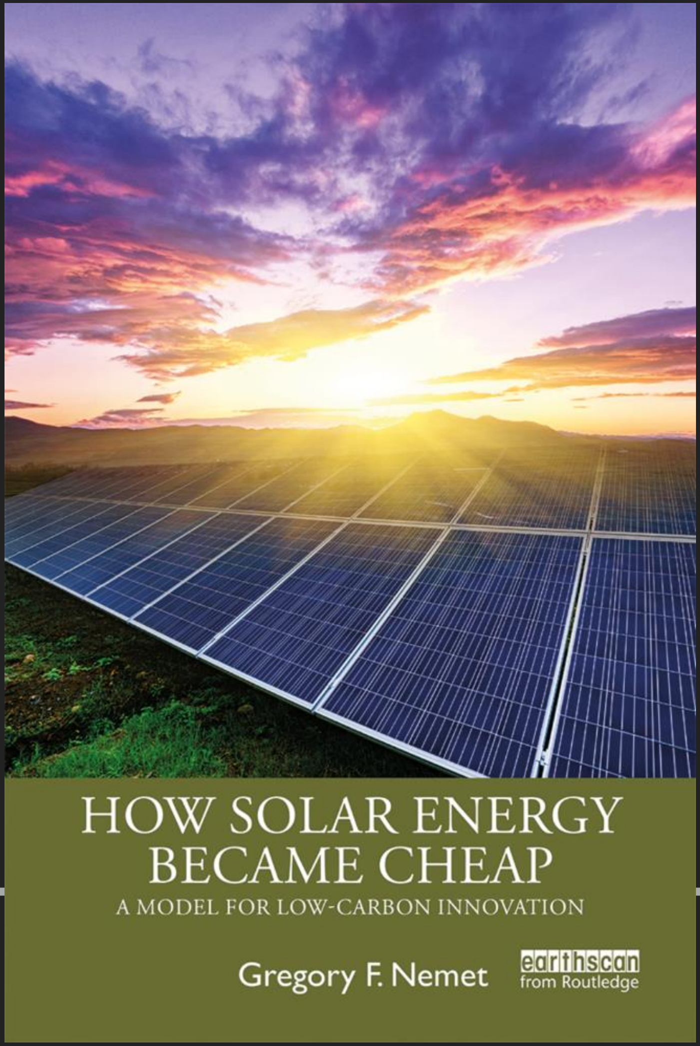
PROF. GREGORY NEMET

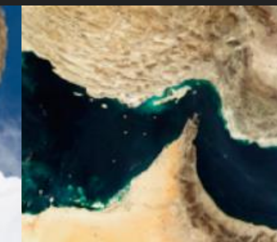
Robert M. La Follette School of Public Affairs
UNIVERSITY OF WISCONSIN–MADISON



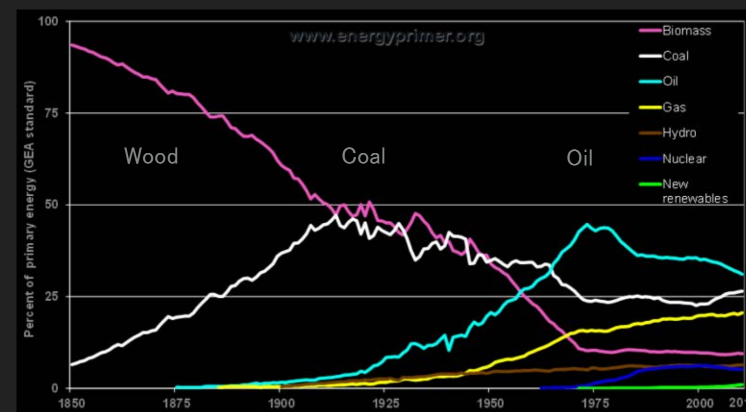
ACCELERATING INNOVATION IN CO_2 REMOVAL

ENERGY TRANSITIONS ARE HARD

1. Want CHEAP, CLEAN,RELIABLE



2. Past transitions took decades



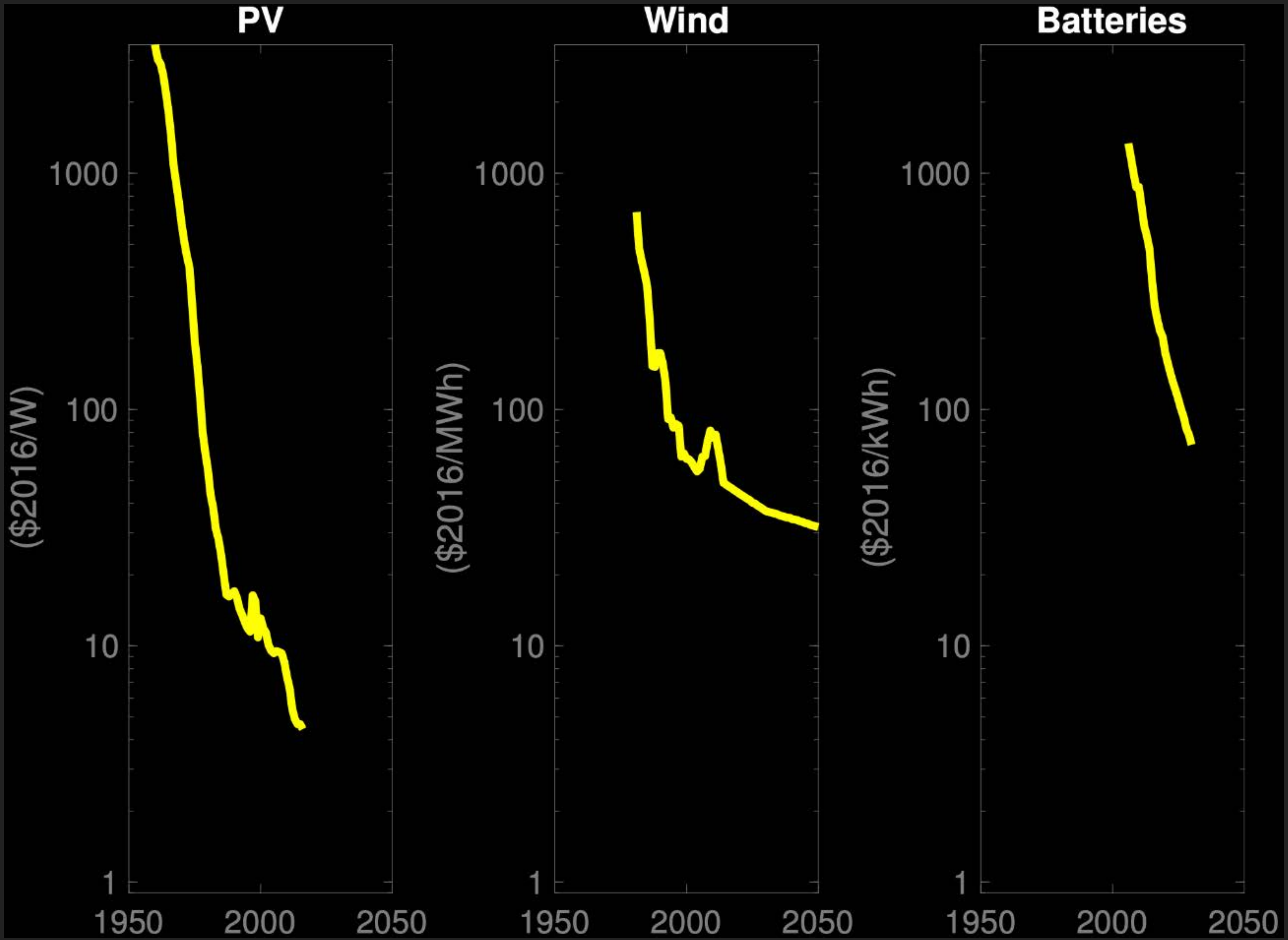
1850 2010

3. CO_2 in atmosphere for >100 yrs

REASONS FOR OPTIMISM

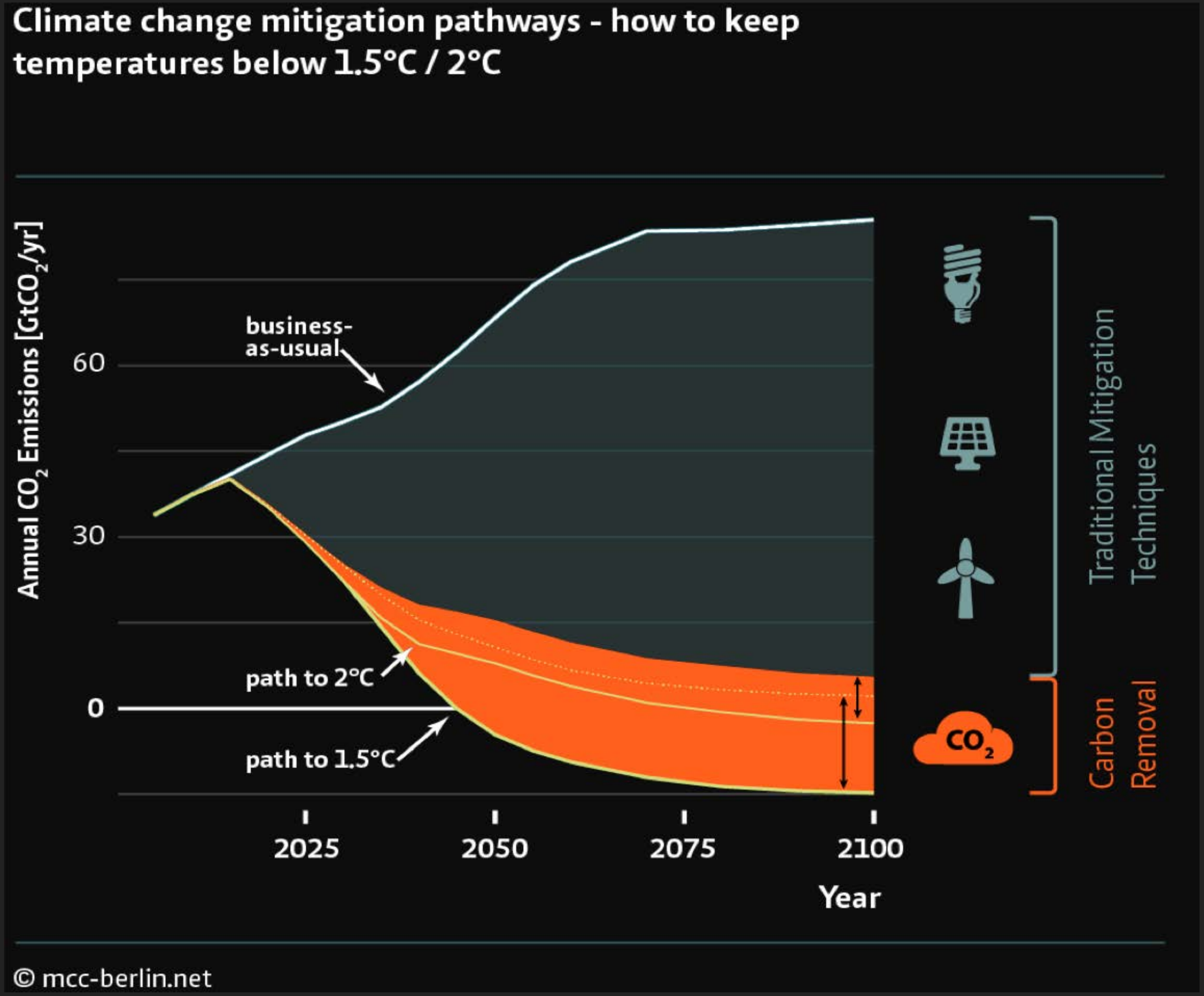
1. **technology** is improving
2. emerging **collective action**
3. learning from **policy experience**
4. success in **other areas**
5. **adaptation** incentives strong
6. **co-benefits**: local and immediate
7. **examples** of low-energy, high-HDI
8. **Youth** and young adults

LONG TERM COST REDUCTIONS



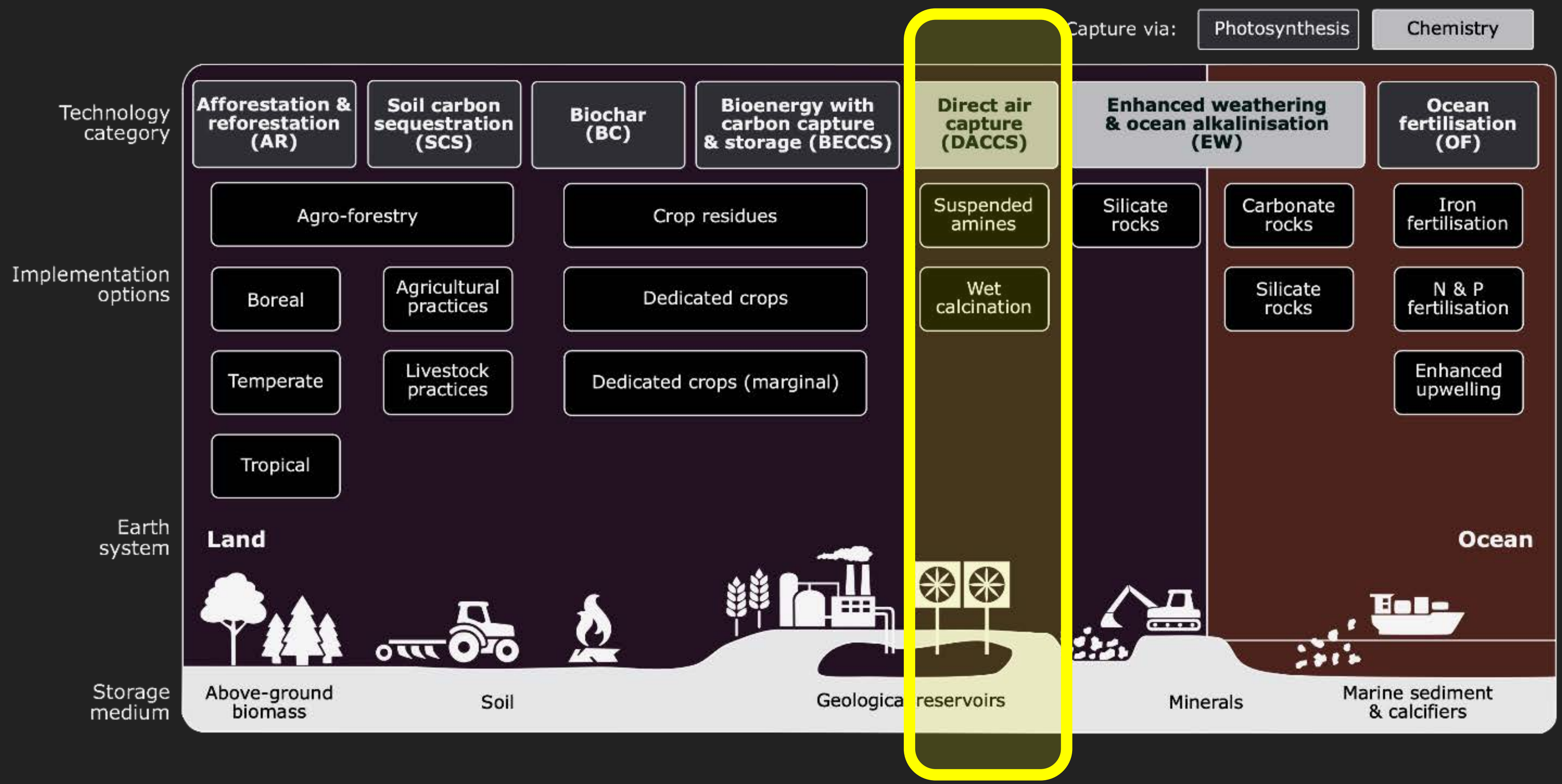
CARBON DIOXIDE REMOVAL

GIGATONS OF CO_2 REMOVAL NEEDED



Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

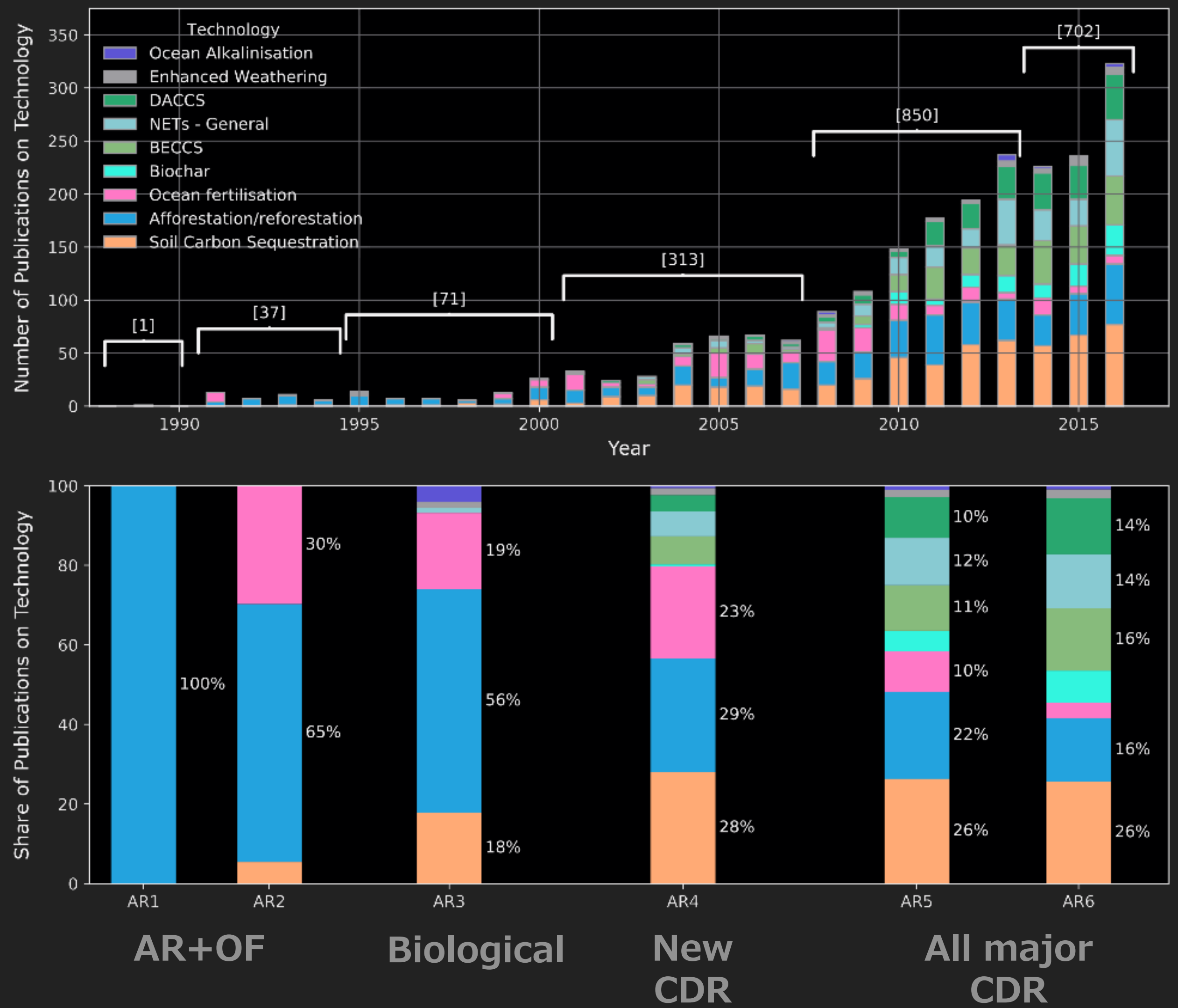
TAXONOMY OF APPROACHES



Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

EXPANDING RESEARCH AREA

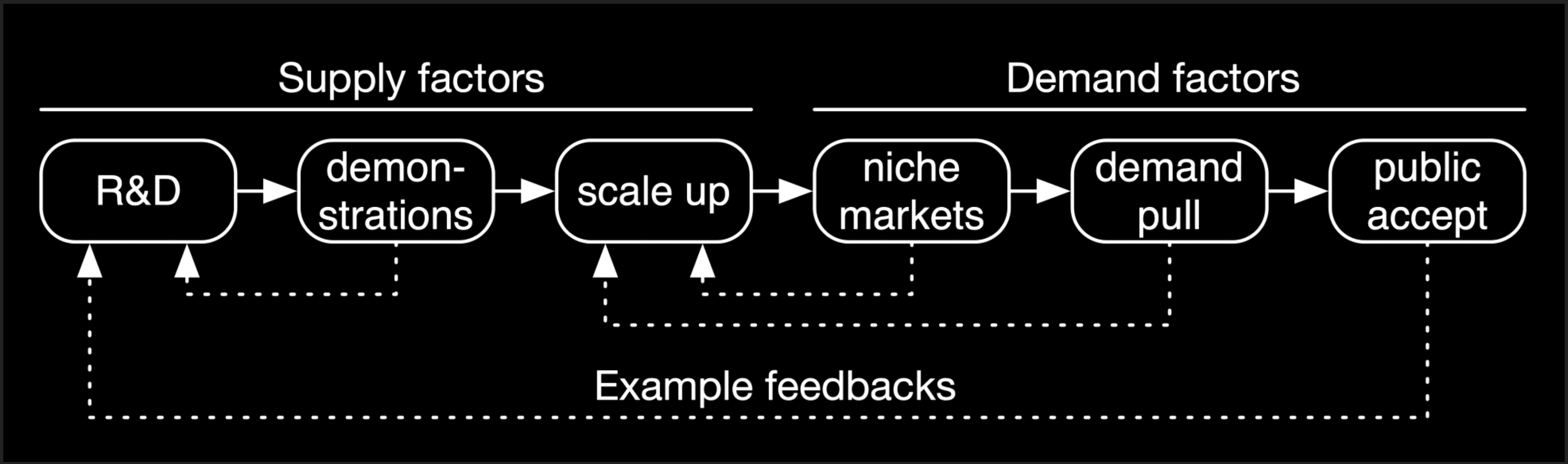
CDR COVERAGE IN IPCC ASSESSMENT REPORTS



Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

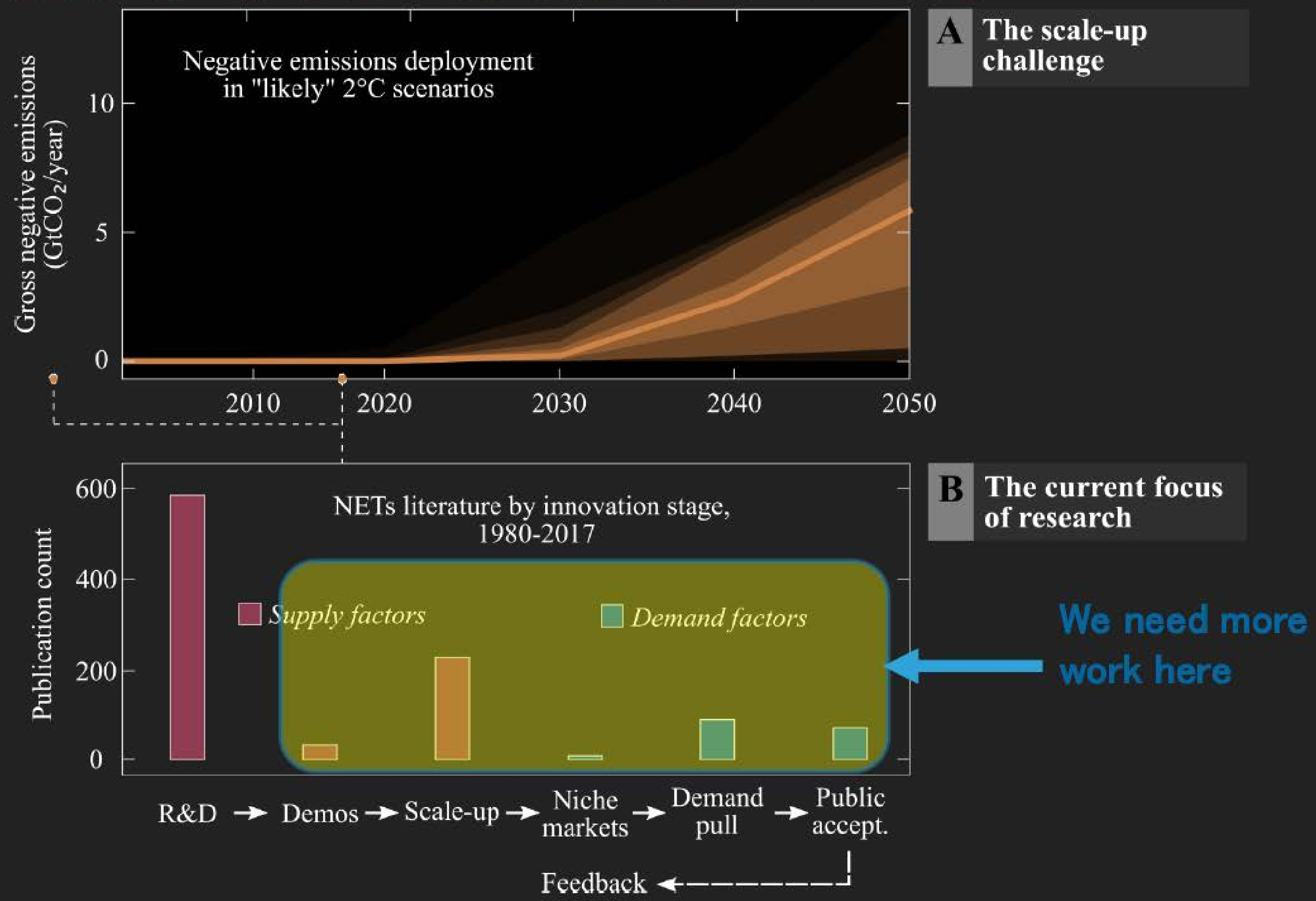
INNOVATION FRAMEWORK

- Approach: code CDR articles by stage of innovation



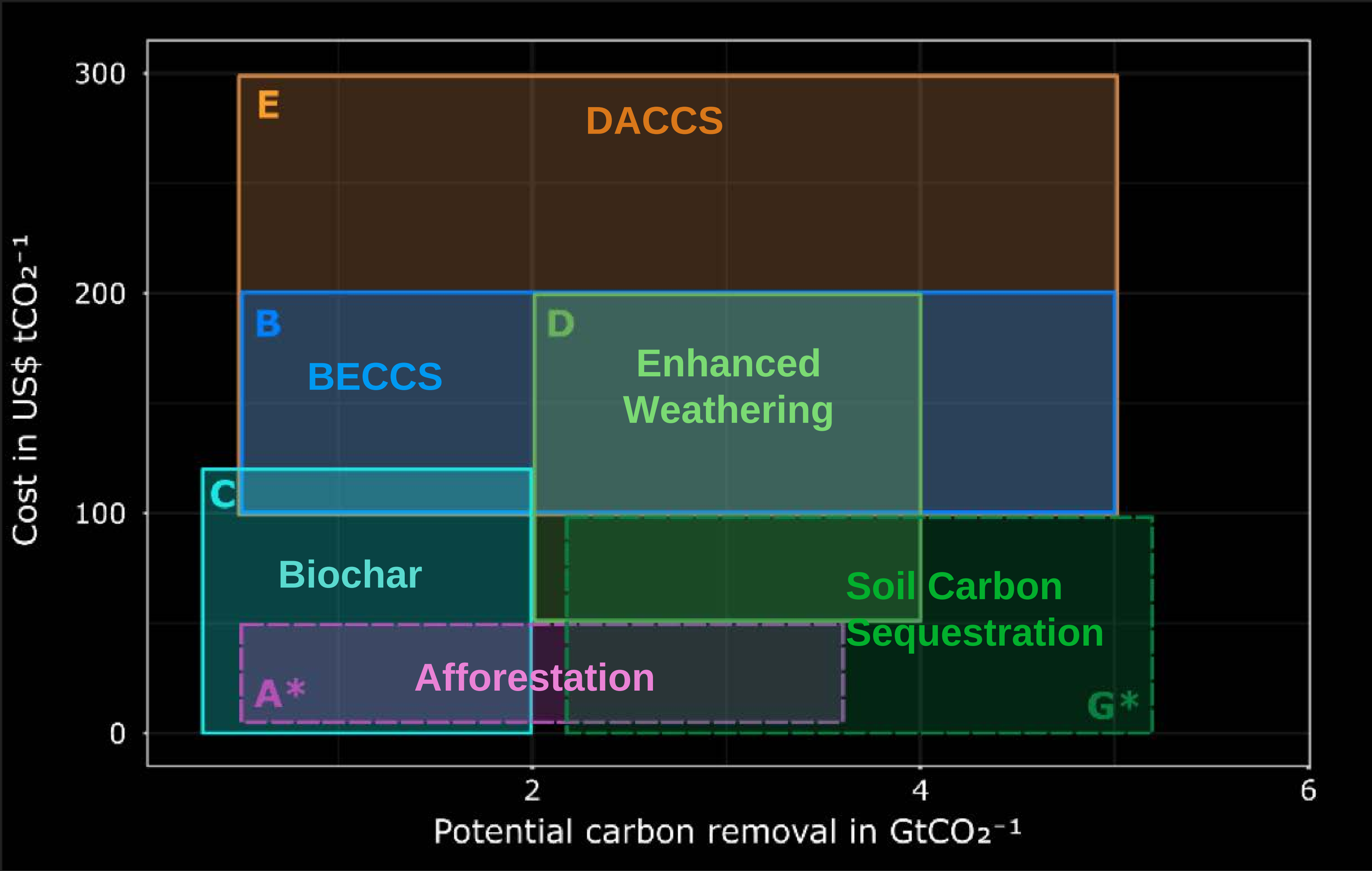
Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

LIT NOT ALIGNED WITH AN IMMINENT SCALE-UP



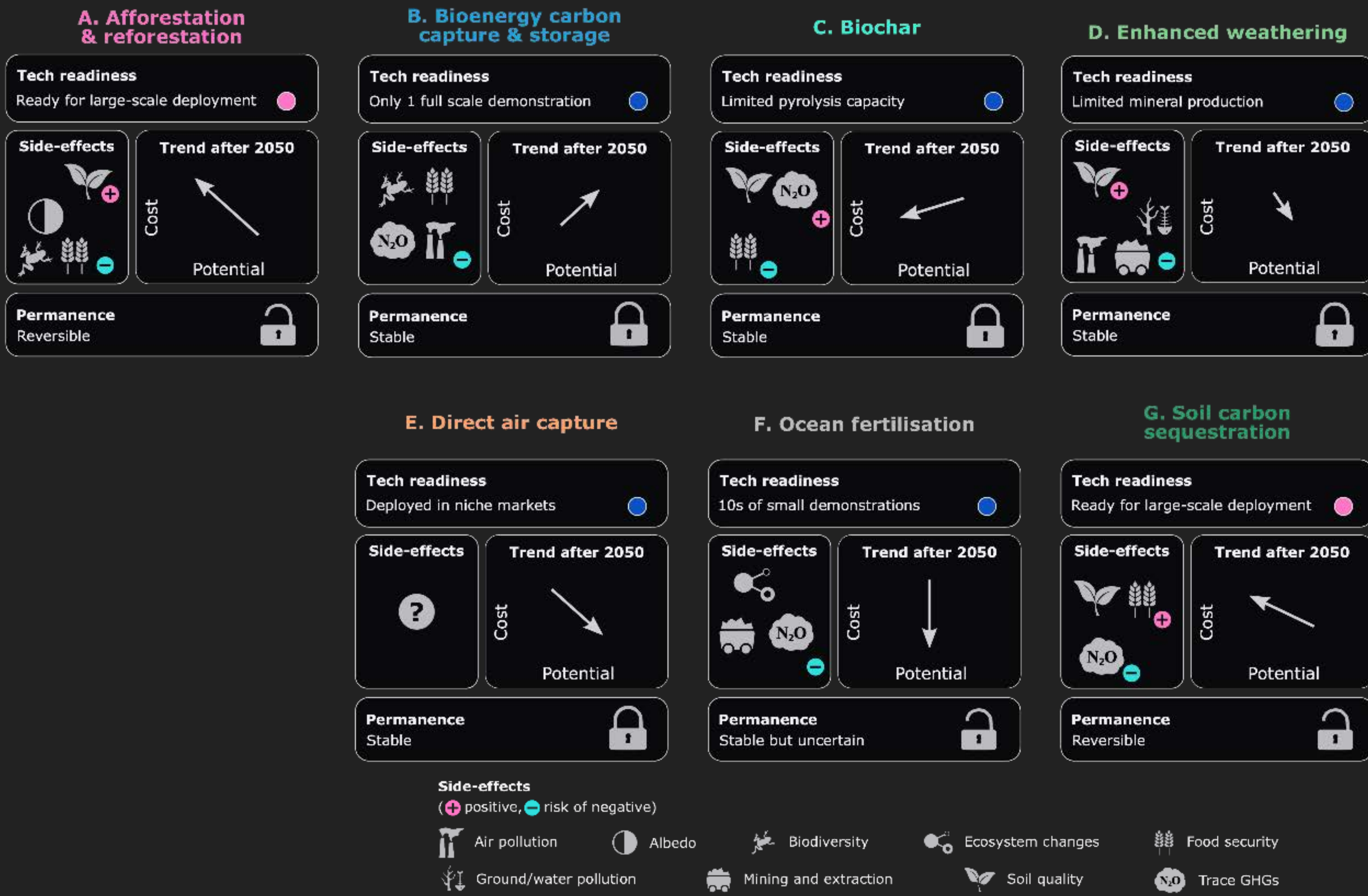
Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

2050: POTENTIAL FOR GIGATONS AFFORDABLY



Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

TECH READINESS, SIDE EFFECTS, PERMANENCE

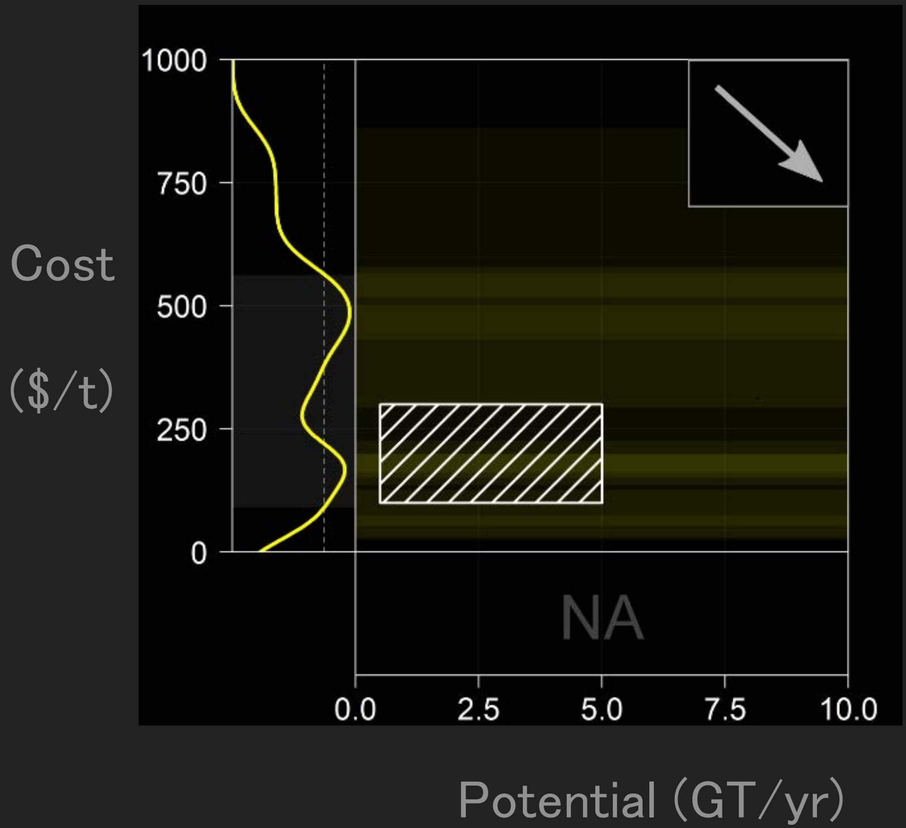


Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

DIRECT AIR CAPTURE

- Very large removal potential
- No clear side effects

- Capital costs
- Energy use
- Solvent use



Source: Nemet et al. / Minx et al./ Fuss et al. 2018, *Environmental Research Letters*

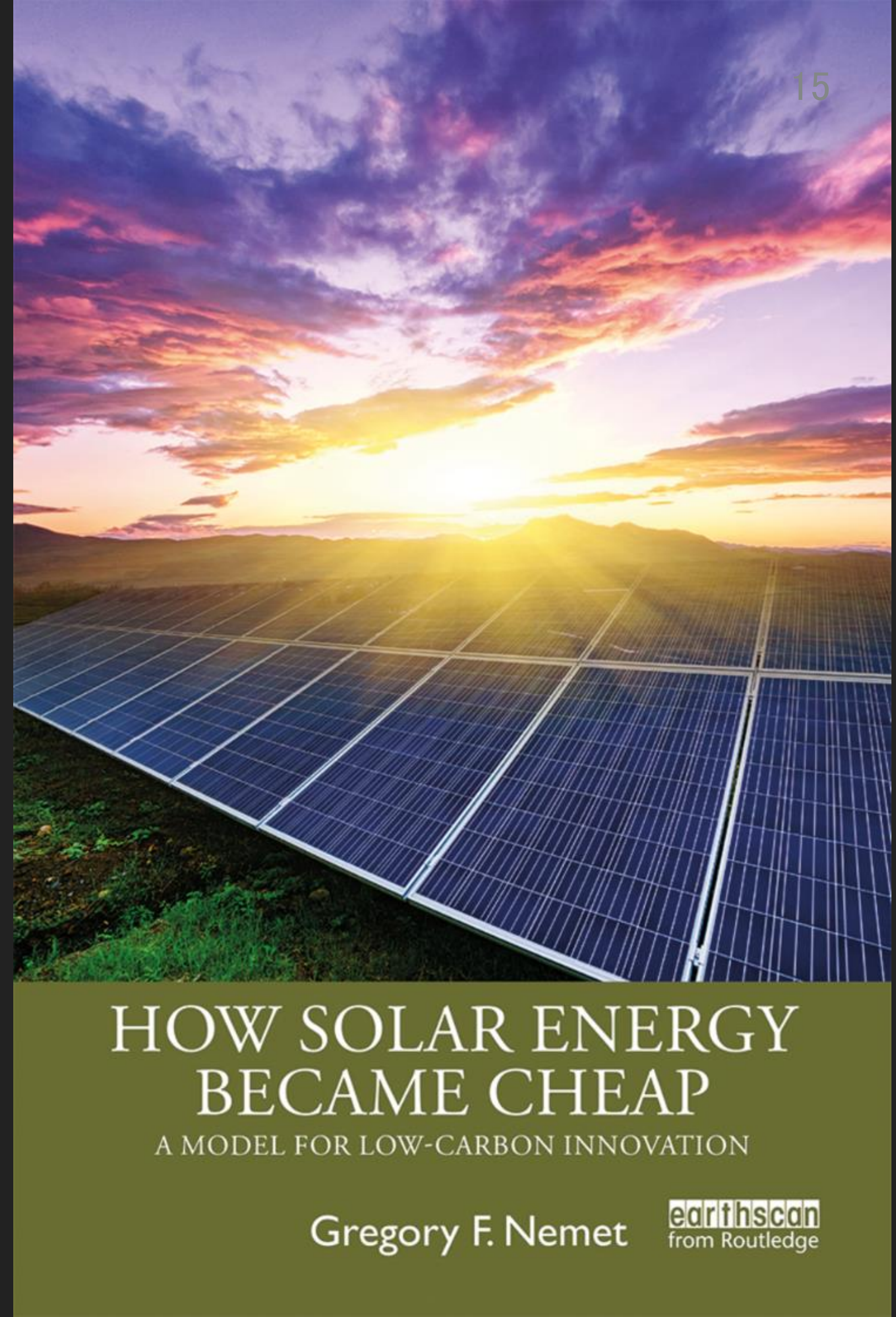
LEARNING FROM SUCCESSFUL TECHNOLOGIES

BOOK PROJECT

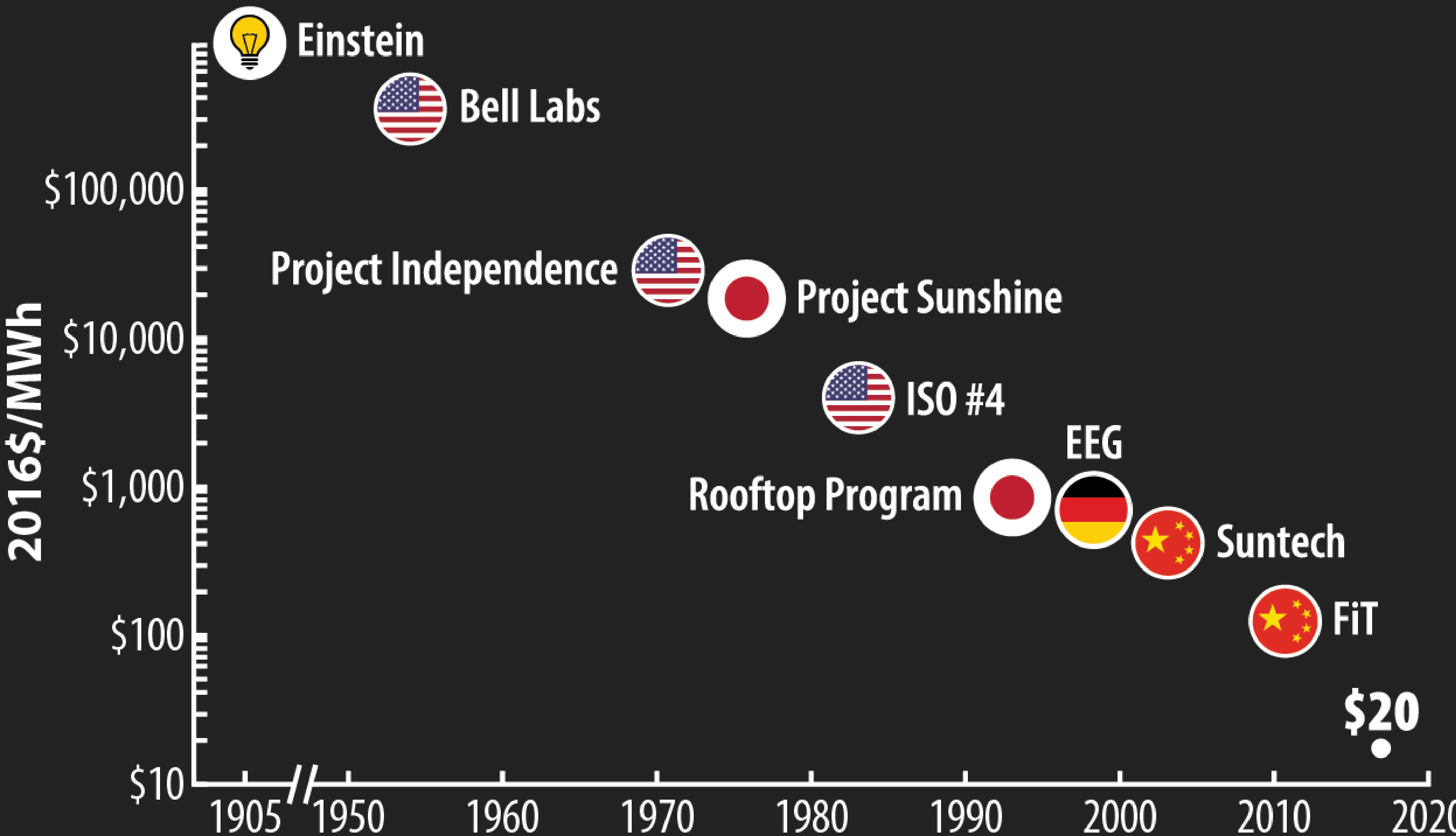
1. How did solar become cheap?
2. Why did it take so long?
3. How can it be a model

ANDREW CARNEGIE FELLOWS PROGRAM

This study was made possible by a grant from Carnegie Corporation of New York. The statements made and views expressed are solely the responsibility of the author.

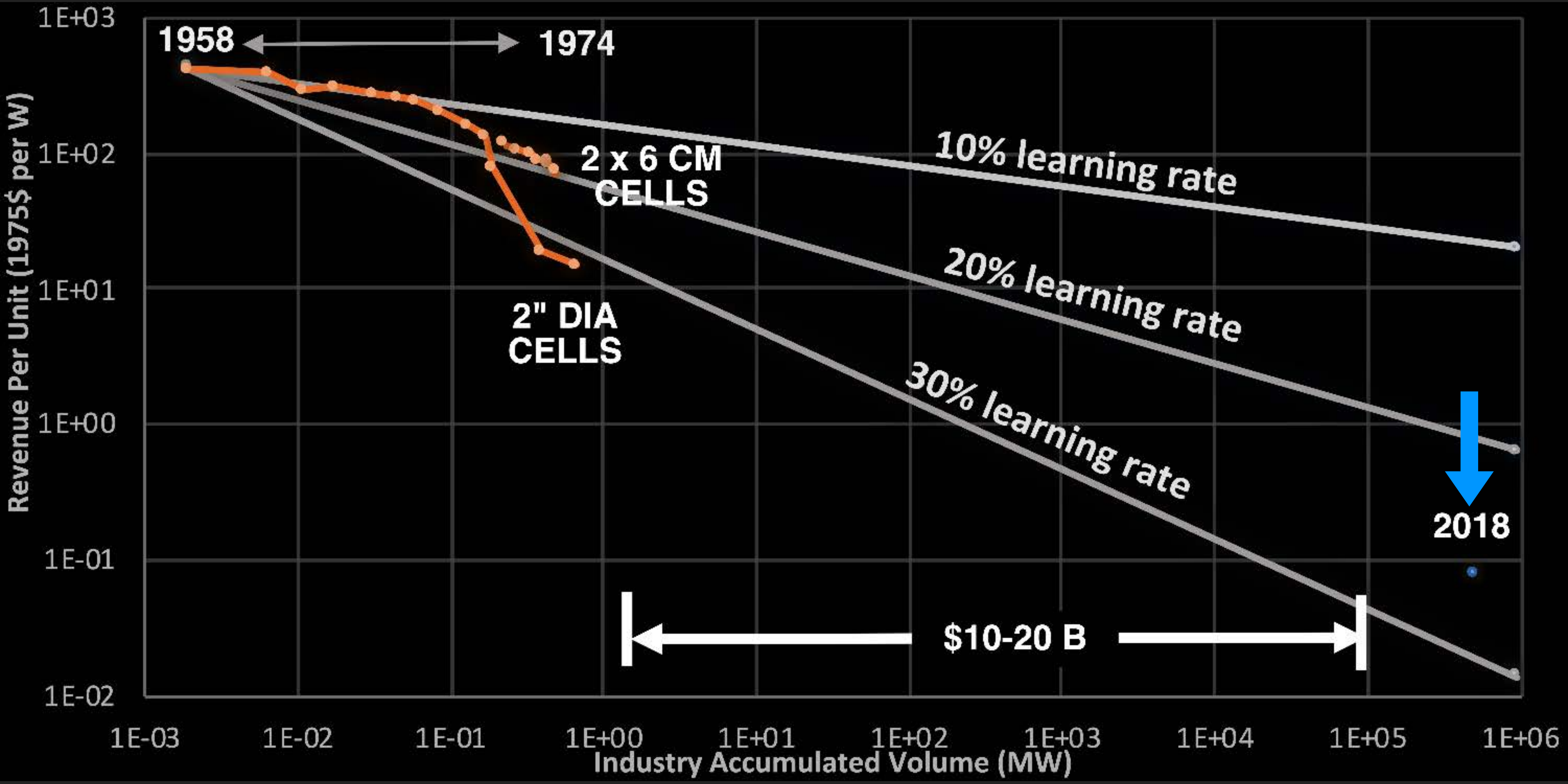


MILESTONES 10^{-4} COST



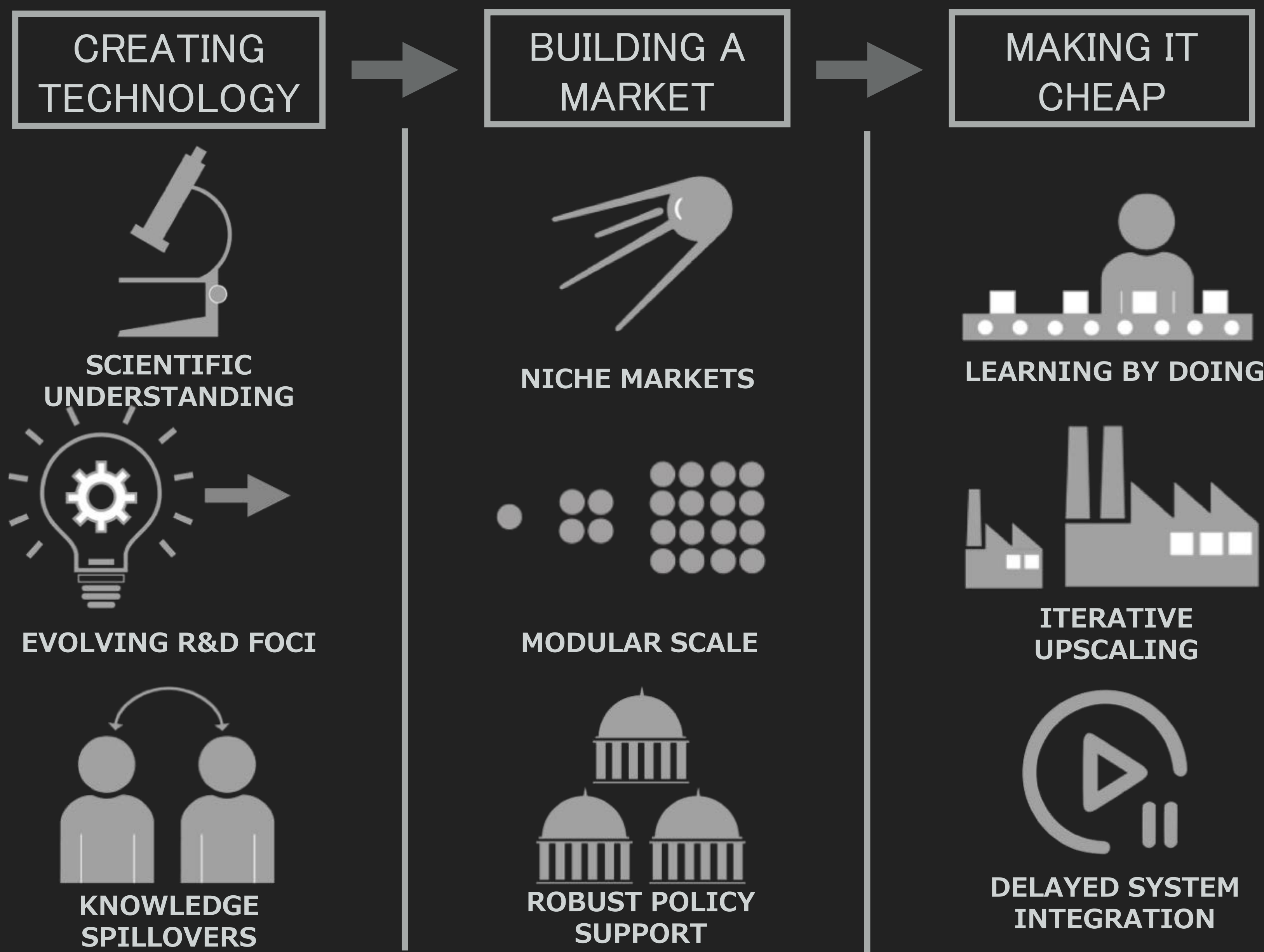
Source: Nemet 2019, How Solar Energy Became Cheap: A Model for Low-Carbon Innovation. Routledge

PROJECT INDEPENDENCE 1ST PV LEARNING CURVE



Source: Nemet 2019, How Solar Energy Became Cheap: A Model for Low-Carbon Innovation. Routledge.

HOW DID SOLAR GET CHEAP?



Source: Nemet 2019, How Solar Energy Became Cheap: A Model for Low-Carbon Innovation.

PV AS A MODEL FOR LOW-CARBON INNOVATION

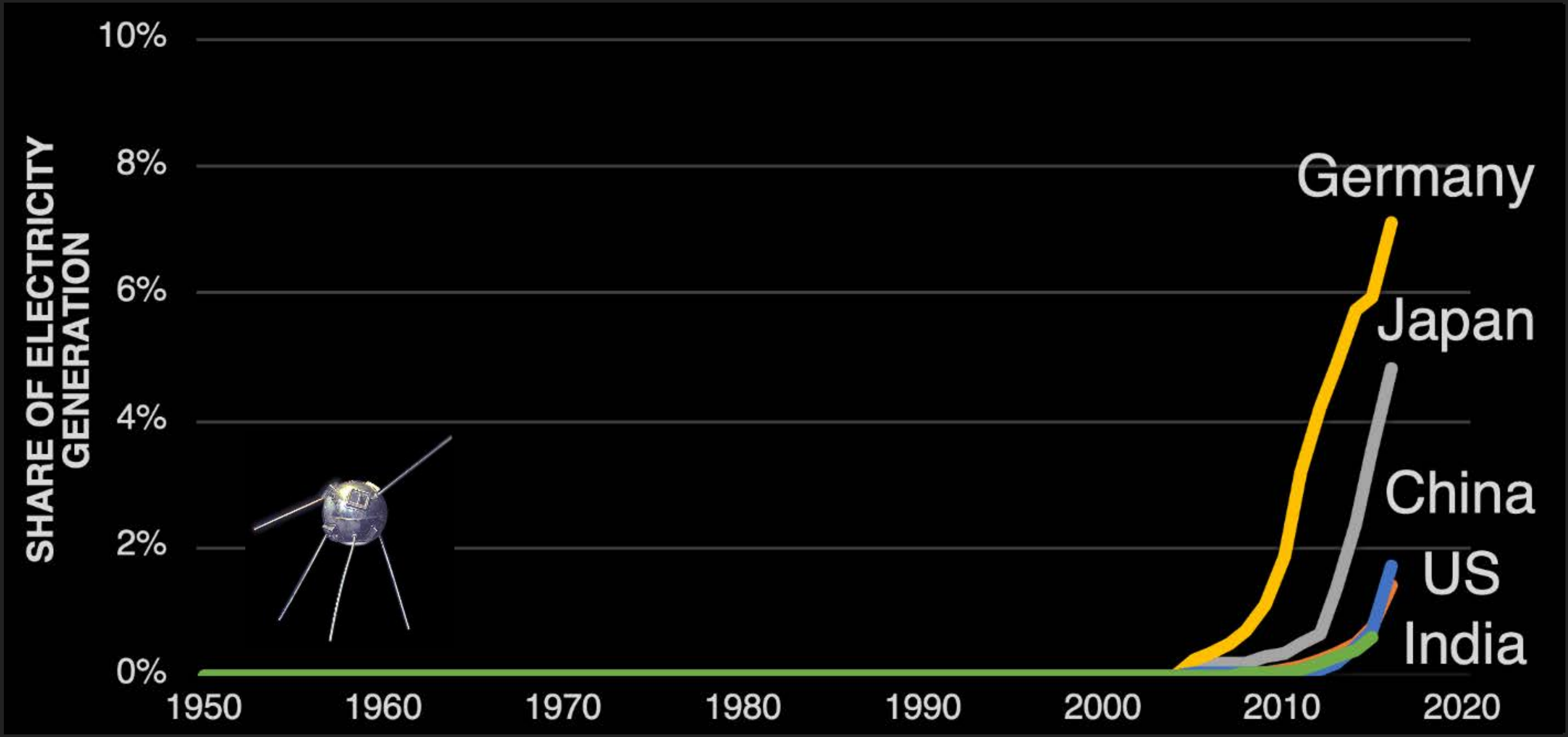
WE NEED MULTIPLE MODELS

	Technology type	Innovation model	Low-carbon target
1.	High-tech, iterative, disruptive	Solar PV	Direct air capture
2.	Low-tech, small, distributed	Green revolution	Soils
3.	Large, system integration intensive	Chemical plants	BECCS
4.	General purpose	Micro-processors	Artificial intelligence

Source: Nemet 2019, How Solar Energy Became Cheap: A Model for Low-Carbon Innovation, Routledge

HOW TO SPEED UP INNOVATION

PV ADOPTION HAS BEEN SLOW

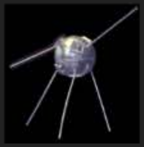


Source: Nemet 2019, How Solar Energy Became Cheap: A Model for Low-Carbon Innovation. Routledge.

ACCELERATING INNOVATION

1st commercial — Low cost — Widespread adoption

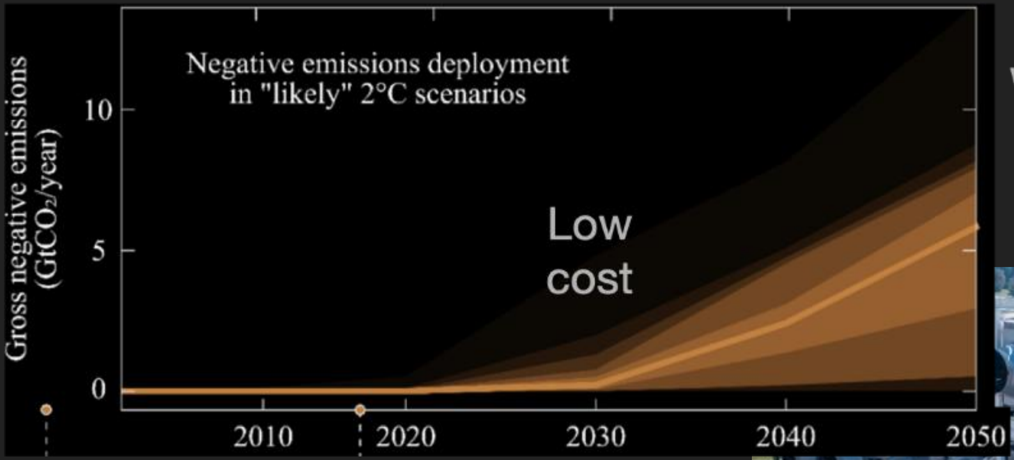
1957 — 2017 — 2040



DACCS

ClimeWorks — Low cost — Widespread adoption

2017 — 2076 — 2099



Widespread adoption

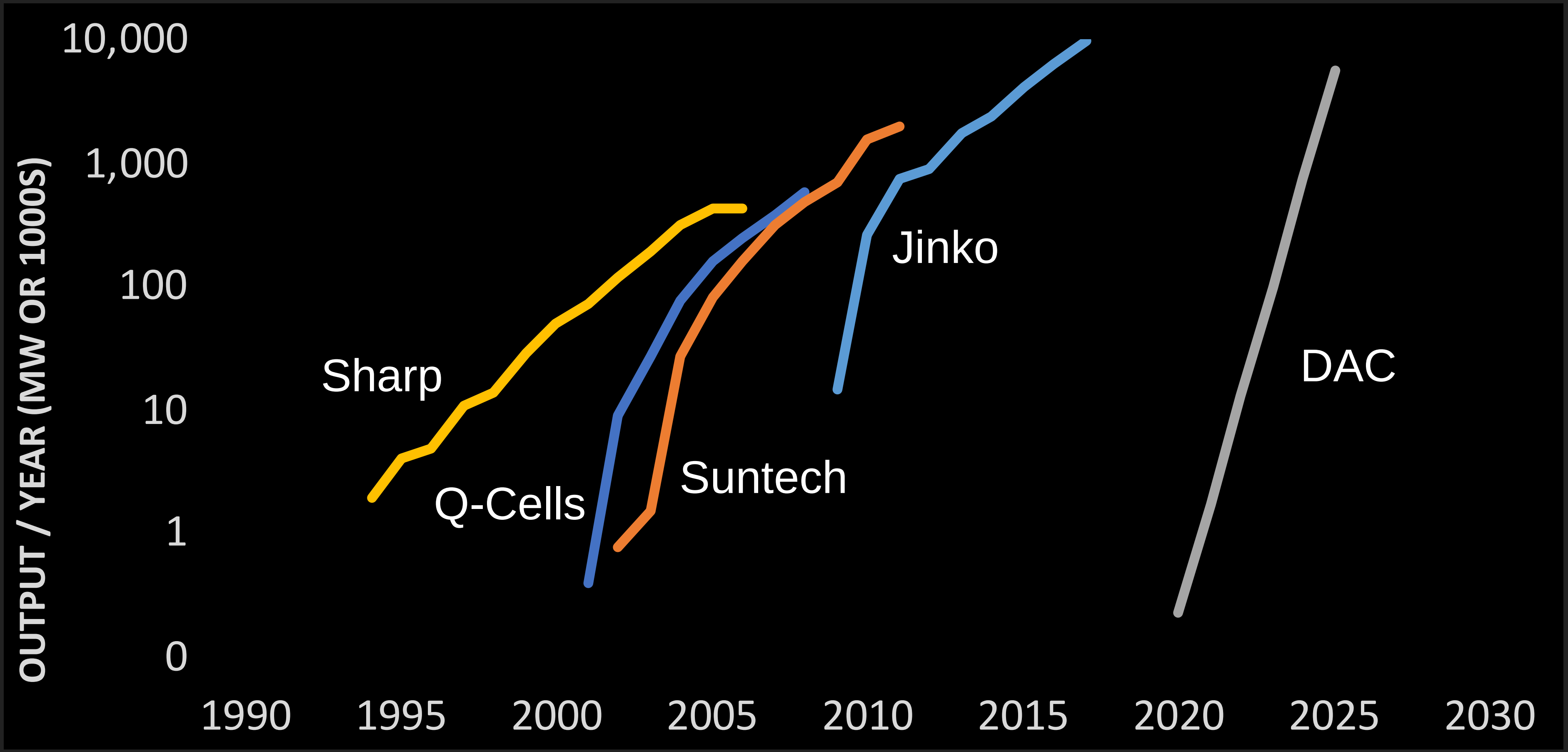
Accelerated model

ClimeWorks — Low cost — Widespread adoption

2017 — 2030 — 2060

Factor of 4 acceleration!

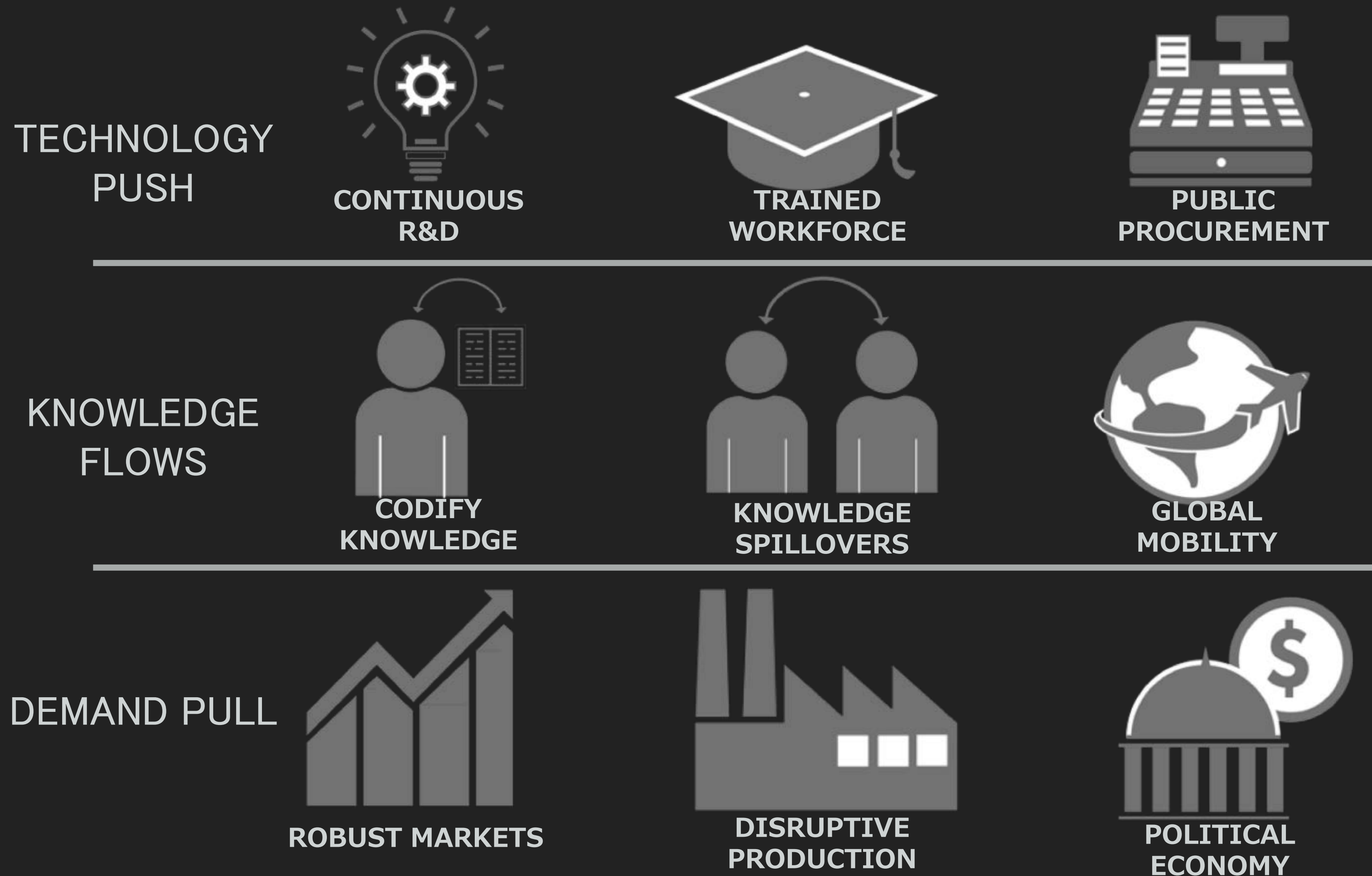
ACCELERATING DIRECT AIR CAPTURE



Scale-up needed for 1% of emissions by 2025 vs PV actuals

Source: Nemet 2019, How Solar Energy Became Cheap: A Model for Low-Carbon Innovation. Routledge.

HOW TO ACCELERATE THE MODEL



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