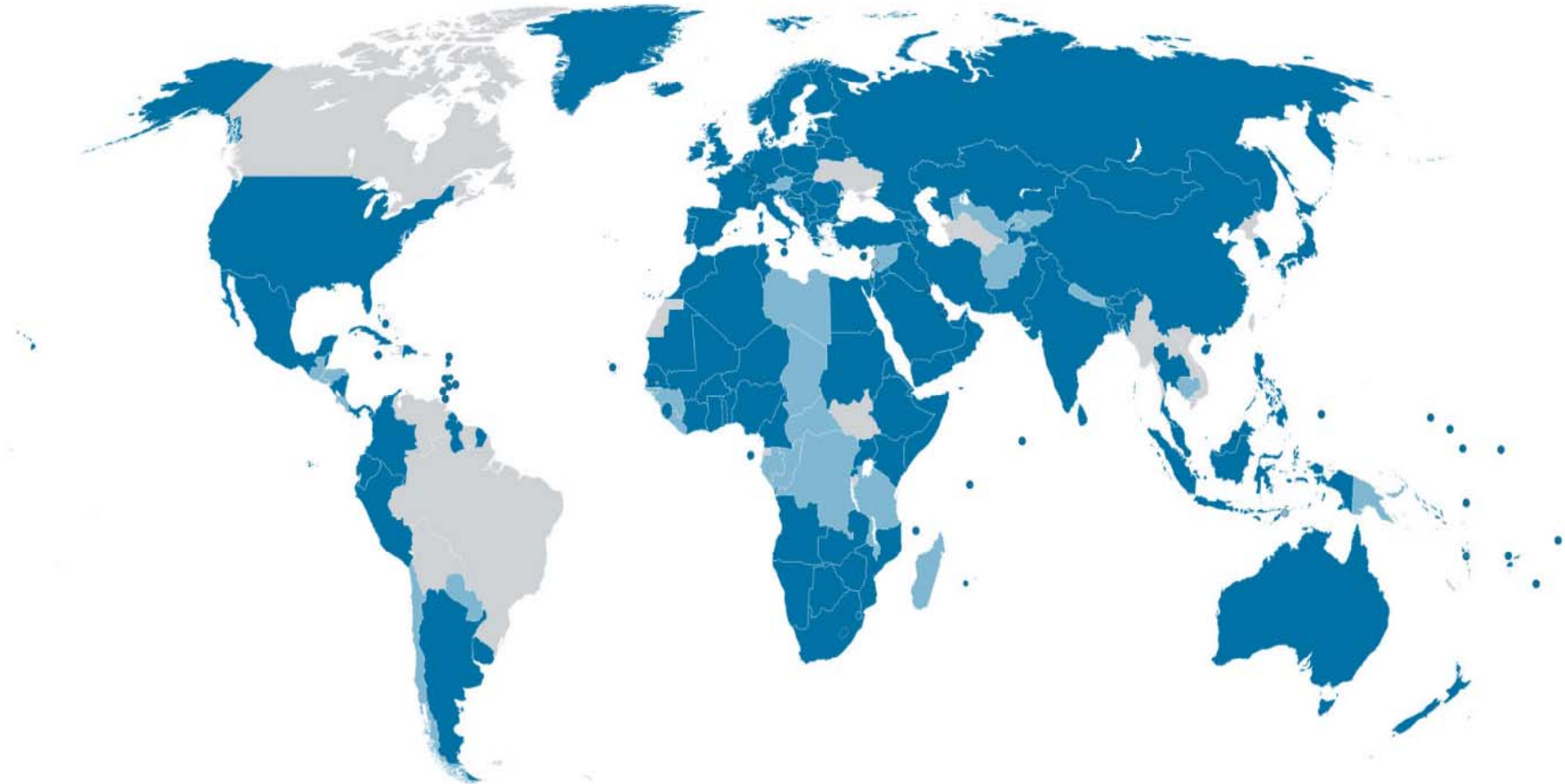




# Green Quality Dialogue

**Bonn, Germany**  
**November 4<sup>th</sup>, 2016**

# Introduction to IRENA



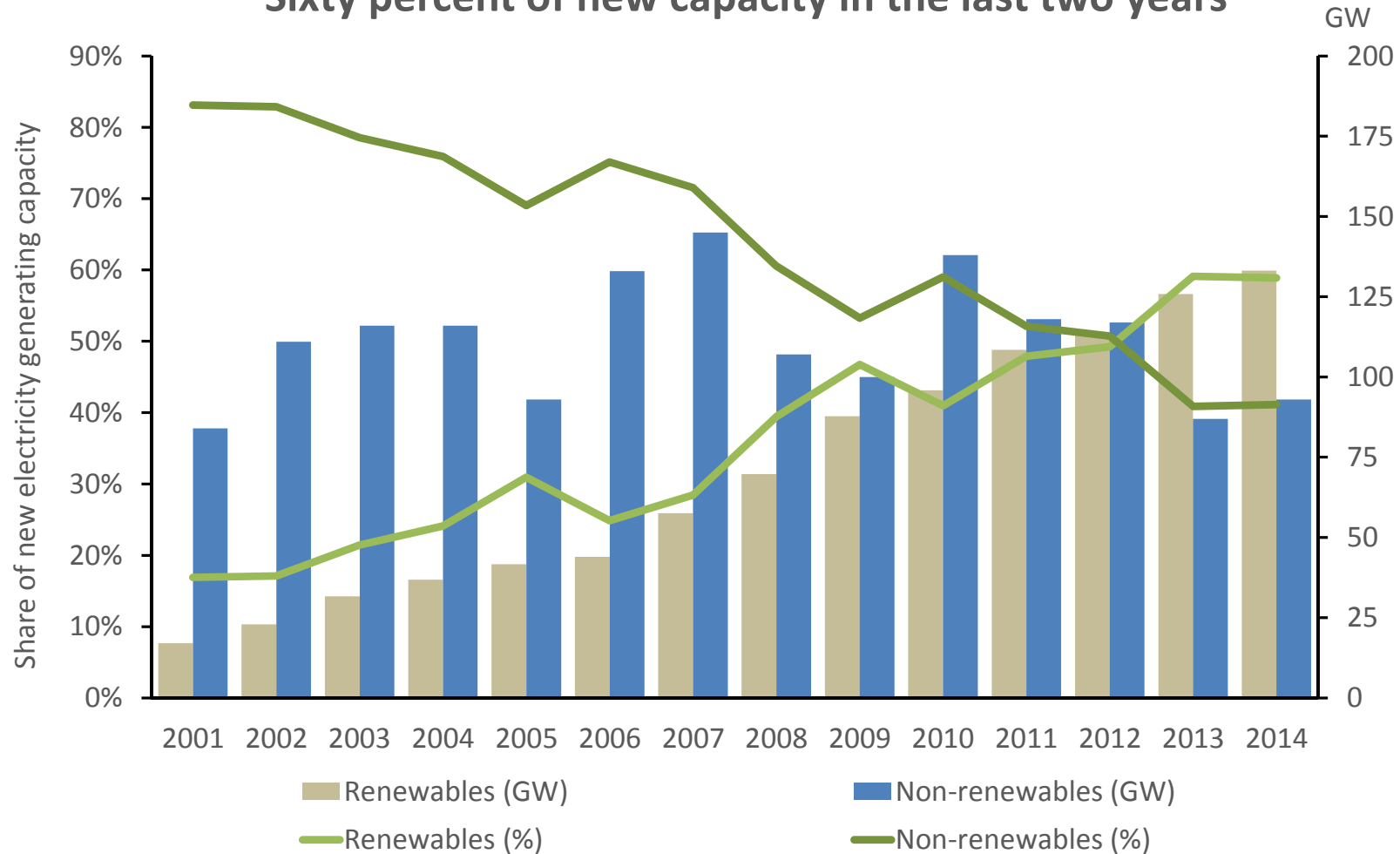
- The Intergovernmental Organisation focused on **renewable energy**
- **149 members** countries (including EU) and 27 in process of accession

# 2015: a record year for renewables

- **47 GW PV, 63 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
- **USD 360 bln investments (USD 330 bln for power)**
- **Cost continue to fall**
  - Solar PV USD 30-48/MWh in Dubai, Mexico, Peru
  - Wind USD 30-37.5/MWh in Morocco and Peru
- **164 countries with RE policies in place**
- **The global energy transition is ongoing**

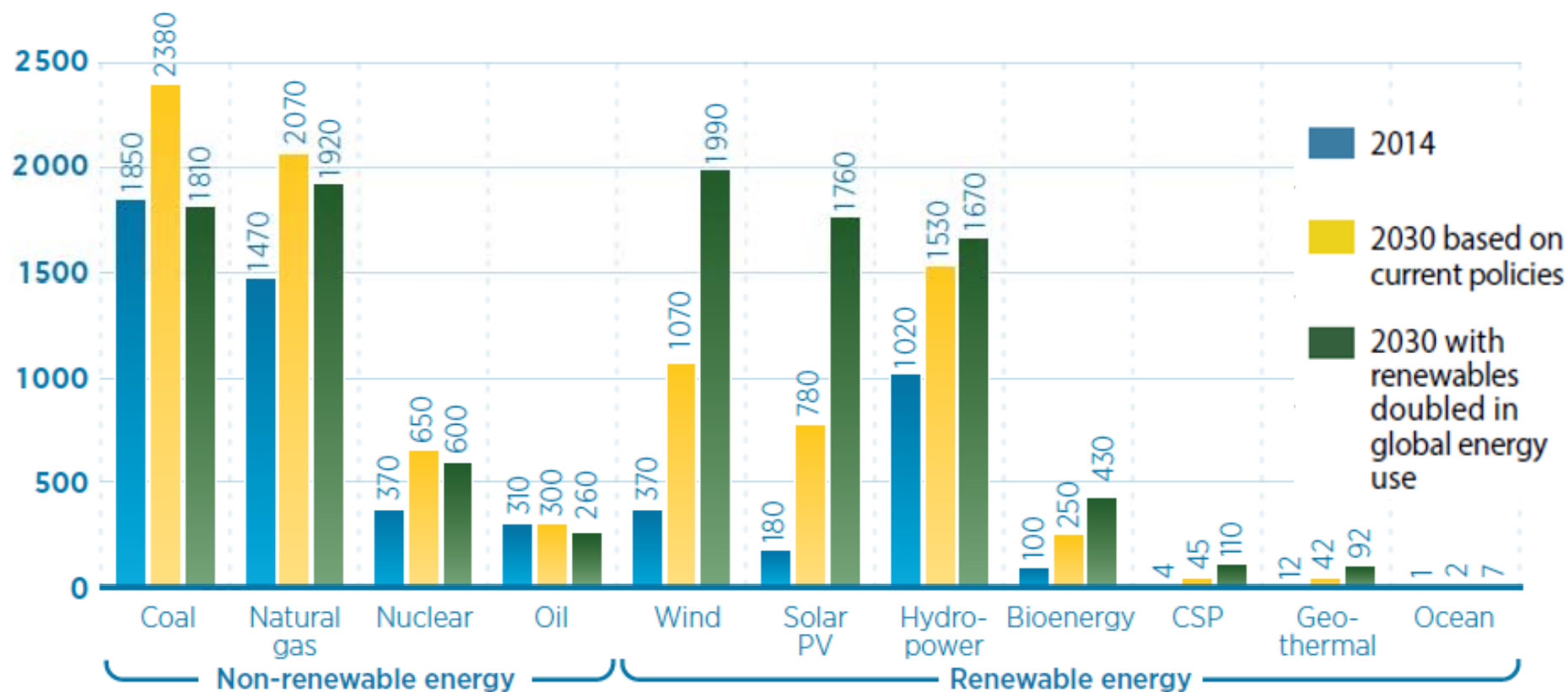
# Renewables investments have overtaken non-renewables

Sixty percent of new capacity in the last two years



# Growth in power technologies

Power generation capacity (GW installed by 2030)



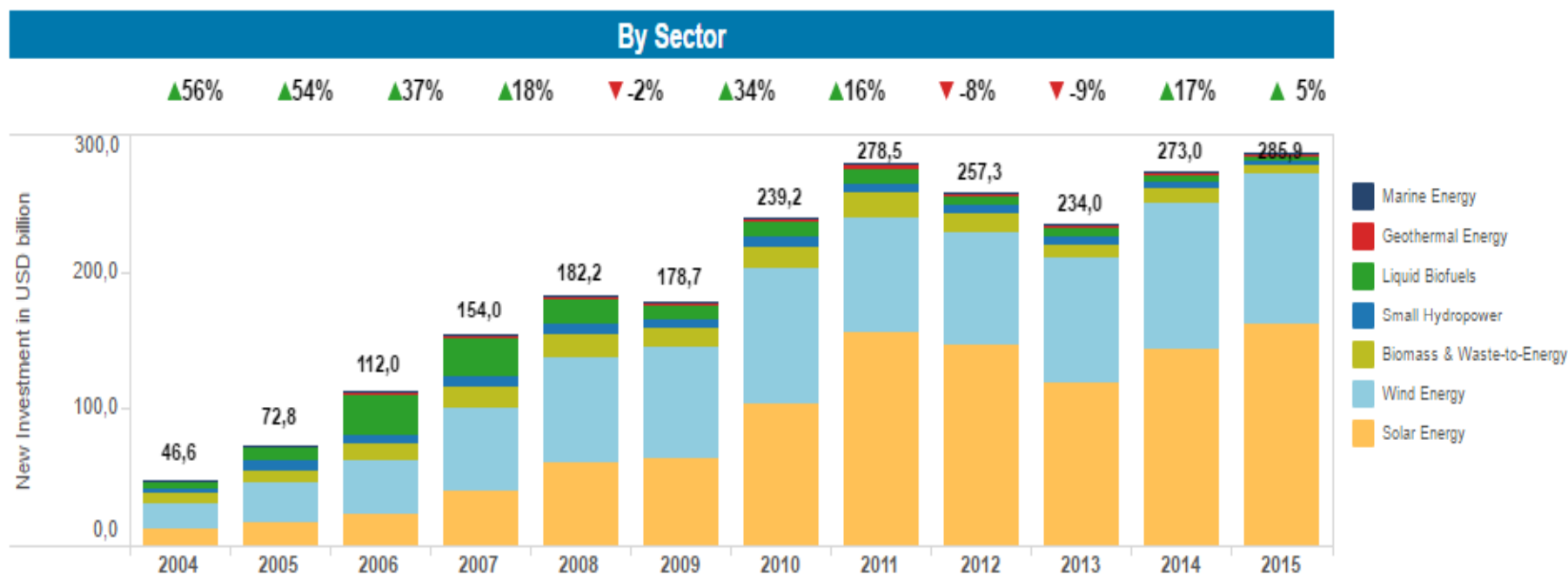
# Cost of renewable power will continue to fall

	Global weighted average data								
	Investment costs (2015 USD/kW)		Percent change	Capacity factor		Percent change <sup>2</sup>	LCOE (2015 USD/kWh)		Percent change
	2015	2025		2015	2025		2015	2025	
<b>Solar PV</b>	1 810	790	-57%	18%	19%	8%	0.13	0.06	-59%
<b>CSP (PTC: parabolic trough collector)</b>	5 550	3 700	-33%	41%	45%	8.4%	0.15 -0.19	0.09 -0.12	-37%
<b>CSP (ST: solar tower)</b>	5 700	3 600	-37%	46%	49%	7.6%	0.15 -0.19	0.08 -0.11	-43%
<b>Onshore wind</b>	1 560	1 370	-12%	27%	30%	11%	0.07	0.05	-26%
<b>Offshore wind</b>	4 650	3 950	-15%	43%	45%	4%	0.18	0.12	-35%

Renewable power generation cost will continue to fall:  
-26% to -59% by 2025

# Renewable power investments per technology

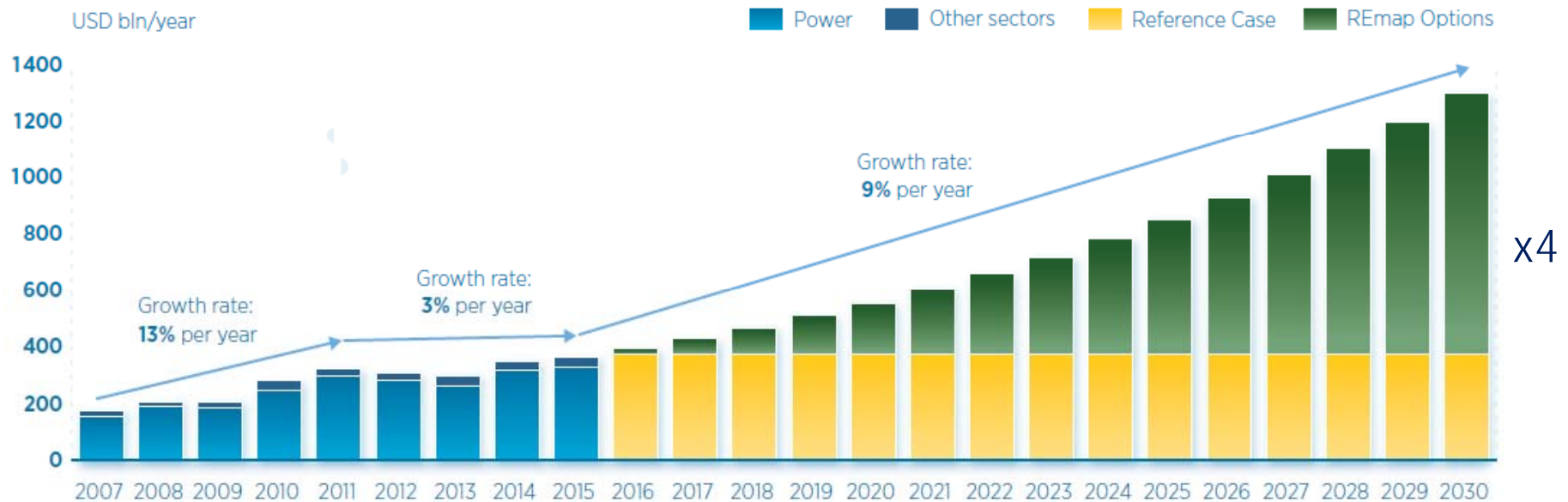
## Global Trends in Renewable Energy Investment 2016



Source: Frankfurt School-UNEP Centre/Bloomberg New Energy Finance (2016), *Global Trends in Renewable Energy Investment*.  
Note: Investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

2015: **286 USD billion**. Solar PV and wind leading

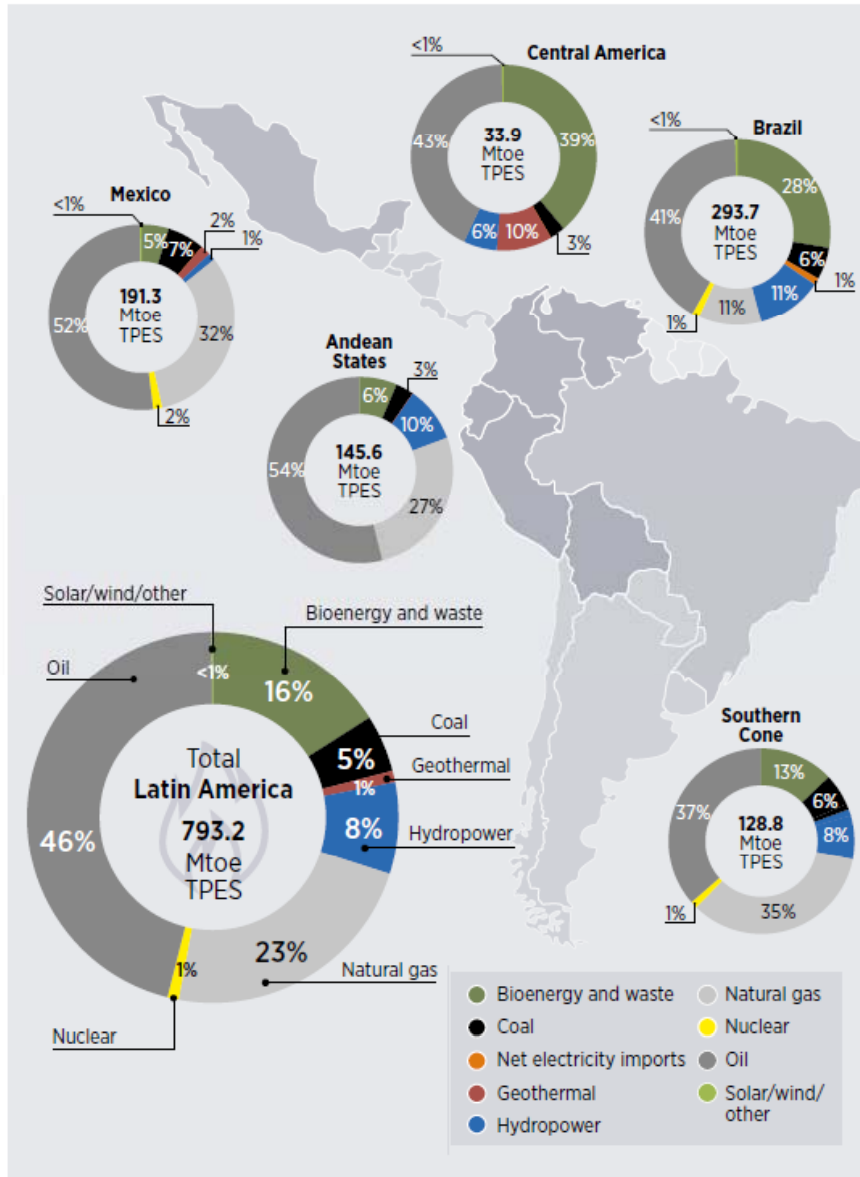
# Accelerating investments in renewables



A continued growth of renewable energy investments is needed:  
**USD 770 billion per year for 2016-2030**

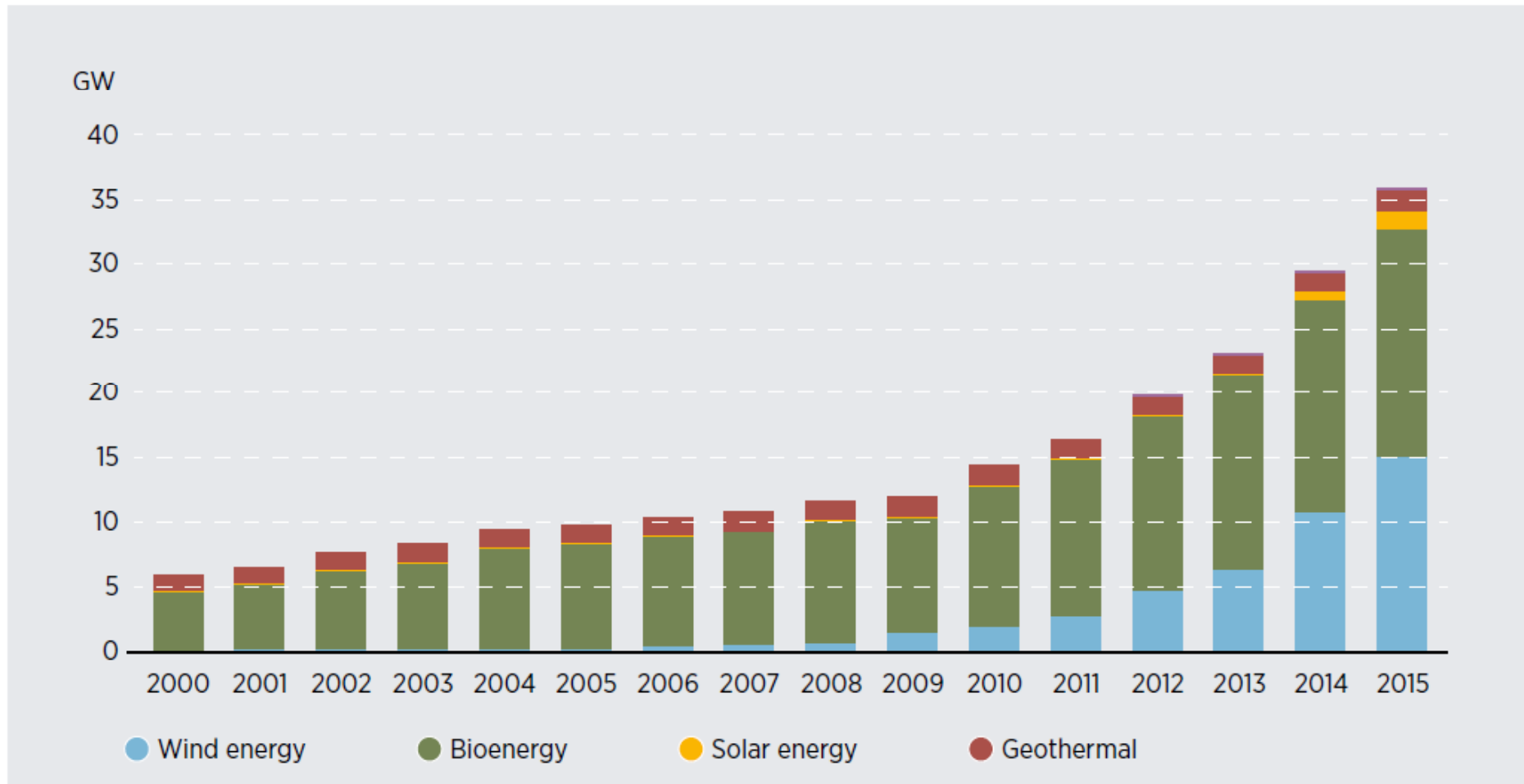


# LATAM – Energy mix



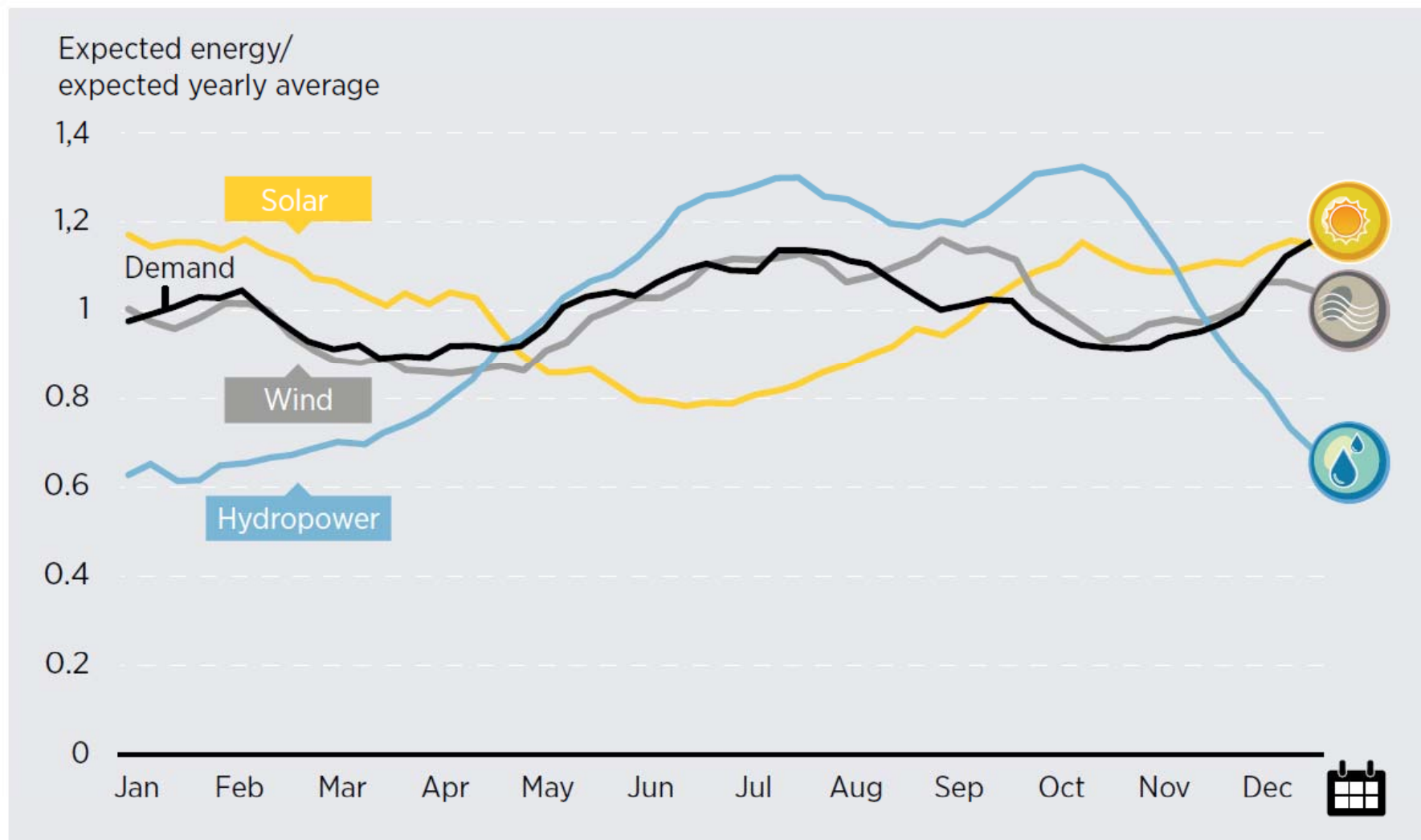
Fossil-based economy

# LATAM – RE power capacity



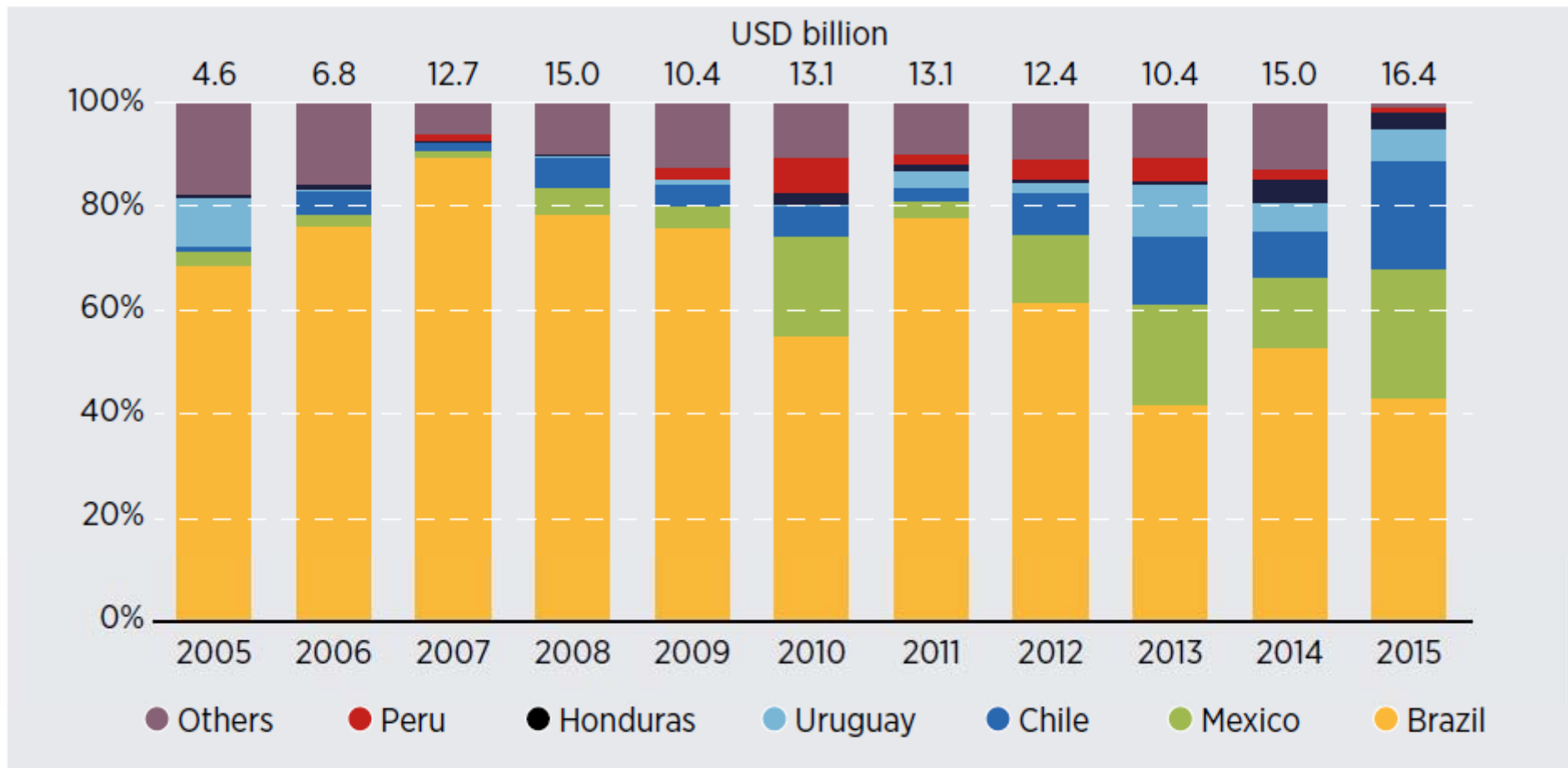
**Wind** is rapidly progressing, followed by **PV**

# Complementarity Hydro & VRE - Uruguay



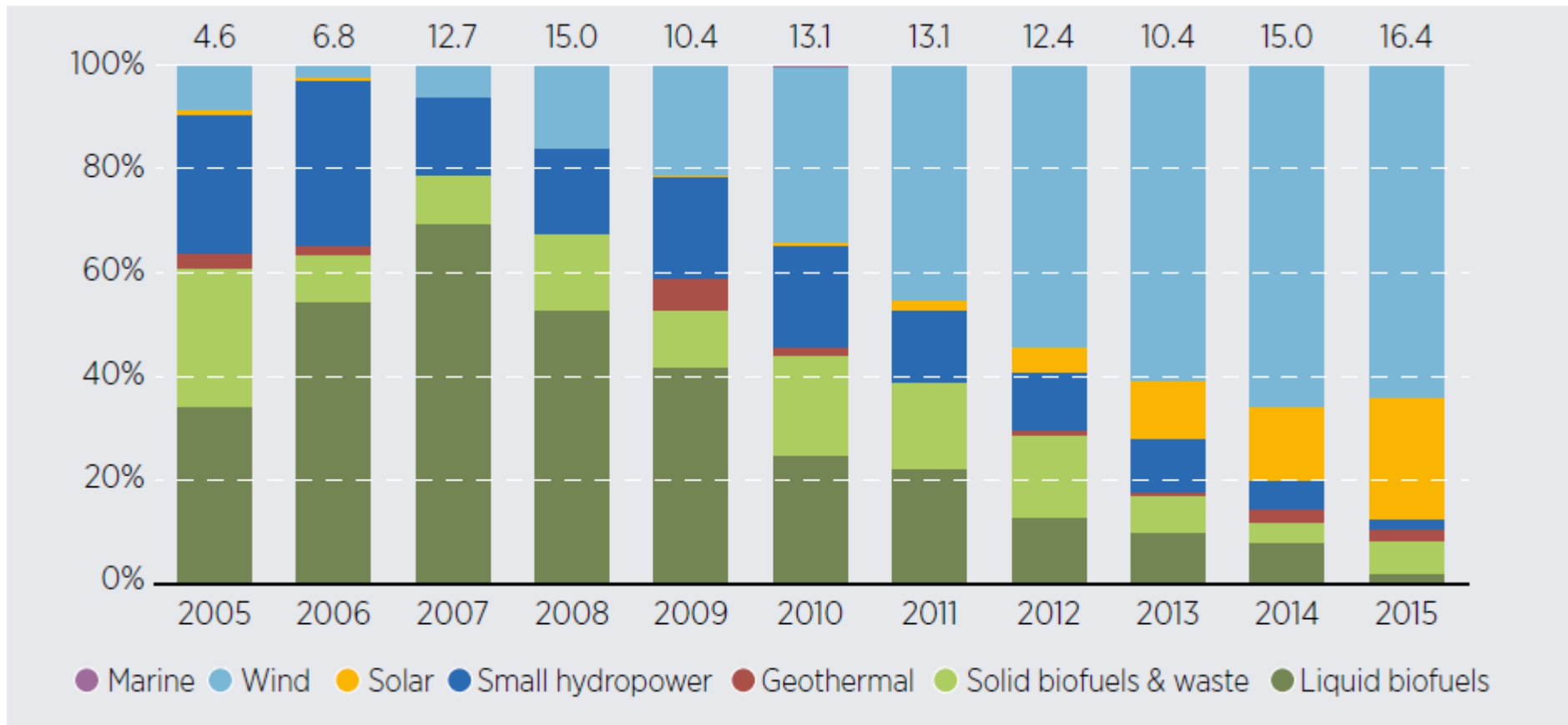
# LATAM – Investments by country

**Brazil** continues to lead  
Mexico, Chile and Uruguay accelerating

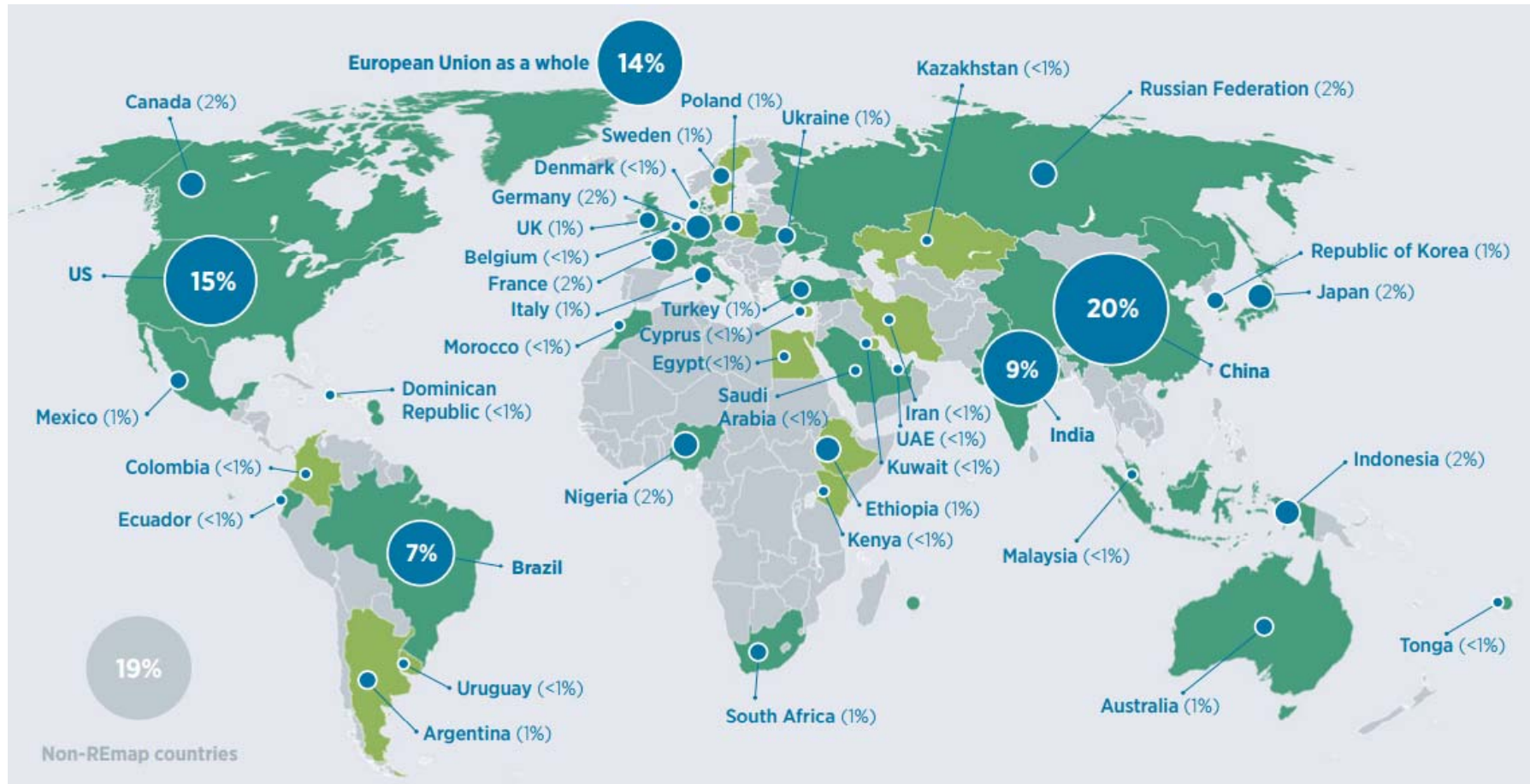


# LATAM – Investments by technology

**Wind and solar have taken from biofuels the lead in investment**



# Market opportunities

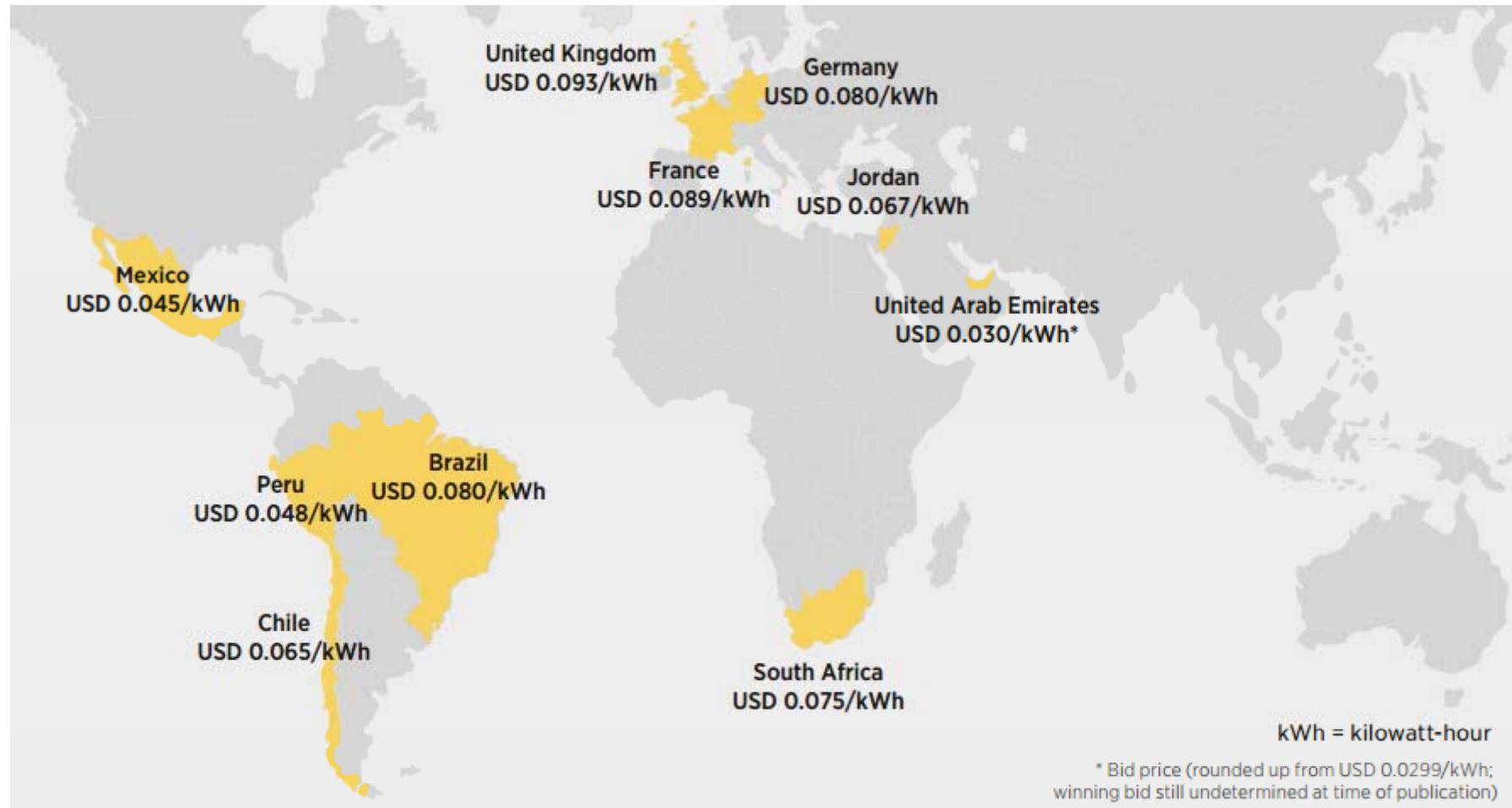


The top five countries make up more than **half** of renewable energy use in 2030; the next five bring this to nearly two-thirds.

Source: IRENA Remap 2016

Note: Percentages indicate how much renewable energy each country consumes of the global total in 2030 if a doubling of the renewable energy share is achieved.

# Prices of utility-scale solar PV in key markets



**Risks** associated to the observed prices?

# Risk management for new technologies

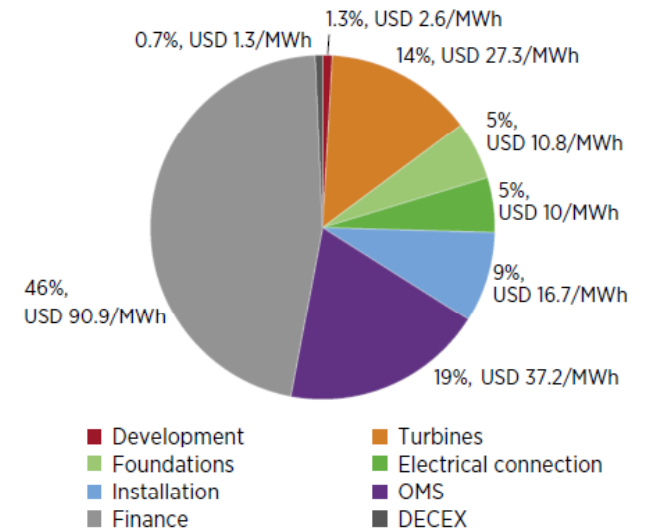
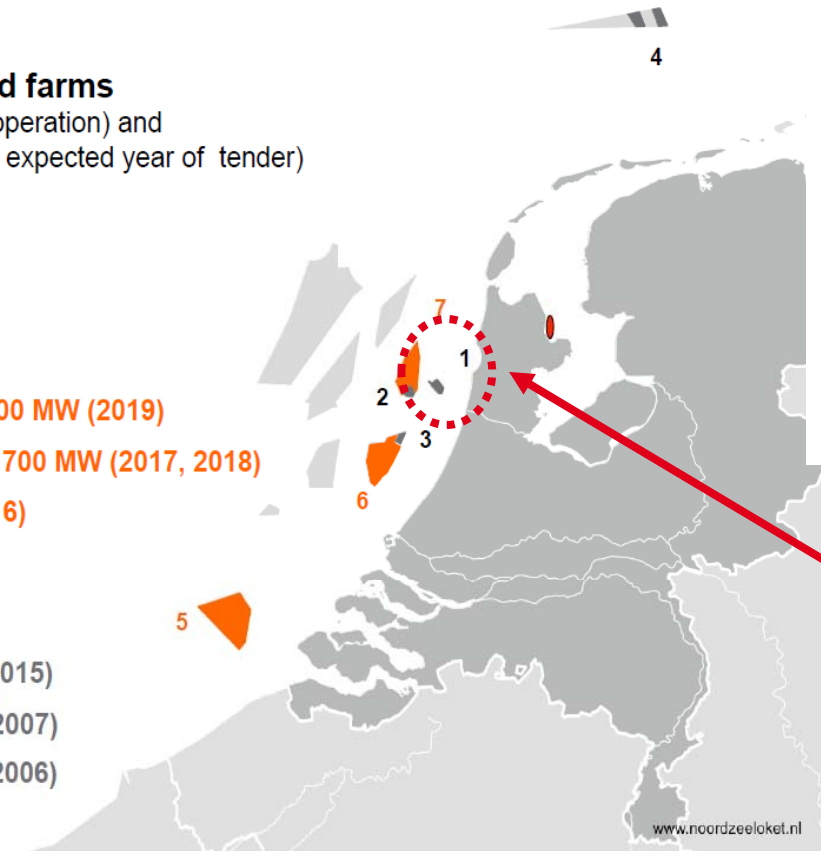
## The Netherlands' offshore status & policy

### The Dutch offshore wind farms

In operation (1-4, with year in operation) and in preparatory phase (5-6, with expected year of tender)

2016: 957 MW

- 7 Hollandse Kust (noord) 700 MW (2019)
- 6 Hollandse Kust (zuid) 2 x 700 MW (2017, 2018)
- 5 Borssele 2 x 700 MW (2016)
- 4 Gemini 600 MW (2016)
- 3 Luchterduinen 129 MW (2015)
- 2 Princes Amalia 120 MW (2007)
- 1 OWEZ 108 MW October (2006)

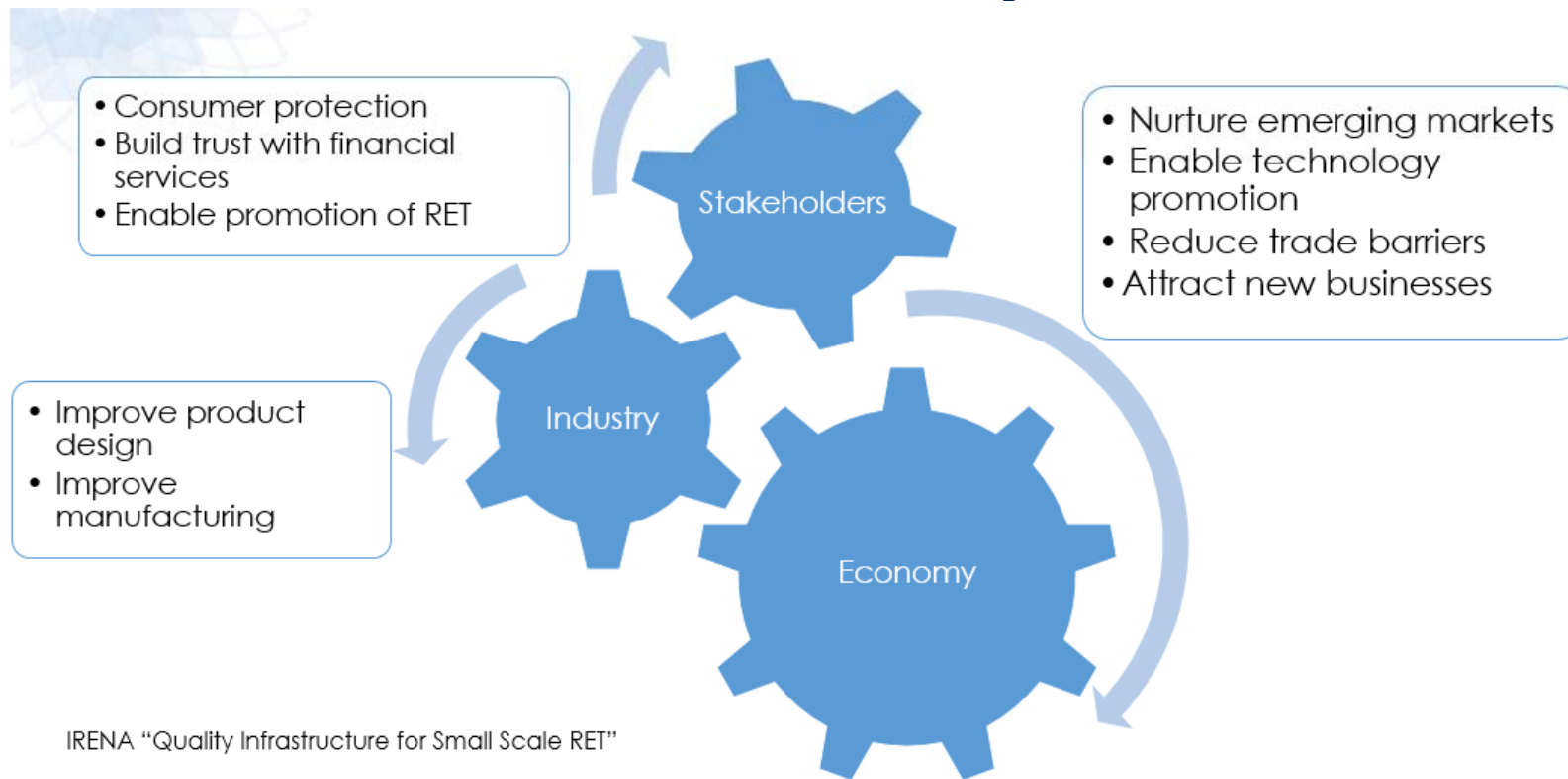


360 million EUR  
~ 60 million risk management



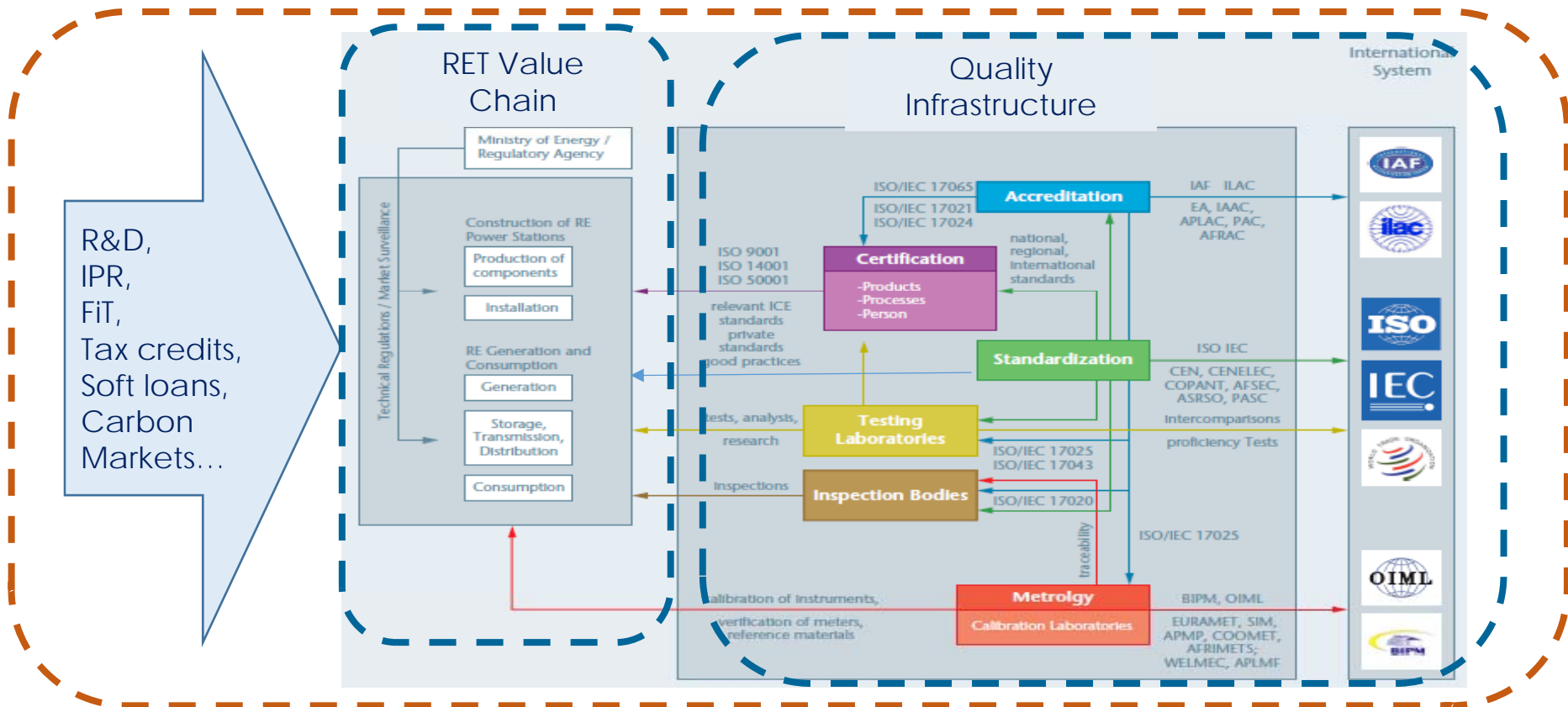
Which **instruments** do we have to mitigate technical risk, attract investment and public acceptance, and meet expectations by all stakeholders in a USD trillion market?

## International standards and conformity assessment schemes



IRENA "Quality Infrastructure for Small Scale RET"

# Implementation requires a Quality Infrastructure



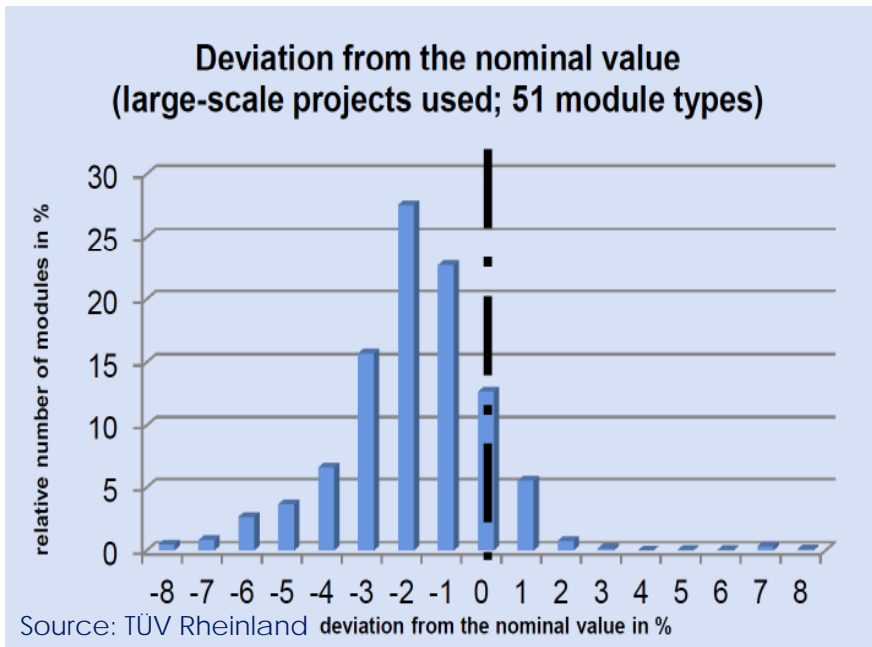
Source: Physikalisch-Technische Bundesanstalt

# Impact of standards and CA on RE markets

It is crucial to engage private sector as well as policy-makers and regulators.

*Where is the evidence of the impact of standards and CA?*

*Example: Higher PV plant outputs due to performance measurements*

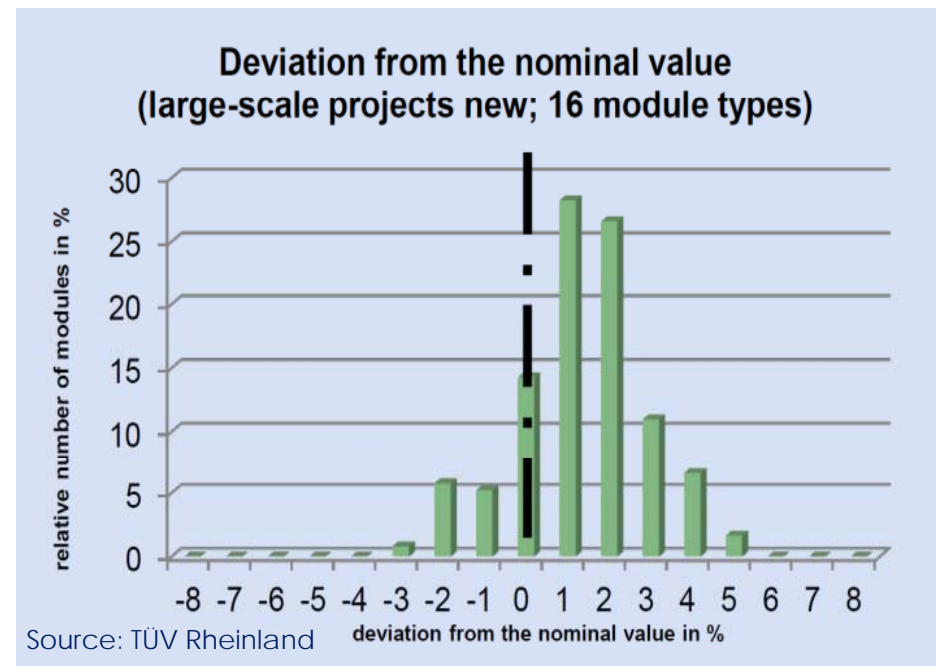


Testing not included in EPC contract

100 MW plant\*: +/- 12 million USD in 25 years

223 GW globally\*: +/- 1 billion USD/year

Testing included in Engineering, Procurement and Construction (EPC) contract



\* CF: 15% | Tariff: 0.12 USD/kWh

# International standards for grid integration

- **International standards:** Platform of discussion on good practices
- **Compliance with codes:** Quality infrastructure for electro-technical sector

Standard	Function	Content
IEC 60617	Terminology	Graphical symbols for diagrams
IEC 60034	Product specifications	Rotating electrical machinery
IEC 60044	Product specifications	Instrument transformers
IEC 60045	Product specifications	Steam turbines
IEC 60076	Product specifications	Power transformers
IEC 60143	Product specifications	Series capacitors for power systems
IEC 60186	Product specifications	Voltage transformers
IEC 60308	Product specifications	Hydraulic turbines
IEC 60358	Product specifications	Coupling capacitors
IEC 60521	Product specifications	AC watt metres
IEC 60687	Product specifications	Static watt metres
IEC 60905	Product specifications	PV devices
IEC 61194	Product specifications	Characteristic parameters of stand-alone PV systems
IEC 61277	Product specifications	Terrestrial PV systems
IEC 61400	Product specifications	Wind turbine design
IEC 61868	Product specifications	Insulating mineral oils
IEC 62052	Product specifications	Electricity metering equipment
IEEE 1094	Product specifications	Wind farm design and operation
IEEE 112	Product specifications	Induction motors
IEEE 115	Product specifications	Synchronous machines
IEEE 421	Product specifications	Synchronous machines
IEEE 929	Product specifications	Solar PV

# IRENA web platform for RE standards and patents: [www.irena.org/inspire](http://www.irena.org/inspire)

- List of standards
- Includes abstracts, normative references
- Organisation developing the standard and the hyperlinks

E.g. Standards for PV Systems



## Search Standards

Search through the catalog of important renewable energy standards

**Disclaimer:** The RE Standards Database has been developed and is maintained by IRENA. The main sources of data used are the ISO and IEC. While by no means exhaustive, this database aims at providing users with a thorough overview of the renewable energy standards most commonly used at an international level.

### Filters

Search in title and abstract

### Technology group

Solar Energy

[Search](#)

### Technology sub category

PV

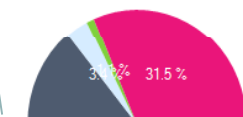
[Search](#)

### Aspects covered

[Search](#)

### Result charts

Bodies



We found 89 entries:

1 [▶](#)

**IEC 60891 ed2.0 : Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics**

#### Abstract:

IEC 60891:2009 defines procedures to be followed for temperature and irradiance corrections to the measured I-V (current-voltage) characteristics of photovoltaic devices. It also defines... [Read More](#)

#### Normative references:

IEC 60904-1, Photovoltaic devices - Part 1: Measurements of photovoltaic current-voltage characteristics  
IEC 60904-2, Photovoltaic devices - Part 2: Requirements for reference... [Read More](#)

Body: IEC | Ref.-No: **IEC 60891 ed2.0**

Technology: **PV** | Publication: **14.12.2009** | Aspect: **Testing, Sampling and Analysis** | Status: **final** | More: [IEC Website](#)

**IEC 60904 1 ed2.0 : Photovoltaic devices - Part 1: Measurement of photovoltaic current voltage characteristics**

#### Abstract:

Describes procedures for the measurement of current-voltage characteristics of photovoltaic devices in natural or simulated sunlight. Lays down basic requirements for the measurement... [Read More](#)

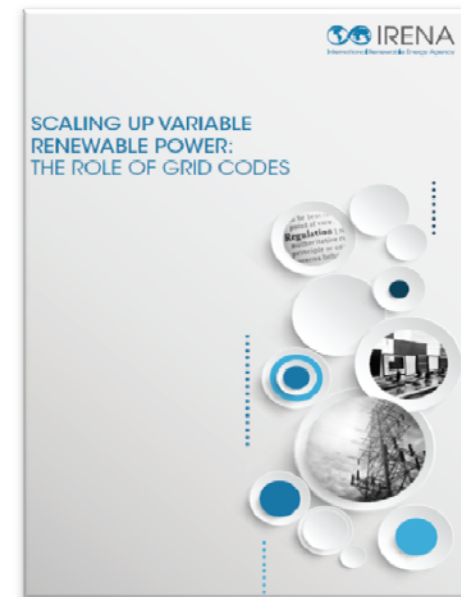
#### Normative references:

IEC 60891: Procedures for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic (PV) devices  
IEC 60904-2: Photovoltaic devices... [Read More](#)

Body: IEC | Ref.-No: **IEC 60904-1 ed2.0**

Technology: **PV** | Publication: **13.09.2006** | Aspect: **Testing, Sampling and Analysis** | Status: **ed3.0 in progress** | More: [IEC Website](#)

# Supporting countries to develop and implement QI for RET



- Interactive web tool on RET standards: [www.irena.org/inspire](http://www.irena.org/inspire)
- Studies on QI for solar thermal, small wind. Forthcoming PV
- Grid integration: grid connection codes
- Workshops with policy-makers and regulators
- Expanding cooperation with PTB, IEC and IECRE, and others

# Assistance to countries



## **Workshop – Developing quality infrastructure for solar water heating systems in LAC**

PTB LAC Project – IRENA - ICE



## **Planning and Technical Standards Development for China's Renewables**

IRENA – CREEI – IEC - IECRE

# Thank you

We are collecting illustrative cases on the impact of standards and CA on RE markets.

**Interested in sharing your case?**

Please contact:

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Alessandra Salgado ([Asalgado@irena.org](mailto:Asalgado@irena.org))

Simon Heisig ([Sheisig@irena.org](mailto:Sheisig@irena.org))



# Back Up



# Grid integration of VRE

## Current and future VRE share in annual generation G20 Countries

