Technology transfer and collaboration in renewable energy

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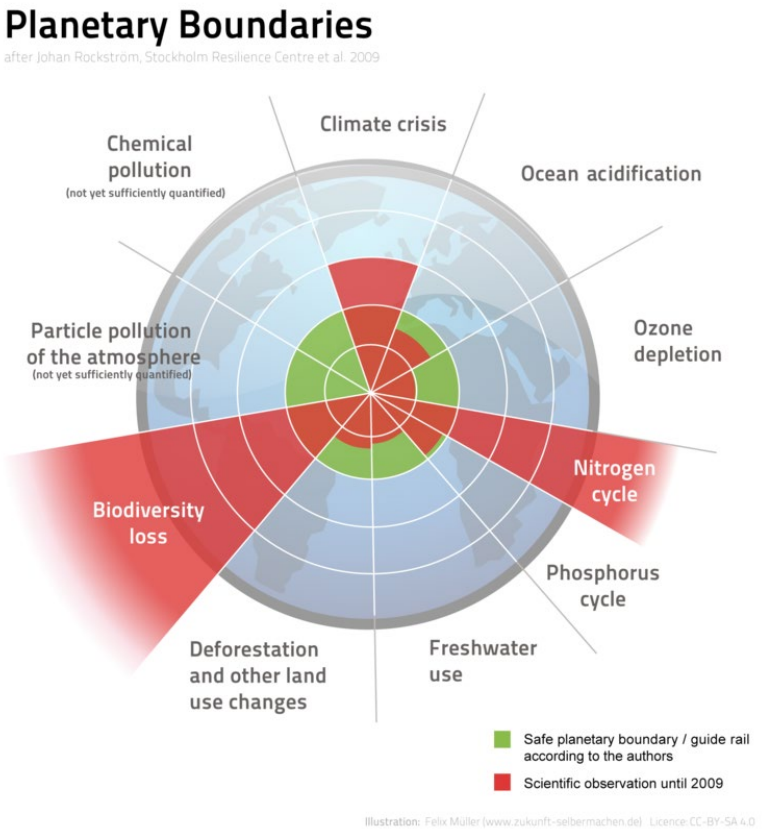
Agenda

1. Why is this important?
2. Technology transfer and collaboration
3. Insights from wind power in China
4. Insights from electrification in sub-Saharan Africa
5. Concluding remarks

1. Why is it important

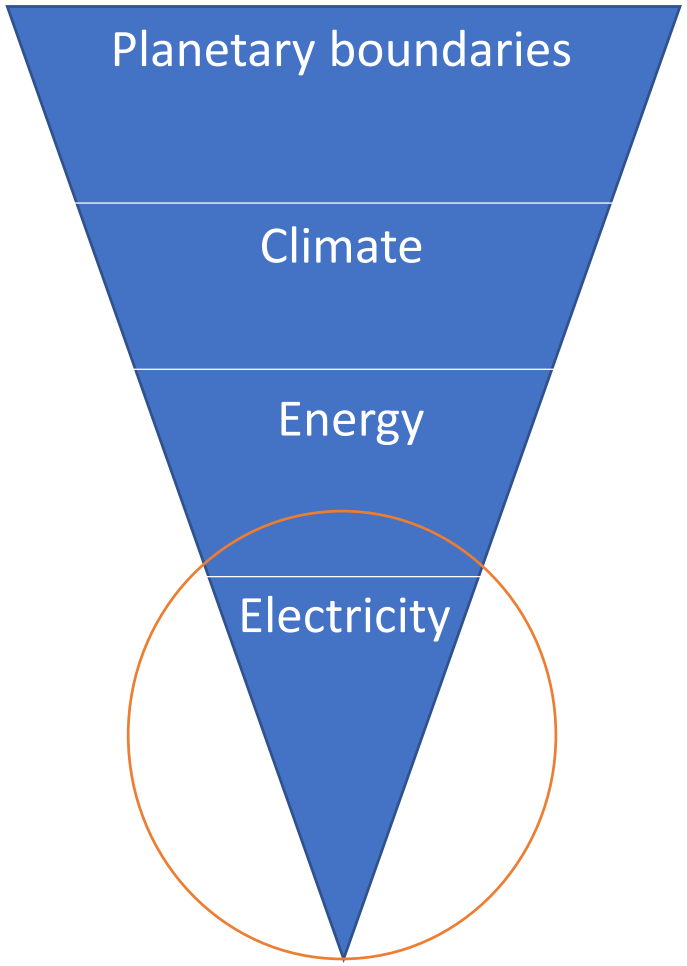
The Green Transformation

- The process of restructuring which brings the economy within the planetary boundaries
- The transformation of energy systems is only a part of the solution to the climate crisis, but an important part



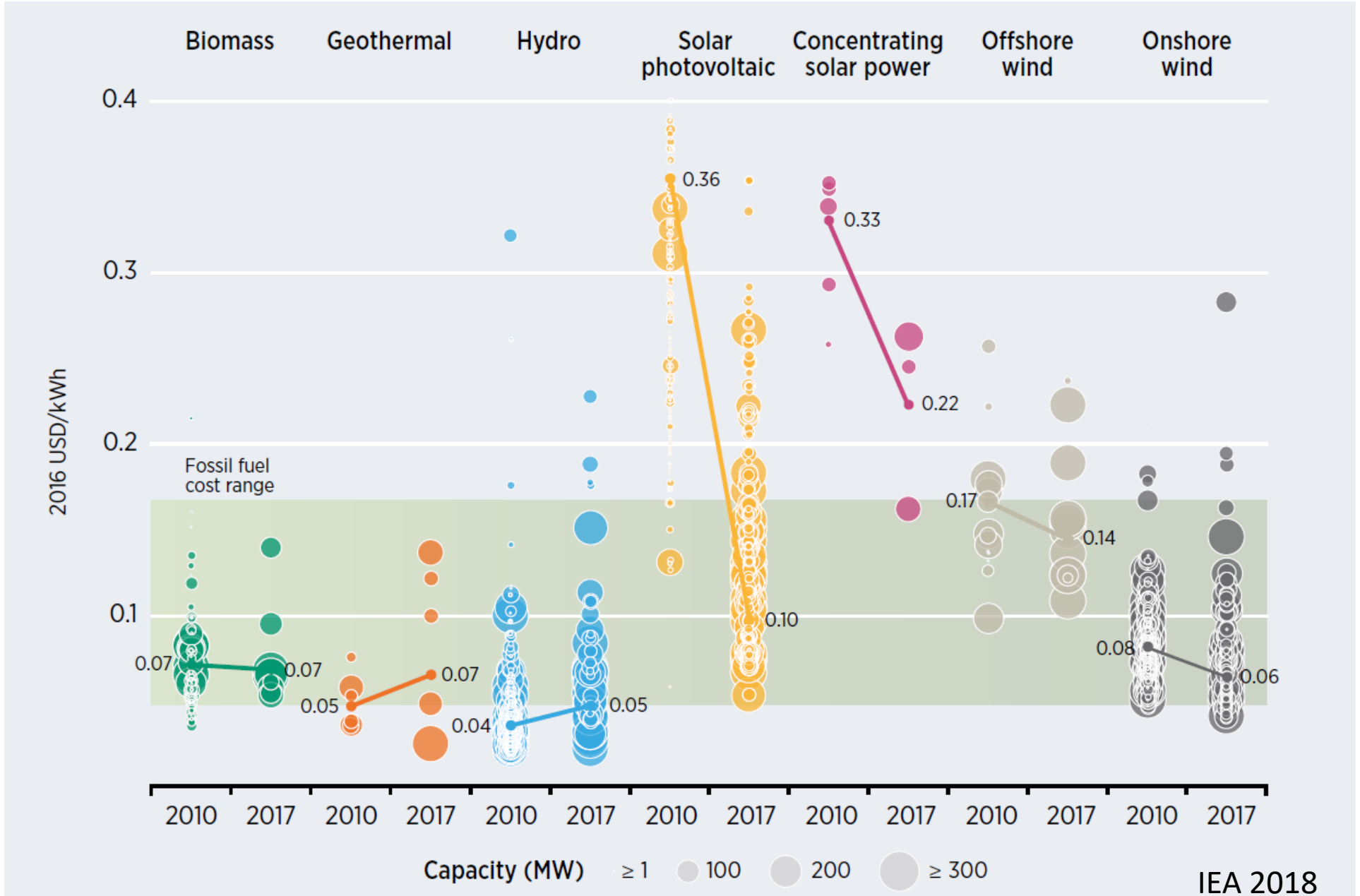
Energy transitions

- Energy transitions are defined as long-term structural change in energy systems
- Current transitions are different from historical ones: directed change from black to green energy



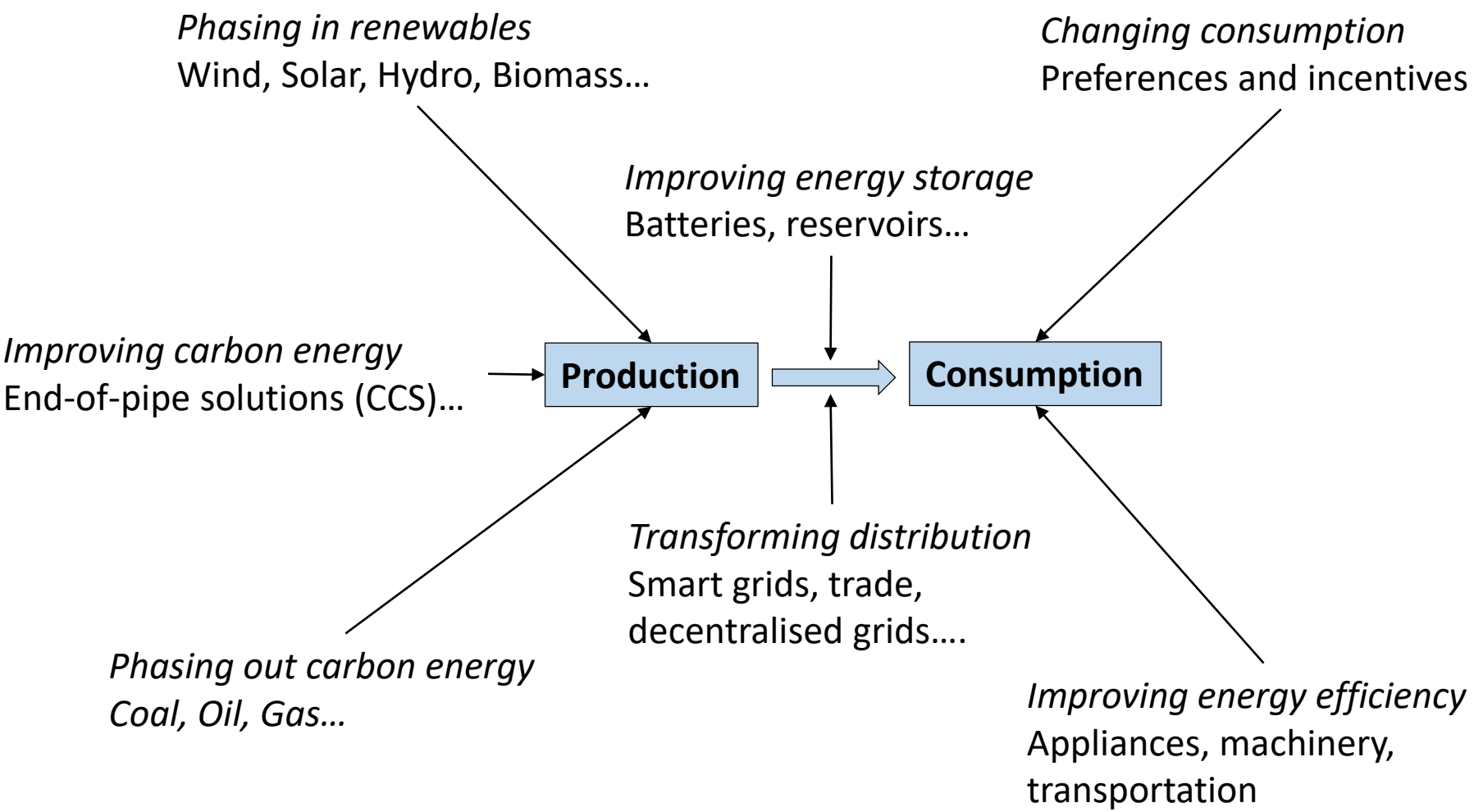
The context of this talk

Levelised cost of electricity: 2010-2017



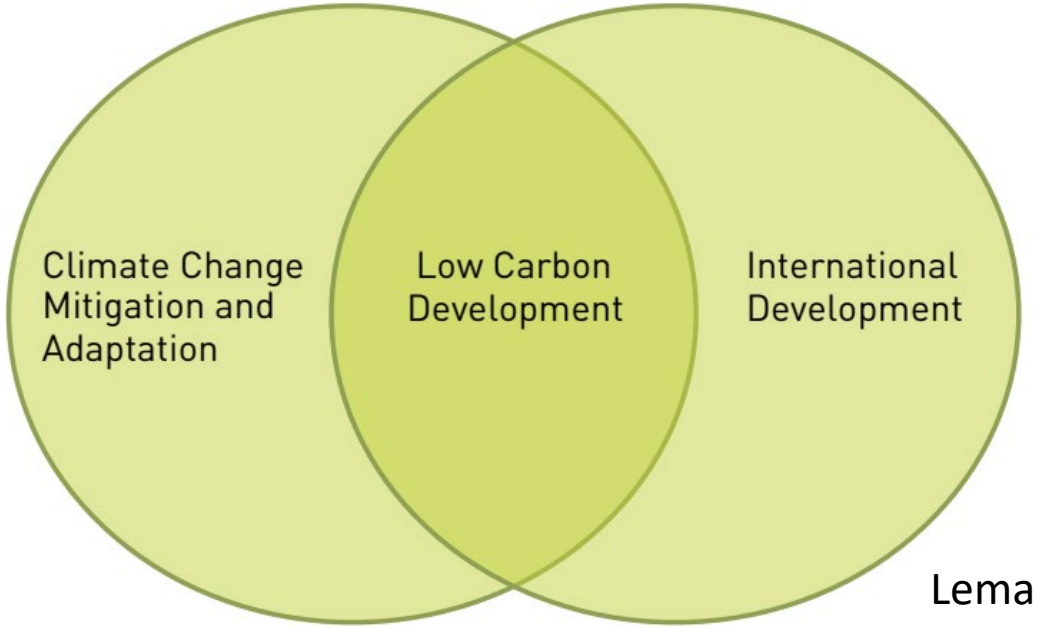
IEA 2018

Transforming electricity systems



Low Carbon Development

- Low-carbon development: strategies that mitigate emissions to avoid dangerous climate change while at the same time achieving economic and social development.
- In this context: using energy transition efforts to achieve industrial development aims – and vice versa



Lema et al 2014

Learning and innovation capabilities

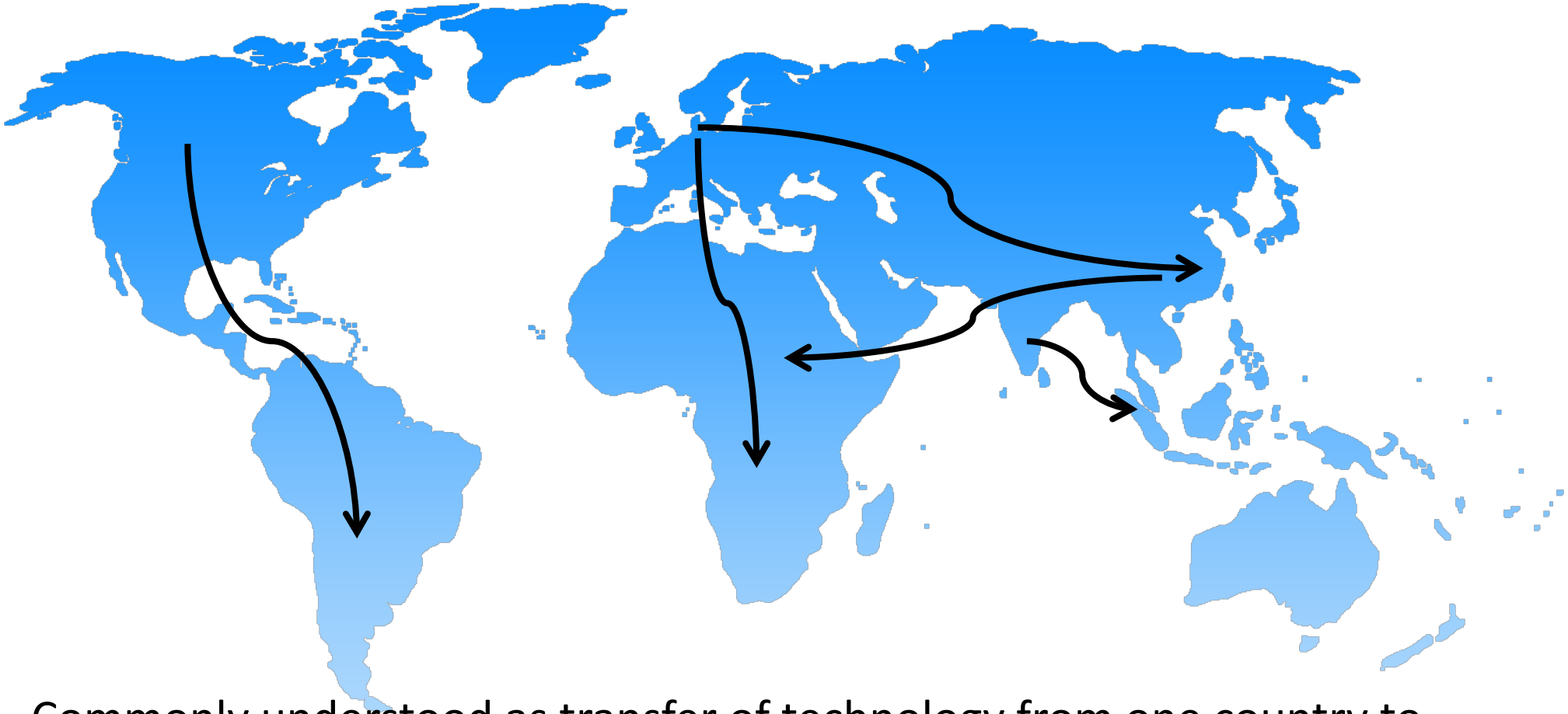
- They increase the creation, diffusion and use of green technologies
- They increase the opportunities for ‘co-benefits’
- LICS perspective as analytical lens (not least elements of public procurement, local content and linkage formation)
- A Schumpeterian process of creative destruction

‘Technology Transfer’

- A key concept in climate change negations (UNFCC) and in and related climate policy arenas
- Dominant point in debate: it can help to improve and replace existing technologies in use (in most efficient and cost effective way)
- TT is demanded by developing countries in these debates – in exchange for emission reductions
- So how do we support (green) technology transfer from advanced economies to the developing world?
- To address this question it necessary to unpack!

2. Technology Transfer and Collaboration in Green technology

What is international technology transfer?



Commonly understood as transfer of technology from one country to another. Typically North to South, but increasing attention is also paid to South-South transfer

What is technology transfer?

A definition:

"Technology transfer is the process by which commercial technology is disseminated. This takes the form of a technology transfer transaction … which involves the communication by the transferor of the relevant knowledge to the recipient"

On page 6 in UNCTAD (2001), 'Transfer of Technology', United Nations Conference on Trade and Development, Geneva

http://unctad.org/en/docs/psiteiitd28.en.pdf.

Technology flows

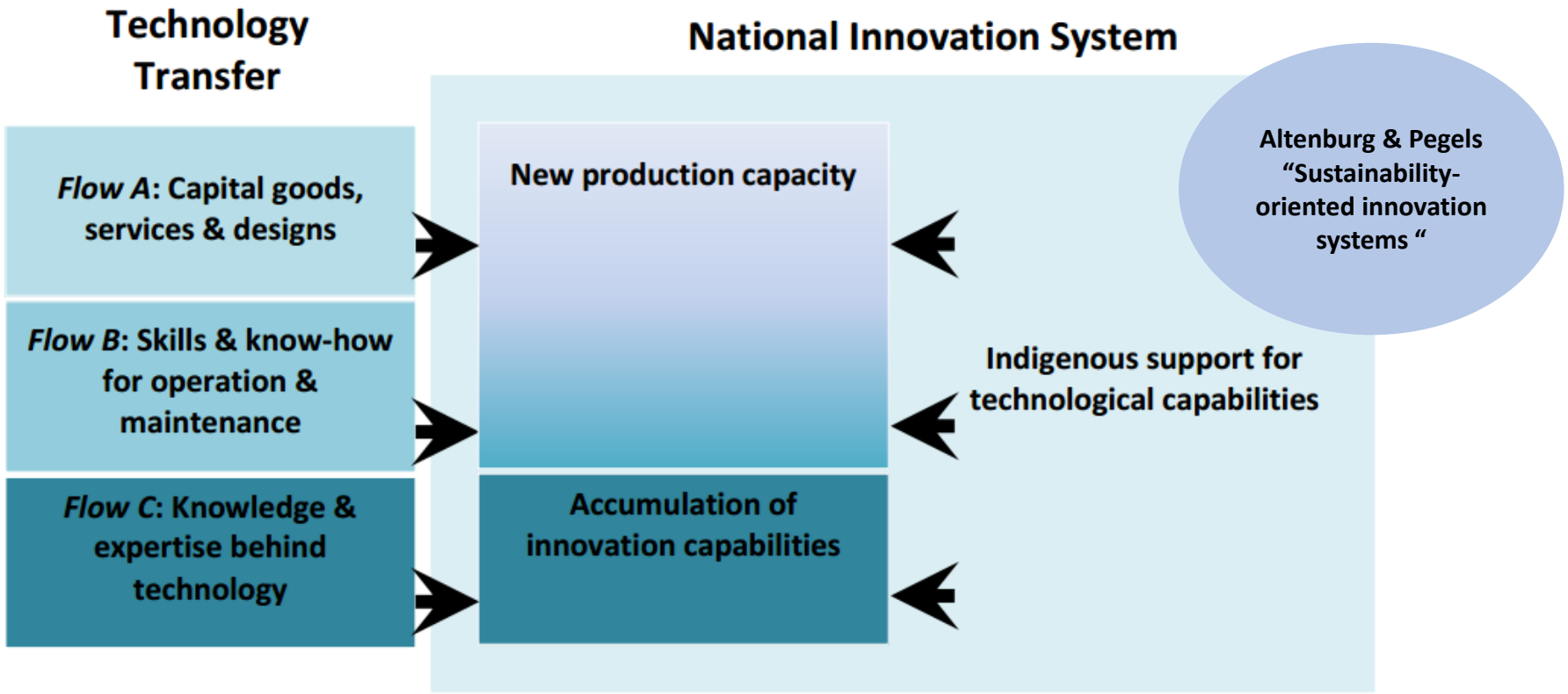


Figure 1: Technology transfer and indigenous innovation

Source: Adapted from Watson et al (2011: 16) based on Bell (1990)

Views on Technology Transfer

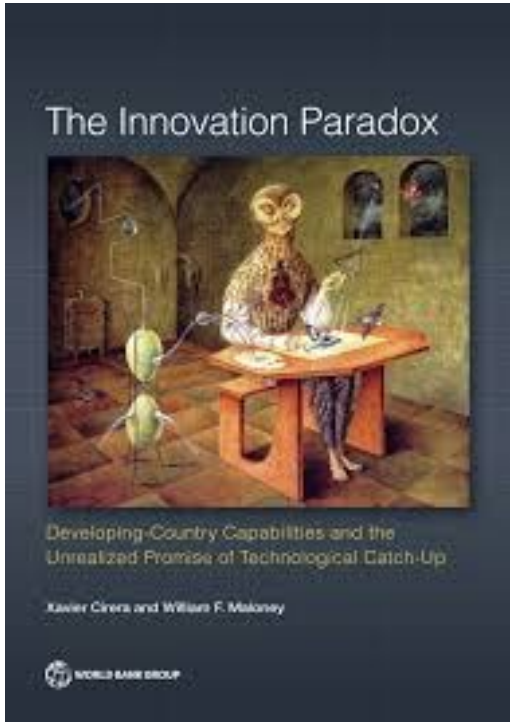
	Narrow View	Broad View
1: Developing countries	• Global economy is divided between Innovating and non-innovating countries	• The distinction between innovating and non-innovating economies is misleading
2: Technological innovation and diffusion	Innovations are: • Global novelties • Innovations are separate from their diffusion	Innovations are: • Often incremental • Often part of the diffusion process
3: Cross border interaction	• Technology transfer consists mainly of tangible assets and related knowledge • Technology transfer is typically a one-way flow	• Technology transfer includes people-embodied knowledge and organisational assets • Effective transfer is an interactive process
4: Localised innovation	• Importing of technologies involves choosing and adopting technologies • Technology transfer and localised innovation are separate processes	• Technology transfer is a creative process • Technology transfer and localised innovation are complementary activities • Transfer requires investments in capability within firms and in innovation systems.

World Bank view:
The Innovation Paradox

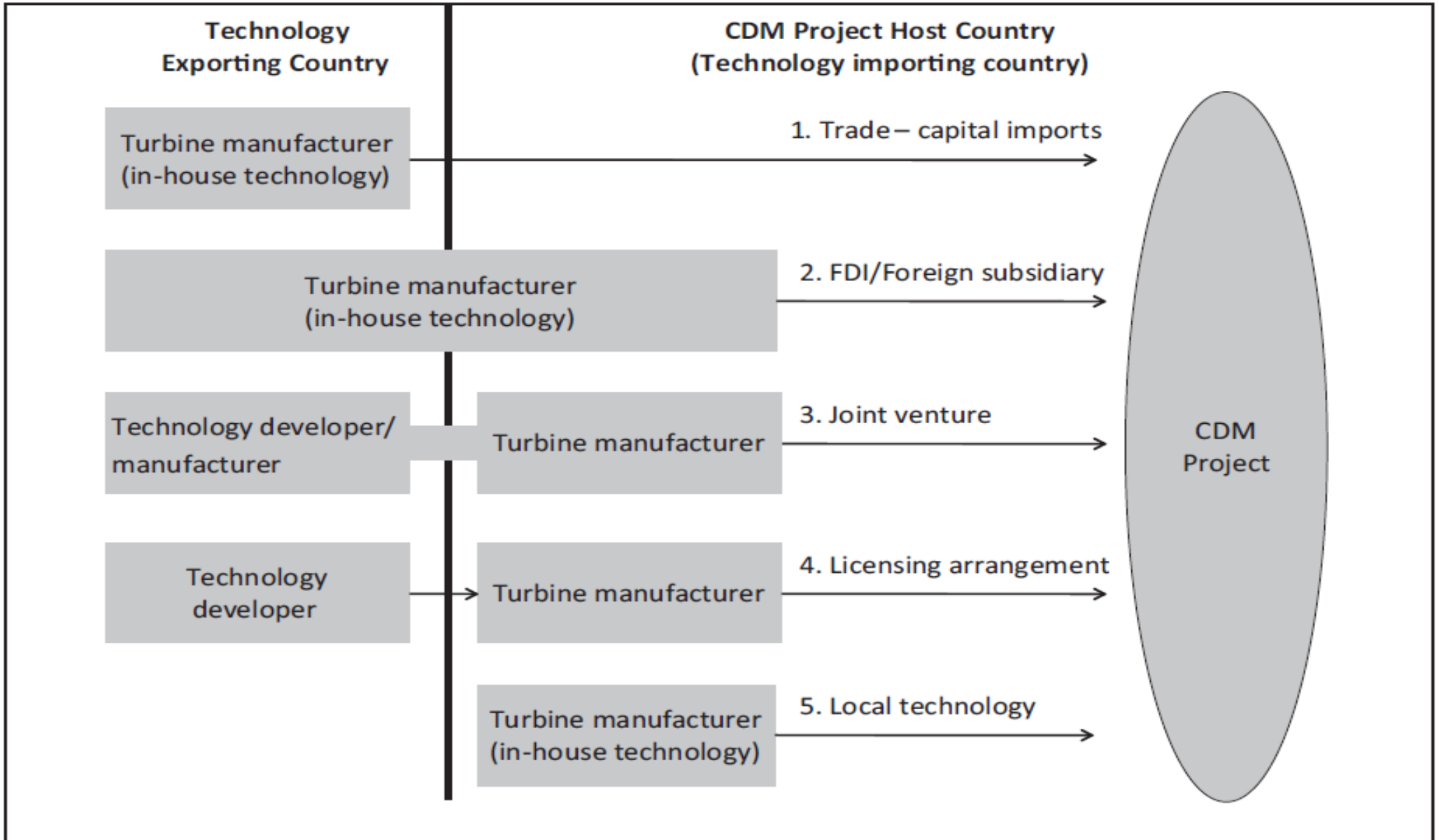
"The ability of lagging countries to tap into a now massive stock of global know-how and technical knowledge — to be able to adopt what has already been invented — is a potential transfer of wealth from rich to poor of historic proportions"

"Developing countries do surprisingly little when it comes to adopting advanced-country experience to upgrading their products, technologies and business processes"

Cirera and Maloney, 2017



Transfer Mechanisms in CDM



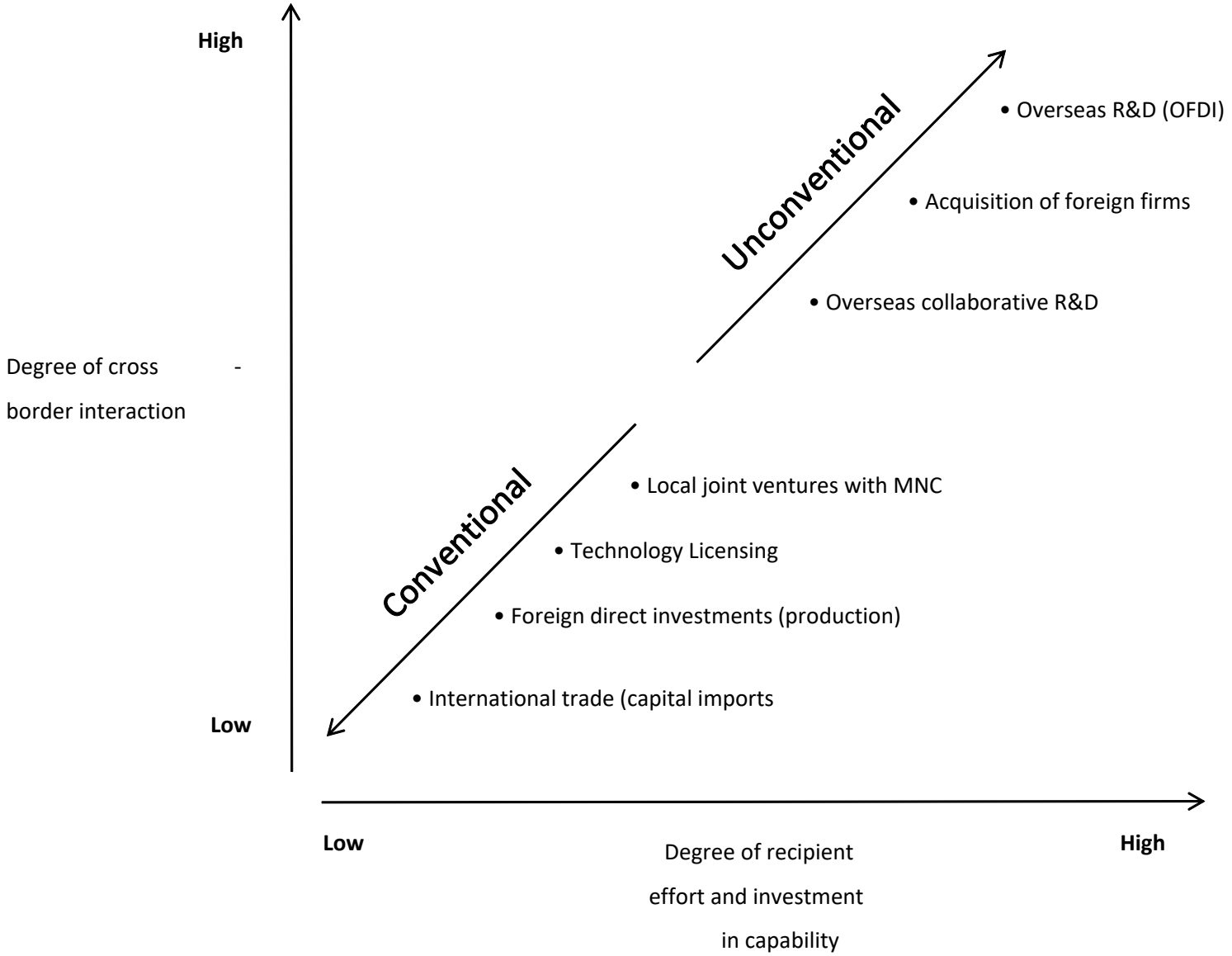
CDM Wind Power

Channel Country	Trade	Foreign subsidiary	Joint venture	License	Indigenous tech	Total
China	28.6%	15.3%	7.1%	45.9%	3.1%	100%
India		25.7%	30%		44.3%	100%
Other	82%	18%				100%
All countries	24.2%	19.5%	14.7%	23.7%	17.9%	100%

n = 182 projects

Source: 'Technology transfer in the clean development mechanism: Insights from wind power' Global Environmental Change, vol 23, no. 1, pp. 301-313

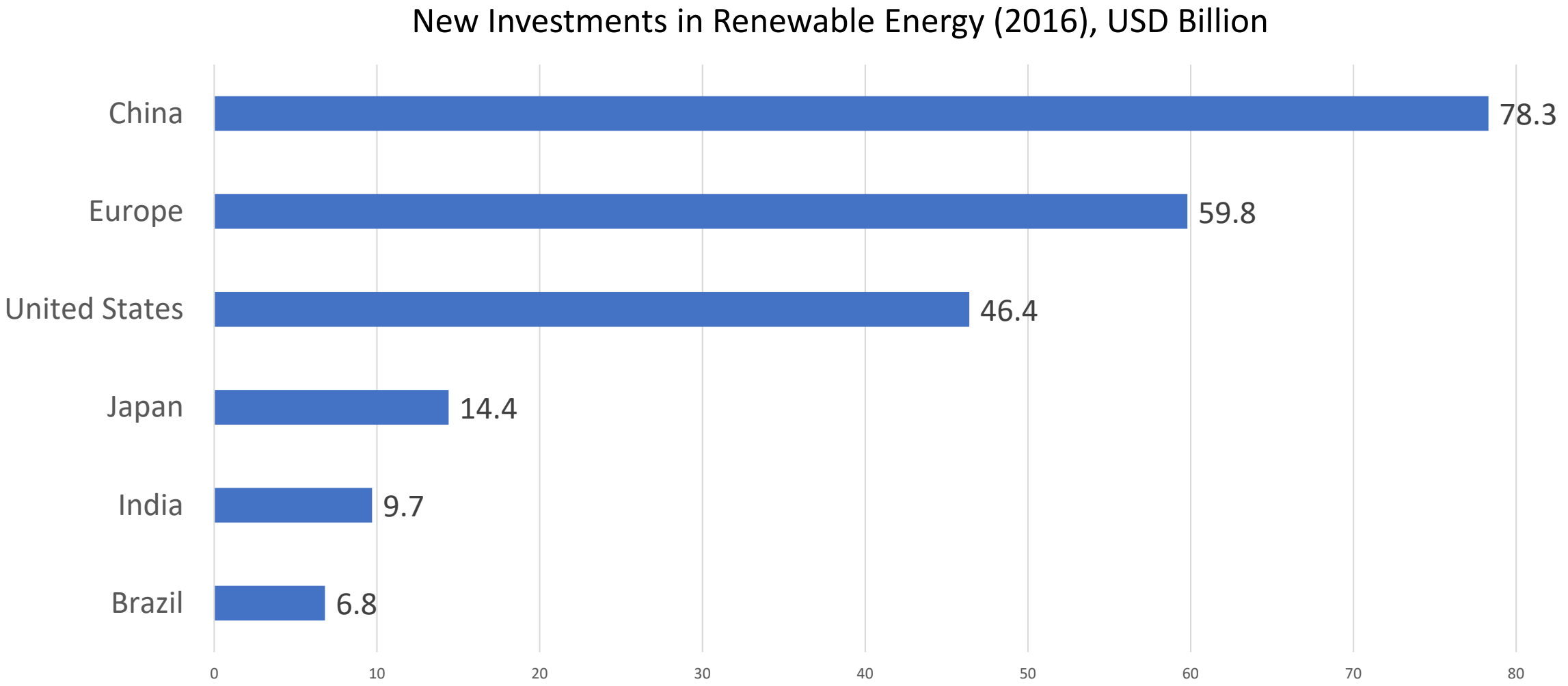
Conventional and unconventional technology transfer mechanisms



Source: 'Technology transfer? The rise of China and India in green technology sectors. Innovation and Development, 2 (1): 23-44

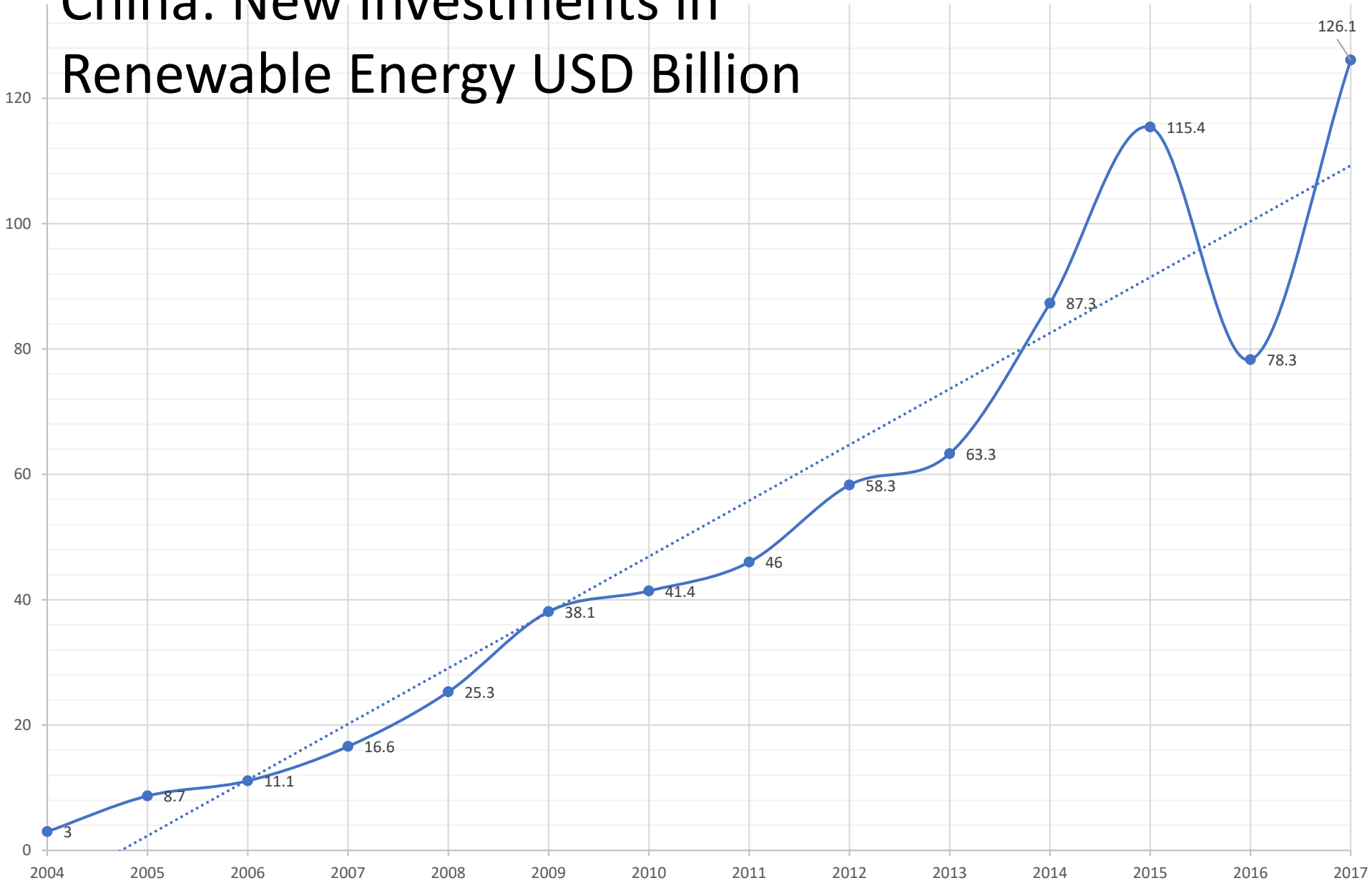
3. Insights from Wind Power in China

Why all this fuss about China?

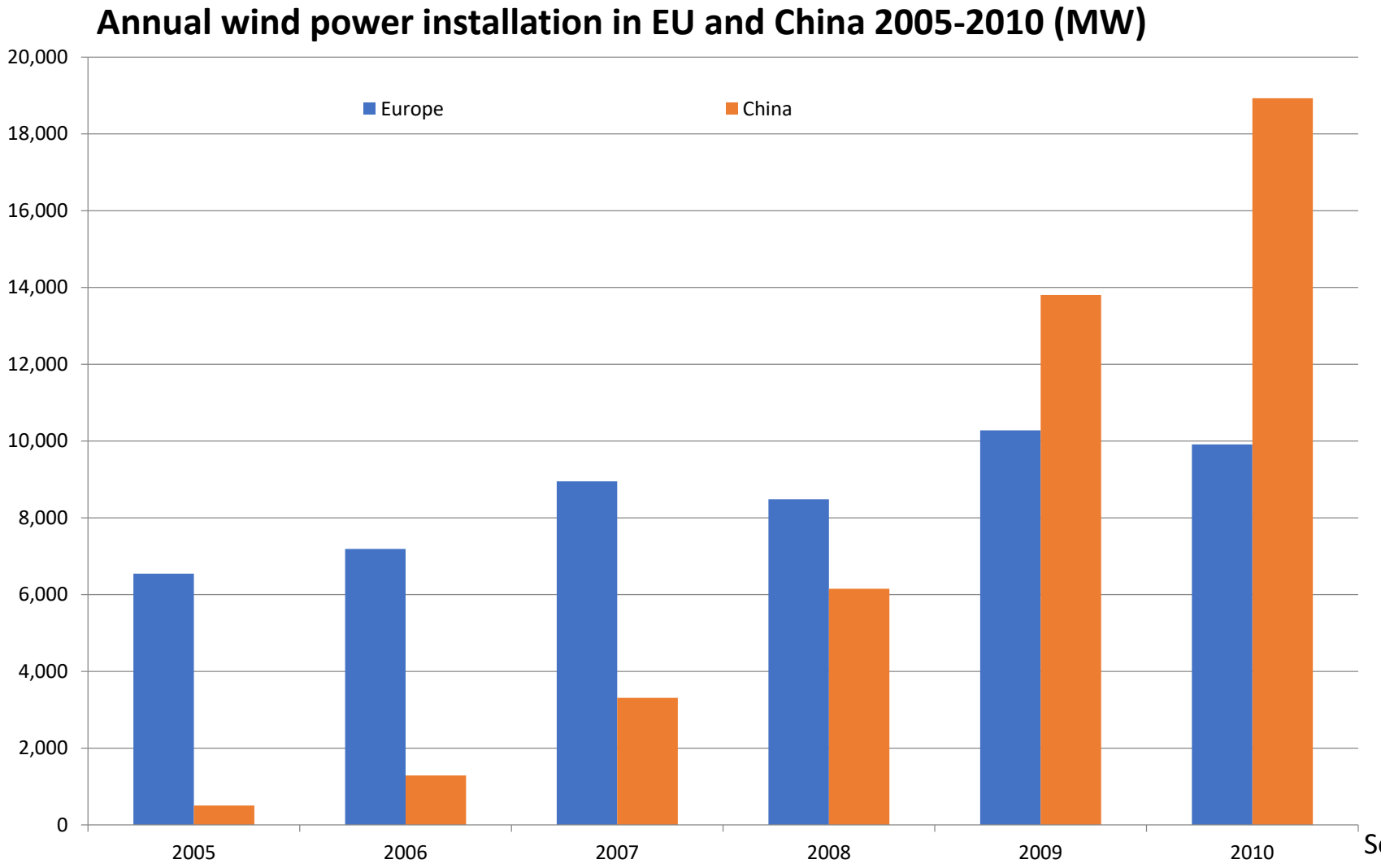


Source: Frankfurt School-UNEP Centre/BNEF

China: New Investments in Renewable Energy USD Billion



In wind, EU (the former market leader) was overtaken by China 10 years ago



Sources: EWEA (2014); CREIA (2012)

Top ten global turbine manufacturers in 2005, 2010 and 2013

2005			2010			2015		
Company	Share		Company	Share		Company	Share	
1. Vestas	27.9%	EU	1. Vestas	14.8%	EU	1. Vestas	13.2%	EU
2. GE Wind	17.7%	US	**2. Sinovel**	11.1%	CN	**2. Goldwind**	10.3%	CN
3. Enercon	13.2%	EU	3. GE Wind Power	9.6%	US	3. Enercon	10.1%	EU
4. Gamesa	12.9%	EU	**4. Goldwind**	9.5%	CN	4. Siemens	8.0%	EU
5. Suzlon	6.1%	IN	5. Enercon	7.2%	EU	5. Suzlon	6.3%	IN
6. Siemens	5.5%	EU	6. Suzlon	6.9%	IN	6. General Electric	4.9%	US
7. Repower	3.1%	EU	**7. Dongfang Electric**	6.7%	CN	7. Gamesa	4.6%	EU
8. Nordex	2.6%	EU	8. Gamesa	6.6%	EU	**8. United Power**	3.9%	CN
9. Ecotécnia	2.1%	EU	9. Siemens WP	5.9%	EU	**9. Mingyang**	3.7%	CN
10. Mitsubishi	2.0%	JP	**10. United power**	4.2%	CN	10. Nordex	3.4%	EU
Others	5.0%		Others	17.5%		Others	31.6%	

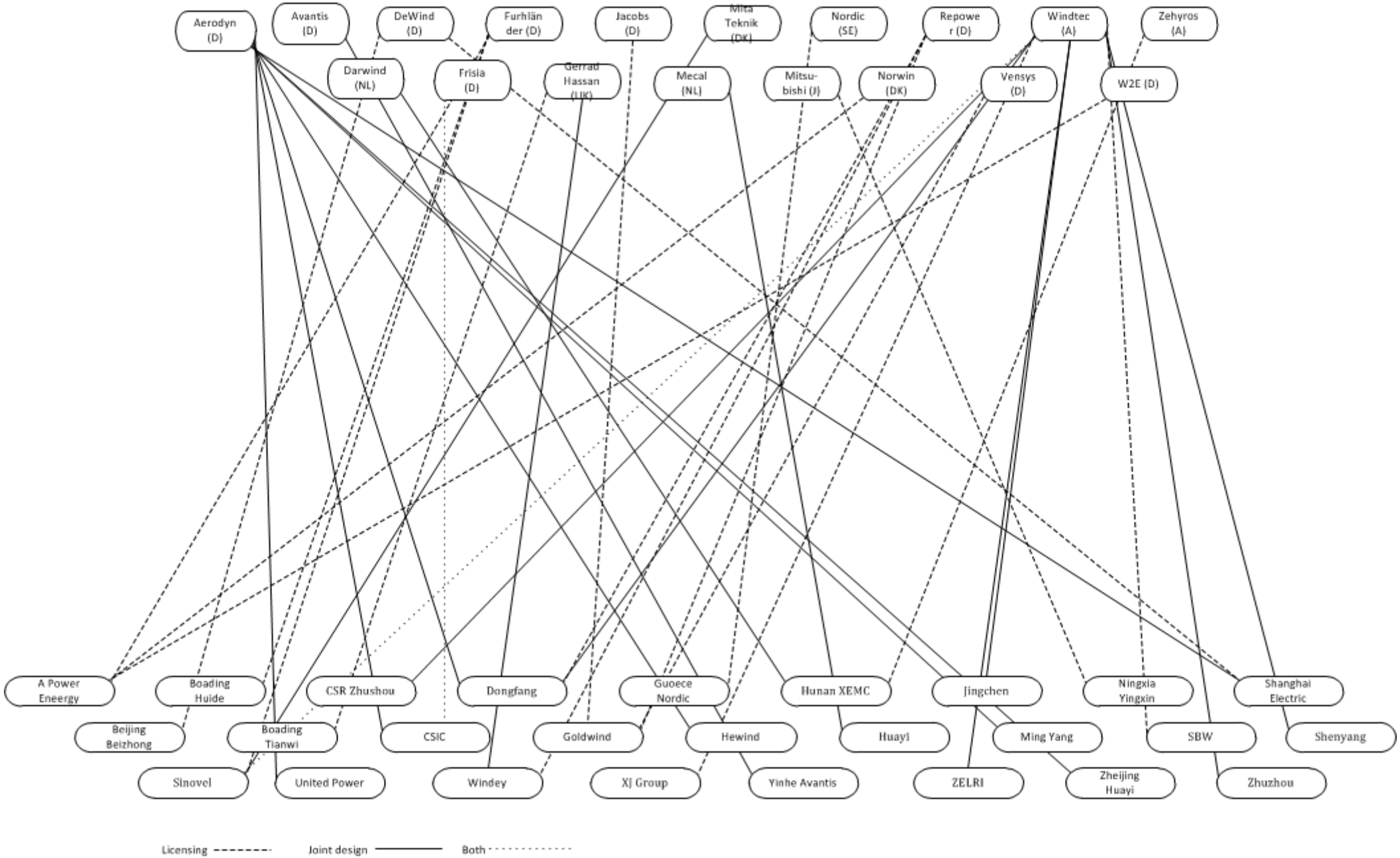
Note: World market shares; Source: BTM 2006, 2011, 2014

Key factors and conditions

Europe	Connections	China

• Changing nature of innovation
  • From informal to formal methods
  • From open source to proprietary
• Changing organisational landscape
• Major process of consolidation
  • Licensing
  • Emergence of technology KIBS
	• Licensing
	• Co-design and collaborative R&D
	• EU firms R&D in China
	• Chinese R&D investments in Europe
	  • Acquisitions
	  • Green field investments
		• Creation of spin-offs and subsidiaries from heavy Industry firms
		• Starting with learning and innovation models with relatively little in-house R&D capacity
		• Availability of designs and services enabled rapid development
		• Now increasing investments in own R&D
		• Strong state support on demand and supply side.

Licensing and joint development



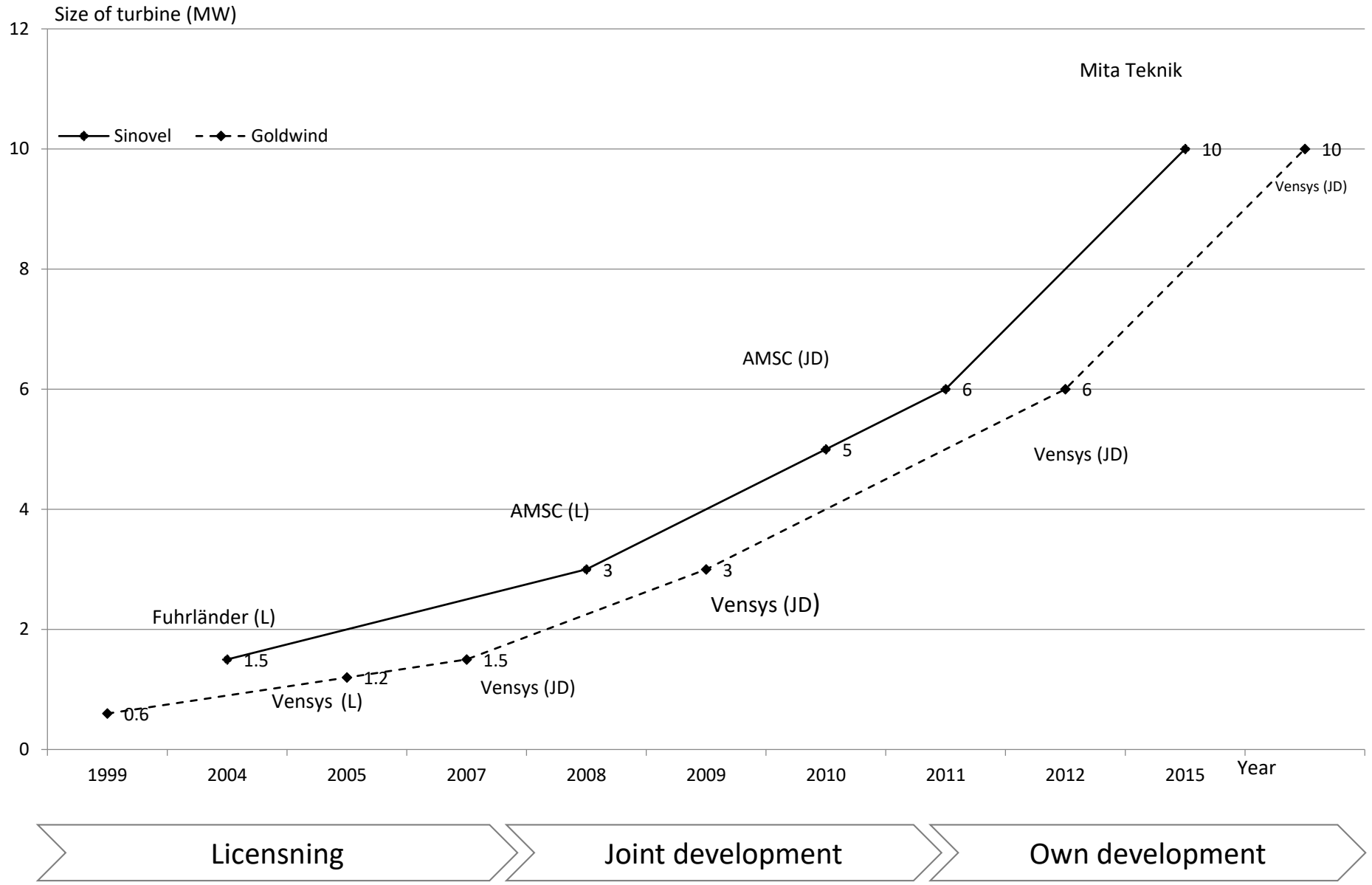
Examples of Chinese lead firm's R&D in Europe/US

Firm	Location	Year	Notes
Goldwind	Germany	2007	Aquisition of Vensys. Ramping the firm up from 20 to 200 people R&D team.
XEMC	Holland	2009	Aquisition of Darwind
Envision	Denmark	2011	Greenfield investment in Aarhus area. Headhunting Vestas and Siemens staff.
Ming Yang	USA/Denmark	2012 2010	R&D centre next to in North Carolina State University (US) and small offoice inside Risø (Denmark)
Titan Wind	Denmark	2012	Acquisition of Vestas tower factory

Examples EU/US lead firm's R&D in China

Firm	Location	Year	Notes
Vestas	Bejing	2010	US$50 million over 5 years; 200 engineers
GE Wind	Shanghai	2000	The center conducts R&D for energy sector including wind. Announced 2010 forecast of $US 2 billion further
Siemens Wind	Shanghai	2011	R&D joint venture with Shanghai Electric focus on R&D. €169,1 mill investment from SWP

Catch-up


Size of turbine (MW)
12
10
8
6
4
2
0
Sinovel
Goldwind
Mita Teknik
10
10
Vensys (JD)
AMSC (JD)
6
6
5
Vensys (JD)
AMSC (L)
3
3
Vensys (JD)
Fuhrländer (L)
1.5
1.2
1.5
Vensys (L)
Vensys (JD)
0.6
1999
2004
2005
2007
2008
2009
2010
2011
2012
2015
Year
Licensning
Joint development
Own development

4. Insights from electrification in SSA

Access to electricity in 2013

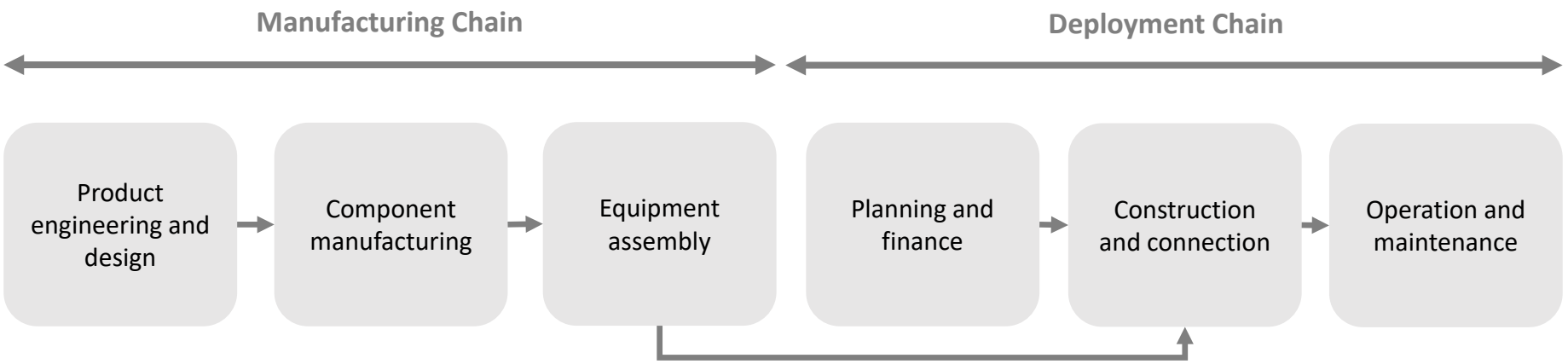
Region	Population without electricity millions	Electrification rate %	Urban electrification rate %	Rural electrification rate %
Developed countries	1	100%	100%	100%
Developing countries	1,200	78%	92%	67%
Sub-Saharan Africa	634	32%	59%	17%
Developing Asia	526	86%	96%	78%
India	237	81%	96%	74%
Latin America	22	95%	98%	85%
Middle East	17	92%	98%	79%
World	1,201	83%	95%	70%

IEA 2015

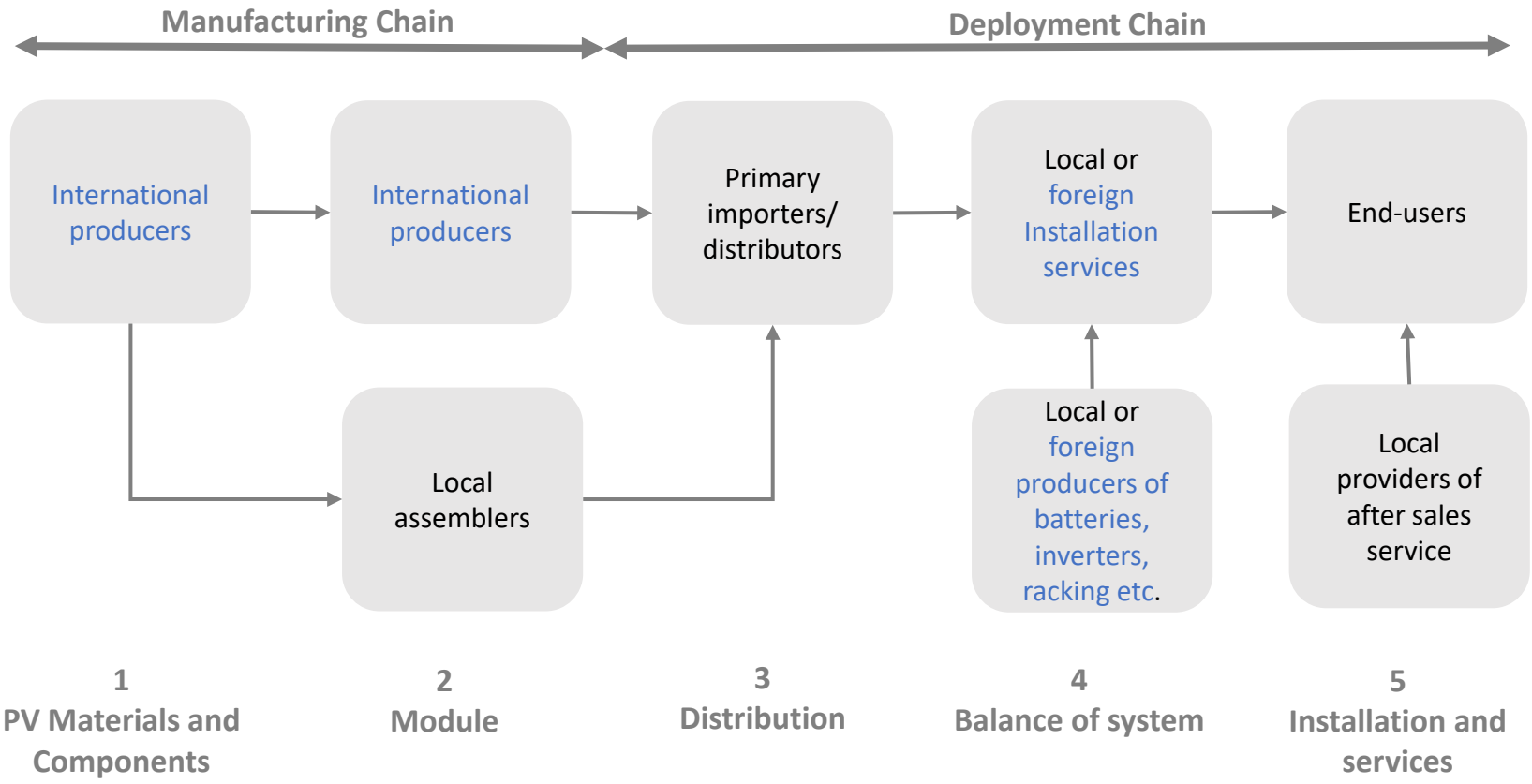
Key perspectives

- What are the prospects for developing production and innovation capabilities arising from renewable electrification efforts?
- Decomposing ‘transfer’ by focusing on linkages and interactive learning
  - Reverse value chains
  - Trade-centred and investment centred value chains
  - Learning from importing

Generic Value Renewable Energy Chain



Solar PV


Manufacturing Chain
Deployment Chain
International producers
International producers
Primary importers/ distributors
Local or foreign Installation services
End-users
Local assemblers
Local or foreign producers of batteries, inverters, racking etc.
Local providers of after sales service
1 PV Materials and Components
2 Module
3 Distribution
4 Balance of system
5 Installation and services

Three Chinese projects in SSA

		Garissa	Adama	Bui
Capacity and ownership	**Energy source**	Solar PV	Wind	Hydro
	Size	55 MW	204 MW	400 MW
	Owner/sponsor	Kenya Rural Electrification Authority (KREA)	Ethiopian Electricity Power (EEP)	Bui Power Authority (BPA), Ghana
Service delivery	**Electricity Distribution**	Kenya Power and Lighting Company (KPLC)	Ethiopian Electric Services (EES)	ECG/Gridco
	Plant operation	Kenya Electricity Generating Company (KECG) and CJCI	EEP	Sino Hydro
	Plant Maintenance	KECG	EEP	Sino Hydro
Infrastructure delivery	**Finance**	Export-Import Bank of China (USD 140 Mio)	Export-Import Bank of China (85%) Government of Ethiopia (15 %)	Export-Import Bank of China (USD 500 mio.); Gov of Ghana (USD 60 Mio);
	EPC and project management	China Jiangxi Corporation for International Economic & Technical Cooperation (CJCI)	HydroChina & CGC Overseas Construction Group	Sino Hydro
	Front-end and detailed engineering	CJCI and Maknes Consulting	HydroChina & CGC Overseas Construction Group	Coyne et Bellier (France) and Sino Hydro
	Core technology supply	JinkoSolar (China)	Goldwind (China) & Sany (China)	Produced in China by Alstom (France)

	Garissa Solar PV Project	Adama Wind Project	Bui Dam Hydro Project
Local jobs	• Construction: 50 Chinese staff and 350 local staff, 250 of which were involved in semiskilled activities. • Operation: Five Kenyan staff and four Chinese national • Also local solar panel cleaners as well as guards.	• Construction: 400 Chinese staff and 1000 local staff. • Operation: handover from Hydro China to EEP occurred after five years, thereby transferring operation and maintenance to Ethiopian nationals in EEP.	• Construction: 170 Chinese staff and 1600 local staff • Operation: 50 Ghanaian nationals involved in operations and routine maintenance undertaken by BPA. • Sino Hydro employed in new contract for additional repair construction.
Local content	• Local equipment inputs and construction services: provision of auxiliary hardware (e.g. cables and wires). • Local consultancy services regarding technical oversight. • Also functionally unrelated infrastructure (including a school) which included local content - CSR	• Local equipment or construction service inputs: None • Services: transportation (on-land shipping of the turbines). • Turbines and other critical equipment sourced from China. • Important involvement of a local university in capacity of owner's consultant.	• Locally sourced manufacturing inputs and construction services, in particular provision of concrete for construction. • An estimated share of 60% local content overall • Critical equipment and components (e.g. turbines) provided from outside.
Local learning	• Inflows of technology: embodied technology (e.g. panels and inverters) and project design specifications. • Involvement of local consulting firm, gaining project-level experience, during the feasibility and construction stages. • Deliberate training efforts, including secondments, confined to post-construction stages related to operations and maintenance.	• Hardware inflows and end-to-end provision design blueprints and project management frameworks. • Project owner-EPC contractor link mediated by university consultants, • EPC contractor involved in transfer of skills for operation and maintenance and associated certification. • Training in China of personnel across state-owned electricity organisations,	• Critical technology sourced from China, with no or limited local transfer of knowledge and expertise related to core technologies and construction project management. • Limited transfer means that maintenance depends on further contracts with the Sino-hydro. • Deliberate training efforts confined to two-week bootcamps for labourers working on the construction site.

5. Concluding remarks

Some conclusions (1)

1. From technology transfer to collaboration
   - Beyond framework conditions for Trade/FDI/IPR
   - Incentives for collaboration
2. From technology transfer to local innovation
   - Strengthening of innovation systems facilitates insertion into global innovation networks
   - Innovation systems strengthened by investing in system elements and creating linkages
   - Finding balance between centralised public R&D and decentralised innovation in enterprises
3. Distinguishing between different types of developing countries
   - Beyond Annex 1 and Annex 2
   - BASIC countries versus LDCs

Some conclusions (2)

4. Focus on local policy framework for investments (e.g. local content specifications) and bargaining power
5. Explicit learning and capability mechanisms to be built into project designs
6. Training of policy makers
7. Investments in educations sectors with specific programs on renewables
8. Linkage formation in sectoral systems

Technology is acquired, not transferred!

Thank you!

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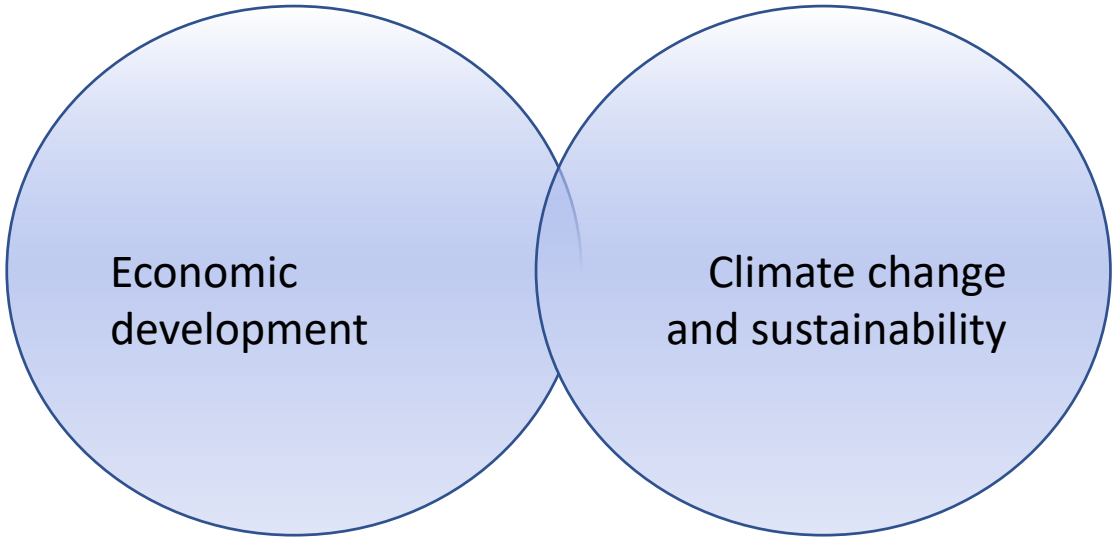
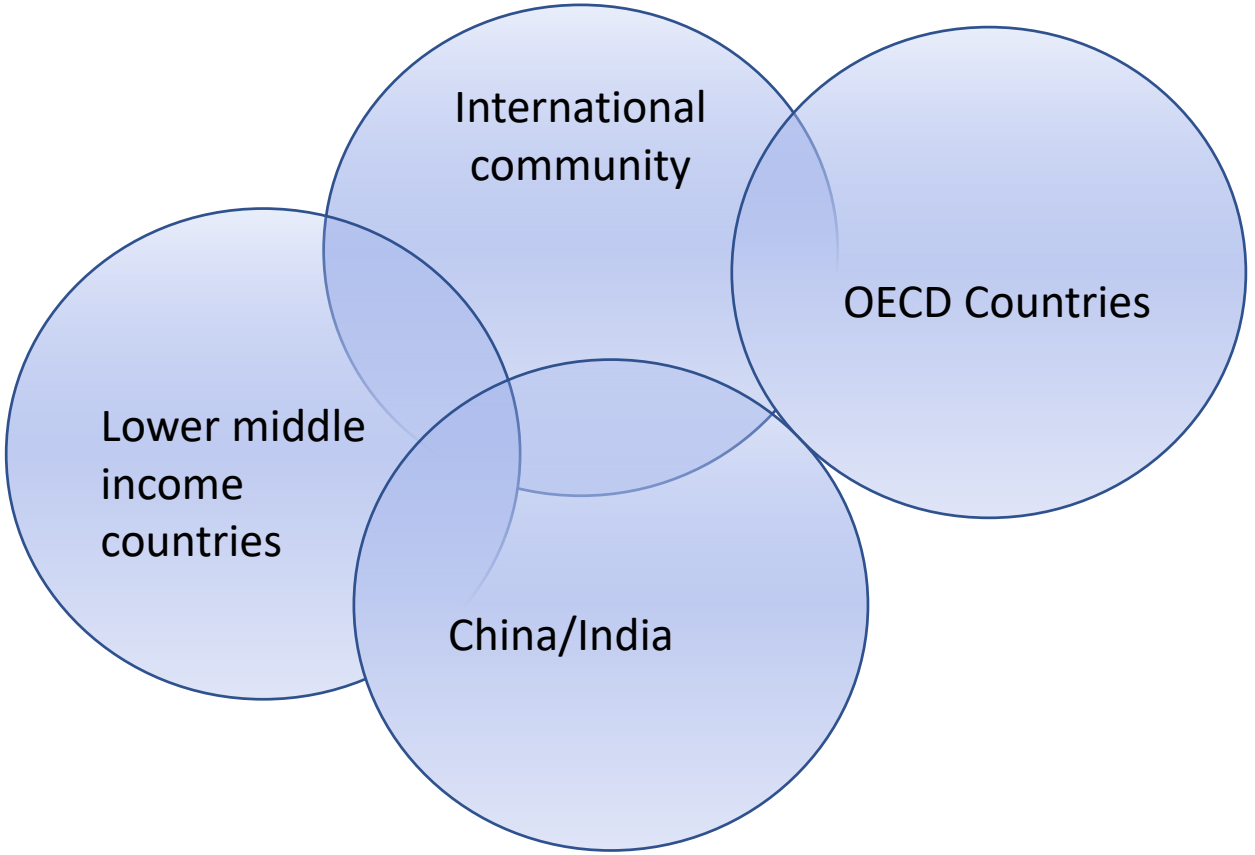
5. Policy Issues

What Priority?



Who's Policy?


International community
OECD Countries
Lower middle income countries
China/India