







The road to
PV and beyond -
from Technology to the Energy System

Becquerel Prize Acceptance - Stefan Nowak
33rd EU PVSEC Amsterdam, 25 September 2017

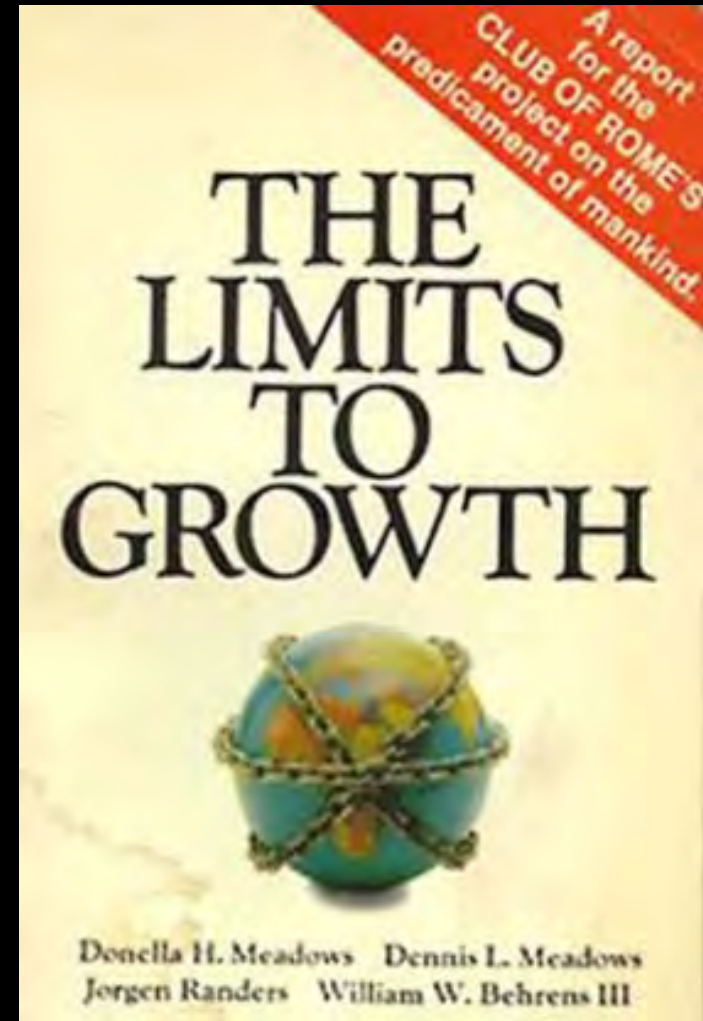
1969



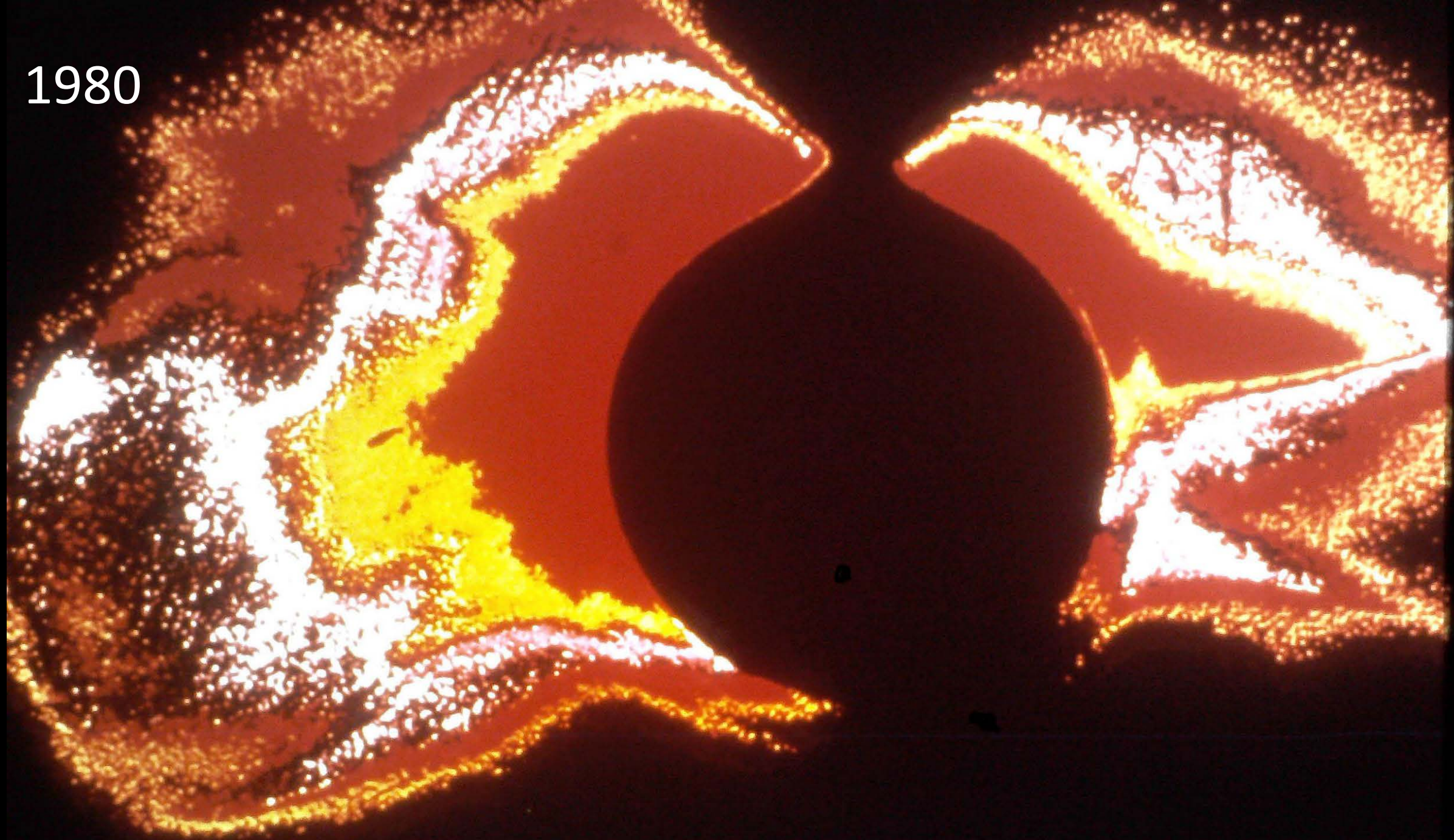




1972



1980



1993

after a journey through different fields...

the choice for photovoltaics ...

and

... my first lesson in energy matters:

working on “alternative energy”

2017



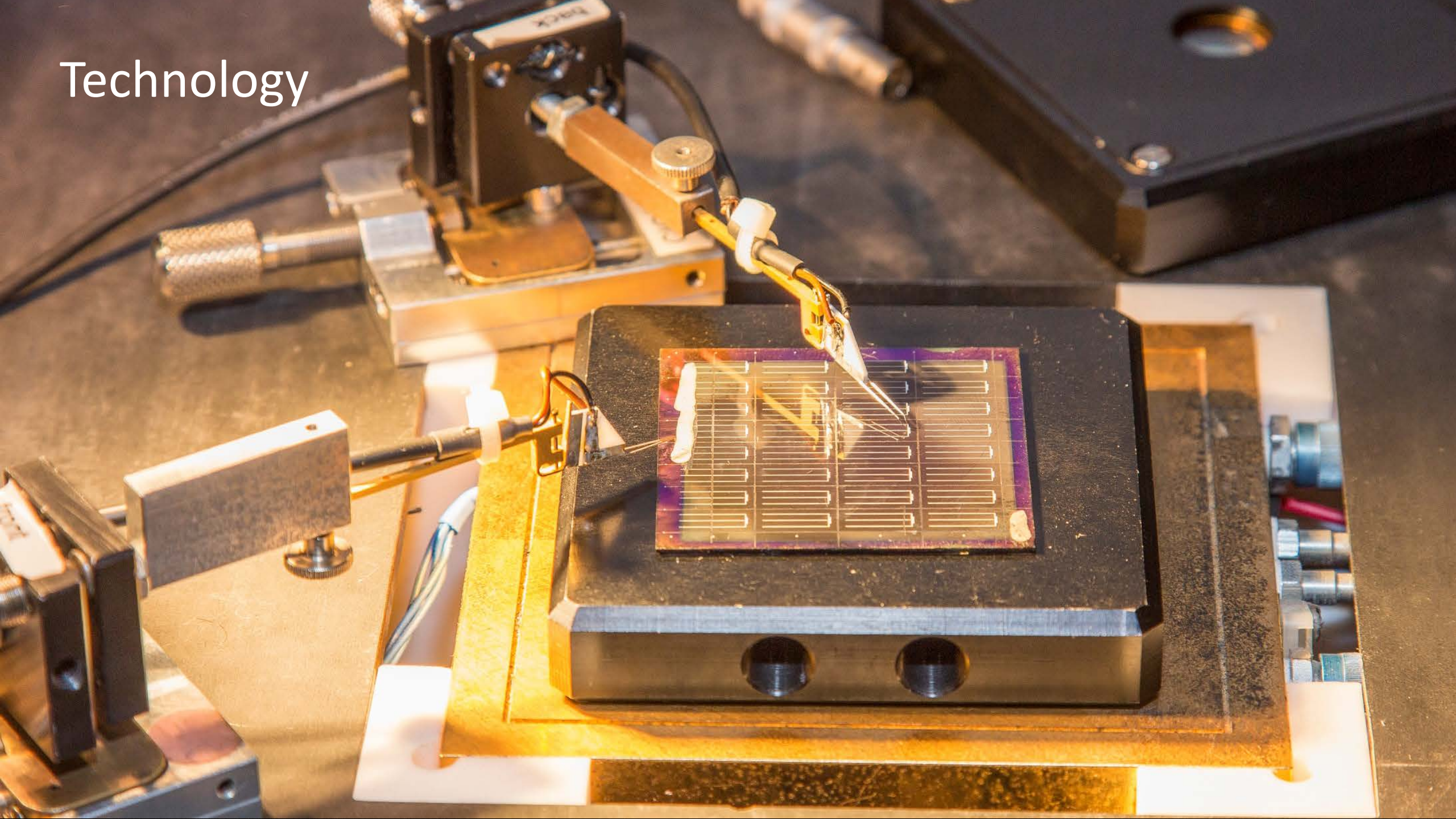
2017

Photovoltaics today: The state of play

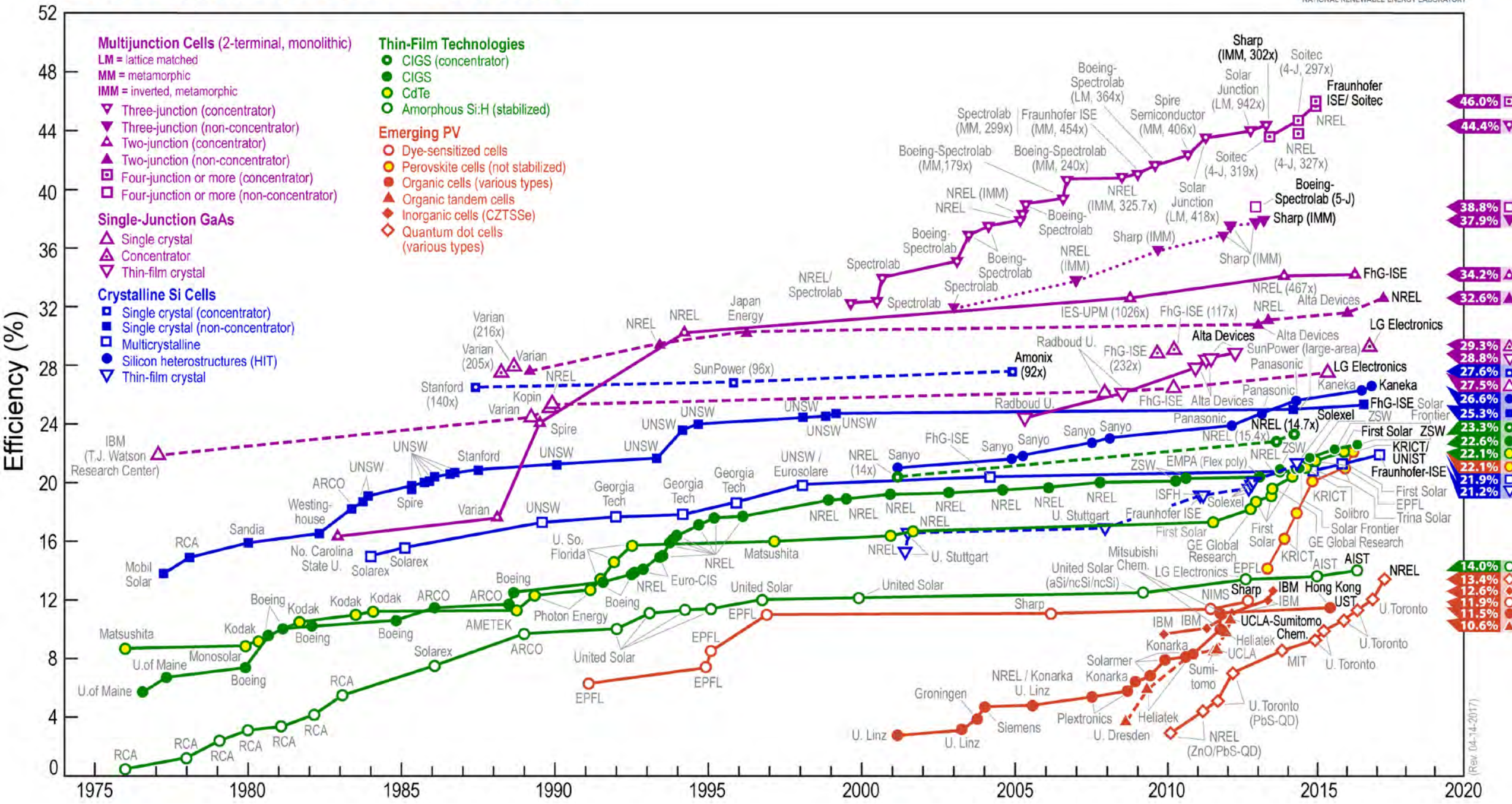
45 years after “The limits to growth”

Some facts...

Technology



Best Research-Cell Efficiencies



Technology: Great achievements!



Products



An aerial photograph of a solar farm, showing multiple rows of solar panels installed on a flat roof. The panels are arranged in a grid pattern, and the roof structure is visible. The image is slightly blurred and has a dark overlay.

Products: Maybe some way to go!

Applications





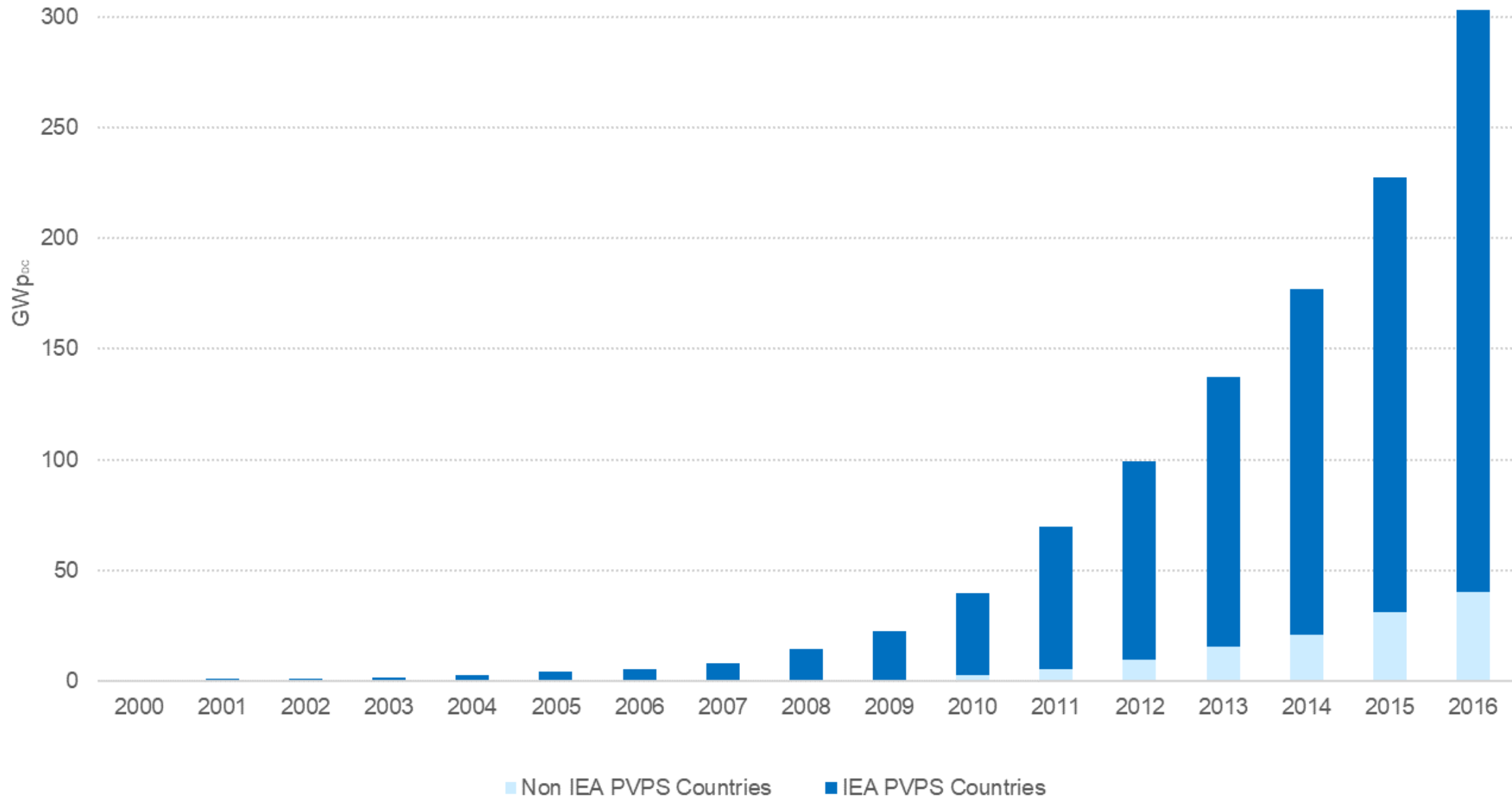




A blurred background image of a desert landscape. In the foreground, there is a wooden fence made of vertical posts and horizontal rails, stretching across the frame. Behind the fence, there are rolling sand dunes under a clear, light blue sky. The overall scene is out of focus, creating a sense of depth and atmosphere.

Applications: Great variety!

Market



Market: Extraordinary growth!

2015: 50 GW, +25%


2016: 75 GW, +50%

2017: ?



Cost





Cost: Enormous reduction!

-75% over 10 years,
< 30 USD/MWh in best cases

Future



“Can we predict the future?”

“No”, says the chaos theorist

“Yes”, responds the astrophysicist

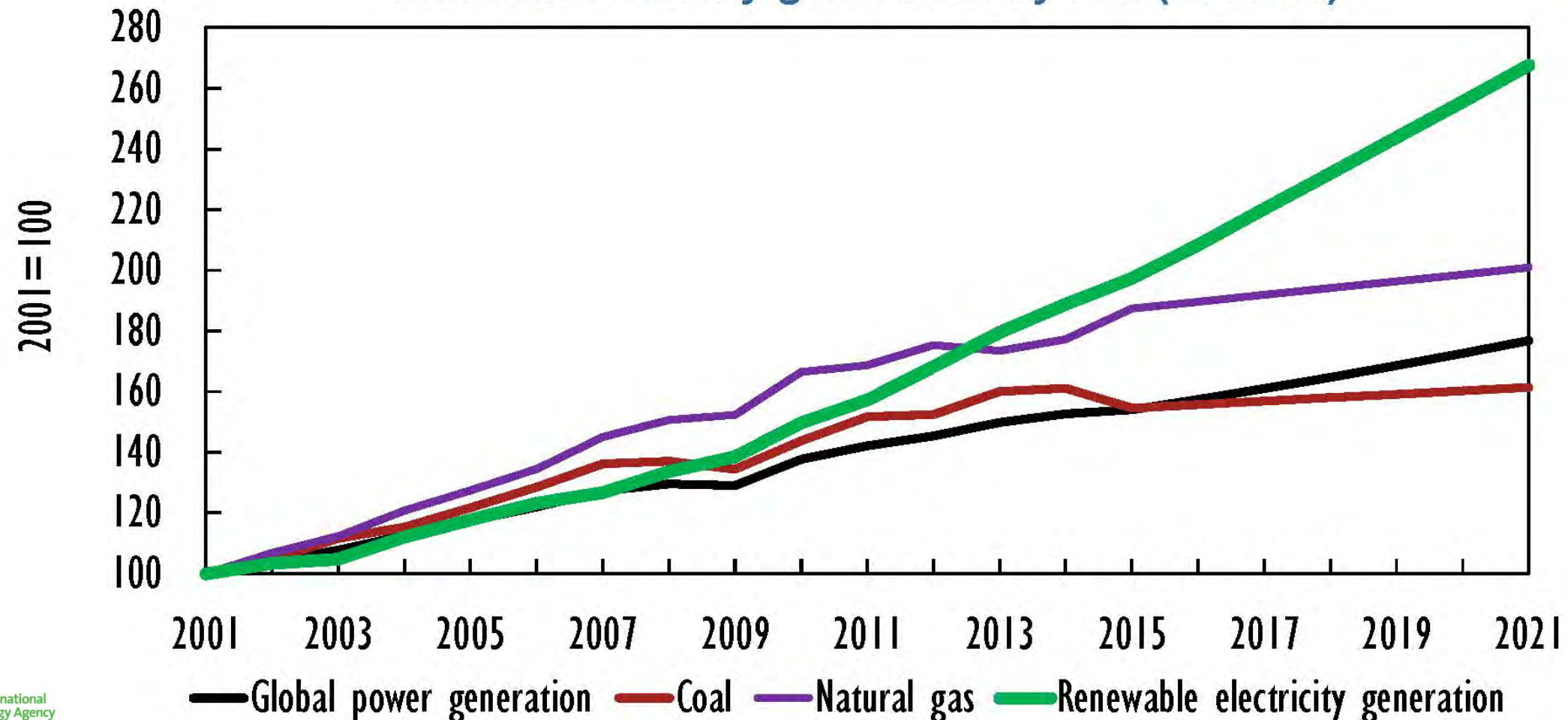
“To an extent”, says the economist

“Usually”, says the meteorologist

U. Pillkahn 2008

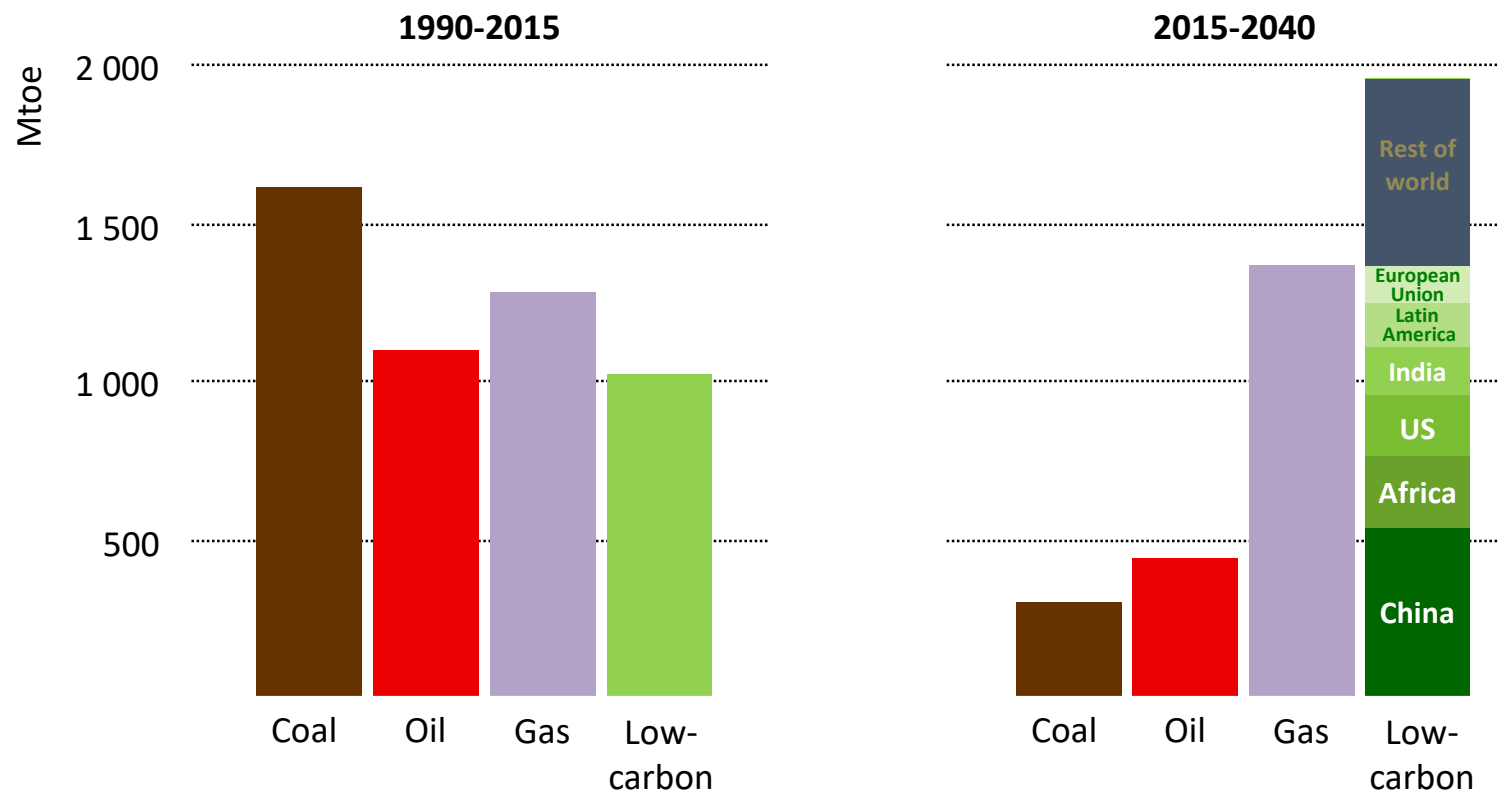
Renewables to remain fastest growing source of electricity generation

Indexed electricity generation by fuel (2001-21)



A new 'fuel' in pole position

Change in total primary energy demand



Low-carbon fuels & technologies, mostly renewables, supply nearly half of the increase in energy demand to 2040

PV's Integration Challenges

- PV & electrical grid integration
high penetration PV, grid management issues, flexibility
- PV & storage
storage technologies, P2X, short term storage, seasonal storage
- PV & buildings
BIPV, BAPV, PVT, technologies, aesthetics, design, standards
- PV & mobility
plug-in hybrids, onboard PV, charging infrastructure
- PV & energy system
power, heat, fuels
- PV & energy market
market design, business models, regulatory framework

And then...







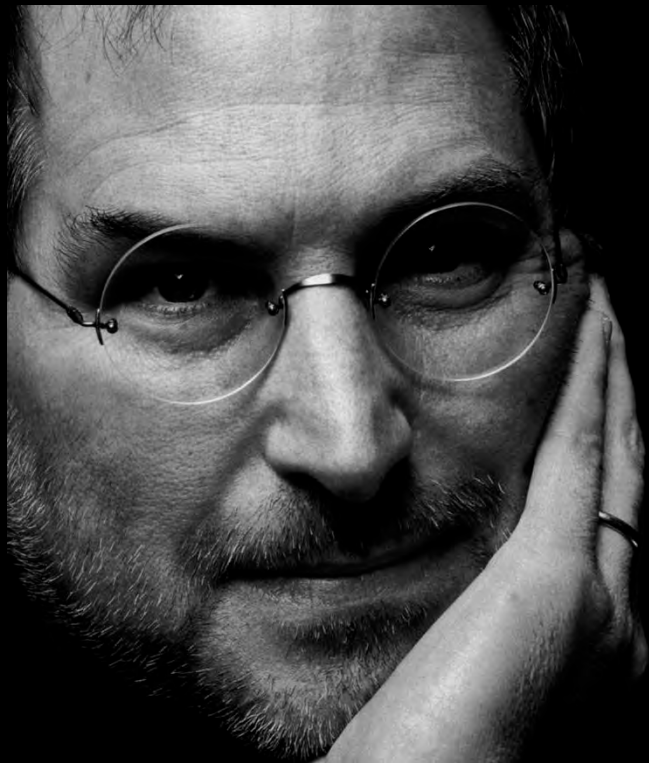
Chris Luebke, Arup
*“The future, always oversold
and under-imagined”*

The difference between
Forecast, scenarios and foresight

2007



_imagine



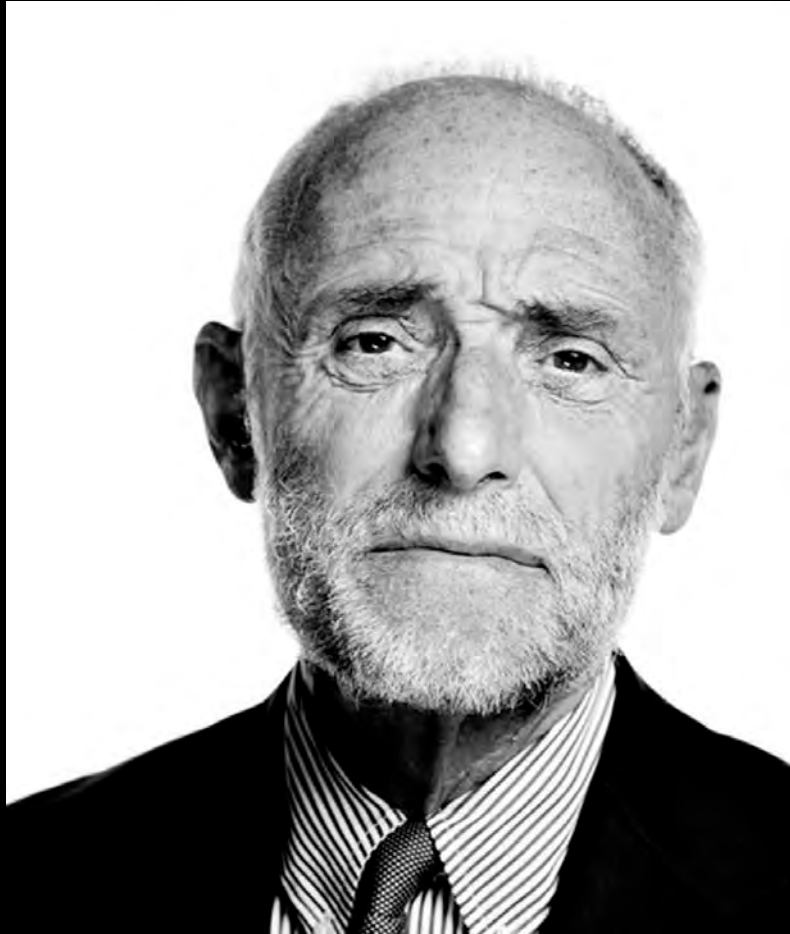
Steve Jobs: iPV

The challenges of becoming mainstream

- Sustainability dimensions
- Integration in the society
- Taking responsibility
- Sharing the future



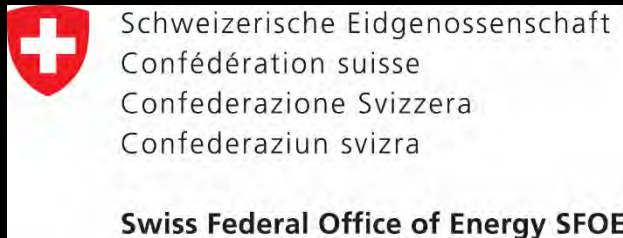
Arrogance



Jakob Kellenberger,
Ex-president International Red Cross:

*“Arrogance as a superlative of
stupidity is globally well distributed,
better than food or other daily
needed goods....”*

Thanks











To conclude: 3 take aways

- Alternative:
There's presently not many other than PV
- Imagination:
Many things could happen over the next 45 years
- Arrogance:
Minds are like parachutes, they only function when they are open*



Thank you

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