The green grid network

Cédric Philibert, Renewable Energy Division

Parliamentary Roundtable on Renewable Energy,

COP22, Marrakech, 15 November 2016

The IEA works around the world to support an accelerated clean energy transition that is

enabled by real-world SOLUTIONS

supported by ANALYSIS

and built on DATA

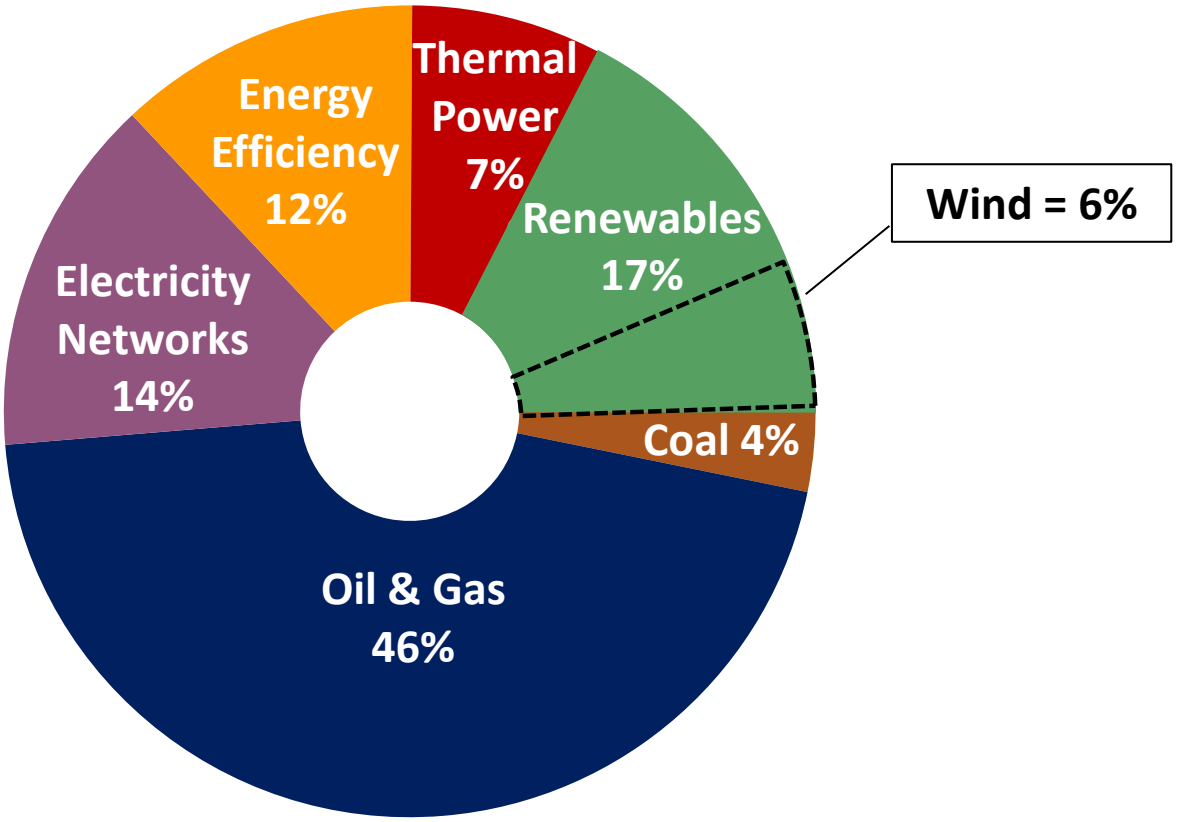
Super-grids or mini-grids?

- Most solar and wind capacities connect to the low and medium voltage distribution grids
- Distributed energy solutions can substitute to grid extensions in providing access
- They can also strengthen the grids and improve the quality of truly intermittent power in some markets
- Super-grids enlarging balancing areas are also helpful in facilitating the integration of variable renewables
- Mini- and super- grids all need to be « smart » - convey information as well as energy, both ways, and coupled with other energy forms/networks

Investment flows signal a reorientation of the global energy system

Global Energy Investment, 2015

USD 1.8 trillion

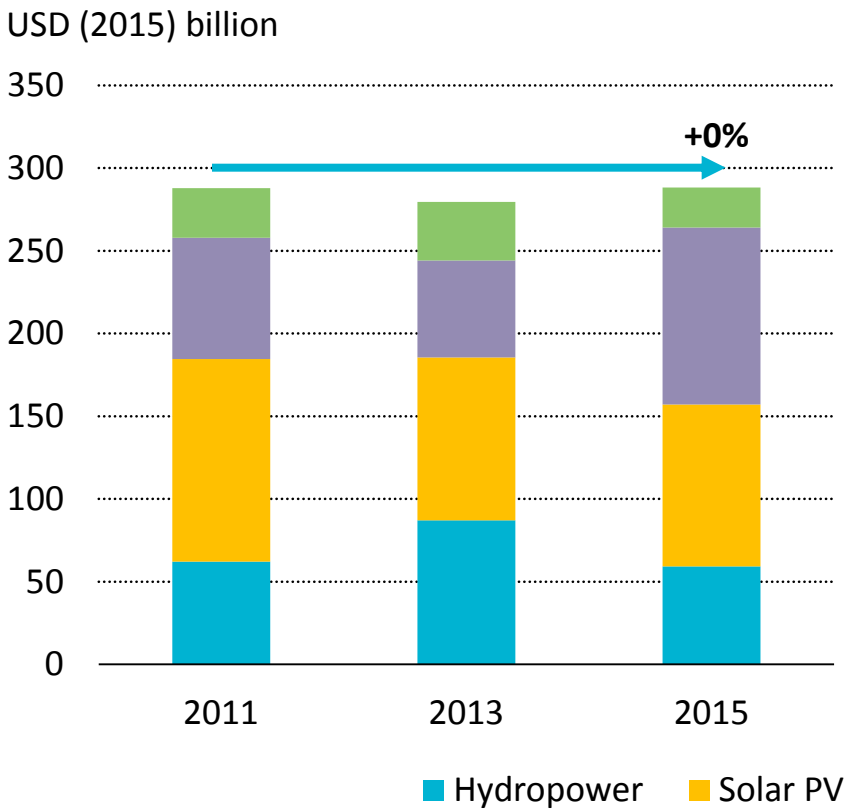


An 8% reduction in 2015 global energy investment results from a $200 billion decline in fossil fuels, while the share of renewables, networks and efficiency expands

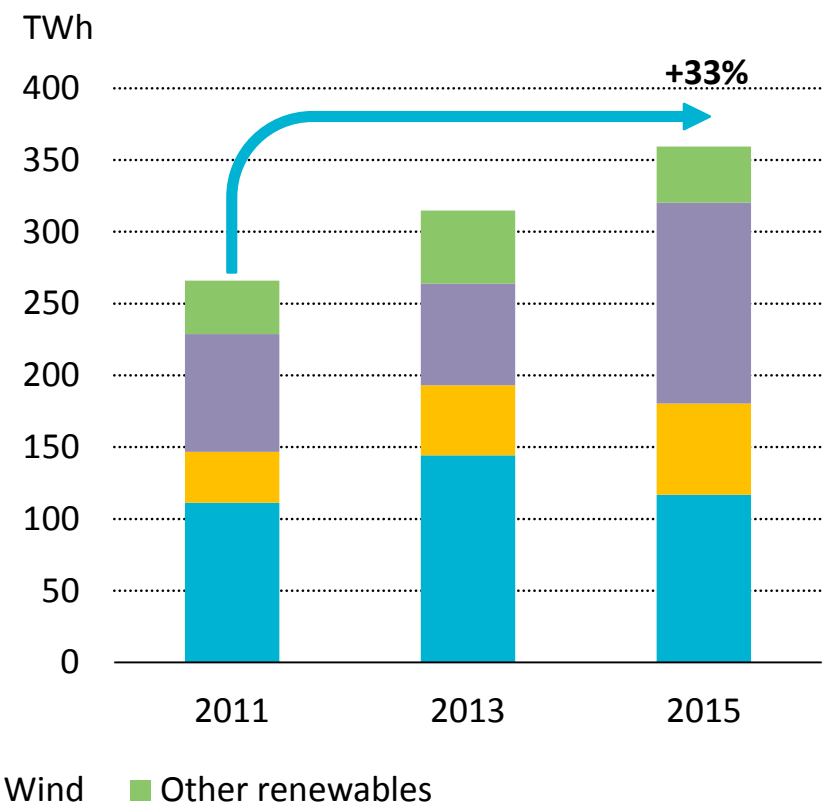
Renewables investment buys much more electricity

World Energy Investment 2016

Global renewable power investment



Generation from investment in capacity



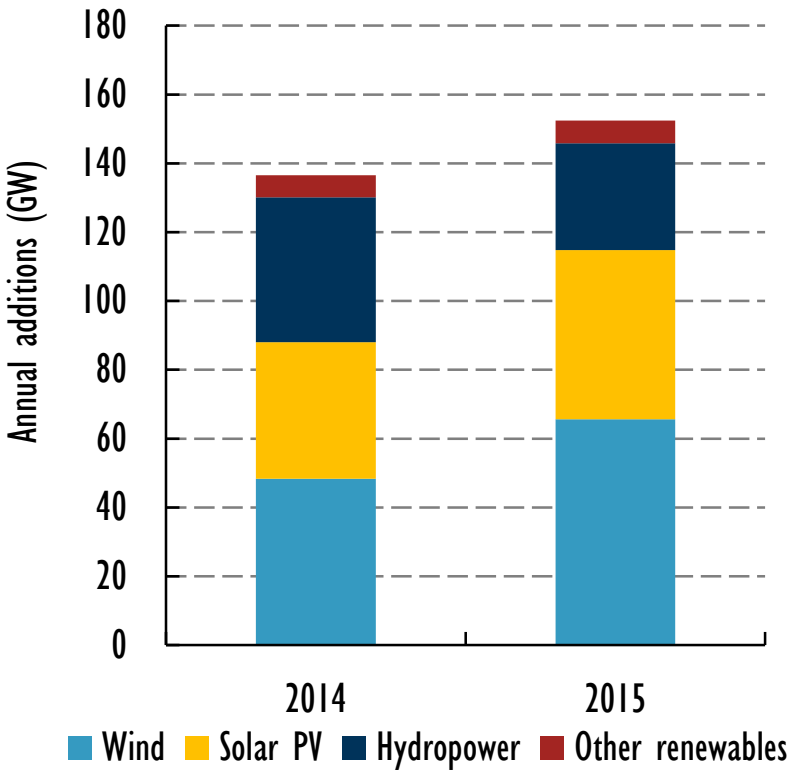
Hydropower Solar PV Wind Other renewables

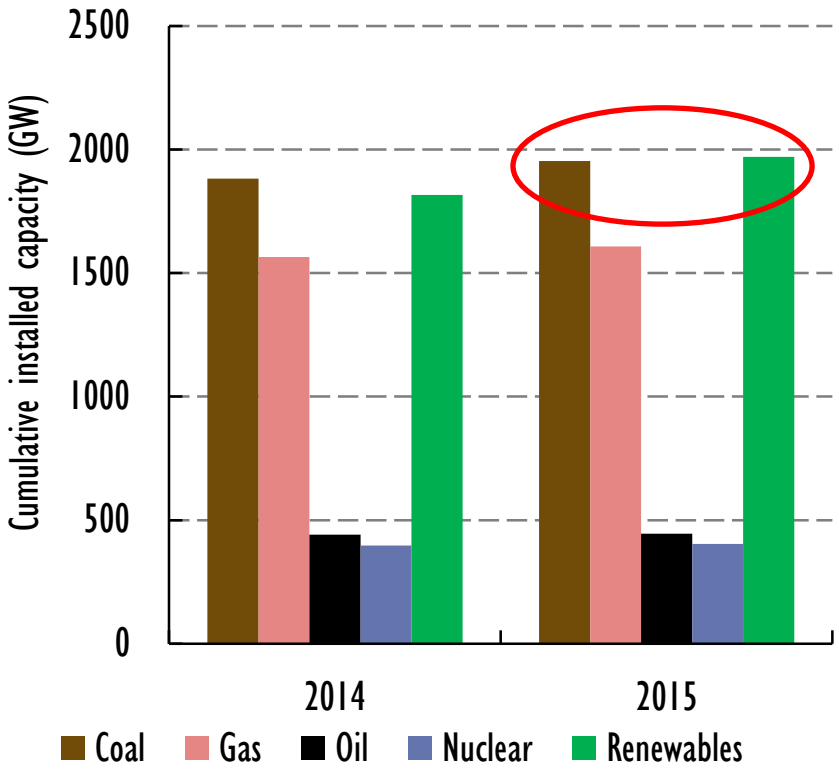
Investment in renewables-based capacity more than covers 2015 global electricity growth. Wind leads, surging 35% in 2015 on economics and record offshore growth

2015: a record year for renewables

RENEWABLE ENERGY
Medium-Term Market Report 2016

Renewable additions (2014-15) and cumulative installed power capacity





Cumulative renewable capacity surpassed coal at the end of 2015

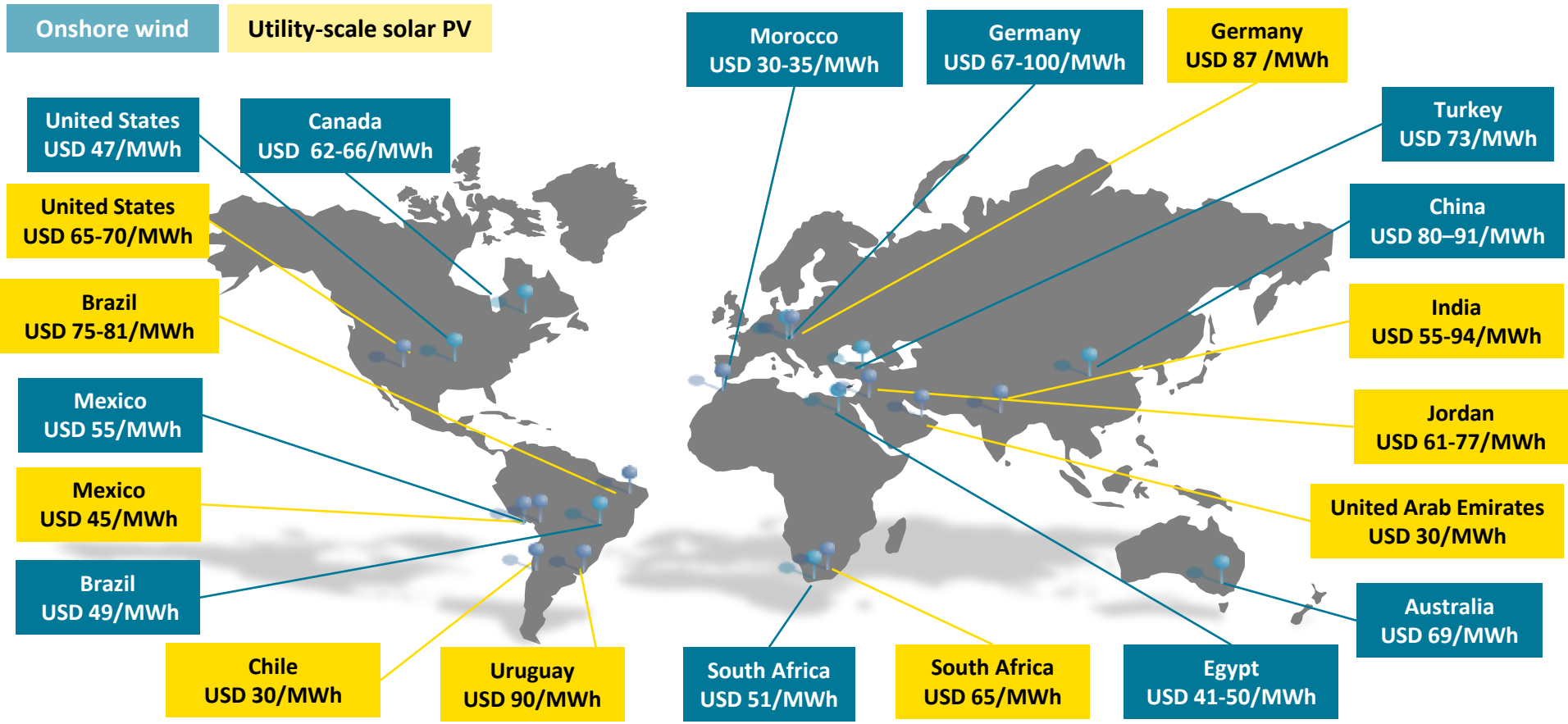
International Energy Agency

Secure • Sustainable • Together

www.iea.org

Record low price announcements

Recent announced long-term contract prices for new renewable power to be commissioned over 2016-2019



This map is without prejudice to the status or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

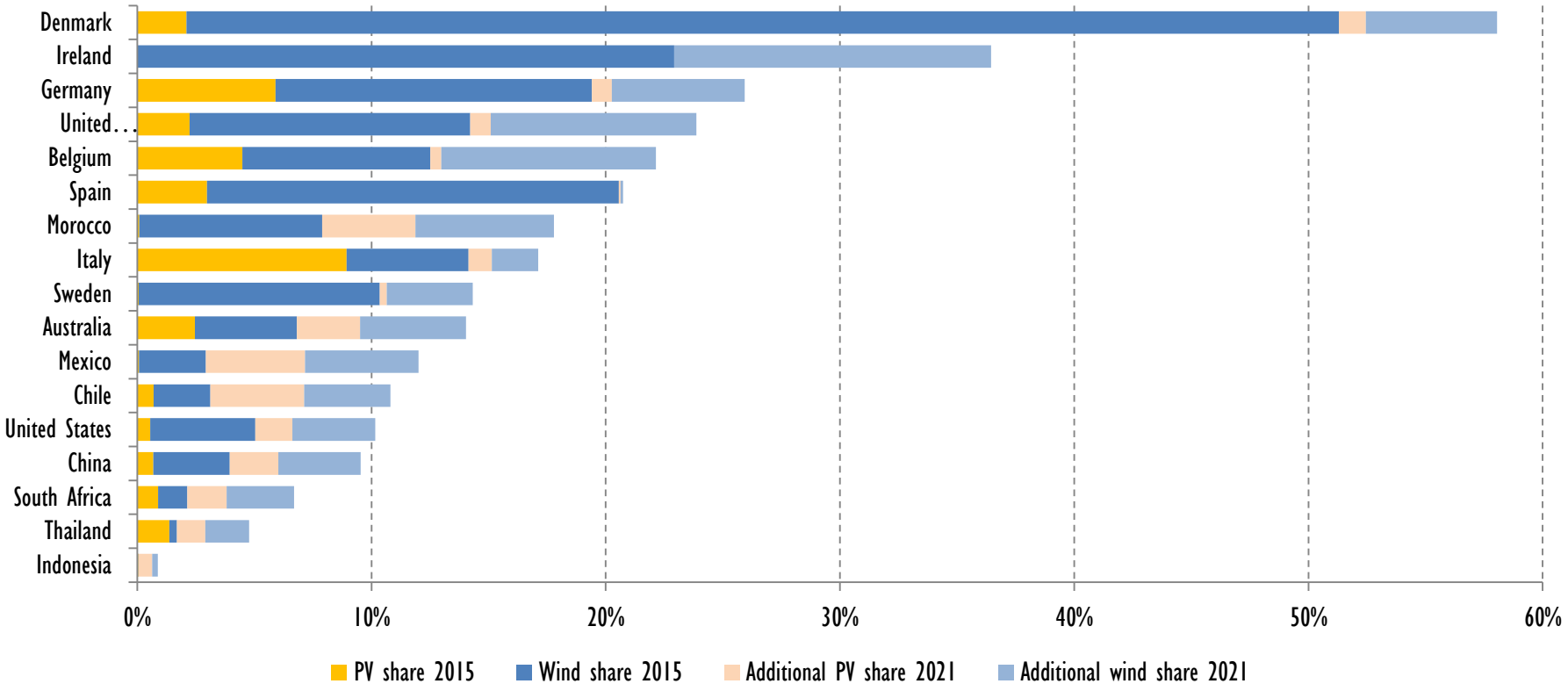
Note: Values reported in nominal USD includes preferred bidders, PPAs or FITs. US values are calculated excluding tax credits. Delivery date and costs may be different than those reported at the time of the auction.

Best results occur where price competition, long-term contracts and good resource availability are combined

Towards high shares of variable renewables

RENEWABLE ENERGY
Medium-Term Market Report 2016

Share of variable electricity generation in 2015 and 2021



Experience in a number of countries shows how to integrate significant shares of VRE

Source: IEA estimates from IEA Medium-Term Renewable Energy Market Report 2016.

The Danish Power System
Installed Capacity, January 1st, 2016

ENERGINET.DK

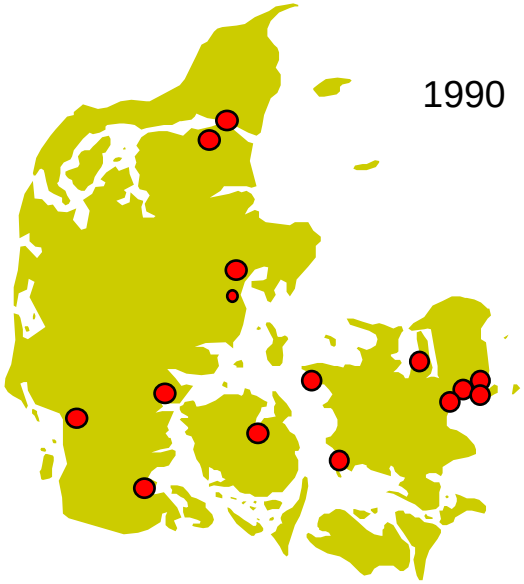
20 Central Power Stations

4,200 MW

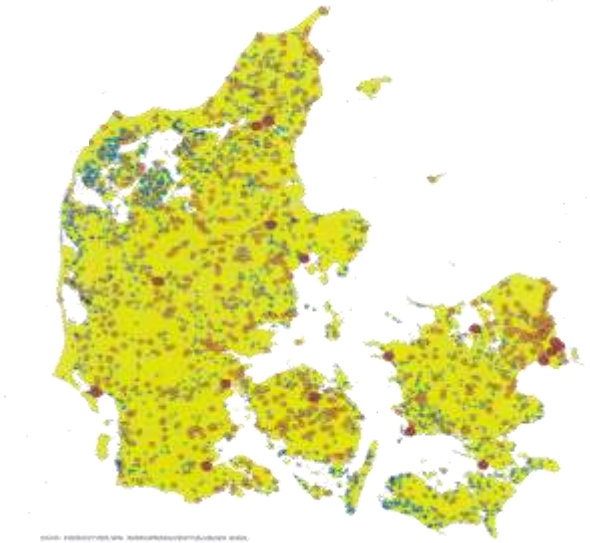
670 Local CHPs

2,300 MW

1990



2015



5,300 Wind Turbines

5,070 MW

94,000 Solar PV

785 MW

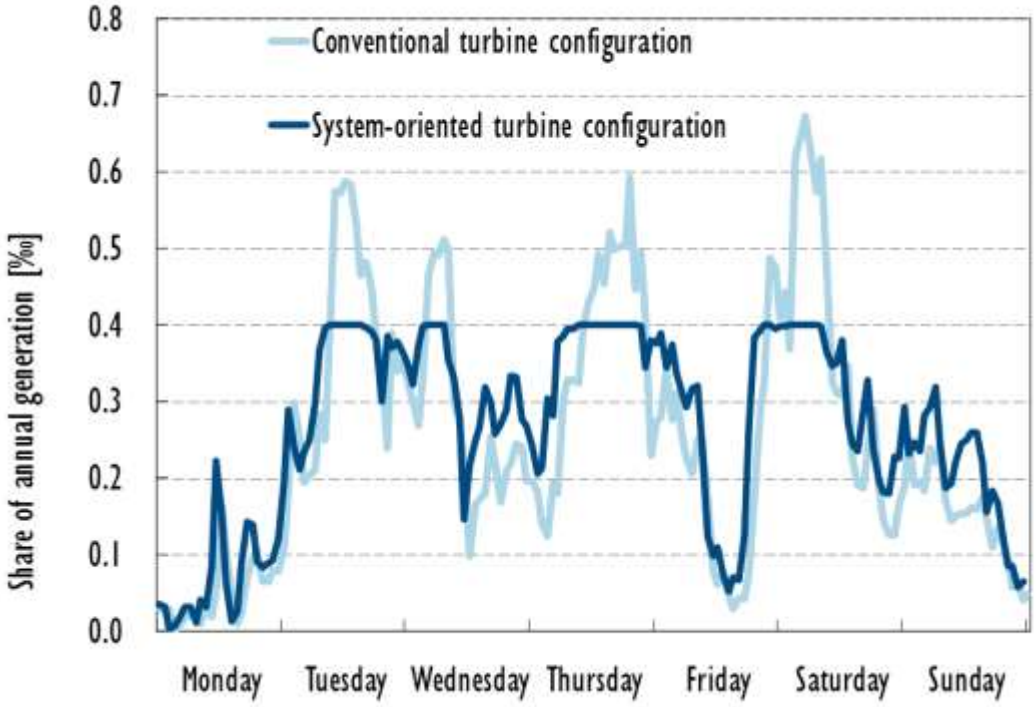
Demand is between 2100 MW and 6300 MW

Increasing variable RE will need more system flexibility

1) Foster System-friendly RE

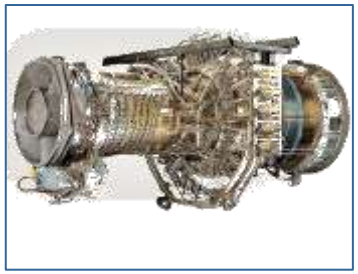
2) Better market design & operation

3) Increase flexibility of other power system components



Grids

Generation

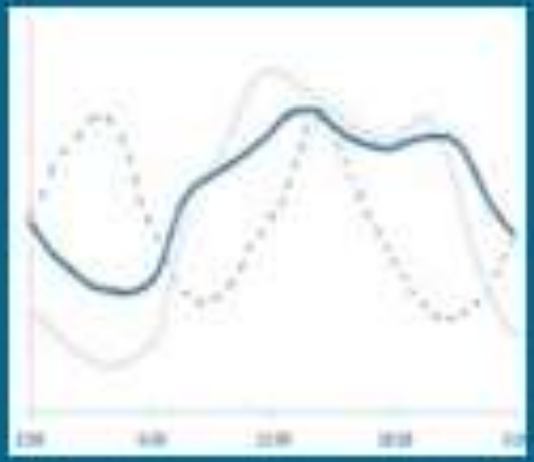


Storage

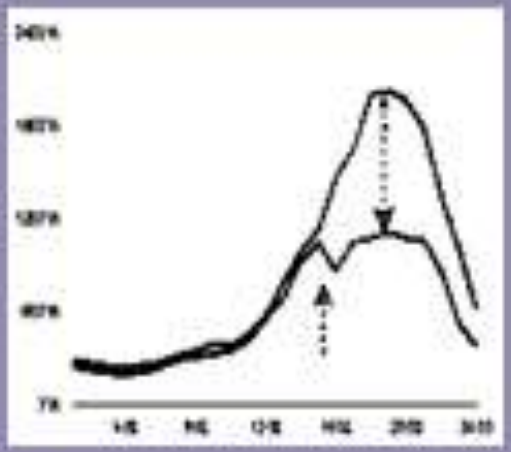
Demand Side

Interconnection can provide a range of benefits to achieve sustainable, secure electricity systems

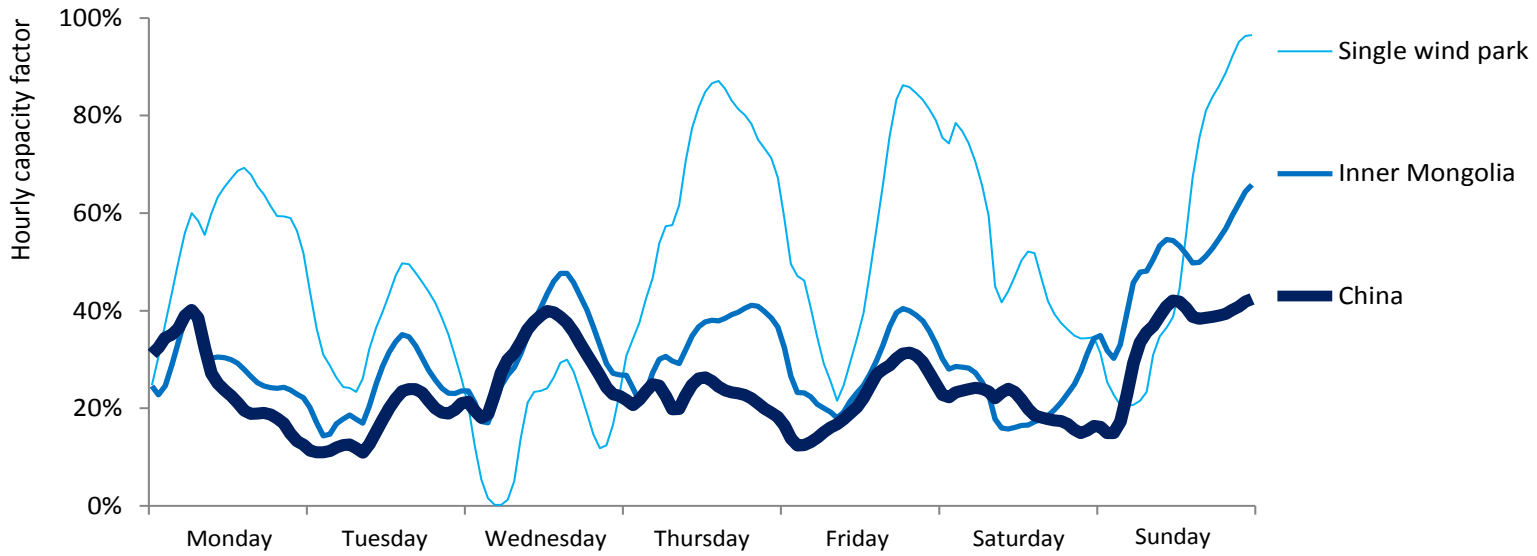
Demand smoothing



Peak reduction

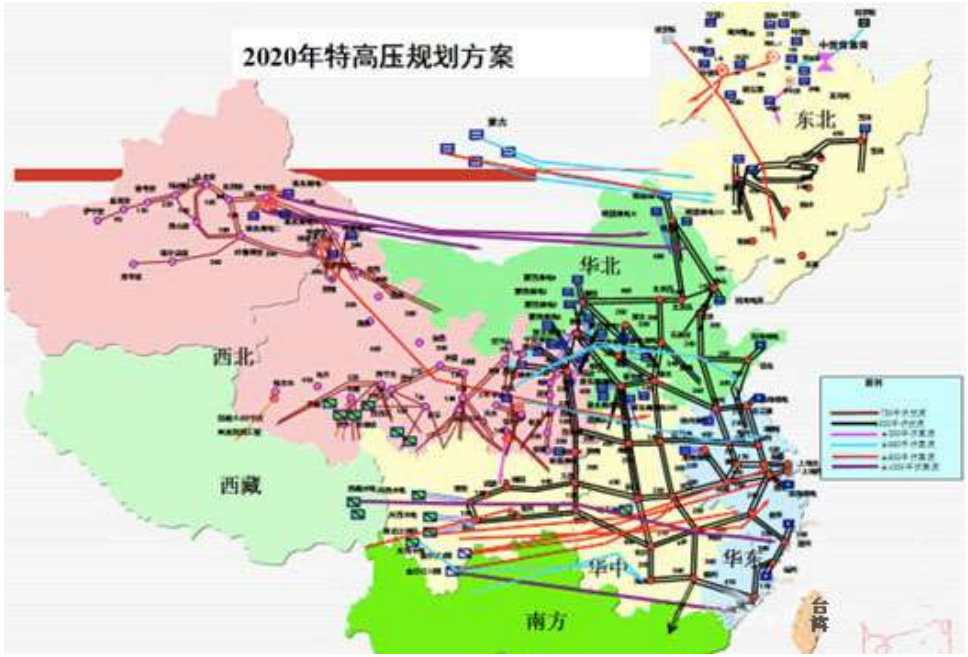


Interconnection can provide a range of benefits to achieve sustainable, secure electricity systems



Electricity can be transmitted over thousands of km and across borders with low electric losses

HVDC lines in China



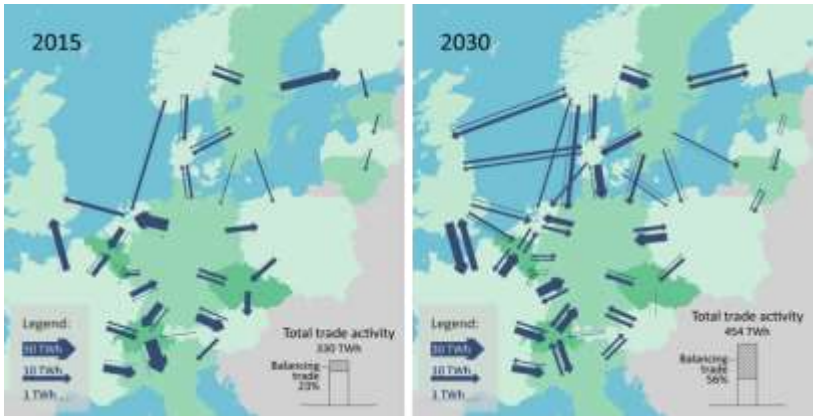
Sources: http://news.bjx.com.cn/zhuanti/2015tgy/ -http://www.xianelectric.com/English/chanpin/HVDC.htm

Large-scale Electricity Interconnection: Technology and prospects for cross-regional energy networks

Europe and North Africa

Central America

South East Asia



Mid-term prospects (source: IEA/NER 2016)

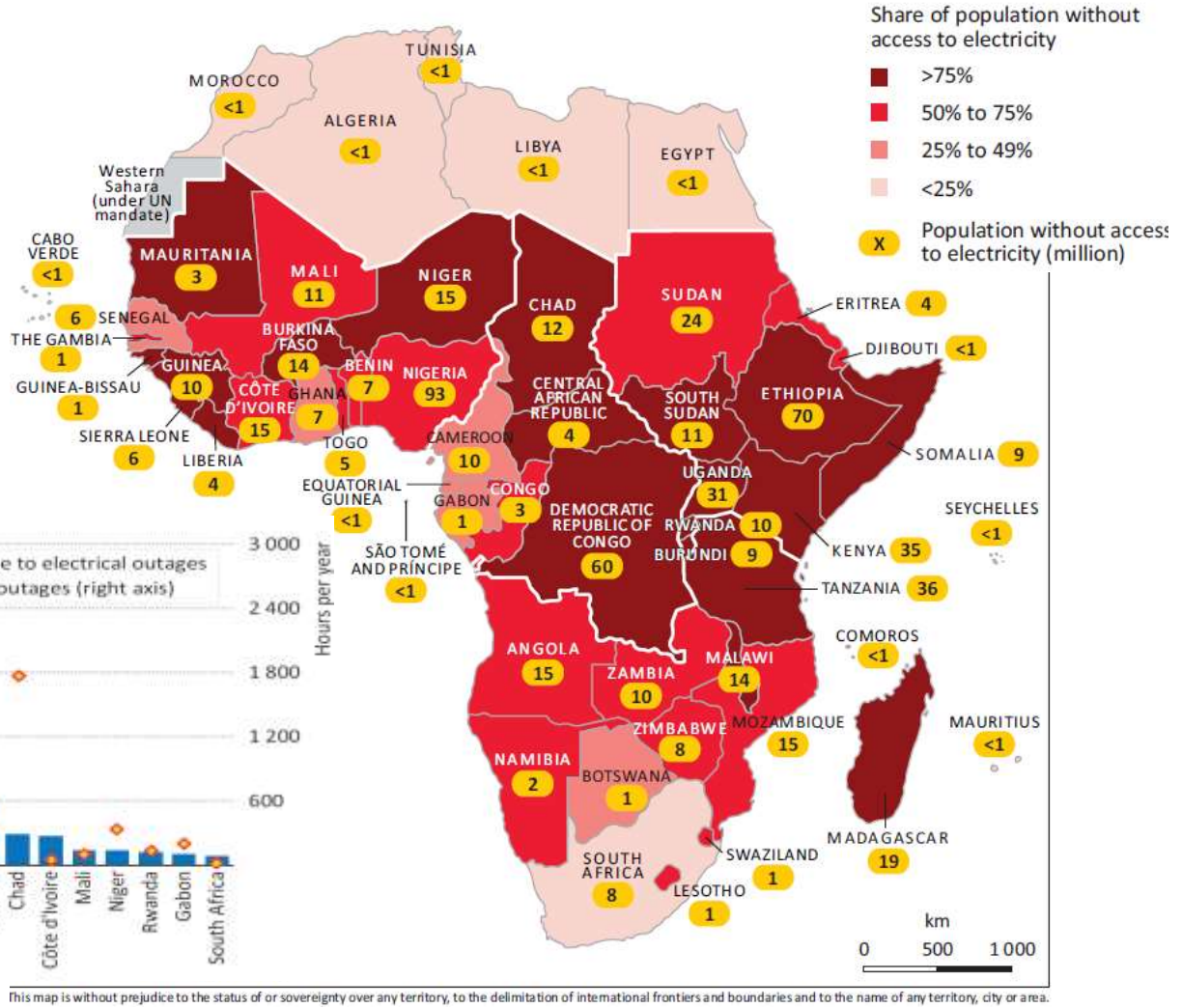
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

Rigorous analysis of current technology and potential deployment trends in Europe and North Africa, South East Asia, Central America and Sub-Saharan Africa

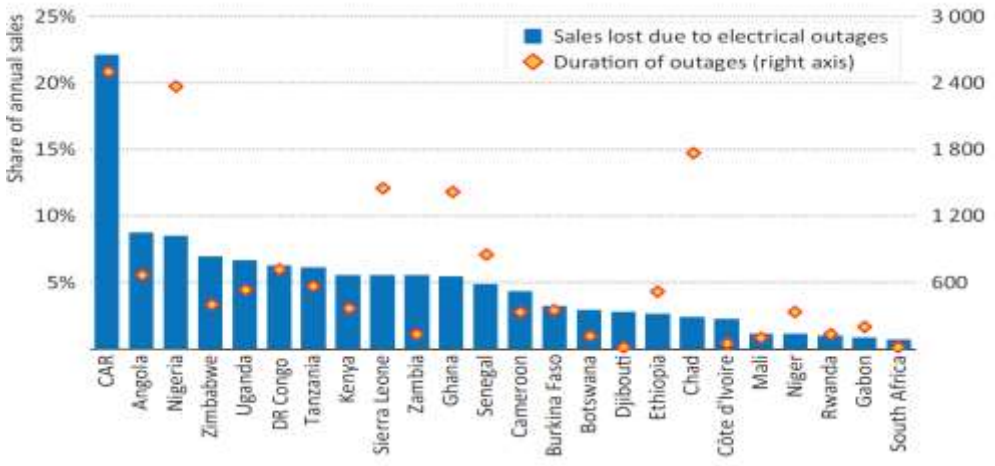
More than 620 millions Africans don't have access to electricity

Africa Energy Outlook

Number and shares of people without access to electricity



Lengths of power cuts (h/y) and economic losses (%)



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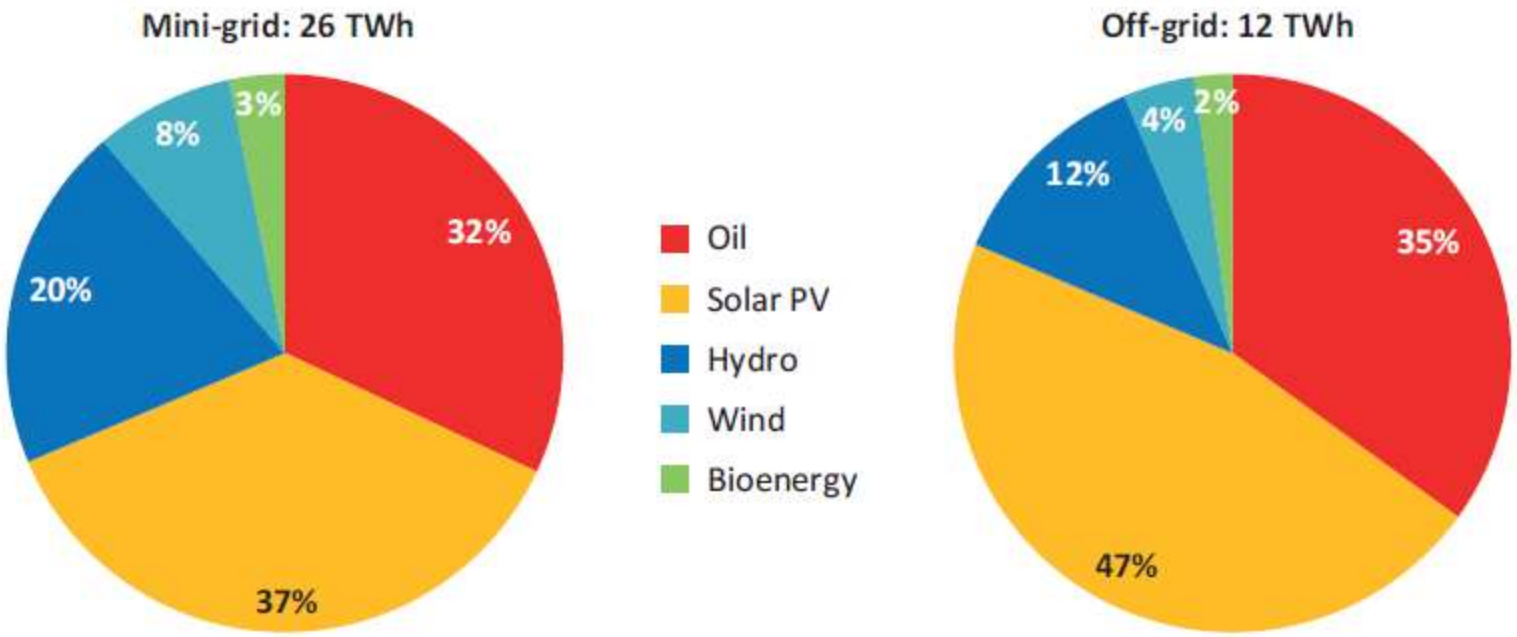
Renewables to dominate off grid

Africa Energy Outlook

Power mix in mini-grids and off grid in Sub-Sahara Africa in 2040 in the New Policies Scenario

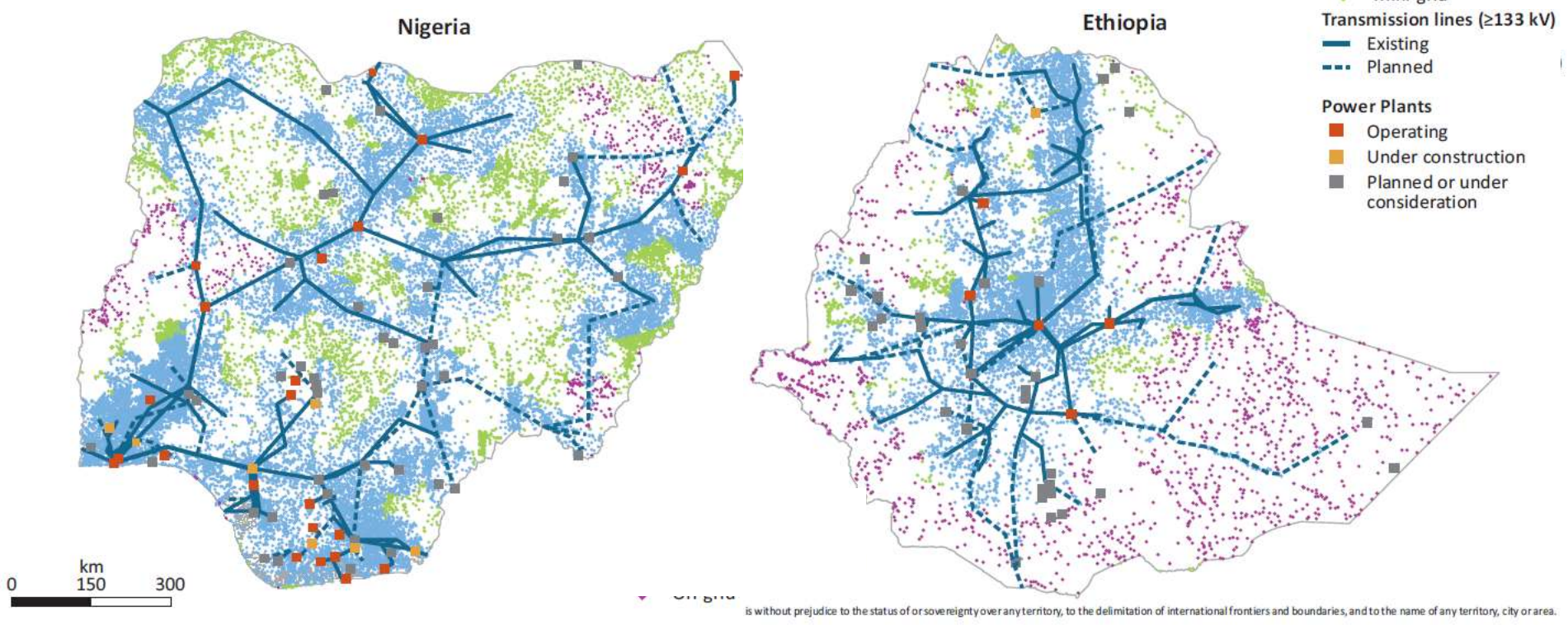


PV will dominate the power mix but will have an even greater share if the cost of battery storage shrink faxter

Grid extensions and distribution solutions

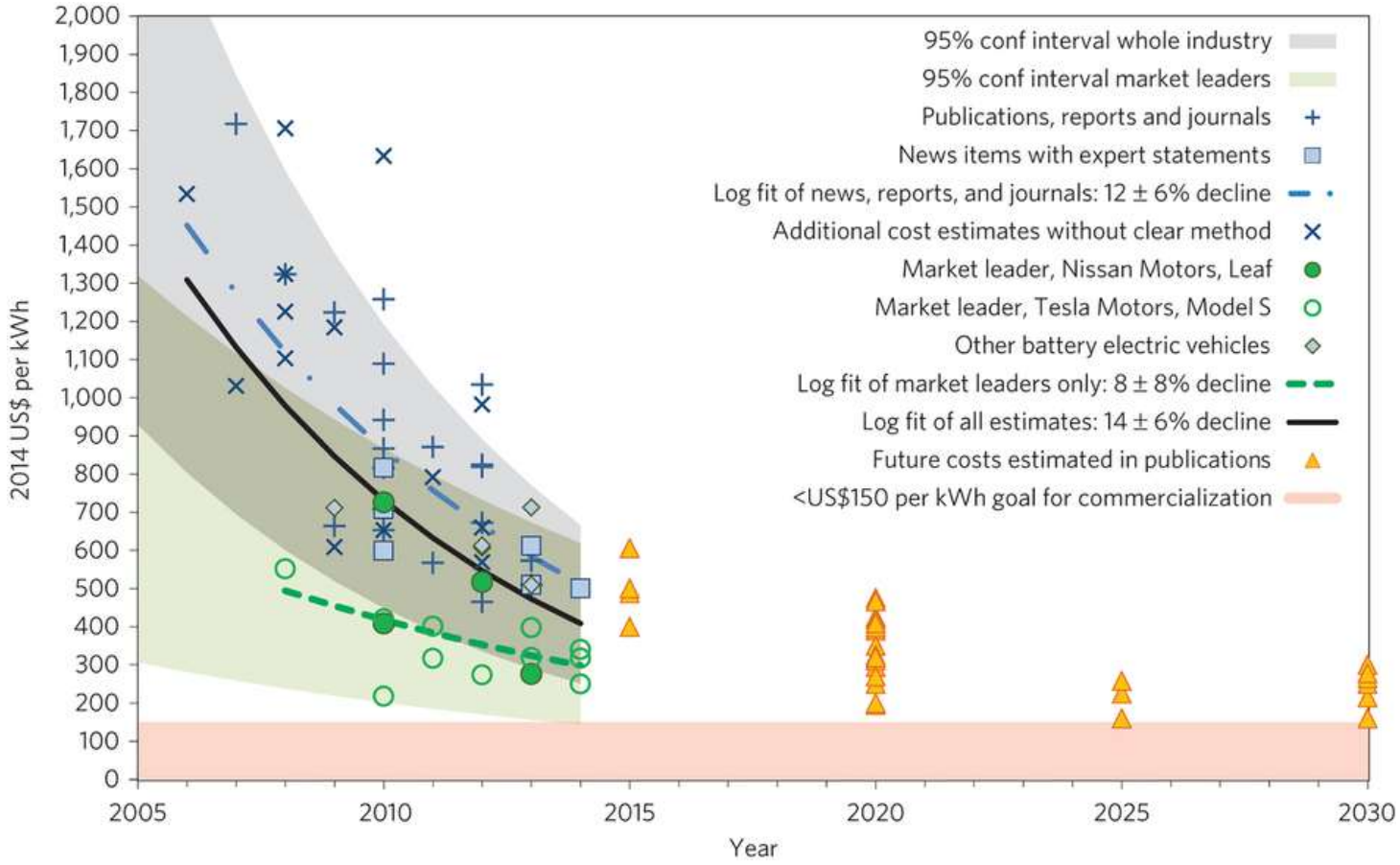
Africa Energy Outlook

Optimal shares by 2040



In the long run various combinations of on-grid, mini-grid and off-grid technologies will subsist

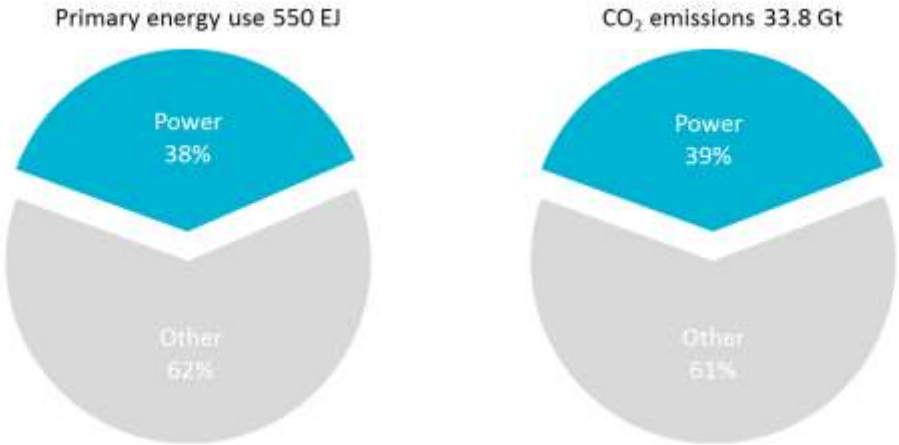
Battery storage cost trends – a breakthrough in sight?



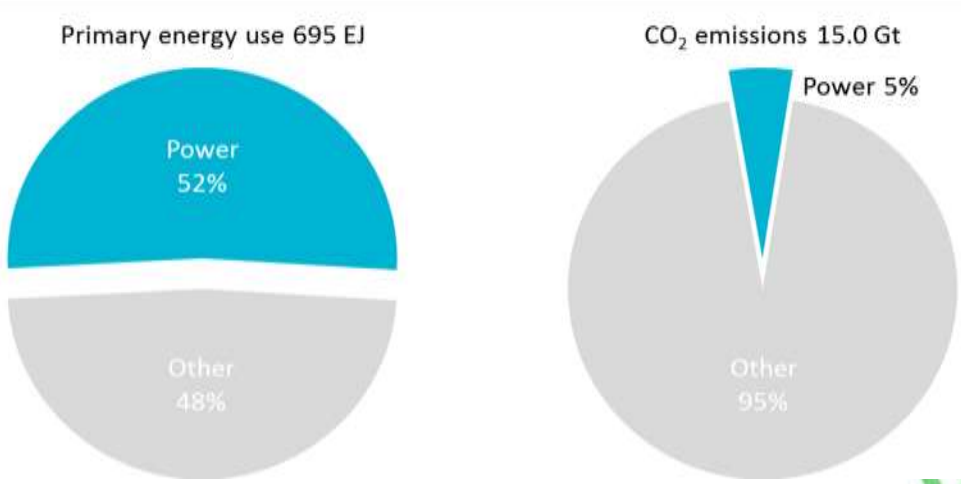
Electricity can power sustainable growth

ETP 2014

2011



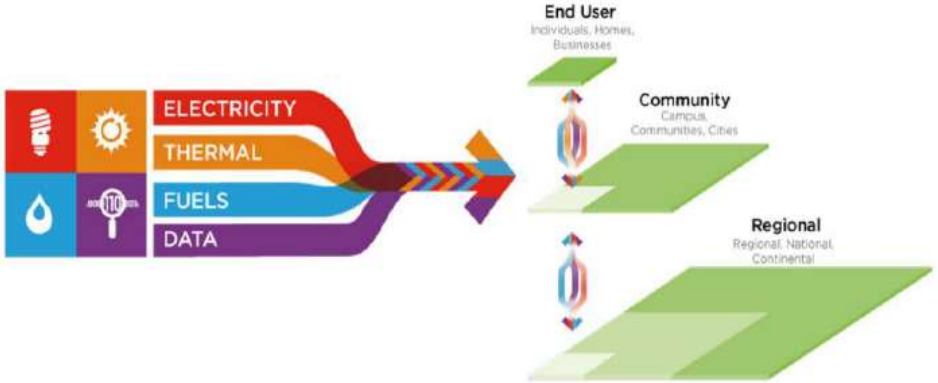
2050 2DS

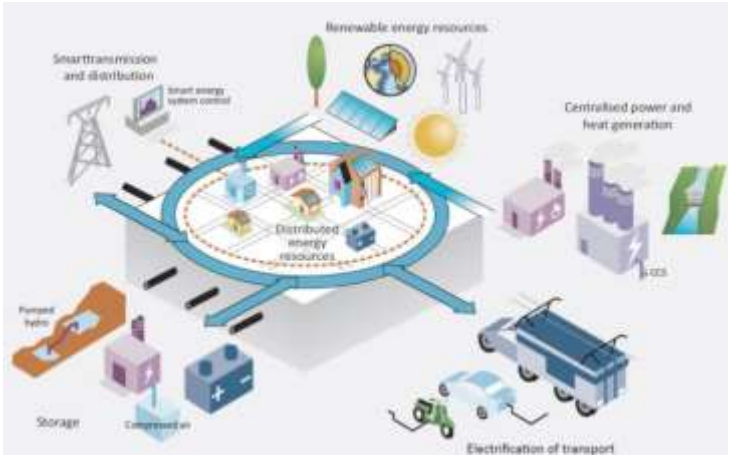


Electrification of transport, buildings and industries will be necessary to decarbonise the economy

Energy systems integration

- "Energy systems integration" is the optimisation of energy systems across different regions and timescales.
- The benefits include increased reliability and performance, cost reduction and environmental impacts
- Most valuable where different sectors intersect (electricity, gas, heat)
- Various technical, economic and regulatory drivers of change





Energy systems integration can greatly improve the efficiency of energy system, reducing network losses, cost and GHG emissions.

Source: left figure NREL, 2012