REmap
A Renewable Energy Roadmap

IRENA
International Renewable Energy Agency

#REmap

ROADMAP FOR A RENEWABLE ENERGY FUTURE

7th Eilat-Eilot Renewable and Clean Energy Conference
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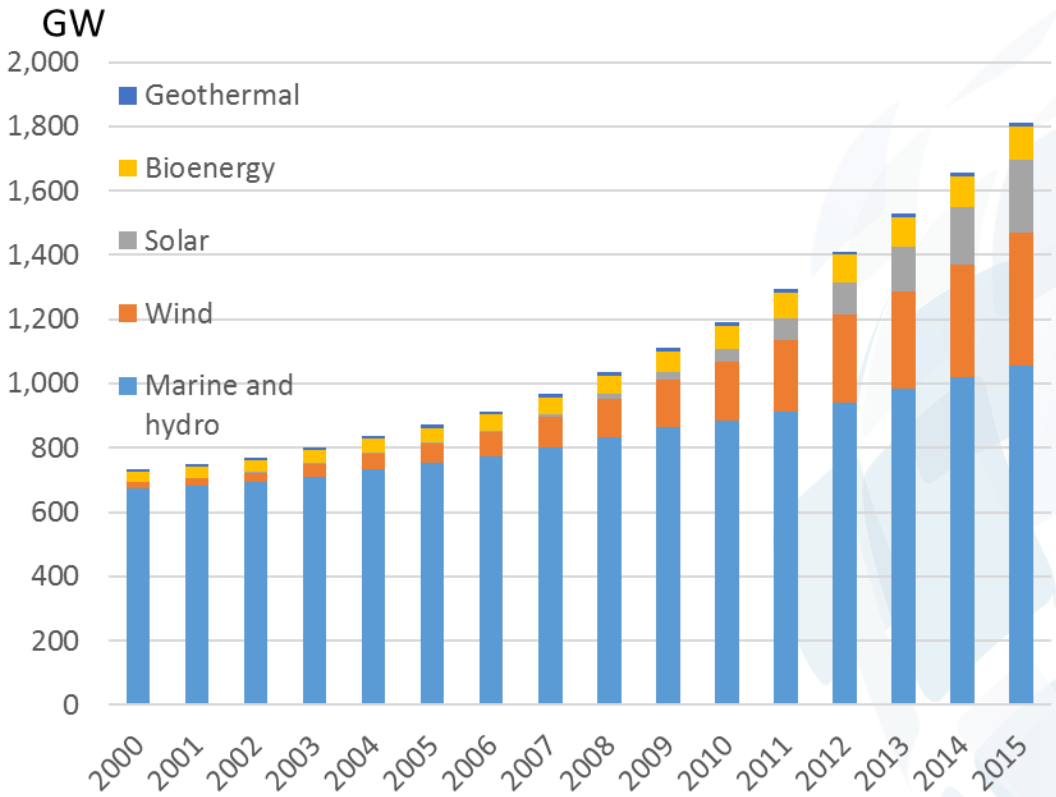
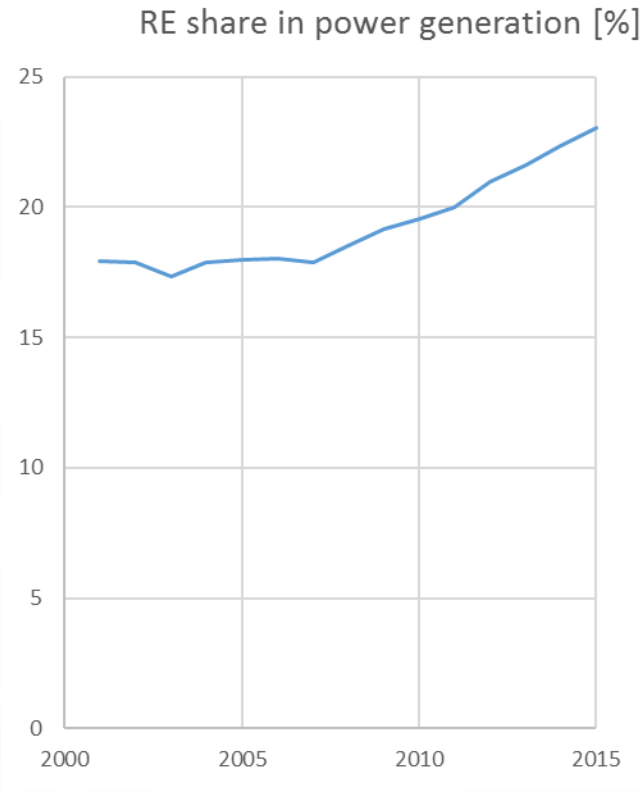
Recent global renewable energy development

2015/2016: record years for renewables

- **51 GW solar PV, 64 GW wind power installed**
  - More than 25% growth from the previous year
  - More than half of all new power generation worldwide is renewable
  - Despite low fossil fuel prices
- **Costs continue to fall:**
  - Solar PV: USD 24-30/MWh in Chile, UAE (2016)
  - Wind: USD 30/MWh in Morocco, Peru (2016)
- **164 countries with RE policies in place**
- **The global energy transition is ongoing**

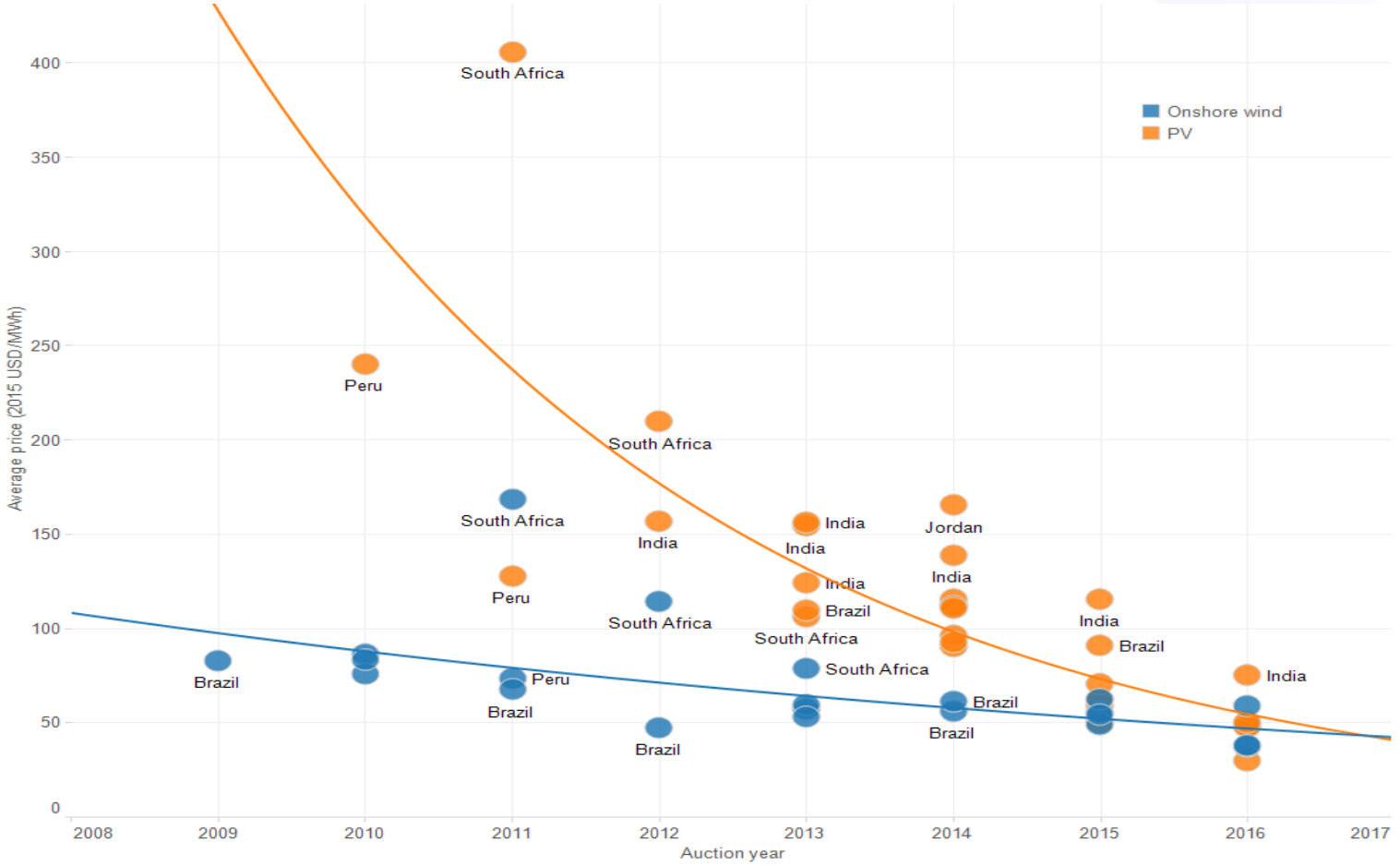
Global trends in renewable power generation



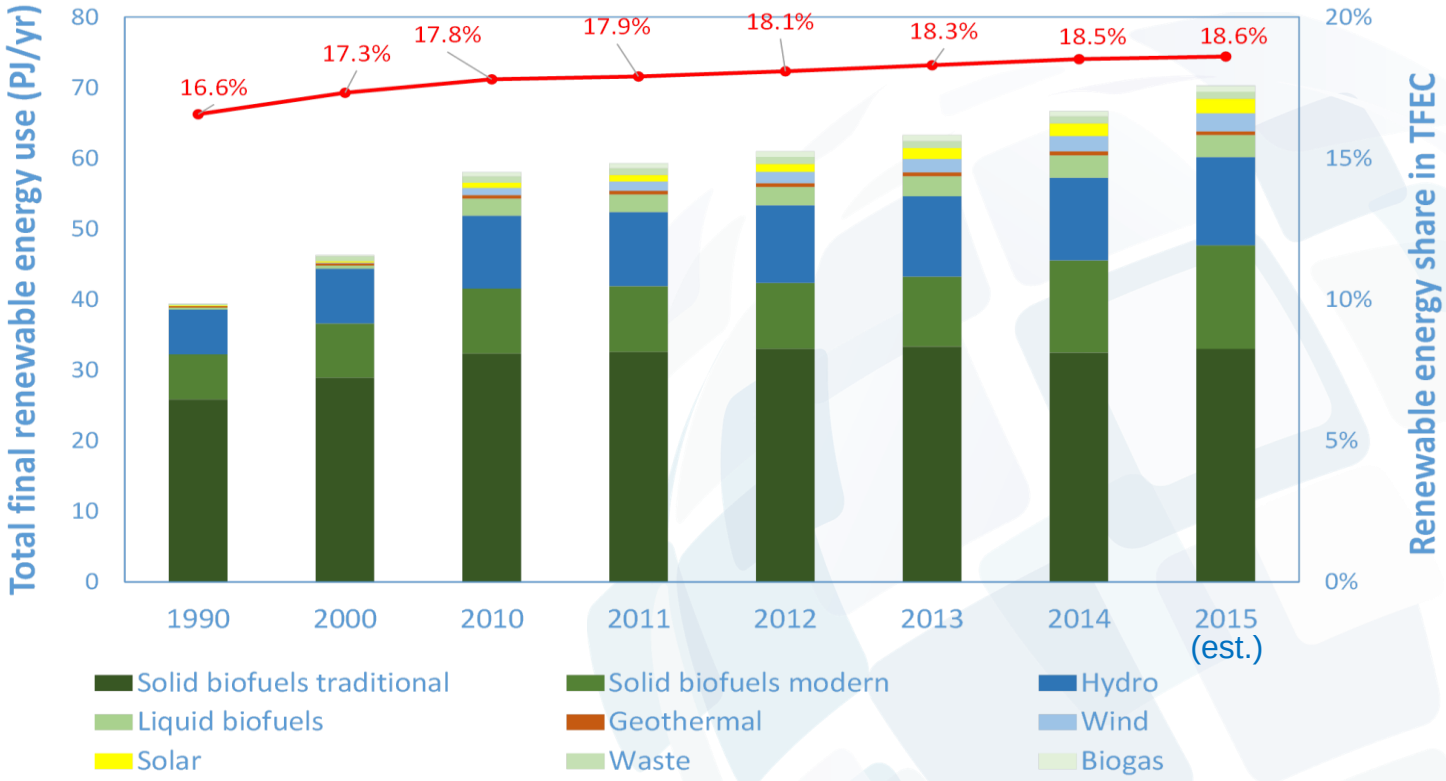


Falling prices

In 2016 utility scale solar PV and onshore wind offered for 3 Usct/kWh in Chile, Morocco, Peru, UAE



Global trends in renewable energy for final use



- **RE share remains flat in the period 1990-2010, some sources growing exponentially**
- **During 2010-2015, significant growth from 17.8% to 18.6% of RE in TFEC (0.17%/yr): RE share in power growing significantly but end-use sectors lagging behind**
- **Business as usual takes the global RE share to 21% by 2030**

Drivers for renewable energy

FALLING PRICES

CLIMATE POLICY

AIR POLLUTION

JOBS

NEW ECONOMIC ACTIVITY

ENERGY SECURITY

REmap programme approach

The REmap approach

- IRENA's REmap programme explores **potential, cost and benefits** of doubling the share of renewables in global energy mix (SE4ALL objective), key to realize **SDG 7: Affordable and clean energy**

- **Technology Options:**
  - This is **not a target setting exercise**
  - Each technology option is characterized by its cost and potentials
  - Technology options can be combined into roadmaps or plans and translated into policy action

- Includes power, district heat, end-uses (industry, transport, buildings)
  - Including sector coupling and power systems aspects

- Developed **together with** and **validated by country experts**

REmap country analyses
Collaboration of IRENA and country experts

What is the RE outlook by 2030 in government plans?

- Overall energy demand forecast
- Sectoral breakdowns
- Government targets for RE
- Share of RE in energy mix (in SE4ALL definition)

What are the costs and benefits of the RE options?

- Accounting for forecast energy prices, discount rates, technology costs
- Derive set of metrics, e.g. investment needs, substitution cost (per technology), net system costs

What are the additional RE deployment options?

- Accounting for RE resources in the country; realistic deployment potential
- Includes large number of technology options across sectors (power, DH, buildings, industry, transport)

Country potentials and technology roadmaps

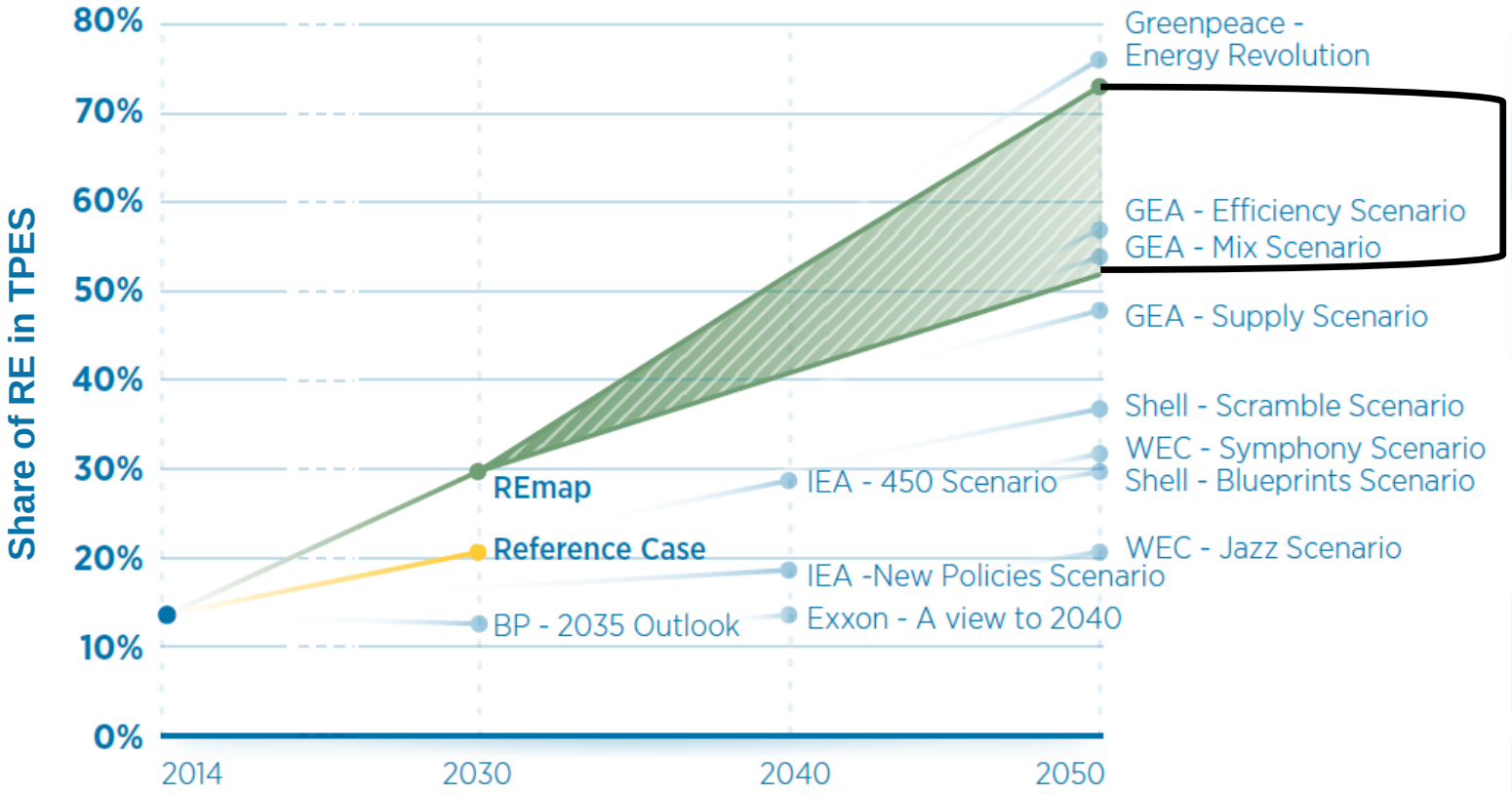
- REmap global analysis issued March 2016
- Today 50 country roadmaps covering 85% of global energy use
  - 10 country reports, 4 regional reports
- Bottom-up analysis of technology options to accelerate RE use
  - Developed in close cooperation with country experts
  - Leading institutes CNREC, NREL, UCC etc.
- All data, assumptions and detailed results are available online:
  - www.irena.org/remap - new REmap on REsource Dashboard
- Analysis can inform areas for cooperation and joint action, including investment, cost, benefits (climate, environment, security, macro-economics) of possible new RE objectives

REmap engagement process

- **Joint work of countries and IRENA**
- **Two parallel tracks:**
  - Country analysis (for all countries included)
  - REmap comprehensive country reports (with interested countries)
- **IRENA works with country experts to conduct analysis**
  - Approximately 1-3 man-weeks of work required by country expert
  - Country report based on close collaboration, longer process
- **An established "REmap tool"**
- **REmap country analysis yields:**
  - Technology pathways
  - Costs, benefits, investment needs
- **Engagement with IRENA on other programmatic activities**

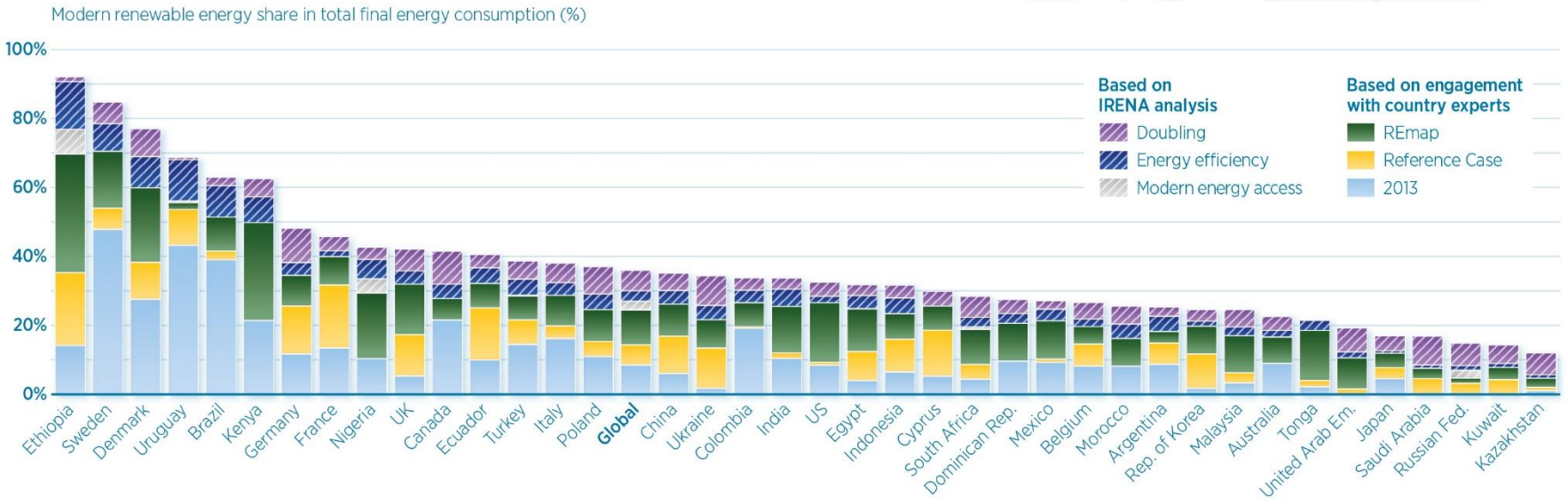
Global renewable energy development under REmap by 2030

About 1%/yr RE share growth needed in 2015-2050



RE share development to 2050 has a lot of opportunity for technology deployment in such a timeframe

Country RE shares in 2030 vary from 10% to 90%



POTENTIAL FOR ADDITIONAL RENEWABLE ENERGY IN ALL COUNTRIES IS IDENTIFIED, WITH GREAT DIFFERENCES BETWEEN COUNTRIES IN STARTING POINTS, LOCAL CAPABILITIES, AND REALISTIC DEPLOYMENT POTENTIAL

Preliminary insights on renewable energy potential development in Israel based on REmap analysis

Policy supporting renewable energy in Israel

- **NDC: reduce GHG emissions to 7.7 tCO2e/capita by 2030, 26% reduction compared to 2005**
  - Interim target of 8.8 tCO2e/capita by 2025
- **NDC sector specific targets:**
  - Energy efficiency: 17% reduction in electricity consumption relative to BAU levels by 2030
  - **Renewable energy: Renewables will account for 17% of generation by 2030**
  - Public transport: 20% shift from private to public transportation

Renewable energy developments to 2030 in the Reference case for the power sector

		Unit	2014	Reference Case 2030
Installed power generation capacity	**Total installed power generation capacity**	*GW*	**16.0**	**25.5**
	Renewable capacity	*GW*	0.7	7.6
	Hydropower	*GW*	0.01	0.01
	Wind	*GW*	0.01	0.7
	Biofuels (solid, liquid, gaseous)	*GW*	0.01	0.14
	Solar PV	*GW*	0.7	6.5
	Solar CSP	*GW*	0.01	0.3
	Non-renewable capacity	*GW*	15.2	17.8
	Renewable energy share in total capacity	*%*	**4%**	**30%**
Electricity generation	**Total electricity generation**	*TWh*	**60.8**	**89.4**
	Renewable generation	*TWh*	0.9	15.2
	Hydropower	*TWh*	0.01	0.03
	Wind	*TWh*	0.01	2.1
	Biofuels (solid, liquid, gaseous)	*TWh*	0.1	0.9
	Solar PV	*TWh*	0.8	11.4
	Solar CSP	*TWh*	0.01	0.8
	Non-renewable generation	*TWh*	59.9	74.2
	Renewable energy share in generation	*%*	**2%**	**17%**

Renewable energy represents 17% by 2030, meeting the renewable energy target in the NDC

Significant opportunities for cost-effective RE in the power sector in Israel

Renewable energy options costs in 2030

- **Solar PV**
  - CAPEX: 800-850 USD/kW
  - LCOE: **50-60 USD/MWh**
  - CF: 20-21%
- **Onshore wind**
  - CAPEX: 1,500 USD/kW
  - LCOE: **70 USD/MWh**
  - CF: 35%
- **Waste to energy**
  - CAPEX: 1,800 USD/kW
  - LCOE: **55 USD/MWh**

vs.

Non-renewable energy costs in 2030

- **Natural gas**
  - CAPEX: 1,000 USD/kW
  - LCOE: **66 USD/MWh**

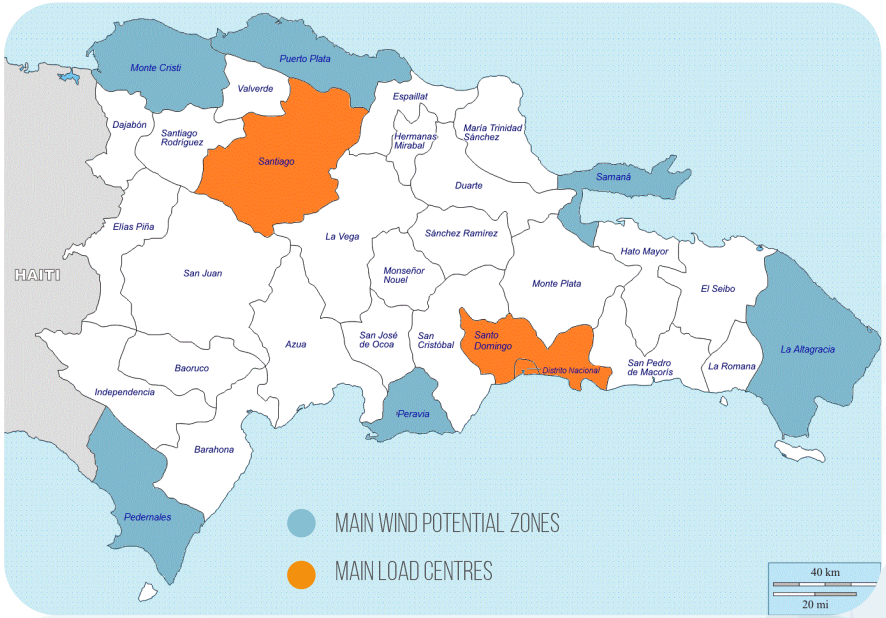
  Note: NG price USD_{2014} 6.4/GJ (USD_{2014} 7.3/mmBTU) in 2030
- **Coal**
  - CAPEX: 1,300 USD/kW
  - LCOE: **85 USD/MWh**

Cost-effective RE development could substitute conventional technologies and also create significant social and economic benefits

Solar PV costs are falling

	Cost reduction potential up to 2025, global weighted average data								
	Investment costs (USD/kW)		Percent change	Capacity factor		Percent change	LCOE (USD/kWh)		Percent change
	2015	2025		2015	2025		2015	2025	
Solar PV	1 810	790	-57%	18%	18%	8%	0.13	0.06	**-59%**
CSP (PTC)	5 550	3 700	-33%	41%	45%	8.4%	0.15 -0.19	0.09 -0.12	**-37%**
CSP (ST)	5 700	3 600	-37%	46%	49%	7.6%	0.15 -0.19	0.08 -0.11	**-43%**
Onshore wind	1 560	1 370	-12%	27%	30%	11%	0.07	0.05	**-26%**
Offshore wind	4 650	3 950	-15%	43%	45%	4%	0.18	0.12	**-35%**

Grid Studies



Example Dominican Republic REmap (4 GW)

- Significant experience with islands studies for 10 MW - 6 GW power systems
  - Capacity expansion
  - Dispatch and operation planning
  - Grid stability
  - Grid investment needs
- Island grids are more prone to grid integration issues
  - Israel is an islanded grid
- Planning allows to identify cost-effective solutions
  - In all cases we find more RE is possible than initially foreseen
- Natural gas plant can serve as backup for renewables
- Renewables lengthen the life of existing gas fields

Measures to increase renewable energy use in end-use sectors in 2030 under REmap in Israel

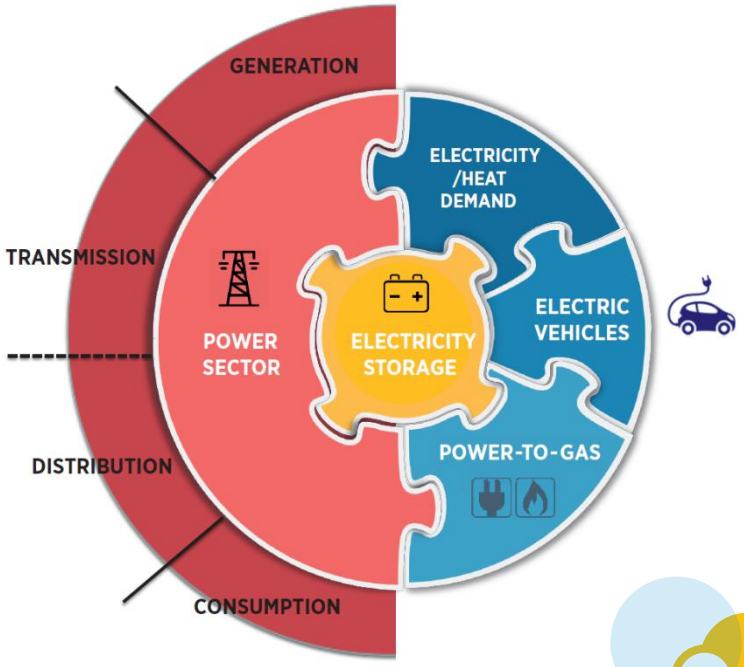
- **Buildings**
  - Heating/cooling with air- and ground-source heat pumps for residential buildings, around 400 thousand installations
  - Heating/cooling with ground-source heat pumps for residential and commercial buildings, around 1,000 installations

- **Industry**
  - Solar thermal can supply a small share of the heat demand in low temperature processes, total: 120 MW_{th}
  - Concentrated solar thermal to provide heat in medium temperature processes or in industries with space-restrictions, total: 80 MW_{th}
  - Ground-source heat pumps provide 5% of cooling demand in food industry

Measures to increase renewable energy use in end-use sectors in 2030 under REmap in Israel

- **Transport**
  - Addition of > 340 thousand battery electric vehicles
  - Addition of > 270 thousand plug-in hybrid electric vehicles

- **Opportunities of storage capacity from EVs**
  - 4 - 13 GWh of storage
  - Flexible charging can facilitate VRE integration



Possible areas of engagement

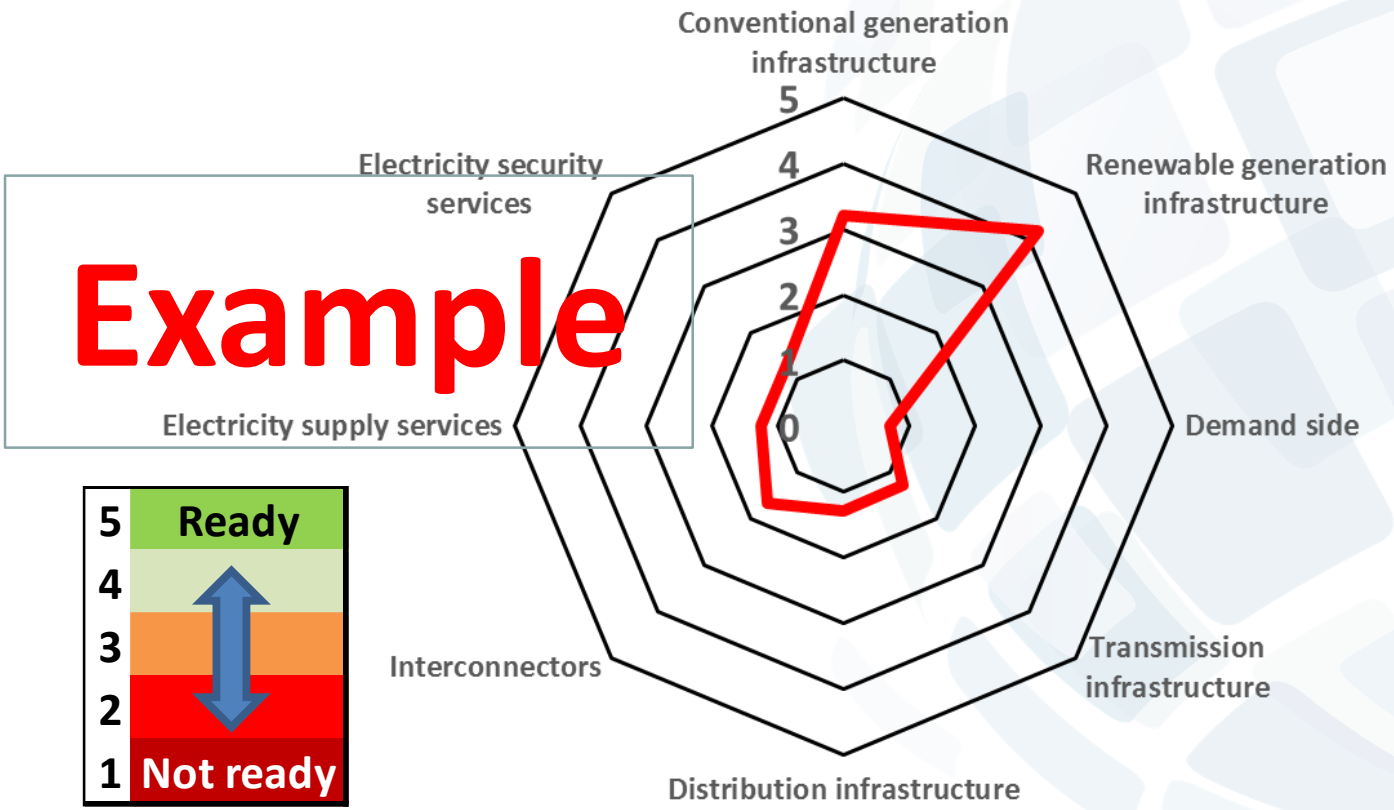
- Enabling policy and regulatory framework
  - Eg design of auction systems
- Grid integration studies
- Tariff impacts
- Technical options in end use sectors
- Review existing studies of remaining potential
  - Notably INDC scoping study

Enabling policy and regulatory framework

- Global technology development accelerates, but enabling policies and regulations remain key
  - Development and integration
- IRENA supports govt. with targeted technical assistance projects which can help transform targets into reality
- Assistance built upon country-level engagement, global practice discussion, pathway identification and capacity building (if needed)

Country-level engagement

- Includes all stakeholders from start to end
- Country-level assessment as starting point



Selected observations from day 1, Eilat/Eilot 2016

- Renewable generation infrastructure
  - Enhance certainty and ensure use of effective tool(s)
  - Support small scale development but ensure a system wide perspective in the medium-term

- Conventional generation infrastructure/storage
  - How to deal with future flexibility needs?
    - Identify needs, options, implementation pathways and govt. role

- Transmission infrastructure
  - How to ensure coordinated development of grid and generation?

What regulatory aspects did we miss? What else matters?

- Renewable generation infrastructure
- Conventional generation infrastructure/storage
- Transmission infrastructure

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Thank you!

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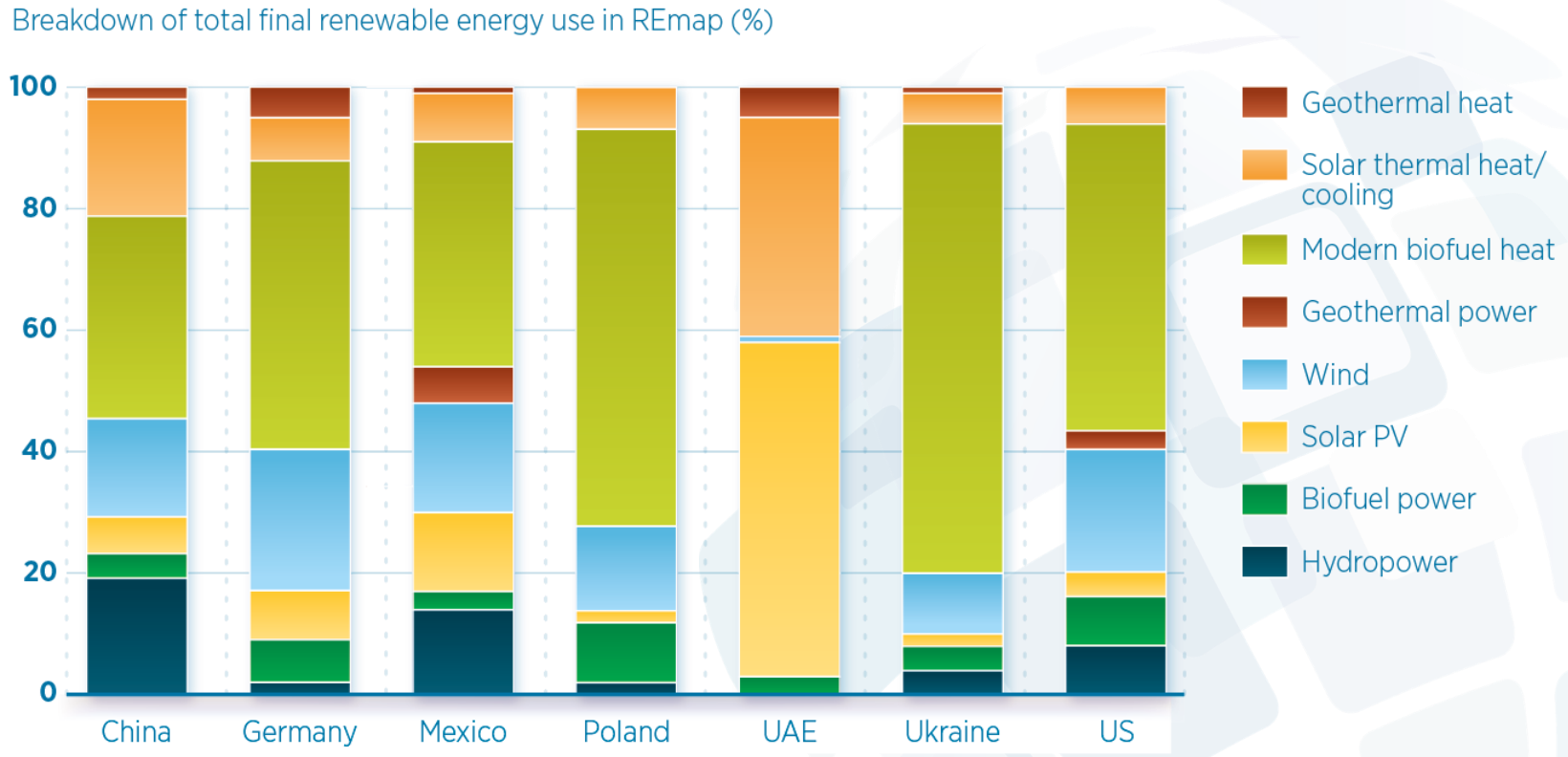
FIGURE 16 **Breakdown of renewable energy use in REmap in seven countries**



THE SPECIFIC MIX OF RENEWABLES IS DIFFERENT EVERYWHERE AND THERE IS NO SINGLE RECIPE