Challenges for the PV Industry in the 21st Century

Pierre Verlinden

… or

Challenges of the Photovoltaic Technology in the Anthropocene

Becquerel Prize
36th EU PVSEC, Marseille, 9-13 September 2019

Thank you to all the scientists, engineers, lab technicians, friends, … who have been part of this adventure with me and have supported my work. I dedicate this Becquerel Prize to them.

In particular, ….

- **My family, my wife Ann Marie**
- At UC Louvain
  - Prof Fernand Van de Wiele
  - Prof Marvin White
- At Université Aix-Marseille III
  - Dr Gérard Stehelin
  - Prof Jean-Pierre David
- At SunPower
  - Dr Dick Swanson
  - Dr Ron Sinton
  - Denis DeCeuster
  - Dr Akira Terao
  - Kristel Wickham
  - Dr Michael Cudzinovic
  - Dr David Smith
- At Origin Energy Solar
  - Prof Andrew Blakers
  - Dr Matthew Stocks
  - Dr Mark Kerr
  - Dr Mick Stucking
- At Honda
  - Takahiro Iwata
- At imec
  - Prof Jef Poortmans
  - Dr Monica Aleman
- At Solar Systems
  - Dr John Lasich
  - Allan Lewandowski
  - Dr Michael Volk, Dr Annelene Dethlefsen
  - Igor Varfolomeev
- At Trina Solar
  - Gao JiFan
  - Dr Feng ZhiQiang
  - Dr Chen Yifeng
  - Dr Yang Yang
  - Zhang Xueling
  - Dr Pietro Altermatt
  - Dr Chen Daming
  - Xu GuanChao
  - Liu Wei, Chen Yan, Zhang KangPing
  - Gao XiaoYan
  - Dr Deng Weiwei, Dr Xiong Zhen
  - Jiao Haijun
  - Xu Jianmei, Shu YunHua, Quan Peng, Zhang Shu
- ….. (and many more)

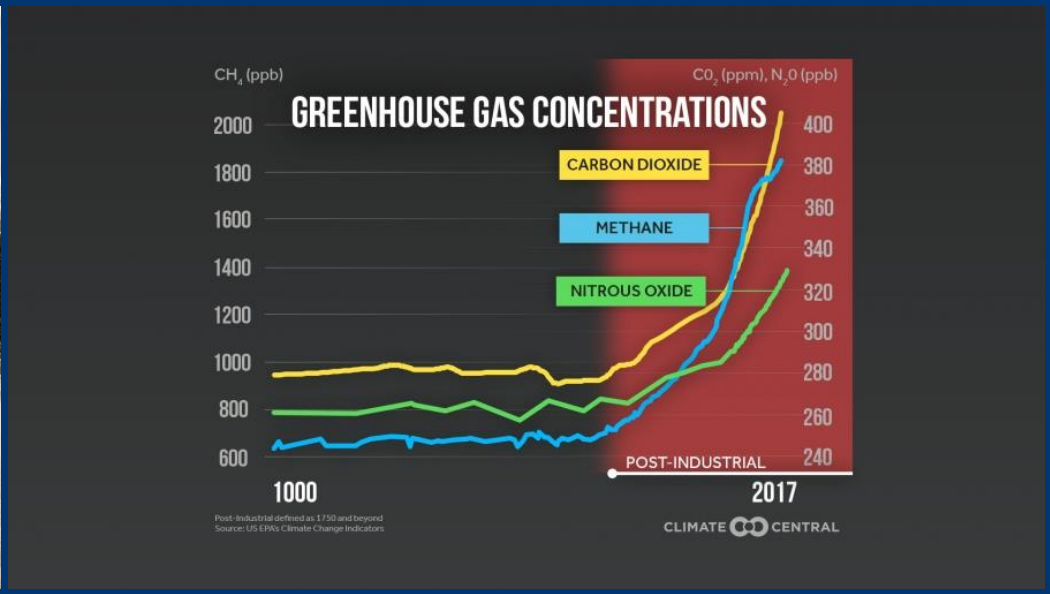
Anthropocene

/ˈanθrəpəˌsiːn/

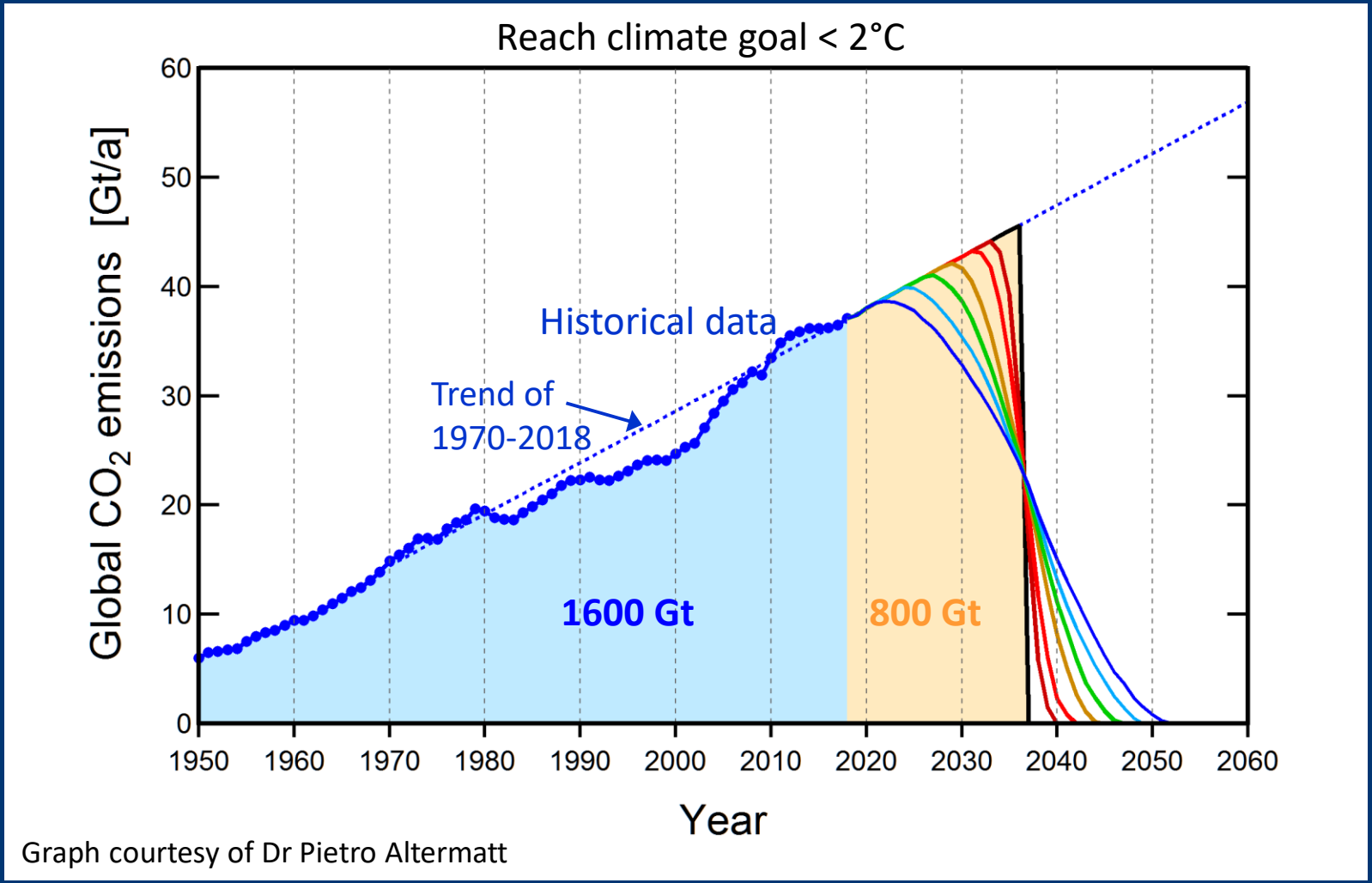
noun

the current geological age, viewed as the period during which human activity has been the dominant influence on climate and the environment.

One proposal, based on atmospheric evidence, is to fix the start with the Industrial Revolution, ca. 1780, with the invention of the steam engine.



To fulfill the Paris COP21 Agreement, we are allowed to generate only 800 GT of CO_2, then zero. The next 10 years will be decisive.

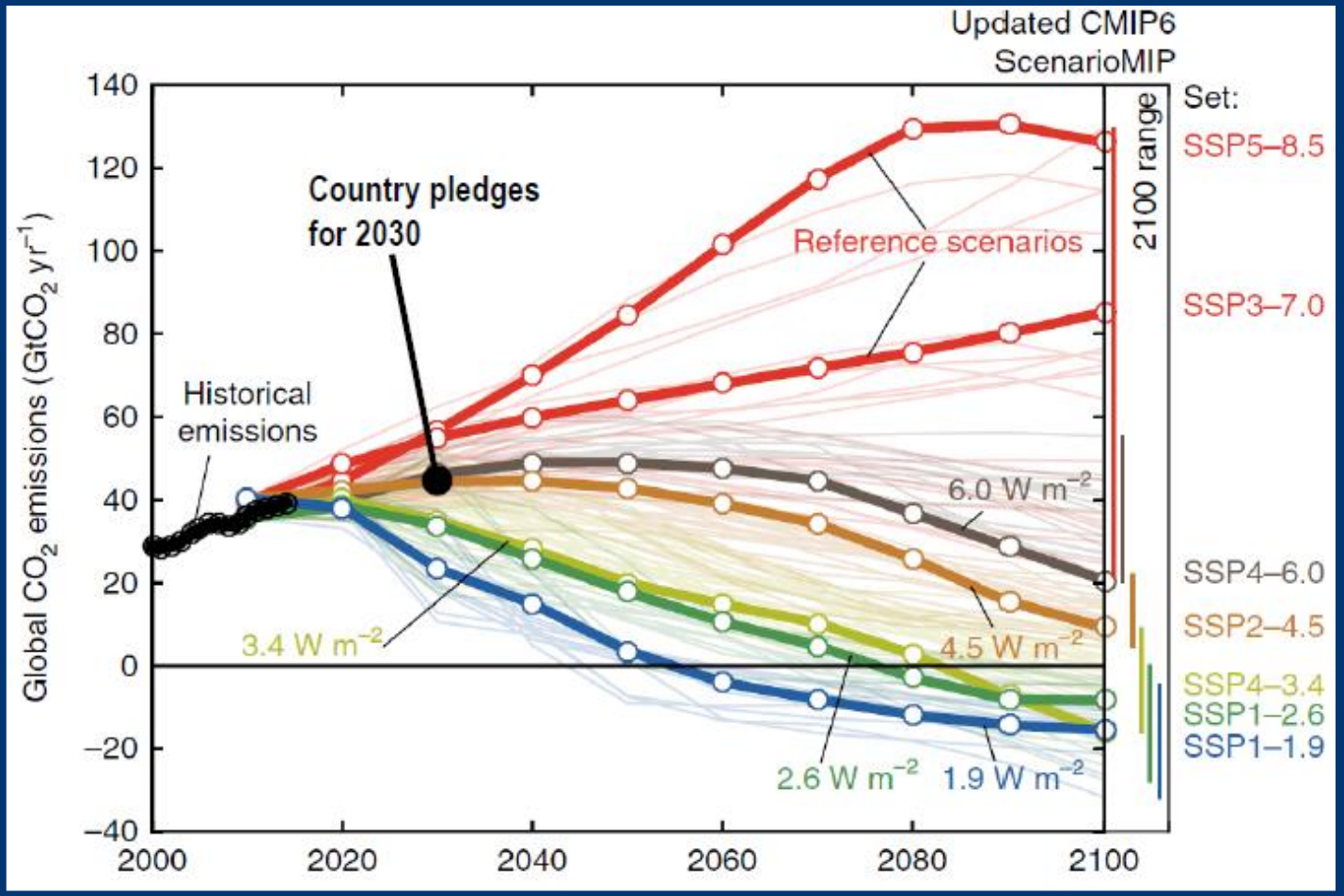


Graph courtesy of Dr Pietro Altermatt

Historical data: U.S. Dep. of Energy (DOE)

[1] G. Luderer et al, Nature (climate change) 8, 262 (2018)

Only fast transition over the next 30 years to net-zero CO_2 emission allows to meet +1.5C -2C



Source: Rogeli et al., Nature Climate Change **8**, pages325–332 (2018)

If we don’t, the consequences will be disastrous!

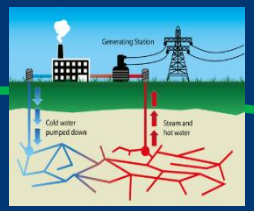
- The World is probably right now on a path of > +4°C by the end of the Century. We are approaching the point when it will be too late to act.
  - Increase of average Earth temperature
  - Destabilisation of Gulf Stream and Jet Stream
  - Extreme climate-related disasters
  - Rise of sea water level
  - Ocean acidification
  - Desertification
- A +4°C World might only support 1 billion people, maybe half a billion !

➢ The only goal is 100% Renewable Energy by 2050

hydro

wind

geothermal



biomass

PV is the most important technology in a 100% RE transition

70-80 TWp by 2050

Syn Fuel Power-to-X

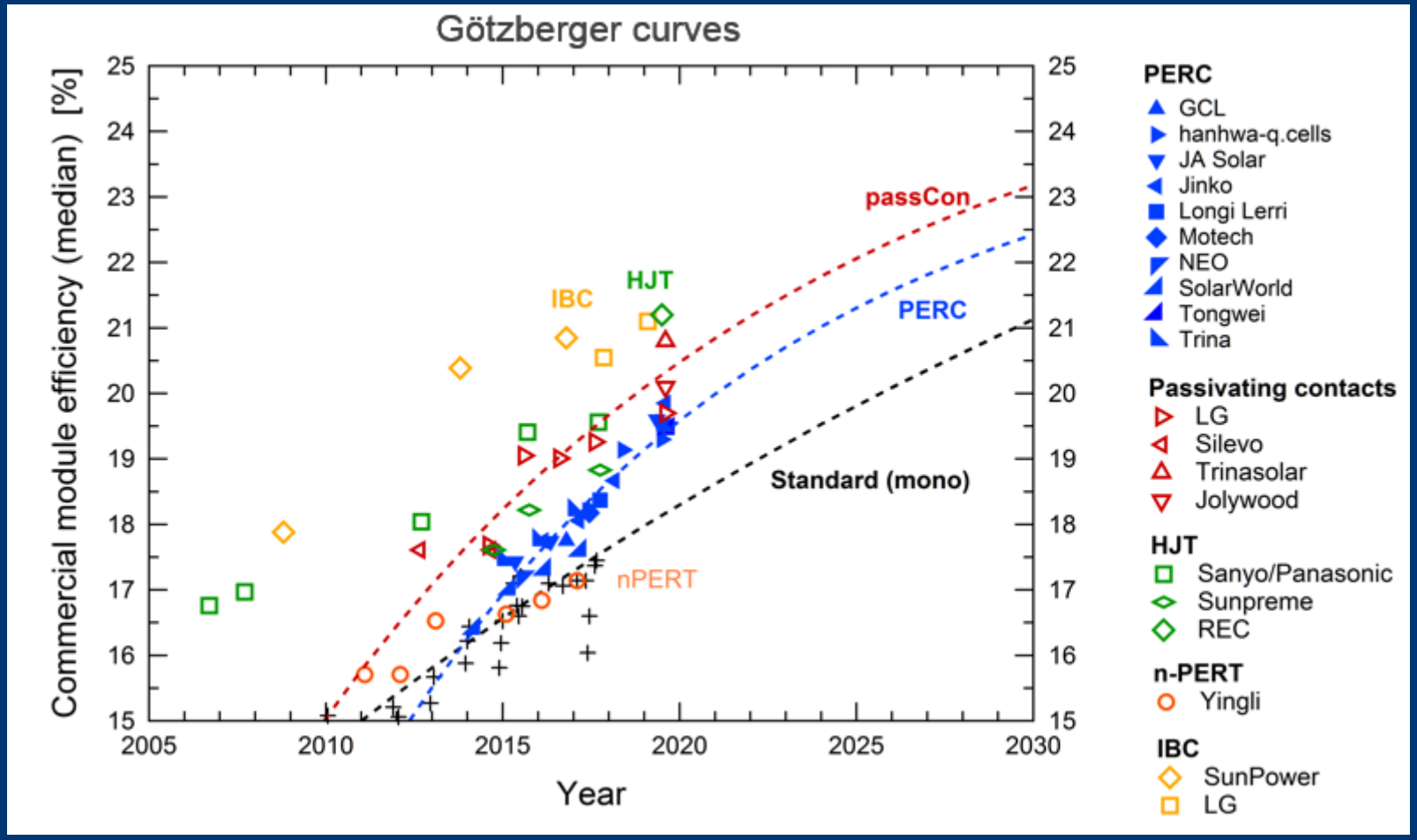
Heat Pump

EV

Industrial Processes

Energy Storage

Module efficiency is not the main challenge

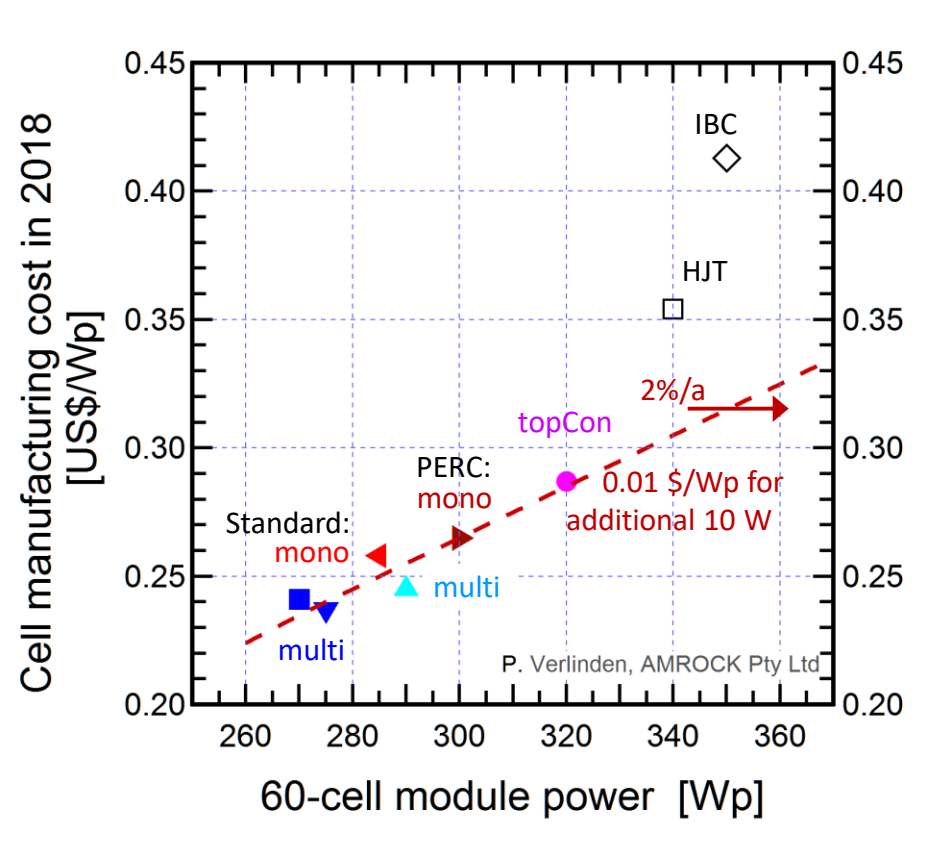


… Silicon-based Tandem with efficiency > 26% will soon be commercially available

Y. Chen et al, IEEE J PV 8, 1531 (2018), and updated data from the PV industry

Graph courtesy of Dr Pietro Altermatt

Many Silicon Technologies to optimise LCOE for different locations or applications

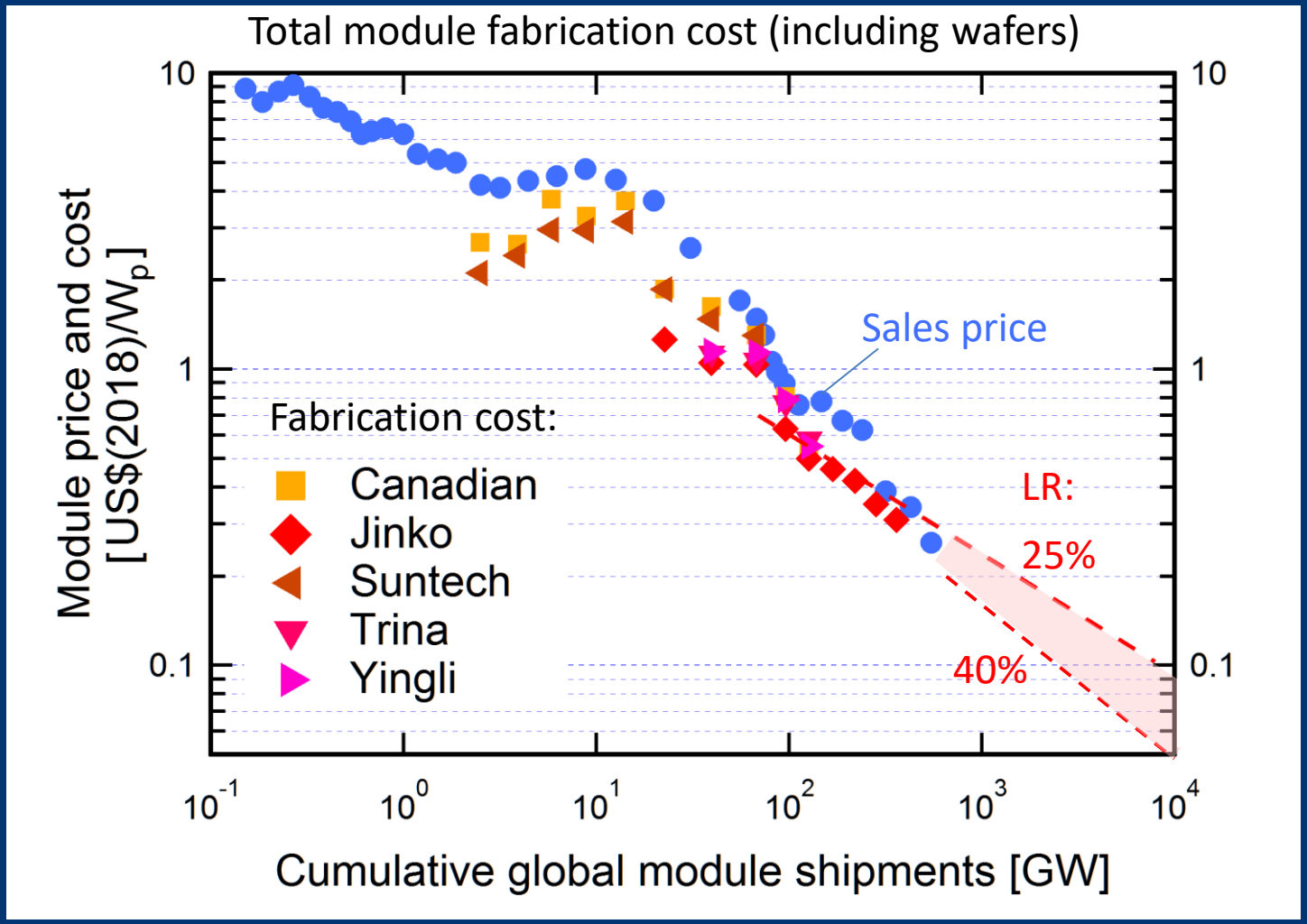


- Efficiency improves by +2% rel. per year
- Price currently decreases by 12% rel. per year
- Learning rate -25% to -40% for every doubling of cum. production

Data: P.J. Verlinden, Session "Understanding the Value of Efficiency in Mainstream PV Markets", 46th IEEE PVSEC, Chicago, June 2019

Graph courtesy of Dr Pietro Altermatt

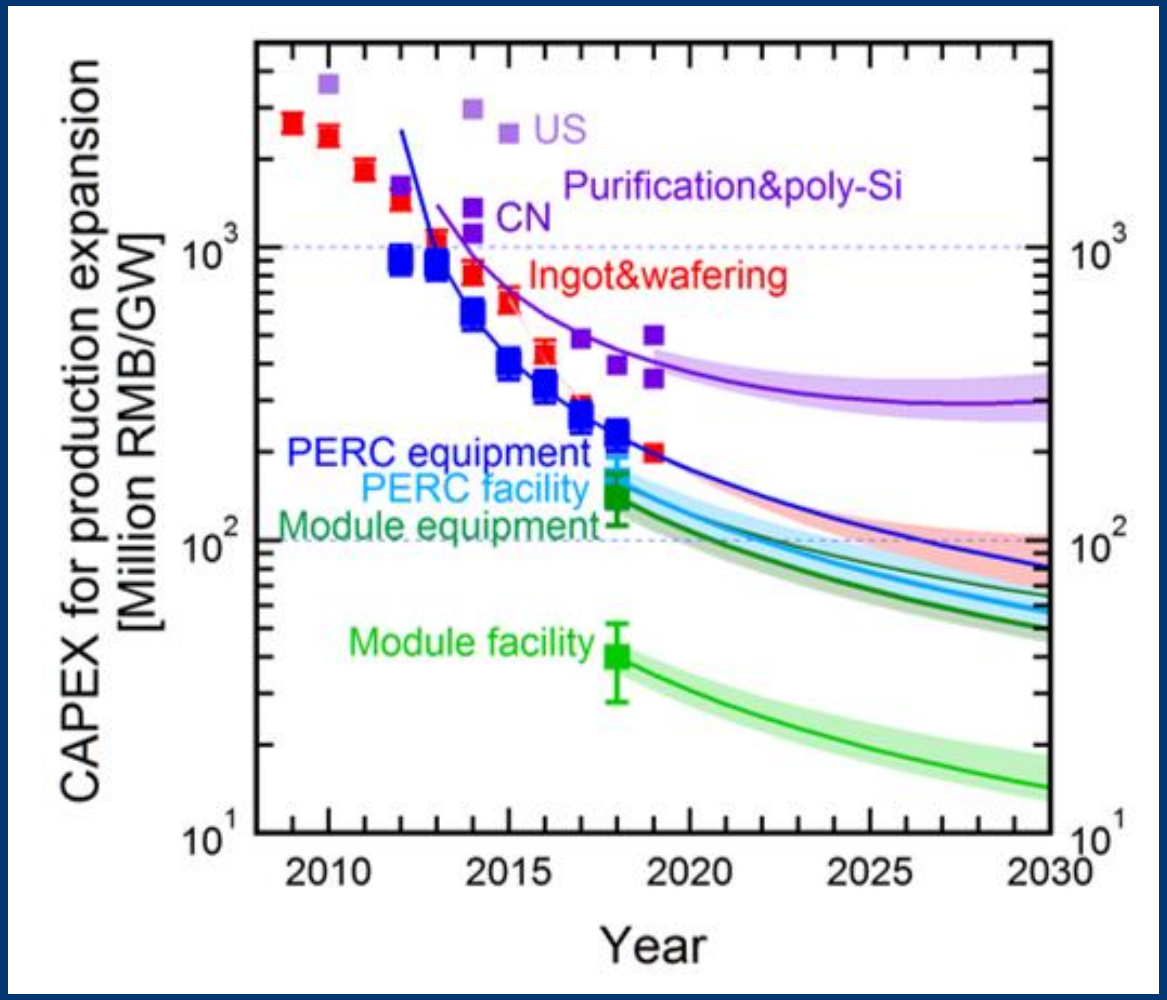
Cost of Generation CAPEX is not the main challenge



PV is already in many parts of the World the cheapest source of energy, even against the marginal cost of coal.

Graph courtesy of Dr Pietro Altermatt and Dr Chen Yifeng

Manufacturing CAPEX is not the main challenge



Already reduced by more than one order of magnitude in the last 10 years

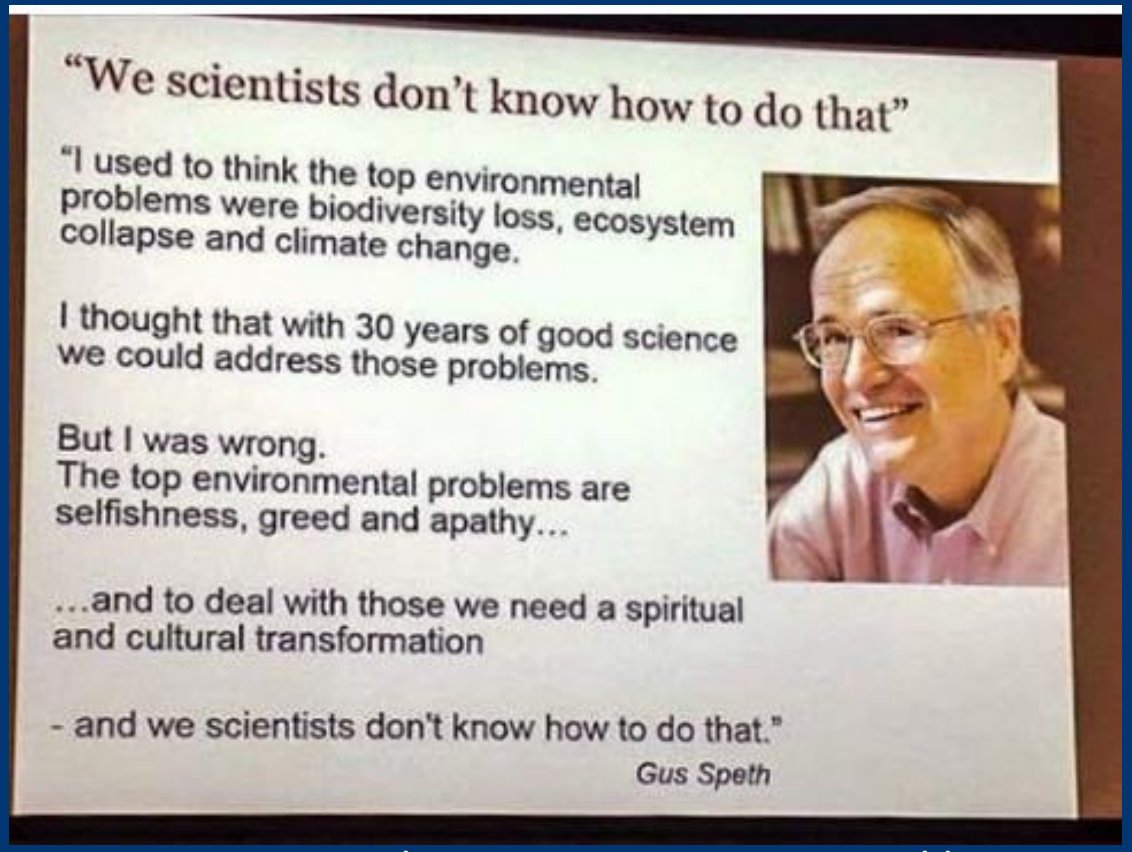
The PV Industry is capable to grow even with low Gross Margin

Y. Chen et al, IEEE J PV 8, 1531 (2018), and updated data from the PV industry
Graph courtesy of Dr Pietro Altermatt

What are our challenges?

- The Time Constants of Climate Change are so long, much longer than most human preoccupations:
  - Politicians: Re-election
  - Entrepreneurs: Return on investment
  - Life expectancy

- Selfishness
- Greed
- Trade barriers
- Return on Investment
- Wrong scale of values
- Populism
- Apathy
- No sense of urgency

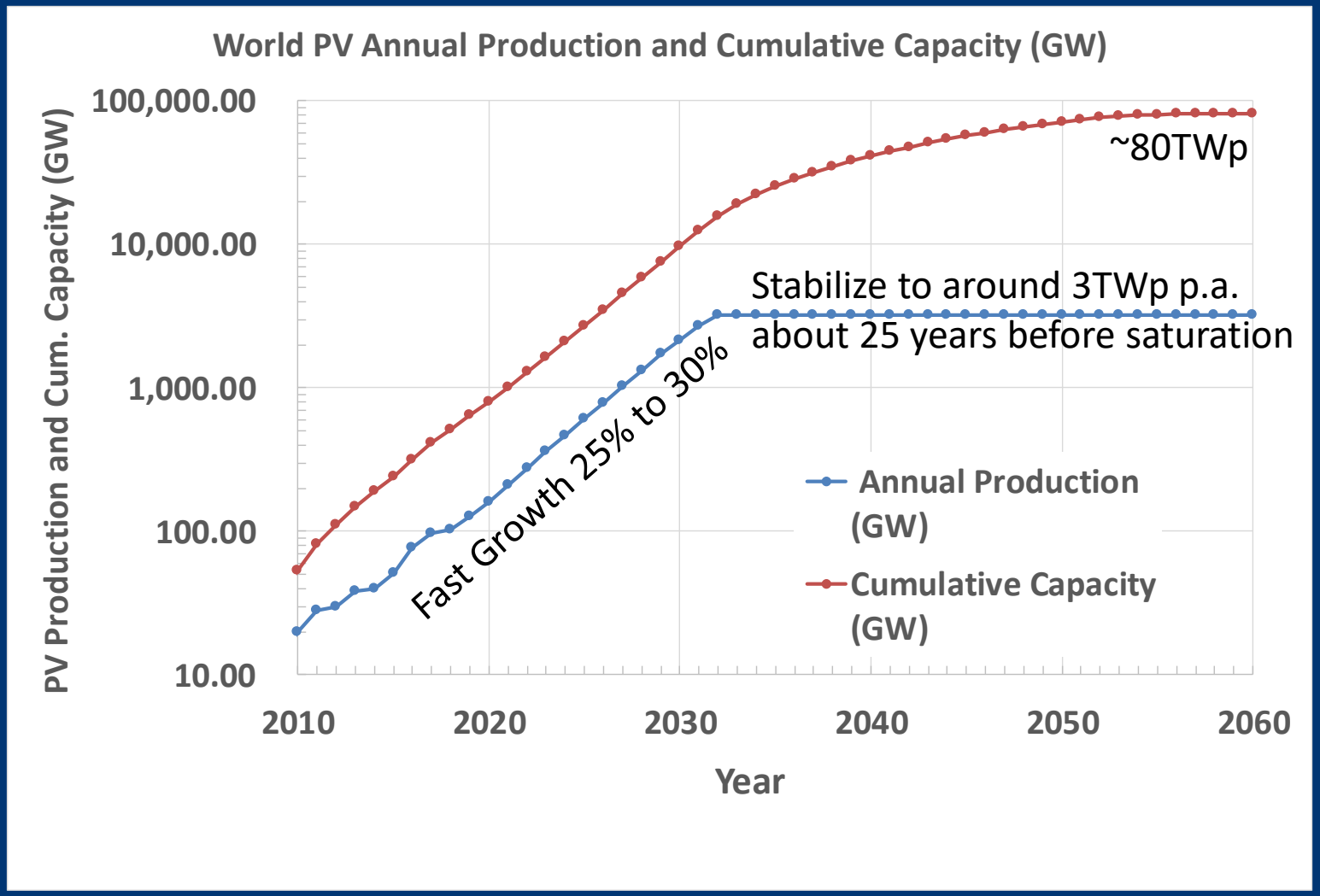


James Gustave Speth, American environmental lawyer

The Energy Transition is a major Change Management Project

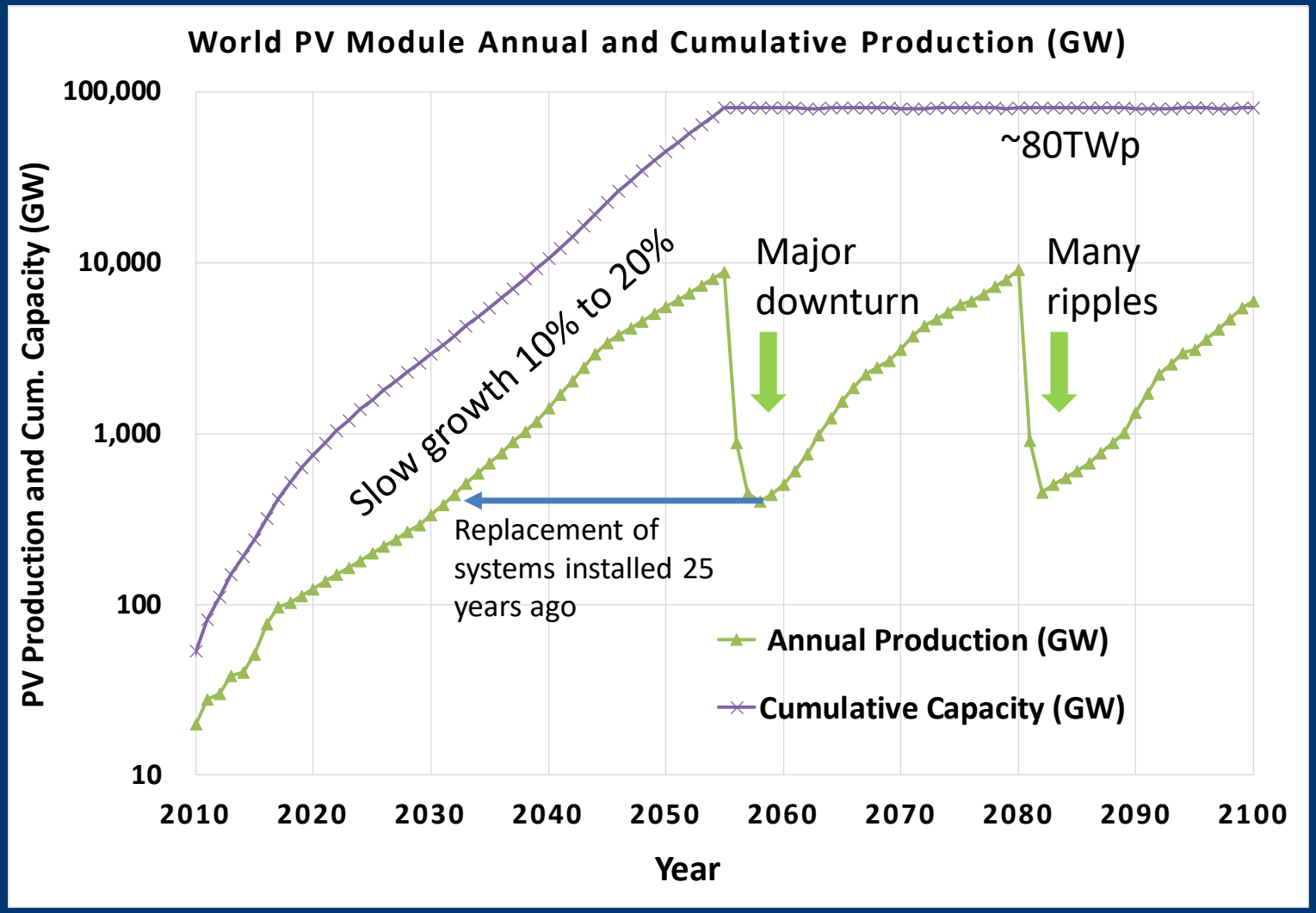
As Scientists, we are good at Technology, not so good at Politics, Regulations, Communication, ….

We must keep 25% to 30% growth rate until 2030



…. if not, we will kill the PV industry with a major downturn in 2055

If we do not grow fast enough right now, …



…. the PV industry will not survive such major downturns in the 2050's

Other Challenges for the transformation of the Energy Economy

- Total electrification: => Promote EV's,
  - With EV's, potentially 100TWh of storage => V2G
  - Potential of 600 GW of PV on the roofs of EV's
  - Potential > 6TW of PV additional capacity
- Green Power-to-X
  - Hydrogen, Syn Fuel, Syn Gas
- Sustainability at the multi TW level
  - Silver to be reduced to less than 10mg/Wp
- Recycling of PV Modules: a growing need (recycling Ag, Al, Cu)
  - Today 100MW of modules to be recycled per year
  - In 10 years, the volume will be 10X larger (~ 150,000 tons)

There are still 1 billion people in the World without access to electricity.

PV must come with
Financing, Pay-As-You-Go

Their needs are more about sanitation, health, education, information, food conservation, improving productivity in agriculture, food processing and fishing industry, …

What are my current preoccupations? What have I done to reduce my CO_2 emissions?

- Is our home 100% CO_2 emission-free?
- Where is our electricity coming from?
- How do we heat and cool the house?
- How do we cook?
- How do we travel?
- Is our EV recharged by 100% green electricity?
- How much CO_2 is embedded in our PV systems?
- What PV technology am I developing? Is it sustainable at the multi-TW level?
- How can I educate my family, my neighbours, the politicians of our countries about the urgency of PV deployment?

➢ We need to install in average the equivalent of ~ 6 to 10 kWp of PV per Capita

Thank You

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