

- RE Tech
  - Internet of Things
  - Blockchain

- Market Regulation
  - Encourage Flexibility, pricing that supports DSM/DSR

- Business Models
  - Decentralized system through distributed generation
  - Platform business model

Innovation trends for the future power system – 3D

- Digitalisation
- Decentralisation
- Demand electrification

Value complementarities in RES

Electrification of end use sectors
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:

- **Electricity generation (TWh/yr)**
  - 2015:
    - 76% Non-Renewables
    - 24% Renewables
  - 2050:
    - 15% Non-Renewables
    - 85% Renewables

- **Breakdown of electricity generation by source:**
  - Non-Renewables: 39% Coal, 11% Oil, 1% Natural gas, 12% Nuclear, 4% Hydropower, 4% Bioenergy, 3% Solar PV, 1% CSP, 1% Wind, 1% Geothermal, 1% Others (incl. marine and hybrid)
  - Renewables: 16% Wind, 35% Hydropower, 36% Solar PV, 4% CSP, 4% Bioenergy, 4% Geothermal, 3% Others (incl. marine and hybrid)

- **EMap Case**
  - 325 GW pumped hydro, 175 GW stationary batteries, 12 380 GWh EV battery capacity

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

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
- Energy efficiency: 29
- Nuclear: 3.7
- Fossil fuels: 42

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

Source: IRENA (2018), Global Energy Transformation: A roadmap to 2050
The role of Quality Infrastructure
Record PV auction prices – what will be delivered?

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

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

**National Quality Infrastructure**
- Accreditation
- Standardisation
  - Certification
    - Products
    - Processes
    - Persons
  - Testing Laboratories
  - Inspection Bodies
- Metrology
  - Calibration Laboratories

**Identify** > **Screen** > **Assess** > **Select** > **Pre-development** > **Development** > **Construct** > **Operate & Maintain** > **Decommission**
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
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!

fboshell@irena.org

www.irena.org
www.twitter.com/irena
www.facebook.com/irena.org
www.instagram.com/irenaimages
www.flickr.com/photos/irenaimages
www.youtube.com/user/irenaorg
Backup slides
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 5.4 GW 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

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-continentially.

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.

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

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

Source: TÜV Rheinland
Calculating the levelised cost of electricity

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

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.

International standards across the project lifecycle

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

Cost/benefit ratio: ➢ 1:10
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