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Deutsches Institut für
Entwicklungspolitik



German Development
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Catching up or developing differently? Techno-institutional learning with a sustainable planet in mind

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“The Challenges of Technology and Economic Catching-up in Emerging Economies”

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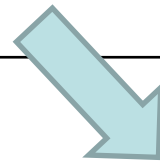
Large global gaps in income and technological capabilities

Converging is exception, not the rule

Strategy matters

Catching up: Imitation to innovation (in steps)

- Starts with imitation
- Takes time



Humankind overstepping planetary boundaries.

Radical decoupling needed

Techno-economic paradigm change

Many technologies & capabilities outdated.

- Imitation may lead to lock-in
- Starting from mature technologies backwards takes time



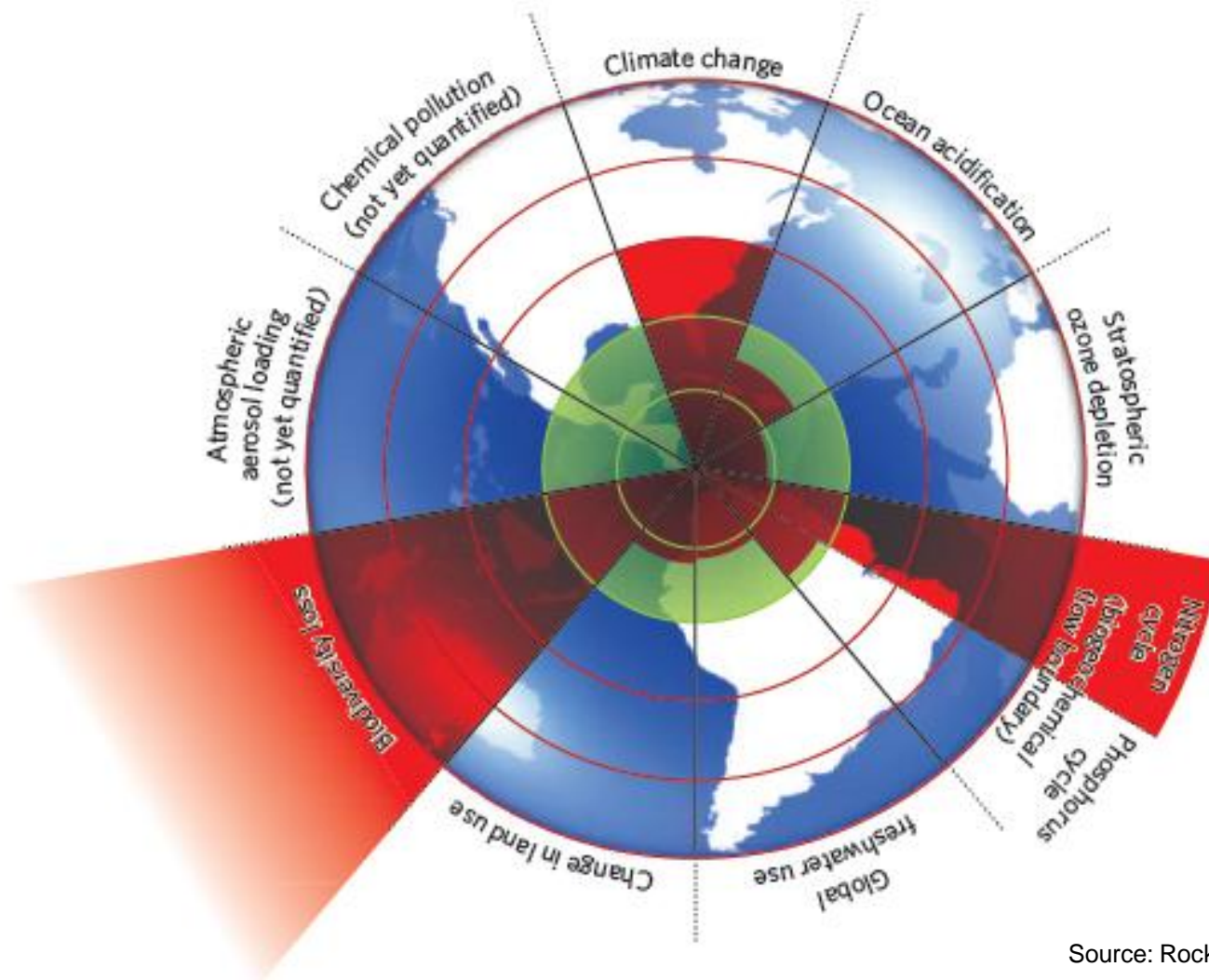
What would a sustainable economy look like?

How can latecomers get there?

Lessons for concept of ,catching up ,?



Planetary boundaries“

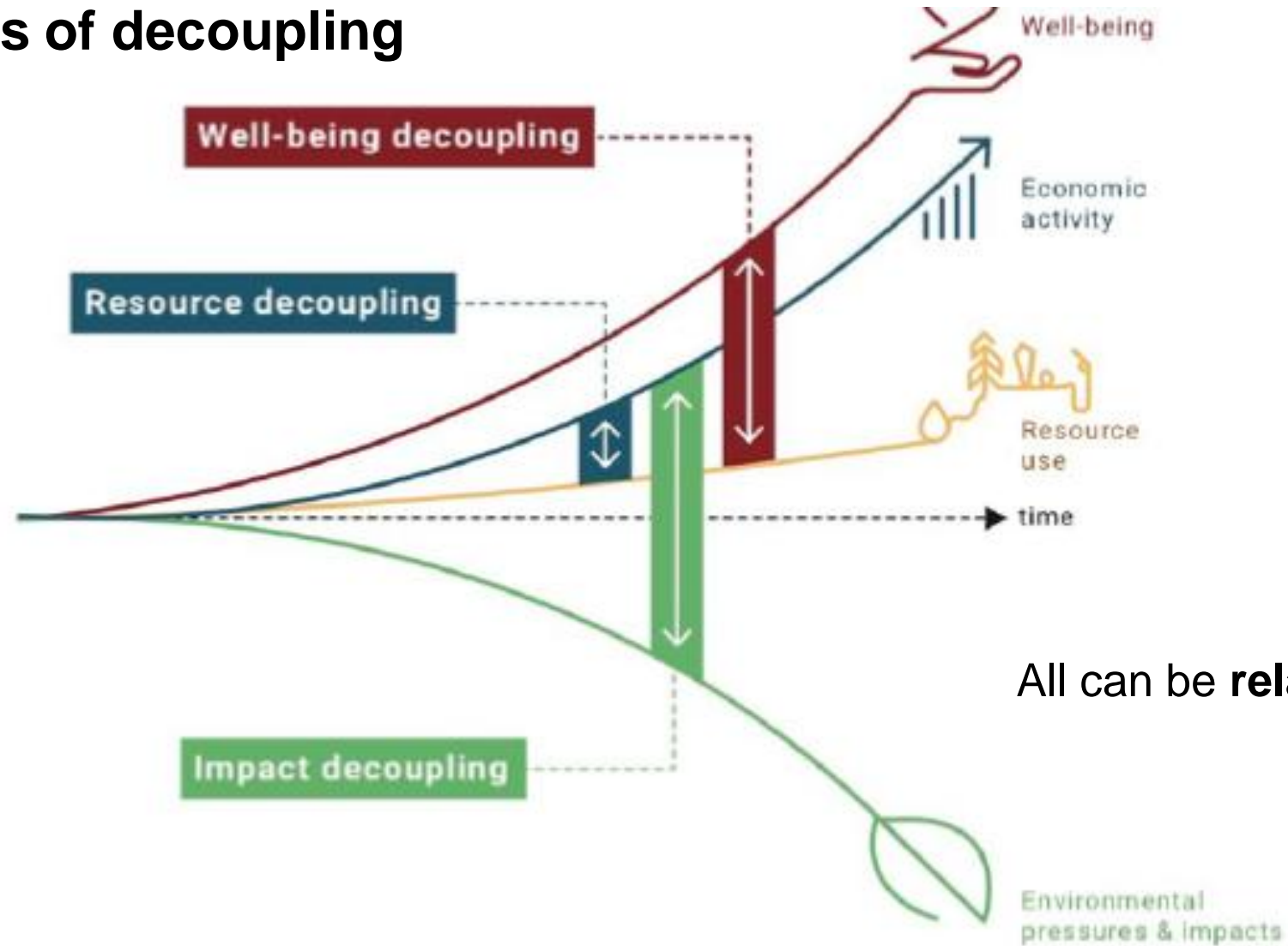


Source: Rockström et al. in Nature 461, 24 September 2009

1. Rethinking economic development with a sustainable planet in mind



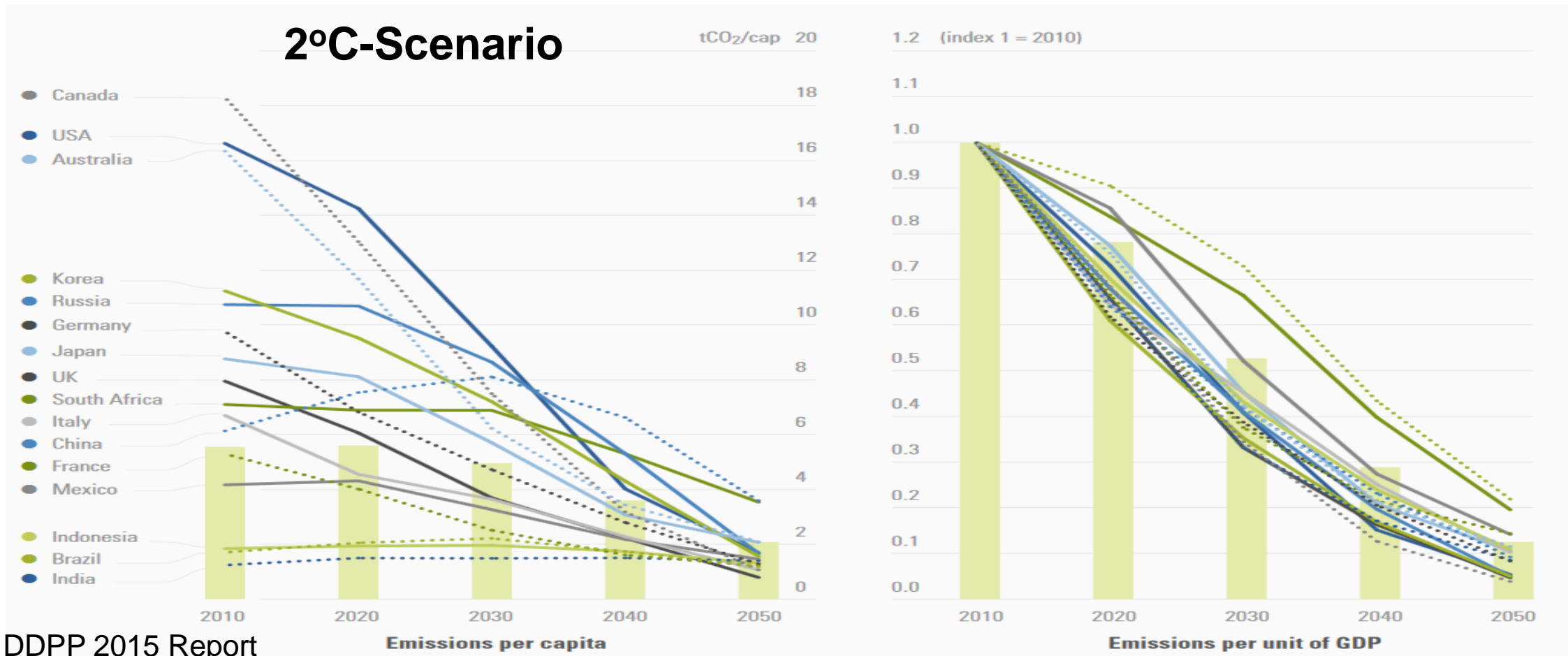
Dimensions of decoupling



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Speed of decarbonization required





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Table 1: Required GHG emissions and GHG intensity reductions for achieving climate targets

Climate targets	Global GHG emissions in 2050, Gt CO ₂ e/year		Annual change of GHG emissions 2013 – 2050 needed to reach targets	Annual reduction of GHG intensity (assuming 0.7% population & 2% GDP growth/year)
1.5 °C	min.	4	-6.5 %	-9.2 %
	median	13	-3.5 %	-6.2 %
	max.	19	-2.5 %	-5.2 %
2.0 °C	min.	9	-4.4 %	-7.1 %
	median	20	-2.3 %	-5.0 %
	max.	26	-1.6 %	-4.3 %

Source: Rogelj (2015), adapted from Petschow et al. (2018)

Resource decoupling similar. needs to increase in the order of 4-9% annually (Jackson 2016)



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Can capitalist market economies be reformed in a way that the GHG intensity decreases at rates around 5-6% annually and resource productivity increases ca 4-9% annually?

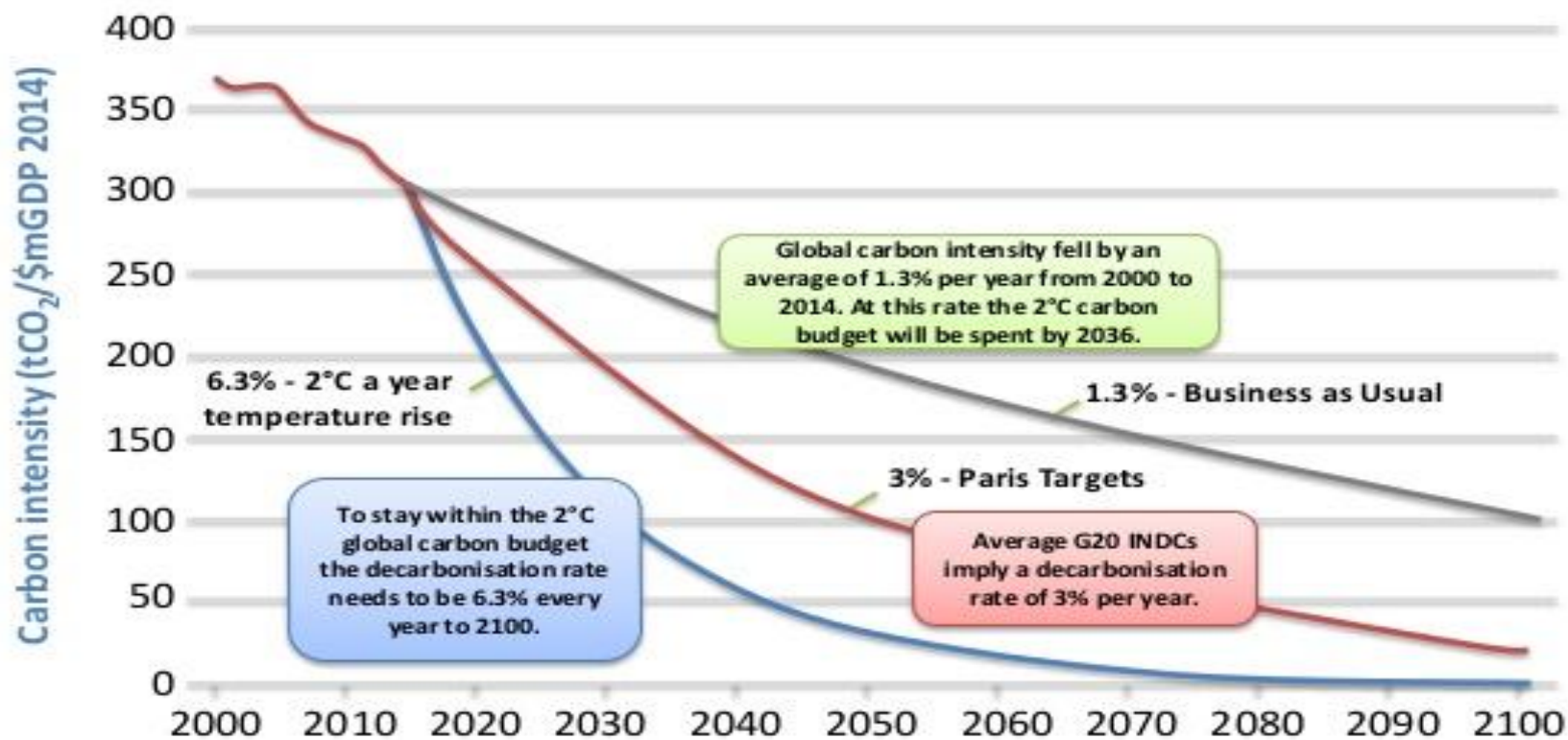
Or are more fundamental reforms necessary, challenging capitalist market economies (steady-state, de-growth, communitarianism ...)?

- **Pessimistic scenario:** Radical de-carbonization impossible while increasing size of the economy (Jackson 2009).
 - Rebound effects
 - Historical rates of decoupling far too low

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Decarbonisation Scenarios Post COP21



Redrawn from PriceWaterhouseCoopers Low Carbon Economy Index 2015
<http://pwc.blogs.com/sustainability/2015/12/pwc-cop21-briefing-paris-climate-summit.html>



Optimistic scenario: Capitalism can adapt, decoupling is technically feasible if drastic measures are taken

(Hepburn, Bowen 2013; IPCC 2014).

- Pricing carbon and other environmental goods
- Stringent regulations where pricing fails
- Technology and deployment missions
- Accelerating transition to non-material drivers of growth.

Still: radical paradigm change. Acceleration crucial

- Will consumer habits adapt sufficiently??
- Can these radical measures be implemented against vested interests??



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- **Power sector:** Phase out coal-and oil-fired power plants, close coal mines and oil pits, develop solar, wind, biomass technologies, rebuild electricity grid, develop smart grid systems & energy storage technologies ...
- **Electrified end-uses, e.g. transport, heating, cooling:** E.g. electric vehicle technology, new battery chemistry, new materials, new types of charging infrastructures, entry of new actors, new transport modes: intermodality, sharing, ride-hailing, driverless technology ...
- **Land use change:** reduced usage of high-energy inputs (chemical fertilisers, mecanisation), sustainable farming techniques (crop rotation, inter-cropping, organic manure, ..)
- **CCS**
- Shift to **non-material drivers of growth:**

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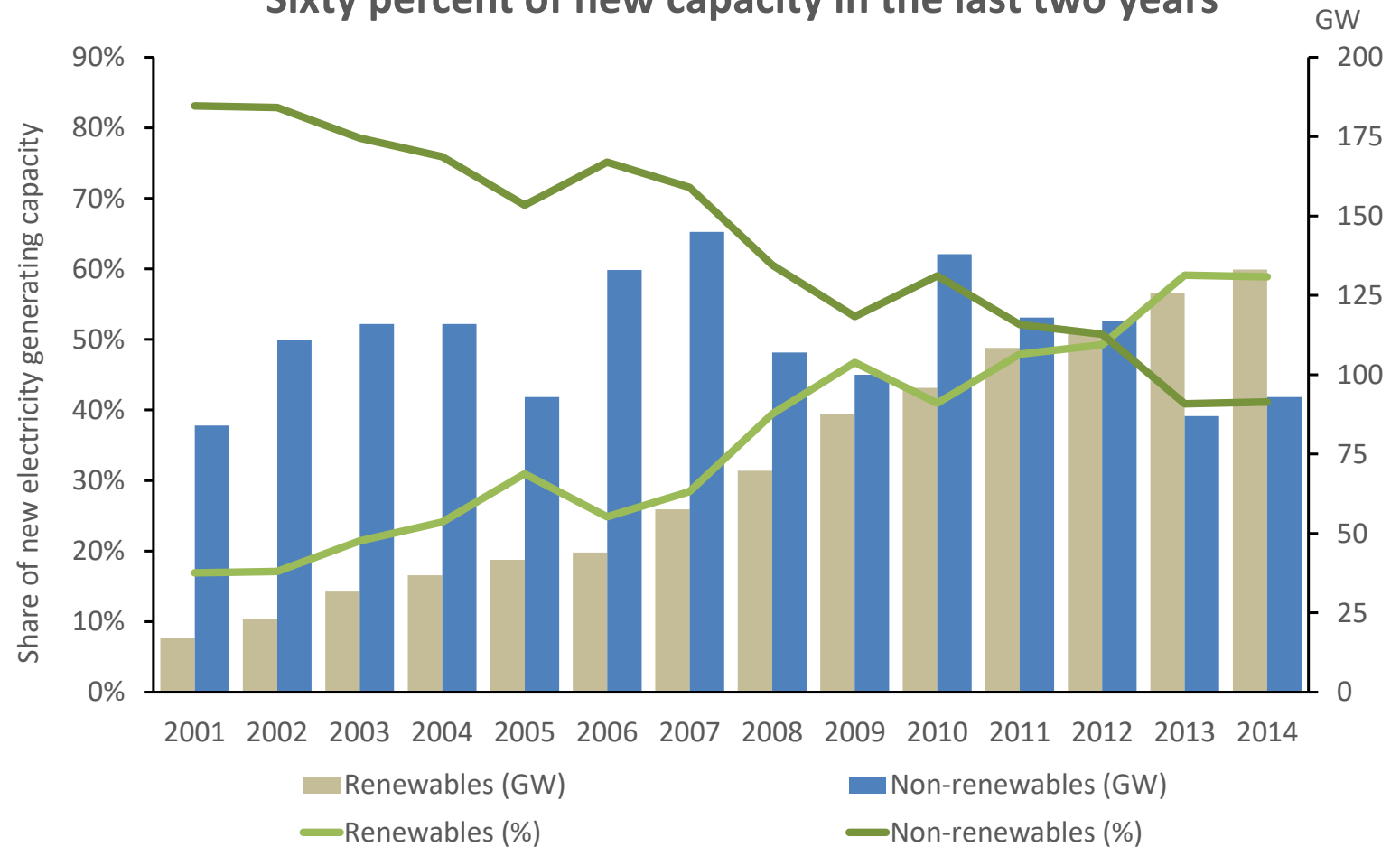


Energy sector

Electric power: Radical change in new investments

Sixty percent of new capacity in the last two years

Impressive changes –
yet still far too slow

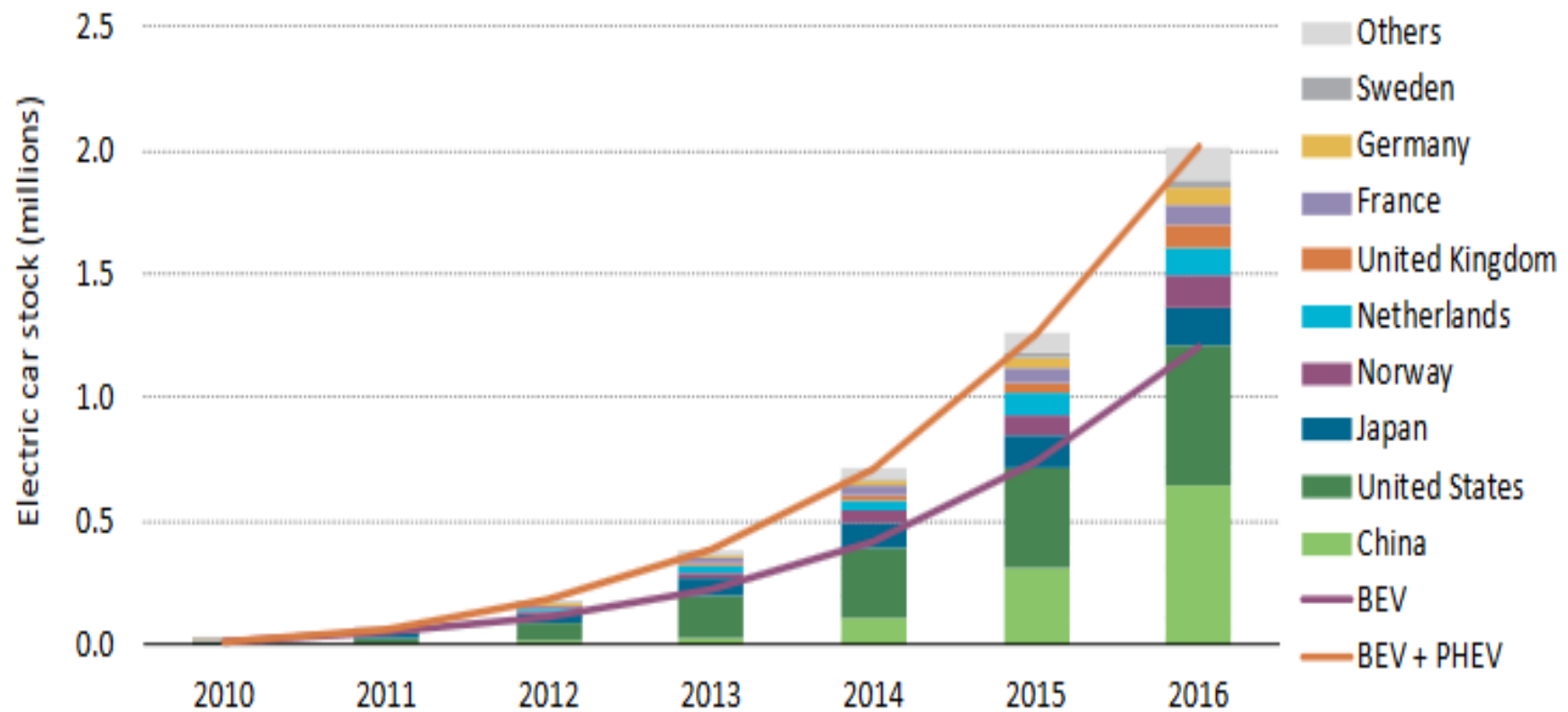


IRENA 2016



Transport sector transformation taking off

Figure 1 • Evolution of the global electric car stock, 2010-16



Source: IEA



2. Determinants and phases of catching up

Stylised insights from the catching up literature (e.g. Verspagen 2016, Hobday 1995, Lee 2013):

Convergence is the exception rather than the norm

‘Social capabilities’ decisive Abramovitz (1986).

Technology diffusion management” rather than “product development-focused R&D’ (Mathews 2001) in the beginning at least...

Strategy (industrial policy) matters ...



2. Determinants and phases of catching up

Typically going through phases.

- Technology acquisition/ pre-catching up: Buying, using imported technologies
- Technological mastery / catching up: Learning to assimilate imported mature technology, emulating foreign modes of production
- Innovation / post-catching up: developing own new capabilities using R&D, different trajectories , leapfrogging



3. Catching up in a scenario of disruptive change

Why previous lessons may become less relevant

Catching up starts from imitation, assimilation of foreign knowledge, technology diffusion management. “historical imitator countries“
(Furman/Hayes 2004)

- ⇒ Imitating, following the stylised pathways may end up in **lock-in, asset stranding, irreversible damage** – at what stage can countries start to diverge from established role models???
- ⇒ **Moving from mature to early stages may be too slow** Narrow time frames
=> increase these risks
- ⇒ **Silent on social innovations/** demand-side issues



3. Catching up in a scenario of disruptive change

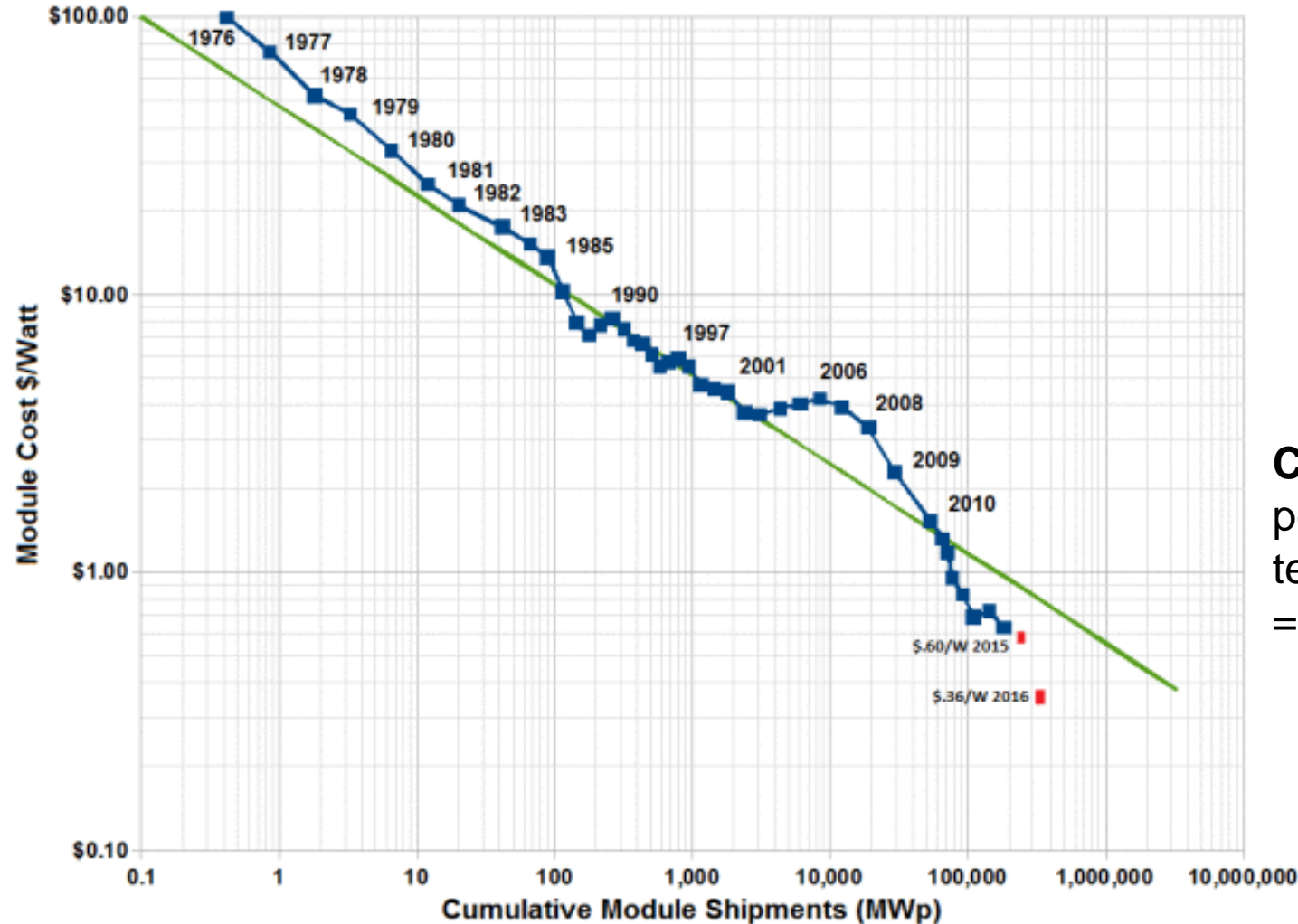
What are the opportunities under green paradigm change

- Old industrialised countries not as much ahead => entry barriers low (no incumbents) + growth opportunities large
 - Policy-driven. Allows ambitious governments to move ahead
 - Not all capabilities are devalued
 - Some green technologies are already mature
 - Porter-hypothesis: mixed evidence...
 - ... but likely to become stronger driver with globalised techno-economic paradigm chain.
1. Link env and competitiveness agendas
 2. Foresight
 3. Social innovations; living labs **..extend**

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Swanson's law (here: PV module cost)



Cost digression leads to systemic tipping points at which green outcompete polluting technologies
=> change becomes irreversible



3. Catching up in a scenario of disruptive change

Technological change	Capabilities			Assets		
	A Enduring	B Stranded	C Newly required	A Enduring	B Stranded	C Newly required
Coal-fired to solar power	Energy system planning, project development, distributed control systems	Capabilities required for coal mining, specific power plant layout	Thin film manufacturing, solar irradiation measurement, smart grid design	Part of grids, back-up power facilities, energy research centers	Power plants, steam turbines, generators	Clean room facilities, converter manufacturing, photovoltaic and solar-thermal power plants
Combustion engine to electric car	Tiered just-in-time supplier systems, automotive R&D, many auto parts, marketing/branding	Manufacturing capabilities for combustion engines, power trains and parts	Lithium batteries, new light materials, thermo management	Manufacturing plants, 80% of supply chains	Fuel filling stations, engine factories	Lithium-battery factories, electric engine factories, charging infrastructure
<i>Some generic capabilities and assets remain valuable, others „strand“ => affecting position of newcomers vs incumbents</i>						

Source: own



3. Catching up in a scenario of disruptive change

1. Some polivLink env and competitiveness agendas
2. Foresight
3. But some already mature, adv of backwardness exist
4. Social innovations; Prosumer movements, sharing economy initiatives and sustainable lifestyle experiments in so called living labs



4. Summing up

1. Shift to sustainable economy => fundamental paradigm change
2. Implications of absolute decoupling not clear. Maybe technically feasible, but politically?
3. Essential lessons from catching up debate still relevant
4. But traditional pathways maybe risky and misleading.



Thank you!

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