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Innovation, Technology Development and Transfer

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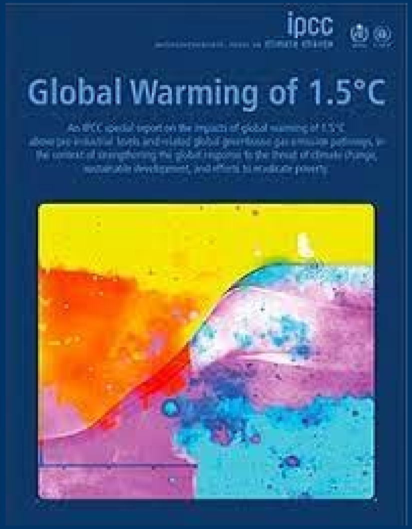
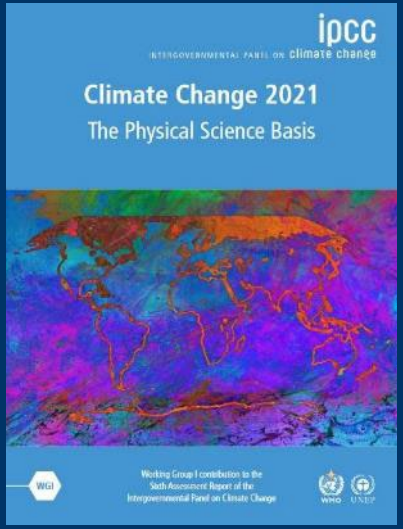
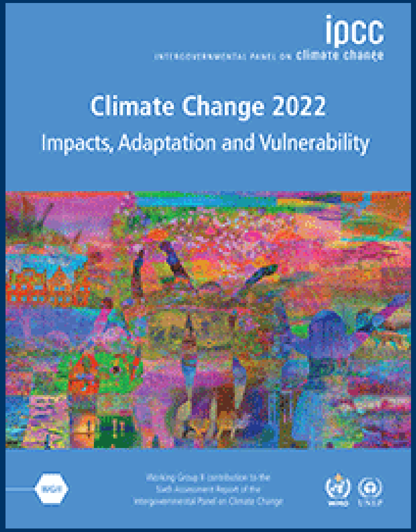


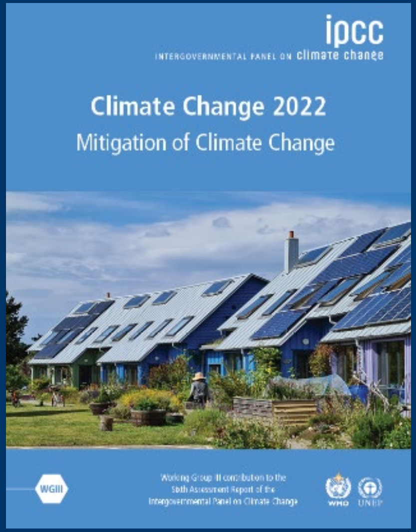
2018



2021



2022



2022

2023

Key messages IPCC Special Report on 1.5°C

Already 1°C of global warming

At current rate, would reach 1.5°C between 2030 and 2052

Clear benefits to limiting warming to 1.5°C

We can still limit warming to 1.5°C but this requires unprecedented changes

Waiting for NDCs means missing 1.5°C

Limiting warming to 1.5°C would go hand in hand with achieving other societal goals

Key messages IPCC Special Report on 1.5°C (update AR6)

Already 1.1°C of global warming

At current rate, would reach 1.5°C between ~~2030 and 2052~~ 2021 and 2040

Clear benefits to limiting warming to 1.5°C

We can still limit warming to 1.5°C but this requires unprecedented ~~changes~~ system transformations

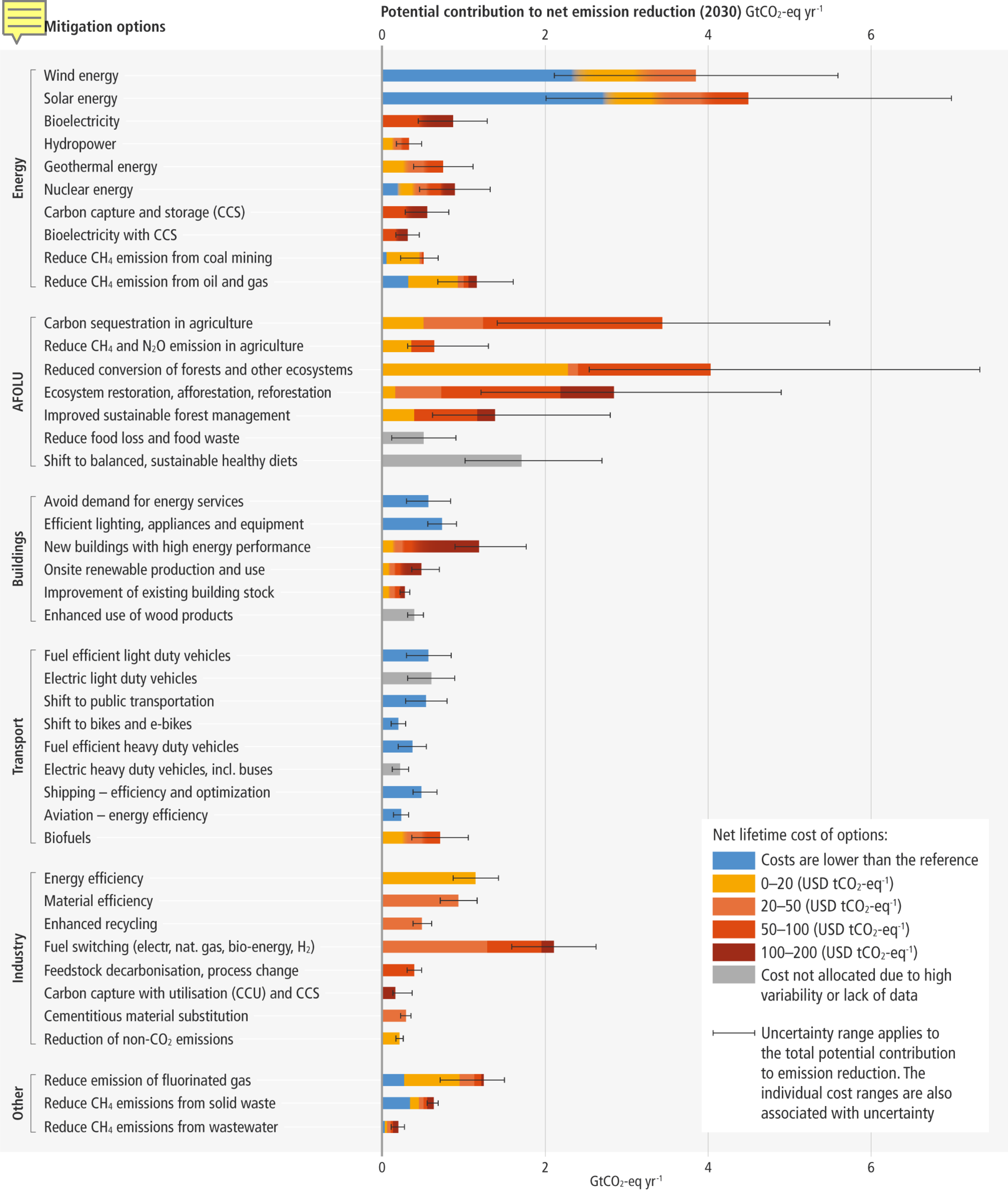
Waiting for NDCs means missing 1.5°C

Limiting warming to 1.5°C would mostly go hand in hand with achieving other societal goals

ipcc INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

TU/e



Many near-term actions are feasible

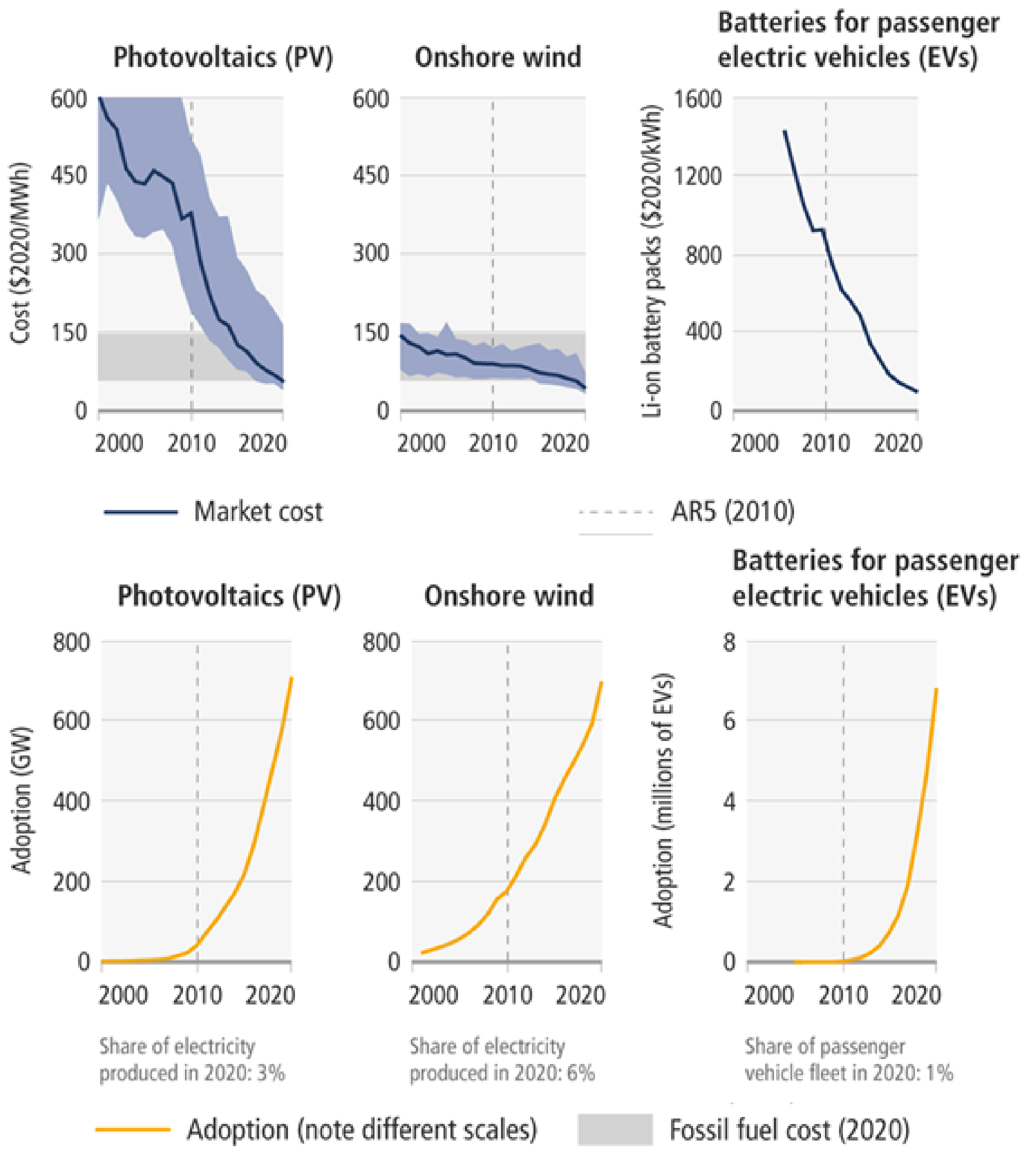
Global emissions can be halved with available mitigation options below 100 USD/tCO_2e

Almost all mitigation options face institutional barriers

Many mitigation options are synergistic with sustainable development goals

For net-zero around 2050, system transitions needed, enabled by conditions such as technology

Strong unit cost reductions in several granular technologies



Unit costs only

Some options are increasingly **technically viable**, rapidly becoming **cost-effective**, and have relatively **high public support**.

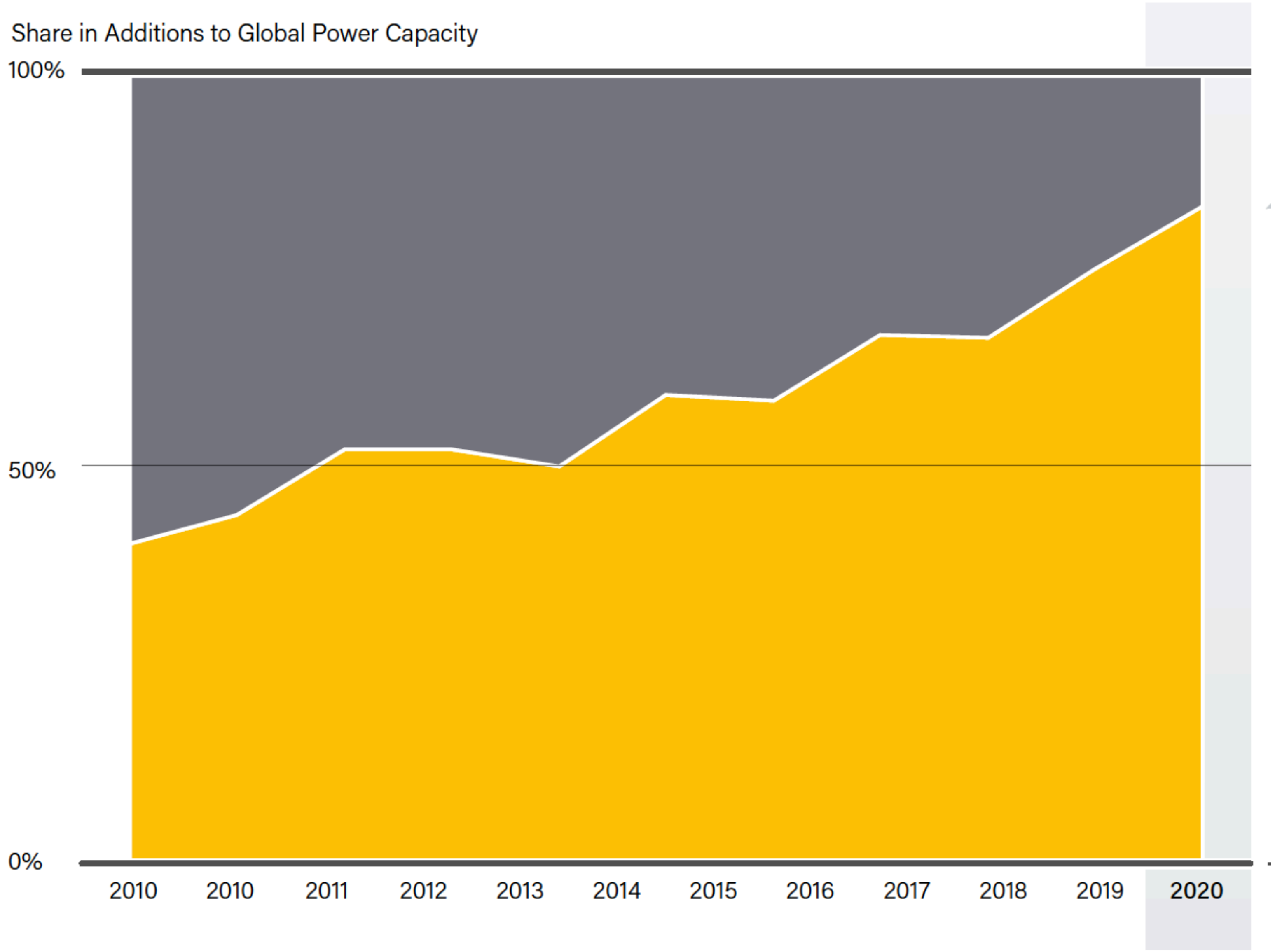
Many options face **institutional** barriers

Adoption of low-emission technologies is **slower in most developing countries**, particularly the least developed ones

Cost reductions more limited in larger-scale technologies

Source: IPCC AR6 WGIII

Technology can be an enabler of accelerated mitigation



Source: GSR 2021

Technological development is not linear

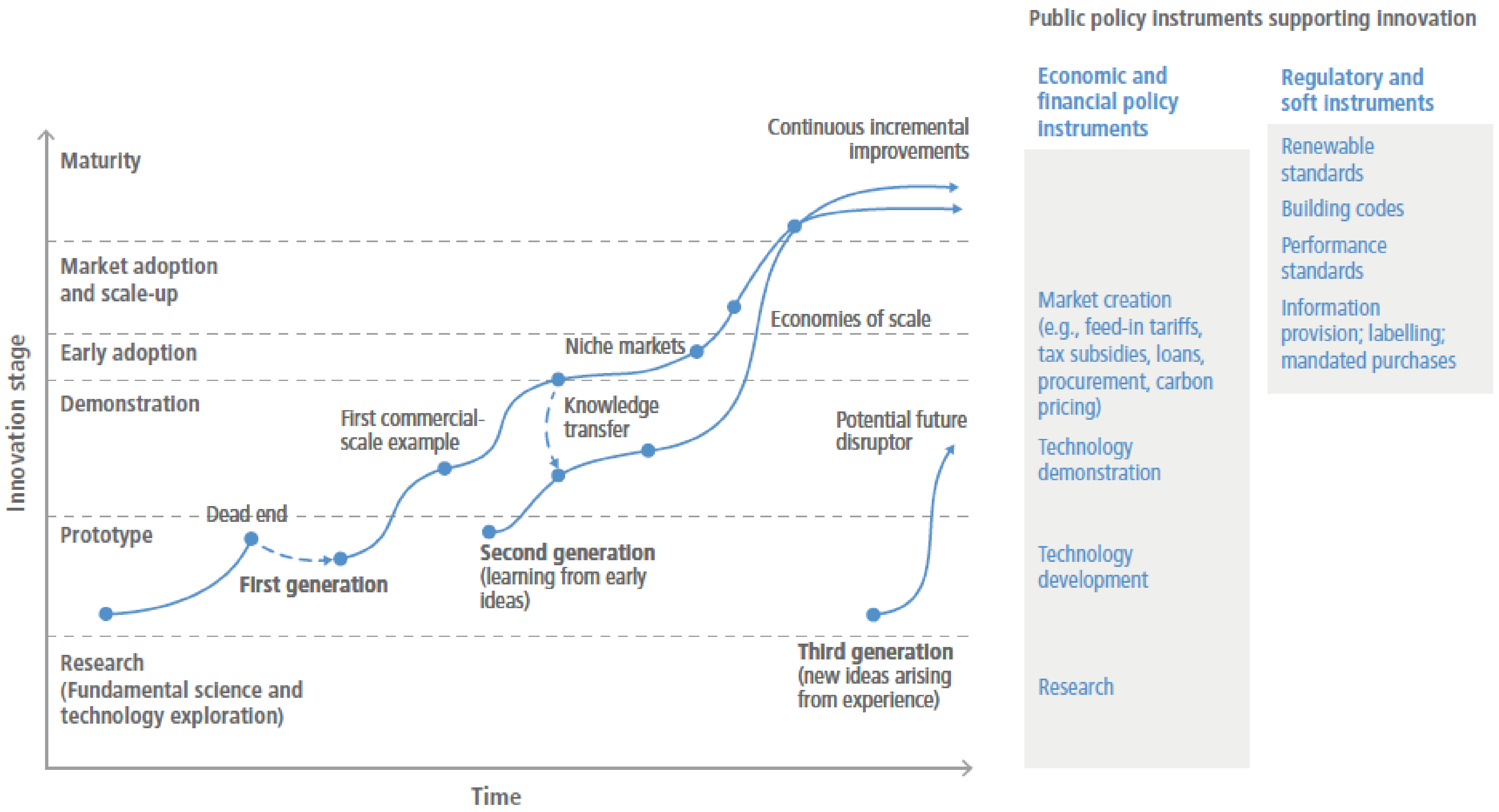


Figure 16.1 | Technology innovation process and the (illustrative) and role of different public policy instruments (on the right-hand side). Source: adapted from IEA (2020a). Note that, as shown in Section 16.4.4, demand-pull instruments in the regulatory instrument category, for instance, can also shape the early stages of the innovation process. Their position on the latter stages is highlighted in this figure because typically these instruments have been introduced in latter stages of the development of the technology.

Source: IPCC AR6 WGIII

… but systemic

Involves a range of actors (universities, research organizations, technology firms, consultancies, law firms, govt agencies, CSOs...)

that interact with each other in order to achieve specific objectives (e.g., generate new knowledge, develop new products)

All embedded in an institutional context (that includes formal rules, such as laws, and informal restraints, such as culture and codes of conduct) that govern the behaviour of the actors and interactions among them

These "innovation systems" underpin the process of successful development and deployment of new and improved technologies

How to monitor?

Function	Input indicators	Output indicators	Outcome indicators	Actors	Policies	Structural and systemic indicators
Guidance of search	Policy action plans and long-term targets Shared strategies and roadmaps Articulation of interest from lead customers Expectations of markets/profits	Level of media coverage Scenarios and foresight projects	Budget allocations Mission-oriented innovation programmes	Governments Interest groups Media	Targets set by government for industry Innovation policies Credible political support	Media strength
Resource mobilisation	Access to finance Graduate in Science, Technology, Engineering, and Mathematics (STEM) Gross expenditure on R&D/total expenditure Domestic credit to private sector Number of researchers in R&D per capita Public energy R&D expenditure/total expenditure Expenditure on education Investment in complementary assets and/or infrastructure (e.g., charging infrastructure for electric vehicles, smart grids) Venture capital on deals	Number of green projects/technologies funded Share of domestic credit granted to low-carbon technology projects Share of domestic credit granted to projects developing complementary assets/infrastructure	Employment in knowledge-intensive activities Employment in relevant industries Scale of innovative activities Rate of growth of dedicated investment Availability of complementary assets and infrastructure	Governments Private firms Private investors (angel, venture capital, private equity) Banks	Financial resources support Development of innovative financing International agreements (e.g., technology agreements) Infrastructure support Project/programme evaluation Innovation policies Higher education policies	
Entrepreneurial activities	Number of new entrants Percentage of clean energy start-ups/incumbents Access to finance for cleantech start-ups	Small and medium-sized enterprises (SMEs) introducing product or process innovation Market introduction of new technological products Number of new businesses Experimental application projects Creative goods exports		Private firms Government Risk-capital providers Philanthropists	Ease of starting a business Risk-capital policies Start-up support programmes Incubator programmes	Start-up support services
Market formation	Public market support High-tech imports	Market penetration of new technologies Increase in installed capacity Number of niche markets Number of technologies commercialised	Environmental performance Level of environmental impact on society Renewable energy jobs Renewable energy production Trade of energy technology and equipment High-tech exports	Private firms Governments Institutions regulating trade, finance, investment, environment, development, security, and health issues	Environmental and energy regulation Fiscal and financial incentives Cleantech-friendly policy processes Transparency Specific tax regimes	Resource endowments Attractiveness of renewable energy infrastructure Coordination across relevant actors (e.g., renewable energy producers, grid operators, and distribution companies)
Creation of legitimacy	Youth and public demonstration Lobbying activities Regulatory acceptance and integration Technology support	Level of discussion/debate among key stakeholders (public, firms, policymakers, etc.)	Public opinion Policymaker opinion Executive opinion on regulation Environmental standards and certification	Governments Stakeholders Citizens Philanthropists	Regulatory quality Regulatory instruments Political consistency	Participatory processes

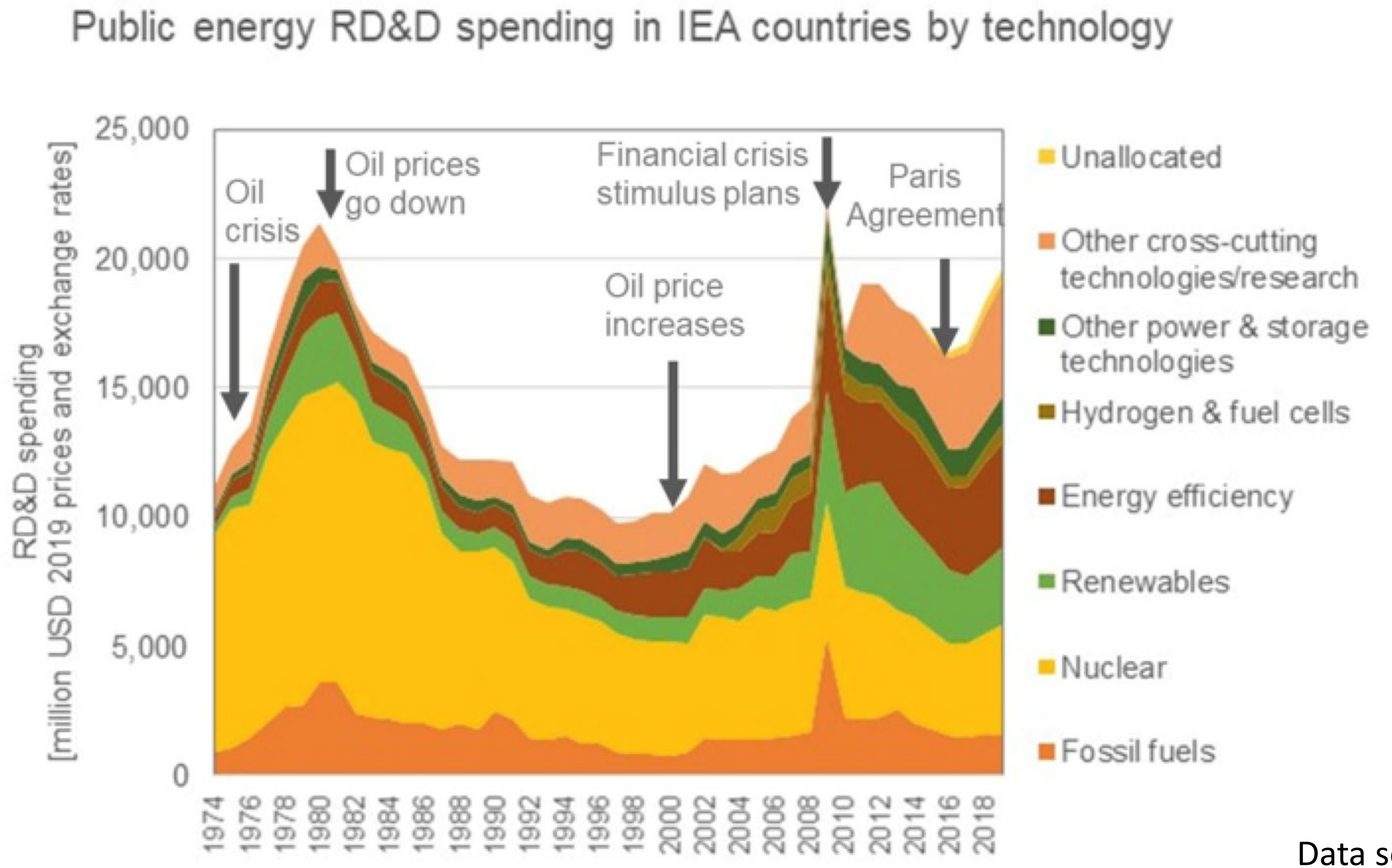
Source: IPCC AR6 WGIII

Table 16.7 | Commonly used quantitative innovation metrics, organised by inputs, outputs and outcomes. Sources: based on Sagar and Holdren (2002); Gallagher et al. (2006, 2011, 2012); Hekkert et al. (2007); Gruebler et al. (2012); Hu et al. (2018); Miremadi et al. (2018); Avelino et al. (2019).

Policies can strengthen innovation

- Creation of markets (e.g., feed-in tariffs, subsidies/tax rebates for EV, standards and labeling program for energy-efficient appliances)
- Removal of systemic barriers such as information provision to public, enhanced interaction between academia and industry, increased legitimacy for low-emission technologies
- Greater investments in public RD&D (substantial increases in last couple of decades – but still only at about same level as post-oil crisis rise)

Greater investments in public research, development and demonstration



Data source: IEA

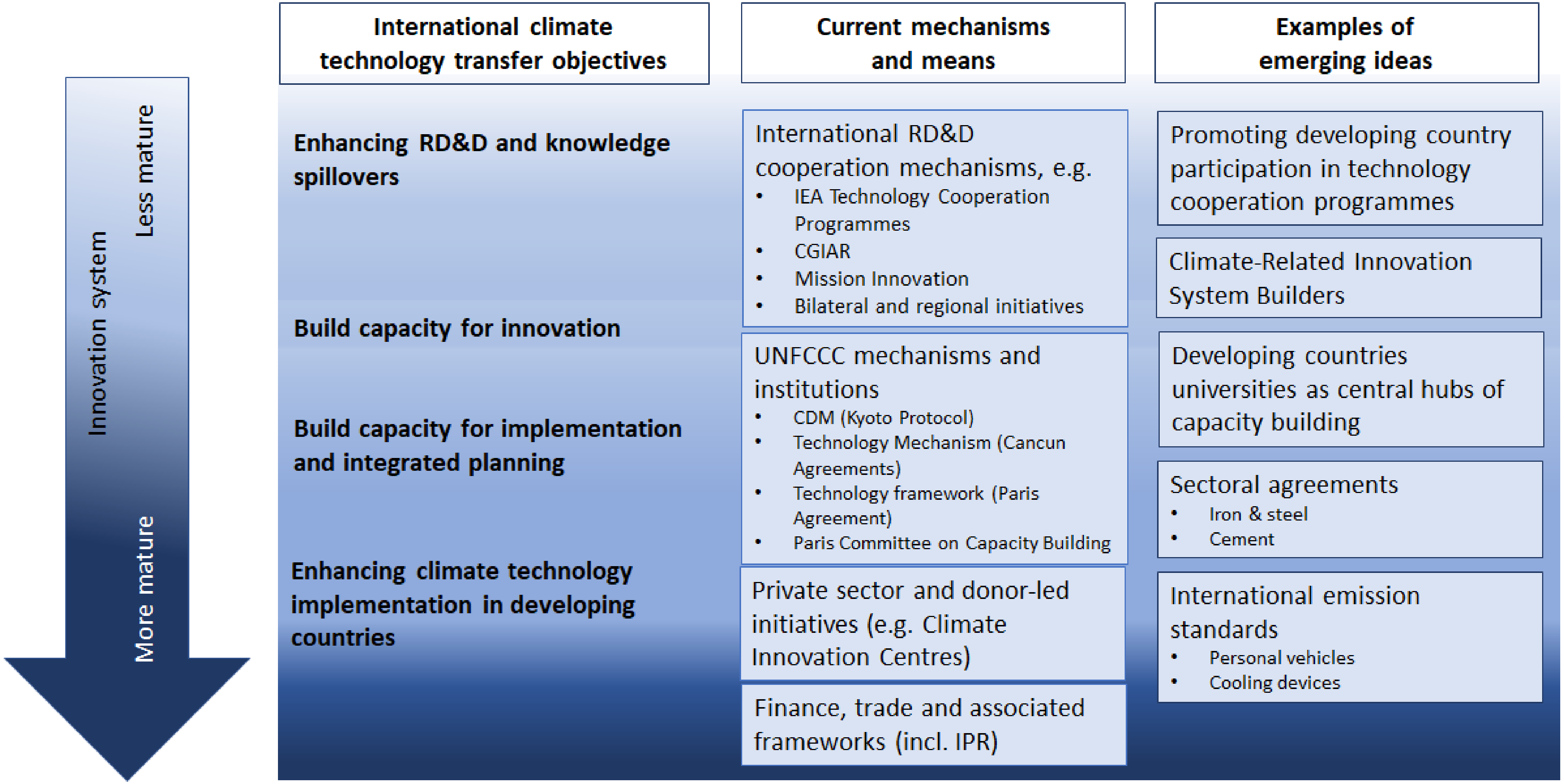
Developing countries have lagged in benefitting from technological opportunities

- Broadly, developing countries have not been as adept as industrialized countries at deploying low-carbon technologies
  - ✓ Higher (financing) costs
  - ✓ Lack of supporting technological systems/infrastructure
  - ✓ Weaker planning and implementation capacity
  - ✓ Human resource constraints
  - ✓ Other development priorities
- Developing countries have not benefitted in the same way
  - ✓ Environmental impacts, low-value jobs and foreign dependencies
- Enhanced technology and capacity to improve these aspects

International cooperation on innovation is a critical enabler for accelerated mitigation

- International cooperation can play an important role in supporting developing countries in their efforts to develop, adapt and deploy climate technologies
- Therefore great benefit to strengthening international cooperation efforts
- Many different channels (multilateral, plurilateral, and bilateral) and foci (R&D, deployment support) of international cooperation
- New ideas and approaches: "Innovation Cooperation", CRIBs, universities as capacity-building hubs, ...

New and emerging ideas for international cooperation on innovation



IPCC AR6 WGIII, Figure 16.3 | Examples of recent mechanisms and emerging ideas (right column) in relation to level of maturity of the national or technological innovation system, objectives of international climate technology transfer efforts and current mechanisms and means. Sources: Sagar (2009); Ockwell and Byrne (2016); Khan et al. (2020); Oberthür et al. (2021).

Technology is an enabling condition for system transformation

Progress in cost reductions

- Mostly granular technologies
- Policy-driven

Developing countries are not benefiting in the same way

- Less uptake of clean technology
- New economic dependencies
- Environmental and social impacts

Innovation systems: institutional capacity, functional approach, ...

International cooperation critical enabler, e.g. to strengthen local innovation systems