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GLOBAL WIND ENERGY COUNCIL

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Drivers for Wind

Wind Energy Denmark

30 October 2018

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GWEC – Uniting the global wind industry and its representative associations

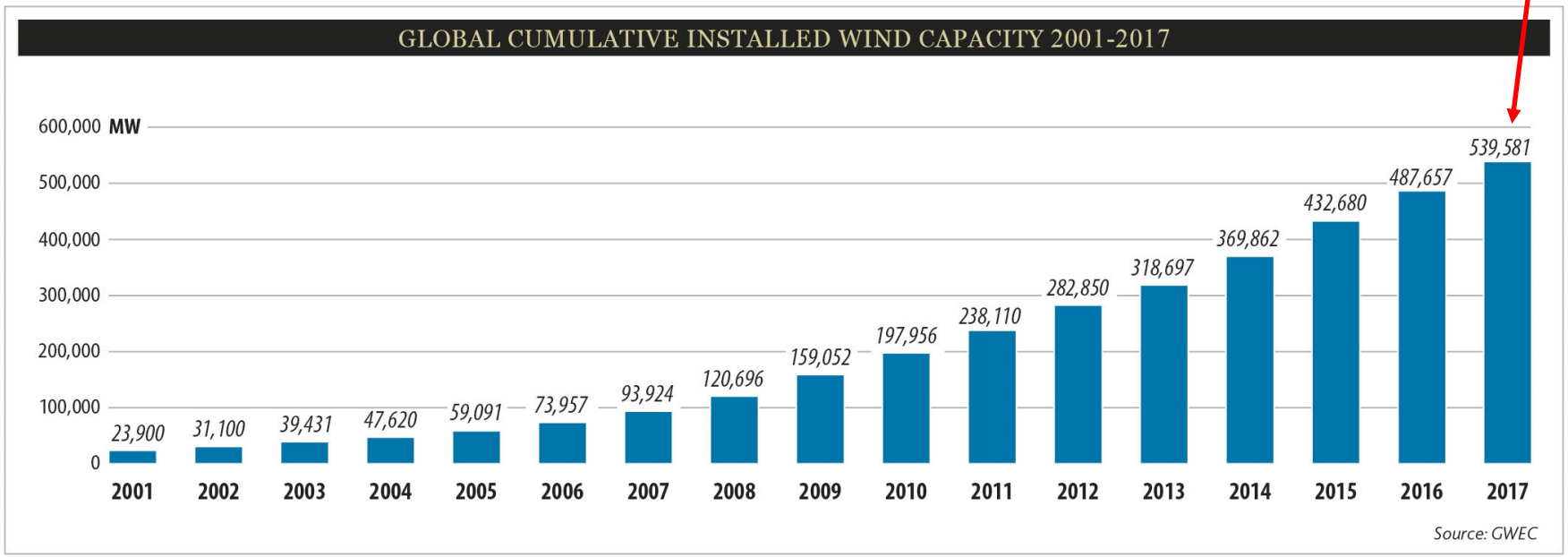
Overview

- State of the wind markets, both onshore and offshore;
- State of the climate: new IPCC report SR15
- Drivers for wind energy
- What needs to be done
- Conclusions

Cumulative Markets

2017 growth: 11%

3.5% Offshore

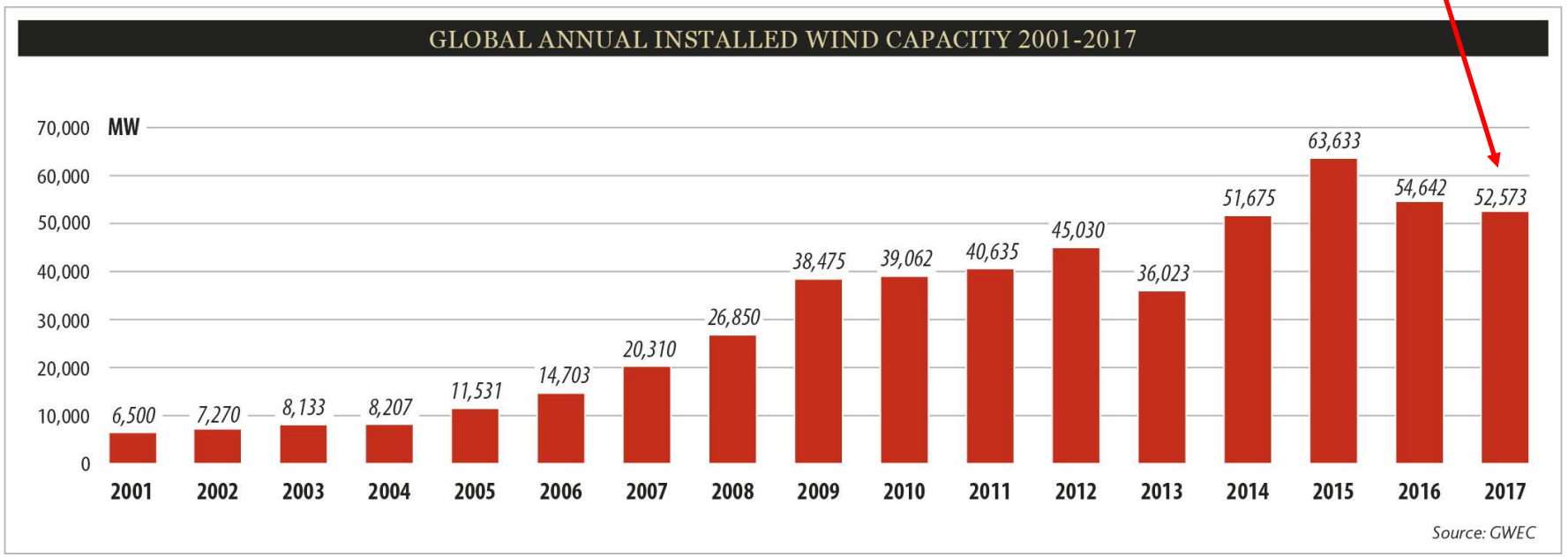


17 yr avg. growth: 22.6%

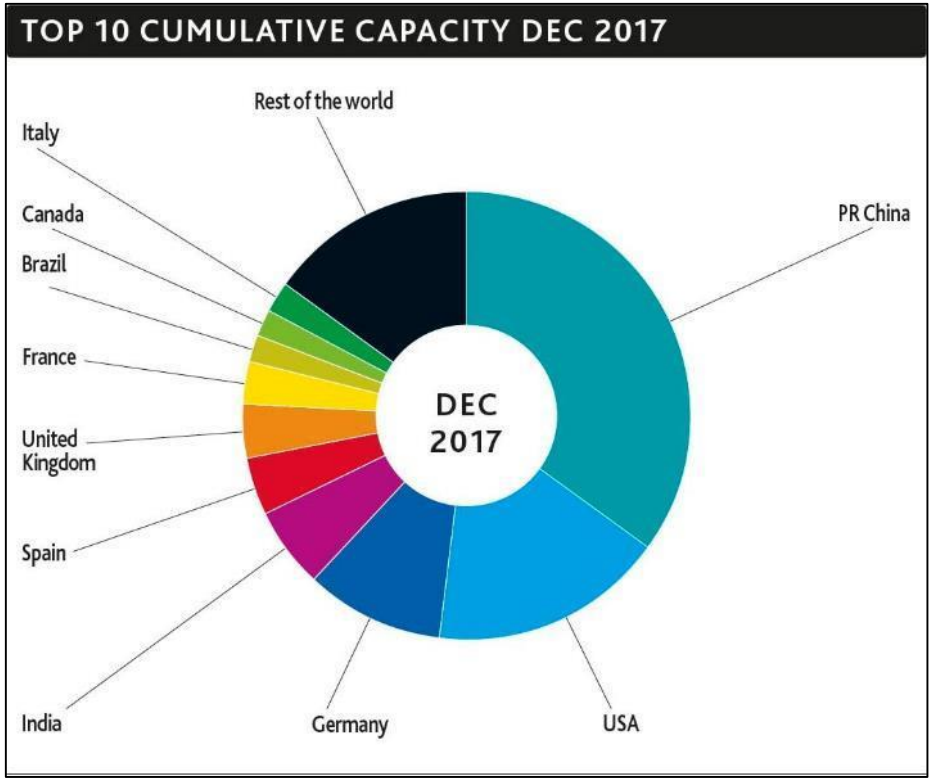
Annual Markets

8.2% Offshore
(20% EU)

2017 growth: -3.8%

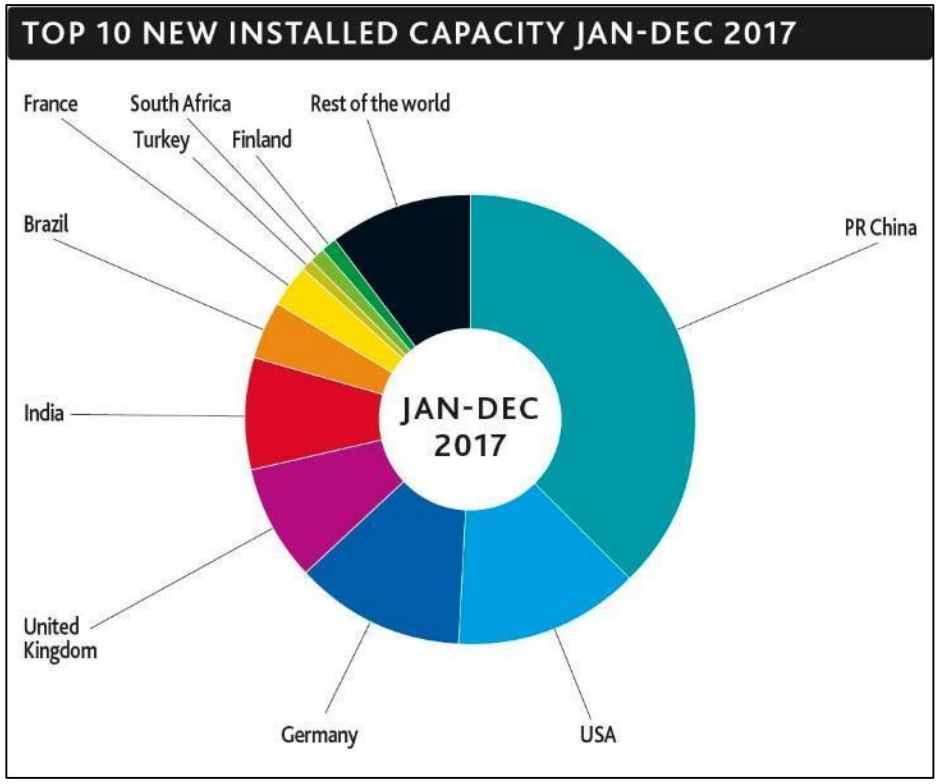


17 yr avg. growth: 19%



Country	MW	% Share
PR China	188,392	35
USA	89,077	17
Germany	56,132	10
India	32,848	6
Spain	23,170	4
United Kingdom	18,872	4
France	13,759	3
Brazil	12,763	2
Canada	12,239	2
Italy	9,479	2
Rest of the world	82,391	15
Total TO P10	**456,732**	**85**
World Total	**539,123**	**100**

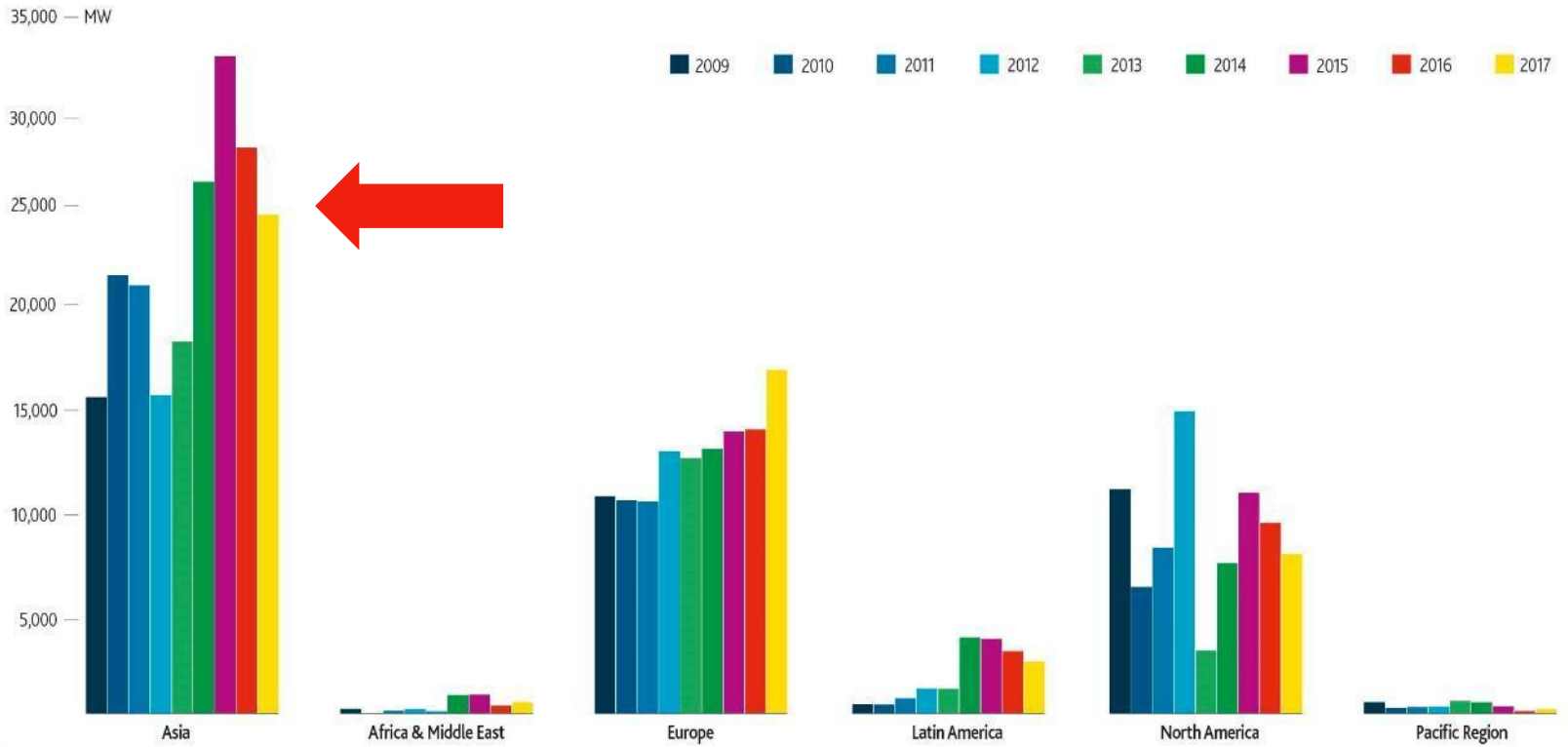
Source: GWEC



Country	MW	% Share
PR China	19,660	37
USA	7,017	13
Germany	6,581	12
United Kingdom	4,270	8
India	4,148	8
Brazil	2,022	4
France	1,694	3
Turkey	766	1
South Africa	618	1
Finland	535	1
Rest of the world	5,182	10
Total TOP 10	**47,310**	**90**
World Total	**52,492**	**100**

Source: GWEC

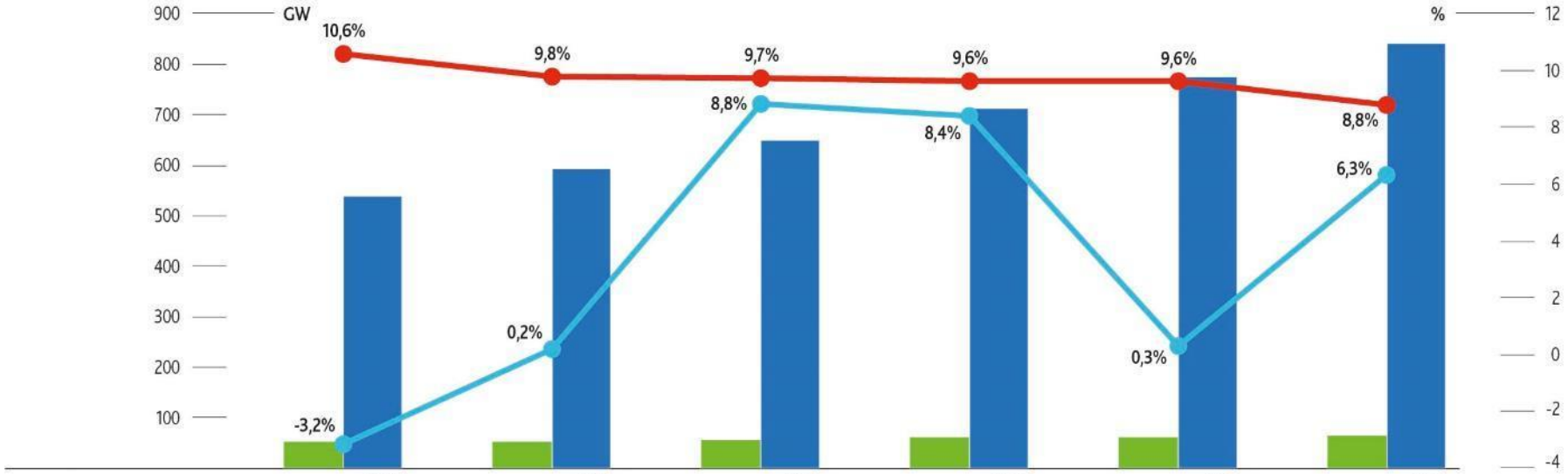
ANNUAL INSTALLED CAPACITY BY REGION 2009-2017



	2009	2010	2011	2012	2013	2014	2015	2016	2017
Asia	15,507	21,481	20,981	15,624	18,252	26,058	33,962	27,721	24,412
Africa & Middle East	251	153	8	131	240	934	953	418	618
Europe	10,660	10,466	10,393	12,862	12,524	12,988	13,831	13,926	16,803
Latin America	471	459	771	1,248	1,240	3,744	3,678	3,078	2,578
North America	11,008	6,208	8,137	14,807	3,112	7,382	10,829	9,359	7,836
Pacific Region	578	294	345	358	655	568	381	140	245

Source: GWEC

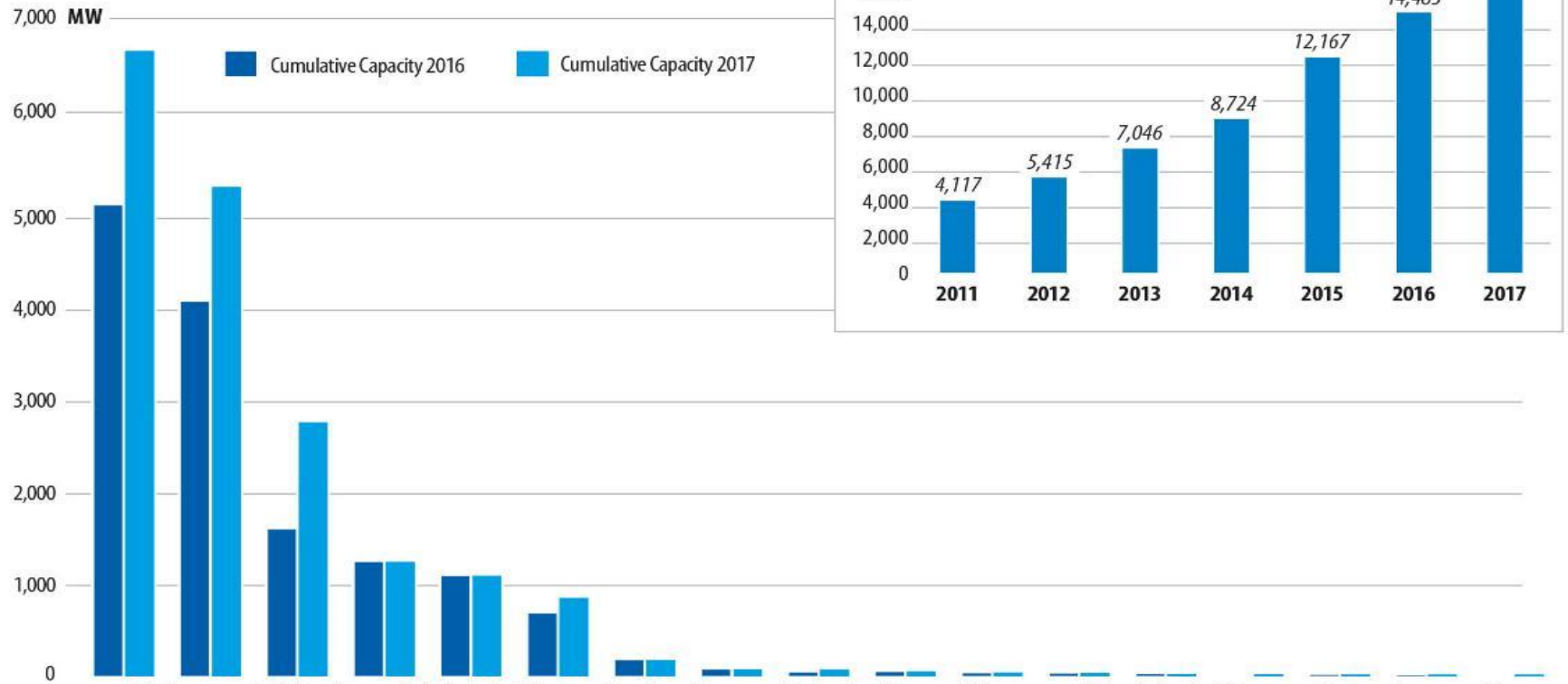
MARKET FORECAST 2018-2022



	2017	2018	2019	2020	2021	2022
Cumulative installed capacity	539.1 GW	592 GW	649.5 GW	711.8 GW	774.4 GW	840.9 GW
Cumulative capacity growth rate	10.6%	9.8%	9.7%	9.6%	9.6%	8.8%
Annual installed capacity	52.5 GW	52.9 GW	57.5 GW	62.4 GW	62.6 GW	66.5 GW
Annual installed capacity growth rate	-3.2%	0.2%	8.8%	8.4%	0.3%	6.3%

Source: GWEC

GLOBAL CUMULATIVE OFFSHORE WIND CAPACITY IN 2017

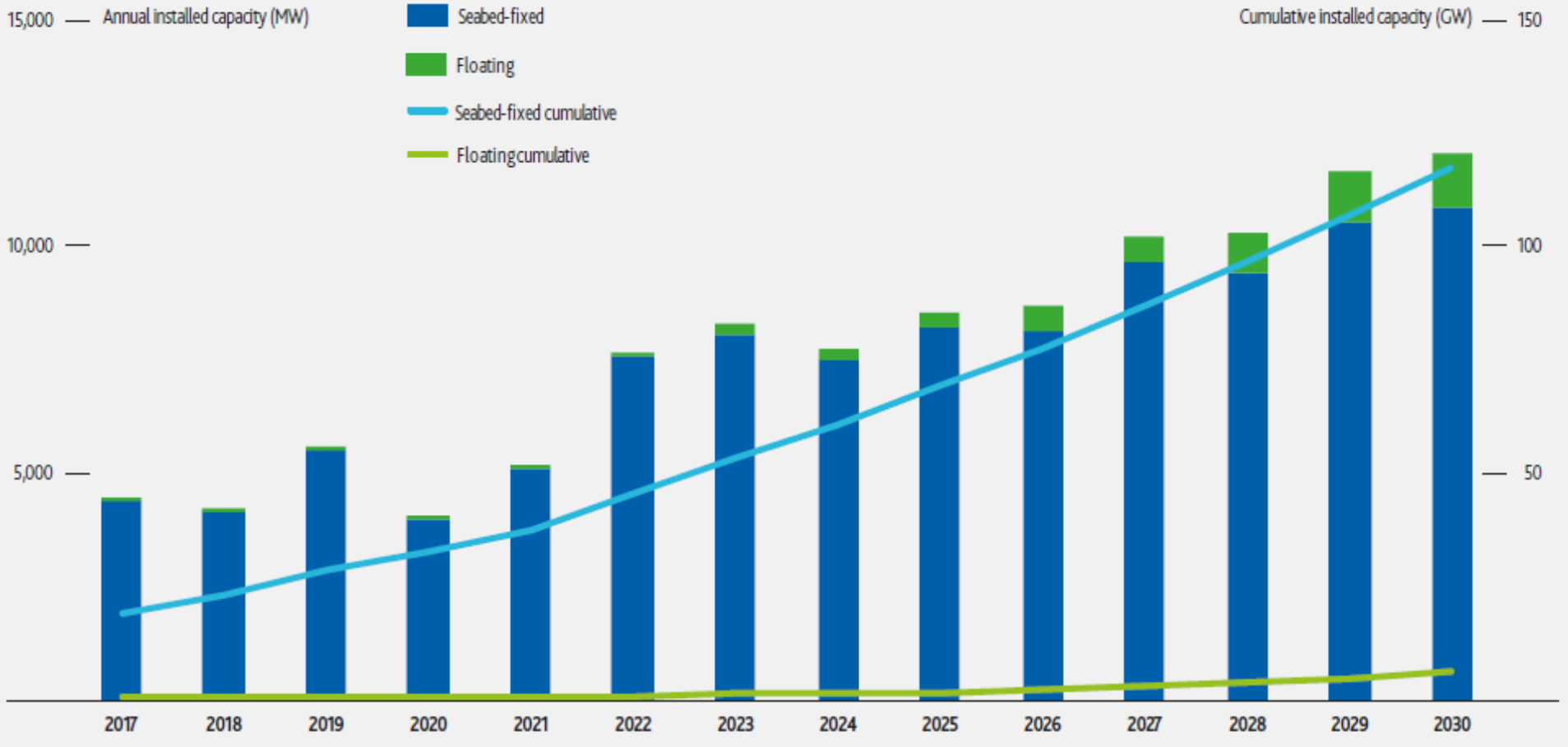


	UK	Germany	PR China	Denmark	Netherlands	Belgium	Sweden	Vietnam	Finland	Japan	S Korea	US	Ireland	Taiwan	Spain	Norway	France	Total
Total 2016	5,156	4,108	1,627	1,271	1,118	712	202	99	32	60	35	30	25	0	5	2	0	**14,483**
New 2017	1,680	1,247	1,161	0	0	165	0	0	60	5	3	0	0	8	0	0	2	**4,331**
Total 2017	6,836	5,355	2,788	1,271	1,118	877	202	99	92	65	38	30	25	8	5	2	2	**18,814**

Source: GWEC

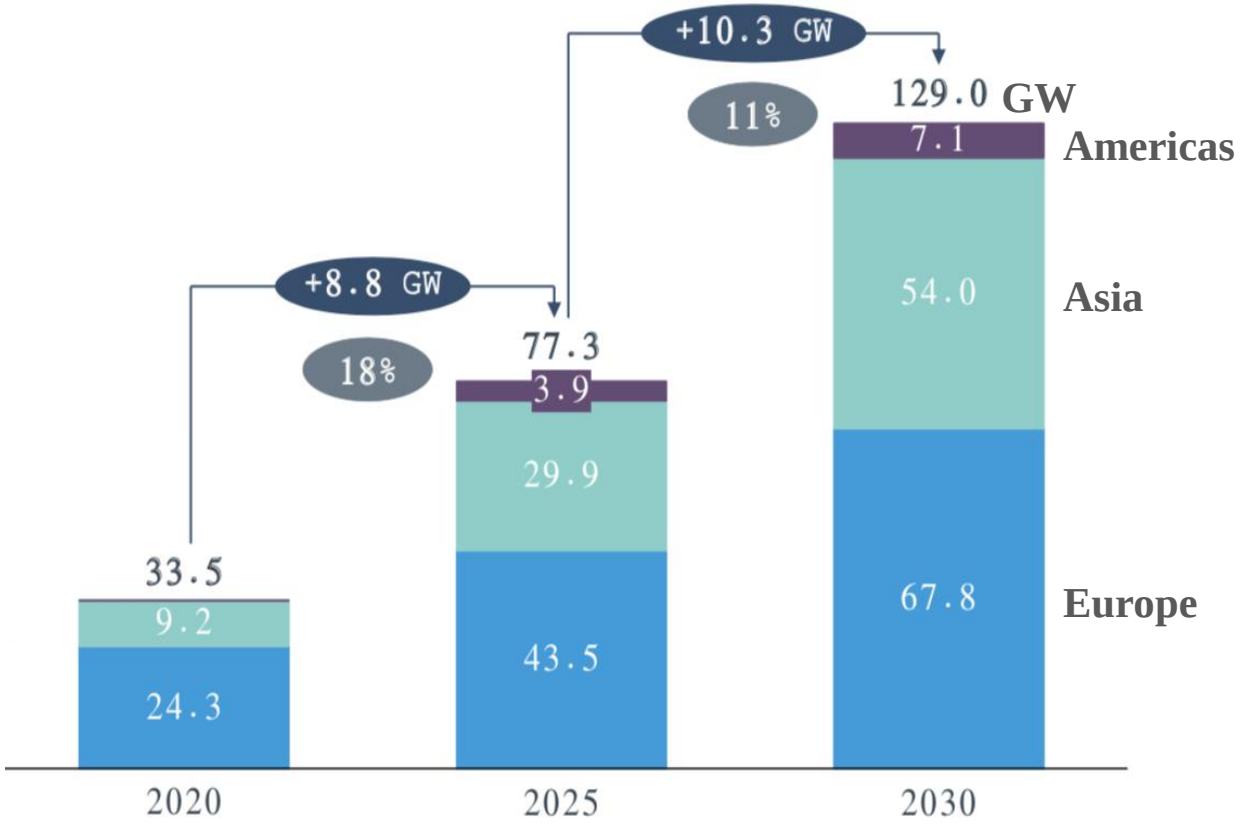
ANNUAL CUMULATIVE CAPACITY (2011-2017)

PROJECTIONS FOR OFFSHORE WIND DEVELOPMENT GLOBALLY OUT TO 2030



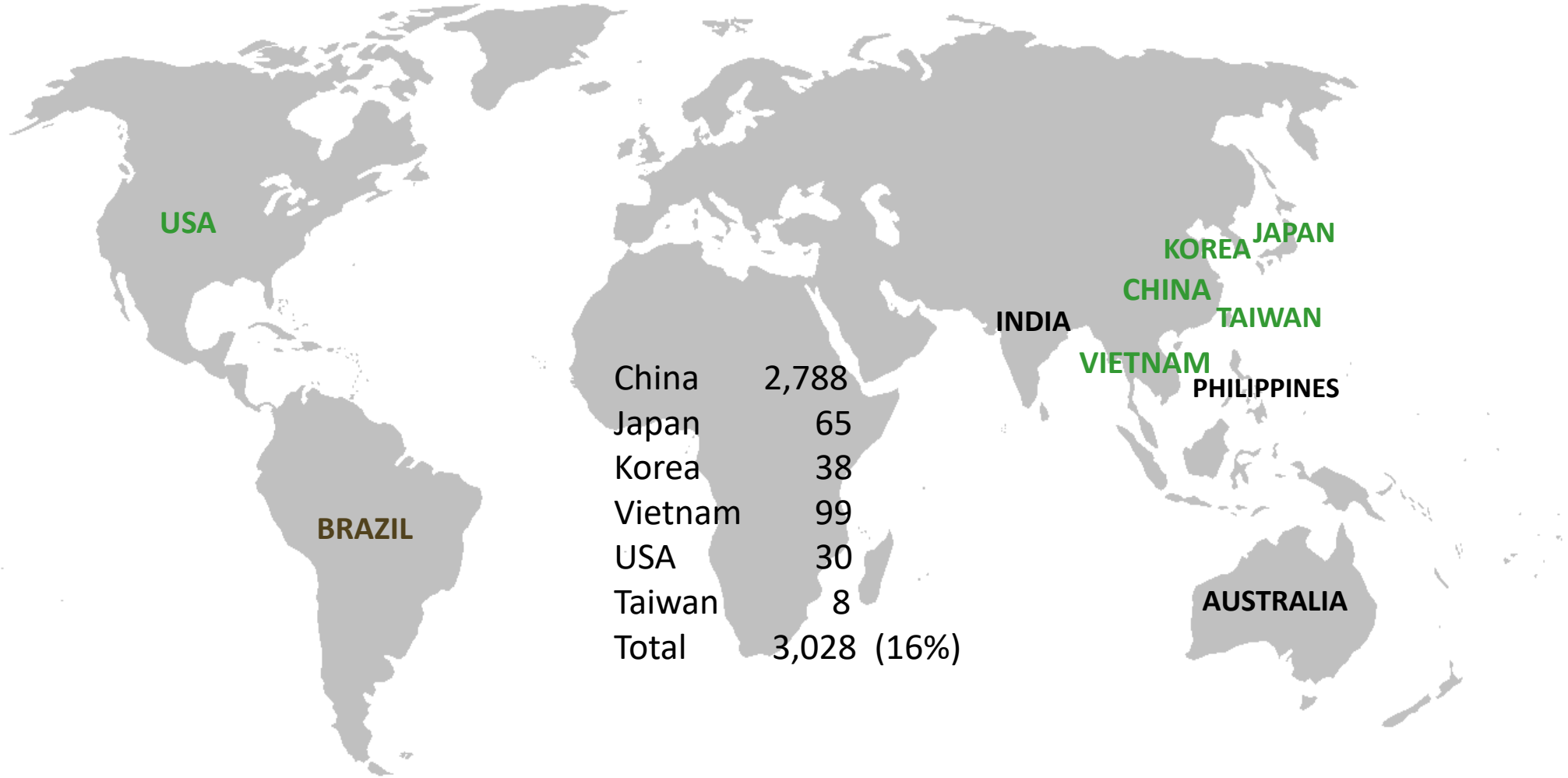
Source: BVG Associates

- Strong growth in established and new offshore wind power markets
- Europe continues to grow, in more countries
- Asia expands rapidly, especially China
- Total investment to 2030 of $500bn



Source: Bloomberg New Energy Finance

Non European Offshore Markets today



China	2,788	
Japan	65	
Korea	38	
Vietnam	99	
USA	30	
Taiwan	8	
Total	3,028	(16%)

Offshore Development Targets/expectations to 2020 (GW)

	2015*	2017**	2020*	Current
• Europe:	9-10	15.78	24	(25)
• China:	5 (2)	2.788	30 (10)	(5)
• Japan	-	0.065	1-2	(0.2)
• Korea	-	0.038	2-4	(0.4)
• USA	-	0.03	0.5-3.0	(0.03)
• Others		0.008	0.6-2.0	(0.5?)
• Total	~14-15 (12.1)		58-65	(31.13)

* The view from end 2013
** Actual 2017

Drivers for wind energy development

Economics

Climate

Business/corporates/consumers

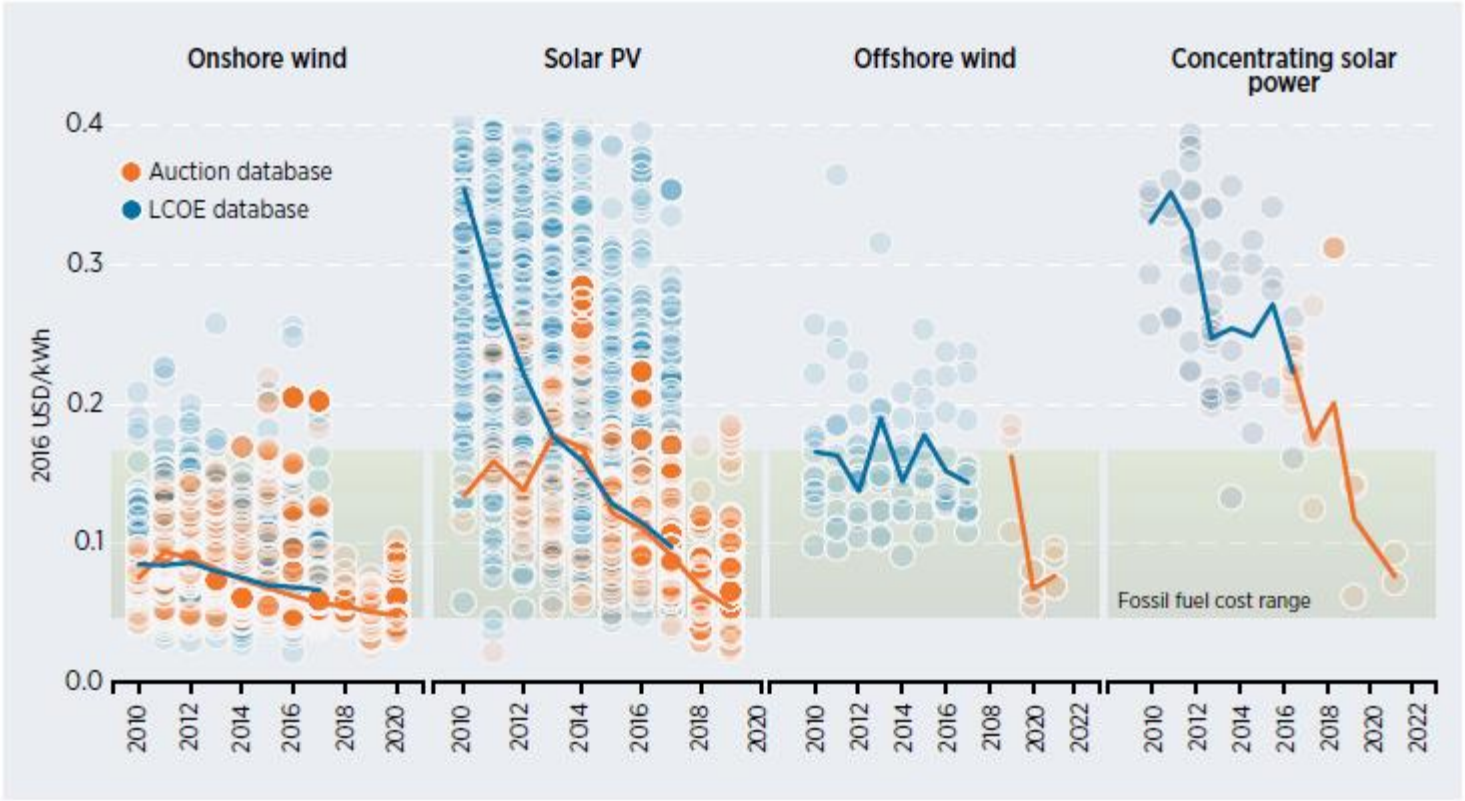
Air pollution/Water

Job creation/industrial development

Demographics – keep rural people on the land

We've won the price war

Figure 2.16 Global levelised cost of electricity and auction price trends for solar PV, CSP, onshore and offshore wind from project and auction data, 2010-2022



Source: IRENA Renewable Cost Database and Auctions Database.

We can look forward to a thriving business in the future…up to a point.

…because the market alone does not get us where we need to go. See https://eto.dnvgl.com/2018/

Without a decarbonization/climate policy signal we are all in trouble.

Paris Agreement

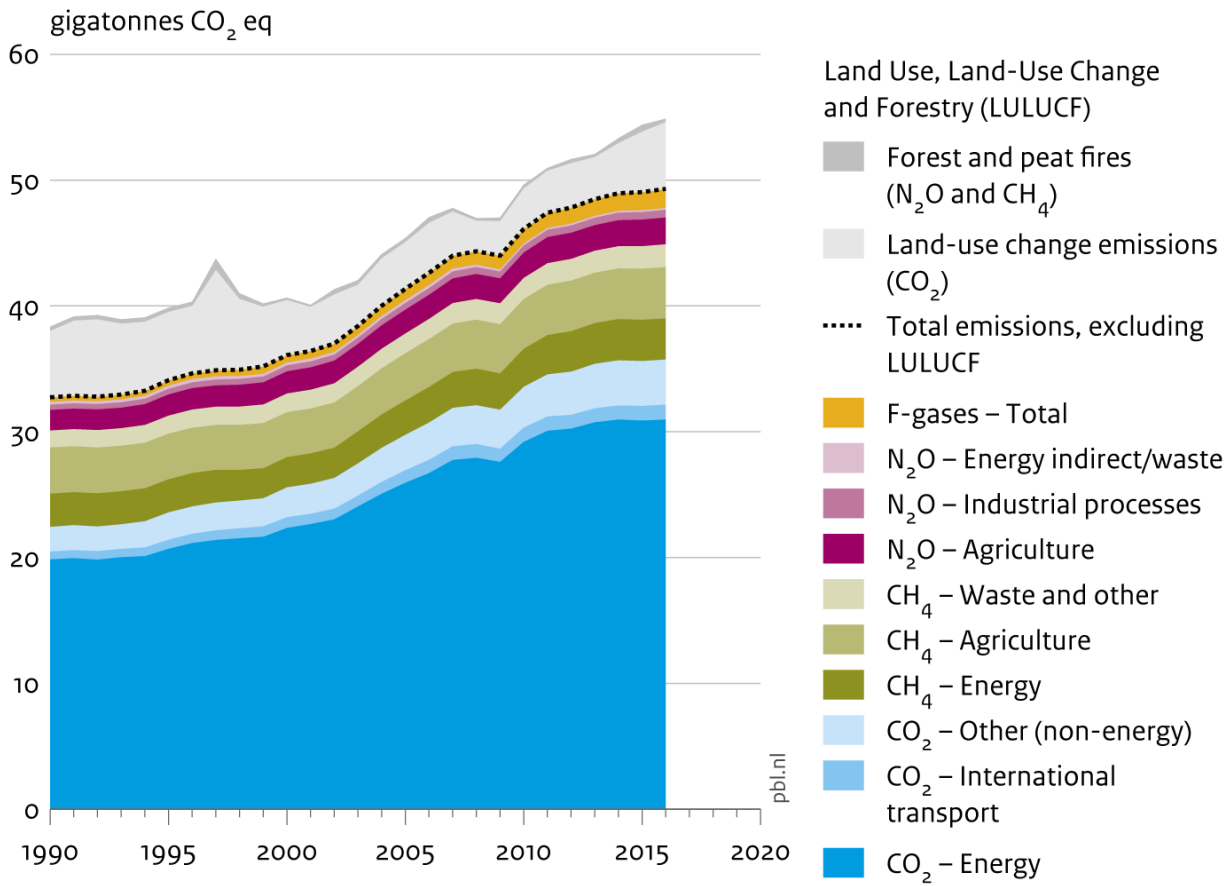
Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

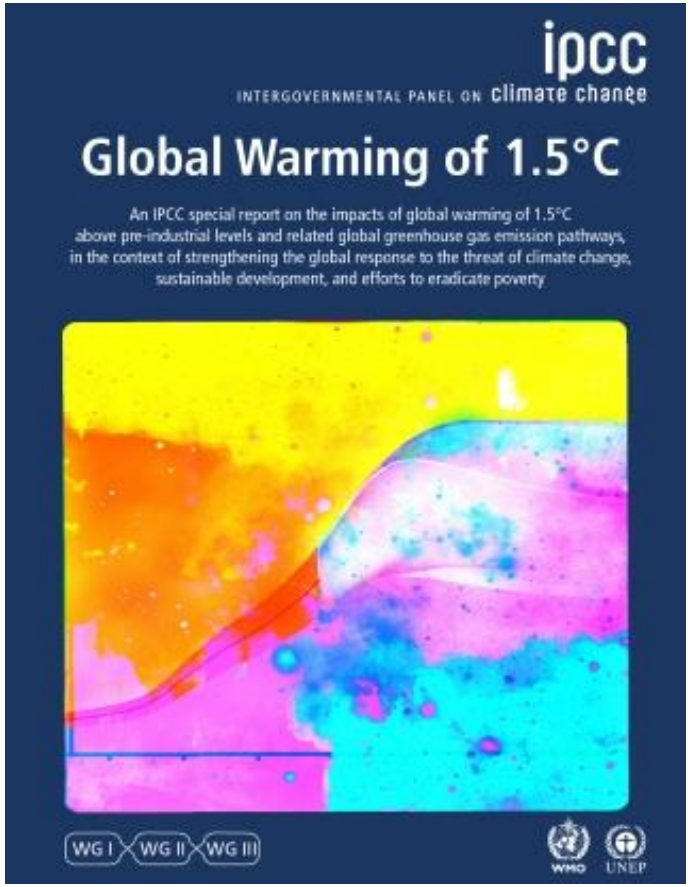
(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

Global greenhouse gas emissions, per type of gas and source, including LULUCF



Source: EDGAR v4.3.2 (EC-JRC/PBL 2017); Houghton and Nassikas (2017); GFED 4.1s (2017)



Key Findings

1. Is there a (big) difference between 1.5 ° and 2.0° of anthropogenic warming?

   In a word, YES. Quite apart from the extra damages, we run real risks of crossing 'tipping points' from which there is no return, particularly in relation to ecosystem transformation and sea-level rise.

2. Is it technically and economically feasible to reach the lower target?

   YES, although it's not easy to meet either of them. But the timing is critical, as each passing decade (we've already wasted two…) makes the job that much harder.

3. Is it politically feasible to meet the target?

   You tell me. I have to operate as if the answer is yes.

Carbon Budget = 550-750 GT *(some say less)*

4. Key imperatives:

   - There is no future for coal
   - There is not much of a future for gas, i.e., the ‘bridge’ we hear so much bout is neither very long nor very high
   - We need to electrify everything that can be electrified, quickly
   - We need decarbonizing strategies for industry *now* which will take decades to achieve
   - Emissions need to basically halve each decade from now on, reaching zero somewhere around 2050
   - The extent and timing of the reduction will determine the extent to which carbon removal strategies (CDR) will need to be deployed
   - We need to clearly distinguish between biological and fossil carbon


Decisive action needed in all sectors
CLIMATE ANALYTICS
MOST IMPORTANT SHORT TERM
Renovate 3–5% of buildings per year
Sustain renewables growth
Climate Action Tracker
No new coal power plants
New buildings zero emissions from 2020
zero-e
STEPS FOR A 1.5°C WORLD
BEV
Last fossil fuel car sold before 2035
Best practice in agriculture
Develop 1.5°C vision for aviation & shipping
Zero deforestation by 2020s
low-e
New industrial installations low carbon after 2020
www.climateactiontracker.org
Climate Action Tracker, 2016: The ten most important steps to limit warming to 1.5°C
Kuramochi et al (2017)

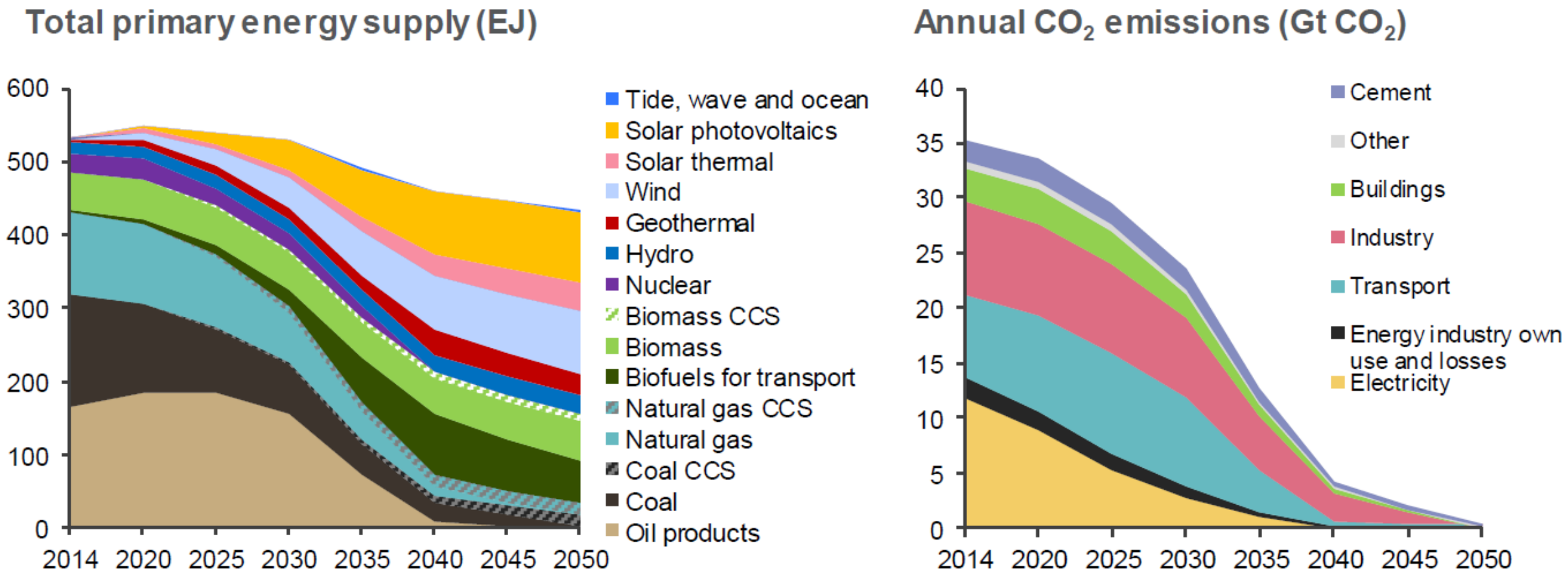


Figure 1. Global total primary energy supply and annual CO_2 emissions in our decarbonisation scenario

Ecofys: Energy Transition within 1.5° C

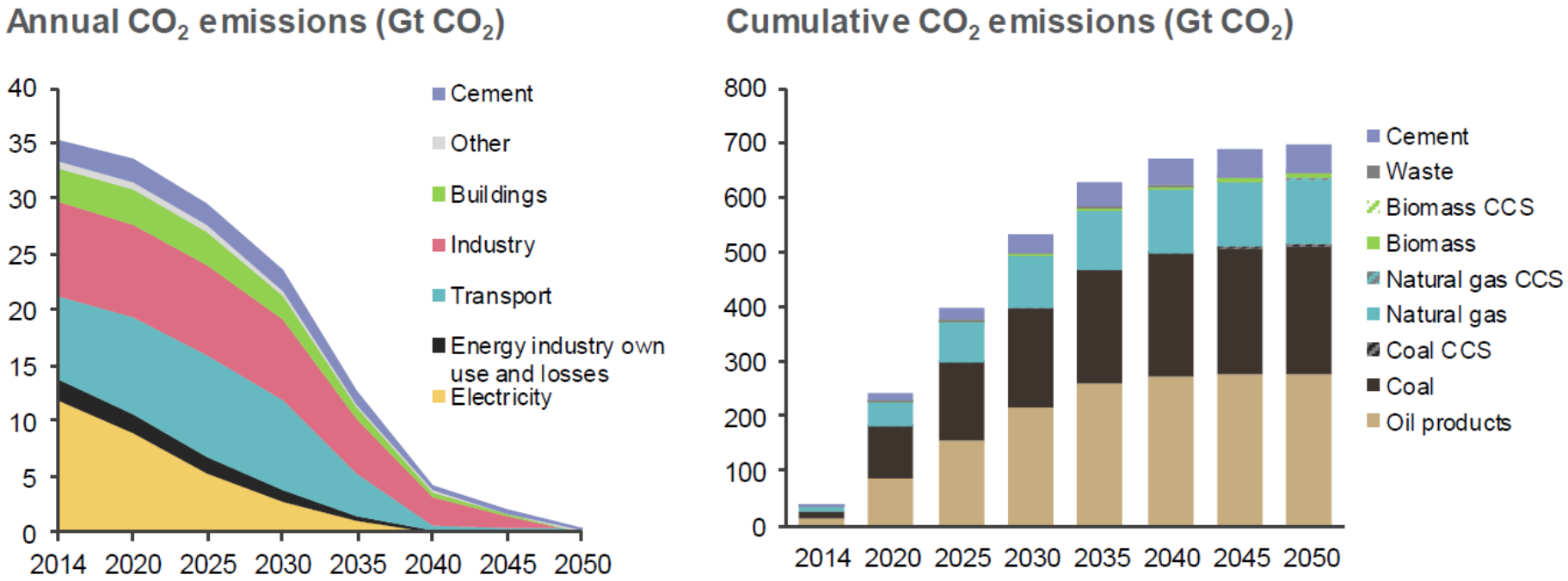
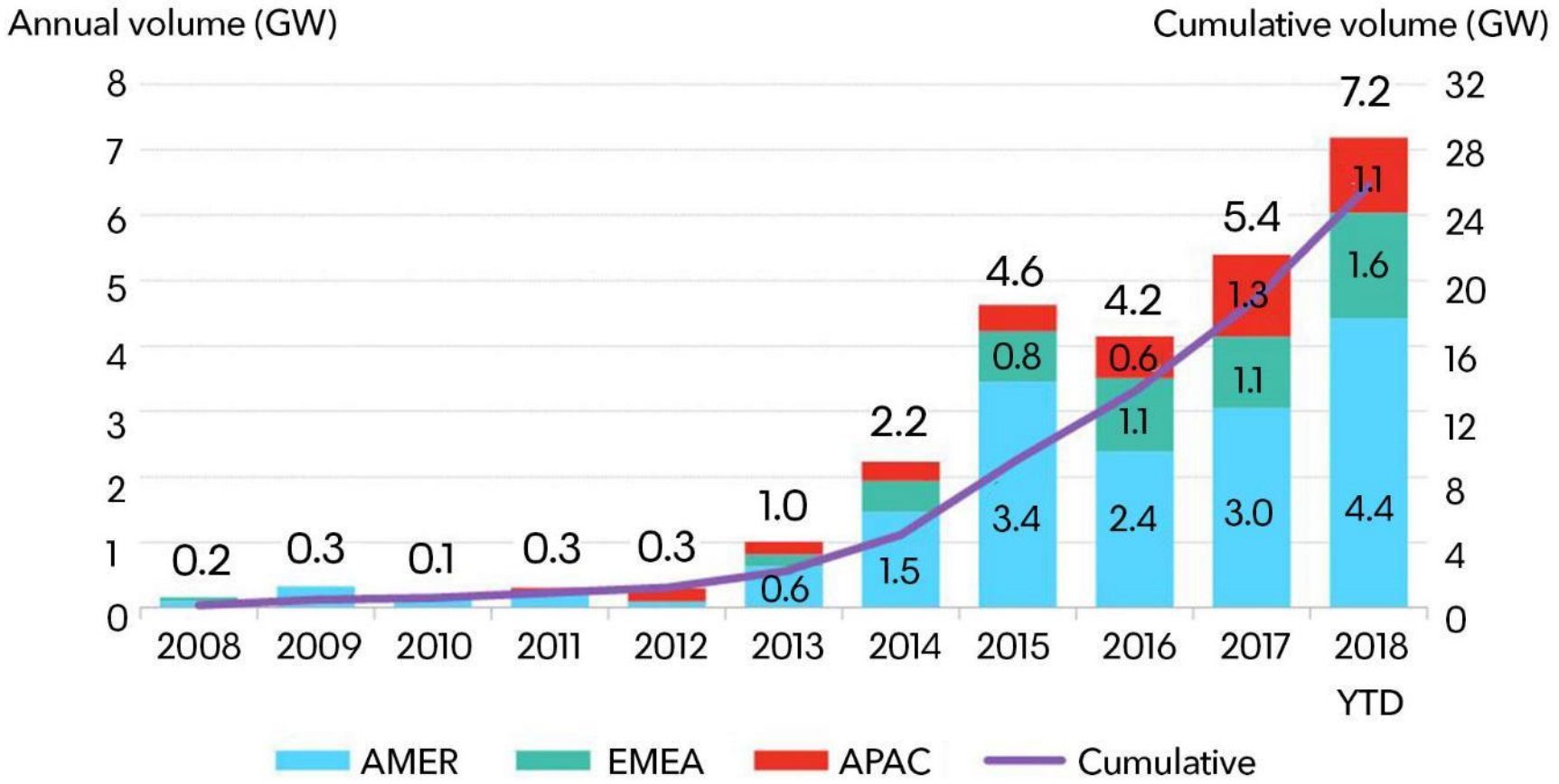


Figure 12. Left: annual CO_2 emissions per sector. Right: cumulative emissions per energy carrier

Ecofys: Energy Transition within 1.5° C

Global corporate PPA volumes, by region



Source: Bloomberg NEF. Note: Data is through July 2018. Onsite PPAs not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. These figures are subject to change and may be updated as more information is made available.

First WHO Global Conference on Air Pollution and Health, 30 October – 1 November 2018

Air pollution kills 600,000 children each year: WHO

Air pollution causes 1 in 9 deaths worldwide

Dr. T.A. Ghebeyesus, WHO DG:

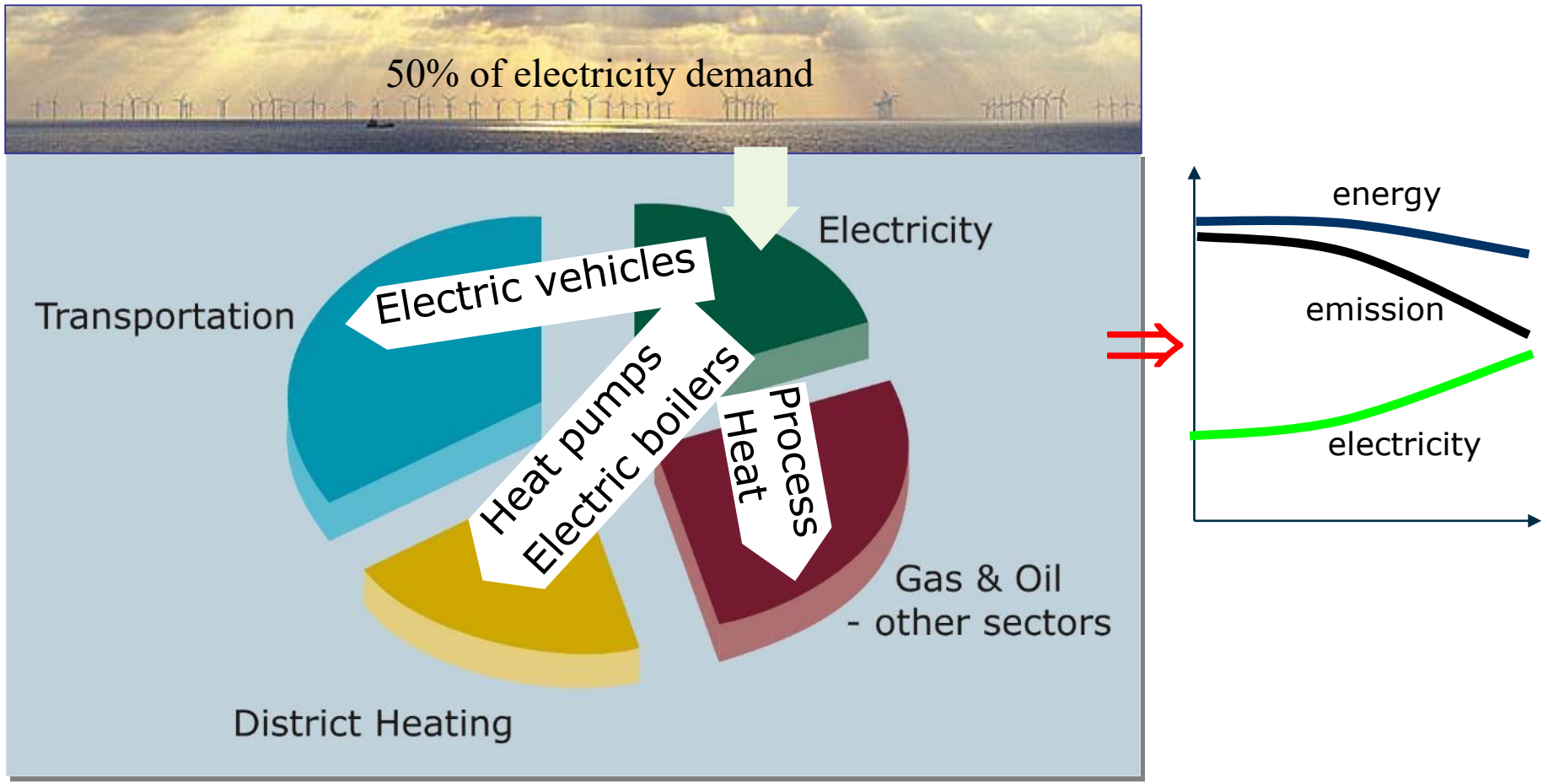
“Air pollution is the new tobacco”

Call to action to target reducing the 7 million deaths per year due to air pollution by 2030, as a contribution to achieving the SDGS.

Key Trends

- Onshore wind, solar PV, and now offshore wind fully competitive and almost universally cheapest sources of new power. CSP, Geothermal and others catching up quickly.
- ‘Electrification’ of just about everything that can be electrified
- Rate of change is extraordinary, and will only increase with digitalisation
- Virtually all scenarios show wind and solar dominating the energy systems of the future.
- Continued rapid technological change happening with materials, siting, plant management and integration.

Coherent and flexible energy systems



Energinet.dk

Key Trends (2)

- Transformation happening at all scales:
    - Large – Increasingly interconnected grids and larger balancing areas
    - Medium scale – hybrids, more offshore (incl. floating)
    - Small scale – mini and microgrids to managing prosumers
- Remaining problems:
    - steel, cement, ships and planes
    - Batteries? Hydrogen/ammonia? Biofuels?

Central Issue

- economically driven change is not fast enough to protect the climate. How to increase the rate of change?
    - Shut down old power plants
    - Price on carbon
    - Subsidy removal
- Need new drivers:
    - Consumers
    - Corporates
    - National/regional targets
    - Something useful out of Paris

Conclusions

- 100% renewable energy system is inevitable, simply because everything else isn't. The remaining question is whether we do it in time to save the climate.

- Unlike 30, 20, or even 10 years ago, *we have the technology, and it's cheap!* But we have to use it, make it work together, and fast.

- Focus on key remaining problems: steel, cement, ships, planes

- Massive disruption underway now in power sector, and it's coming in ground transport…more on the way. If we could plan it, it could be better…unlikely, but we live in hope!

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Thank you!

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