

# Carbon Age is over. What comes next?

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ELECTRIFYING THE FUTURE WITH SMART INFRASTRUCTURE 2018  
Bergamo/Dalmine, November 28, 2018

## Do you remember this summer?

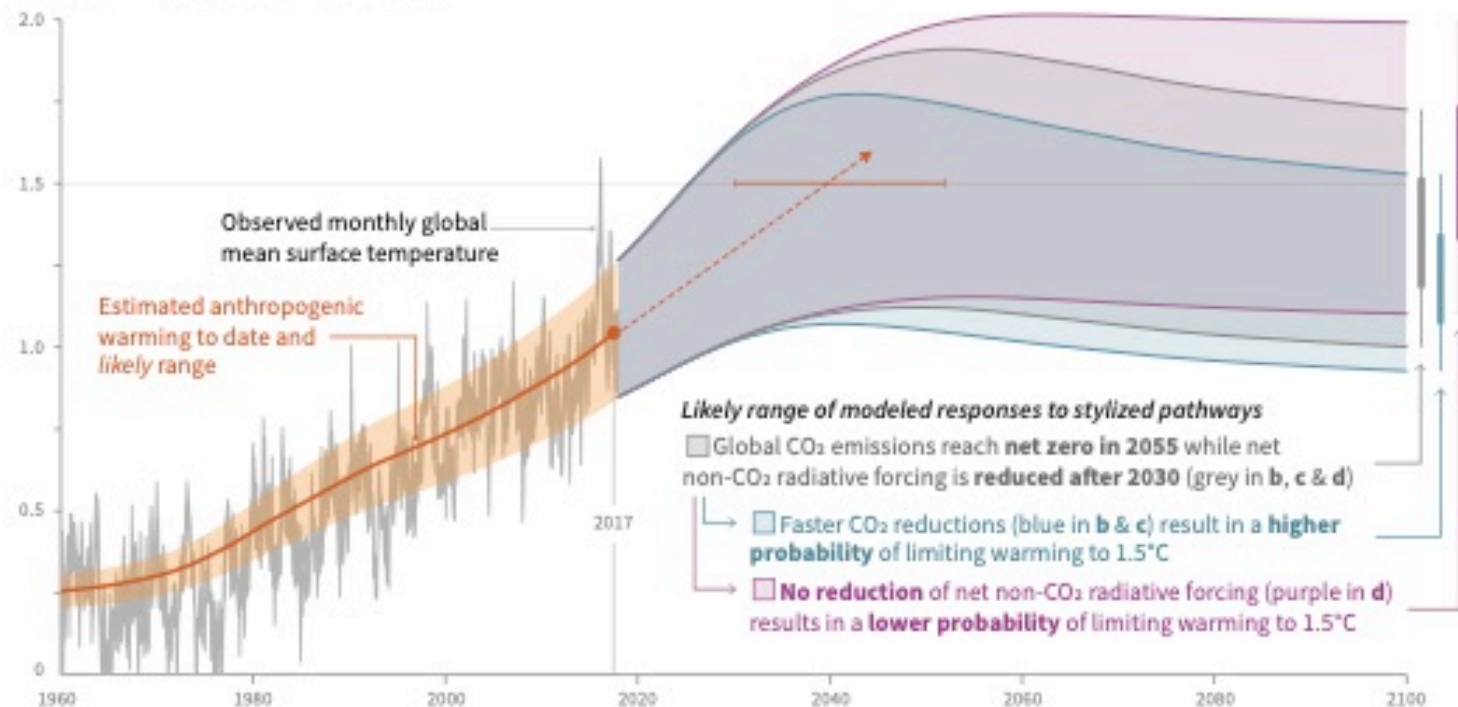
- heat waves across 4 continents – clear connection to climate change (Oxford University, 5 models),
  - scientists warn of the domino effect (National Academy of Science, US),
  - put the energy policies in line with the Paris Agreement and implement the carbon tax (OECD Report),
  - air conditioning: from 1,6 bil. to 5,6 bil. by 2050 = 10 pcs./sec. within next 30 years (IEA „The Future of Cooling“),
- = decarbonisation of the world economy needed.

## IPCC Report – Global Warming of 1,5 C°

### Cumulative emissions of CO<sub>2</sub> and future non-CO<sub>2</sub> radiative forcing determine the probability of limiting warming to 1.5°C

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

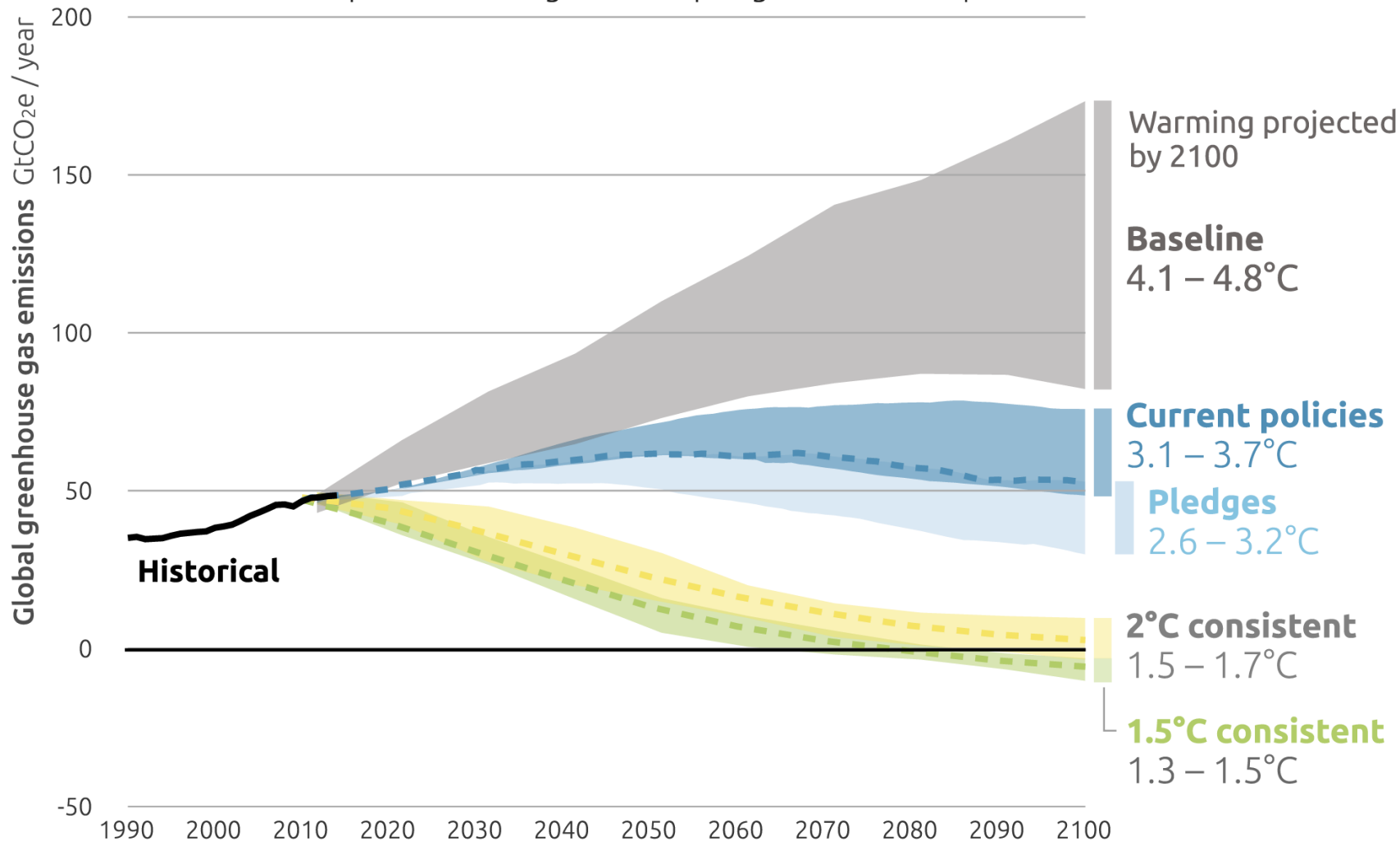
Global warming relative to 1850-1900 (°C)



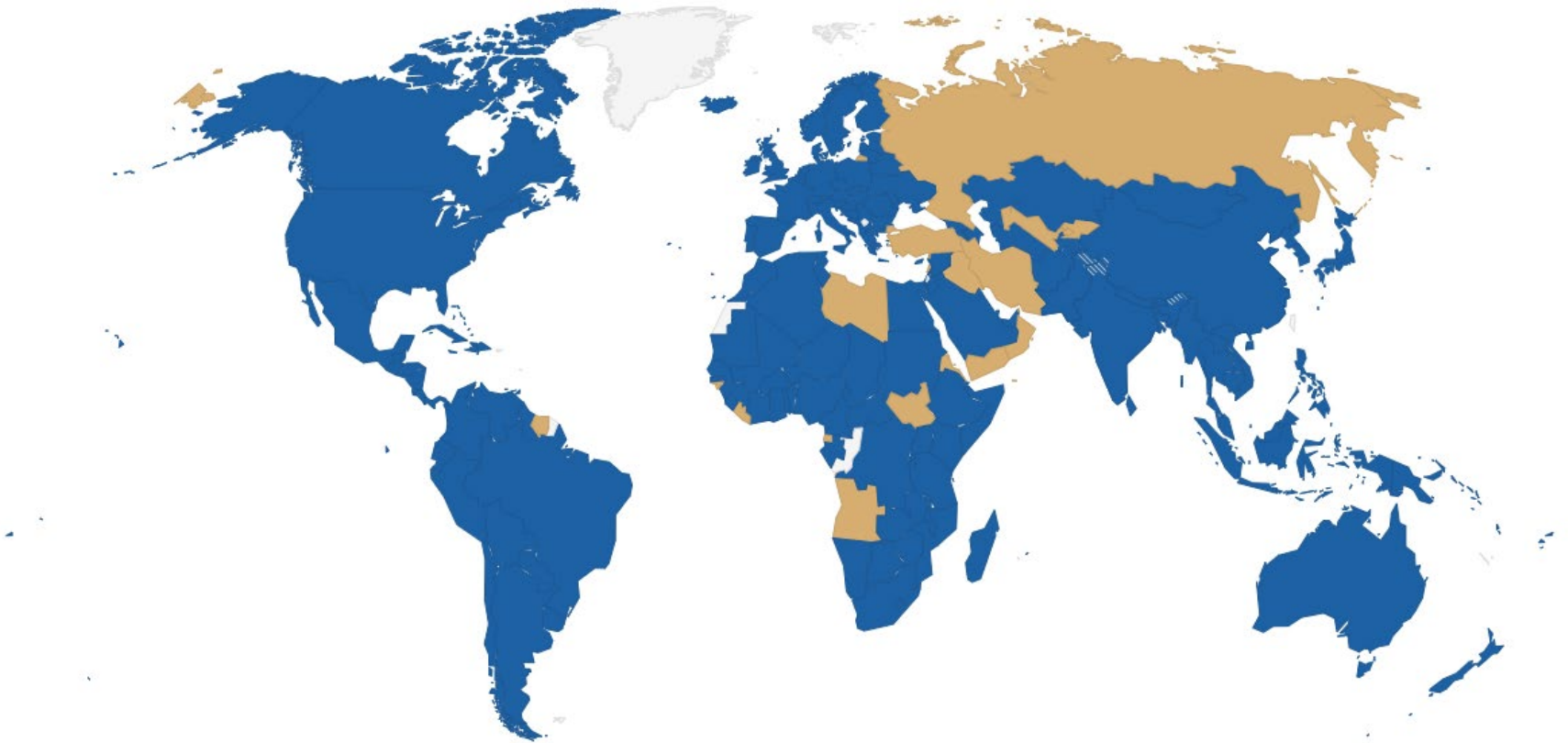
# Climate Action Tracker, 2018

## 2100 WARMING PROJECTIONS

Emissions and expected warming based on pledges and current policies

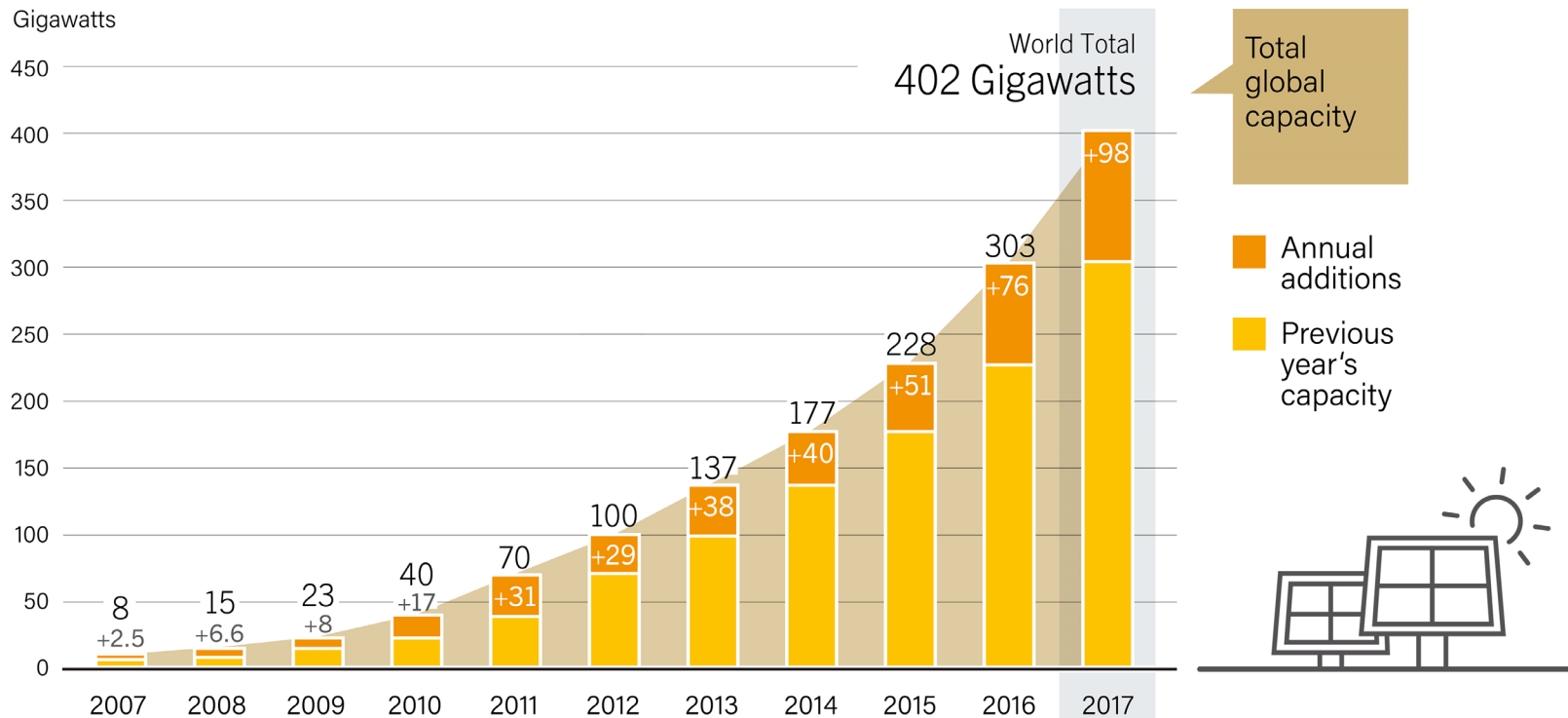


Paris Agreement: 195 signed, 179 ratified, 89% global GHG covered



# Global Energy Transition is unstoppable: over 402 GW in PV !

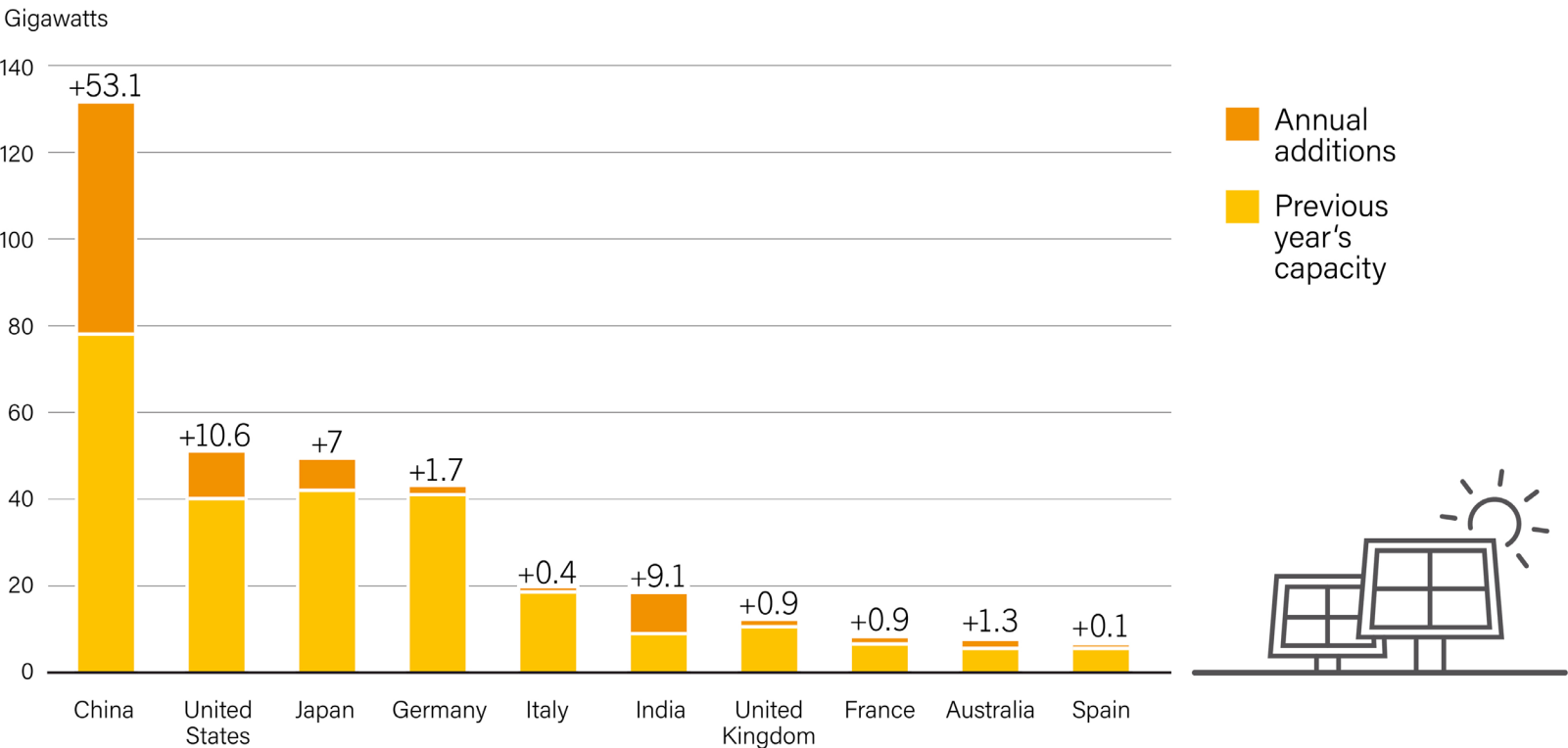
Solar PV Global Capacity and Annual Additions, 2007-2017



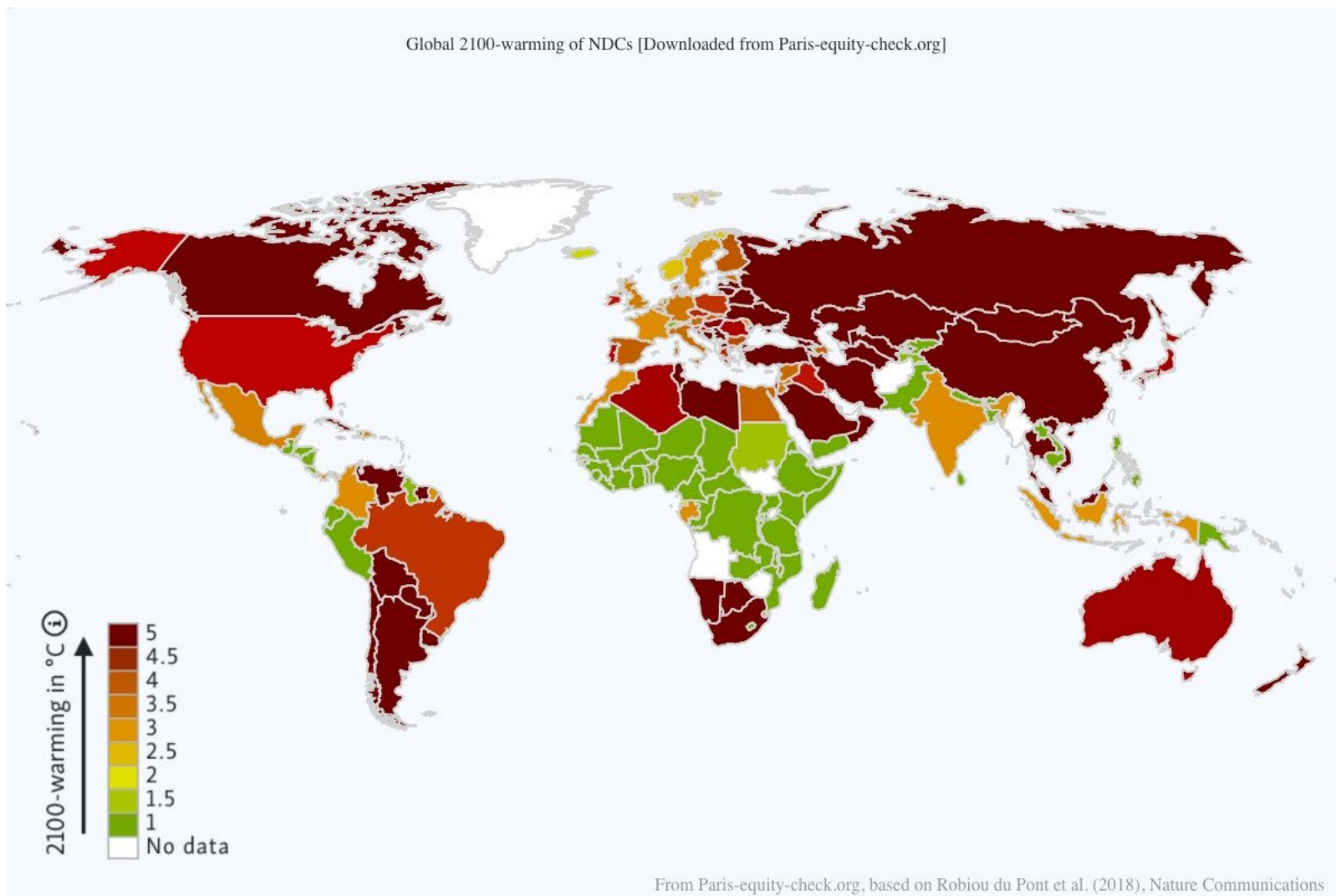
Source: IEA PVPS

# Global Energy Transition is unstoppable: look at China and India

Solar PV Capacity and Additions, Top 10 Countries, 2017



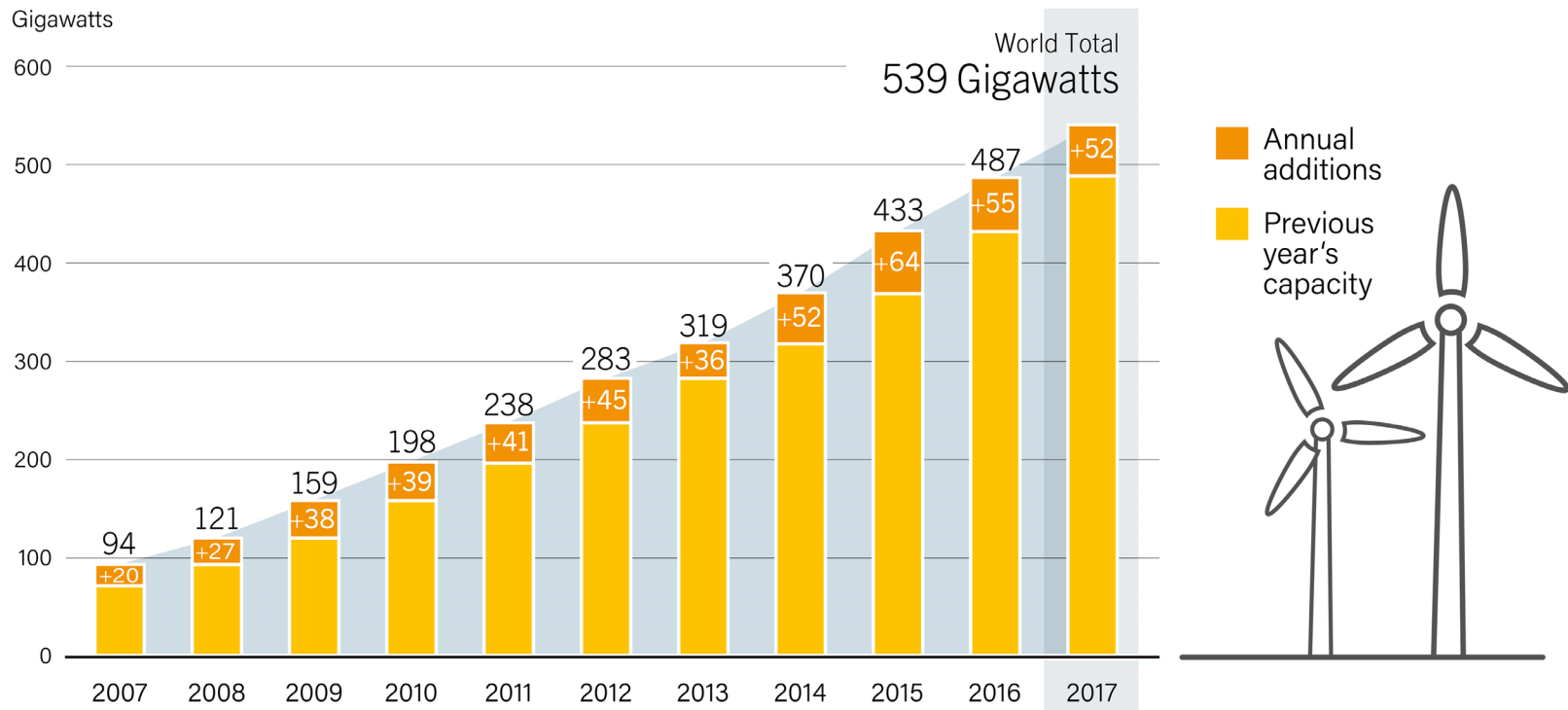
## CLIMATE ACTION TRACKER 2018





# Global Energy Transition is unstoppable: wind wins the RE race so far!

Wind Power Global Capacity and Annual Additions, 2007-2017



## Global Energy Transition is unstoppable

- Power sector experienced the greatest increase in RE capacity in 2016,
- mainly solar PV and wind power,
- developing countries produce more RE than developed,
- 86% of all new power stations in Europe – renewable energy,
- energy transition accelerates,
- becoming a large dominantly market driven business.

## The Third Industrial Revolution

Jeremy Rifkin (2011)

Five pillars of 3<sup>rd</sup> IR:

Shifting to RE,

Buildings into micro-power plants,

Hydrogen and other storage at home,

Power grid into inter-grid,

Electric plug-in and fuel cell vehicles.

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- 190 mil. micro power plants in Europe,

- 3-D printing.

## The Fourth Industrial Revolution,

Klaus Schwab (2016)

Artificial Intelligence (AI),

Robotics,

Internet of Things (IoT),

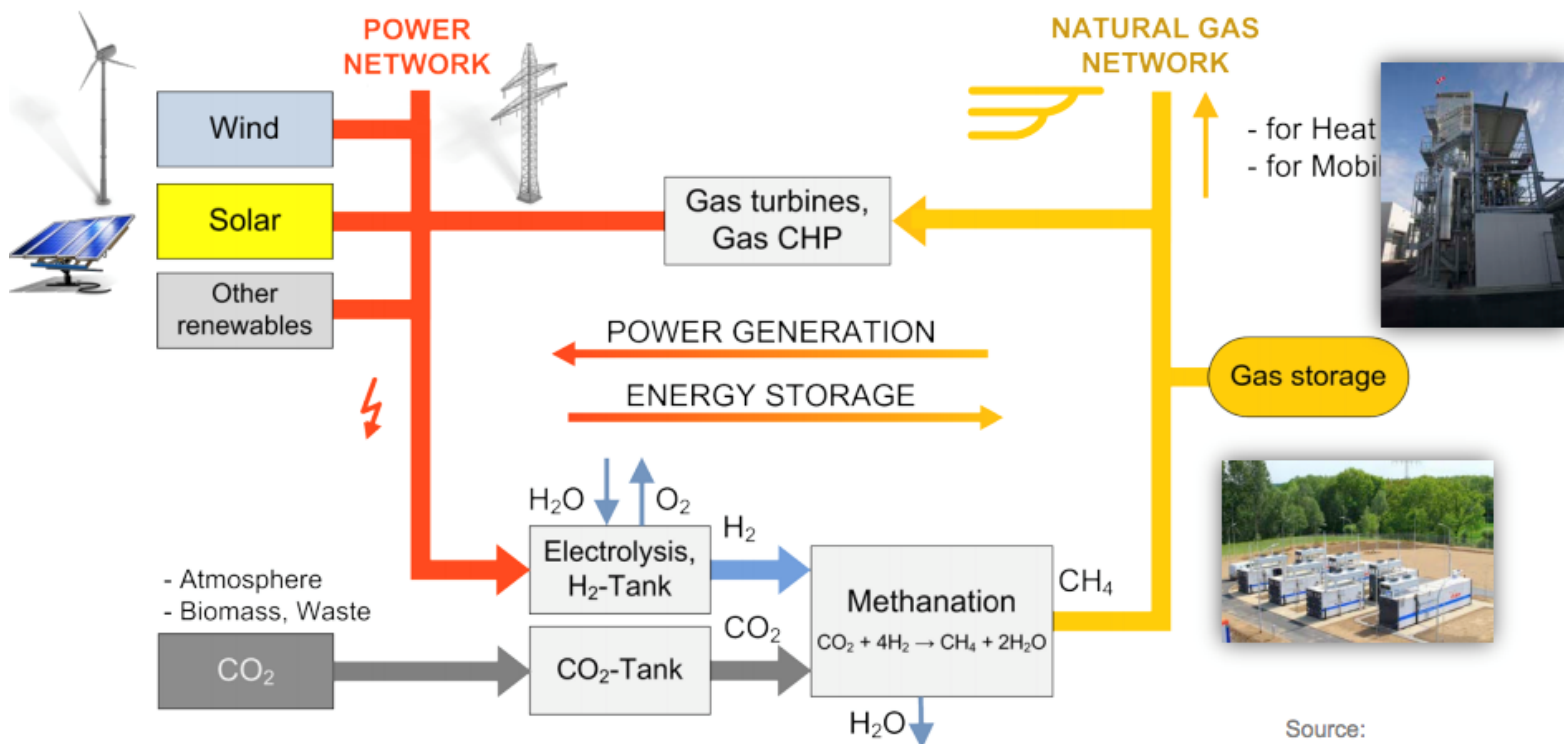
Autonomous vehicles.

# Renewable electricity into green gas conversion = WINDgas and SOLARgas

## Power-to-Gas – The original

Energy storage by coupling electricity and gas networks

Technical copy of photosynthesis → power fuel

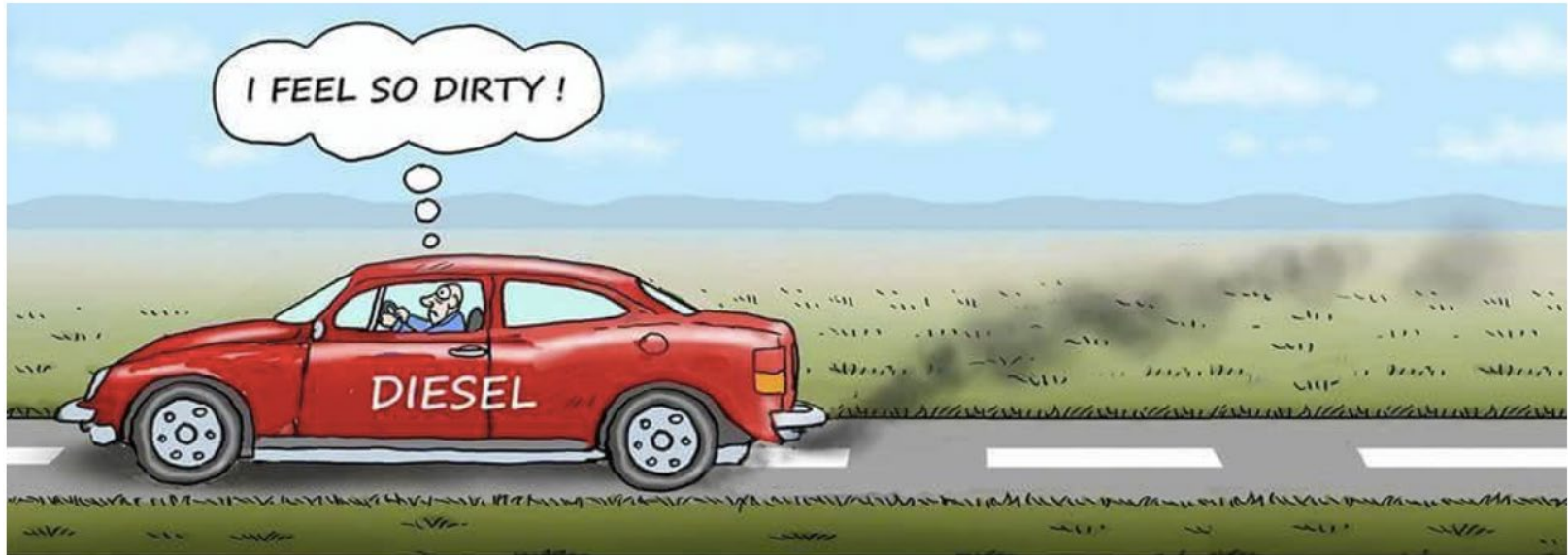


Source:  
Stern + Specht, 2008

Stern, M. (2009): Bioenergy and renewable power methane in integrated 100% renewable energy systems. Limiting global warming by transforming energy systems. Kassel University, Dissertation.

<http://www.upress.uni-kassel.de/publi/abstract.php?978-3-89958-798-2>

ZERO emission vehicles? Renewable electricity powered only.



## 2058

### 1. World population will stop on 8,1 billion people

- will peak around 2040,
- flow to the cities to escape poverty,
- half of the population in the cities already,
- better education, healthcare, safer reproduction = less children,
- the trend is already here: number of children per woman 4,5 to 2,5 over last 40 years,
- climate refugees (27 out of 65 million/2017).

2058

## 2. Feet-not-Cars

- 13 cities leading a car free movement,
- Madrid put a ban on non resident vehicles this month,
- Oslo next year,
- German Highest Administrative Court ruled, that cities can ban cars from some streets due to the pollution,
- Bike super highways (London, now Berlin),
- more than ½ Copenhagen's citizens ride a bike to work (lowest car ownership in Europe) etc.

2058

### 3. Decentralized Renewable Energy harvesting

- hundreds of millions micro power plants,
- energy democracy: pro/sumers (households, industry) and energy communities will dominate energy systems,
- smart grids / micro grids / inter-grids,
- energy storage (batteries, power-to-gas, including electric cars).



2058

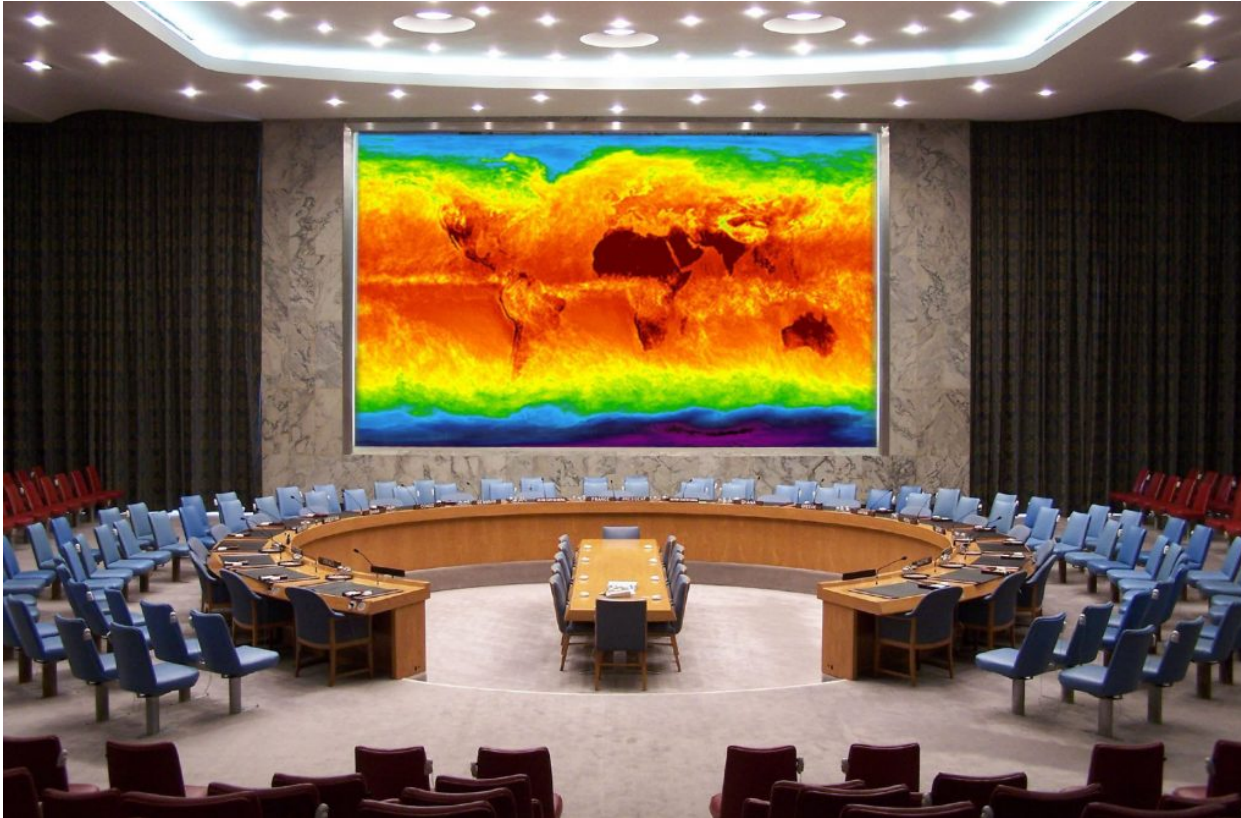
#### 4. 3-D printing

- from “mass production to the production by the masses”,
- Internet-of-Things will change the way of manufacturing, market and goods delivery,
- reduction of production and transportation costs,
- air pollution – environment.

## 5. Mobility-as-a-Service

- The new generation of Millennials and Generation Z – no interest in car ownership,
- rather see costs and an environmental impact,
- look for a smartphone “do it for me” solution,
- “mobility ecosystem” will be dramatically different from today,
- multi modal journeys combining walk/bike/rail/car/taxi/...? will run on a platform where an algorithm will decide on behalf of us,
- cheaper, cleaner, safer (no accidents),
- completely new model of the economy of mobility,
- RE-lectric cars, WINDgas/SOLARgas, hydrogen-electric, 2<sup>nd</sup> gen. biofuels incl. bioCNG ...

We do know what, why, when and how. Not that bad!



Security council and climate change. Illustration courtesy bwats2 and AIRS

Thank you for your kind attention.

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