

再生可能エネルギーが拓く未来

小山 雅臣

エコプレミアムクラブ

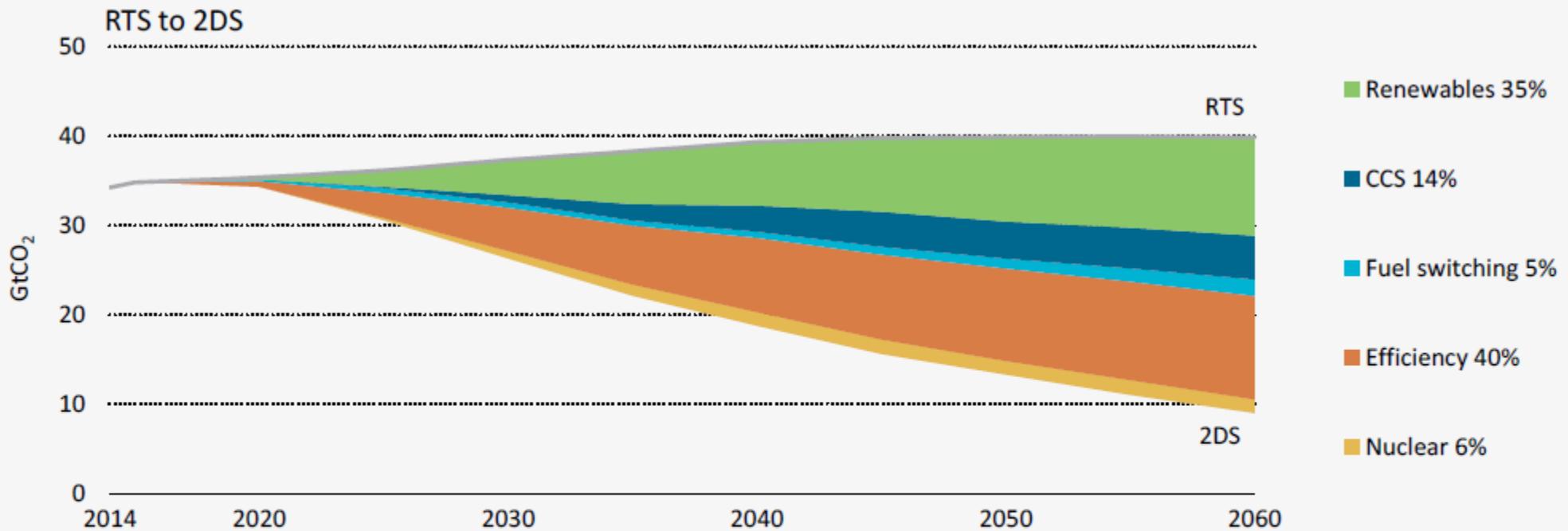
2017年8月4日

目次

1. 最近の再生可能エネルギー導入動向
2. 今後の再生可能エネルギー導入
3. 技術開発の動向（太陽光発電の例）
4. 関連技術の動向
5. 再生可能エネルギーがもたらすもの

1．最近の再生可能エネルギー導入動向

再生可能エネルギーと省エネルギーが鍵となる技術



Note: GtCO₂ = gigatonnes of carbon dioxide.

Key point

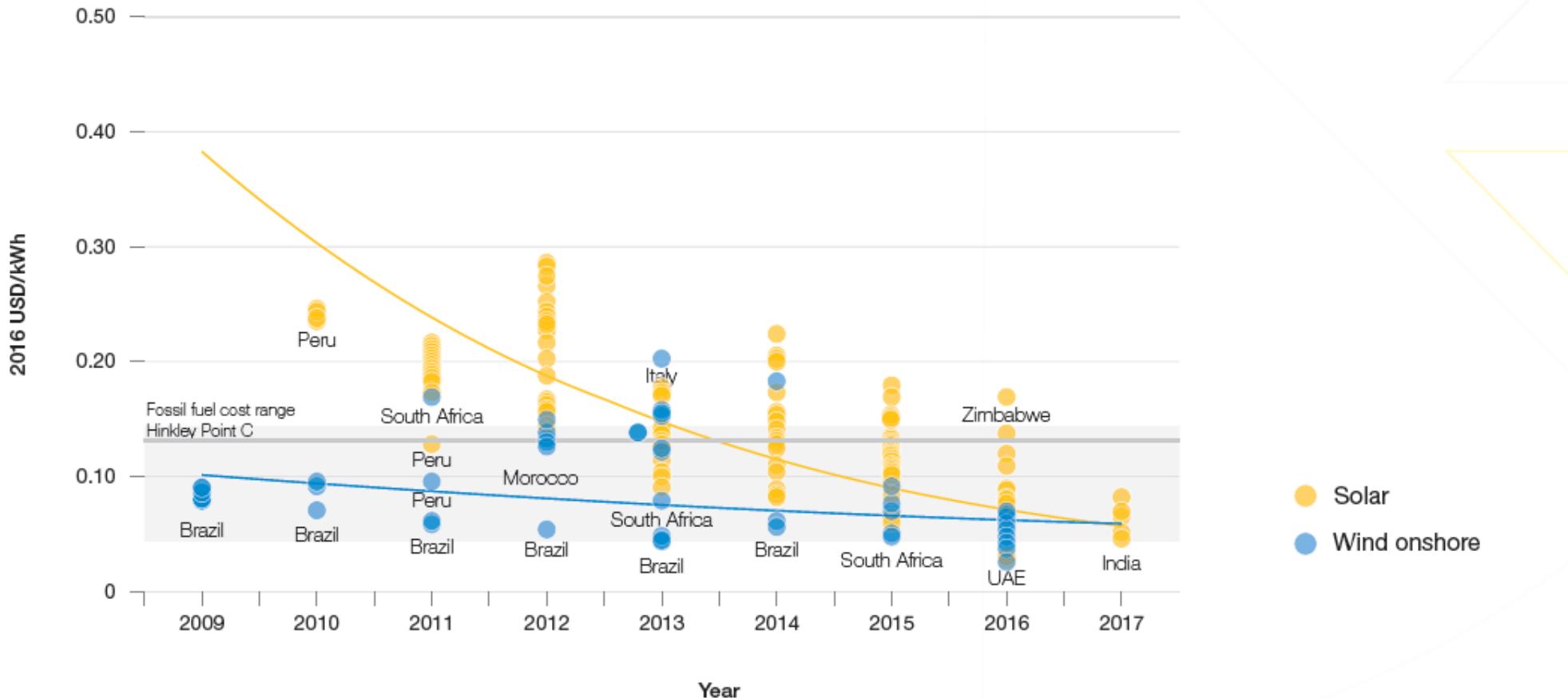
Reduction efforts are needed on both the supply and end-use sides; focusing on only one does not deliver the 2DS.

The Reference Technology Scenario (RTS) takes into account today's commitments by countries to limit emissions and improve energy efficiency, including the NDCs pledged under the Paris Agreement.

The 2°C Scenario (2DS) lays out an energy system pathway and a CO₂ emissions trajectory consistent with at least a 50% chance of limiting the average global temperature increase to 2°C by 2100.

Source: Tracking Clean Energy Progress (IEA, 2017)

太陽光発電と陸上風力発電による電力買取契約価格

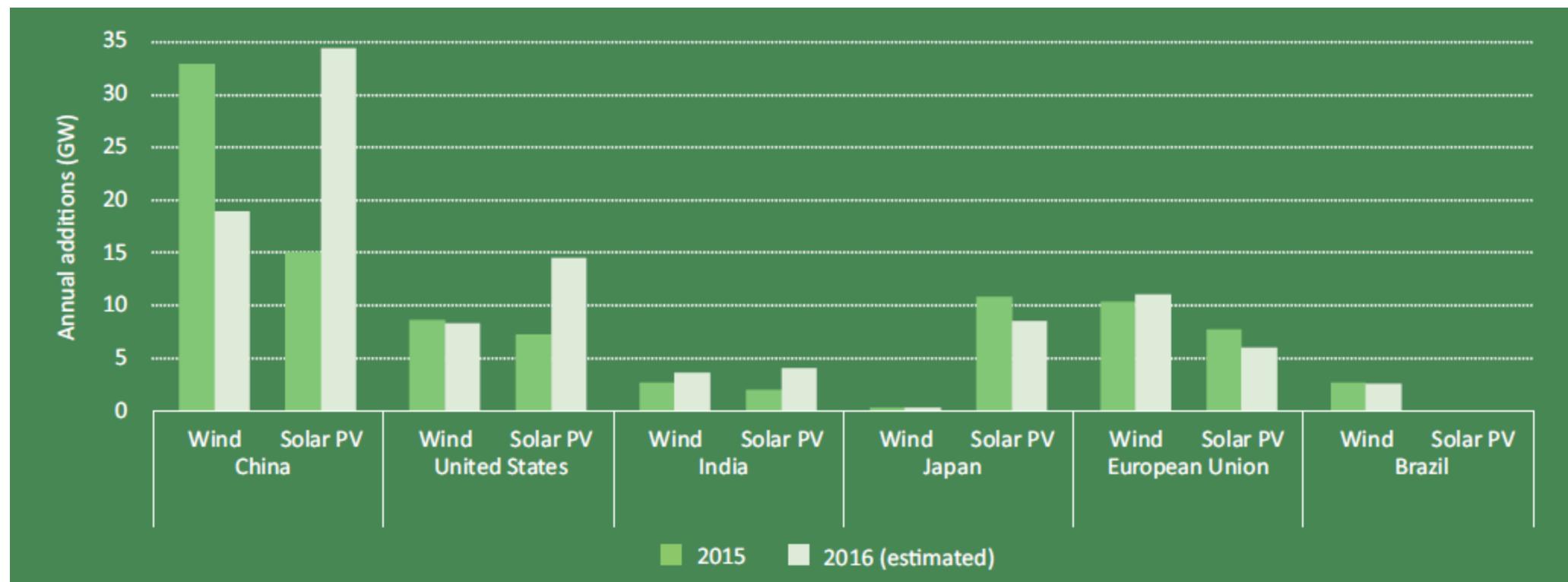


SOURCE: International Renewable Energy Agency (IRENA)

© SOLARPOWER EUROPE 2017

PPA PRICES FOR SOLAR PV AND WIND ONSHORE POWER PLANTS IN DIFFERENT COUNTRIES

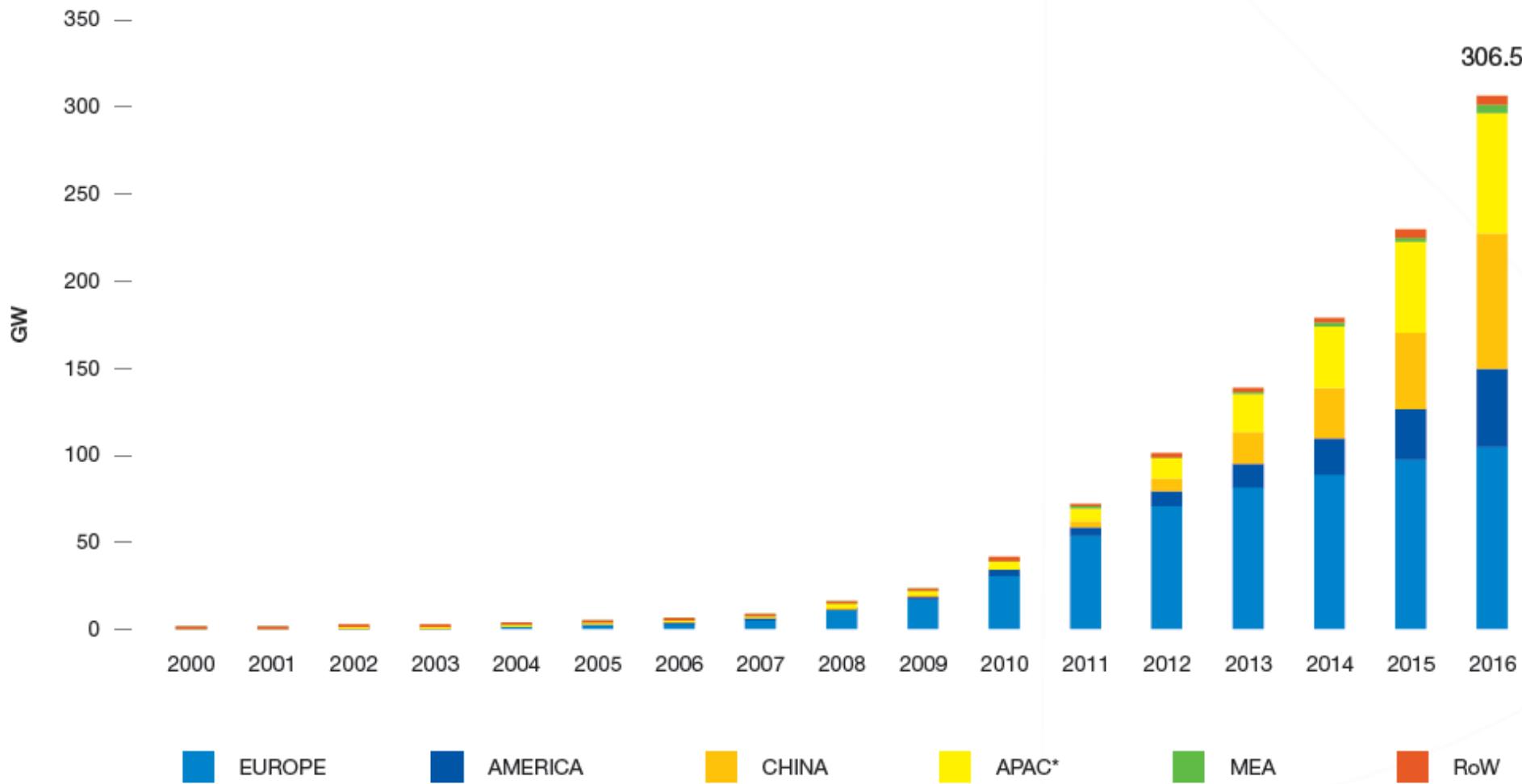
風力及び太陽光の年間追加発電容量(2015, 2016年)



Wind and solar PV annual additions 2015 and 2016 (estimated)

Source: Tracking Clean Energy Progress (IEA, 2017)

2000-2016年の地域別太陽光発電導入総容量の推移



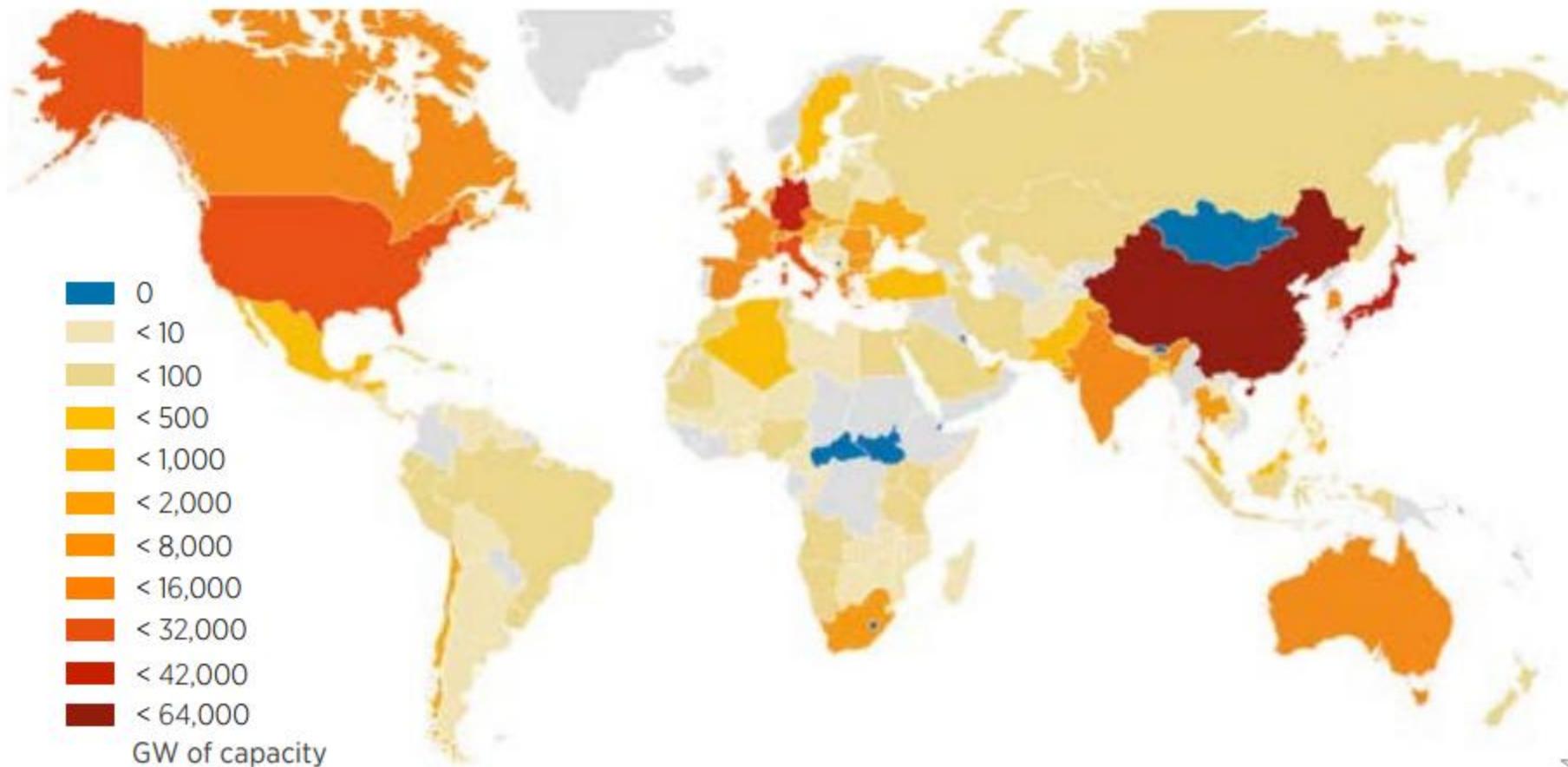
*APAC excl. China

© SOLARPOWER EUROPE 2017

EVOLUTION OF GLOBAL TOTAL SOLAR PV INSTALLED CAPACITY 2000-2016

Source: Global Solar Market Outlook for solar power 2017-2021 (Solar Power Europe, 2017) 6

国別太陽光発電導入容量(2015年)



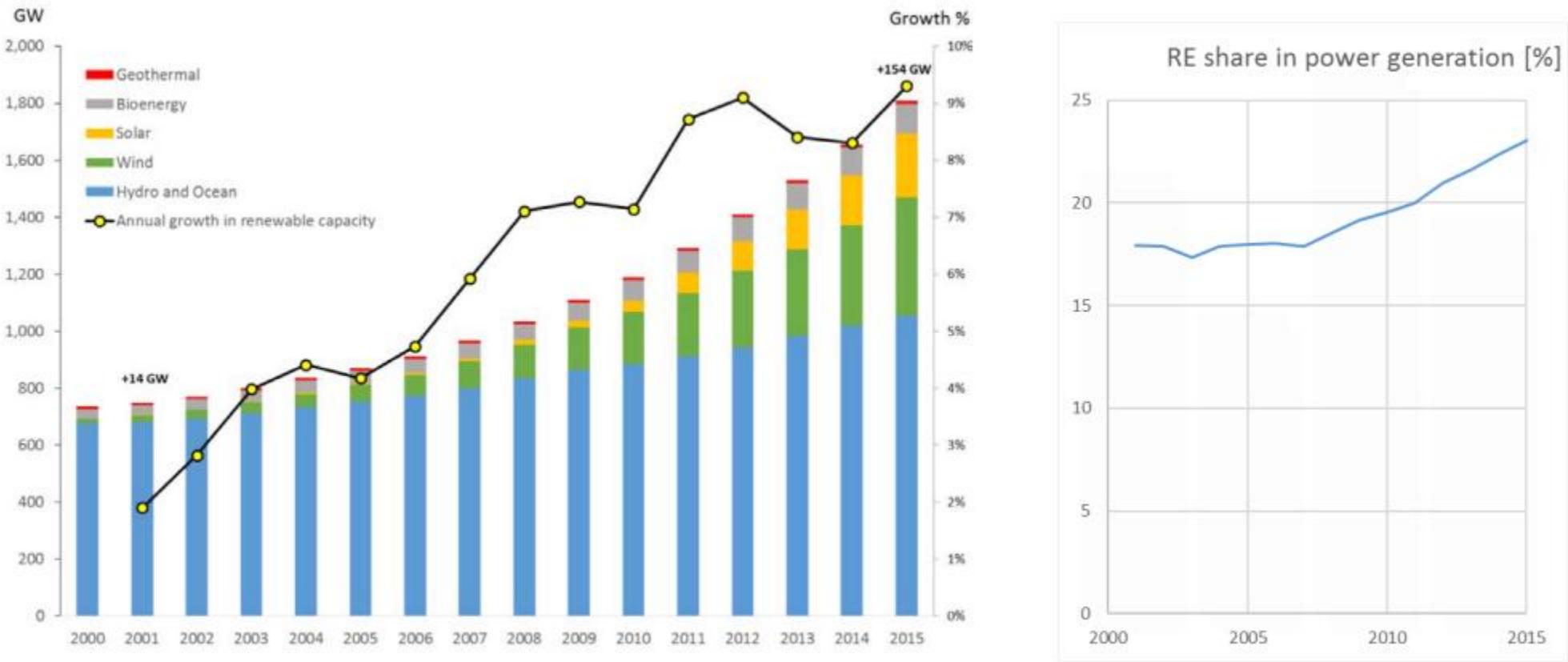
Source: IRENA, 2016j

²⁸ Includes all asset classes (asset finance, corporate R&D, government R&D, public markets, reinvested equity, small distributed capacity and venture capital/private equity) and excludes large-scale hydropower (over 50 MW). The solar PV figure does not include corporate R&D, government R&D, public markets, reinvested equity and venture capital/private equity. Note that USD 12 billion was invested in "unspecified solar" during 2015 (BNEF, 2016a). At least some of this applies to solar PV, but is not included in the USD 149 billion.

Global cumulative installed solar PV capacity by country, 2015

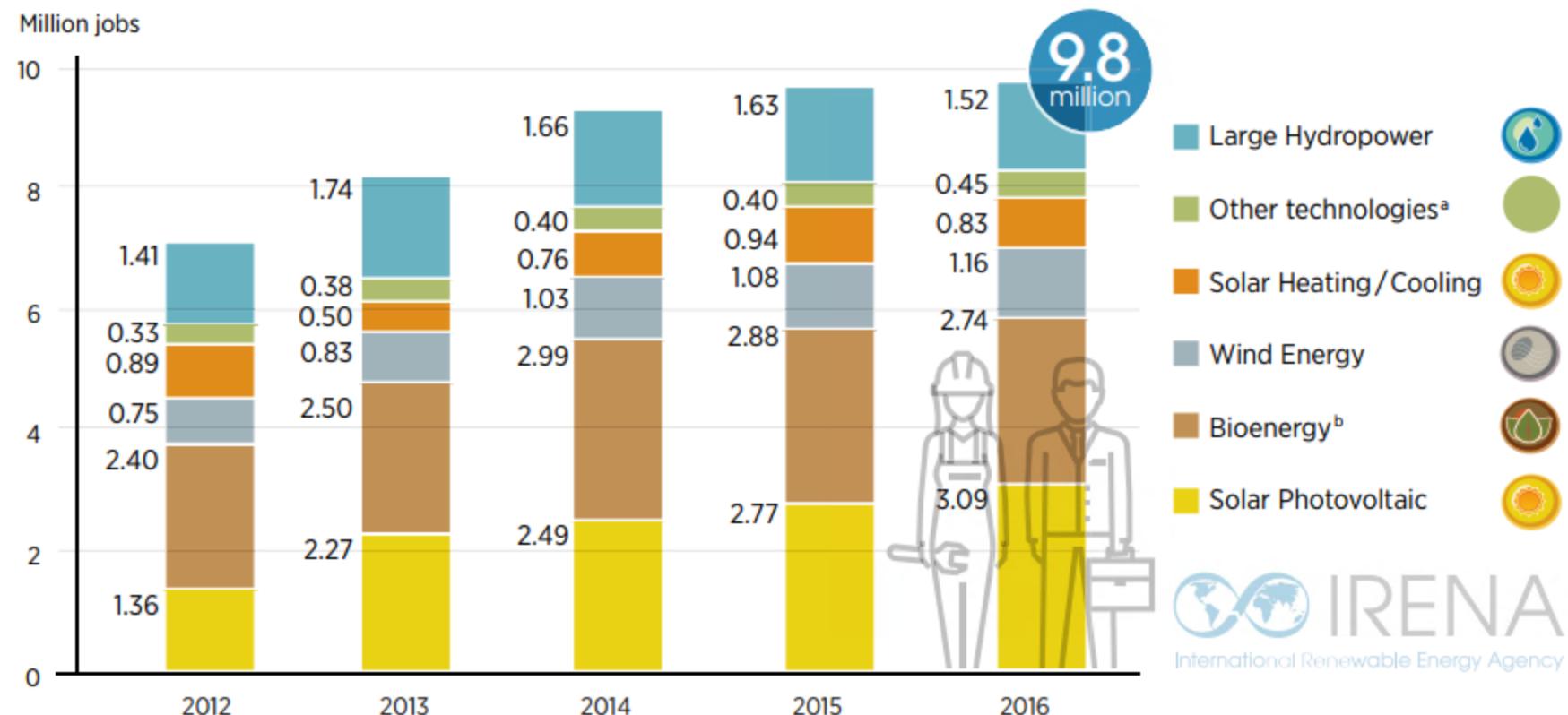
Source: REthinking Energy 2017 (IRENA, 2017)

再生可能エネルギー発電容量と発電におけるシェア



Source: Accelerating Energy Transition through Innovation(IRENA, 2017)

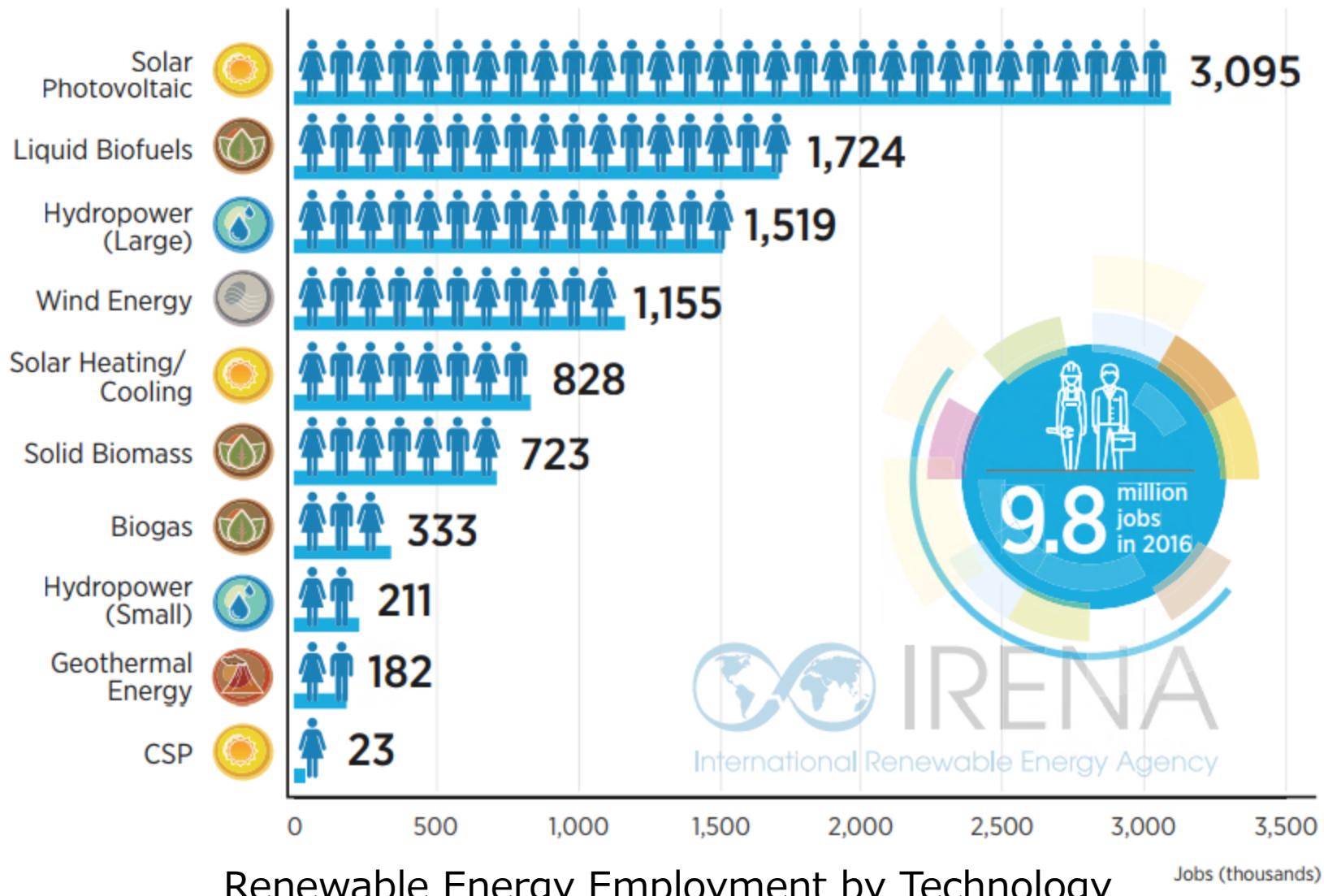
世界の再生可能エネルギー関連雇用(2012-2016年)



Global Renewable Energy Employment, 2012-2016

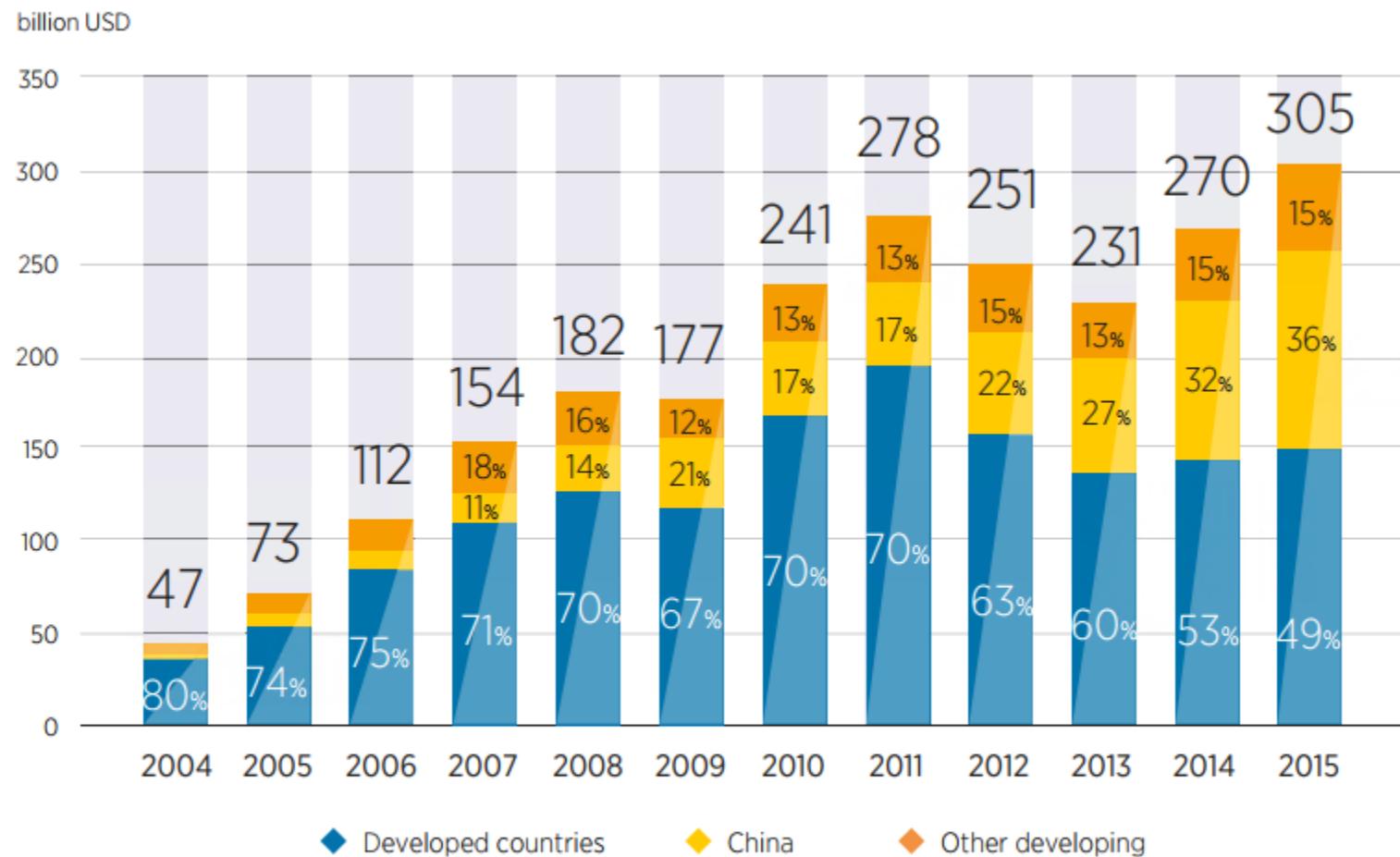
Source: Renewable Energy and Jobs, Annual Review 2017 (IRENA, 2017)

技術別再生可能エネルギー関連雇用



Source: Renewable Energy and Jobs, Annual Review 2017 (IRENA, 2017)

世界の再生可能エネルギーへの投資及び地域別シェア(2004年-2015年)



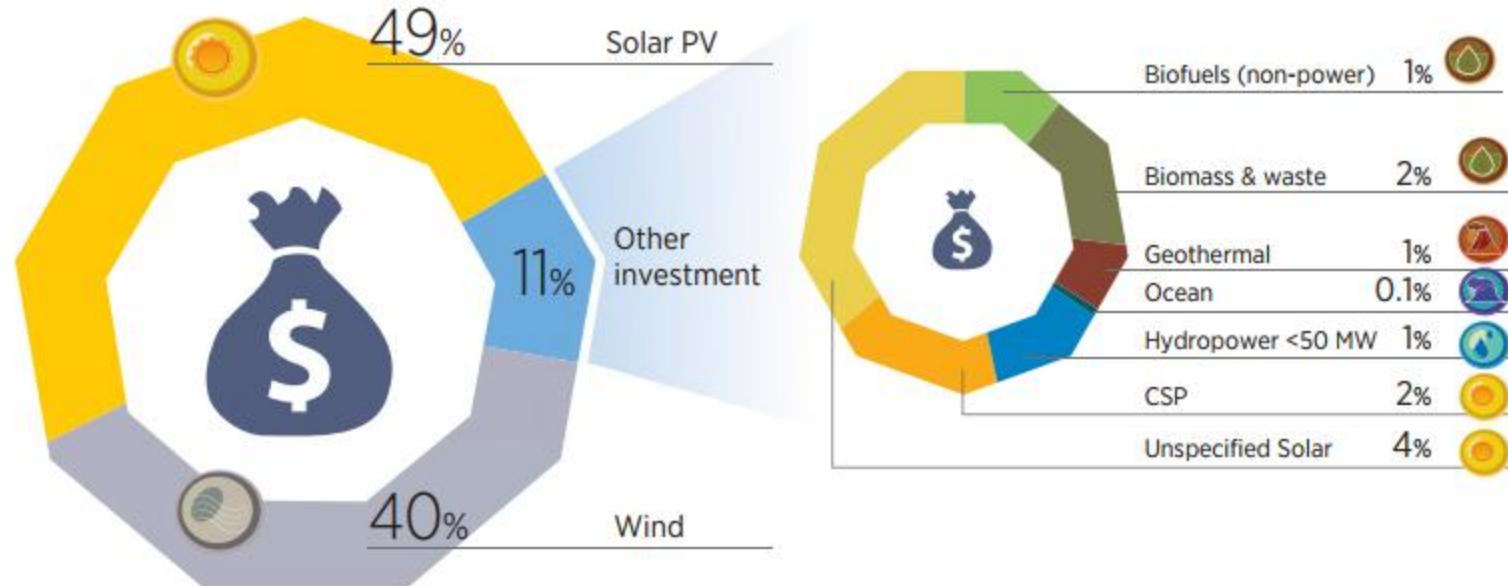
Source: BNEF, 2016a

Note: a) This includes all asset classes (asset finance, corporate research and development (R&D), government R&D, public markets, reinvested equity, small distributed capacity and venture capital/private equity). It excludes large-scale hydropower (over 50 MW) due to lack of data for the years before 2010. Figures are in current USD.

Global Investment in Renewables, and Share by Geography, 2004-2015

Source: REthinking Energy 2017 (IRENA, 2017) 11

技術別世界の再生可能エネルギー投資(2015年)



Source: BNEF, 2016a

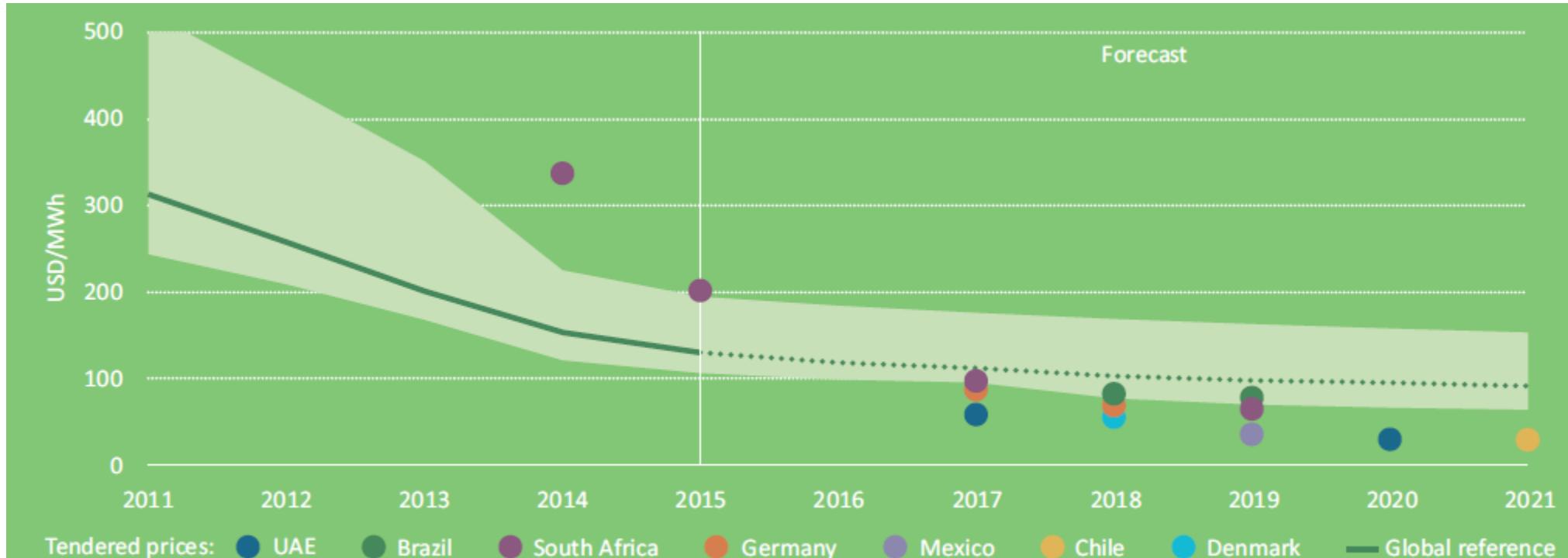
Note: a) This includes all asset classes (asset finance, corporate R&D, government R&D, public markets, reinvested equity, small distributed capacity and venture capital/private equity). It excludes large-scale hydropower (over 50 MW). Figures are in current USD.

Global investment in renewables by technology, 2015

Source: REthinking Energy 2017 (IRENA, 2017)

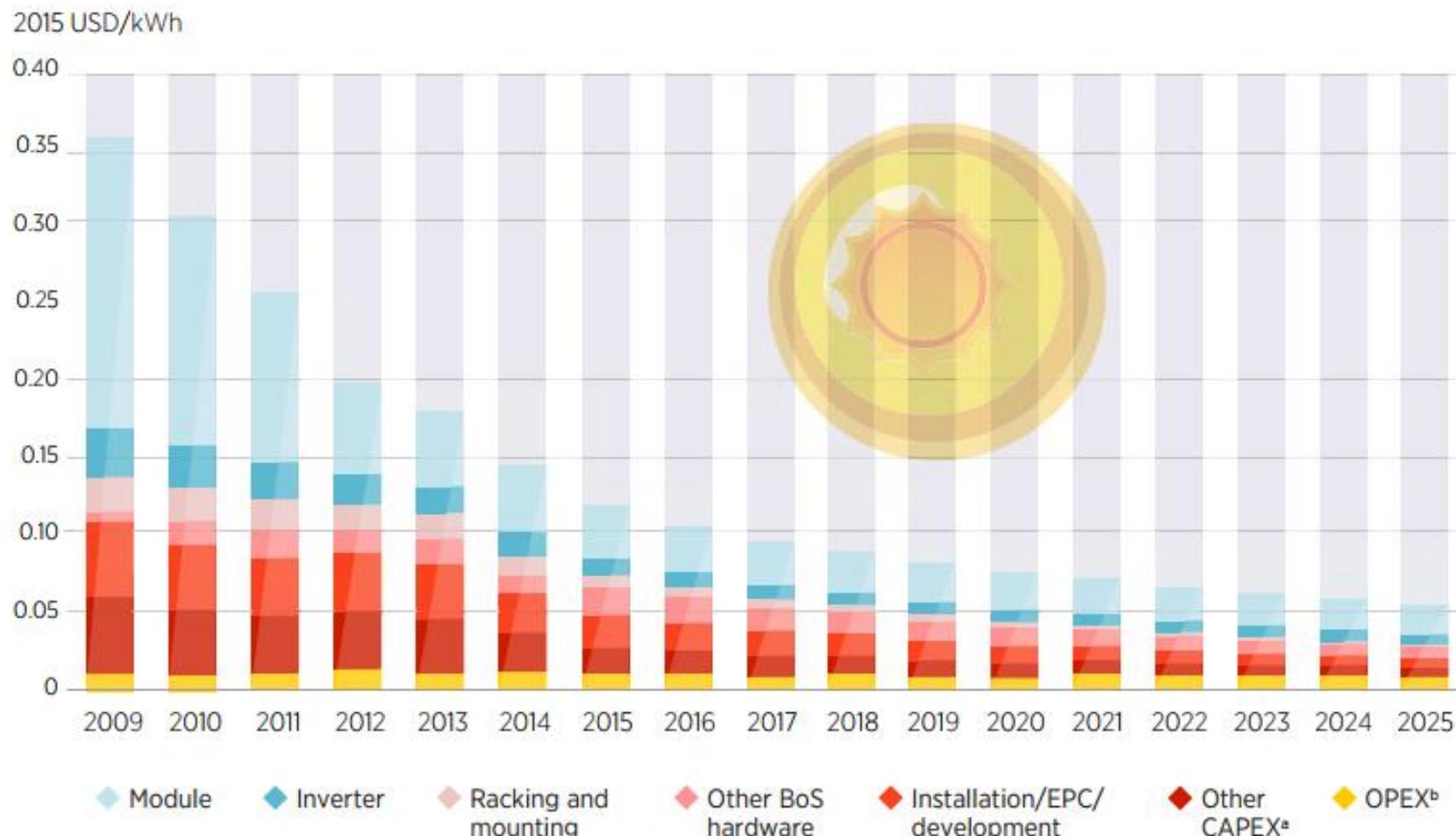
2. 今後の再生可能エネルギー導入

太陽光発電のLCOEと契約価格



Source: Tracking Clean Energy Progress (IEA, 2017)

発電事業規模太陽光発電の加重平均LCOE(2009-2015年実績及び2016-2025年見込)



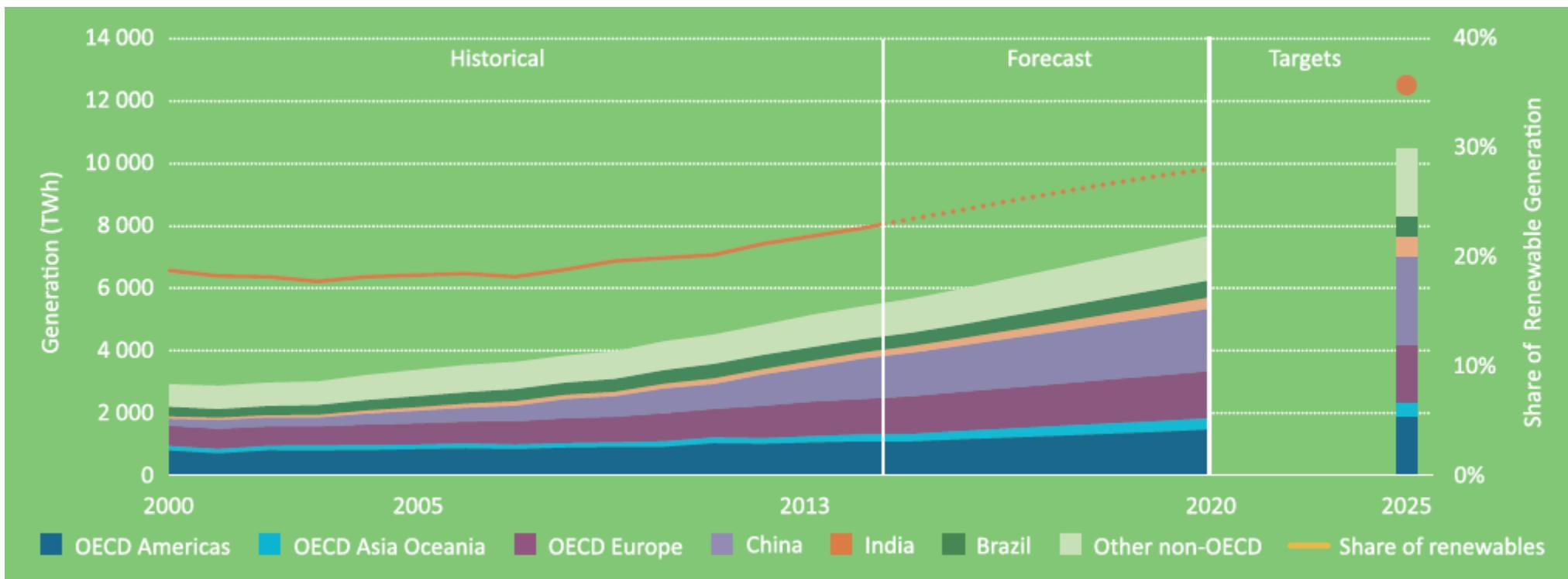
Note: a) CAPEX = capital expenditures, b) OPEX = operating expenses

Source: Results use a 7.5% weighted average cost of capital (WACC); all other input assumptions are from IRENA (2016p)

¹⁹ This estimate assumes that 200-300 TWh solar PV replaces coal power plants, which operate at 35% efficiency and emit 1 million tonnes of CO₂ per TWh.

Global weighted average utility-scale solar PV LCOE, actual (2009-2015) and projected (2016-2025)

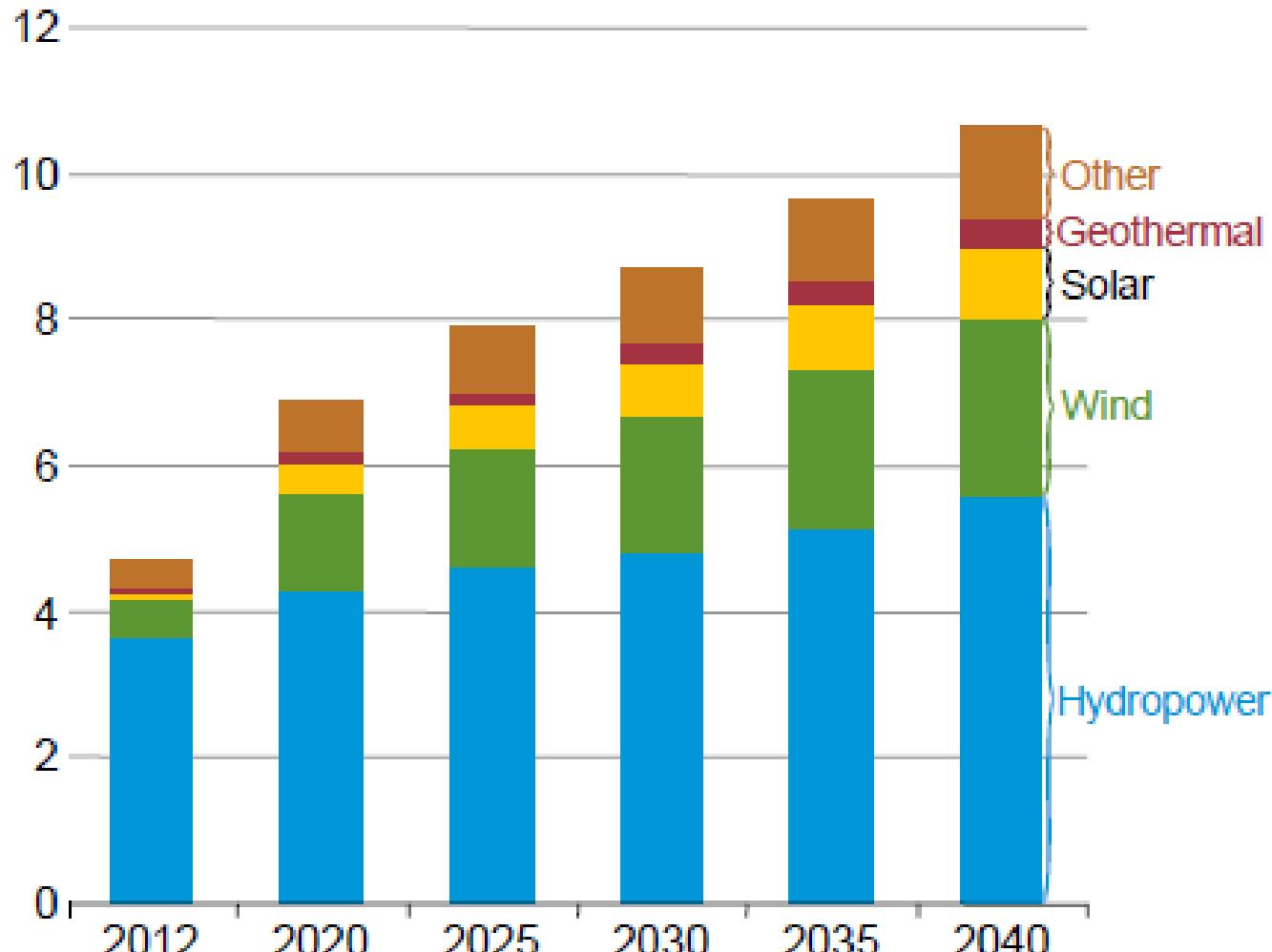
地域別再生可能エネルギー発電量（実績、予測、目標）



Total renewable power generation by region

Source: Tracking Clean Energy Progress (IEA, 2017)

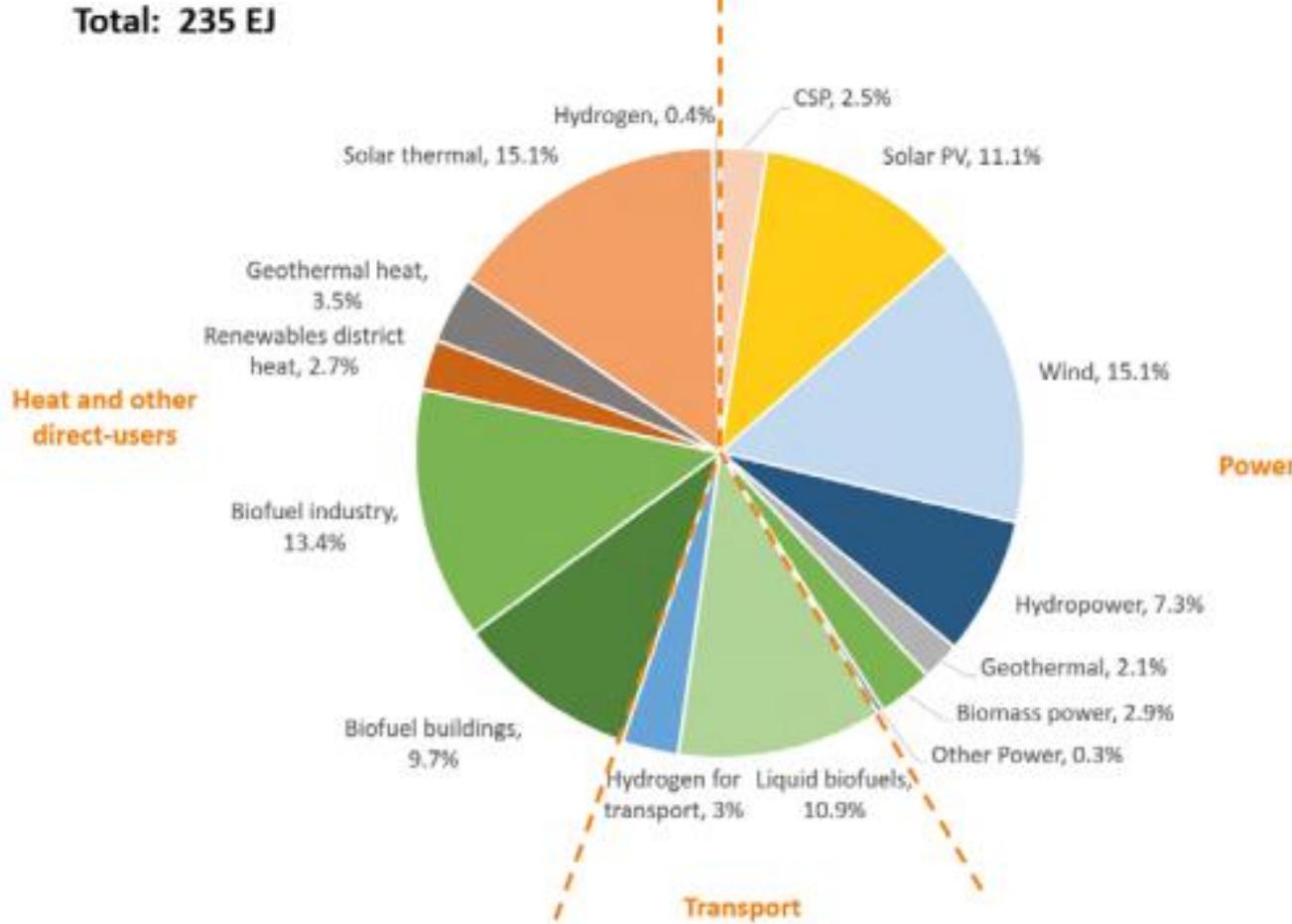
世界の再生可能エネルギー発電量(2012-2040)



Note: Other generation includes biomass, waste, and tide/wave/ocean.

World net electricity generation from renewable power by fuel, 2012–40 (trillion kilowatthours)

2050年における再生可能エネルギー技術の発展予想



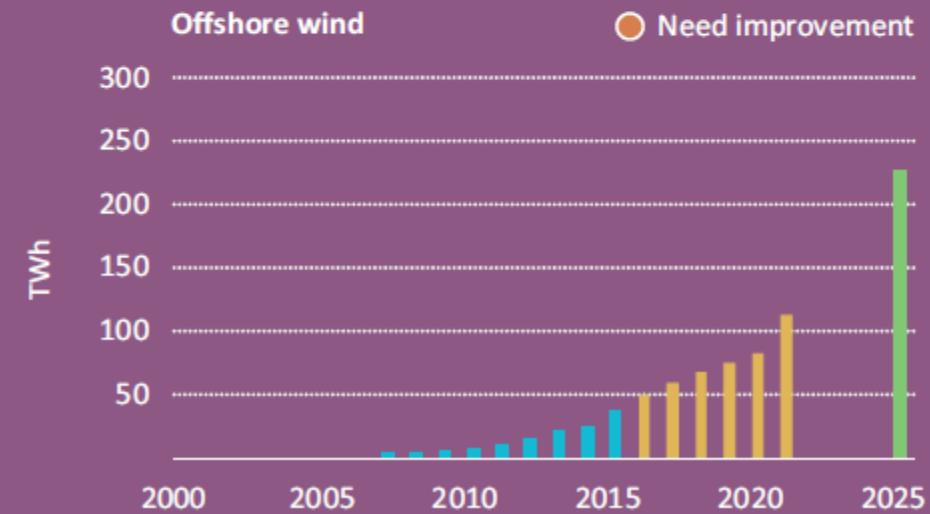
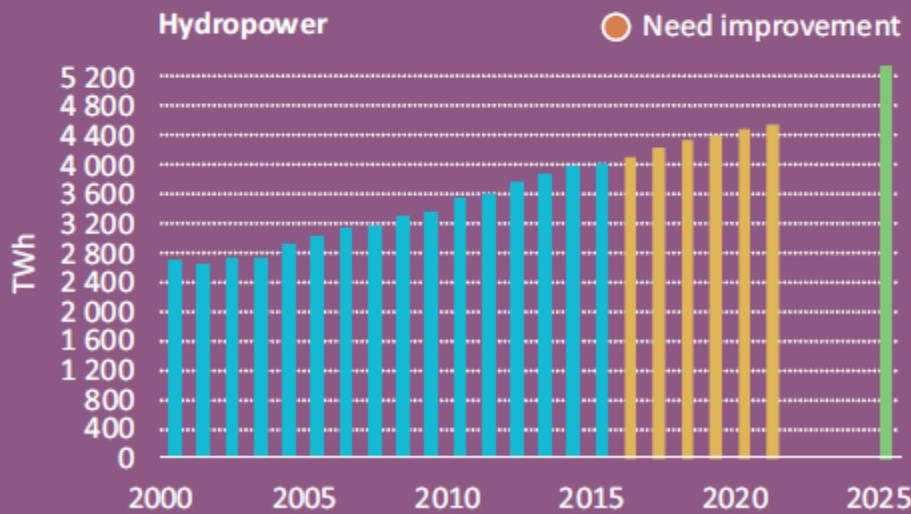
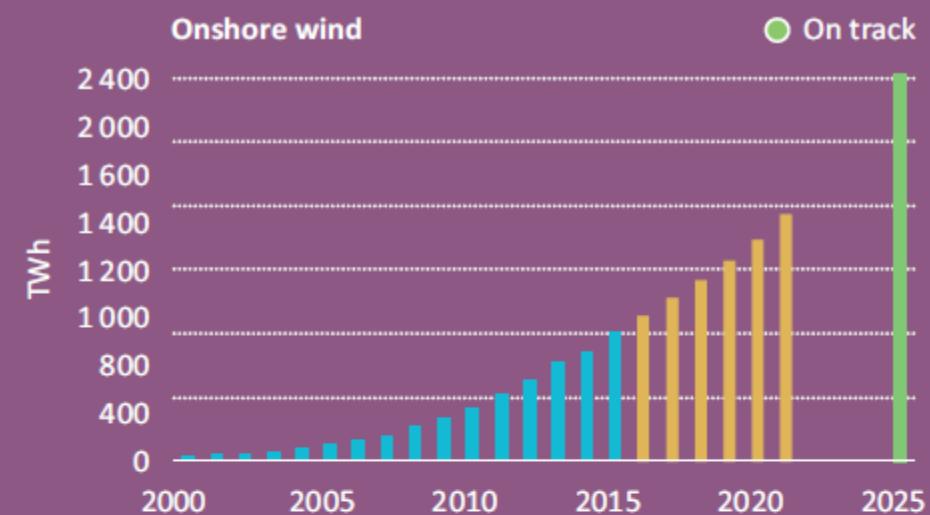
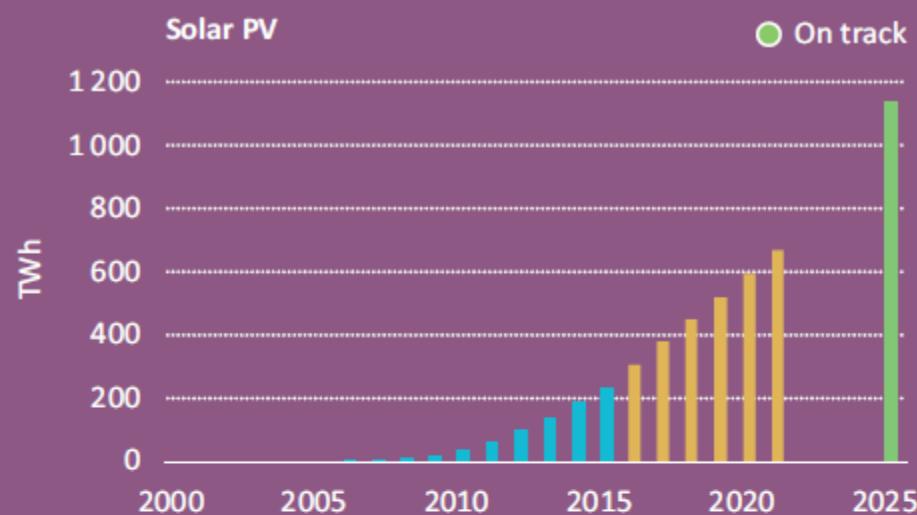
Based on IRENA estimates

Note: EJ = exajoules. CSP = concentrated solar power

Renewable energy technology development in 2050

Source: Accelerating Energy Transition through Innovation(IRENA, 2017) 18

再生可能エネルギー発電の技術別導入量（発電電力量）（実績及び見通し(forecast)）(1)



再生可能エネルギー発電の技術別導入量（発電電力量）（実績及び見通し(forecast)）(2)

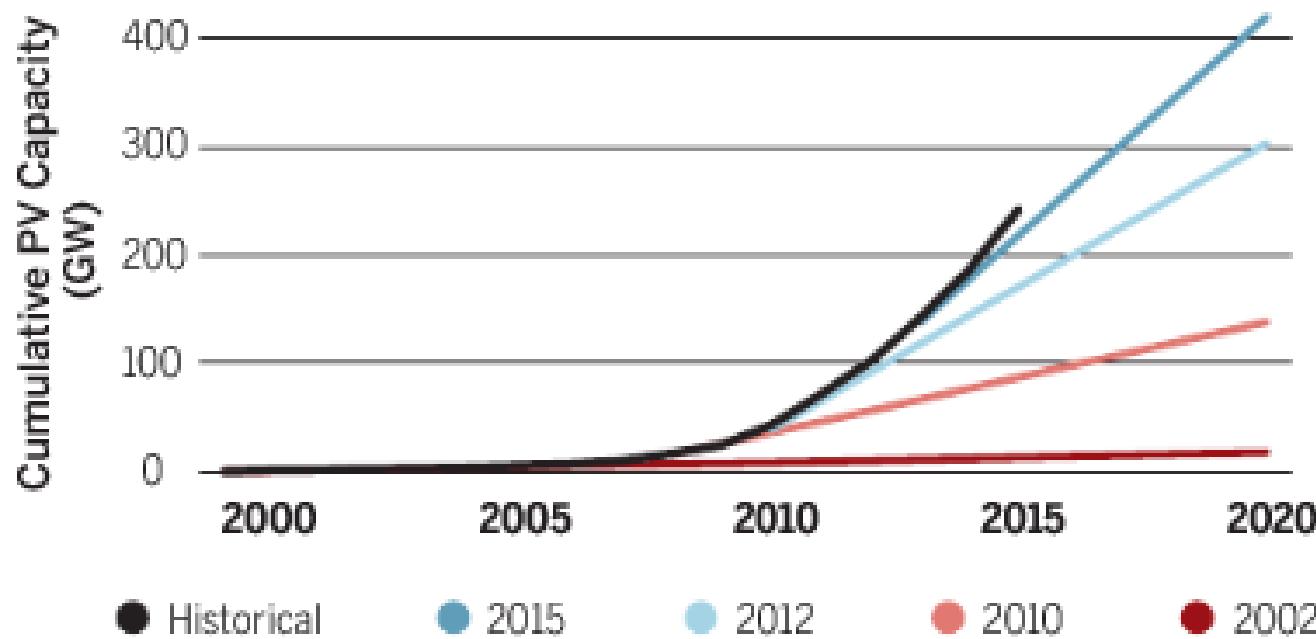


Source: Tracking Clean Energy Progress (IEA, 2017)

太陽光導入量の推移（予測と実際）

Cumulative PV installations

Projected (labeled by year of IEA publication) versus actual (labeled as "historical"). See supplementary materials for data sources and discussion.

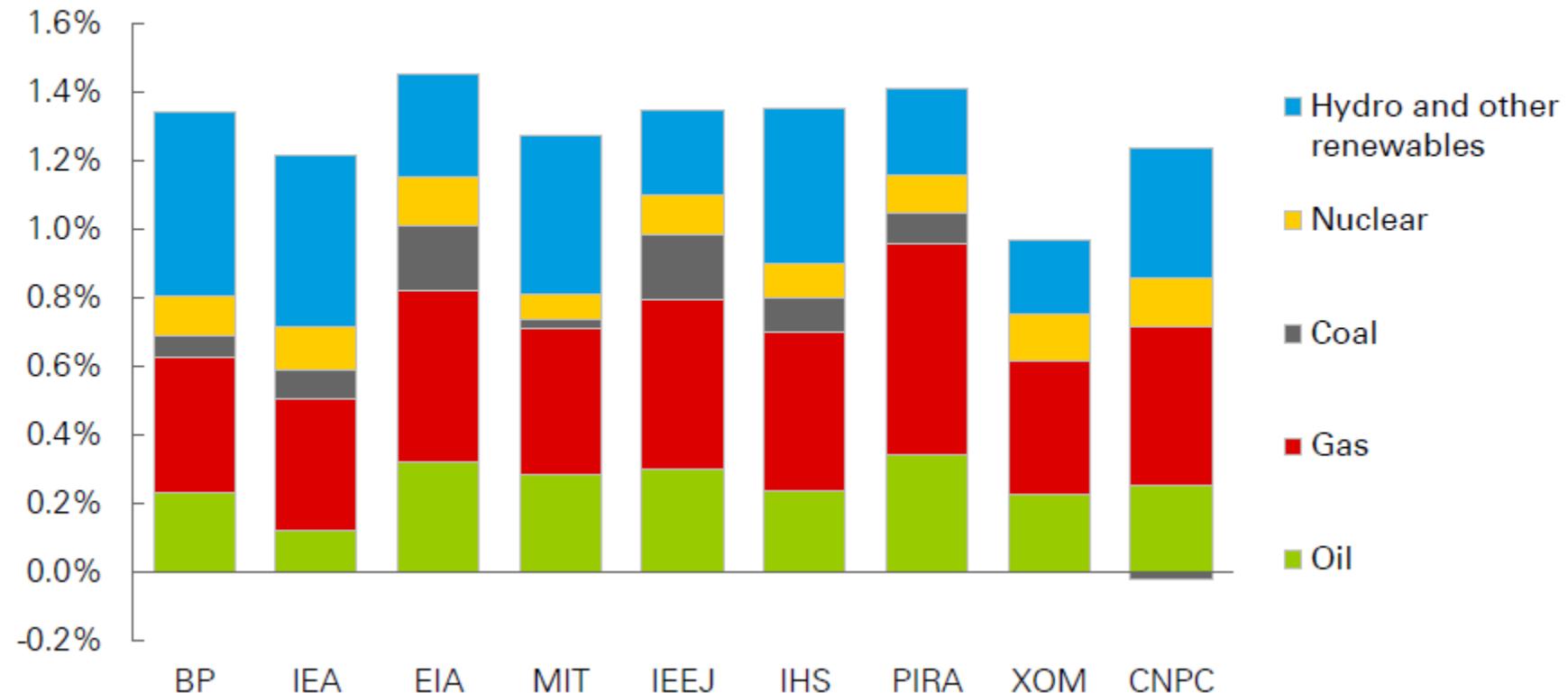


Source: Terawatt-scale photovoltaics: Trajectories and challenges (Nancy M. Haegel et al, 2017)

種々のアウトレックでの比較

Contributions to growth of energy consumption, 2015-2035

% per annum



BP: BP Energy Outlook, 2017 edition, 2017

IEA: International Energy Agency, World Energy Outlook 2016 , Paris, France, November 2016

EIA: US Energy Information Administration, International Energy Outlook 2016, Washington, D.C., United States, May 2016

MIT: MIT Joint Program on the Science and Policy of Global Change, 2016 Food, Water, Energy and Climate Outlook, Cambridge, MA, United States, 2016

IEEJ: Institute of Energy Economics Japan, Asia/World Energy Outlook 2016, Tokyo, Japan, October 2016

IHS: IHS Energy, Rivalry: the IHS Planning Scenario, July 2016

PIRA: PIRA Energy Group, Scenario Planning Guidebook, Appendix, February 2016

XOM: ExxonMobil, 2017 Outlook for Energy: A View to 2040, December 2016

CNPC: CNPC Economics & Technology Research Institute, Energy Outlook 2050, 2016

Greenpeace, Energy Revolution, September 2015

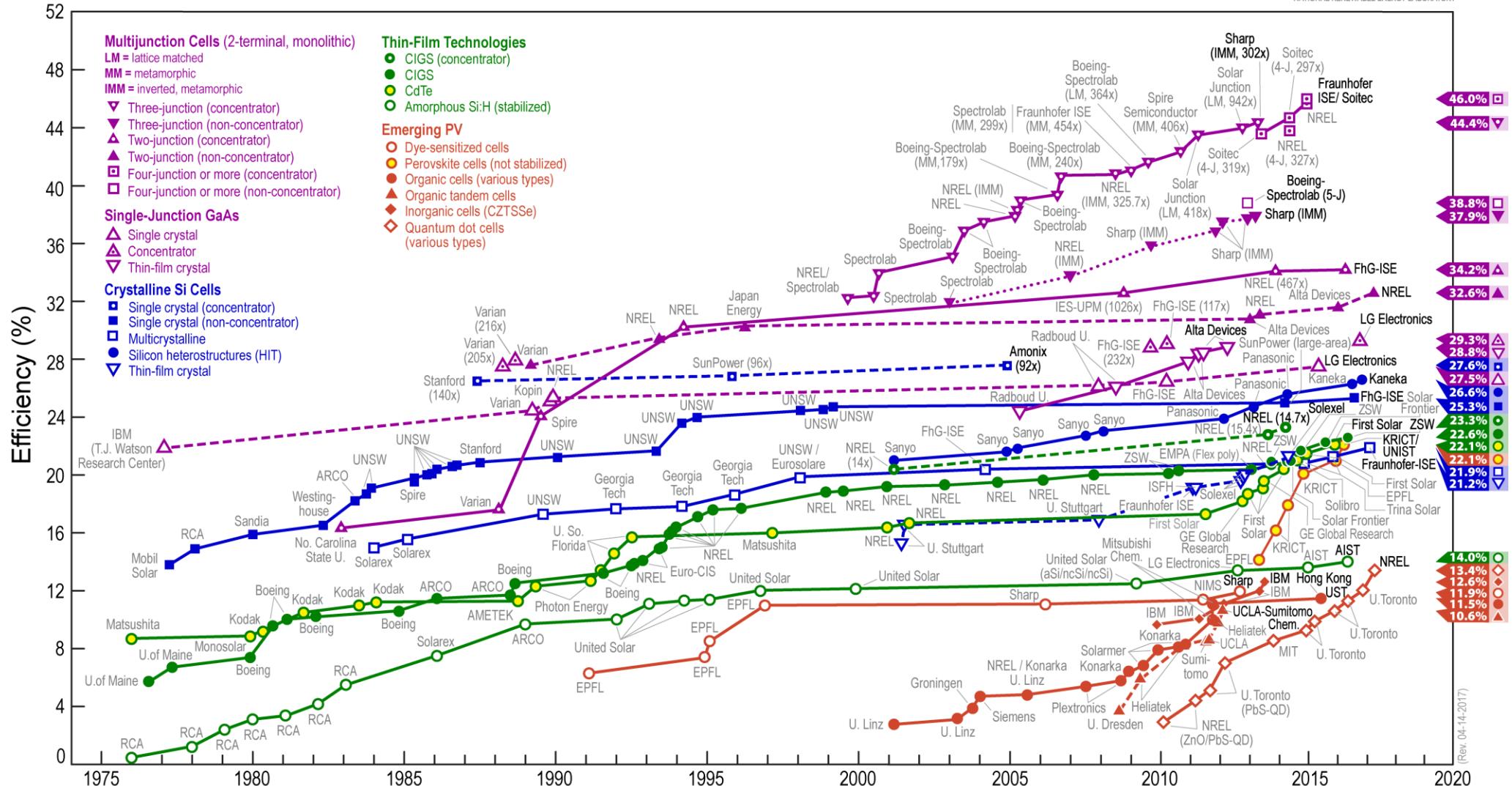
Source: BP Energy Outlook, 2017 edition (BP, 2017)

3．技術開発の動向（太陽光発電の例）

太陽電池研究開発における発電効率向上の歴史

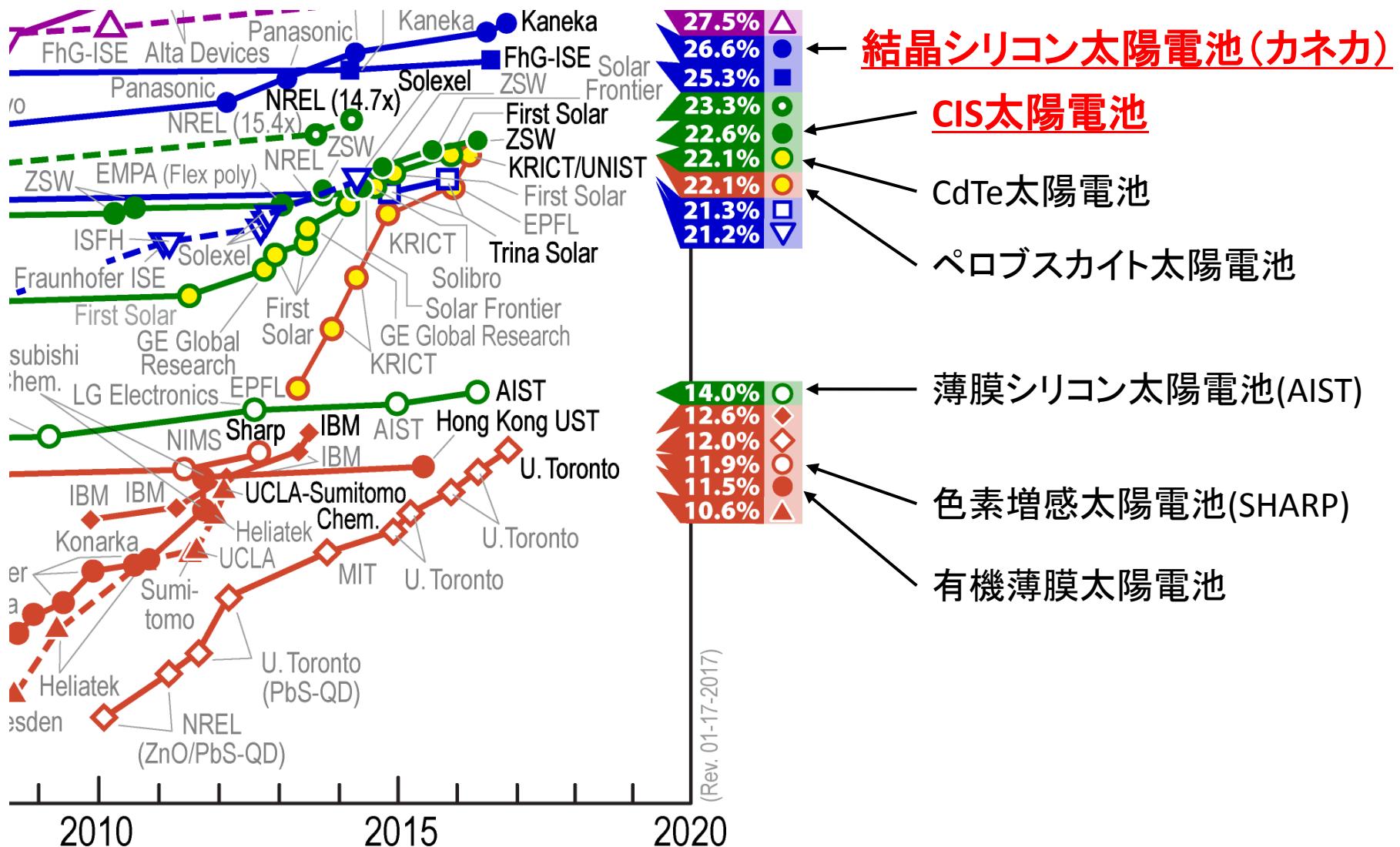
Best Research-Cell Efficiencies

NREL
NATIONAL RENEWABLE ENERGY LABORATORY



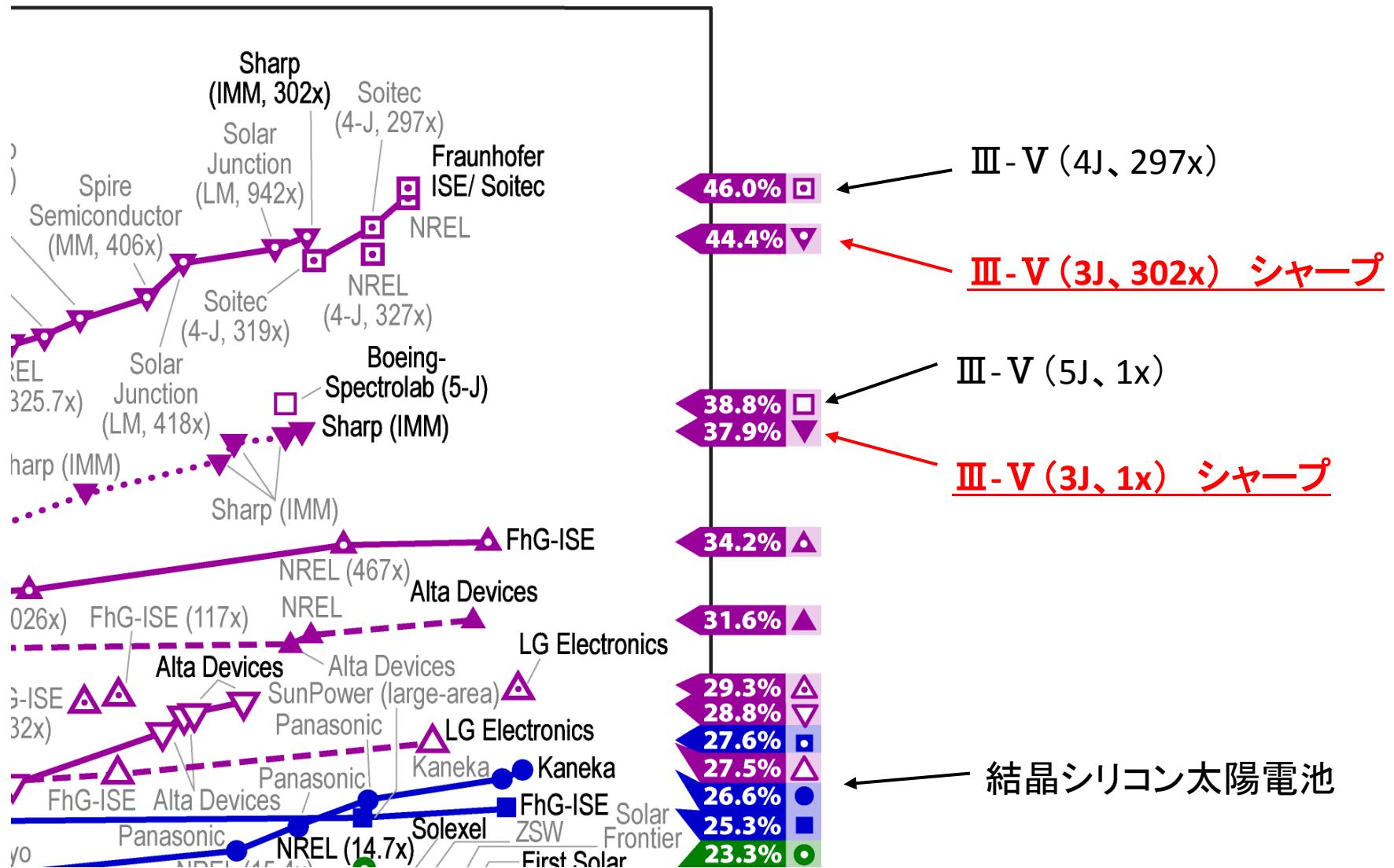
Source: NREL homepages

太陽電池開発の推移 (結晶シリコン、CIS)



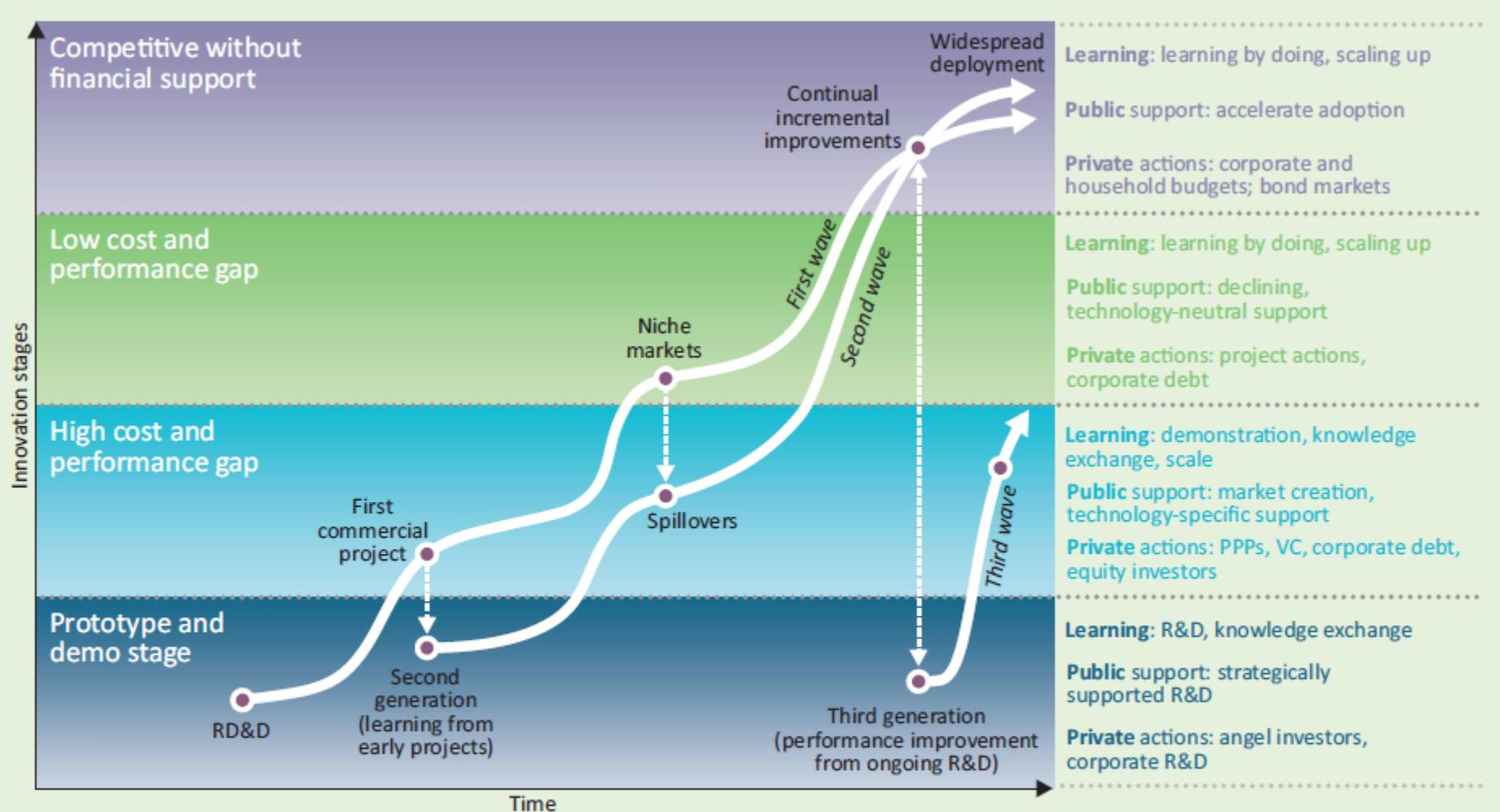
Source: NREL (modified by NEDO)

太陽電池開発の推移 (III-V化合物太陽電池)



Source: NREL (modified by NEDO)

技術の発展段階及び技術革新の源泉（太陽光発電の場合）

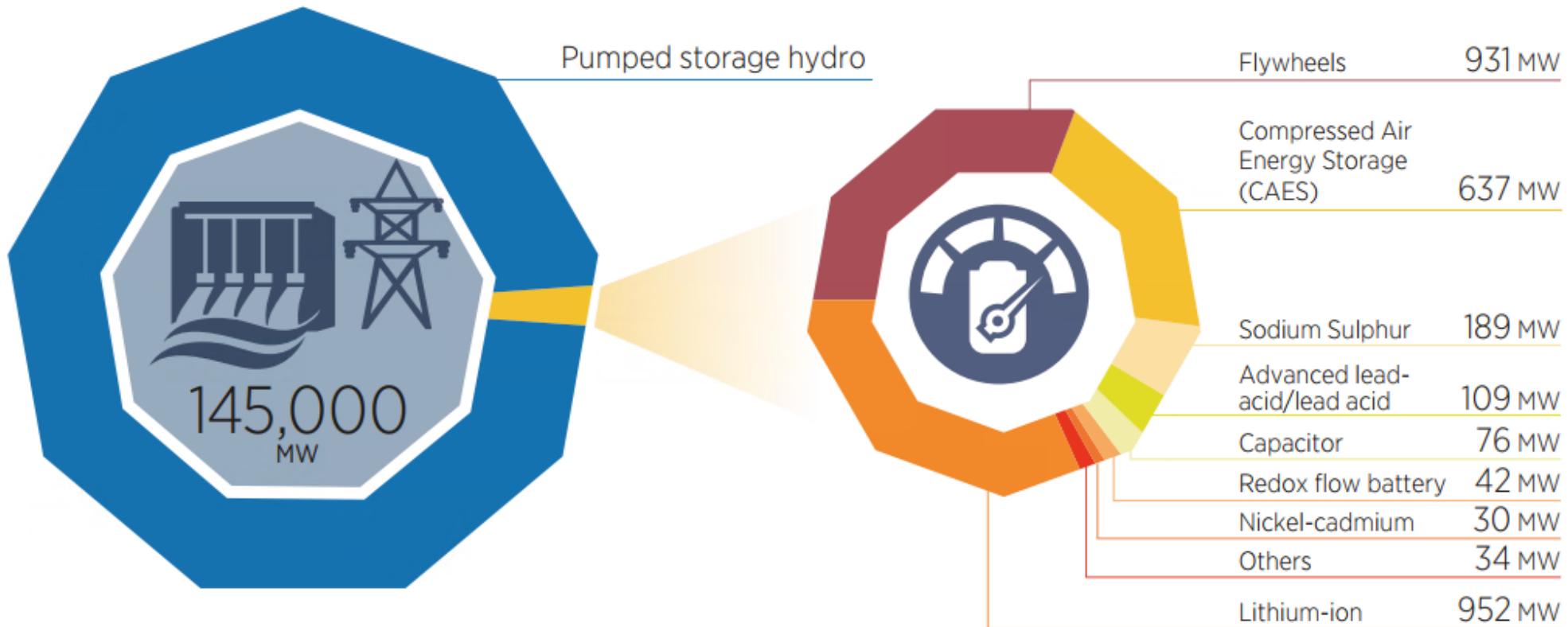


Key point: Innovation is an evolutionary process whereby today's commercial technologies – whether low-carbon or high-carbon – can be out-competed by solutions that are currently at the prototype stage if conditions are right.

Stages of technology evolution and sources of innovation illustrated for solar PV

4. 関連技術の動向

世界の電力蓄電システムにおける蓄電技術別シェア(MW)



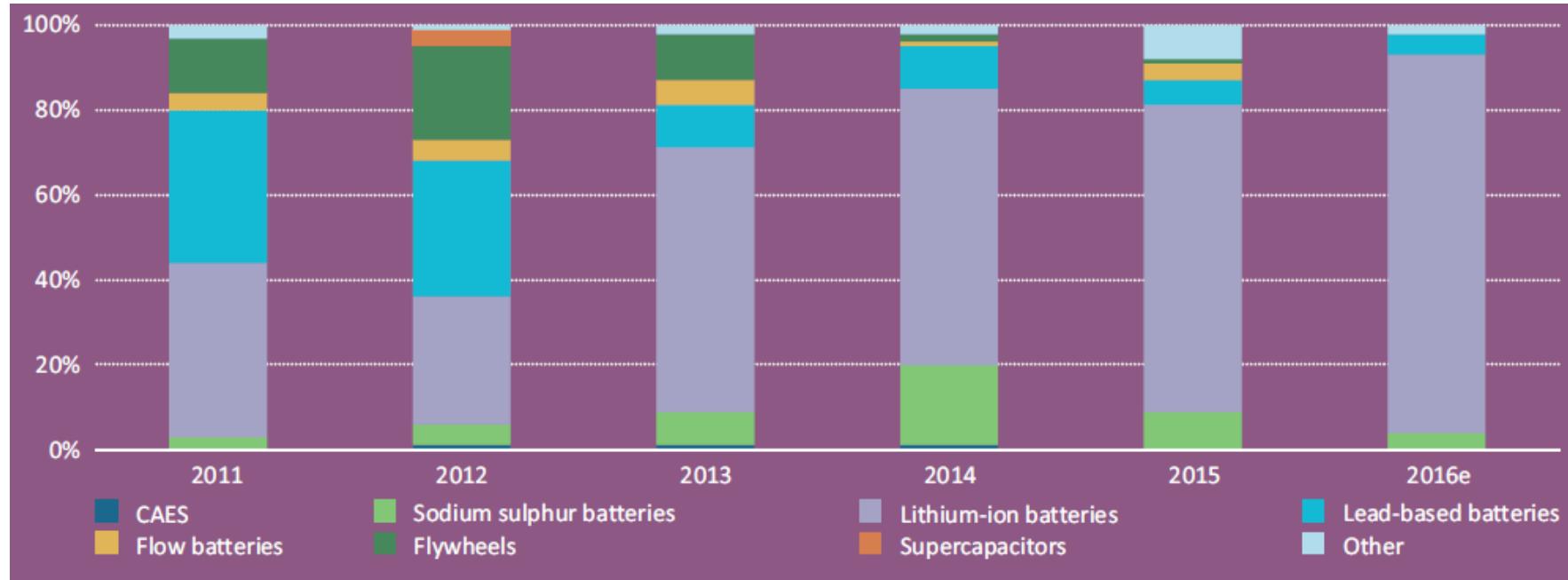
Note: Pumped storage data are for 2016; other data are for 2014.

Source: IRENA, 2015h; pumped storage data from IHA, 2016

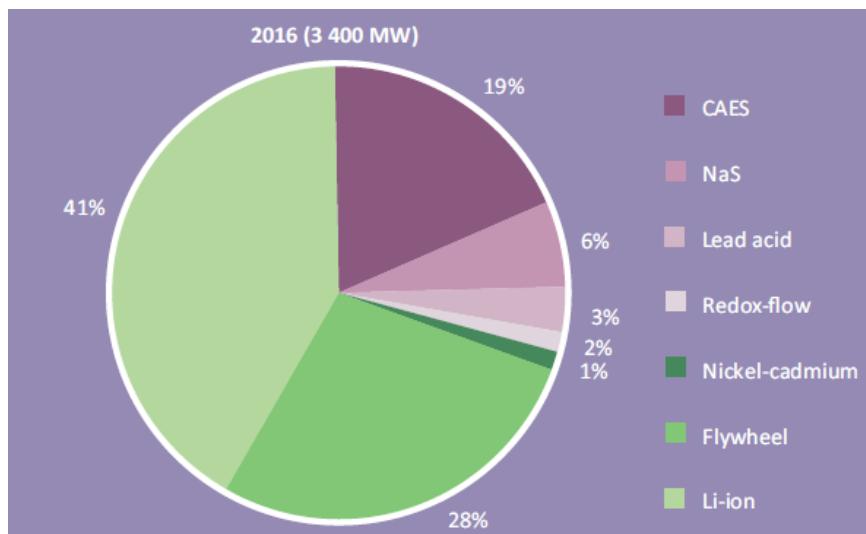
Share of various storage technologies in global electricity storage system (MW)

Source: REthinking Energy 2017 (IRENA, 2017)

蓄電技術の年別導入割合及び2016年における割合(揚水発電を除く)



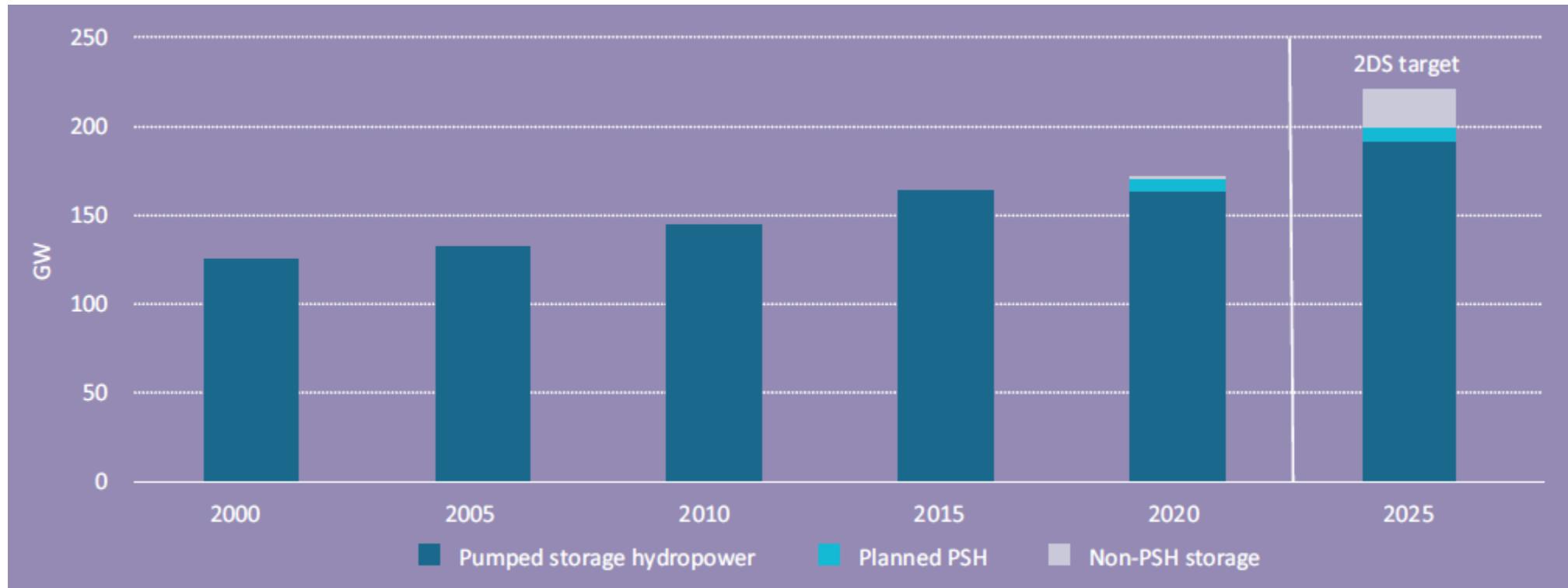
蓄電技術の年別導入割合(揚水発電を除く)



2016年における蓄電技術の割合(揚水発電を除く)

Source: Tracking Clean Energy Progress (IEA, 2017)

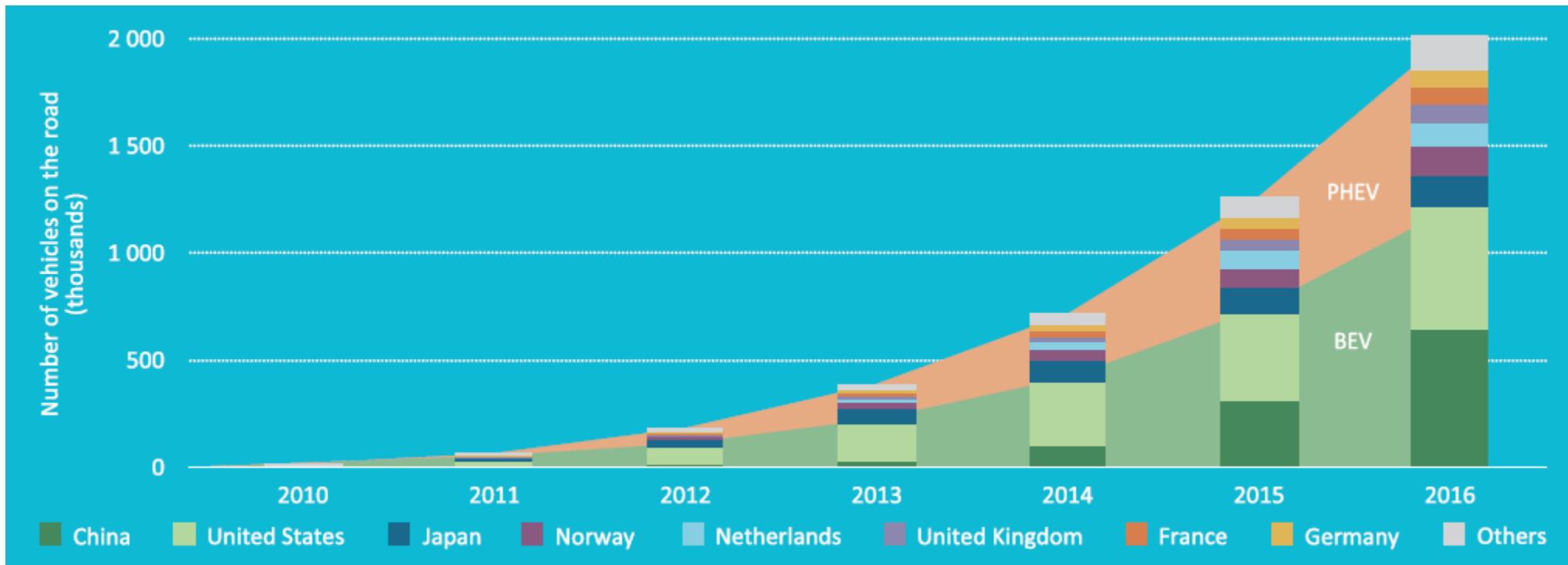
世界の蓄電技術導入量 (GW)



Globally installed electricity storage (GW)

Source: Tracking Clean Energy Progress (IEA, 2017)

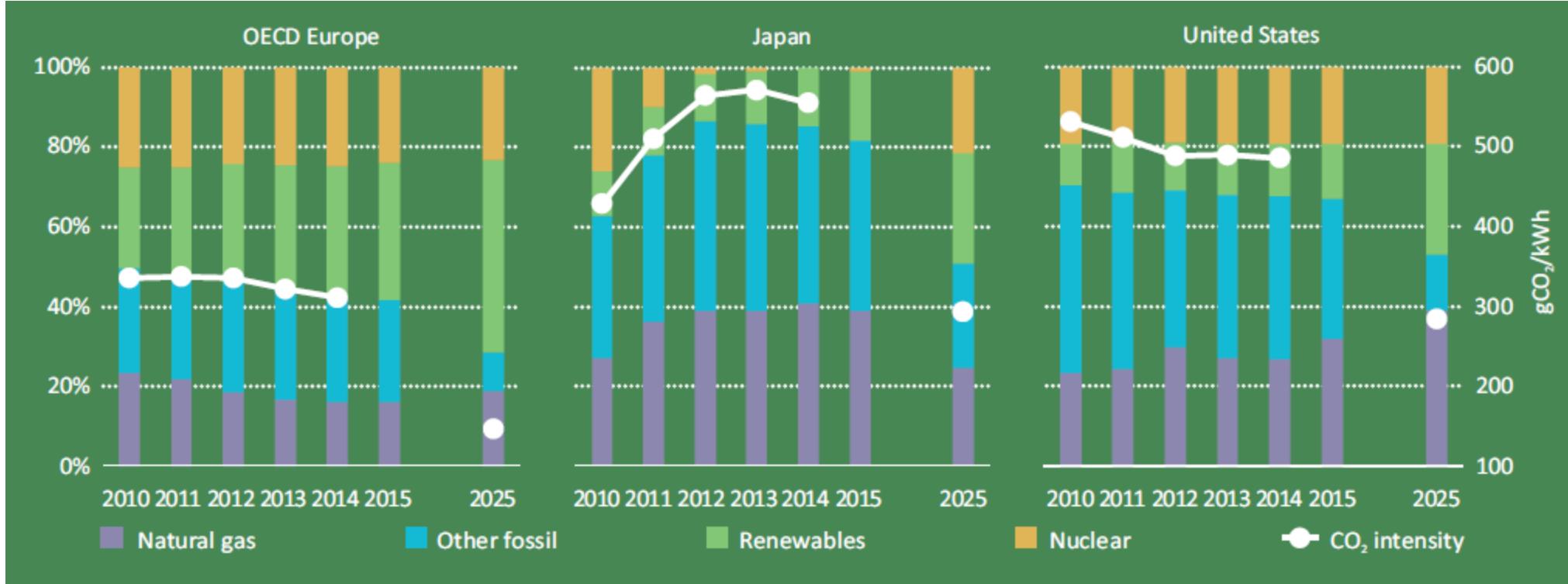
電気自動車(BEV, PHEV)の導入量推移(2010-2016年)



Evolution of the electric car stock (BEV and PHEV), 2010-16

Source: Tracking Clean Energy Progress (IEA, 2017)

発電ミックスと二酸化炭素排出原単位



Power generation mix and related CO₂ intensity

Source: Tracking Clean Energy Progress (IEA, 2017)

5. 再生可能エネルギーがもたらすもの

再生可能エネルギーの拡大：エネルギー転換への鍵

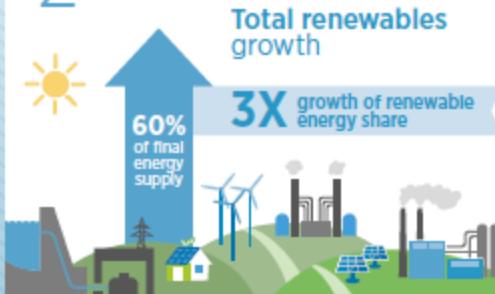
Renewable Energy Growth: Key to the Energy Transition

1 Renewables worldwide today



- 19% of final energy supply
- 24% of power generation

2 Share in the 2050 energy mix



Total renewables growth

60% of final energy supply

3X growth of renewable energy share



Renewable power growth

80% of electricity supply

3.5X growth of renewable power share

→ Enough to:

- replace coal and oil power generation

3 Where to scale them up

Potential by 2050:



- 78% in buildings
• Electrification



- 50% in transport
• Biofuels + electrification



- 39% in Industry
• Solar thermal + biofuels

To UNLOCK GROWTH in renewables



Infrastructure

- Vehicle charging stations

Innovative technologies

- ICT
- Smart grids

Clear and credible policies

- Long-term planning
- Incentives
→ Enabling conditions
- Flexible market design

New financing and business models

- Low-carbon technology investment

To learn more, see [Perspectives on the Energy Transition](#)

全てのSDGs(持続可能な発展への目標)を支えるクリーン・エネルギー



Affordable and clean energy supports all the SDGs

Source: REthinking Energy 2017 (IRENA, 2017)

36