Technology Strategies for Climate Protection

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The Space of ETIS

Innovation life cycle stage

Energy system component (technologies)

	R&D	Niche Markets	Diffusion	Phase-out
End use (energy services)				
Conversion (to fuels/electricity)				
Supply (extraction)				

Levels of investment & capital depreciation

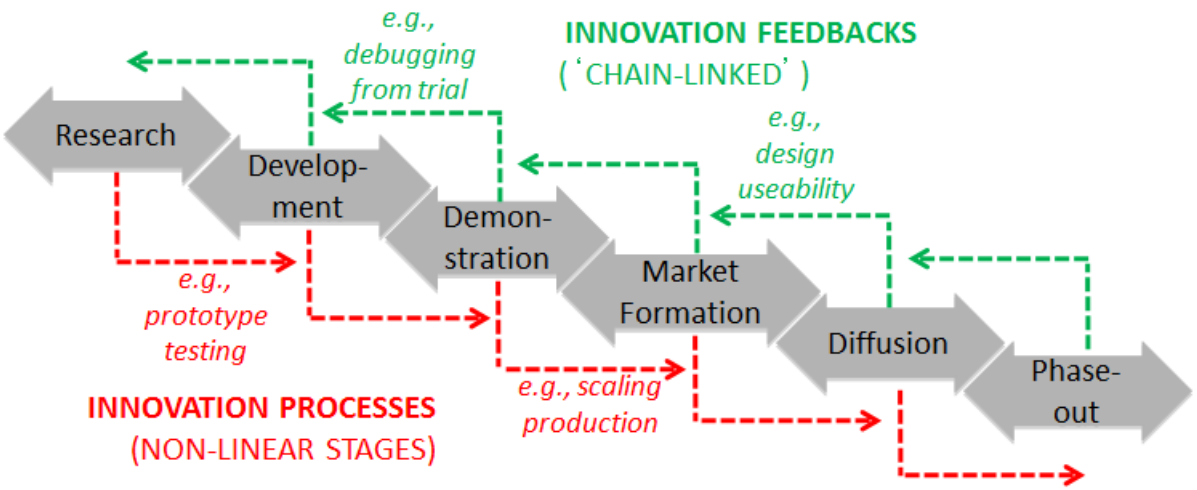
ETIS

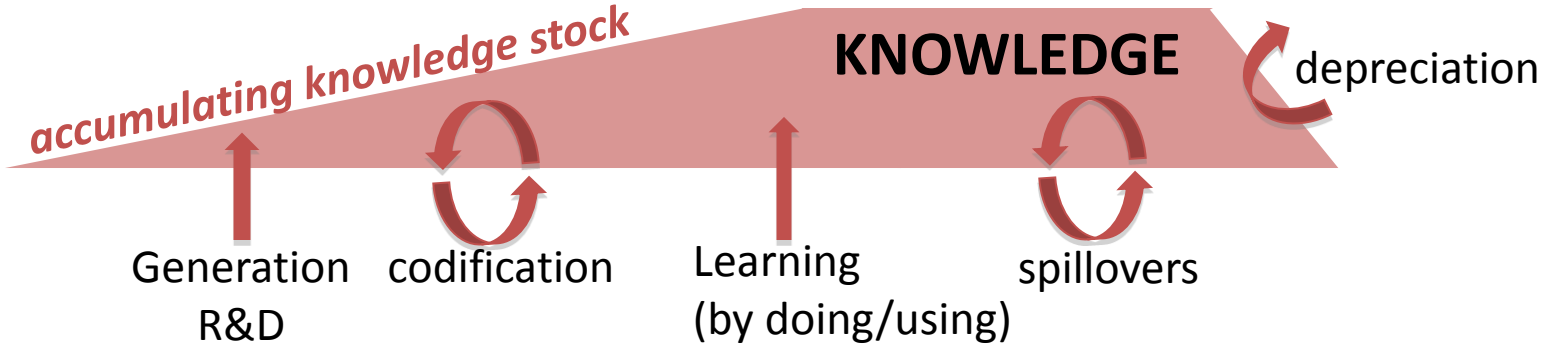
Innovation system components:

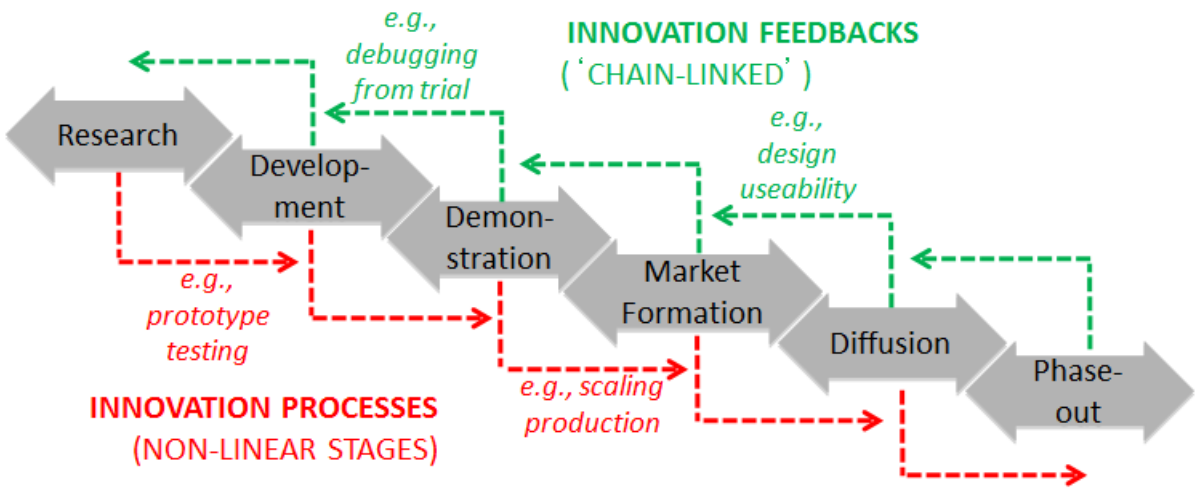
- Life-cycle stages
- Innovation processes (R&D to obsolescence)
- Feedbacks

Drivers:

- Knowledge
- Actors/Institutions
- Resources
- Technology


e.g., debugging from trial
INNOVATION FEEDBACKS
('CHAIN-LINKED')
e.g., design useability
Research
Develop-ment
Demon-stration
Market Formation
Diffusion
Phase-out
e.g., prototype testing
e.g., scaling production
INNOVATION PROCESSES
(NON-LINEAR STAGES)


accumulating knowledge stock
KNOWLEDGE
depreciation
Generation
R&D
codification
Learning
(by doing/using)
spillovers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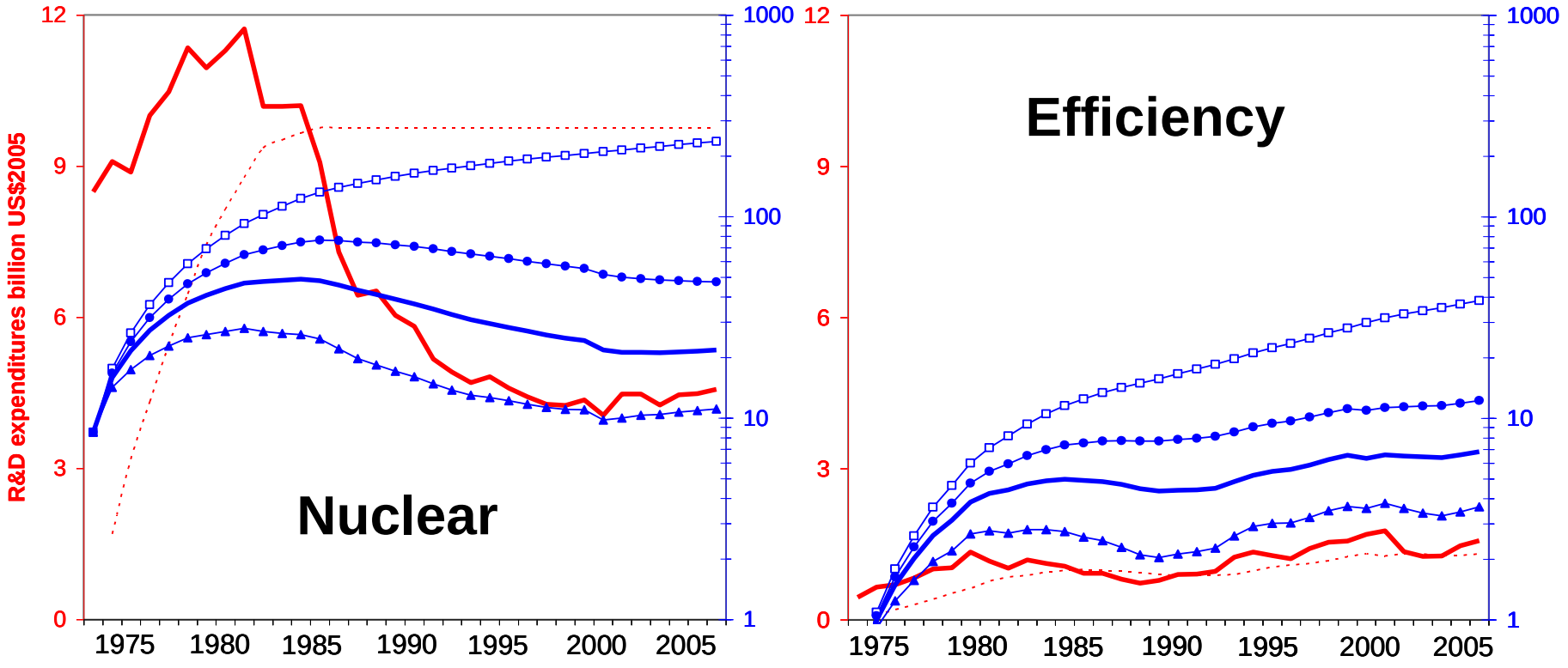
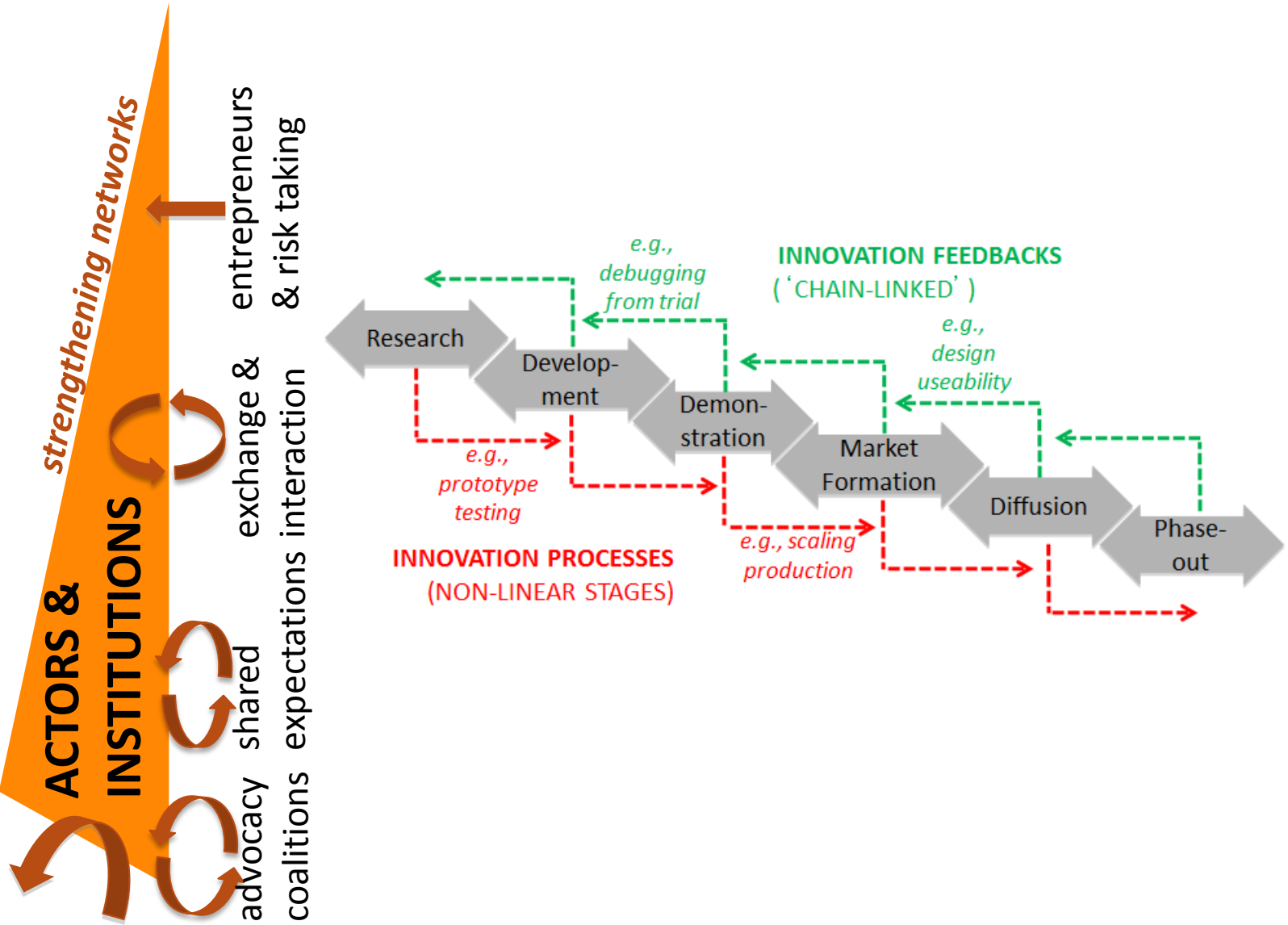
Knowledge Management: Impact of R&D Expenditure Continuity on Knowledge Stock Depreciation, Nuclear vs. Efficiency (IEA countries)

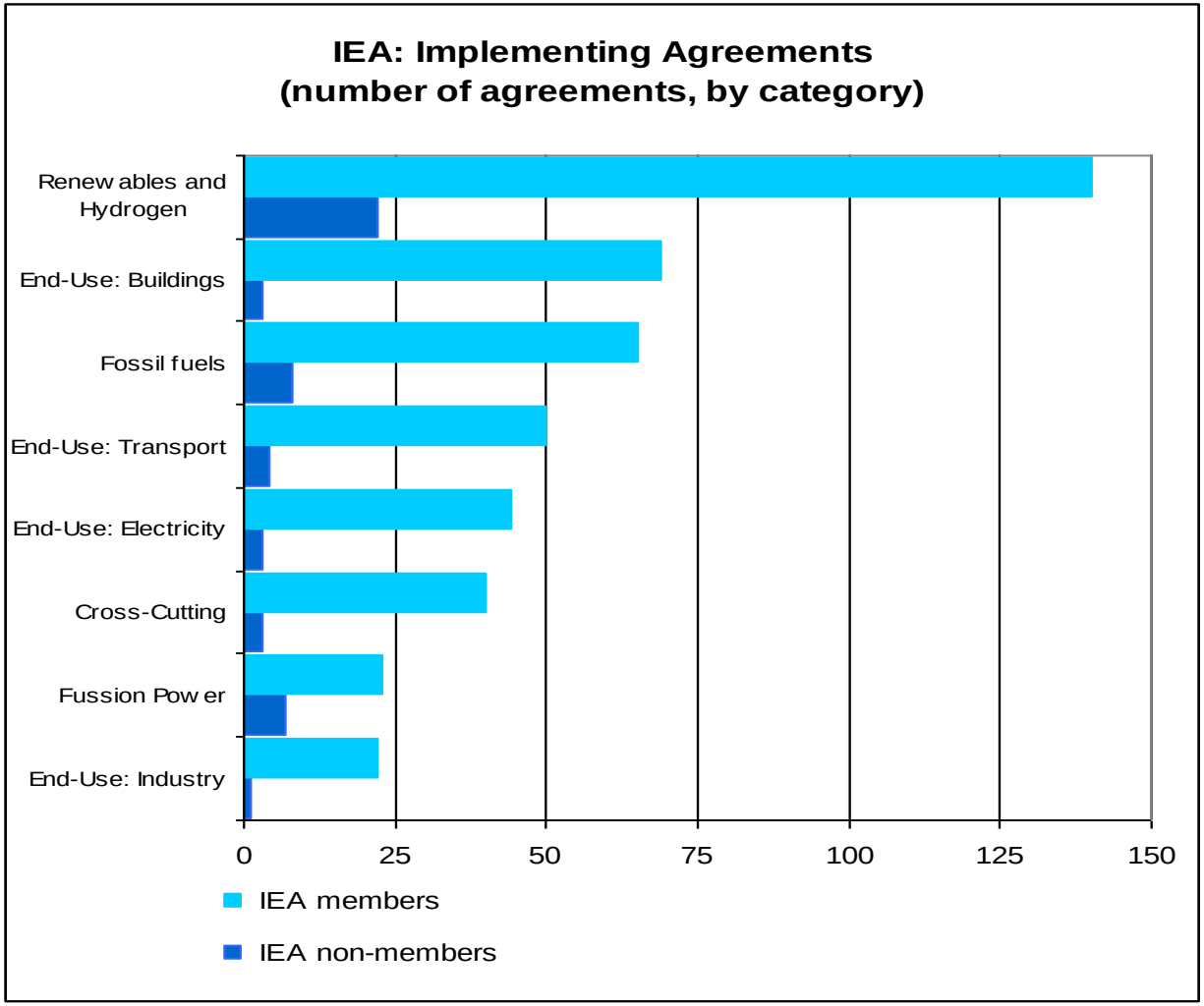


Source: GEA KM24

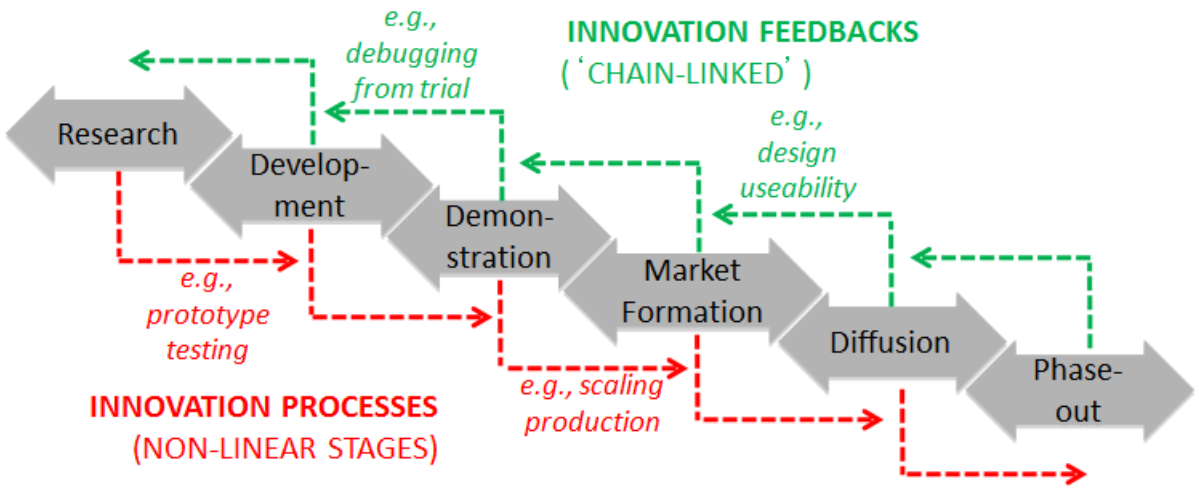


Resistance to change

“North”-”South” Clean Energy Technology Cooperation



Largest DC participation: concentrated solar, biofuels (8 countries), fossil fuels [coal] (India, China, Mexico, SA), fusion (China, India, Russia)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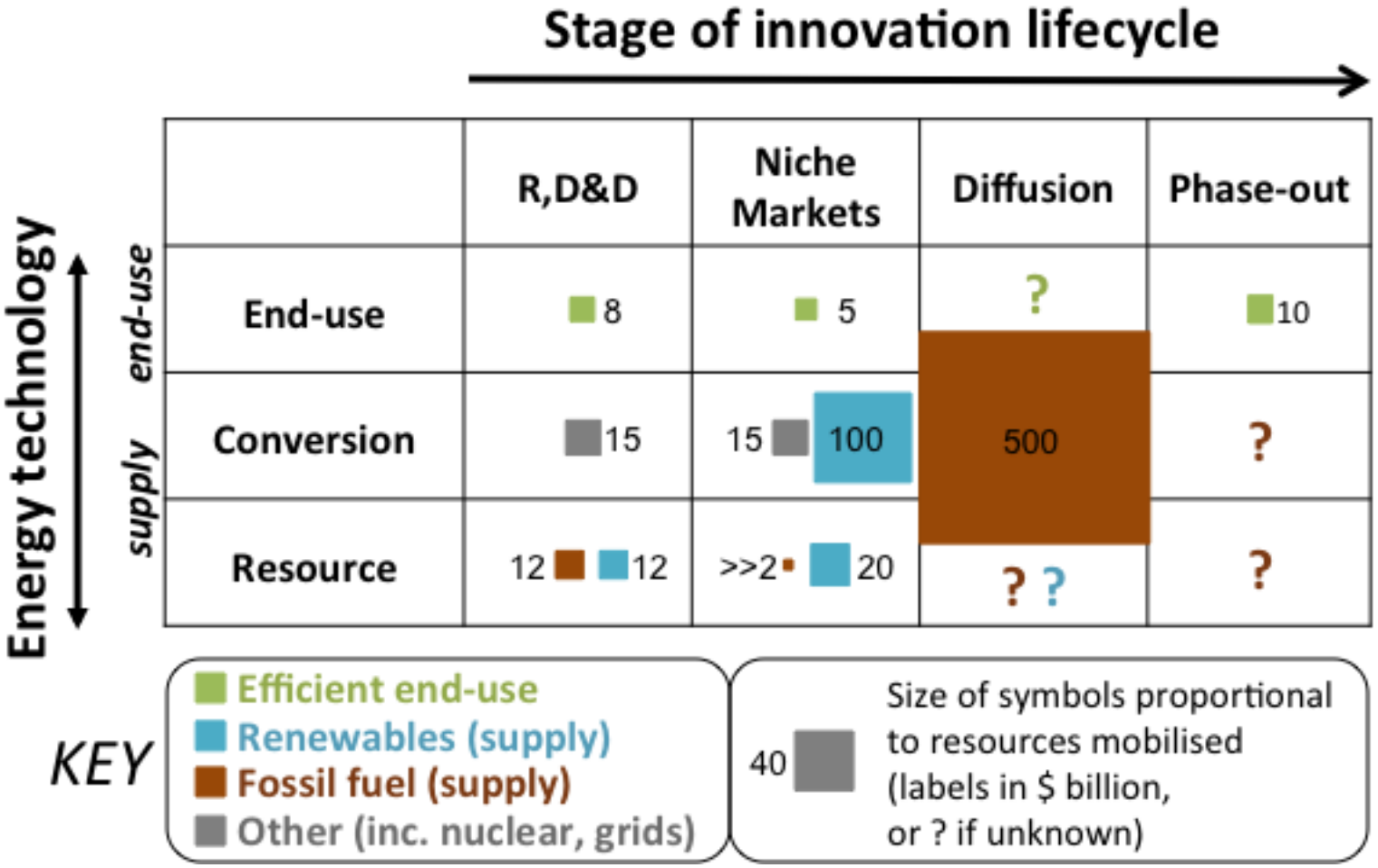
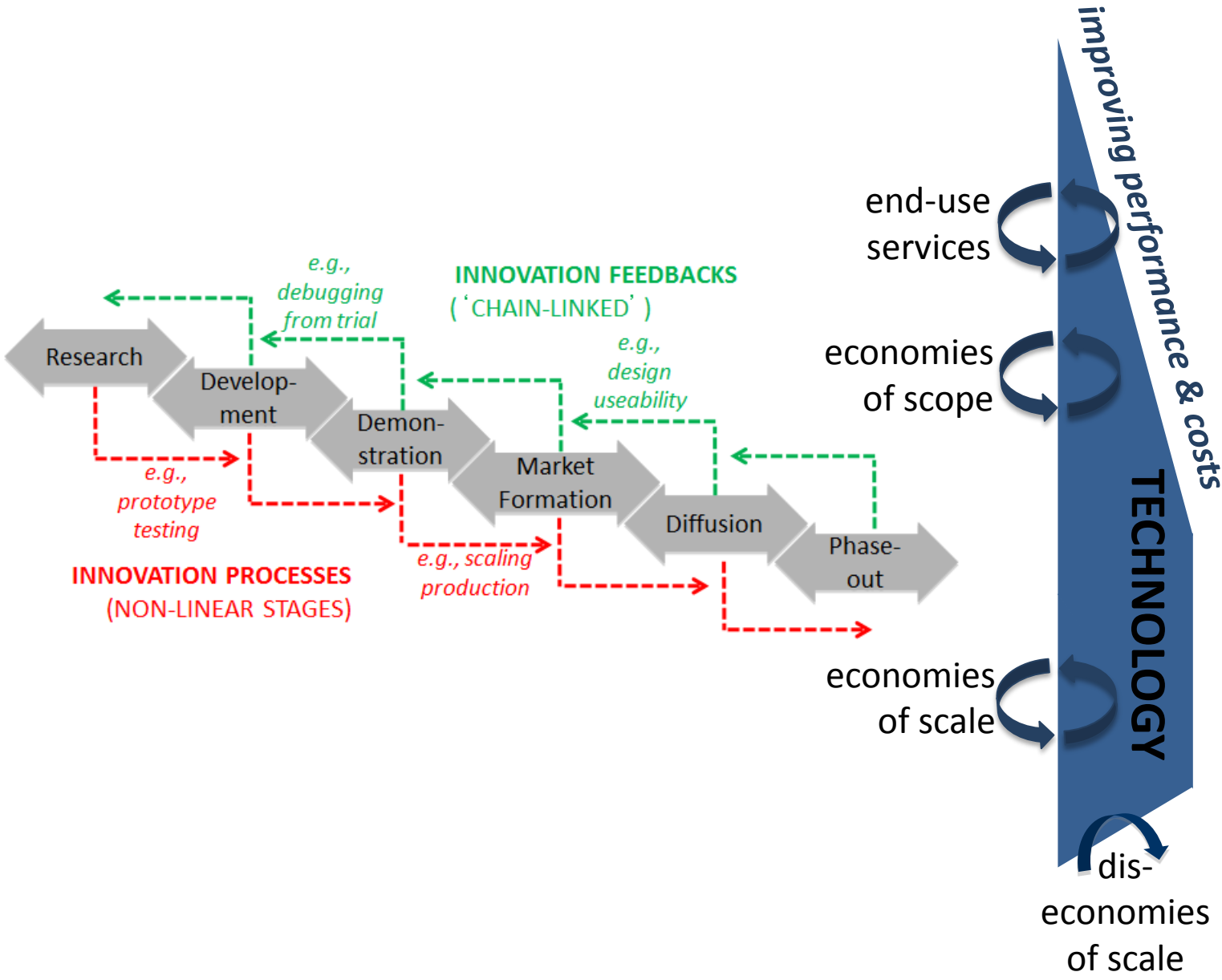
increasing mobilization
RESOURCES
legacy of failure
public policy
Resource mobilisation

Current Public ETIS Policy Focus (policy-induced resource mobilization, billion US$2005)



Source: Wilson/Grubler/Gallagher/Nemet, *Nature CC* 2012


improving performance & costs
TECHNOLOGY
end-use services
economies of scope
economies of scale
dis-economies of scale
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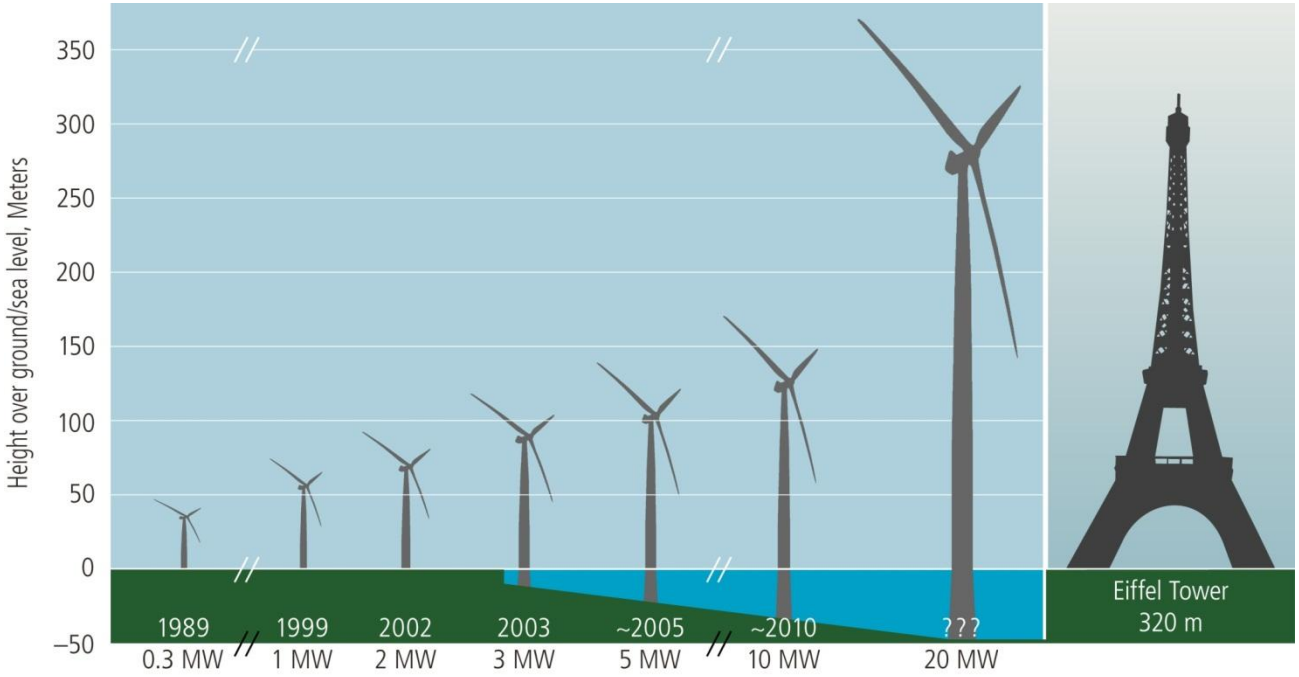
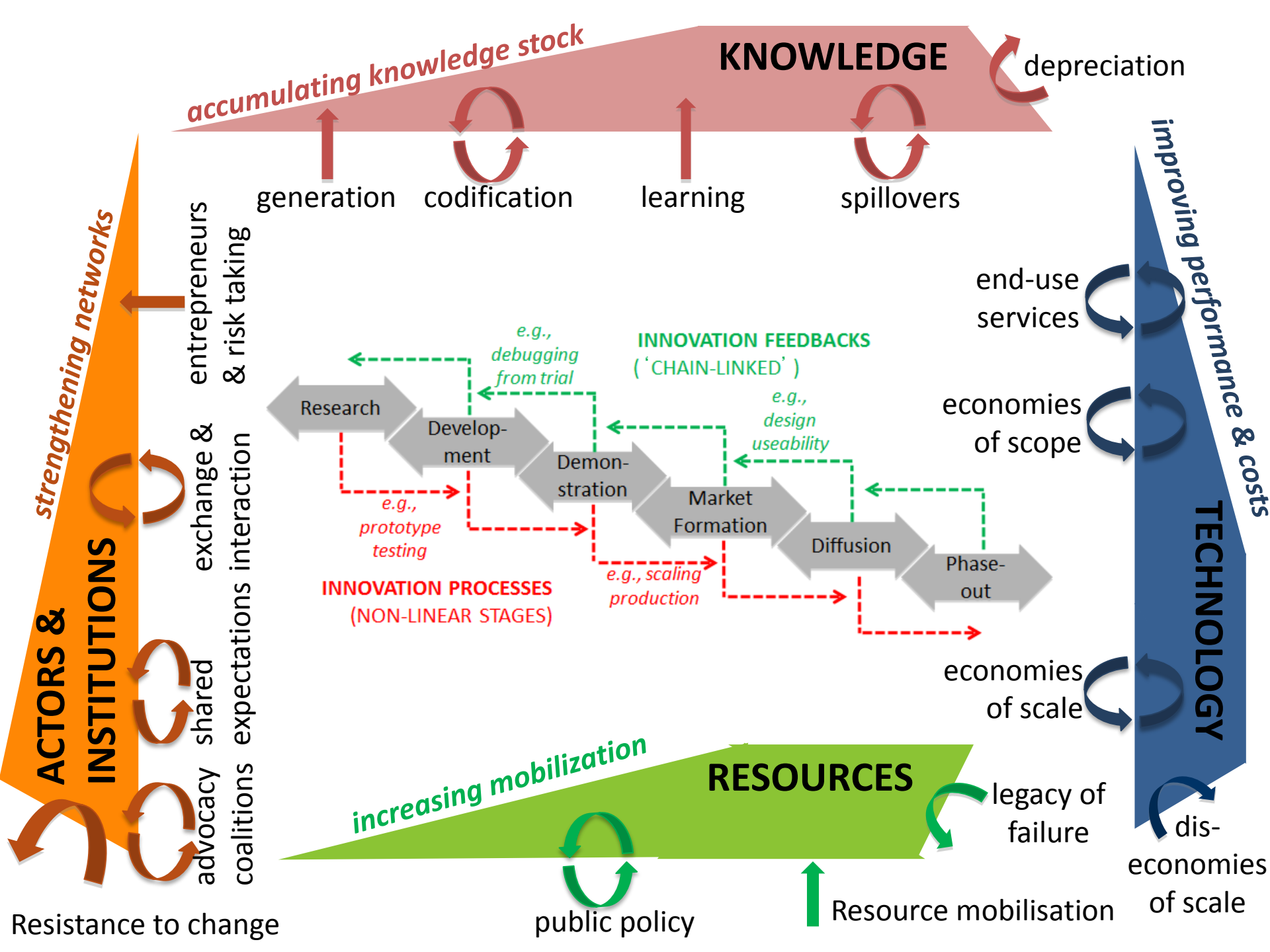
Opening the Black Box of “Learning”: Example Wind



Learning Rates US Wind Turbines	experience measure	
	cum MW	cum Units
costs uncorrected	15.0	26.9
costs corr. for scale economies	8.6	15.9

Source: Grubler/Wilson, in press, and ALPS-2012 Report


accumulating knowledge stock
KNOWLEDGE
depreciation
generation
codification
learning
spillovers
strengthening networks
improving performance & costs
ACTORS & INSTITUTIONS
TECHNOLOGY
entrepreneurs & risk taking
exchange & interaction
shared expectations
advocacy coalitions
Resistance to change
e.g., debugging from trial
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RESOURCES
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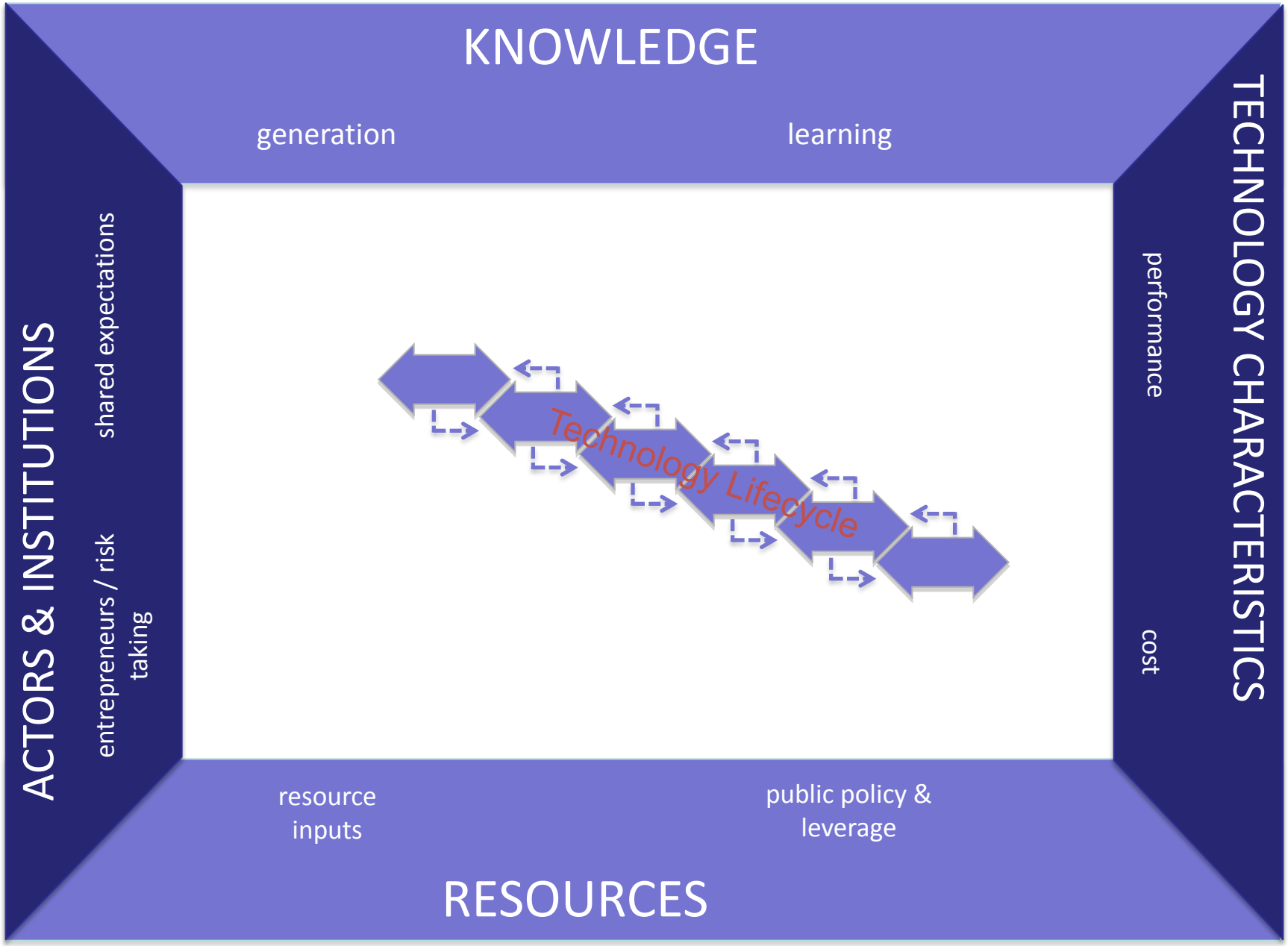
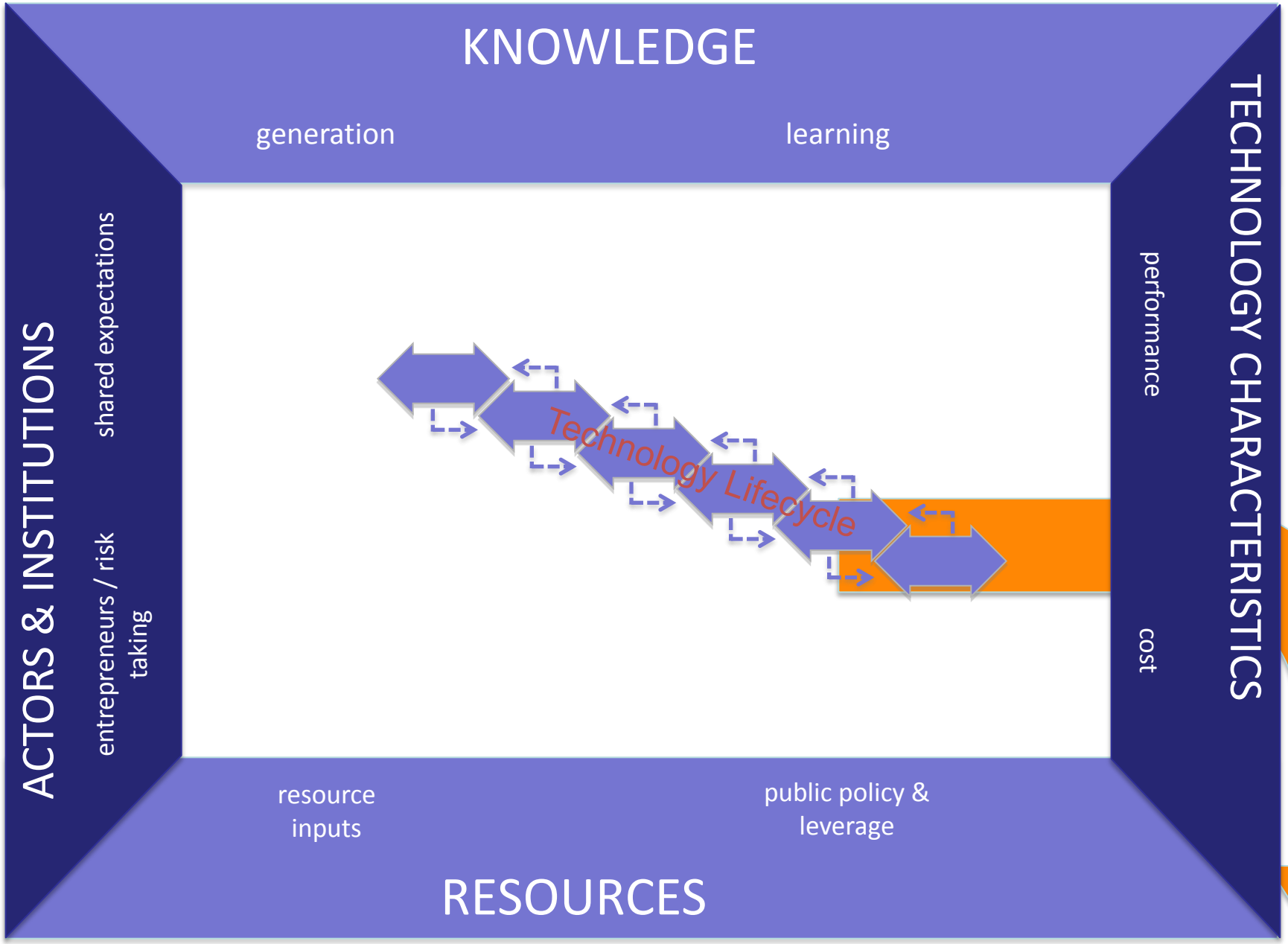
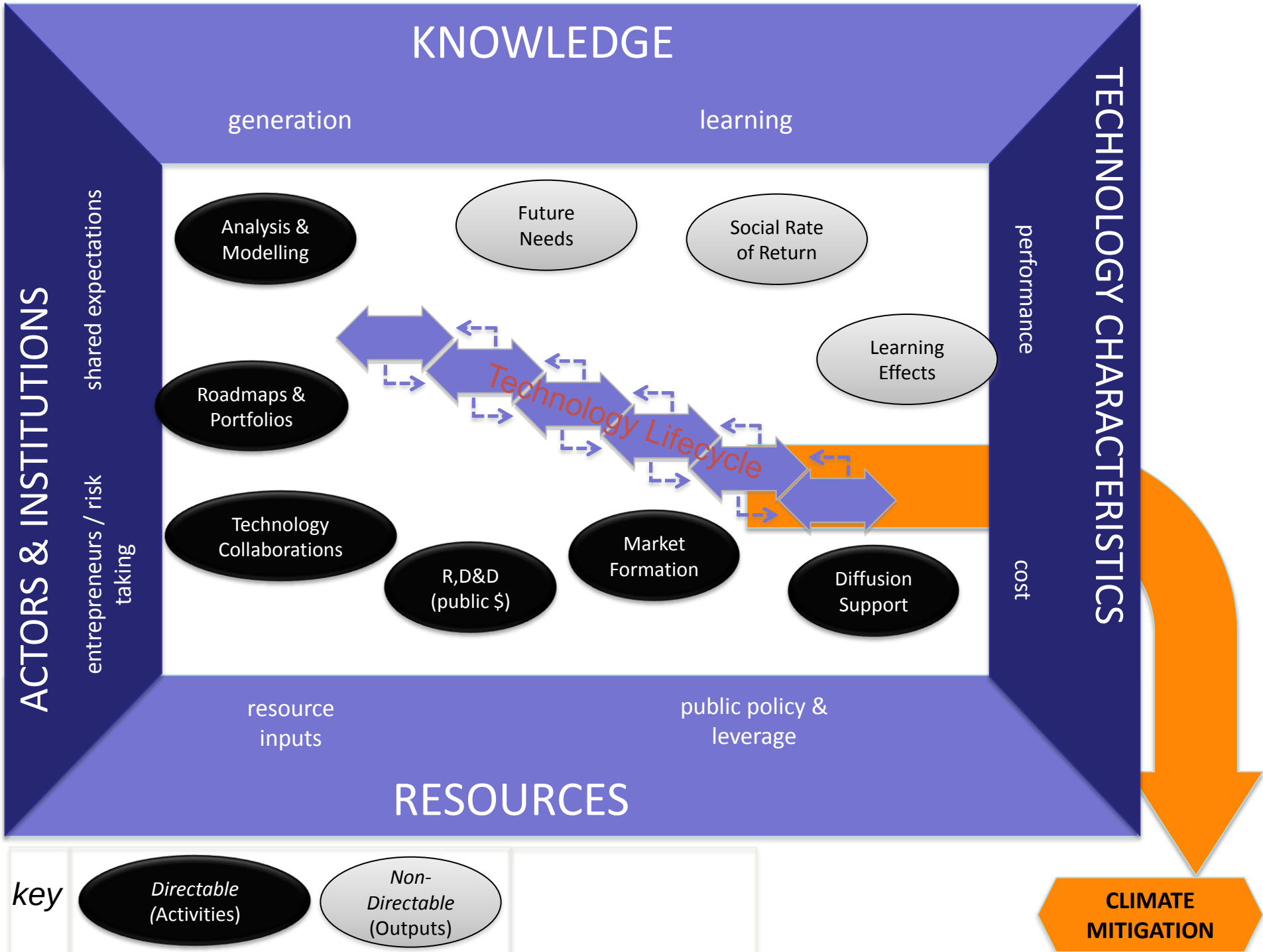
public policy
Resource mobilisation


KNOWLEDGE
generation
learning
ACTORS & INSTITUTIONS
shared expectations
entrepreneurs / risk taking
TECHNOLOGY CHARACTERISTICS
performance
cost
Technology Lifecycle
resource inputs
public policy & leverage
RESOURCES



CLIMATE MITIGATION


KNOWLEDGE
generation
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ACTORS & INSTITUTIONS
shared expectations
entrepreneurs / risk taking
TECHNOLOGY CHARACTERISTICS
performance
cost
Analysis & Modelling
Future Needs
Social Rate of Return
Learning Effects
Roadmaps & Portfolios
Technology Lifecycle
Technology Collaborations
R,D&D (public $)
Market Formation
Diffusion Support
resource inputs
public policy & leverage
RESOURCES
key
Directable (Activities)
Non-Directable (Outputs)
CLIMATE MITIGATION

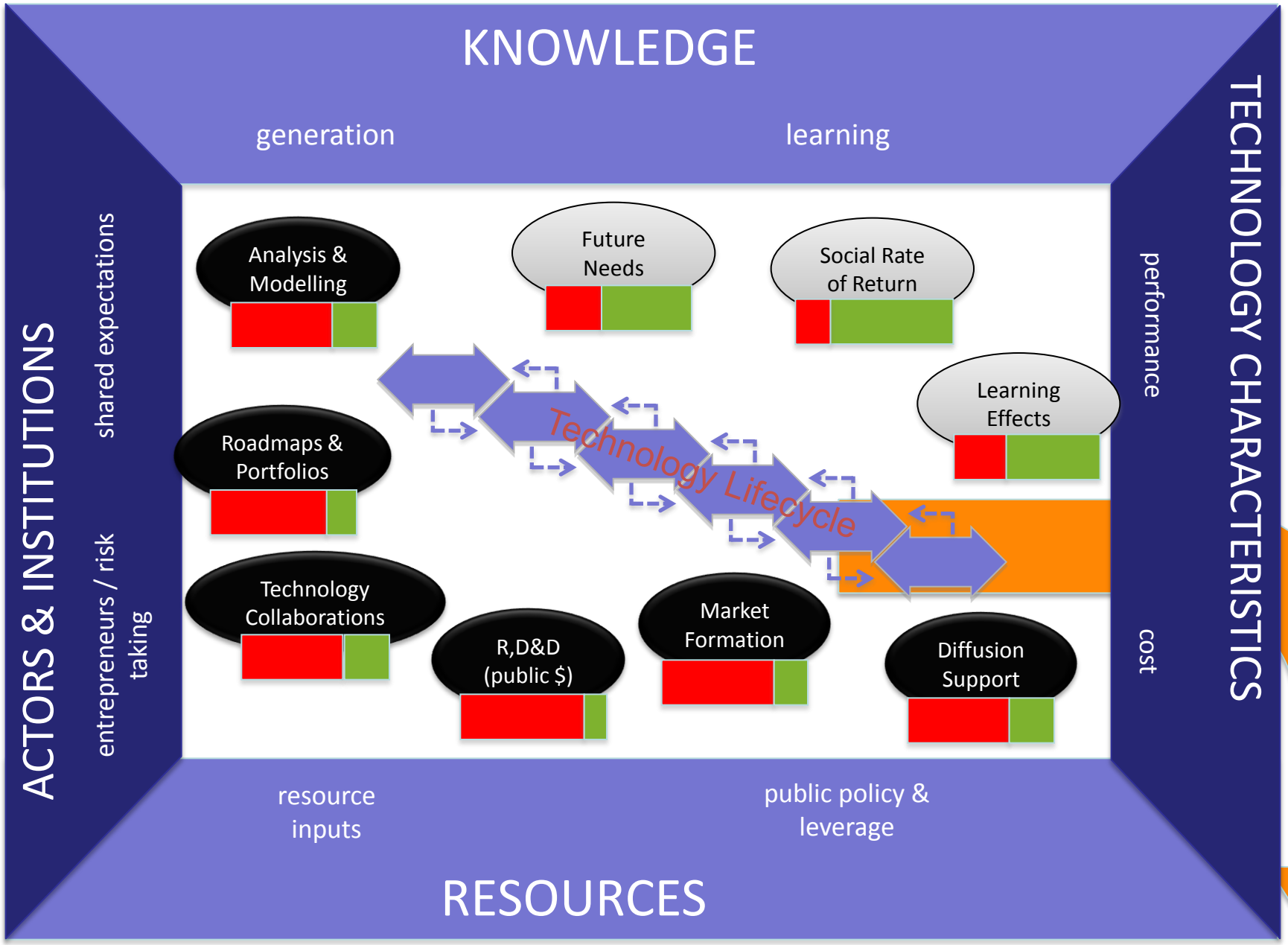
ETIS Inputs vs Outputs (US, Billion US$)

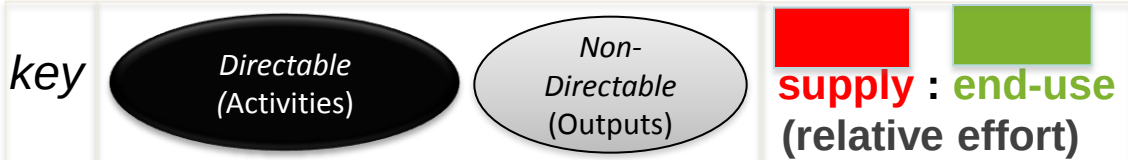
Input: R&D (2008$)

	public	private	Total
End-use	0.5	0.1(?)	0.6
Fossil supply	0.7	1.2	1.9
Non-fossil supply	1.5	0.1	1.6
Other & Supply Infrastructure	1.4	1.2	2.6
Total	4.1	2.6	6.7
End-use as % of Total	12%	4%	9%

Output: Social Rates of Return

	28 historical case studies 1978-2000 (1999$)		7 scenario assessments 2006-2050 (2005$)	
	End-use	Supply	End-use	Supply
Costs	0.4	1.1	0.9	1.8
Economic benefits	30.0	10.8	6.5 – 28.5	6.6 – 7.6
Env.&security benefits	3.2 – 21	? – 60	n.a.	n.a.
C/B Ratio 1	75	10	7 – 32	~4
C/B Ratio 2	83 –128	10 – 64	n.a.	n.a.





CLIMATE MITIGATION

Alternative Technology Strategies

- Not only new and improved technologies, but new systemic innovation environment that
- Maximizes knowledge generation, preservation and international spillovers
- Provides aligned and stable incentives
- Invests into more diversified, risk tolerant portfolios, especially more into:
  energy end-use and efficiency
  more “granular” technology options

Unit Scales of Technology: “granular” vs. “lumpy”

World in 2010	installed capacity	average unit size	numbers in use
	GW	MW/unit	units
nuclear PPL	372	850	437
coal PPL	1627	350	4,649
oil PPL	559	150	3,727
gas PPL	1168	100	11,680
wind turbines	238	1.5	158,667
solar PV modules	70	0.00012	583,333,333
passenger aircraft	1989	100	19,890
passenger cars	70780	0.1	707,800,000
electric bicycles (1)	36	0.0003	120,000,000
television sets	146	0.00006	2,425,000,000
CFL lightbulbs	60	0.000015	4,000,000,000
mobile phones	27	0.000005	5,400,000,000

PPL = power plants, (1) China only

Source: ALPS-2012 Report