DYNAMIC POLICY DESIGN FOR HIGH WELLBEING + LOW RESOURCE USE

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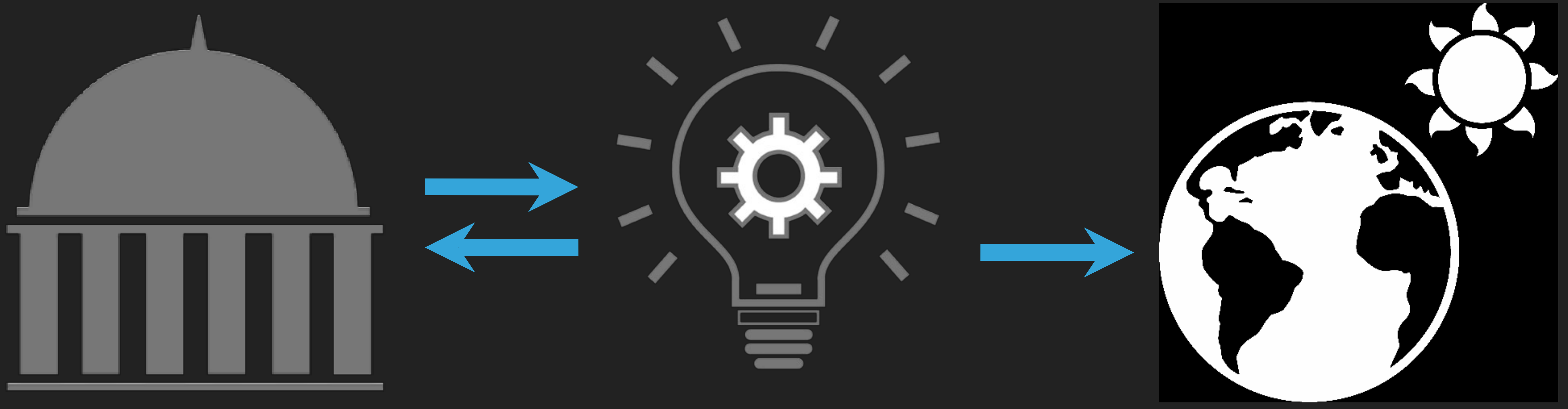


CLIMATE POLICY REQUIRES

A **COMPREHENSIVE**, **INCLUSIVE**, AND **DYNAMIC** APPROACH TO

STIMULATING INNOVATION AND ACCELERATING ADOPTION OF LOW CARBON TECHNOLOGIES.

PUT DYNAMIC LOW-CARBON TECHNOLOGIES AT THE CENTER

1. Major progress in low-c technologies + digitalization

2. Makes low-c transition feasible and affordable

3. Need policy: pollution, knowledge, systemic

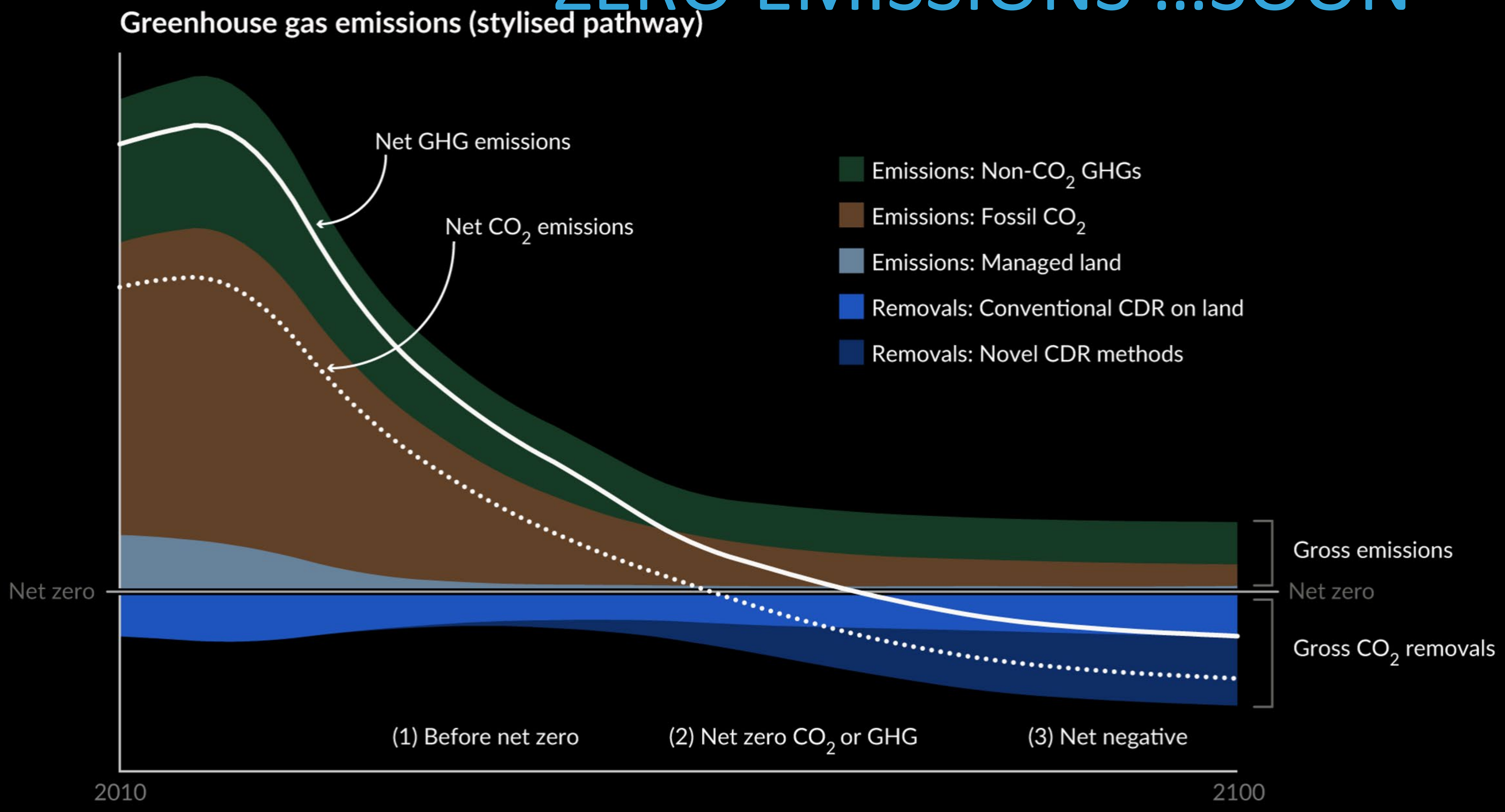
4. Design policy with technology dynamics

5. Comprehensive policy mix.

DYNAMIC INDUSTRIAL POLICY FOR CLIMATE CHANGE

1. urgency and acceleration as goals
2. multiple policies, strategic sequence
3. govt engages deeply in innovation
4. tech+ inclusivity, social acceptance
5. local learning and system integration
6. boost capacity in government
7. adaptive, learn from experiments

<2C REQUIRES TRANSITION TO NET ZERO EMISSIONS …SOON

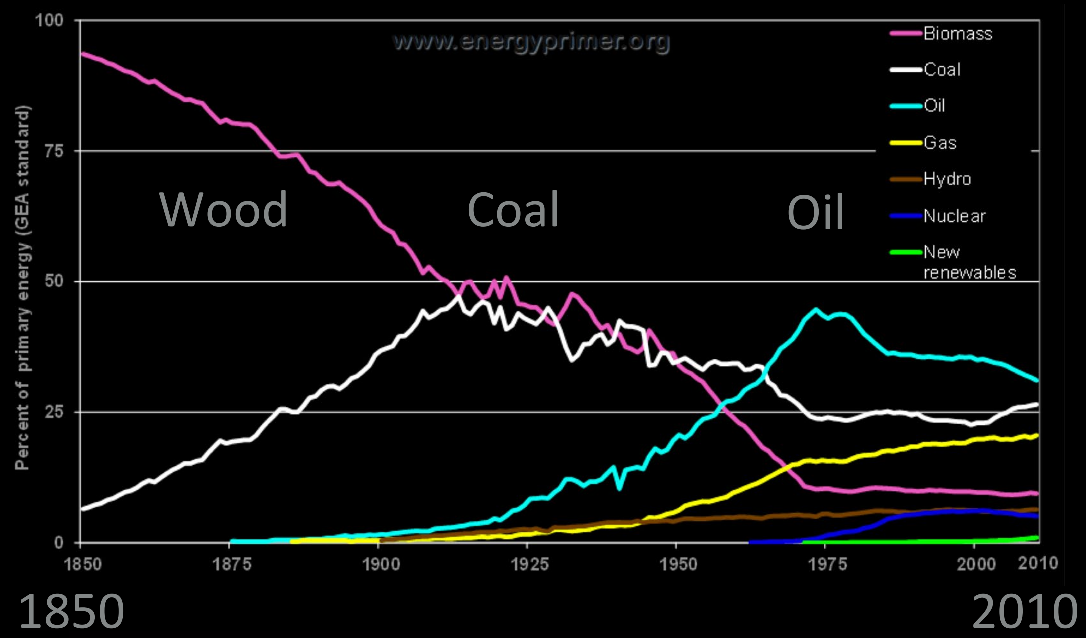


stateofcdr.org

Smith et. al (2023)

ENERGY TRANSITIONS ARE HARD

1. Want CHEAP, CLEAN,RELIABLE



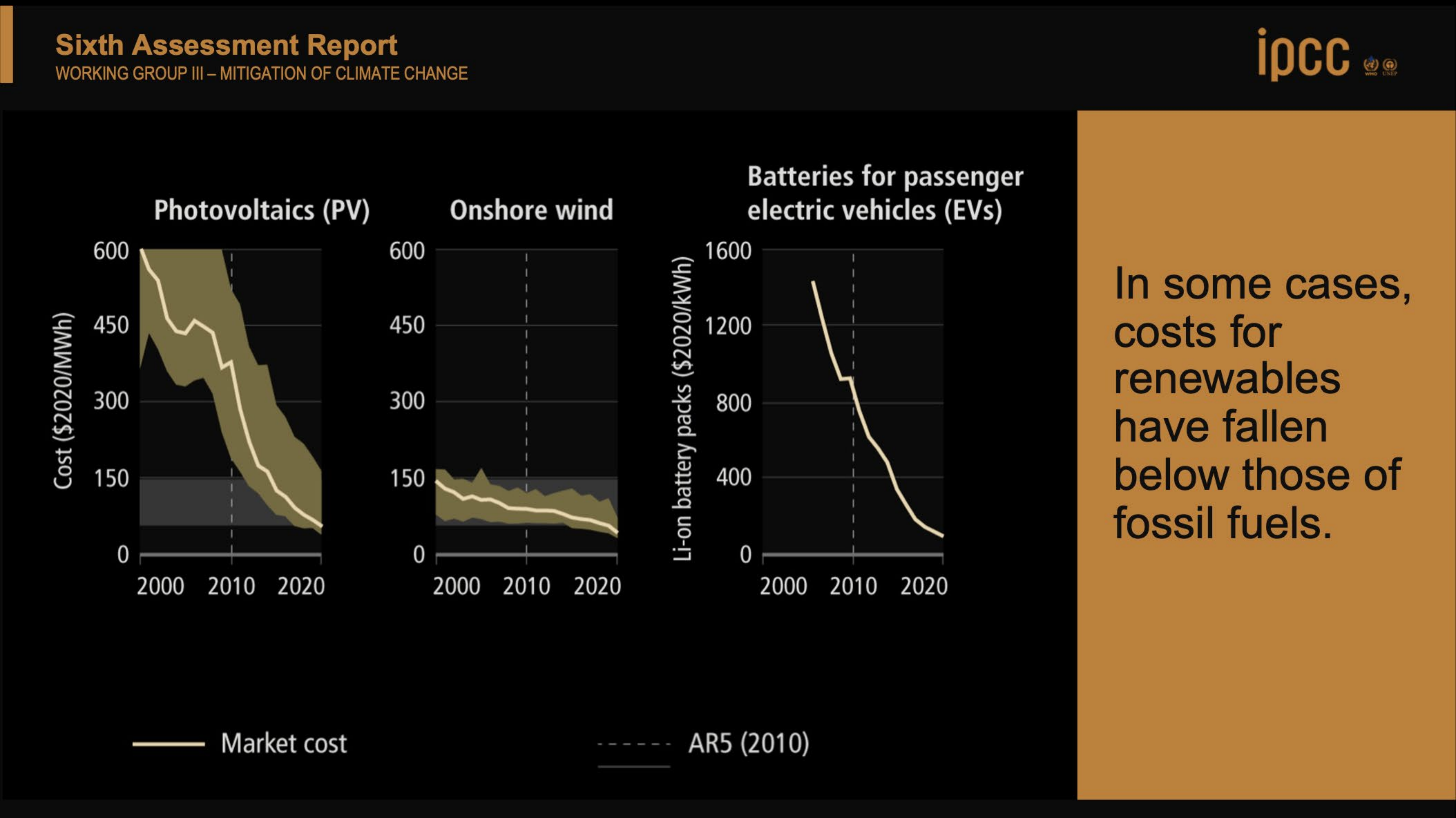
2. Past transitions took decades

3. CO_2 in atmosphere for >100 yrs

REASONS FOR OPTIMISM

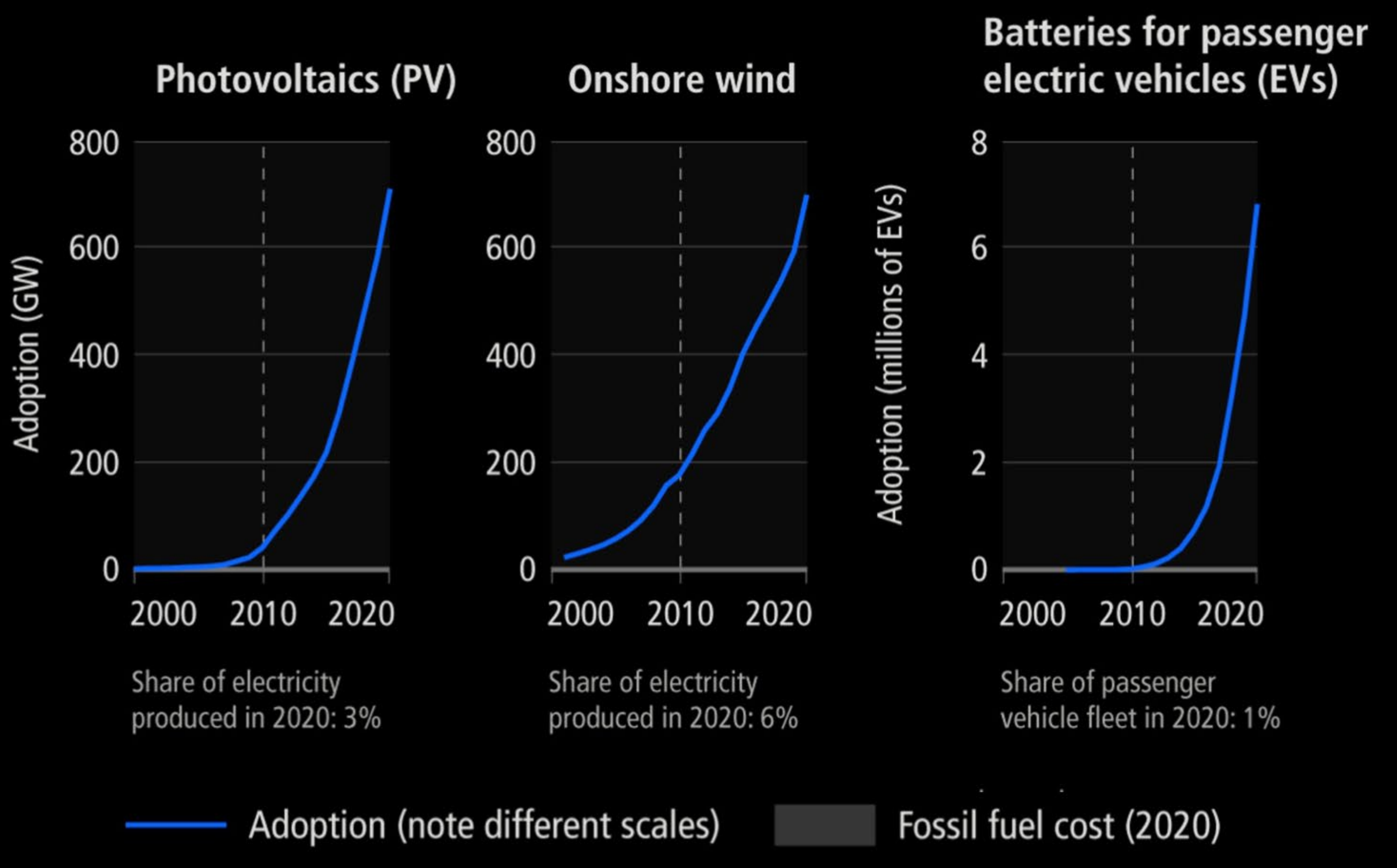
1. **technology** is improving
2. emerging **collective action**
3. learning from **policy experience**
4. success in **other areas**
5. **adaptation** incentives strong
6. **co-benefits**: local and immediate
7. **examples** of low-energy, high-HDI
8. **young** adults

COST REDUCTIONS



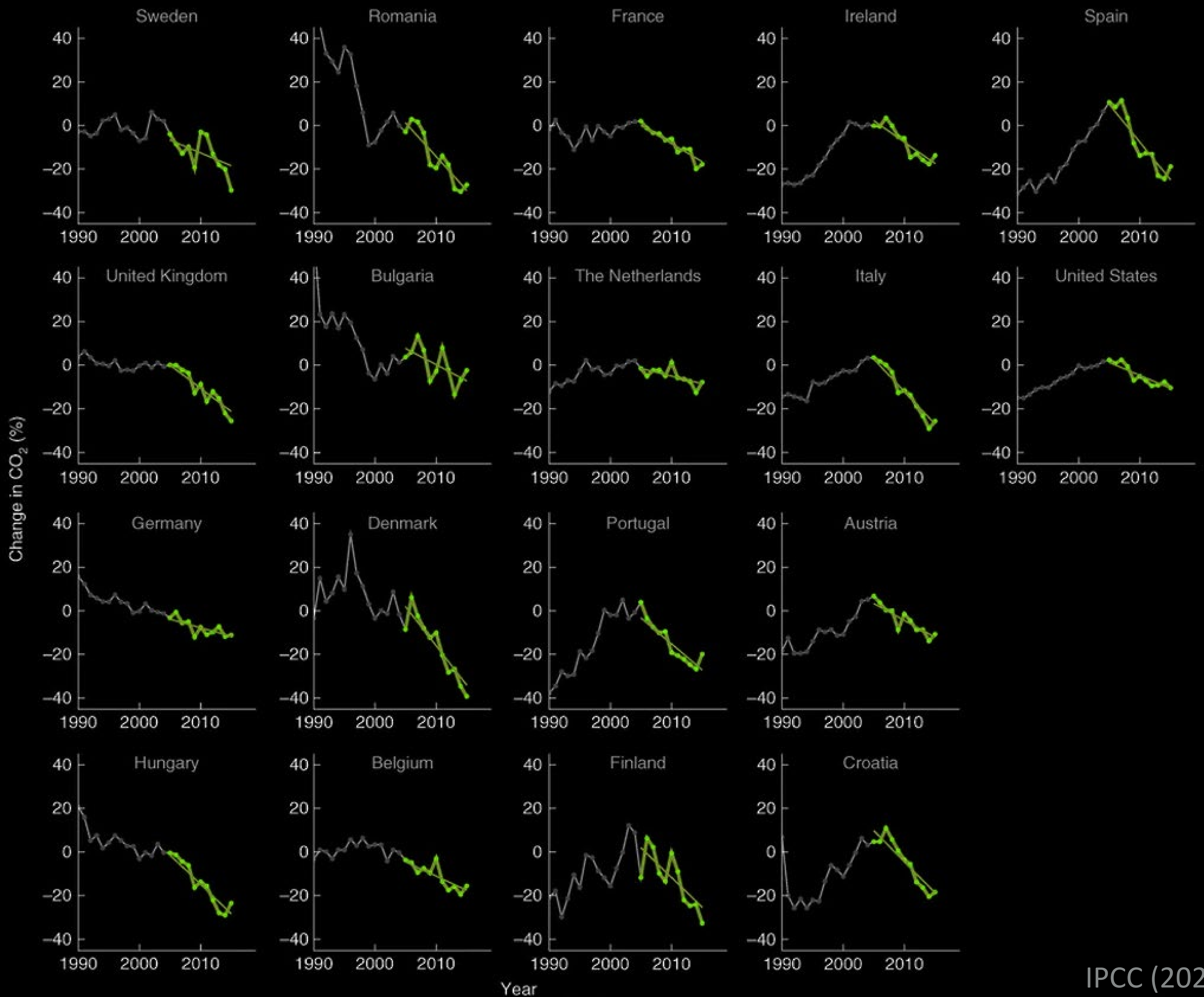
RAPID ADOPTION

Sixth Assessment Report
WORKING GROUP III – MITIGATION OF CLIMATE CHANGE



Electricity systems in some countries and regions are already predominantly powered by renewables.

RAPID DECARBONIZATION NOW



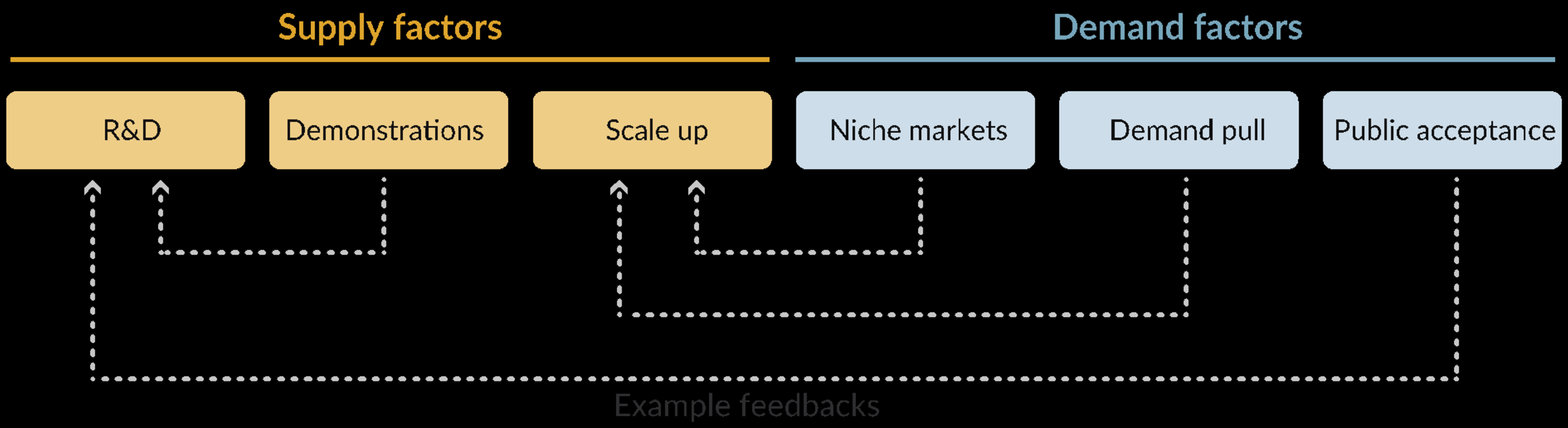
IPCC (2022)

STILL, WE NEED POLICY BECAUSE

- Pollution externality
- Knowledge spillovers
- Innovation system failures
- Inclusive well-being
- Speed of transition

Nemet (2013, forthcoming, 2023)

INNOVATION THEORY



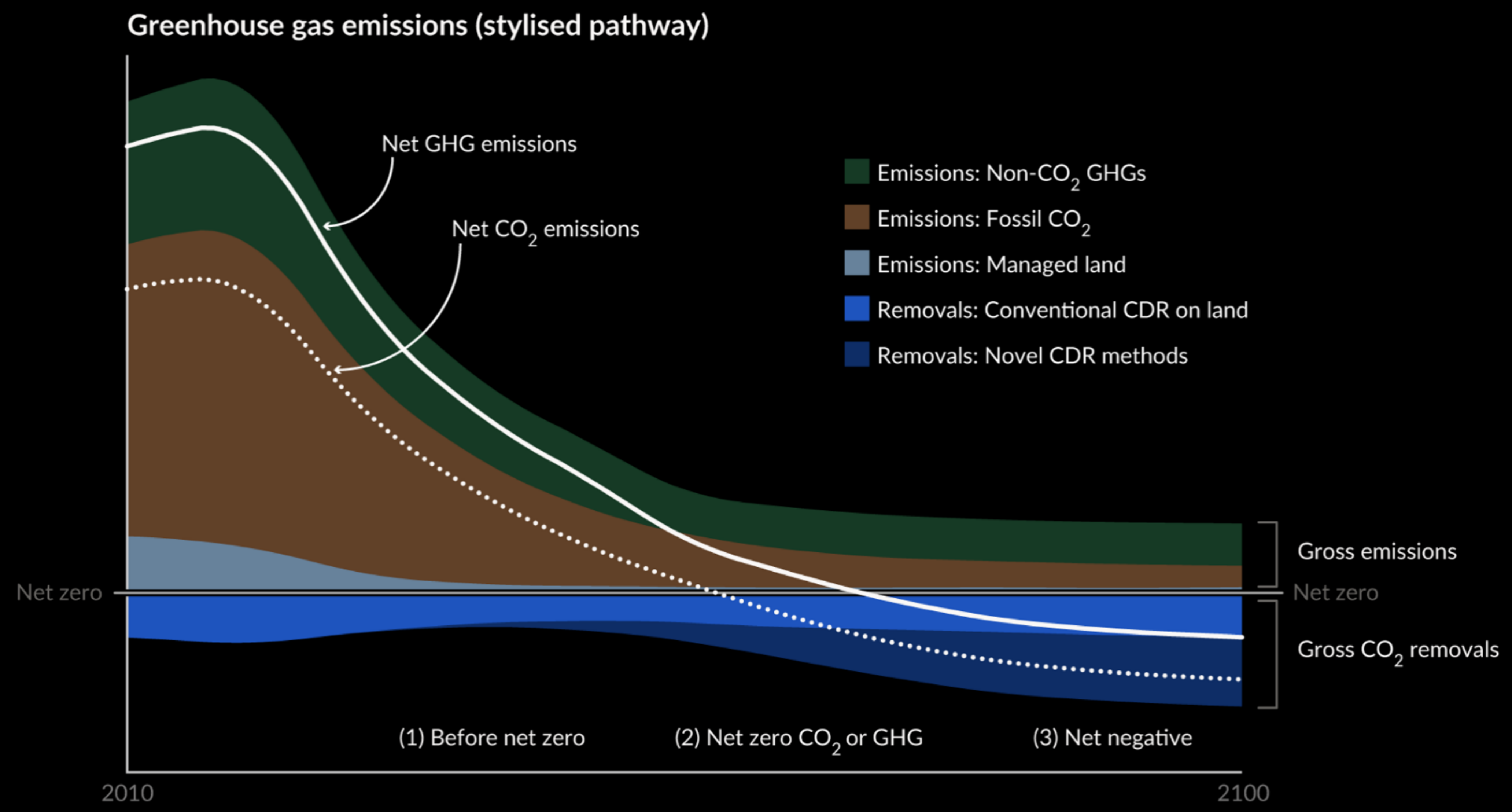
...AT SPEED

Nemet et al. (2018)

TRENDS IN POLICY FOR CLIMATE

	1990s-	2000s-	2010s-	2020s
Approach	**Environmental Policy**	**Endogenous technological change**	**Innovation systems**	**Green deal**
Policy problem	Pollution	Pollution Knowledge spillovers	Pollution Knowledge spillovers Innovation sys. failure	Equity Pollution Knowledge spillovers Innovation systems Speed
Policy solution	Carbon price	Carbon price R&D	Tech Push Meso Demand pull C px	Social policy Tech Push Meso Demand pull C px
Exemplar	Acid rain	Apollo	Solar PV	Net zero C

EMPIRICAL RESULTS TO INFORM POLICY DESIGN FOR NET ZERO



Smith et. al (2023)

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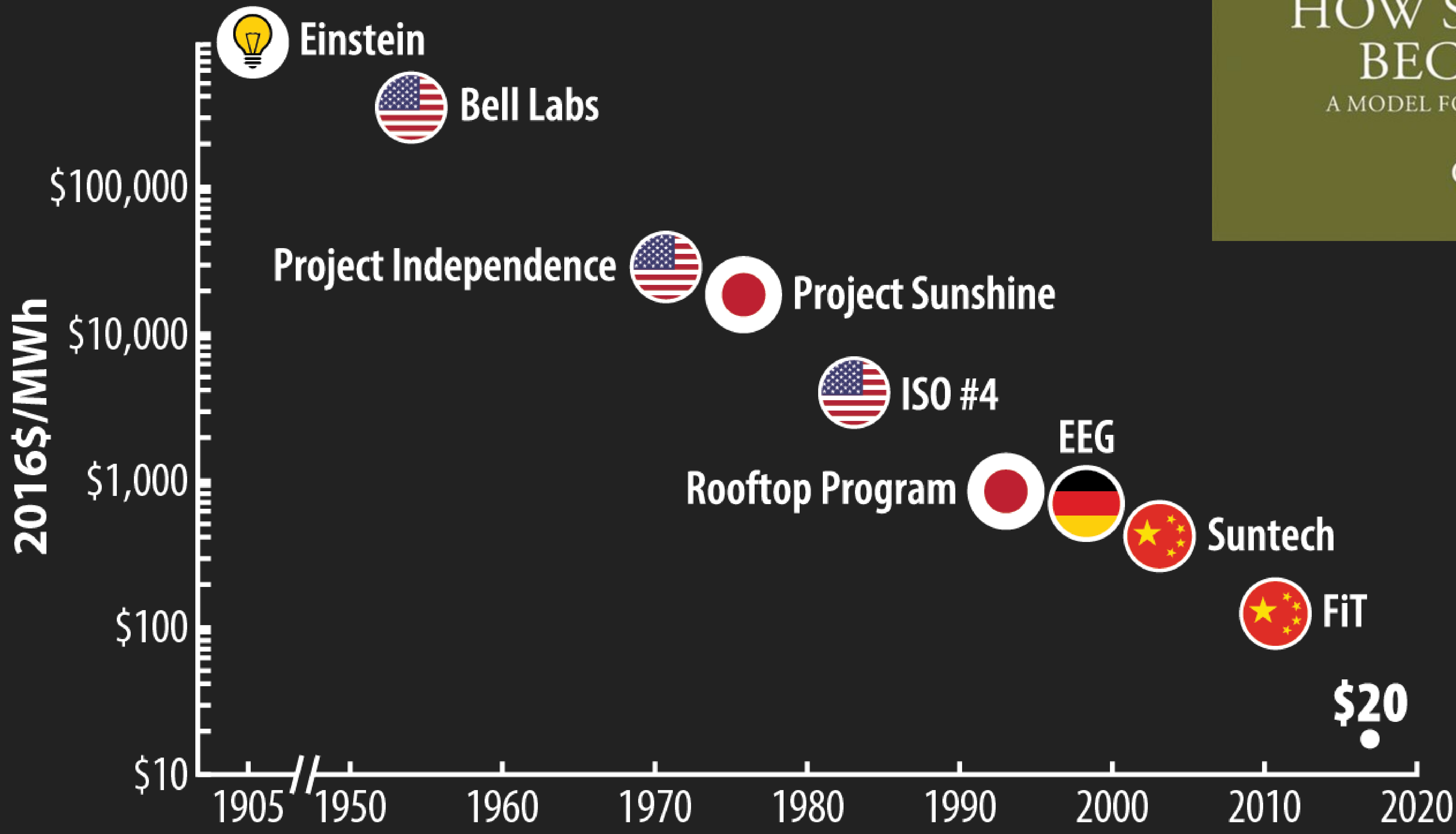
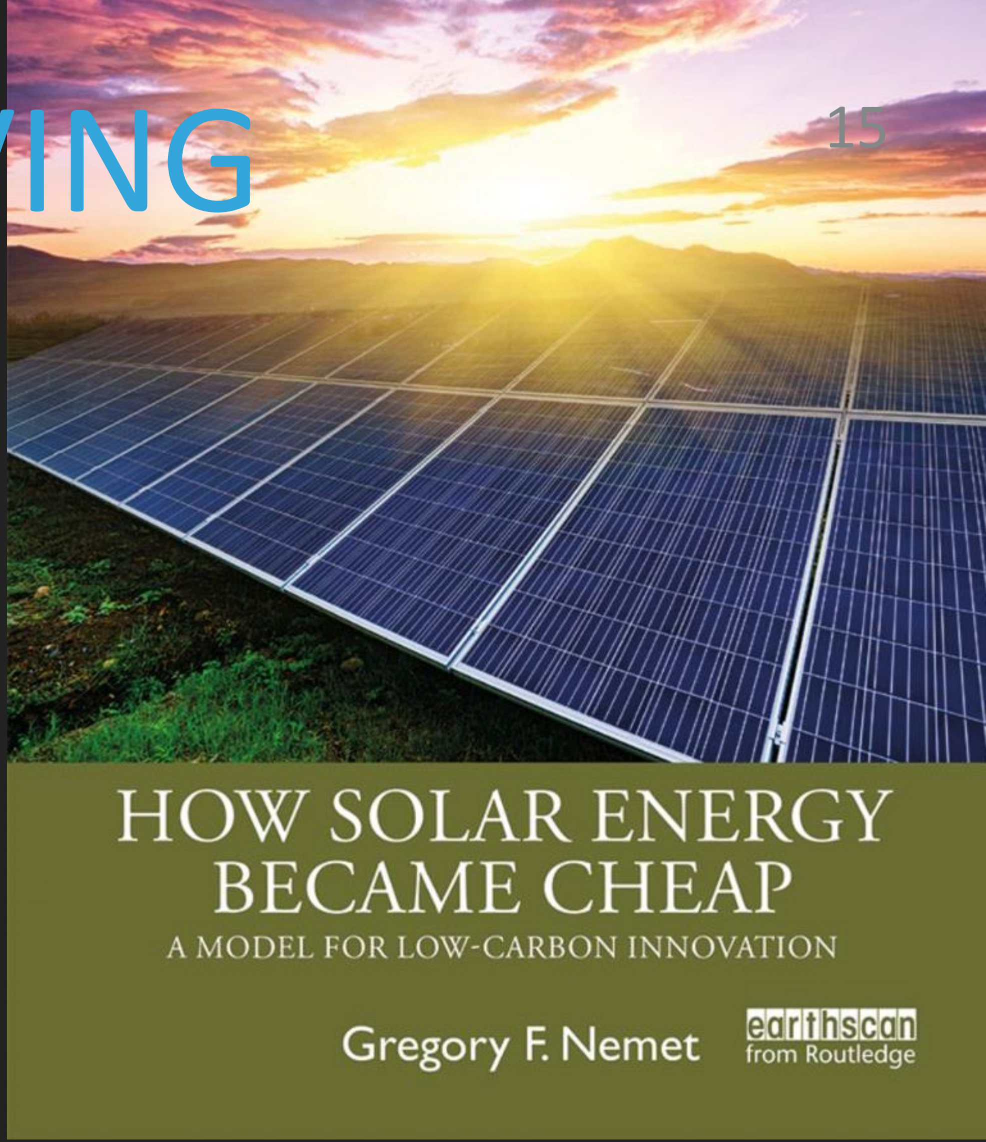
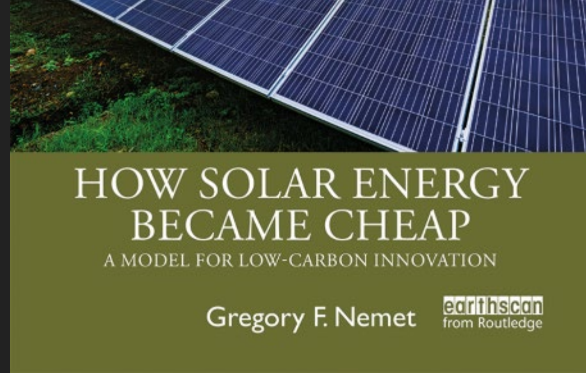
TECHNOLOGY IS IMPROVING

HERE IS HOW…

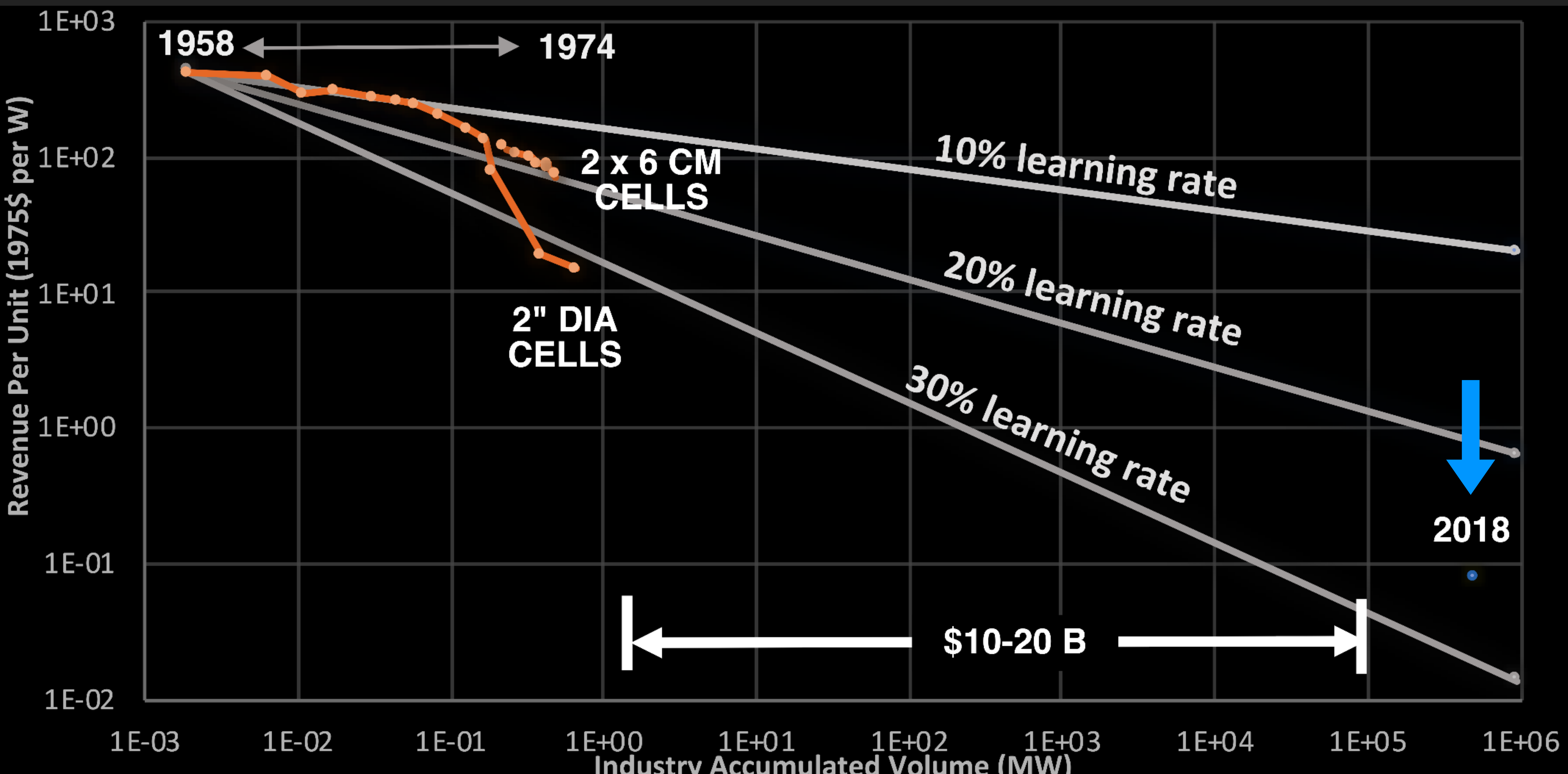




- 10^{-4}
- Policy
- Global
- Small

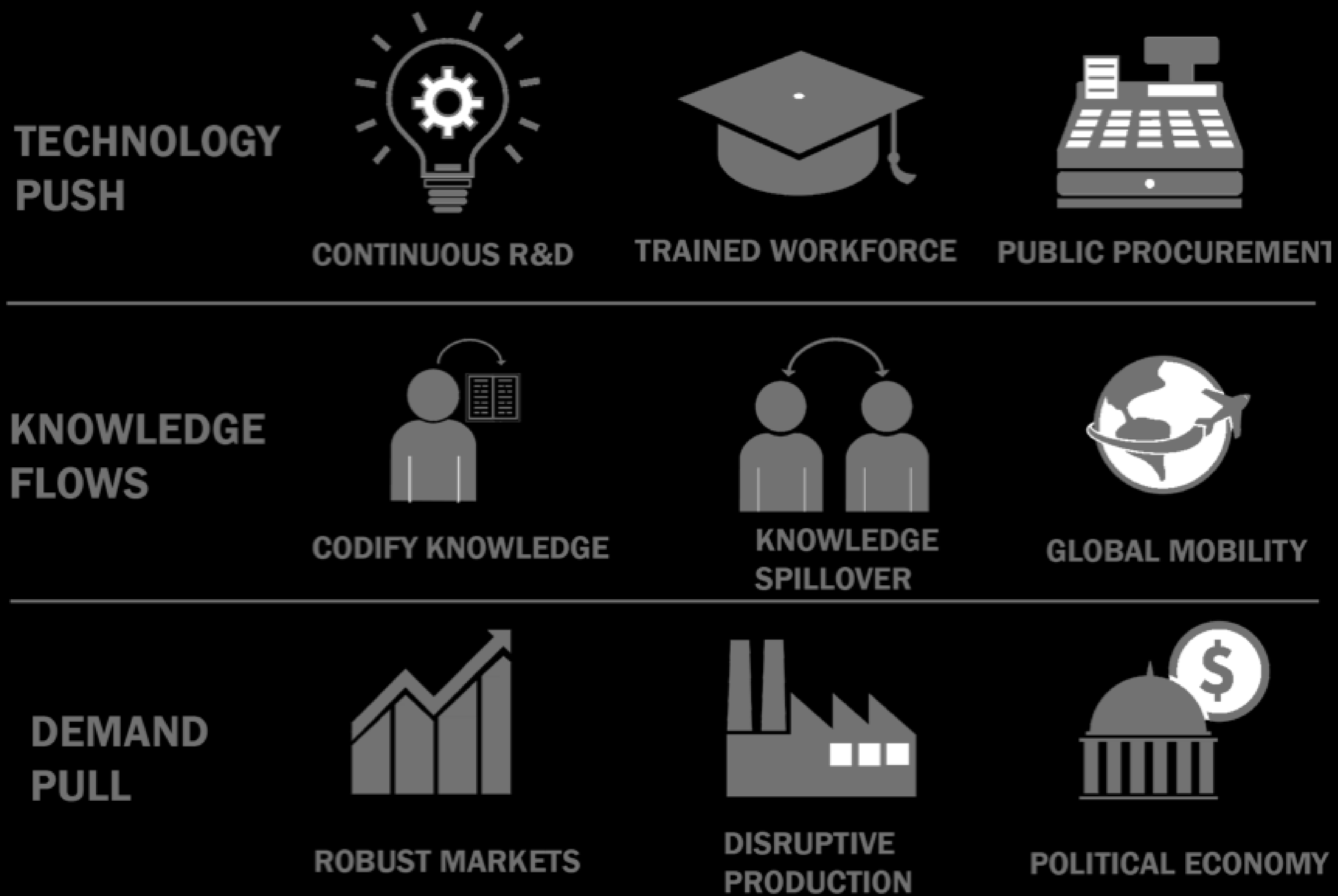


PROJECT INDEPENDENCE 1ST PV LEARNING CURVE



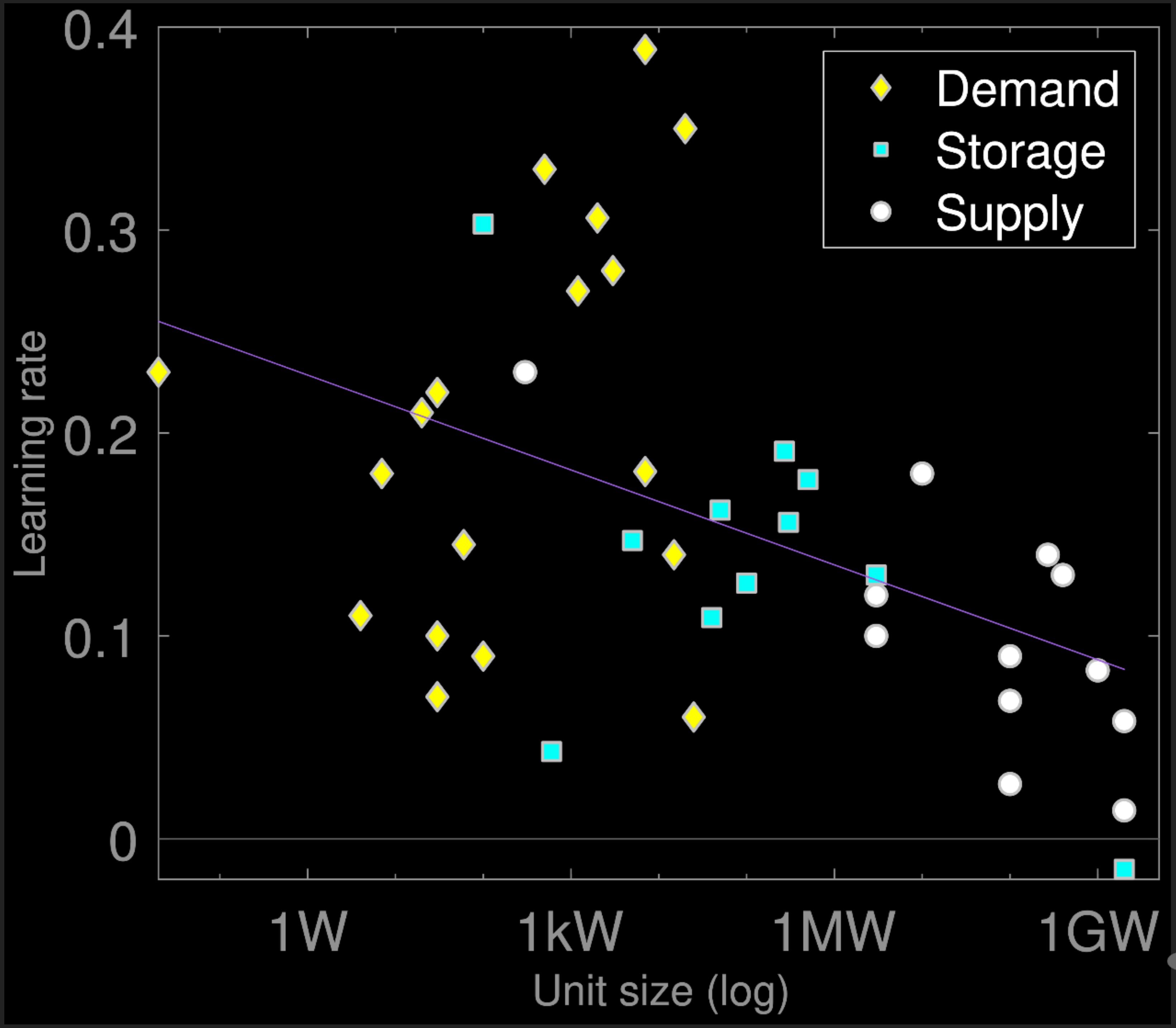
A NEW ROLE FOR PUBLIC POLICY

- Focus on dynamic technology…and acceleration
- More like industrial policy than environmental policy
- That demands a lot more capability in governments



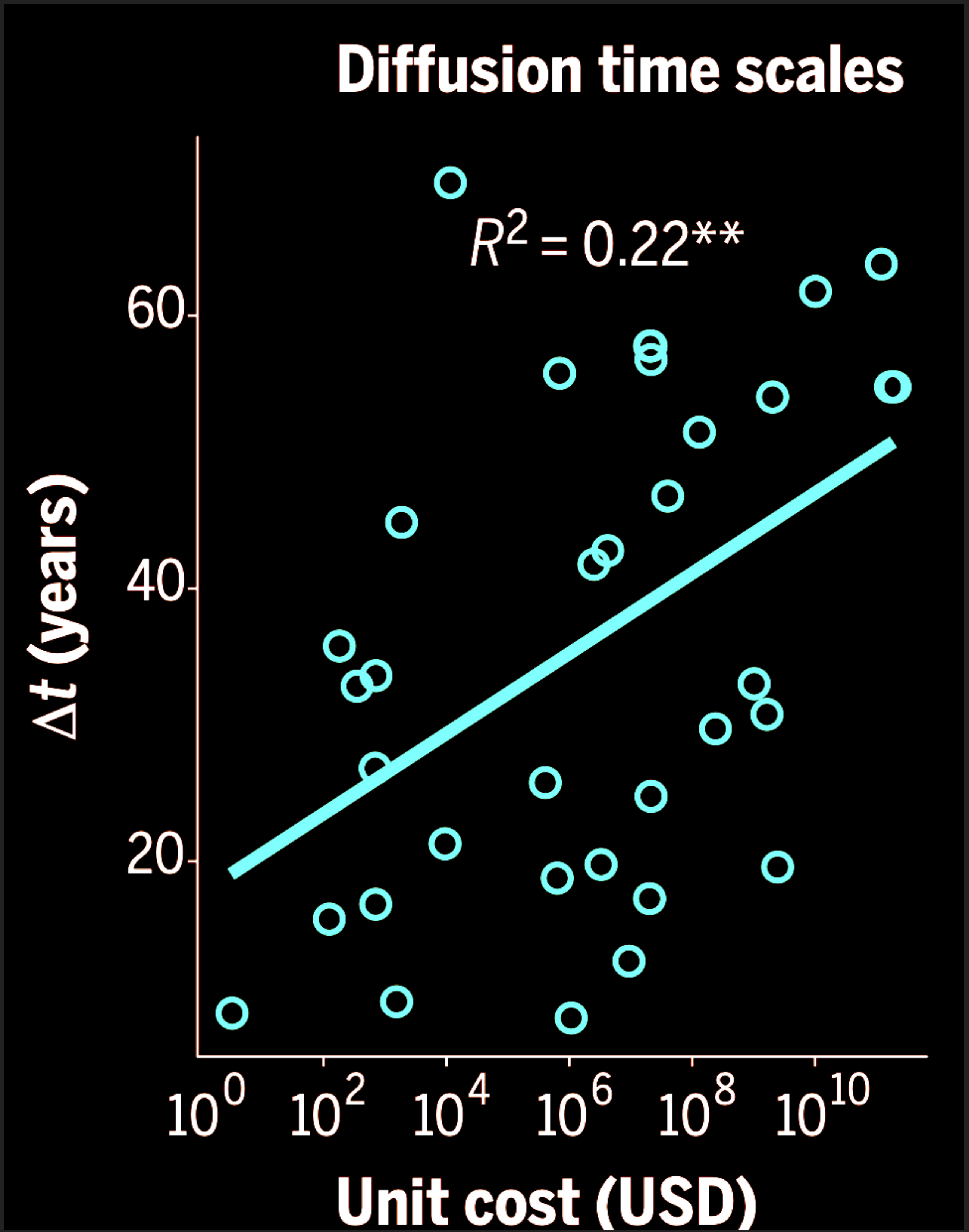
Nemet, 2019

SMALL TECHNOLOGIES IMPROVE MORE QUICKLY



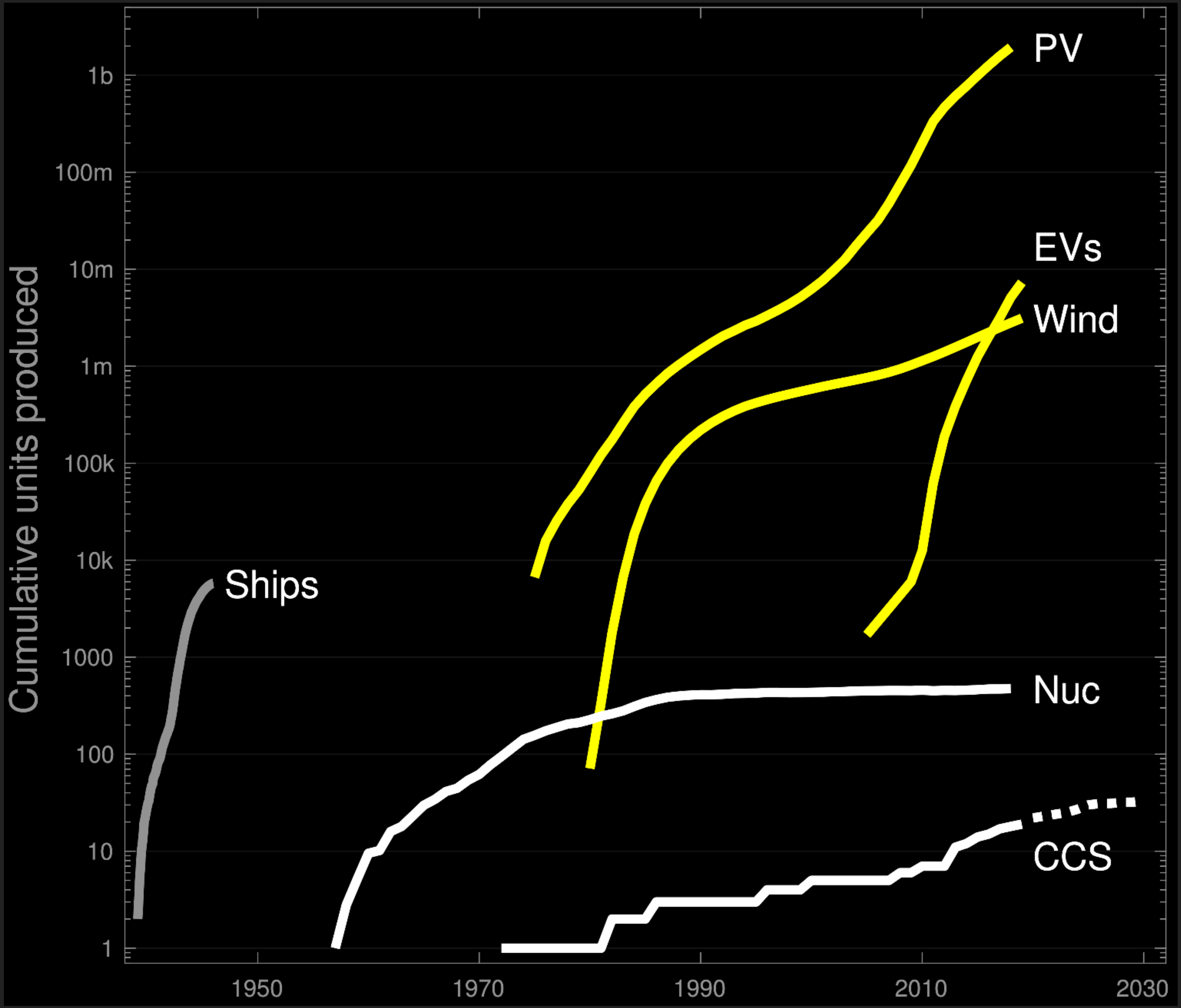
Sweerts et al. 2020

SMALL TECHNOLOGIES ADOPTED MORE QUICKLY



Wilson et al. 2020

SMALL TECH MEANS MORE ITERATIONS

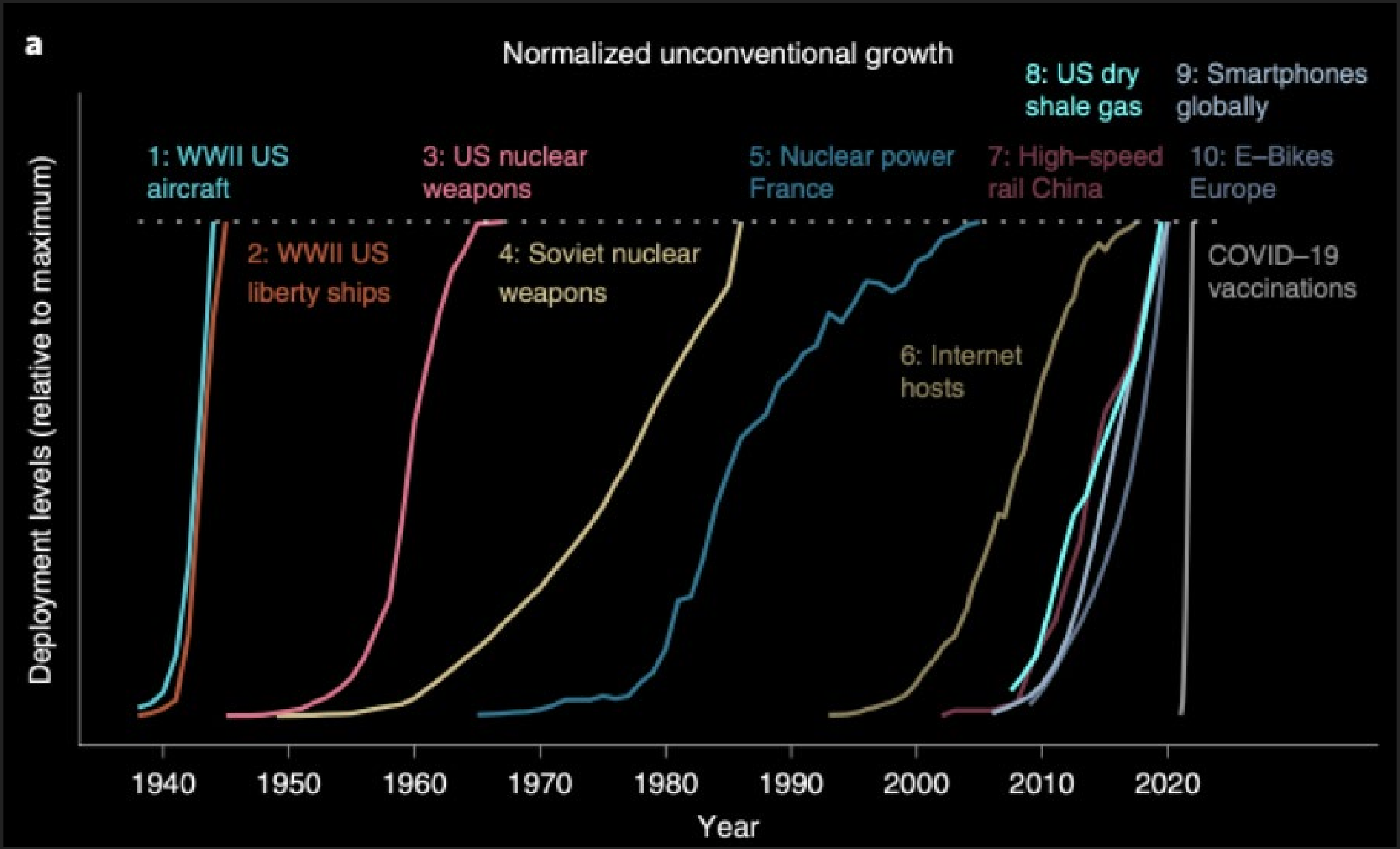


Nemet 2020

SMALL TECHNOLOGIES MAY TURN OUT TO BE MORE SCALABLE THAN LARGE ONES

...SPEED

EXPANDING THE EVIDENCE BASE



Odenweller, A., Ueckerdt, F., Nemet, G.F., Jensterle, M., Luderer, G., 2022. Probabilistic feasibility space of scaling up green hydrogen supply. Nat Energy 1–12. https://doi.org/10.1038/s41560-022-01097-4

HISTORICAL TECHNOLOGY ADOPTION DATASET (HTAD)

Infrastructure
- Electricity access
- High speed rail
- Natural gas pipelines
- Oil pipelines
- Oil production
- Public roads
- Railroads

Food and Health
- COVID vaccines
- Hybrid corn
- Herbicide-resistant soybeans
- Herbicide-resistant cotton
- Herbicide-resistant corn
- Insect-resistant corn
- Insect-resistant cotton
- Nitrogen fertilizer
- Potash fertilizer
- Phosphate fertilizer

Transportation
- Automatic transmission
- Bikes
- Cars
- Disc brakes
- Electric bikes
- Jets
- Motorcycles
- Power steering
- Radial tires
- Steam locomotives
- Steamships

Energy End-Use Technologies
- Air conditioning
- Air source heat pumps
- CFLs
- Electric vehicles
- Ground source heat pumps
- LEDs

Space and Defense
- Liberty ships
- Nuclear weapons
- Satellite launches

Sea and Water
- Aquaculture production
- Capture fisheries
- Desalination plants
- Oil and gas rigs

Digitalization
- Bits shipped
- Cell phone subscriptions
- Computing growth
- Internet bandwidth
- Internet data traffic
- Internet hosts
- Internet servers
- Internet users
- Magnetic data storage
- Microprocessor clock speed
- Processor performance
- Random access memory
- Social media share
- Transistors per Microprocessor

Energy Supply Technologies
- Biofuel
- Biogas
- Carbon capture & storage
- Coal
- Concentrated solar power
- Flow battery
- Hydroelectric power
- Liquified natural gas
- Natural gas
- Nuclear
- Offshore wind
- Refineries
- NOx pollution controls
- Pumped Hydro
- Shale production
- Solar PV
- Solar thermal
- Solid biomass
- Stationary Steam Engines
- Wind

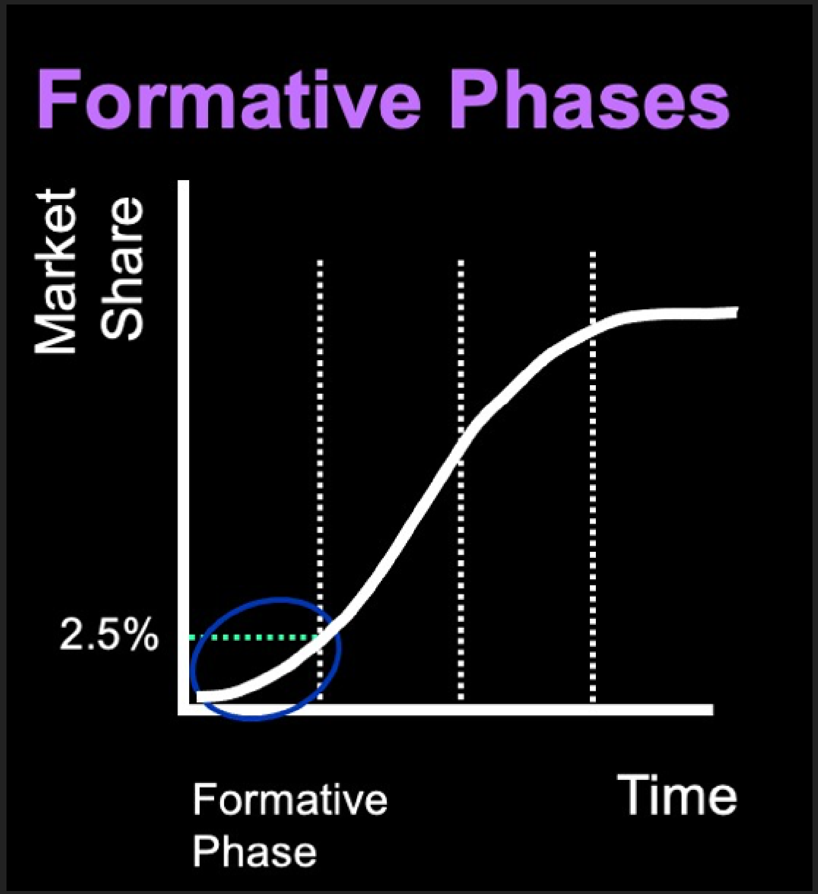
Materials
- Aluminum
- Cadmium
- Cement
- Copper production
- Copper mining
- Copper refining
- Iron ore
- Lead
- Nickel
- Raw steel
- Salt
- Sand and gravel

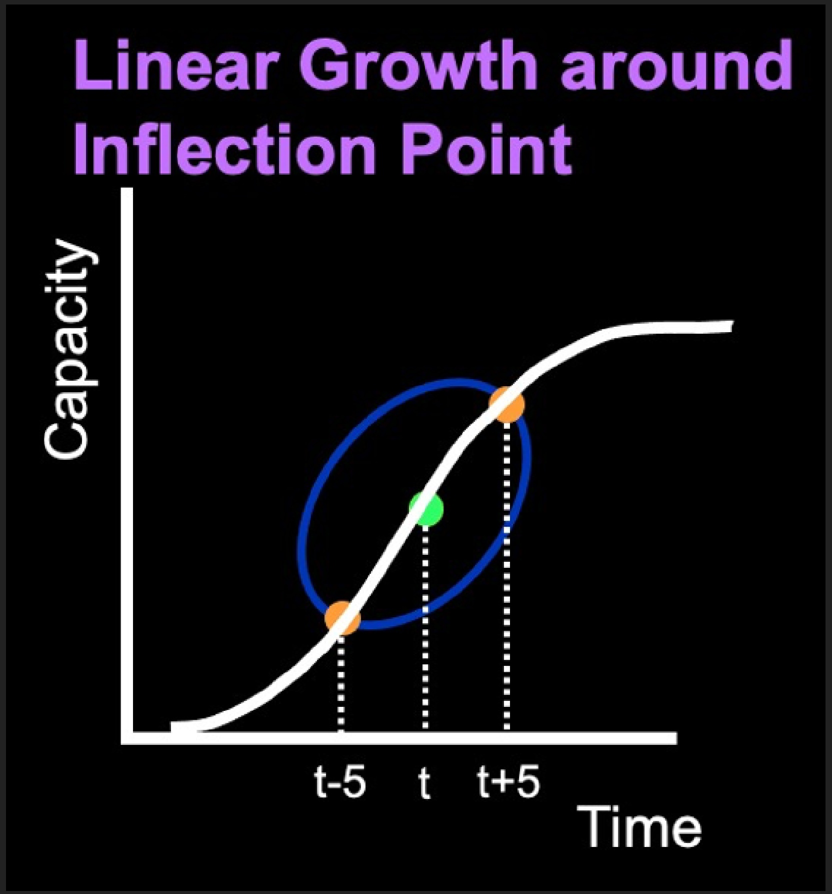
Household Appliances
- Cellphones
- Color TVs
- Dishwashers
- Dryers
- Freezers
- Landlines
- Microwaves
- Radios
- Refrigerators
- Toilets
- Vacuums
- Washers

Storage Technologies
- Latent heat
- Lead acid battery
- Lithium-ion battery
- Sensible Heat
- Sodium Battery

Nemet, Greene et al. (2023)

FUNCTIONAL FORM



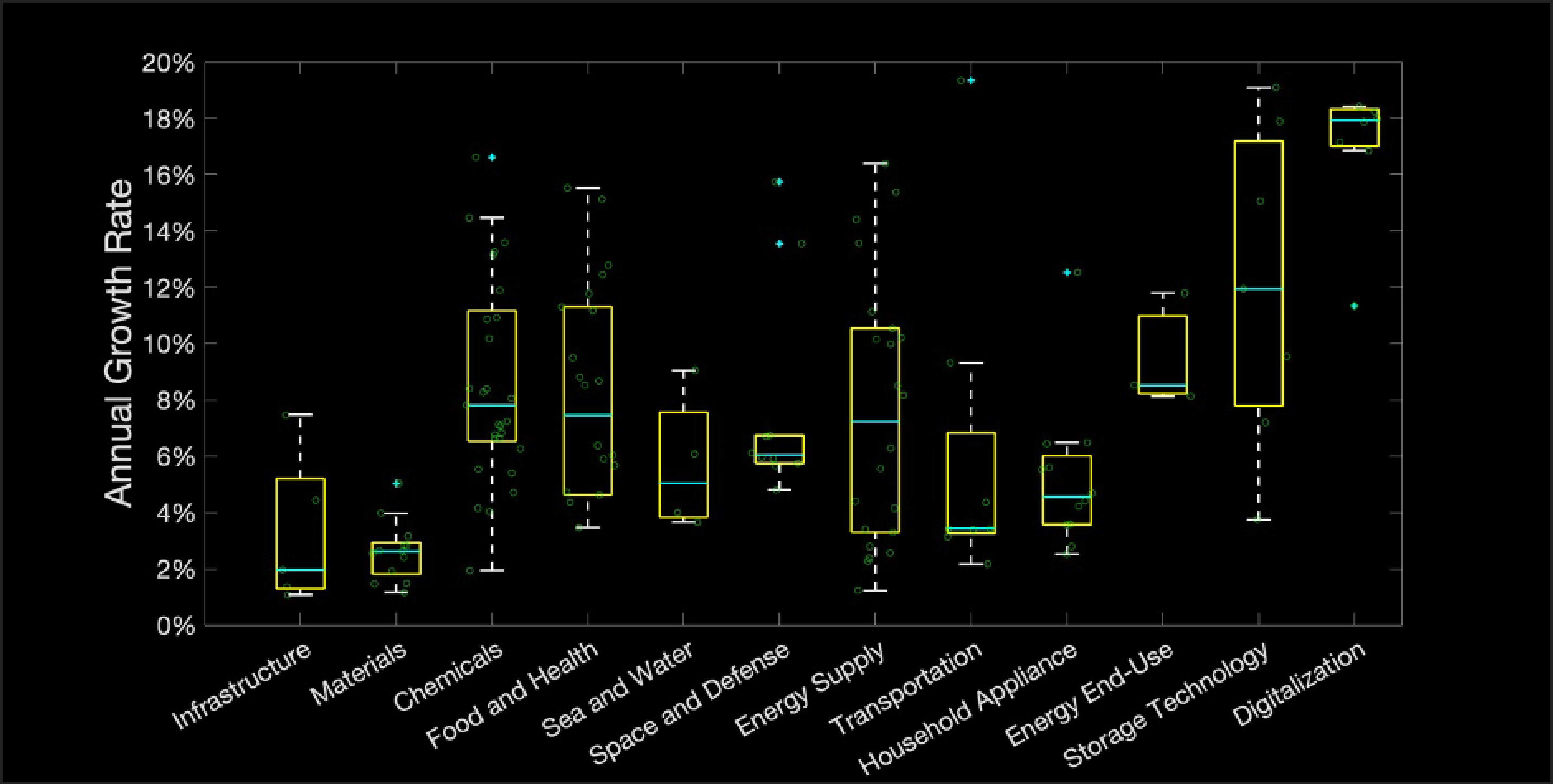


GeoEngineering and Negative Emissions Pathways in Europe

European Research Council
Established by the European Commission

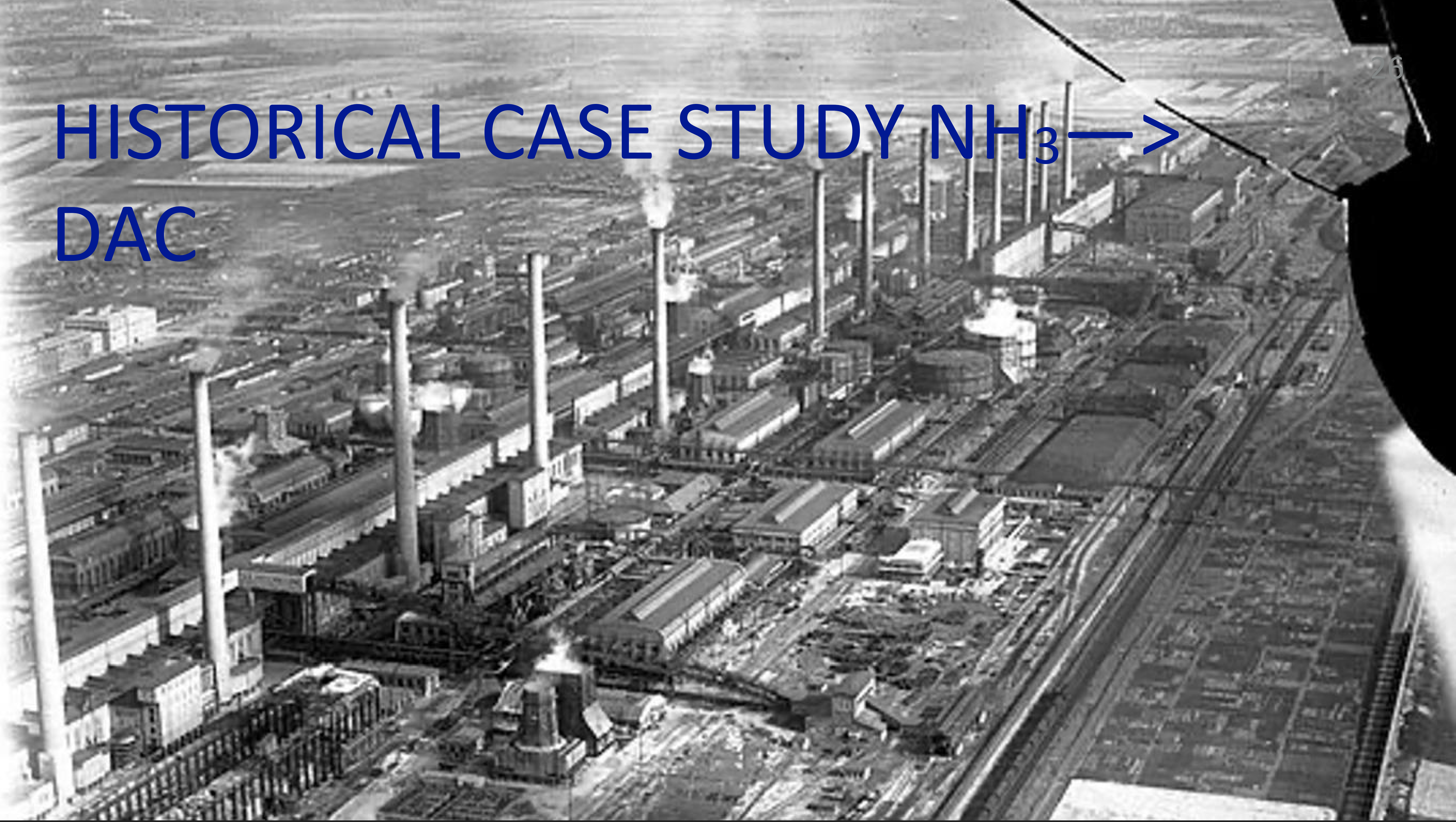
Nemet, Greene et al. (2023)

HISTORICAL GROWTH RATES



Nemet, Greene et al. (2023)

HISTORICAL CASE STUDY NH_3—> DAC

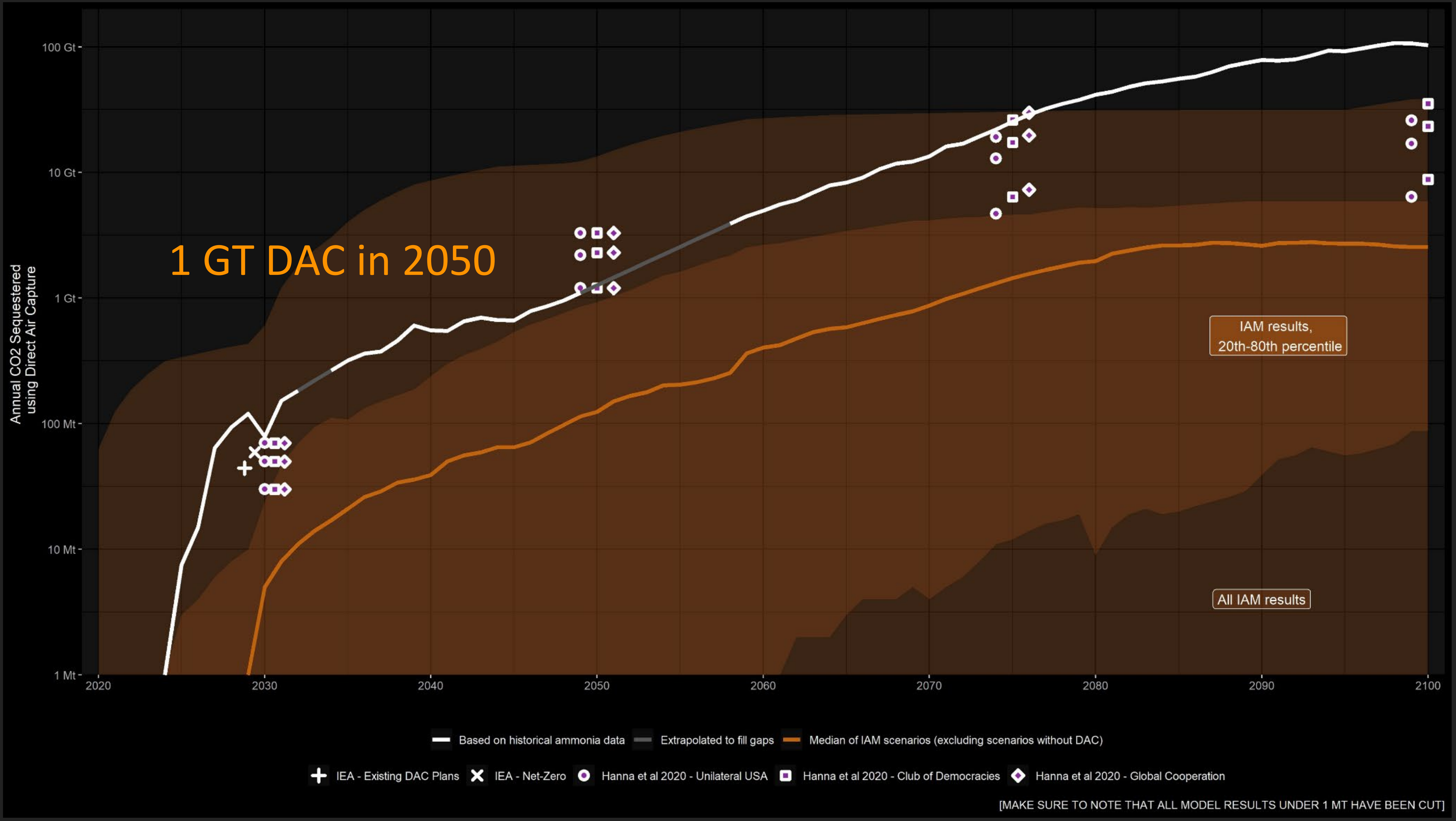


1. 1920s convergence on dominant design
2. Growth supported by major global events: 2 world wars, Green Revolution

Roberts and Nemet (2022) “SHARD”

Roberts and Nemet (2023)

APPLYING NH_3 TO DAC



Roberts and Nemet (2023)

FOCUS EFFORT ON:

- DYNAMIC TECHNOLOGIES
- SMALL UNIT SIZE
- ITERATIVE IMPROVEMENT
- INCLUSIVE WELL-BEING
- LOCAL SYSTEM INTEGRATION

HIGH WELLBEING, LOW RESOURCE USE

themes

- decent living standards
- innovation
- digitalisation

High-with-Low scenario

development pathway to 2050 delivering *high* wellbeing with *low* resource use

pathway characteristics

- rapid transformation
- high feasibility, low risk
- inclusive, human-centred

Wilson, Nemet et al. (2023)

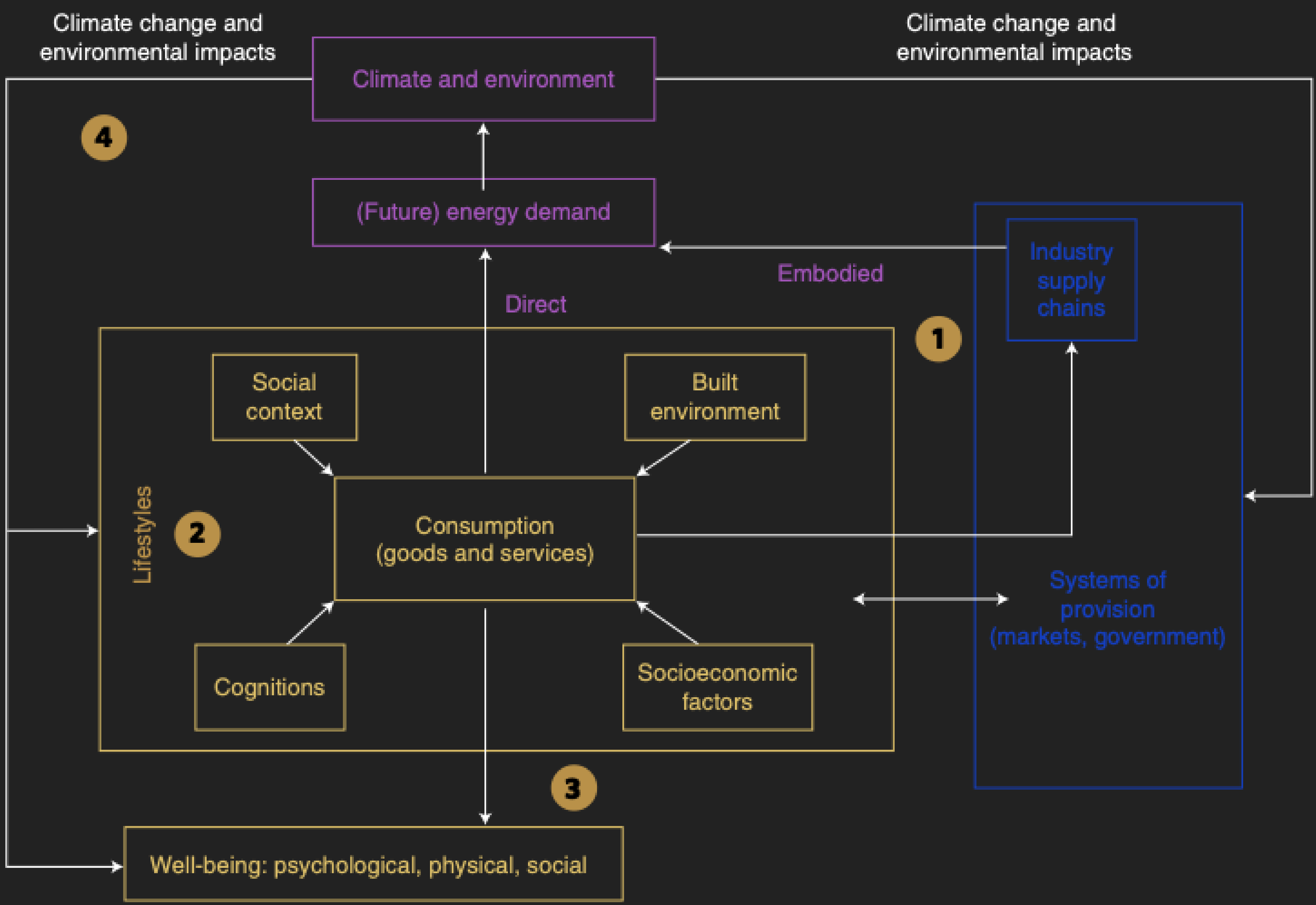
HIGH WITH LOW:

CHARACTERISRTICS

1. *Multiple attributes and new services.*
2. *Many heterogeneous adopters.*
3. *Evolving social preferences.*
4. *Peer and network effects.*
5. *Small-scale, 'granularity'.*
6. *Many iterations.*
7. *Local system integration.*
8. *Rebound effects.*

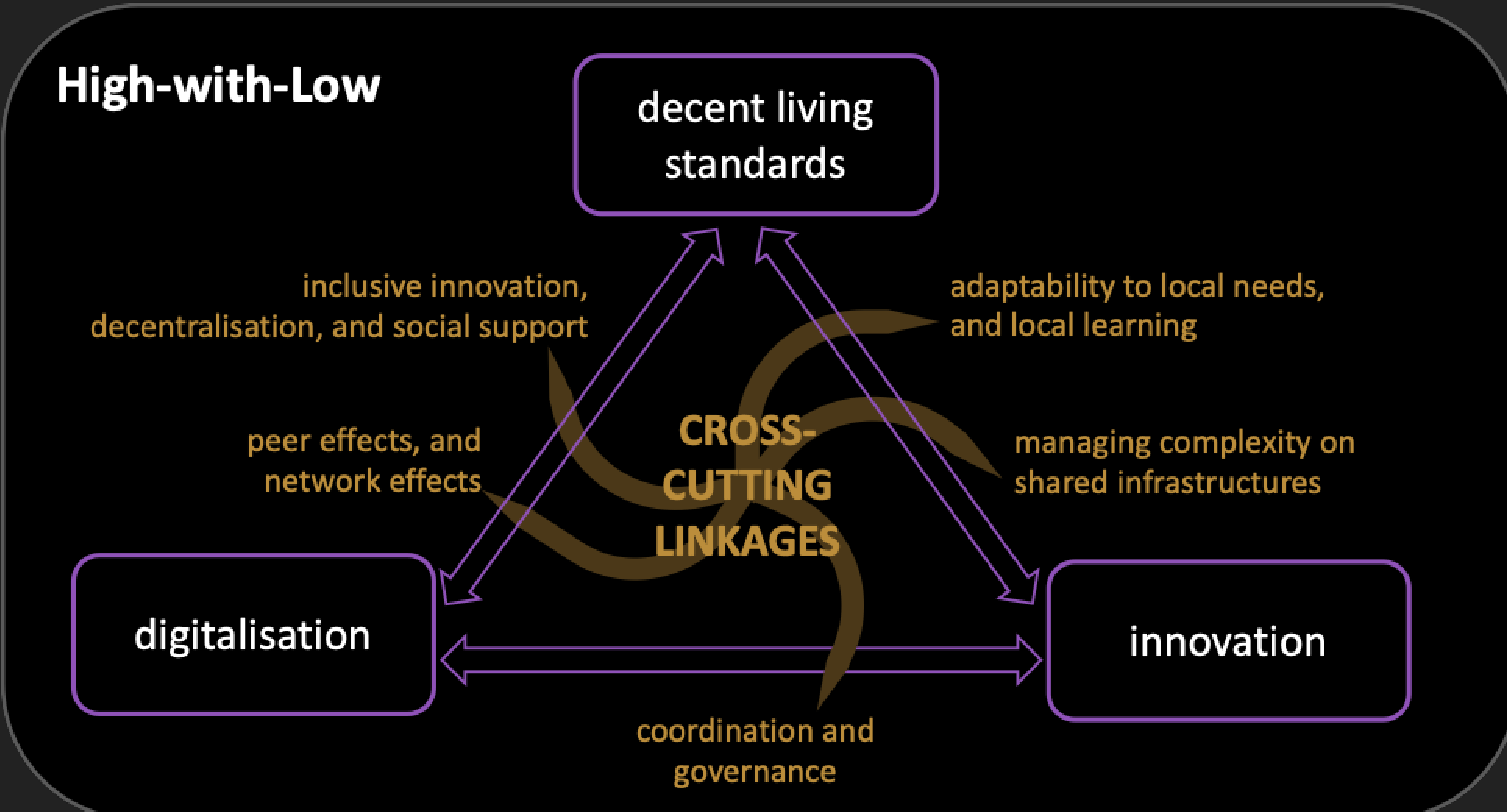
Wilson, Nemet et al. (2023)

HIGH WITH LOW: SYSTEM



Wilson, Nemet et al. (2023)

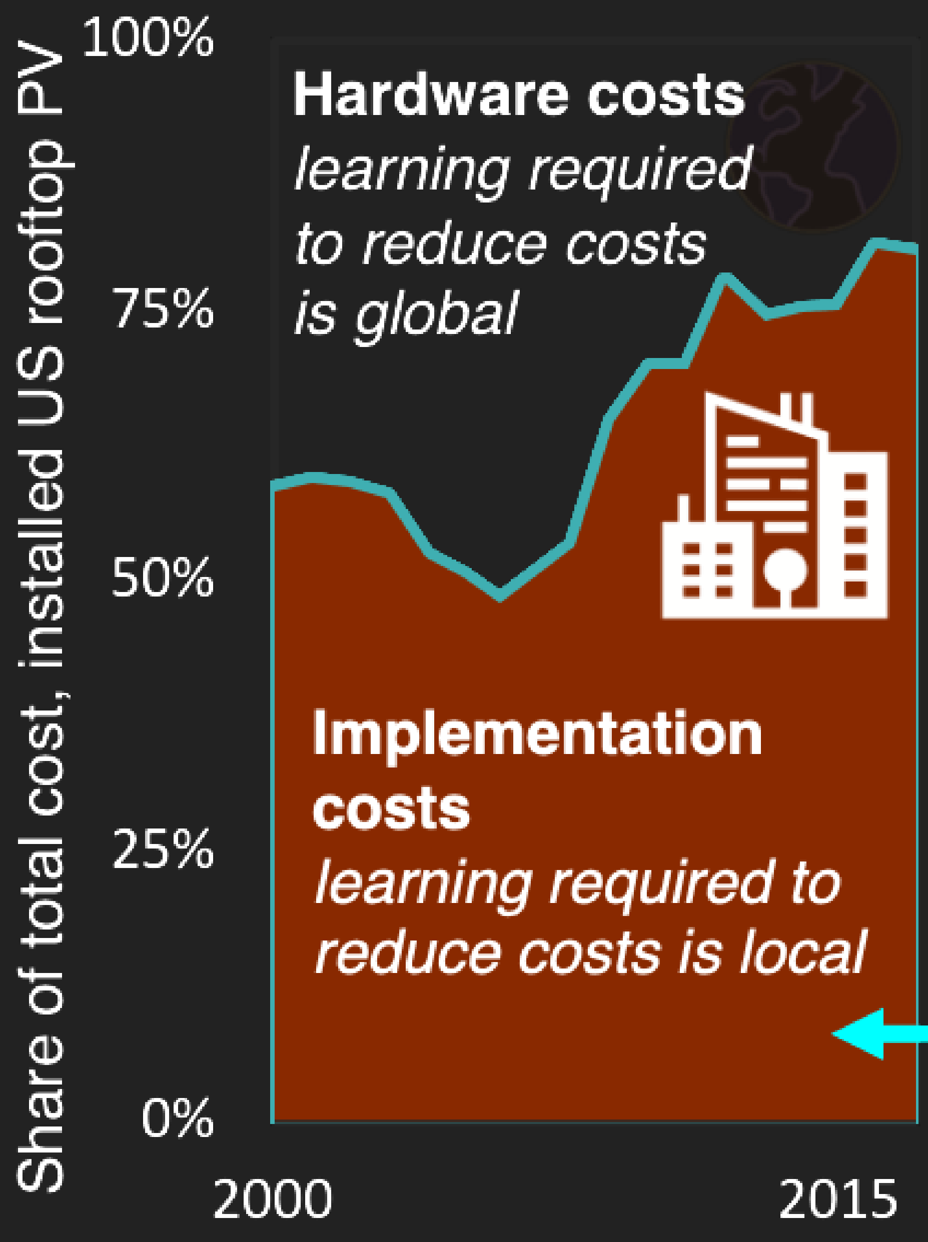
INCLUSIVE WELL BEING



Wilson, Nemet et al. (2023)

LOCAL LEARNING

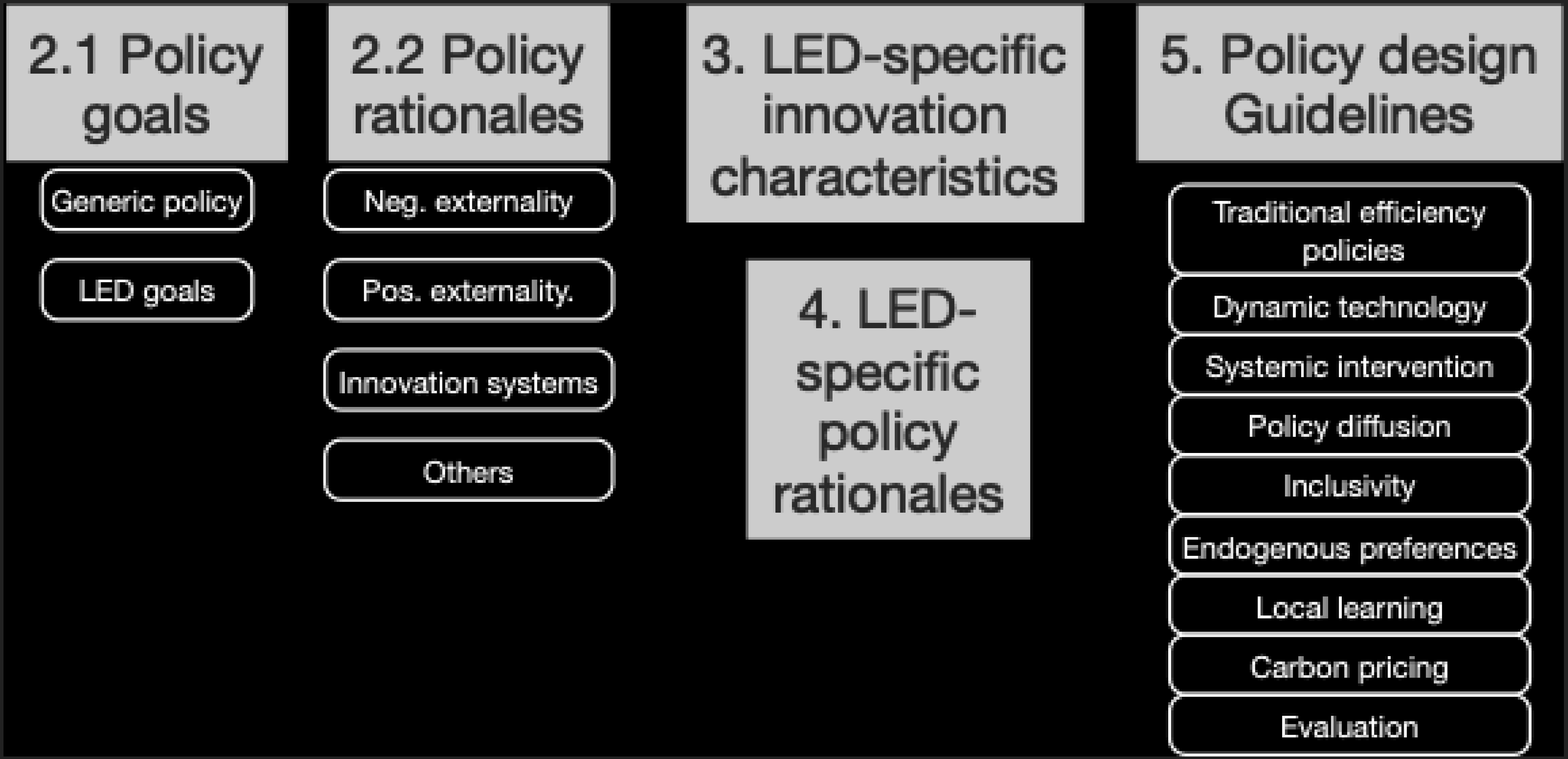
- Total costs have fallen
- Decarbonization requires even lower costs
- Implementation accounts for most of costs now
- Focus needed on implementation cost reductions



Needed:
research on policy to enhance local learning and reduce implementation costs

Neij and Nemet (2022)

HIGH WITH LOW POLICY



Nemet and Greene (2022)

A DYNAMIC PUBLIC POLICY REGIME

CREATE innovations	→ ENABLE adoption	→ RE-ORIENT for humans
R&D	subsidies	education
Demos	infrastructure	training
	Carbon price	acceptance