Photovoltaics vs nuclear – prospects and impediments

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Raitenhaslach, 25 August 2020

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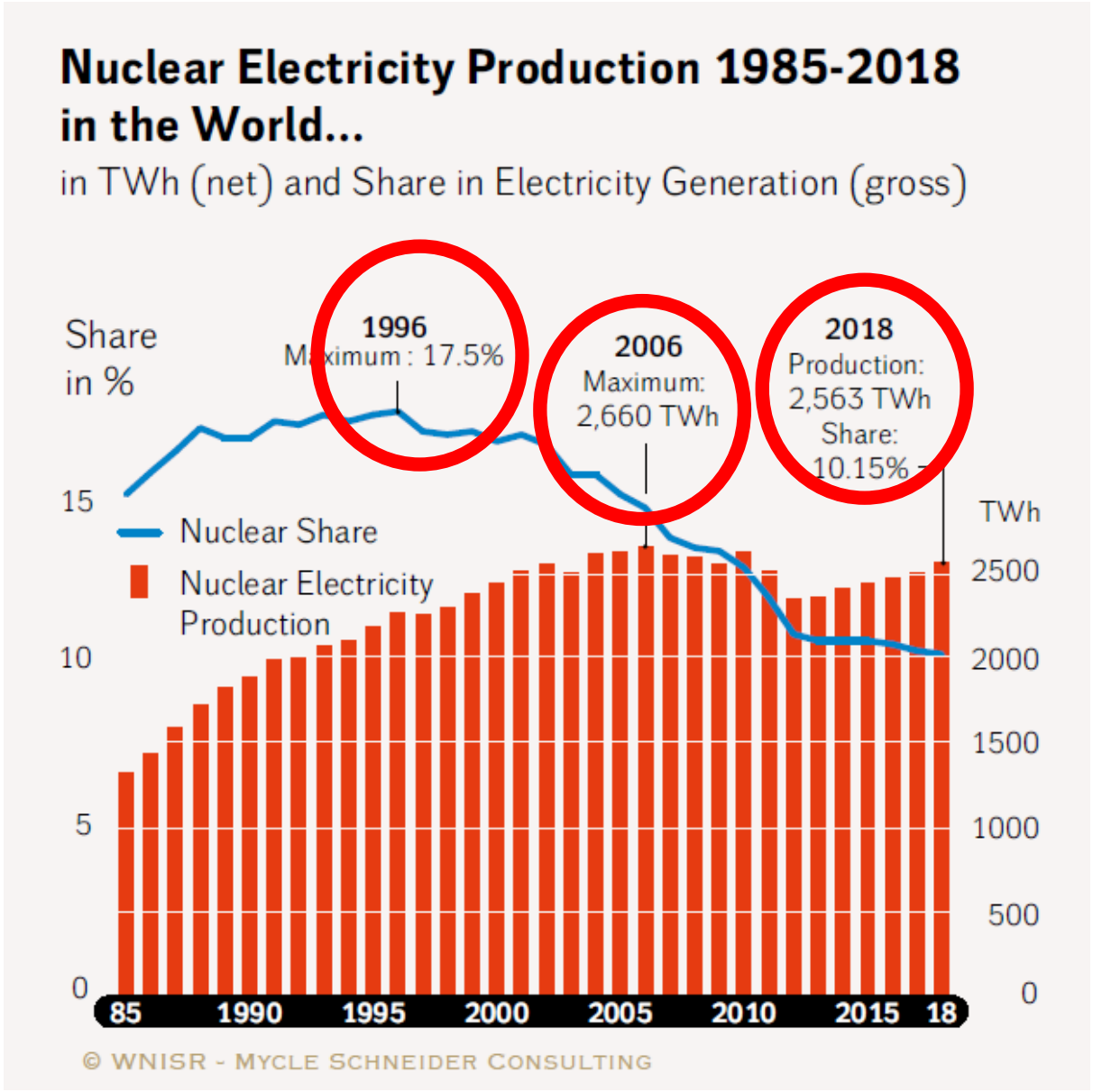
2. Historical development of nuclear costs
3. Historical developments of PV costs
4. Towards prosumagers
5. Future developments
6. Conclusions

1. INTRODUCTION: HISTORICAL DEVELOPMENTS OF NUCLEAR AND PV


Nuclear Electricity Production 1985-2018 in the World...
in TWh (net) and Share in Electricity Generation (gross)
Share in %
1996
Maximum : 17.5%
2006
Maximum:
2,660 TWh
2018
Production:
2,563 TWh
Share:
10.15%
Nuclear Share
Nuclear Electricity Production
TWh
15
10
5
0
2500
2000
1500
1000
500
0
85
1990
1995
2000
2005
2010
2015
18
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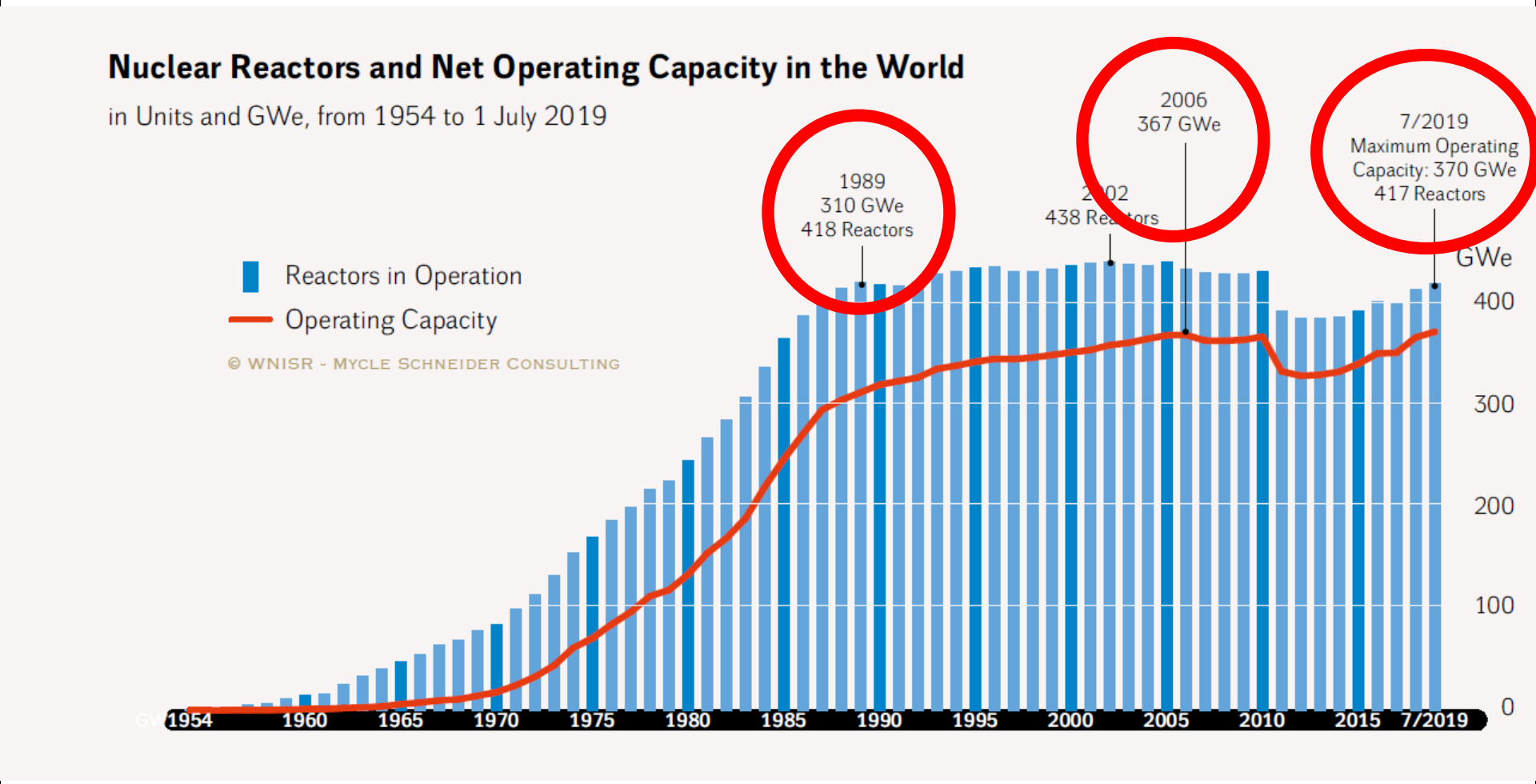
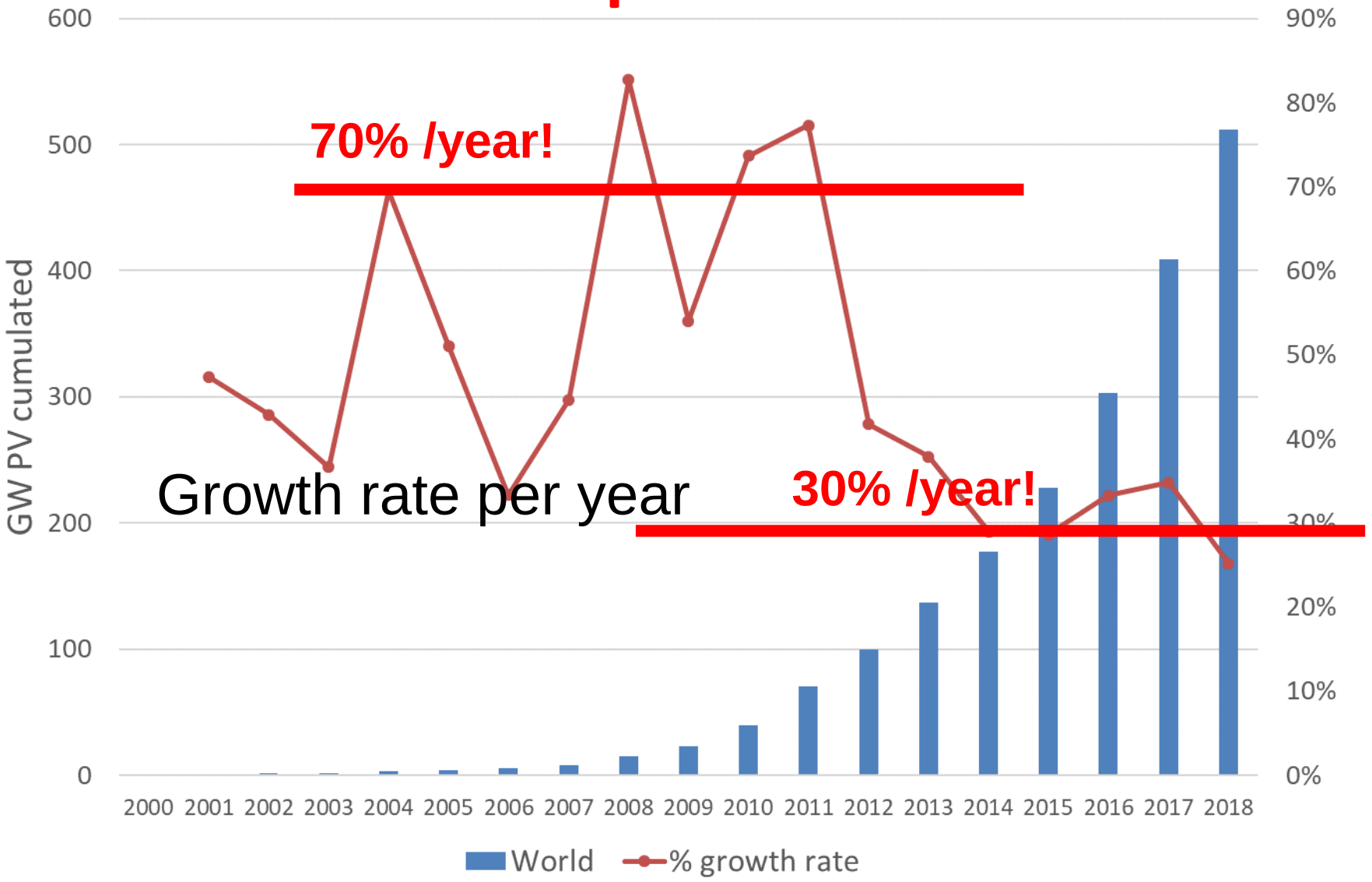
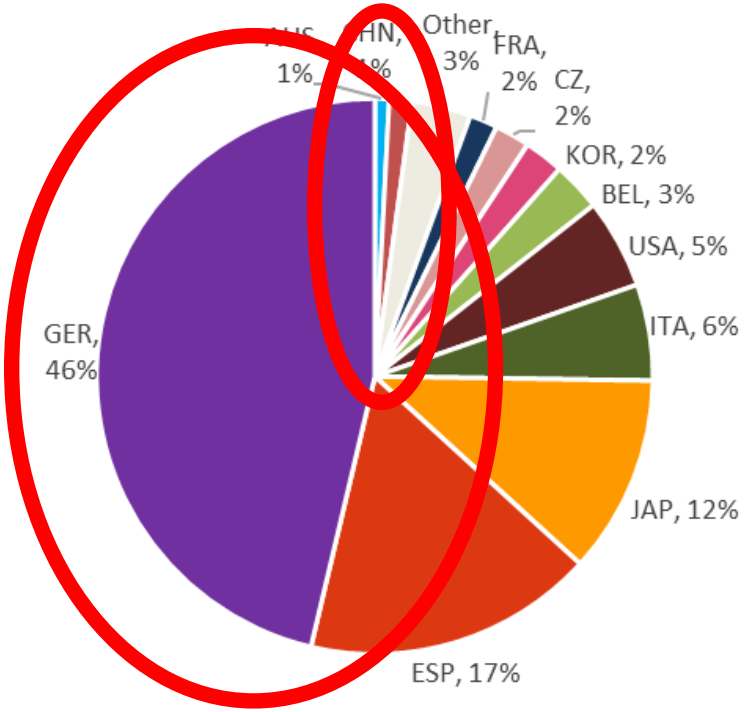

Nuclear Reactors and Net Operating Capacity in the World
in Units and GWe, from 1954 to 1 July 2019
1989
310 GWe
418 Reactors
2006
367 GWe
7/2019
Maximum Operating
Capacity: 370 GWe
417 Reactors
Reactors in Operation
Operating Capacity
© WNISR - Mycle Schneider Consulting
GWe
400
300
200
100
0
1954
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
7/2019

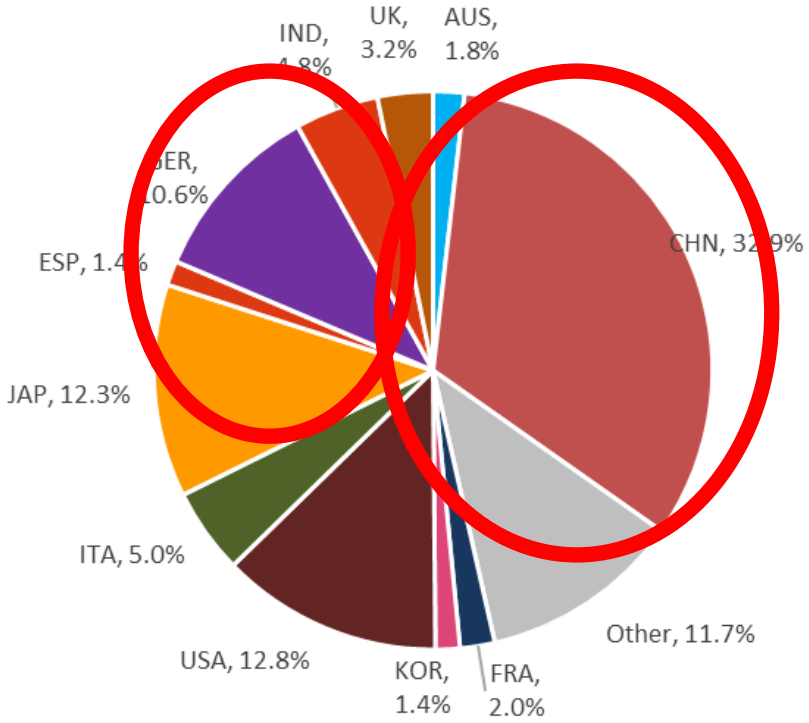
World-wide cumulative PV capacities



Total installed capacity 2018: 512 GW (compared to 23 GW in 2009)

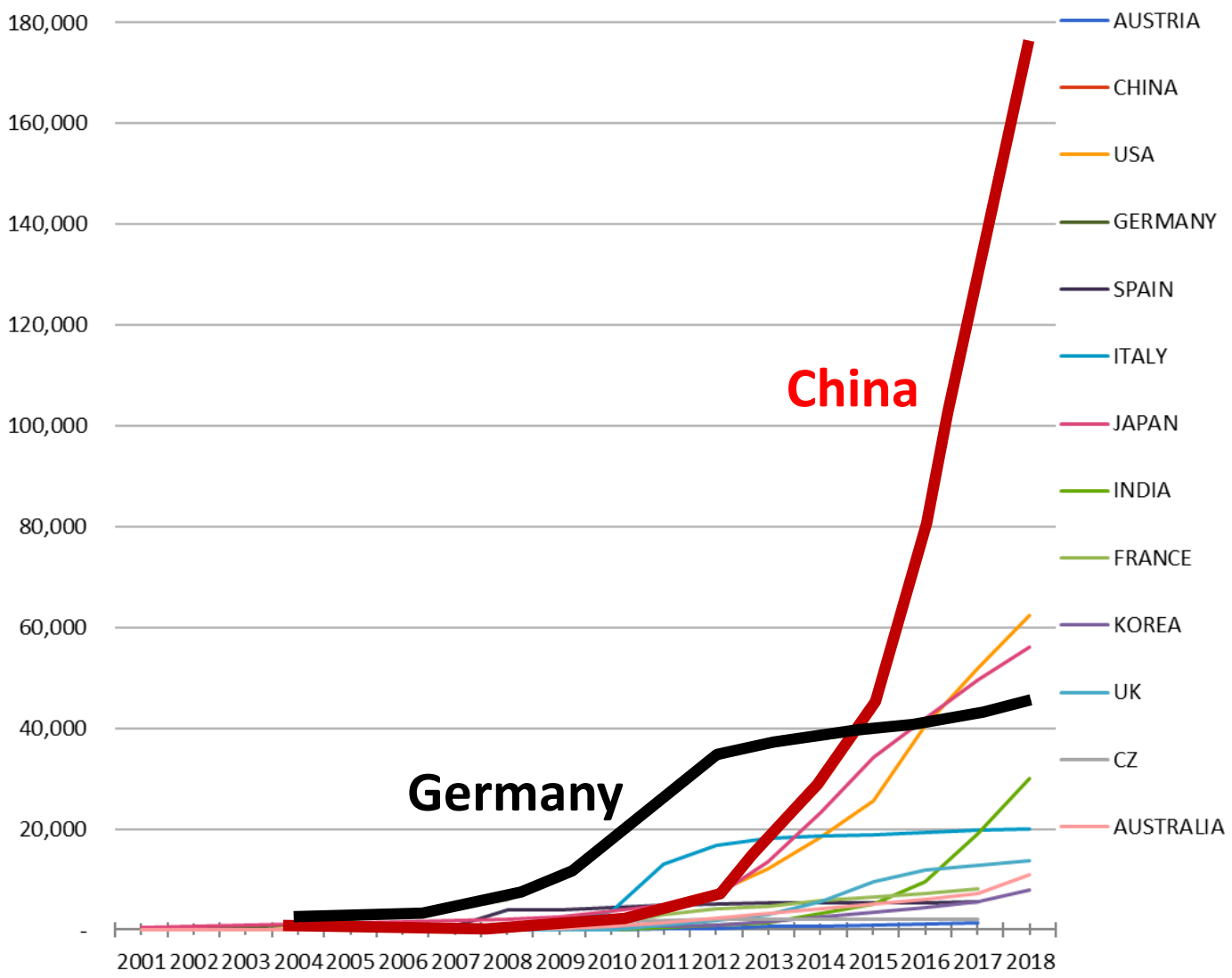


2009



2018

Cumulative PV capacities by country

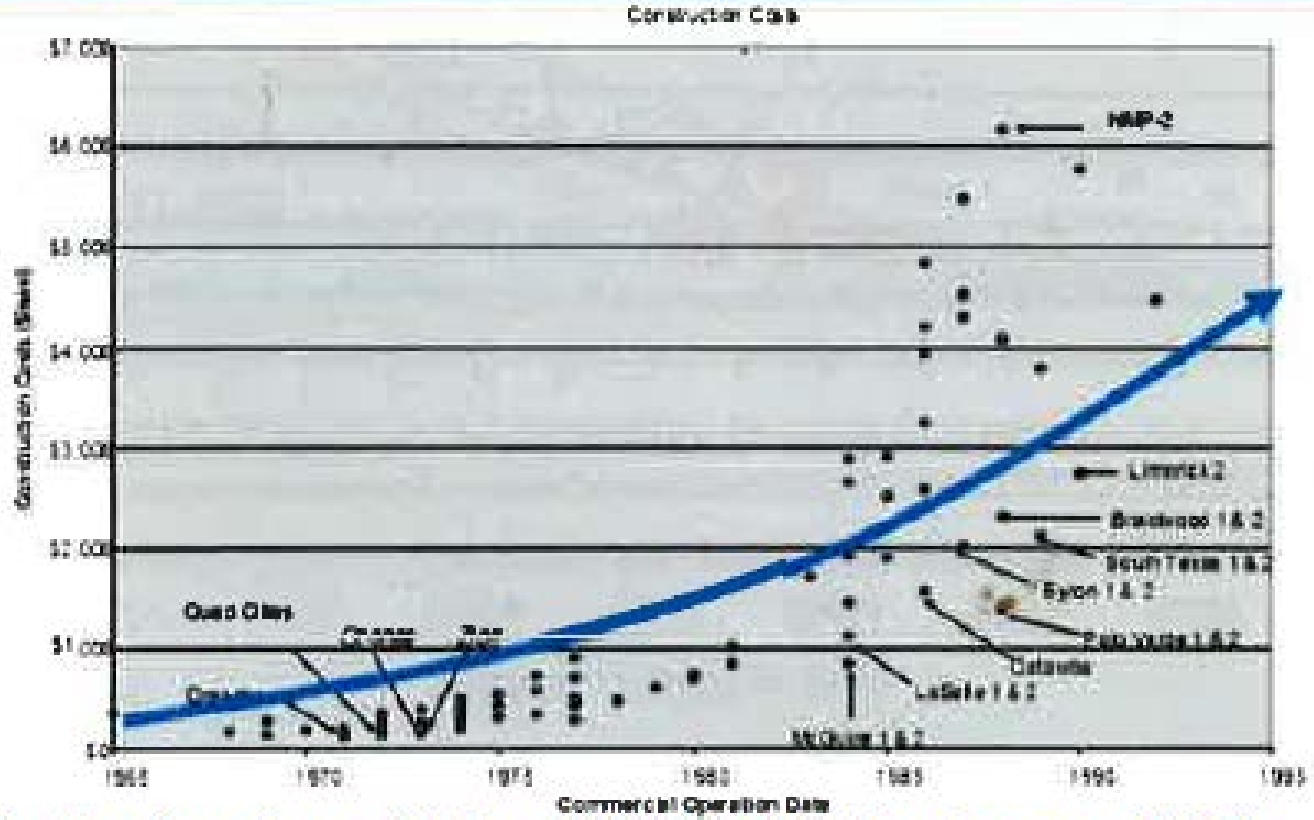


2. HISTORICAL COSTS DEVELOPMENTS OF NUCLEAR

JIM HARDING: U.S. COSTS DEVELOPMENTS

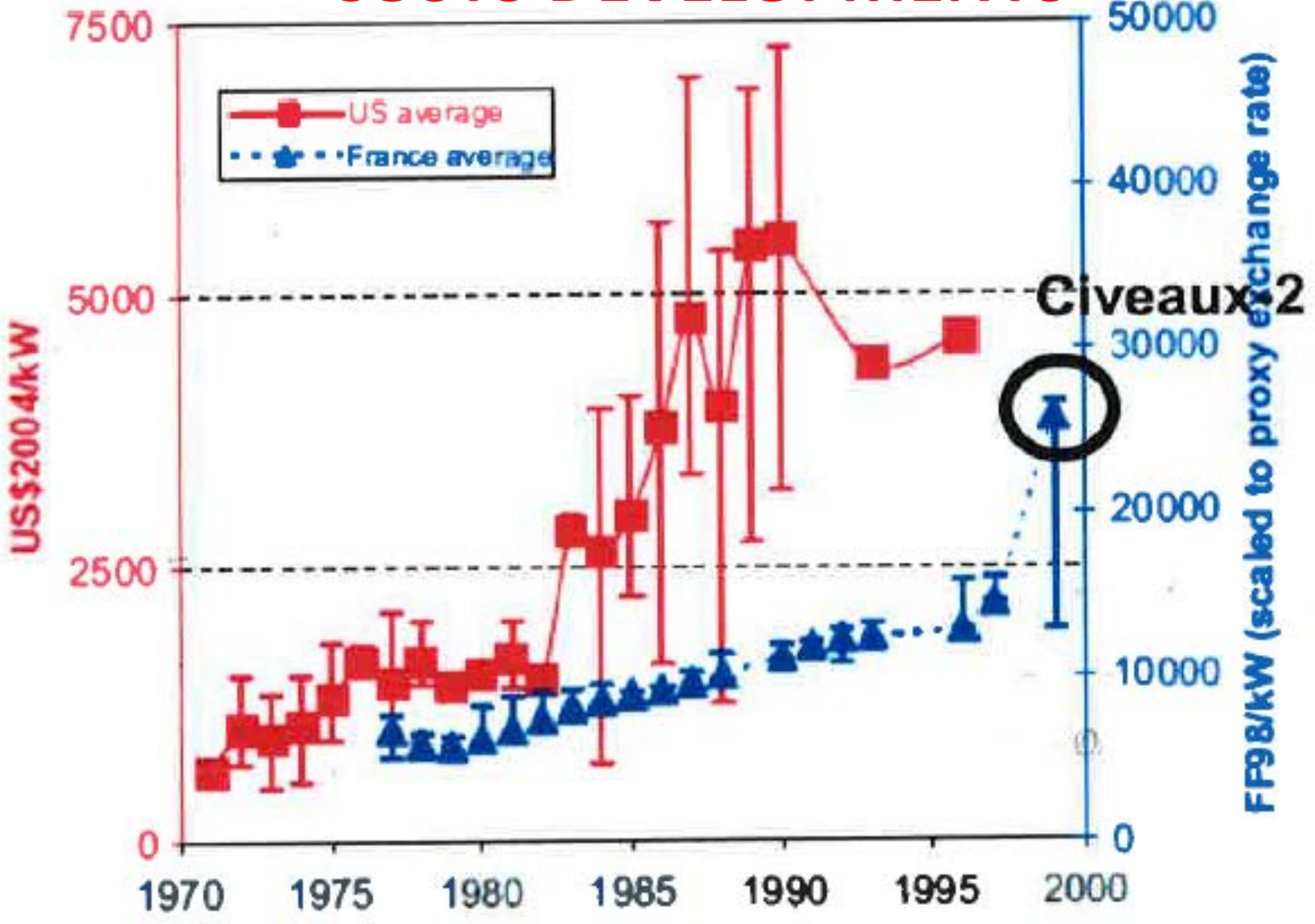
Constellation Energy

Background - Industry Experience "Last Time"



Source: Jim Harding: Seven Myths of the Nuclear Renaissance (2007)

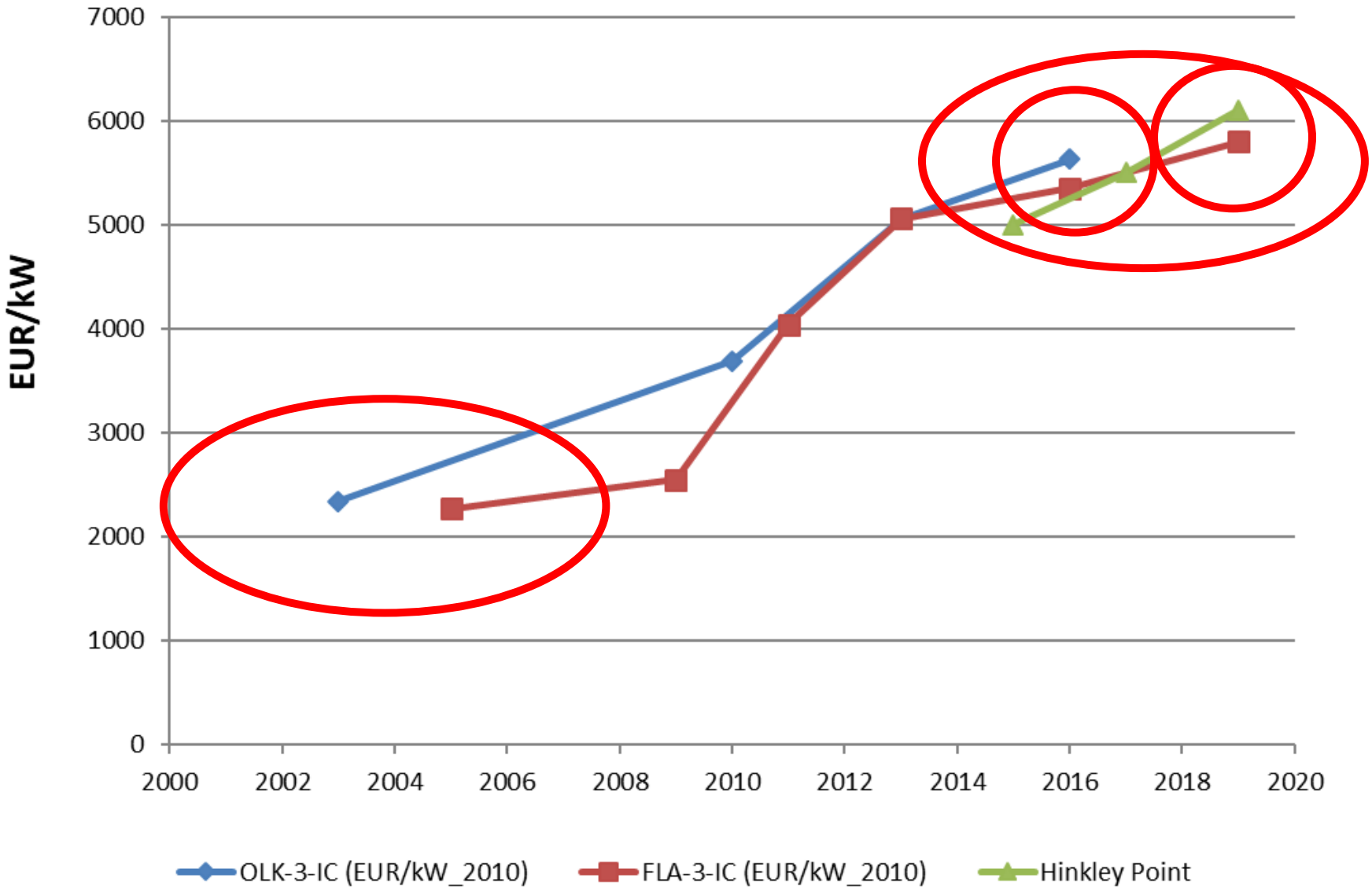
ARNULF GRUEBLER: U.S. AND FRANCE COSTS DEVELOPMENTS



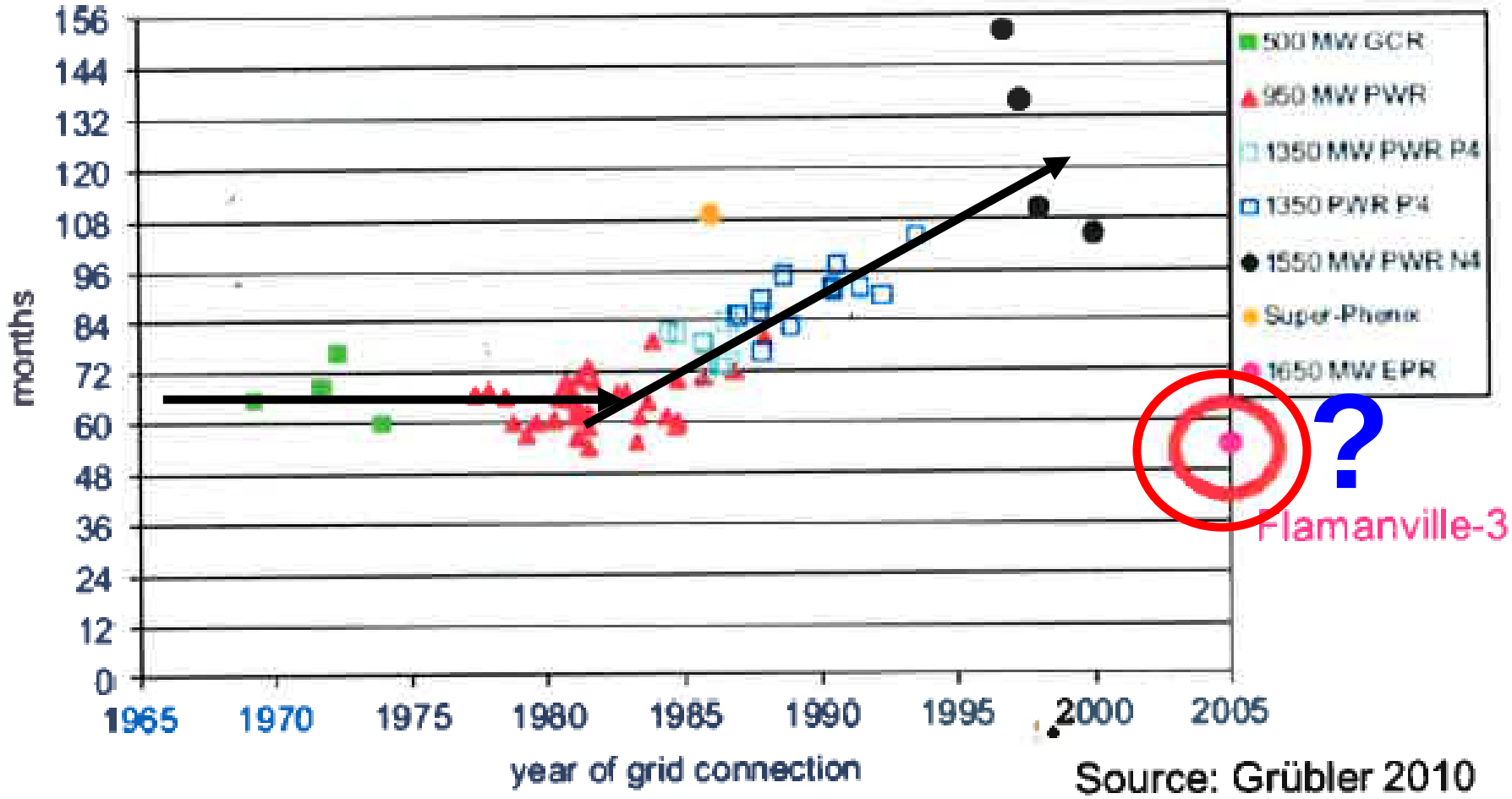
Source: Grübler 2010

COST DEVELOPMENT OF OLKILUOTO-3, FLAMANVILLE-3 AND HINKLEY POINT C

Development of Investment costs

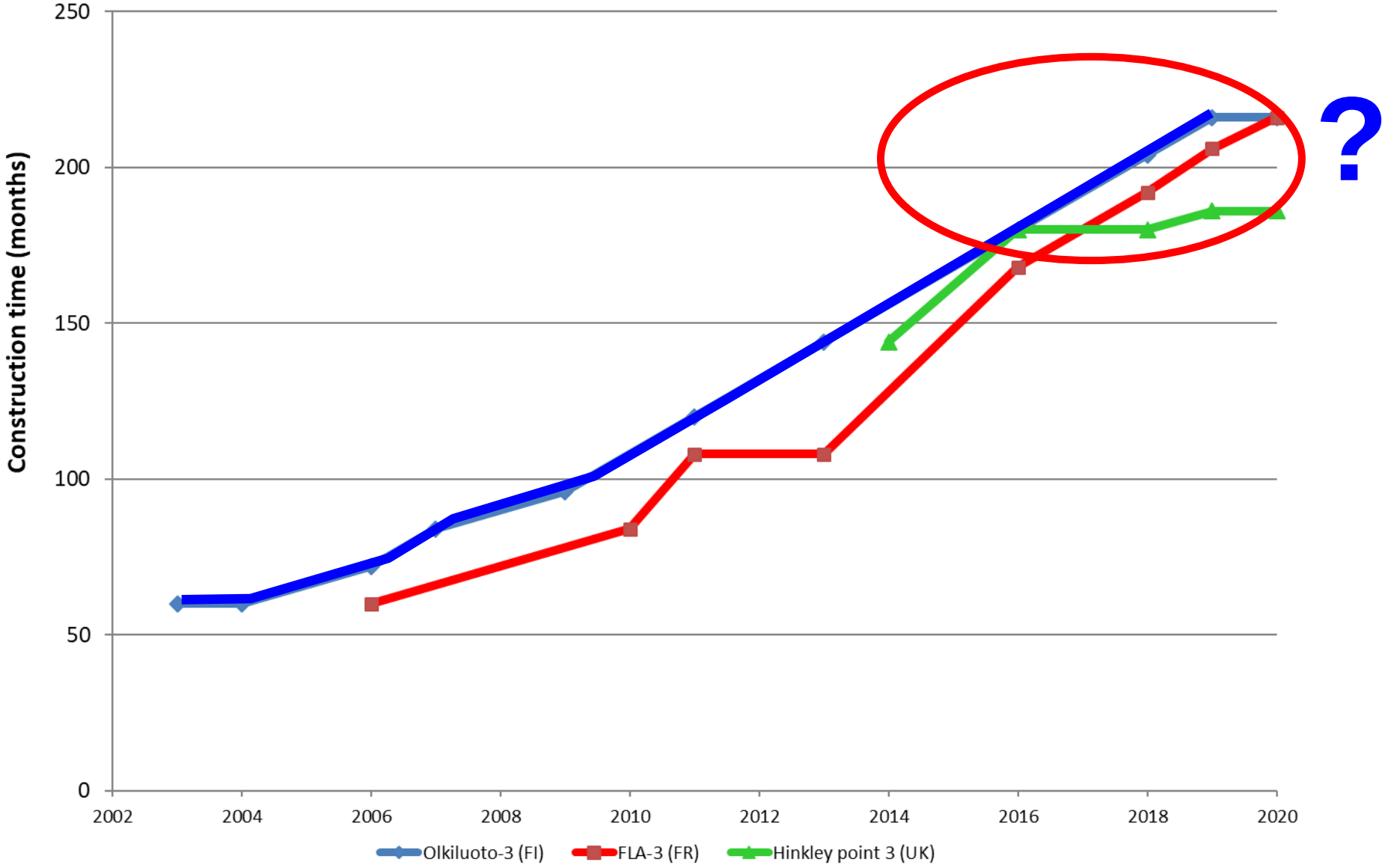


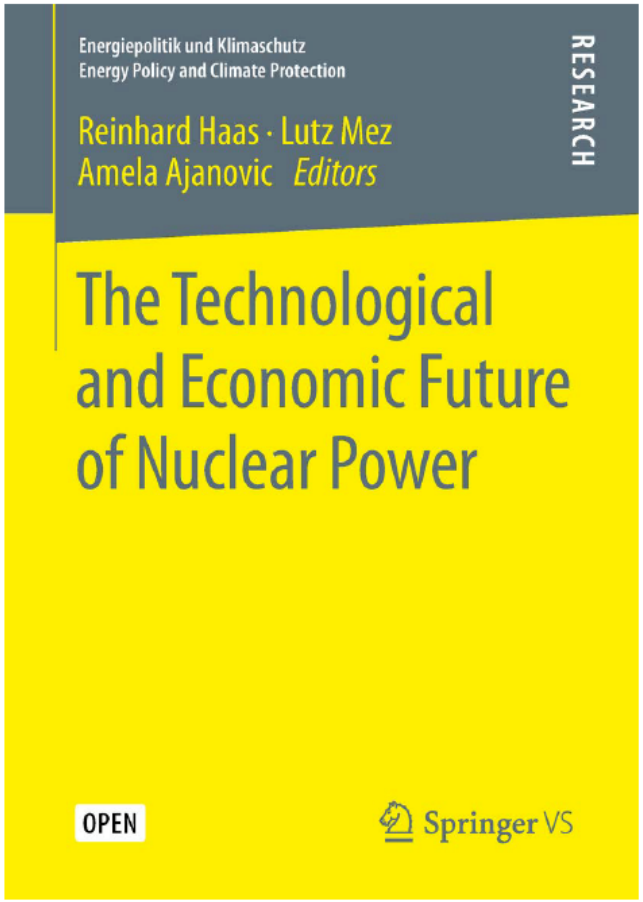
DEVELOPMENT OF CONSTRUCTION TIMES



Source: Grübler 2010

Recent dynamics of construction times



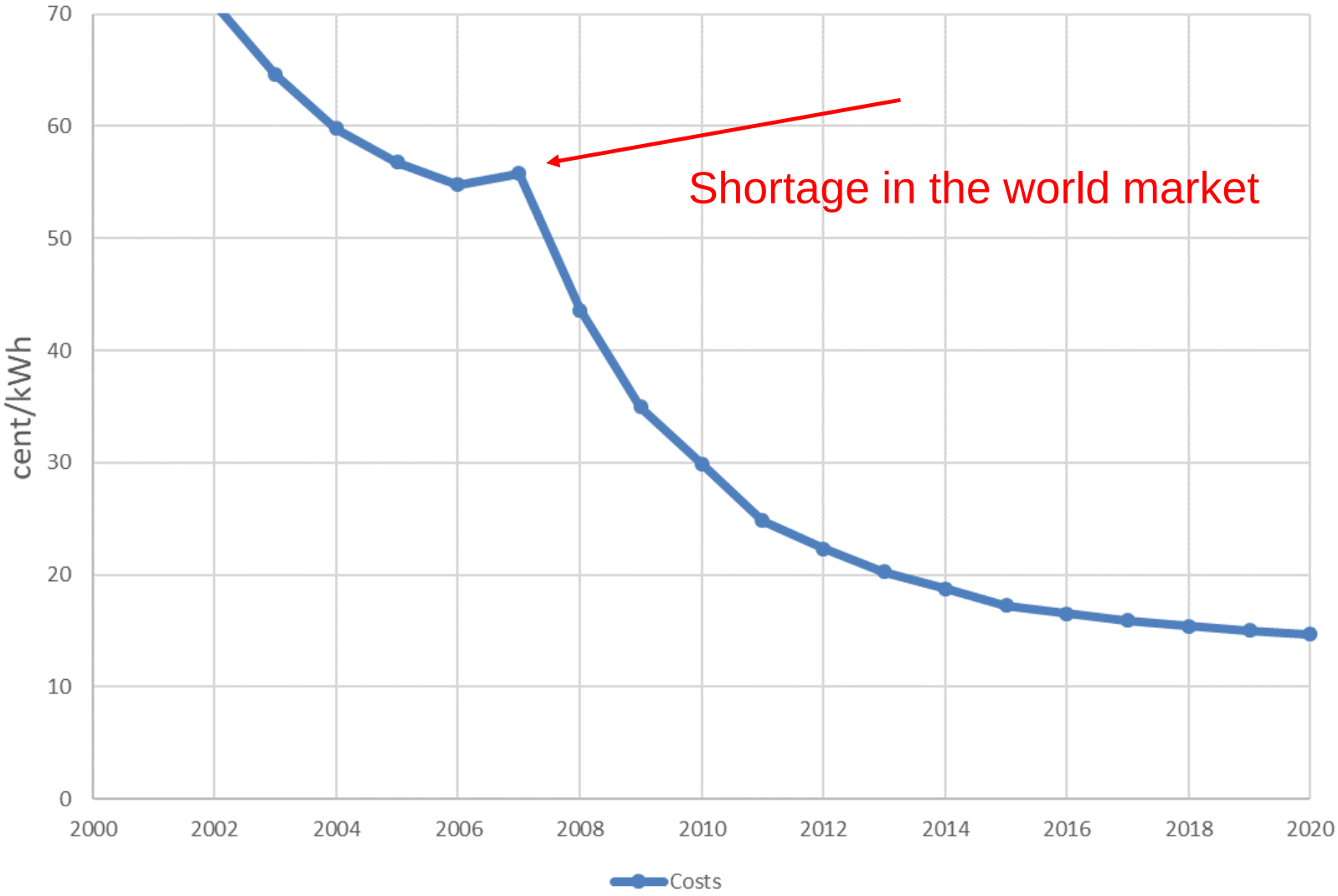


This open access book discusses the eroding economics of nuclear power for electricity generation as well as technical, legal, and political acceptance issues. Th use of nuclear power for electricity generation is still a heavily disputed issue. Asi from technical risks, safety issues, and the unsolved problem of nuclear waste disposal, the economic performance is currently a major barrier. In recent years, t costs have skyrocketed especially in the European countries and North America. A same time, the costs of alternatives such as photovoltaics and wind power have significantly decreased.

Published in 2019, Open access available

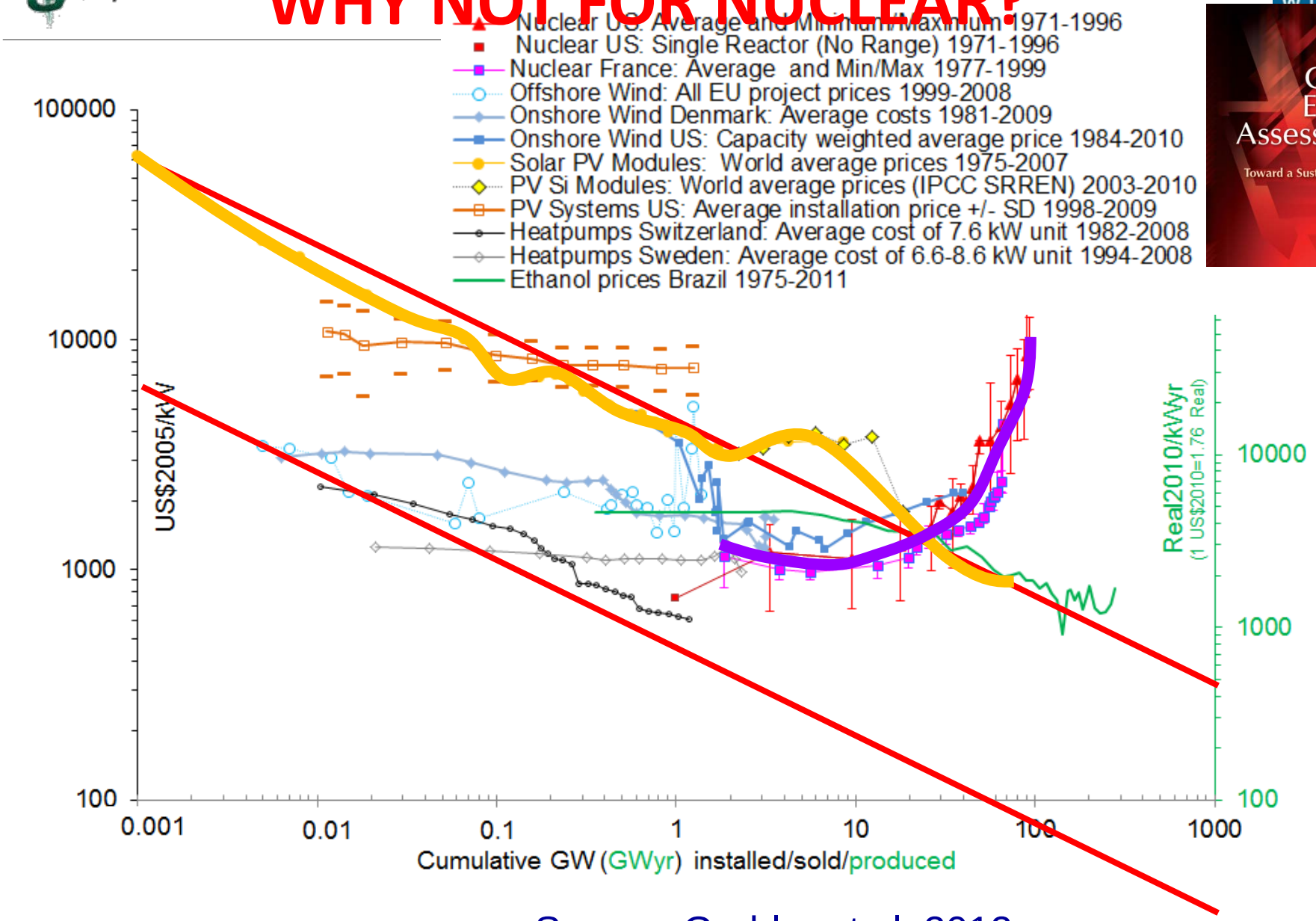
3. HISTORICAL DEVELOPMENTS OF PHOTOVOLTAIC COSTS

ELECTRICITY GENERATION COSTS OF PHOTOVOLTAICS IN GERMANY (5 kWp)



2019 and 2020 preliminary

TECHNOLOGICAL LEARNING: WHY NOT FOR NUCLEAR?

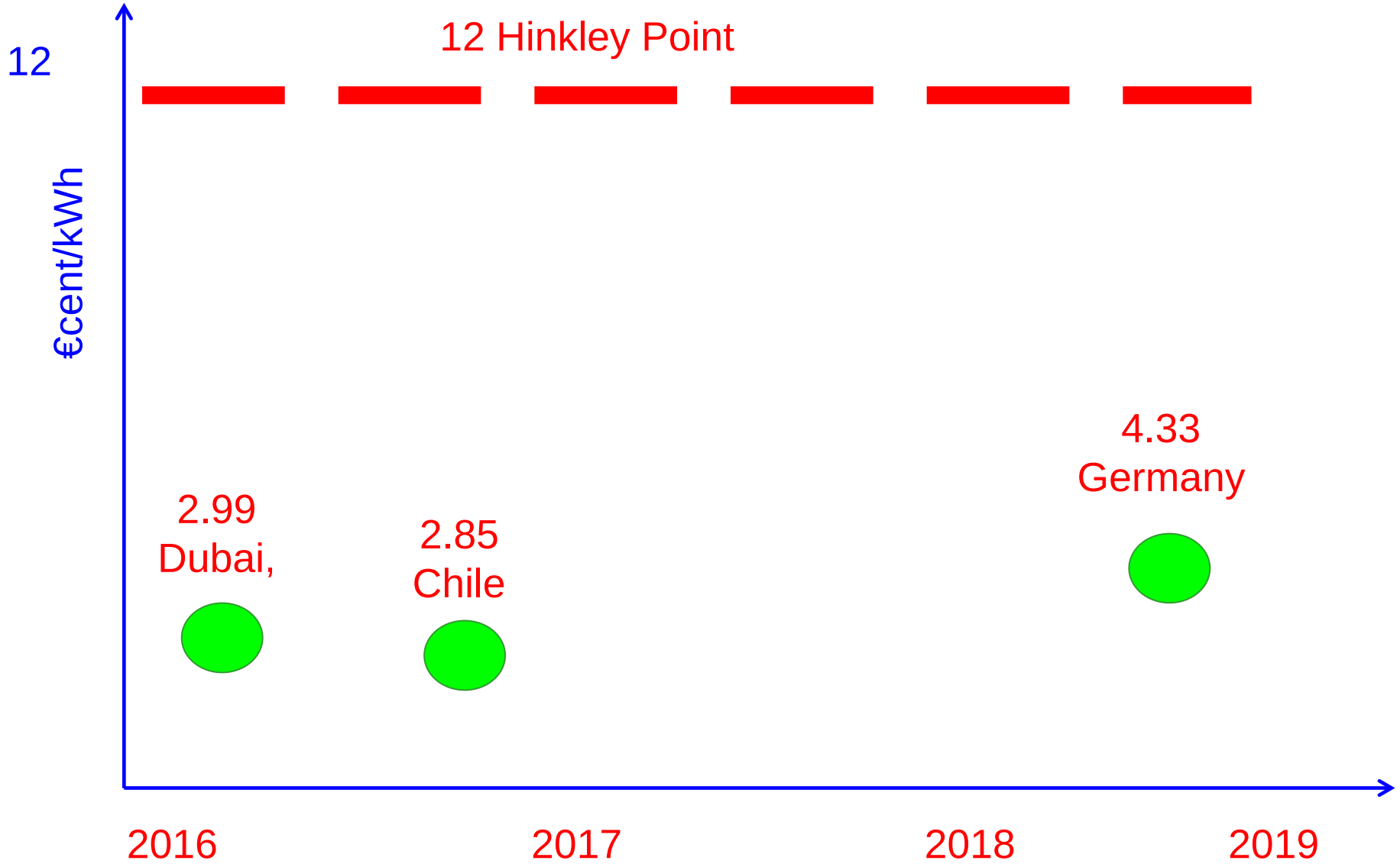


Source: Grubler et al, 2012

SUBSIDIES FOR PV VS NUCLEAR

As long there is no price on CO2 …..

PV Electricity generation bids vs Nuclear

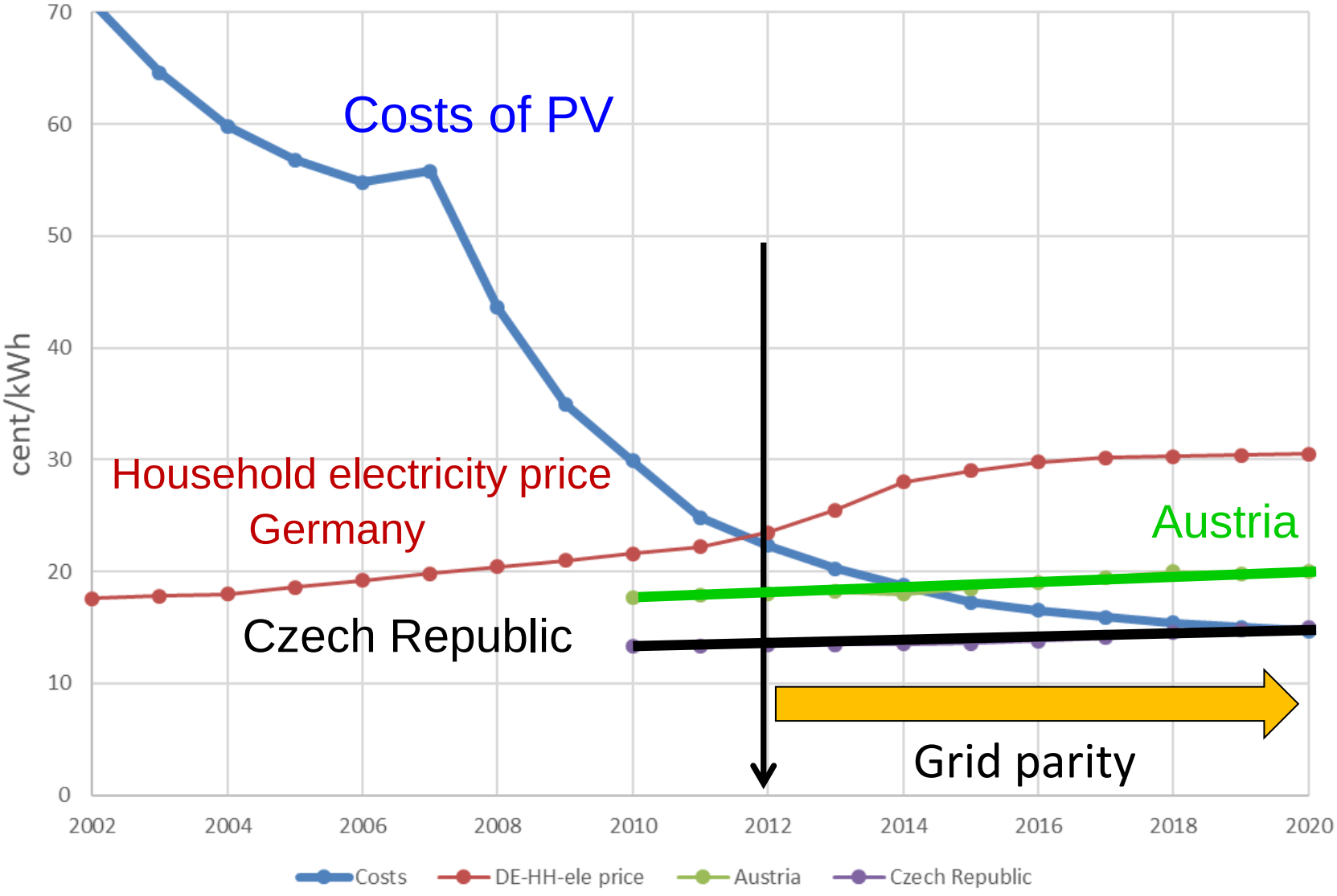


4. TOWARDS PROSUMAGERS

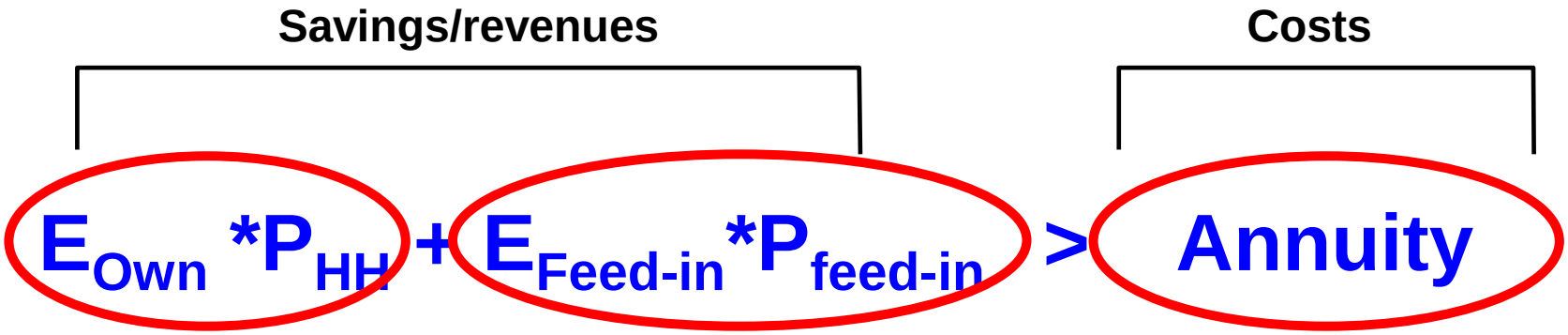
Building integration vs large area plants

→ What are the PV potentials world-wide? →
Building integration vs large area plants?

Grid parity: PV-costs and household electricity prices



Assessment of Grid Parity



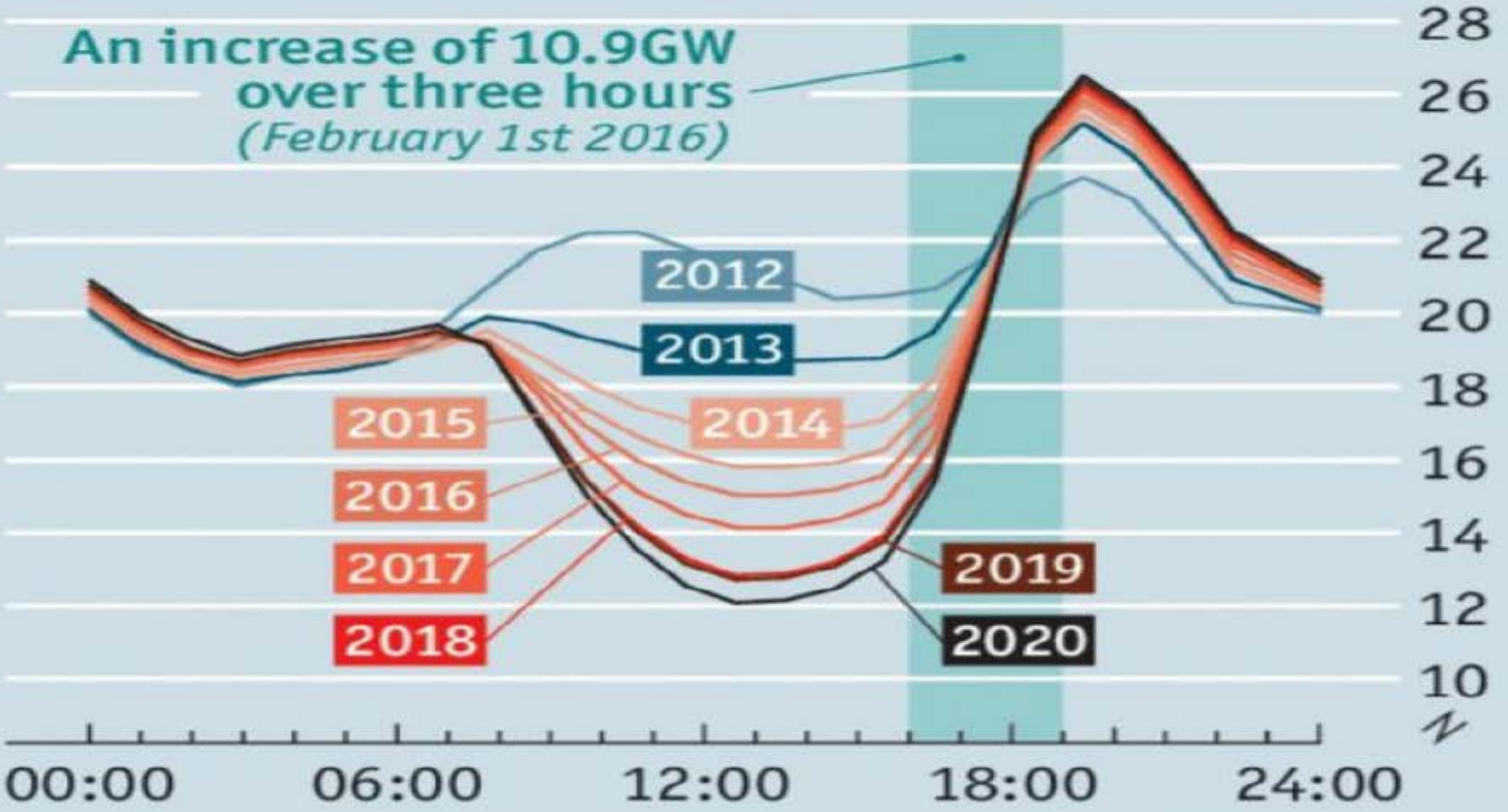
Grid parity term

Subsidy still necessary?

Who gets the bill?

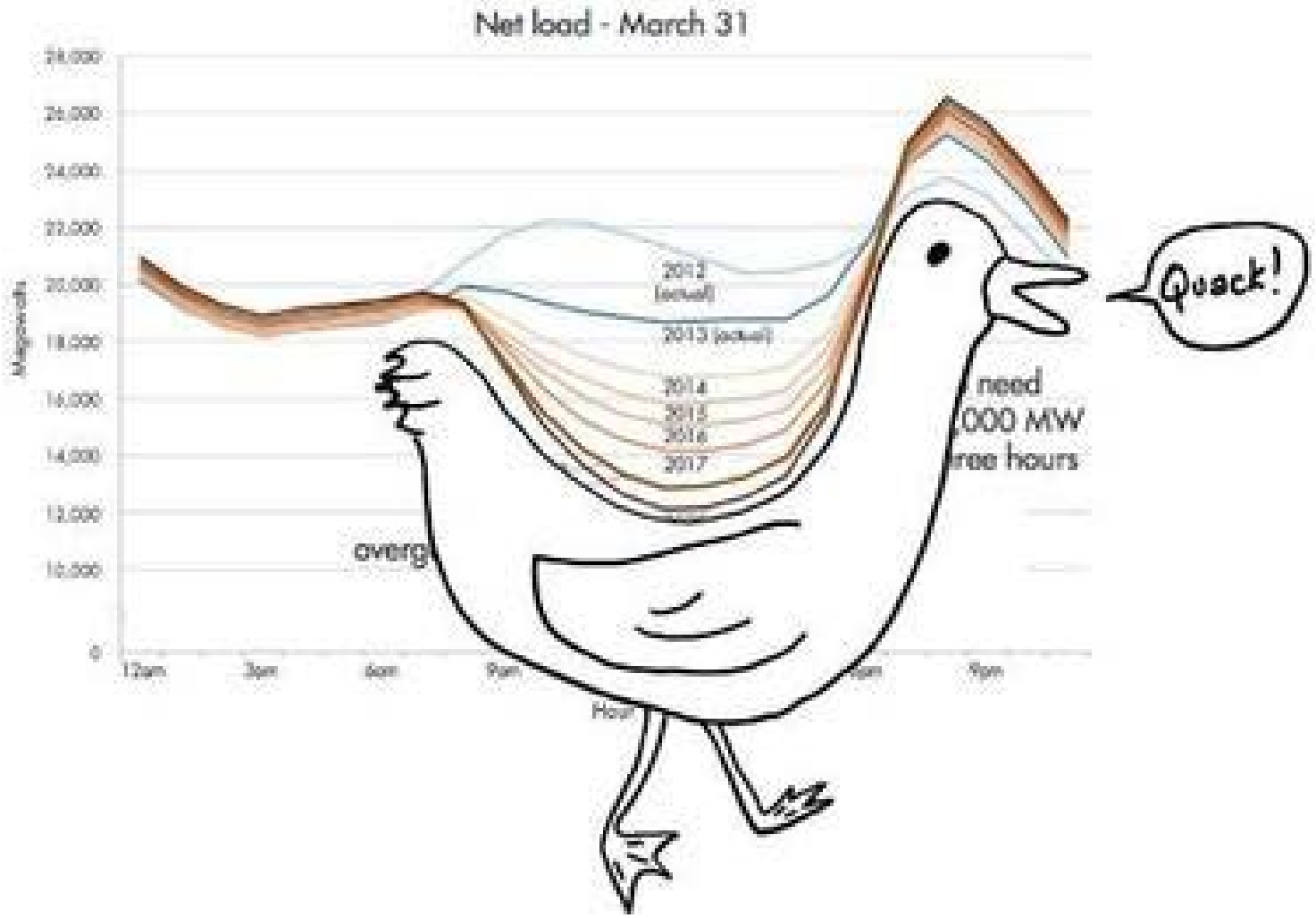
California, net electricity-load requirement*

Typical spring day, gigawatts

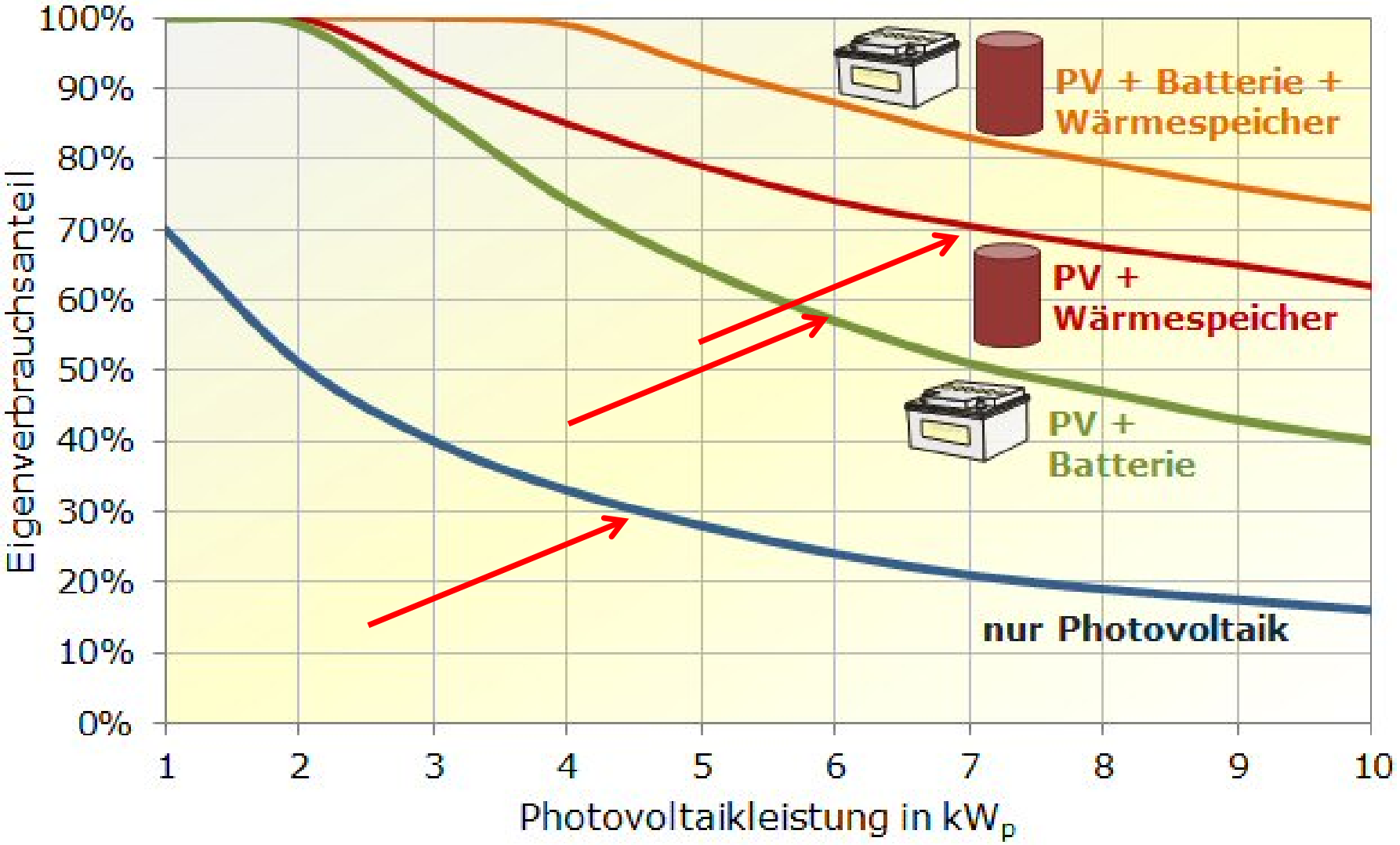


*Demand minus renewable generation

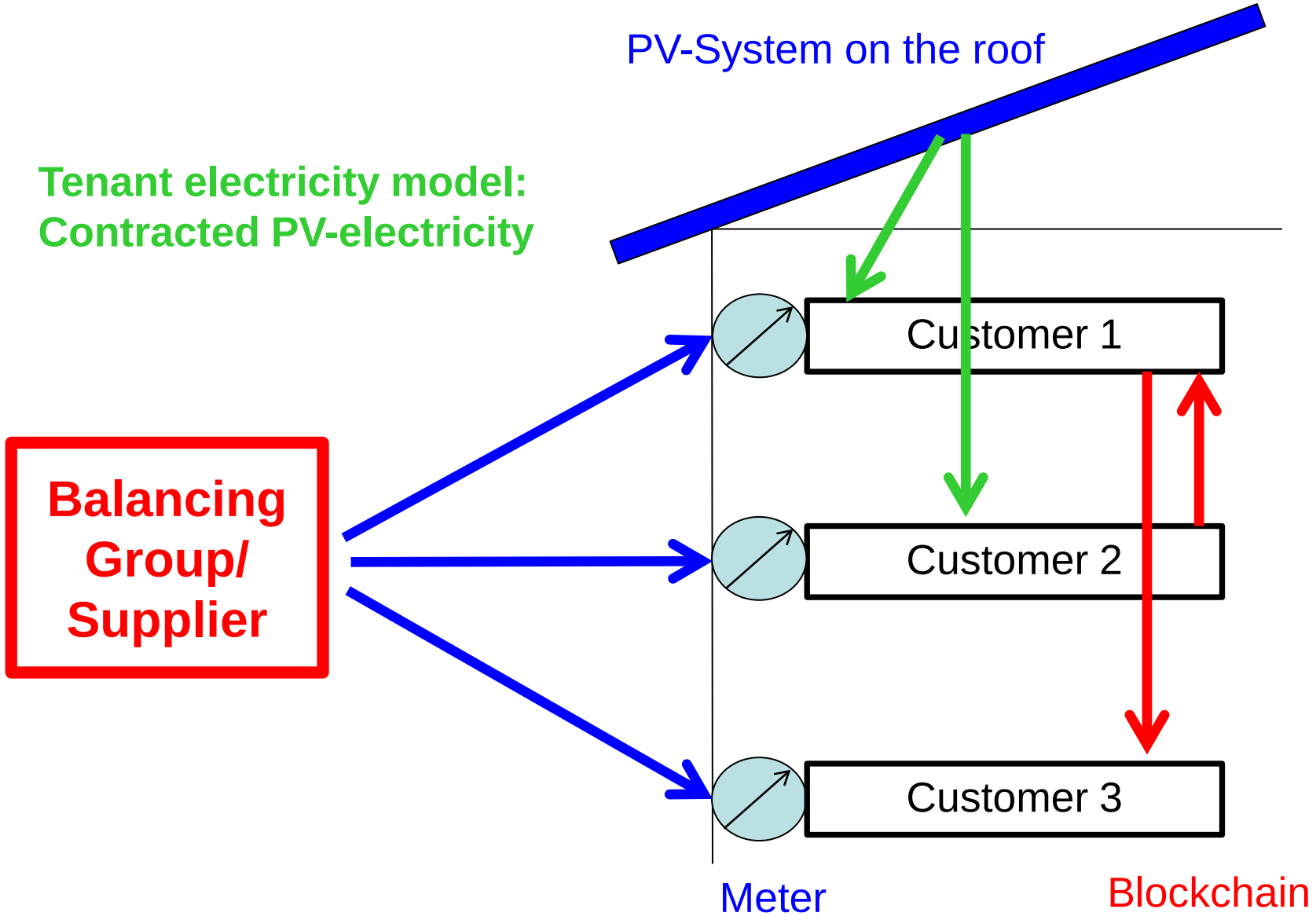
Source: California ISO


Net load - March 31
Megawatts
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
0
12am
3am
6am
9am
9pm
2012 (actual)
2013 (actual)
2014
2015
2016
2017
Quack!
need
000 MW
ree hours

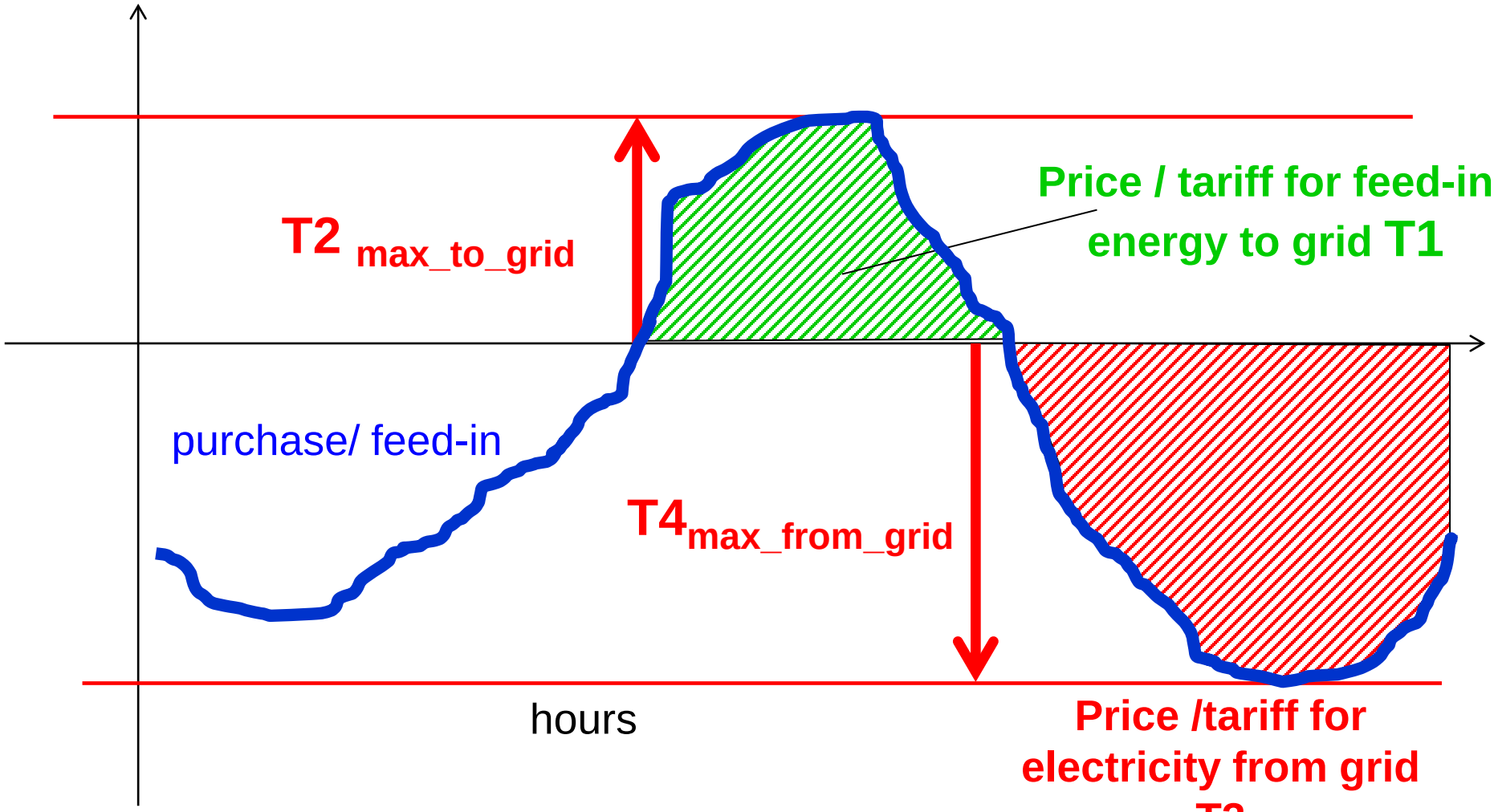
Share of own consumption



Tenant electricity model and Blockchain



Bidirectional tariffs for power and energy



5. FUTURE PERSPECTIVES

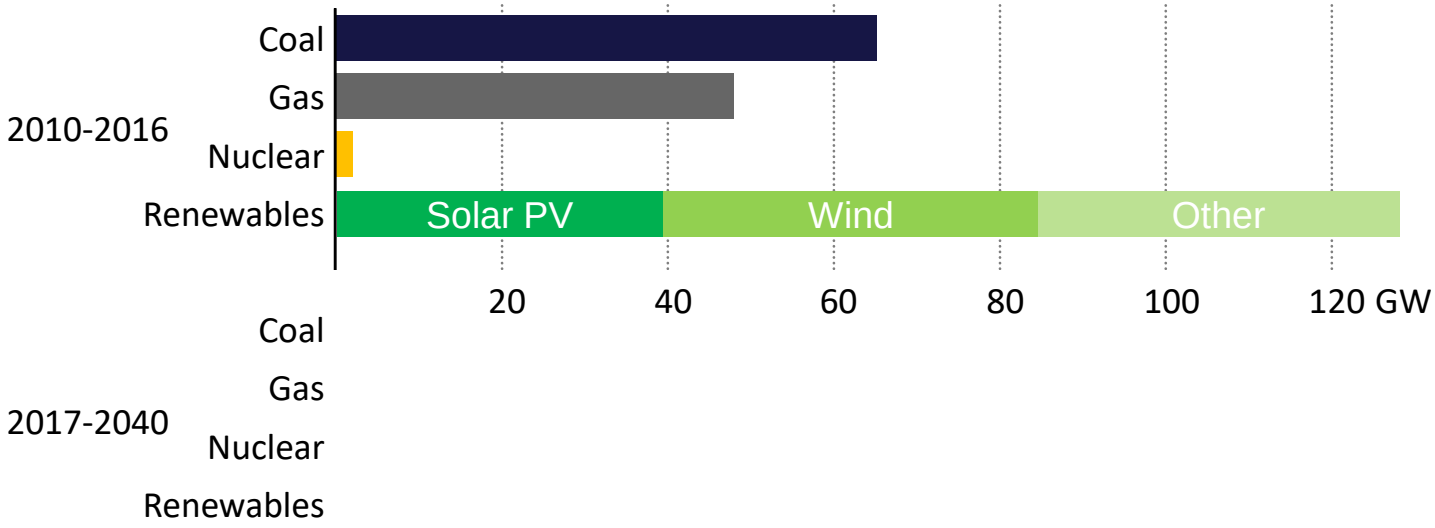

World Energy Outlook 2018
Slide library
World Energy Outlook 2017
Slide library
World Energy Outlook 2019
International Energy Agency

Tipping the energy world off its axis

- Four large-scale upheavals in global energy set the scene for the new *Outlook*:
  - The United States is turning into the undisputed global leader for oil & gas
  - Solar PV is on track to be the cheapest source of new electricity in many countries
  - China's new drive to "make the skies blue again" is recasting its role in energy
  - The future is electrifying, spurred by cooling, electric vehicles & digitalisation
- These changes brighten the prospects for affordable, sustainable energy & require a reappraisal of approaches to energy security
- There are many possible pathways ahead & many potential pitfalls if governments or industry misread the signs of change

Solar PV forges ahead in the global power mix

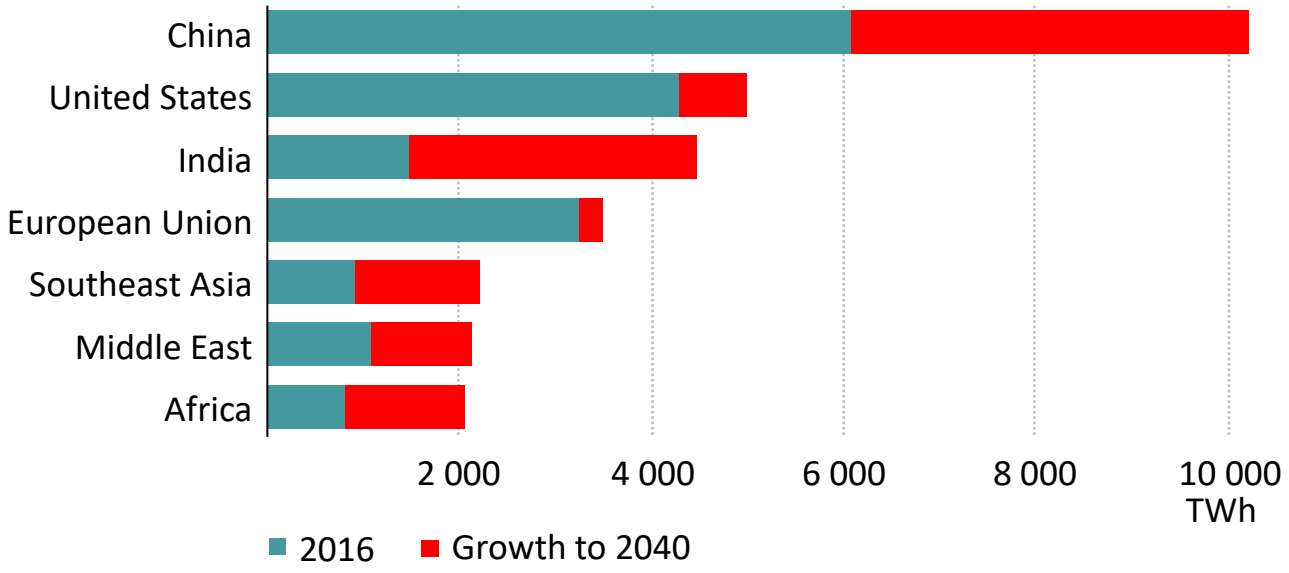
Global average annual net capacity additions by type



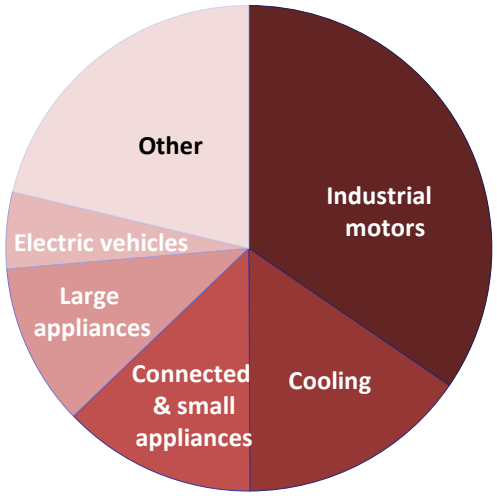
China, India & the US lead the charge for solar PV, while Europe is a frontrunner for onshore & offshore wind: rising shares of solar & wind require more flexibility to match power demand & supply

The future is electrifying

Electricity generation by selected region



Sources of global electricity demand growth

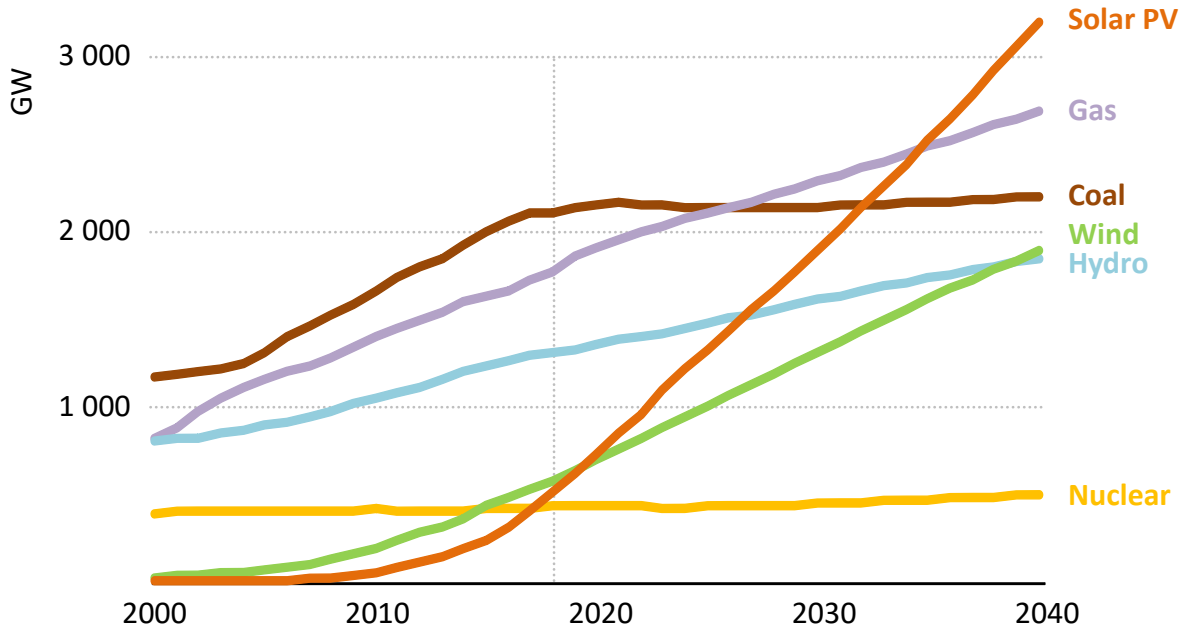


India adds the equivalent of today's European Union to its electricity generation by 2040, while China adds the equivalent of today's United States

Mostly countries with high solar insolation

New solar PV projects are taking off

Global power capacity by source in the Stated Policies Scenario



The power mix is being re-shaped by the rise of renewables and natural gas. In 2040, renewables account for nearly half of total electricity generation.

6. CONCLUSIONS NUCLEAR

- It is impossible to find any sound economic argument in Europe in favour of nuclear
- Currently, in Europe nuclear is the most expensive option to generate electricity
- Regarding climate change: Nuclear will be to late
- And it will occupy money which could be used in a better way
- And finally: The costs of Decomissioning …

6. CONCLUSIONS PV

- Sustainable electric. system → integration of a broad technology portfolio & demand-side options!
- IEA on PV: chance to become the electricity technology with highest share world-wide
- most urgent: exhaust full creativity for flexibility of all market participants incl. decentralised PV systems
- Shedding of PV at noon? Or inceasing storage?
- Central vs decentral ?
- Yet, with increasing success new barriers are looming, e.g. rooftop taxes