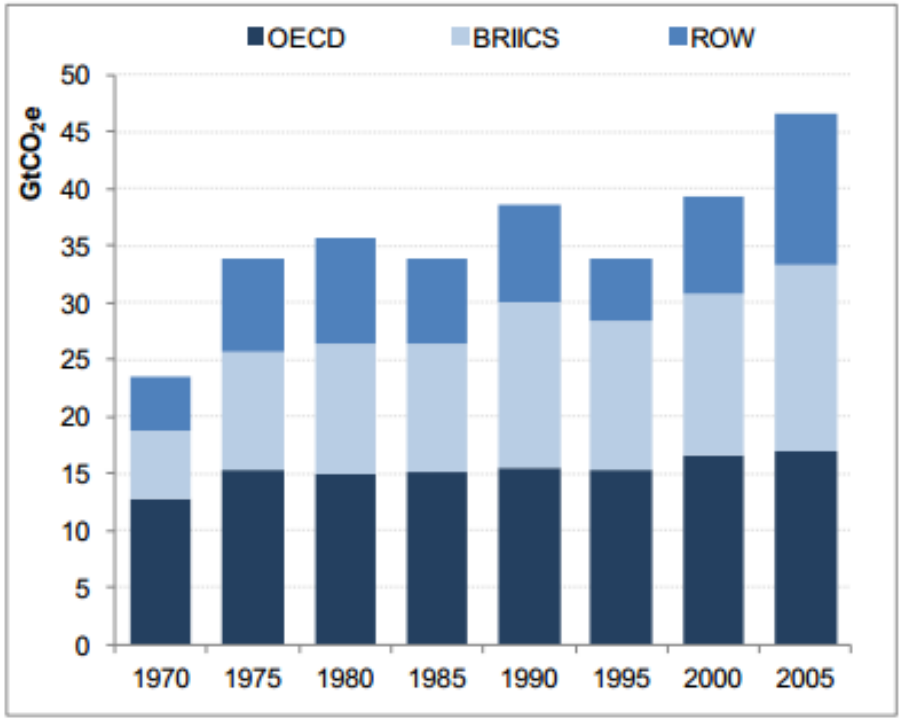
An Innnovation Perspective On Green Transition

Presentation at The Salzburg Energy Seminar & Reform Group Meeting, 26-30 August 2013

Professor Atle Midttun

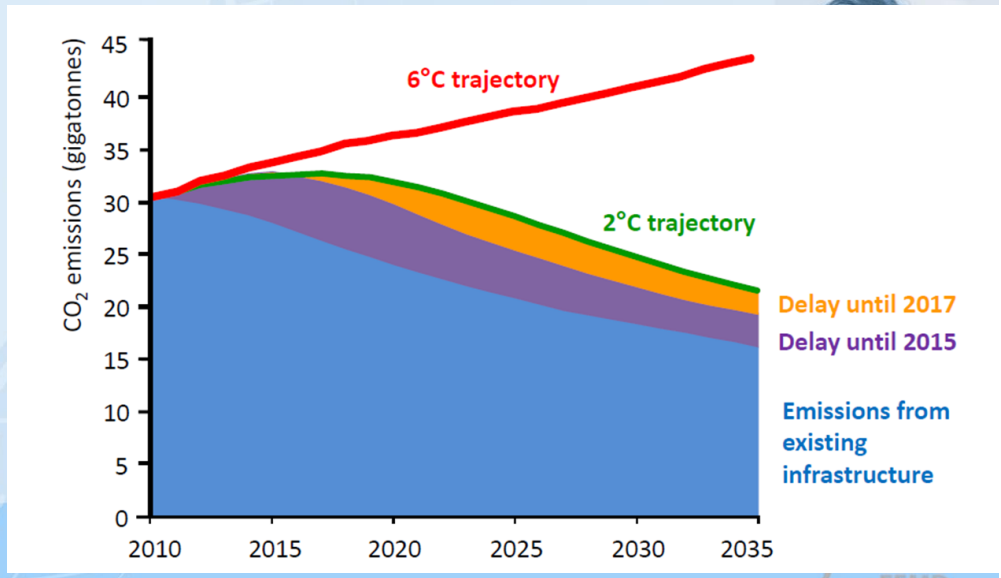
GREEN TRANSITION: ARE WE MAKING IT?

GHG emissions by regions:1970-2005



Source: OECD

IEA Scenarios



Source: IEA – World Energy Outlook 2012

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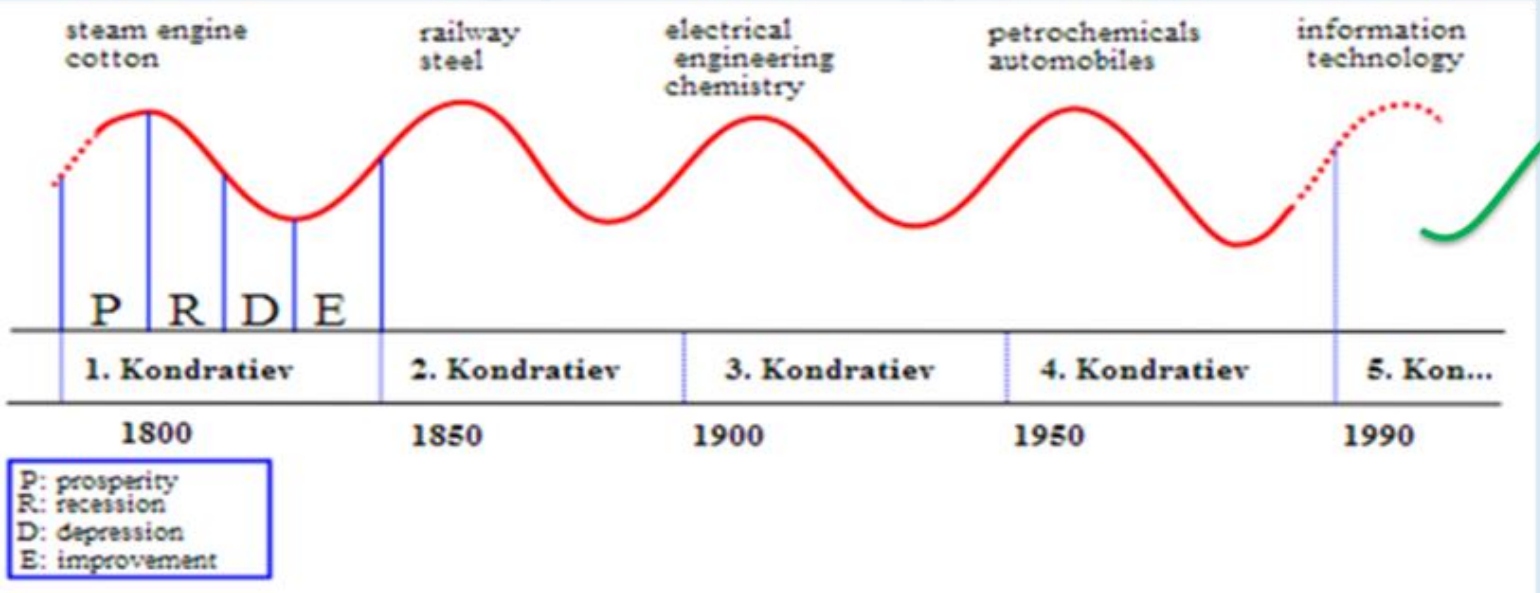
EFMD EQUIS ACCREDITED

Ecomodernity, a new Kondratiev Cycle?



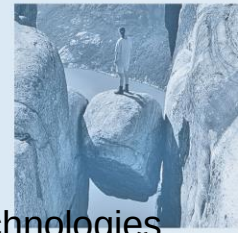
Green Growth ?

Technological Revolutions according to Perez

Table 1. Five successive technological revolutions, 1770s to 2000s

Technological revolution	Popular name for the period	Core country or countries	Big-bang initiating the revolution	Year
FIRST	The 'Industrial Revolution'	Britain	Arkwright's mill opens in Cromford	1771
SECOND	Age of Steam and Railways	Britain (spreading to Continent and USA)	Test of the 'Rocket' steam engine for the Liverpool-Manchester railway	1829
THIRD	Age of Steel, Electricity and Heavy Engineering	USA and Germany forging ahead and overtaking Britain	The Carnegie Bessemer steel plant opens in Pittsburgh, Pennsylvania	1875
FOURTH	Age of Oil, the Automobile and Mass Production	USA (with Germany at first vying for world leadership), later spreading to Europe	First Model-T comes out of the Ford plant in Detroit, Michigan	1908
FIFTH	Age of Information and Telecommunications	USA (spreading to Europe and Asia)	The Intel microprocessor is announced in Santa Clara, California	1971

Source: Perez (2002)

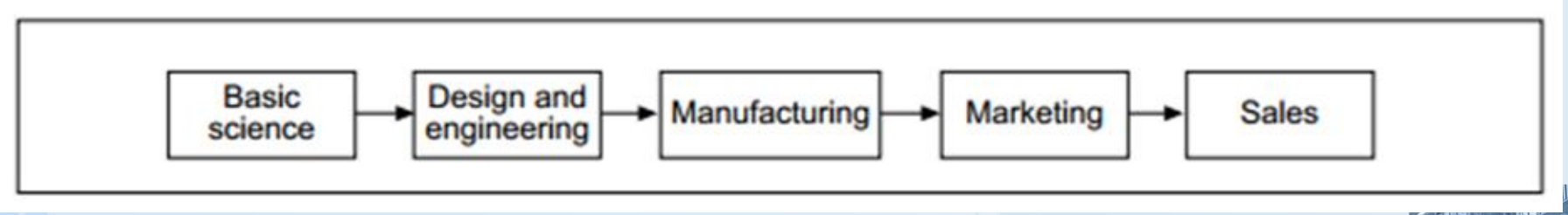


What distinguishes a TR from a random collection of technology systems and justifies conceptualizing it as a revolution are two basic features.

1. The strong interconnectedness and interdependence of the participating systems in their technologies and markets.
2. The capacity to transform profoundly the rest of the economy (and eventually society).

Green Transition From an Innovation Perspective

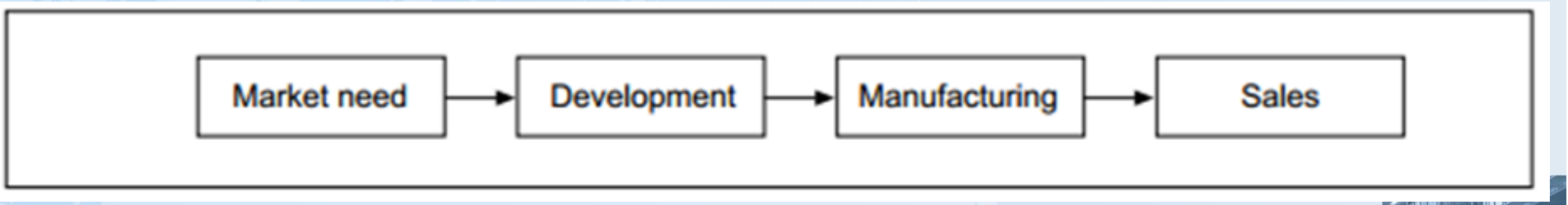
Technology Push



From Rothwell 1994

- Big Science to drive Green transition:
  - Nuclear
  - NASA Solar
  - CCS ?
  - Geoscience
- Problems
  - Over-confidence in science to deliver
  - Underestimation of commercial realities
  - Underestimation of consumer and societal preferences

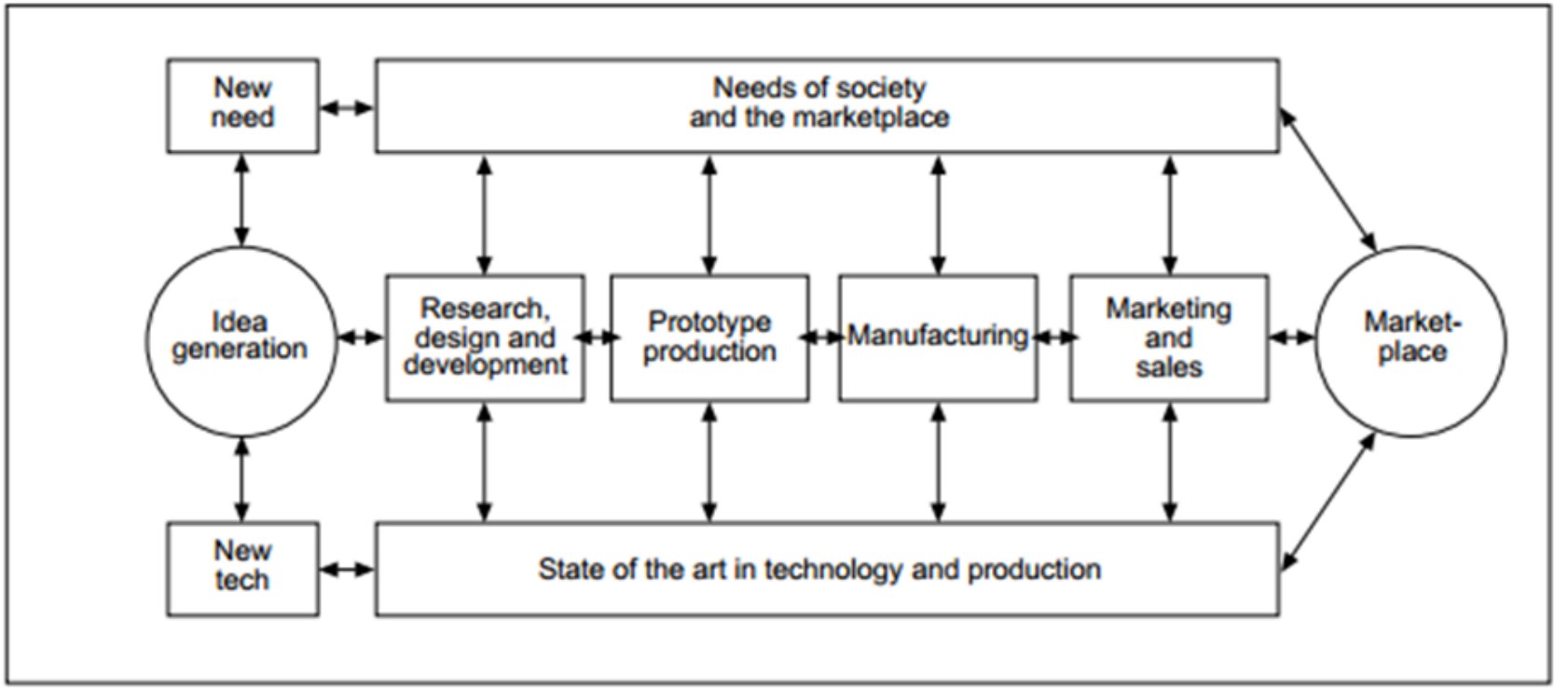
Demand Pull



From Rothwell 1994

- Markets to drive Green transition:
  - Green consumers
  - Niche markets
  - CO_2 markets
- Problems
  - Over-confidence in consumer engagement
  - Underestimation of need for iterative dynamics

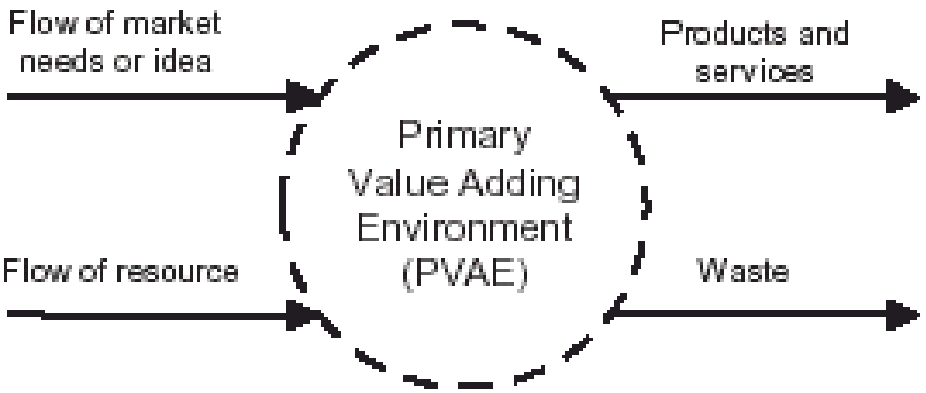
The Coupling Model



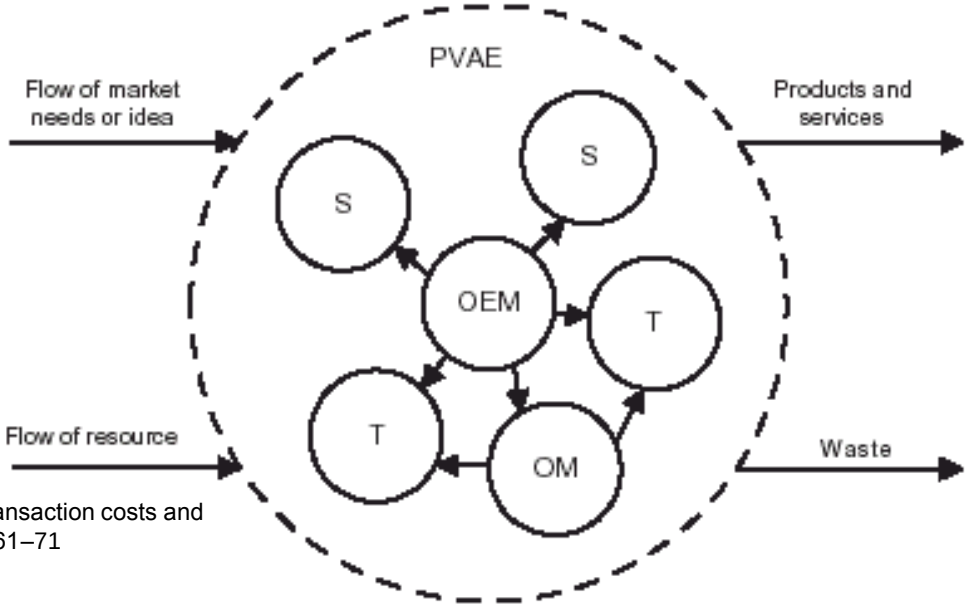
From Rothwell 1994

Complex Industrial transformation processes

The integrated company (Chandler)



The ”outsourced” value creation system - Open innovation

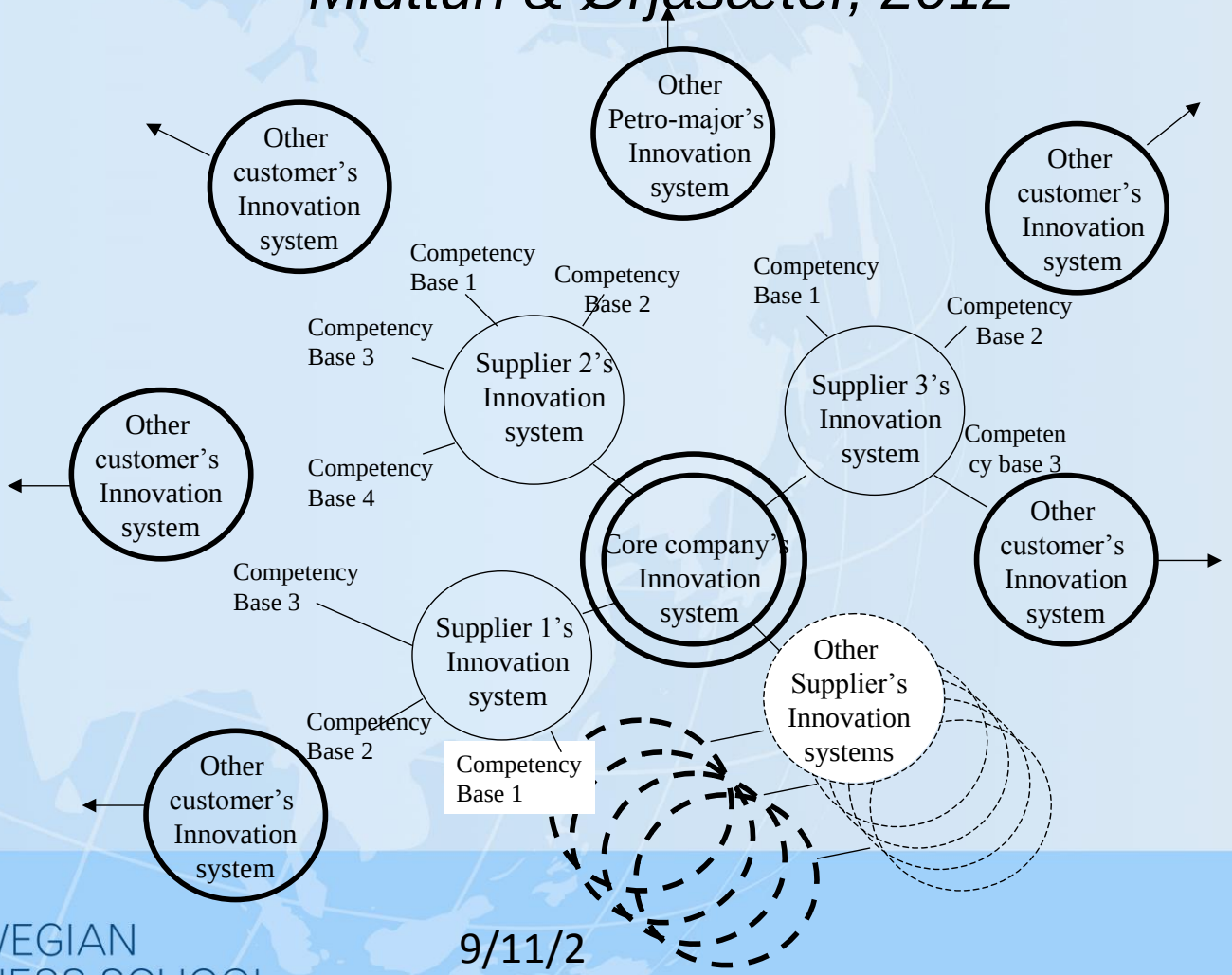


Ian McCarthy Angela Anagnostou “The impact of outsourcingon the transaction costs and boundaries of manufacturing” Int. J. Production Economics 88 (2004) 61–71

OEM =original equipment manufacturer
S = service organization
T = transportation organization
OM = other manufacturer

Organising Innovation: Multiplier effects of industrial systems

Midttun & Ørjasæter, 2012



Bridging Radical and Incremental Innovation

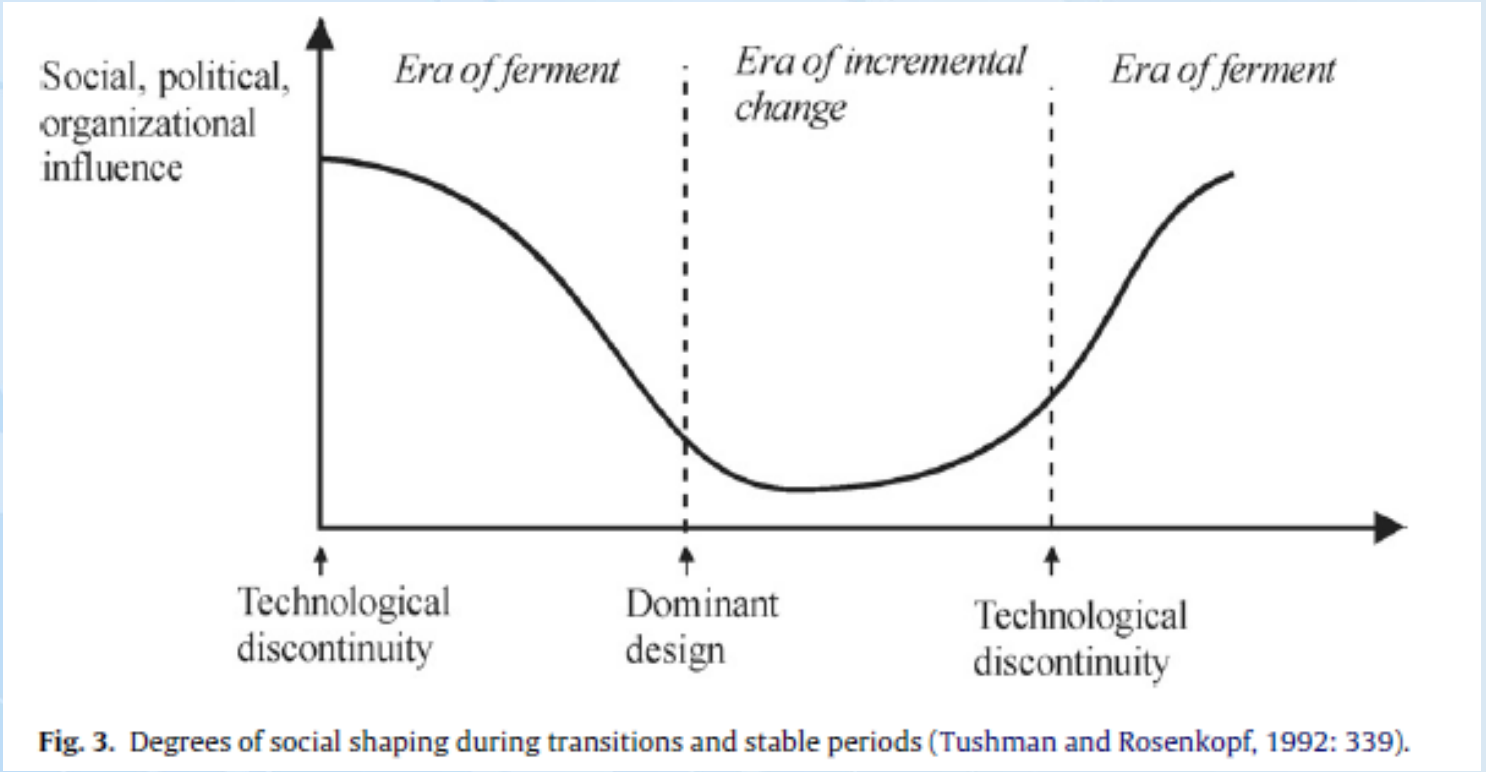


Fig. 3. Degrees of social shaping during transitions and stable periods (Tushman and Rosenkopf, 1992: 339).

Green Cars

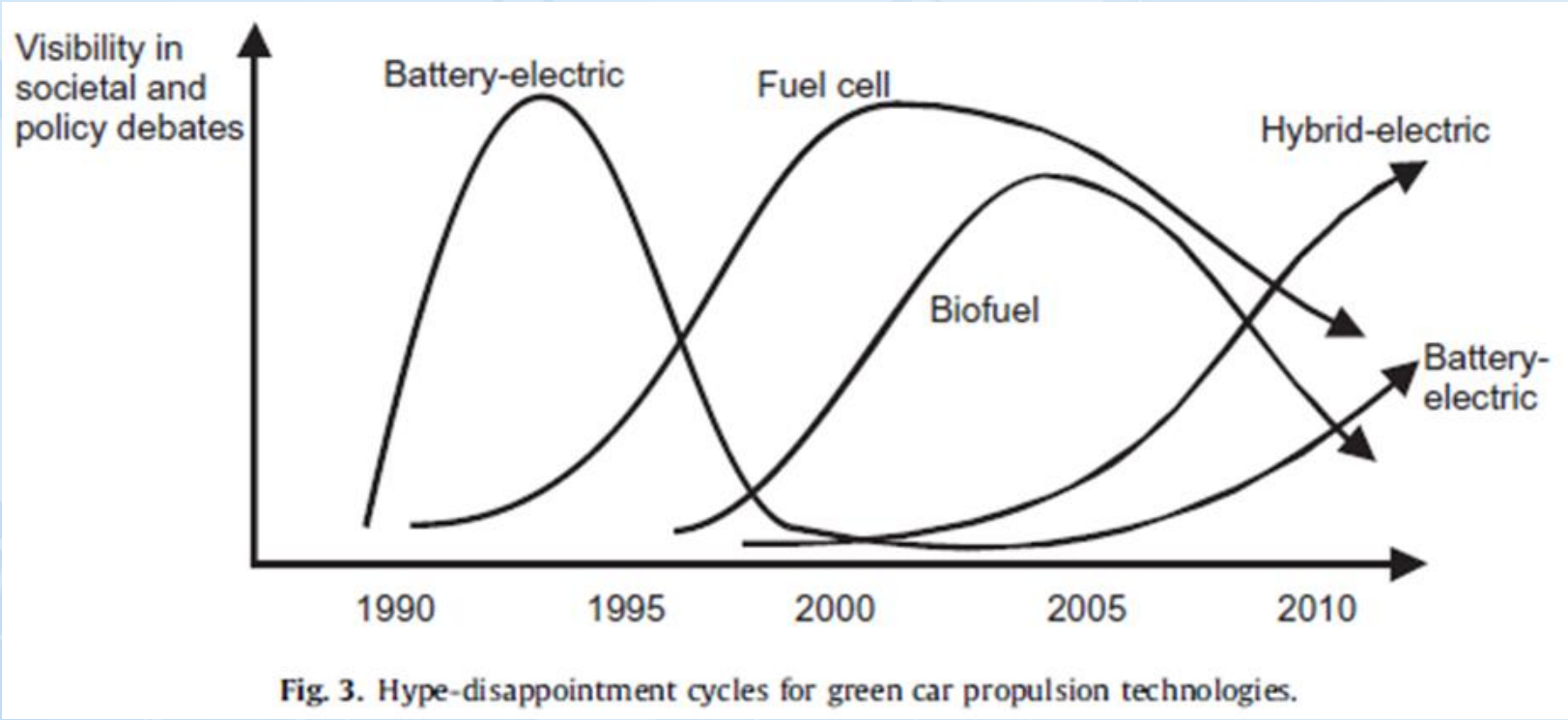


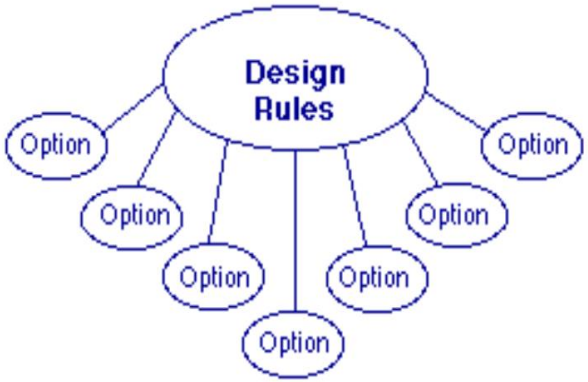
Fig. 3. Hype-disappointment cycles for green car propulsion technologies.

Electric Care Radical or Incremental Innovation?

Modularity Creates Design Options

System Before Modularization

System after Modularization



The Battle of Modernities

Fig. 3. Carbon modernity: generation by source 1973–2010. *Source*: IEA (2011a).

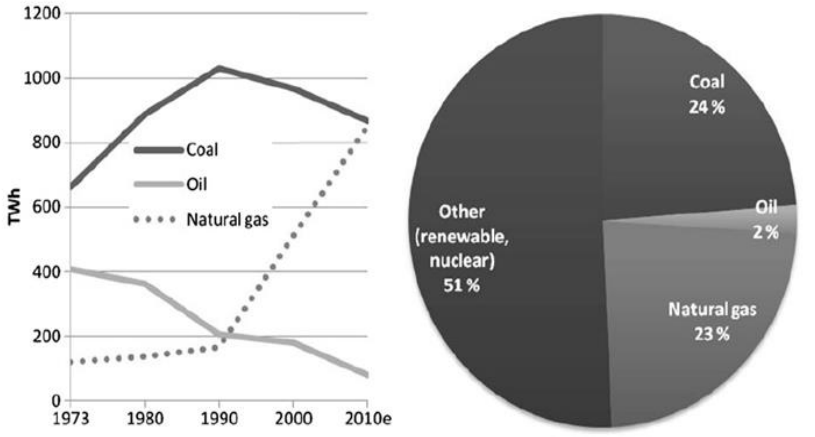


Fig. 6. EU power capacity mix in 2000 and 2011. *Source*: IEA (2011a).

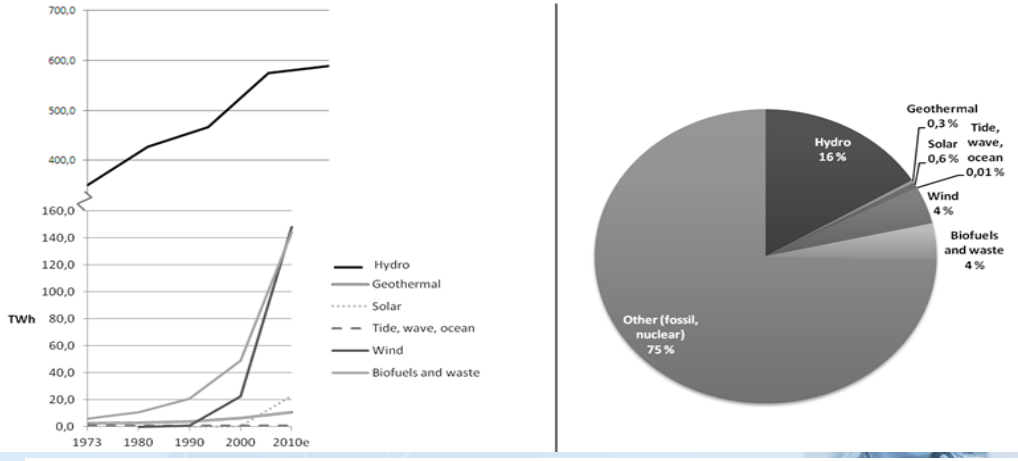
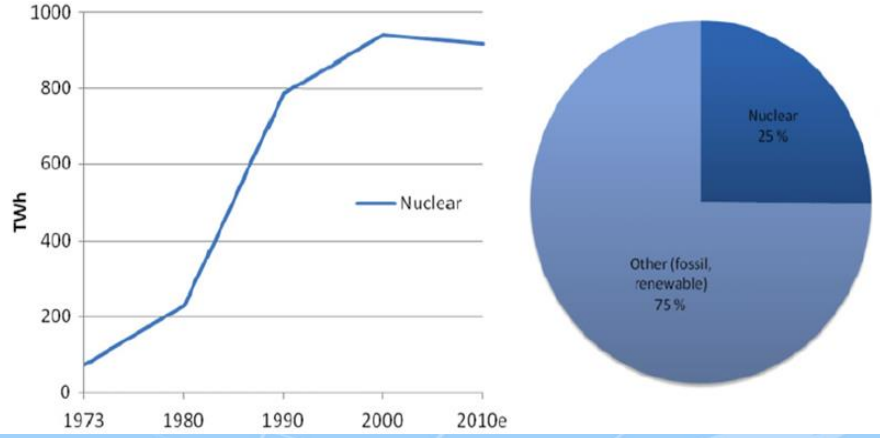
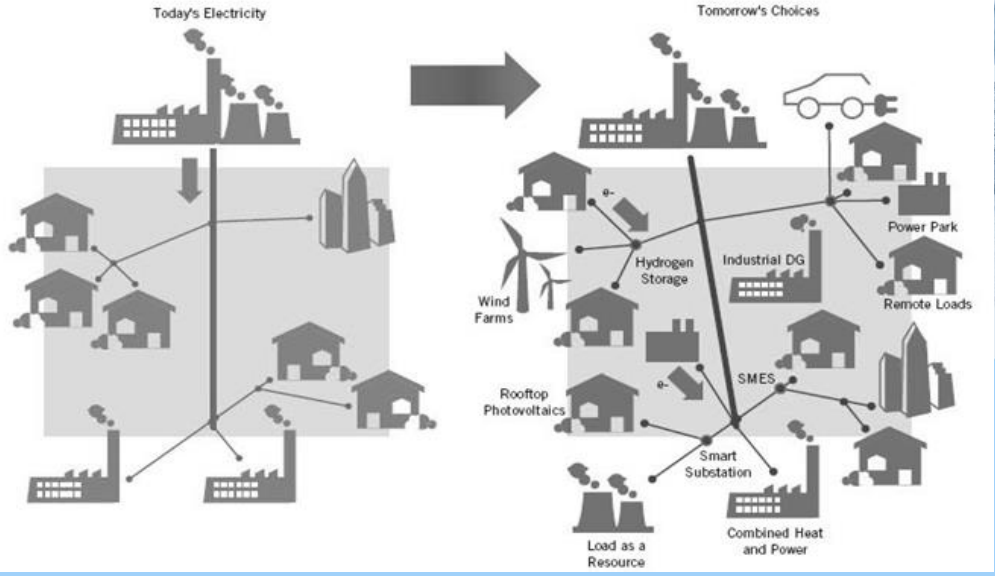
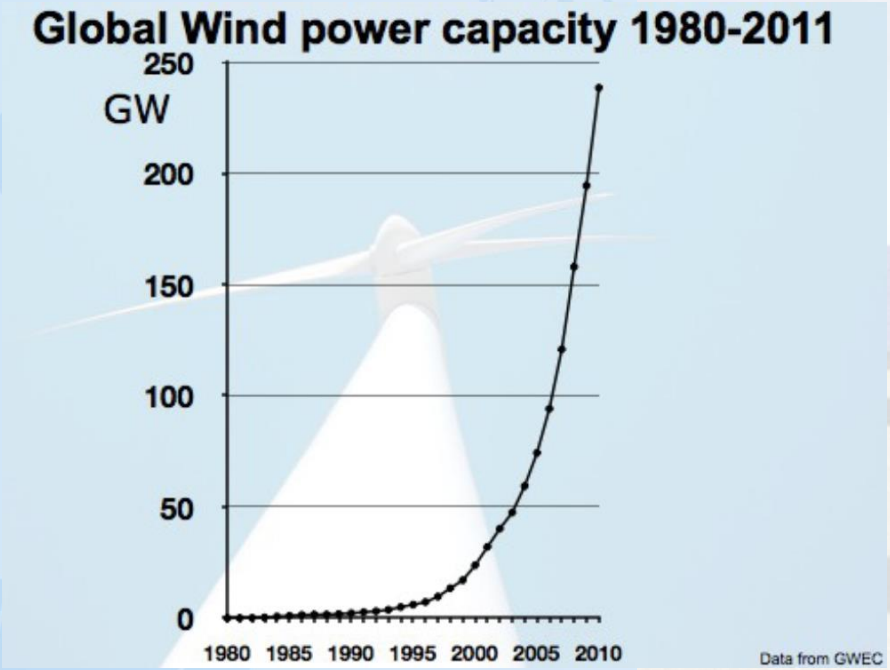


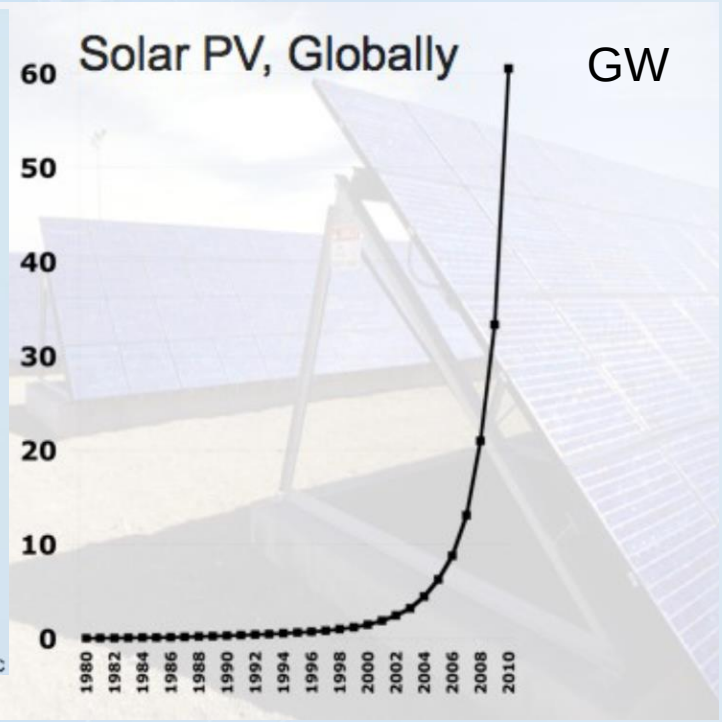
Fig. 4. Nuclear modernity: generation by source, 1973–2010 *Source*: IEA (2011a).

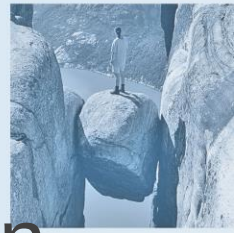




Takeoff for Green Energy

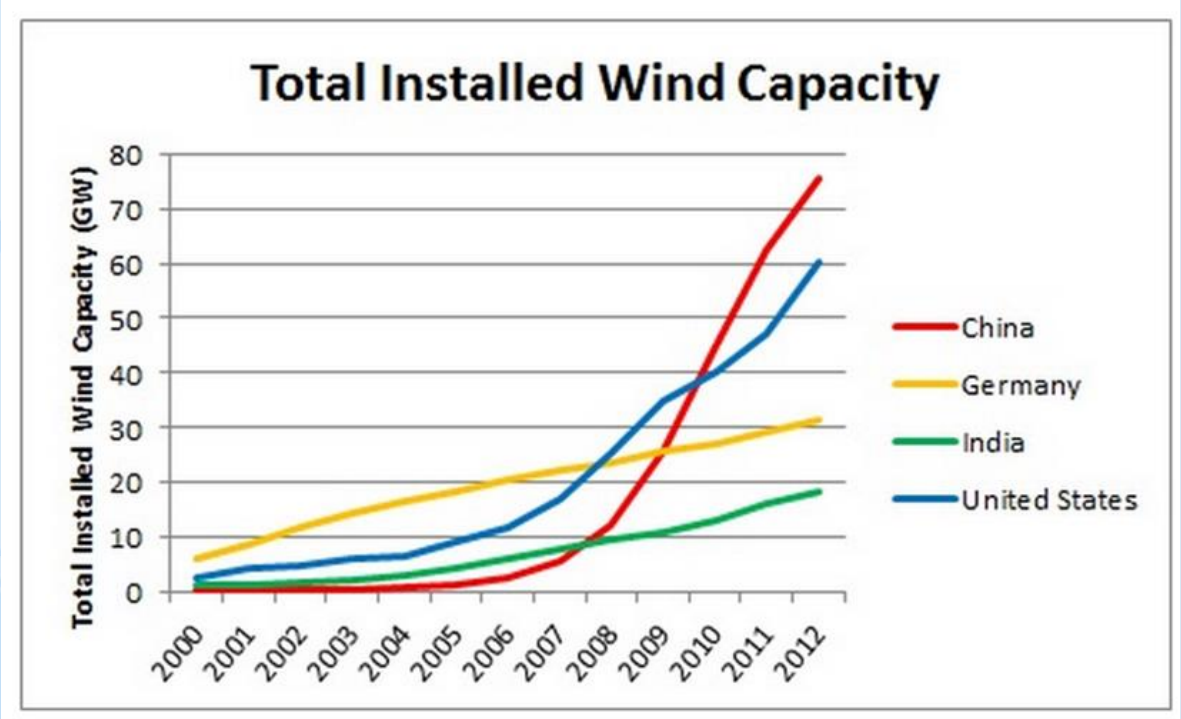






From Kåberger 2012

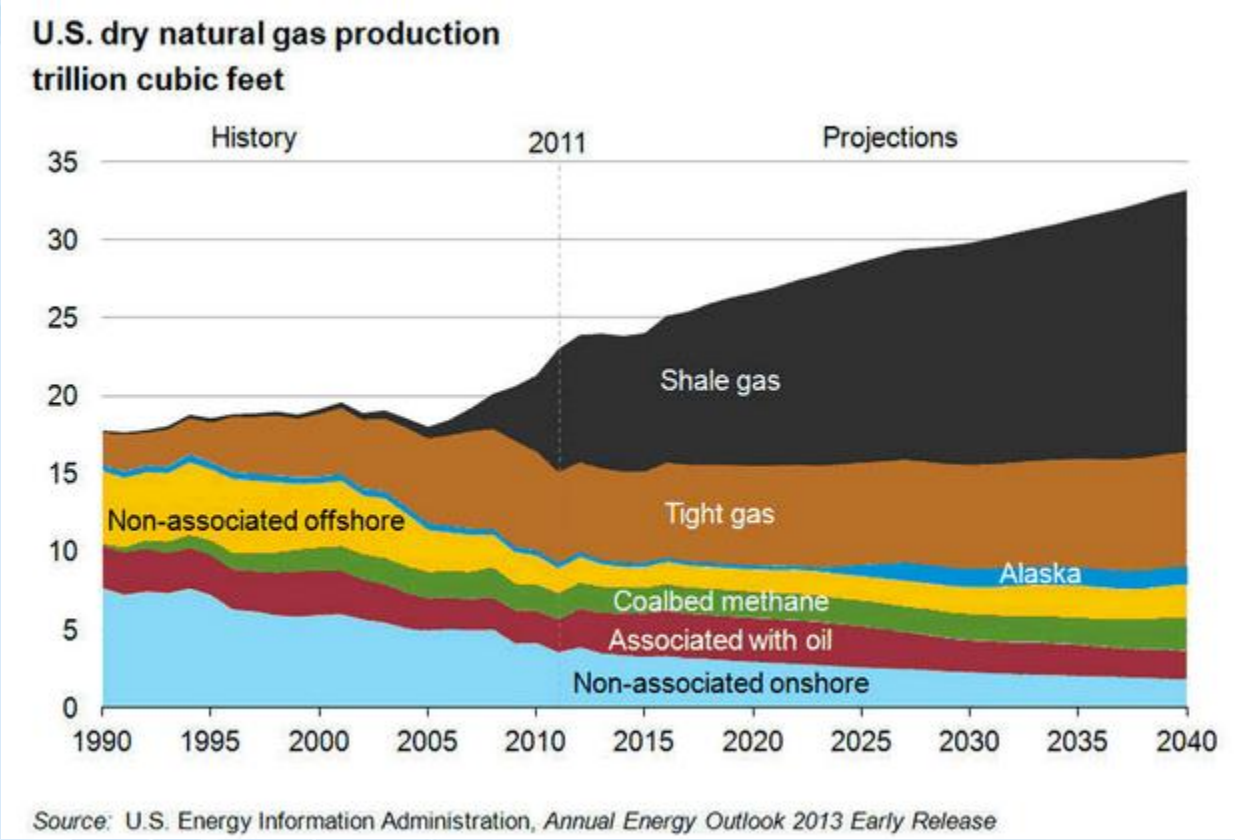
A Result of Policy and Technology Migration



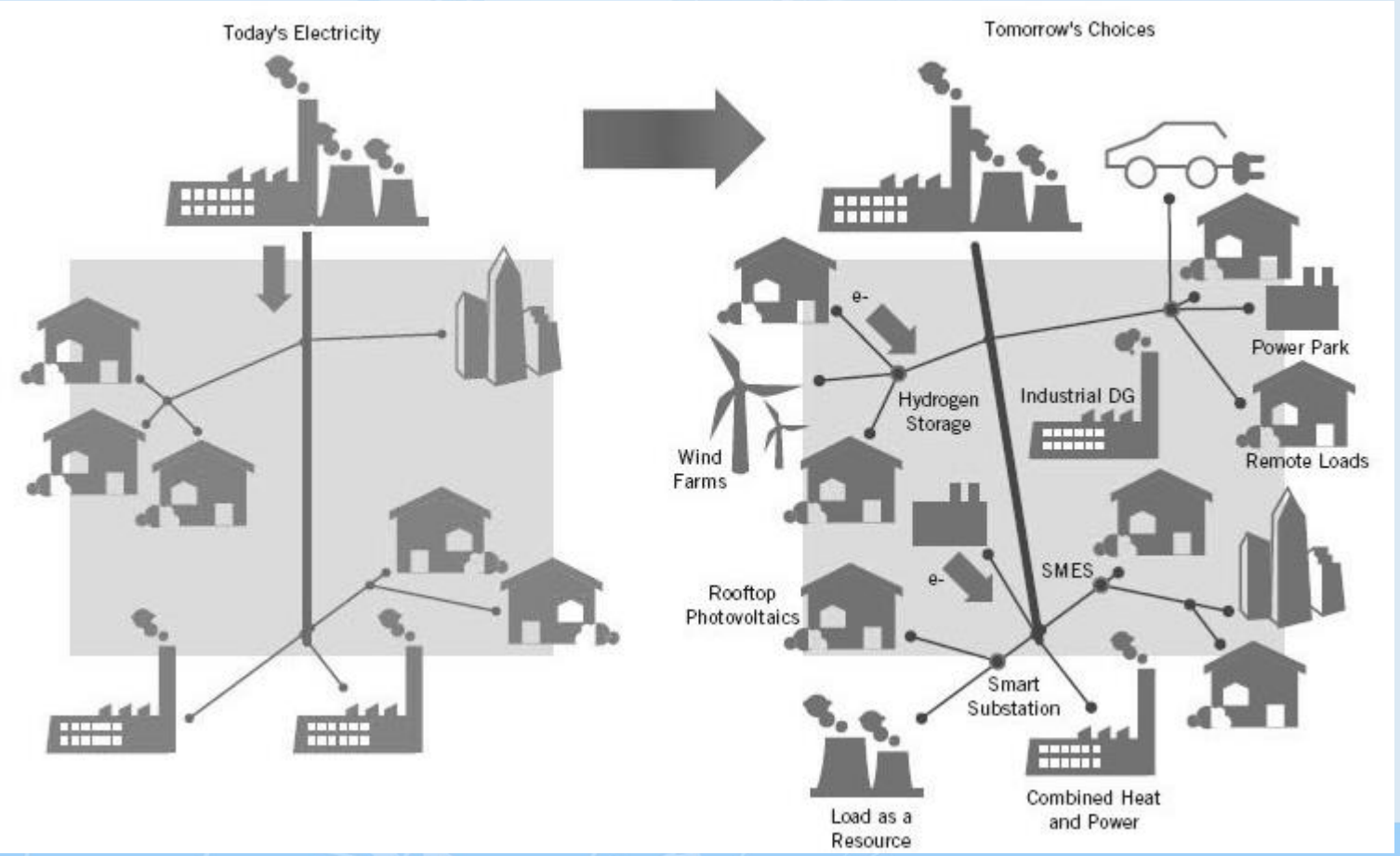
http://www.chinafaqs.org/library/chinafaqs-renewable-energy-china-graphical-overview-2012

Green Fracking?

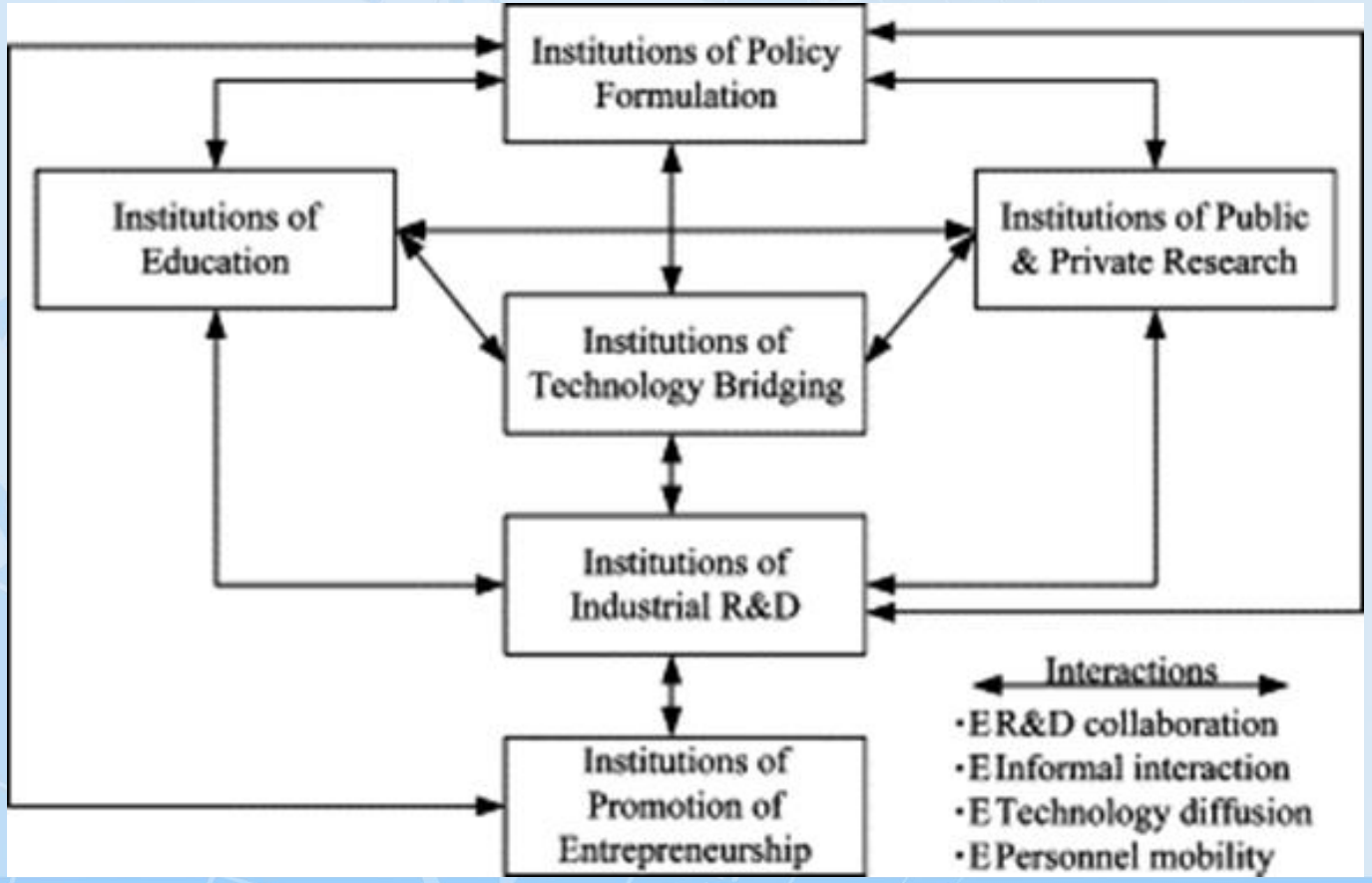
Green fracking in the US?



Smart Grids, crossover between el and IT



The system of Innovation model Bringing in Public Policy



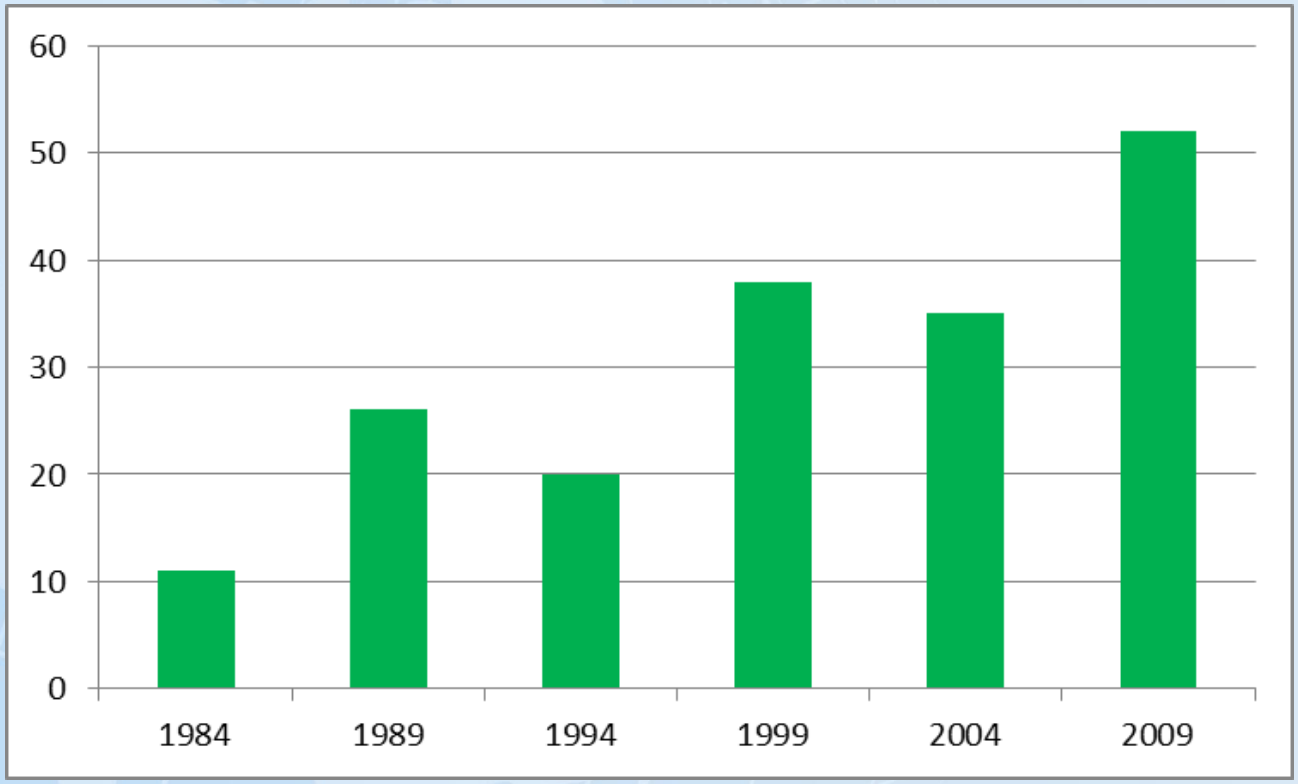
Green Transition and the Kantian Rule

Act only according to that maxim whereby you can, at the same time, will that it should become a universal law

(Foundations of the Metaphysics of Morals 1785)

Acutely important in the age of the Anthroposcene

The Greens in the EU parliament



Source: Wikipedia & Europeangreens.eu

Greening Policies

Road Map 2050

•By 2050: cut emissions to 80% below 1990 levels

Road Map 2050

•achieve a reduction of GHG emissions by 80 %

Remix – 100% renewable electricity is achievable by 2050

Energiewende…

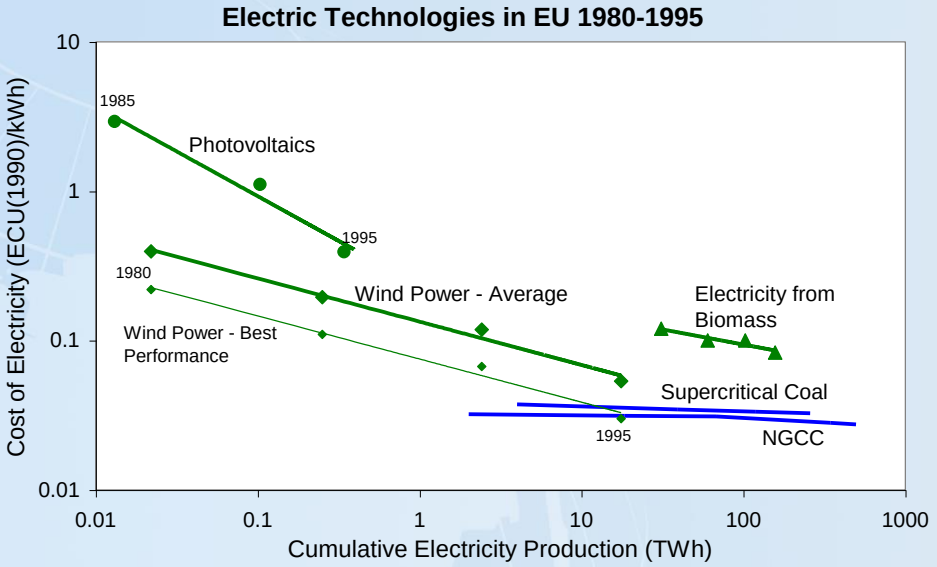
CO2 emission per unit of GDP will be 40-45 percent lower in 2020 than in 2005

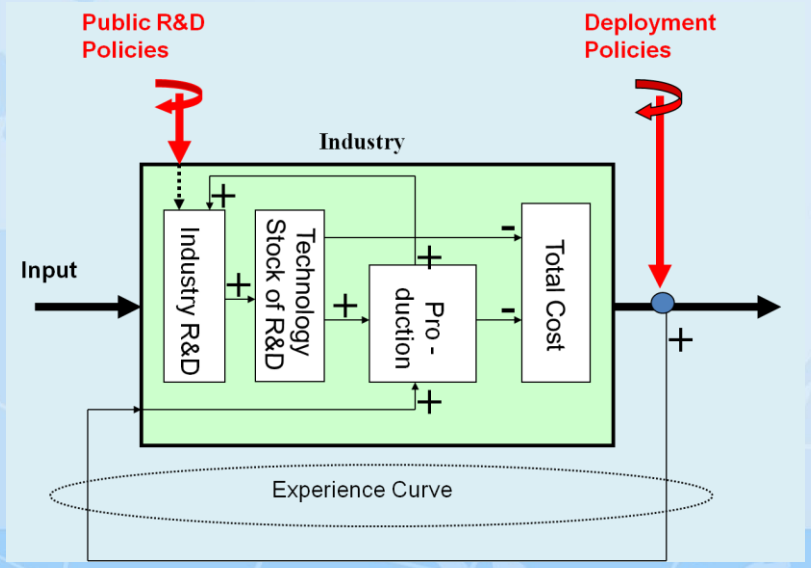
Increase the share of renewable energy in its energy mix to 15 percent by 2020.

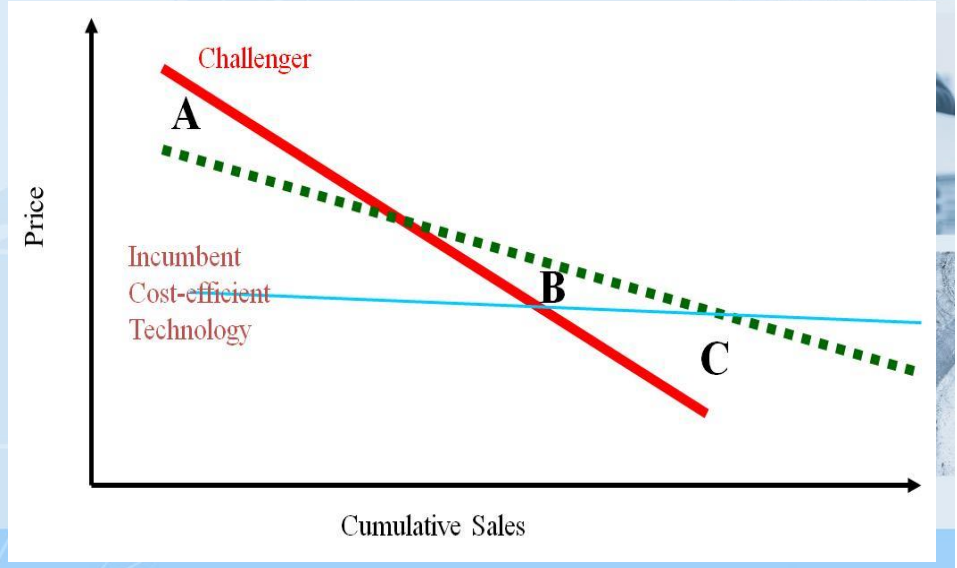
Experiments with circular economies

•Germany, Japan and China are trying out **Circular economies**

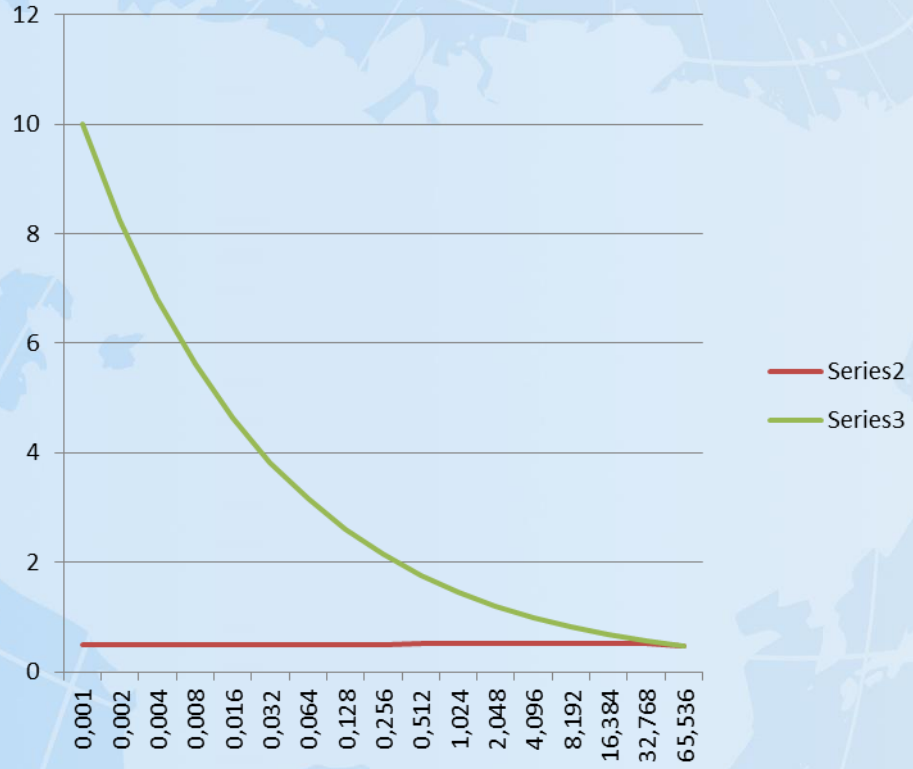
The Dynamics of Experience/ Technology Learning



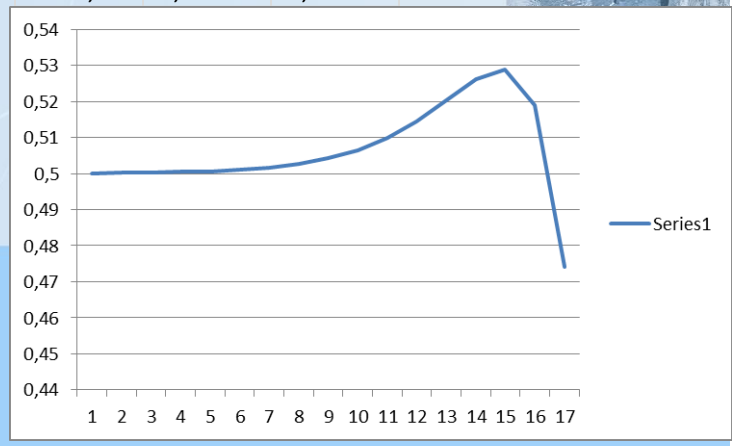




The learning effect



0,001	0,500095	10
0,002	0,500155	8,25
0,004	0,500252	6,80625
0,008	0,500409	5,615156
0,016	0,500661	4,632504
0,032	0,501063	3,821816
0,064	0,501698	3,152998
0,128	0,50269	2,601223
0,256	0,504214	2,146009
0,512	0,506505	1,770458
1,024	0,509837	1,460628
2,048	0,514439	1,205018
4,096	0,52024	0,99414
8,192	0,526228	0,820165
16,384	0,52894	0,676636
32,768	0,519079	0,558225
65,536	0,474137	0,460536



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Dumping Effects of Renewables

Dumping effect of renewables volume

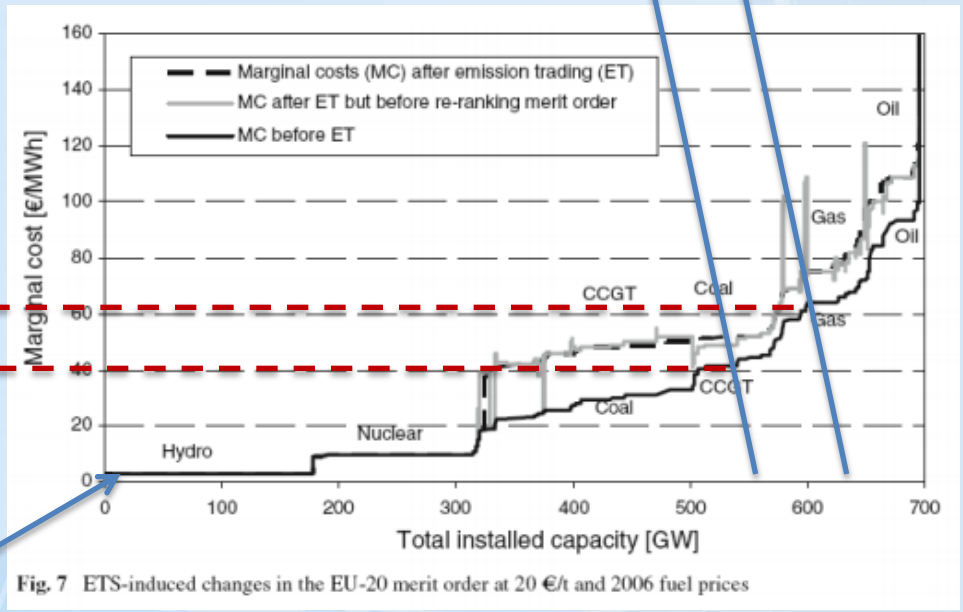


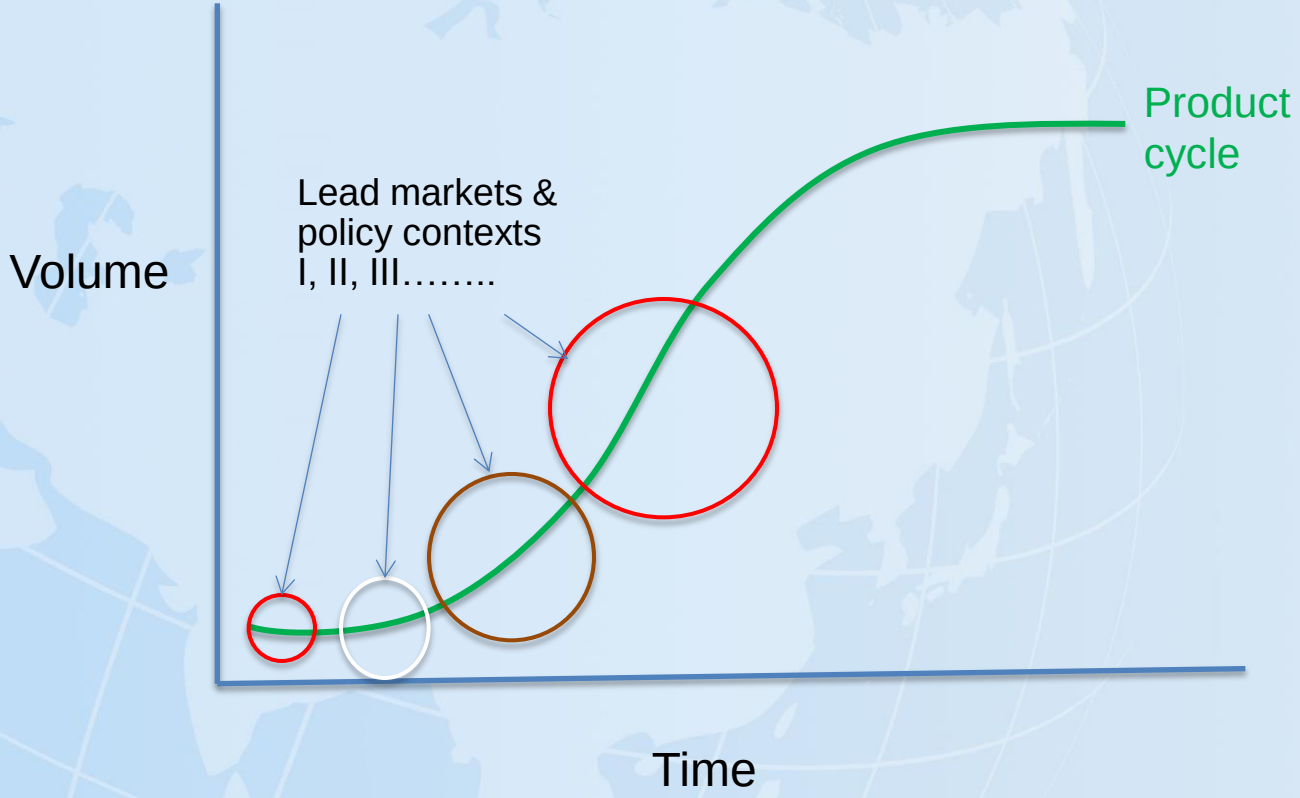
Fig. 7 ETS-induced changes in the EU-20 merit order at 20 €/t and 2006 fuel prices

Dumping effect of renewables

Input renewables
With very low operating costs

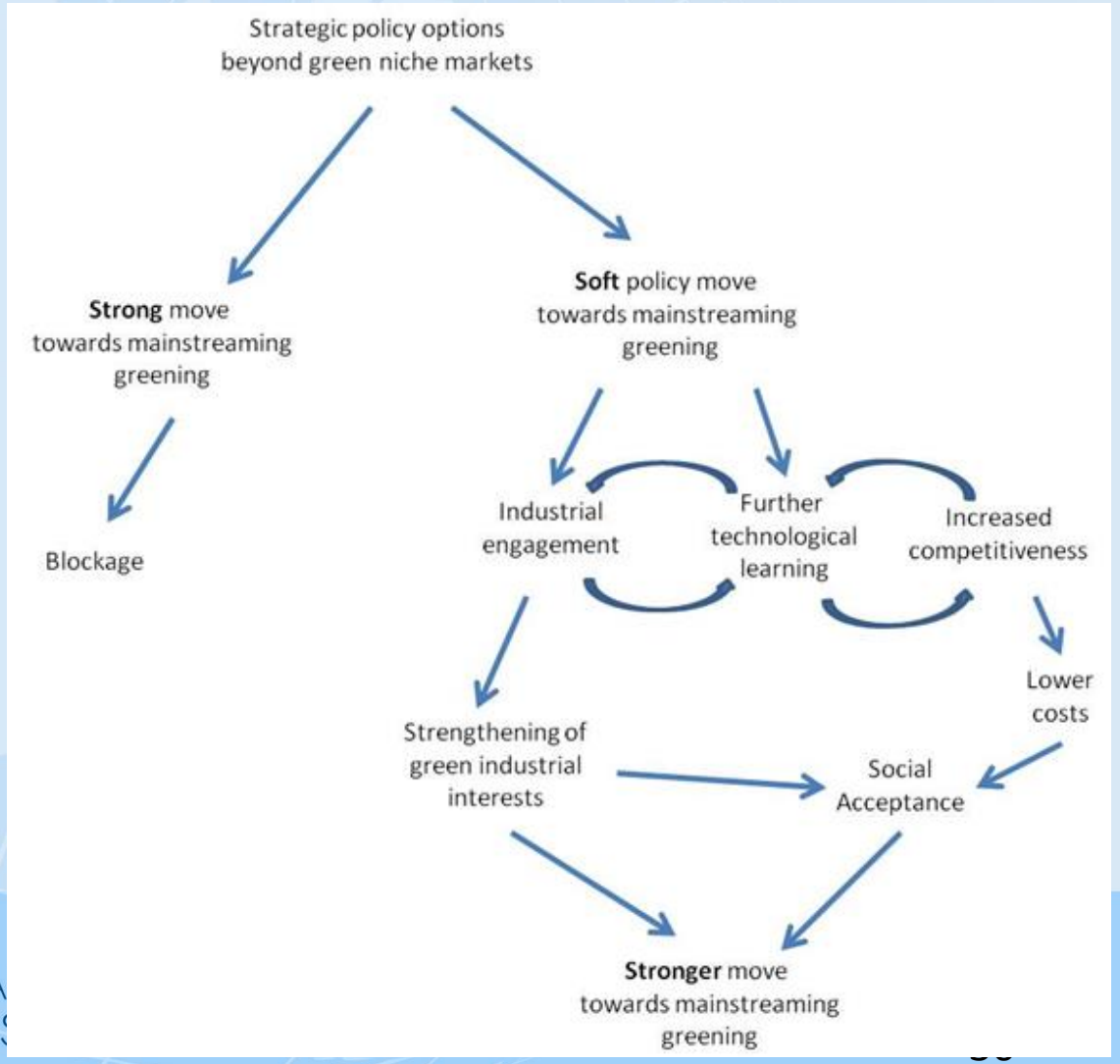
GREENING PROCESSES IN A GLOBALISING ECONOMY

Technology Migration Across Lead Markets



Sequential Lead Markets for PV

The Relay Model



Green Transition on Three Continents

Advanced technological and economic capacities
Greening through replacement
Vested interests and zero sum games
Loose out in volumes to Asia

Rapid growth with eco-efficiency focus
Environmental focus
Massive rollout of new modern capital stock
Taking technological frontier positions in many fields

Unapologetic about growth
Greening must be coupled to development
Options for leapfrogging
But poor infrastructure

THE END

Green Politics EU

Road Map

- By 2050: cut emissions to 80% below 1990 levels through domestic reductions alone.
- Increase the share of energy from renewable sources to 20% (from around 8.5% today) by 2020
- To make the transition towards a low-carbon society EU will invest an additional €270 billion or 1.5% of its GDP annually

Core green policy

- Greenhouse Gas Monitoring and Reporting (2002)
- EU Emissions Trading System (2003)
- Effort Sharing Decision (2009)
- Carbon Capture and Storage (2009)
- Transport/Fuels (1998)
- Ozone Layer Protection (2009)
- Fluorinated Gases (2006)

Source: EU

Green Politics Japan

Road Map

- By 2020: achieve a reduction of GHG emissions by 25% below 1990 levels
- By 2050: achieve a reduction of GHG emissions by 80 %

Core green policy

- 1990-2003: A number of laws and legal systems was passes in order to establish the ‘Recycling-based Society’



Source: OECD

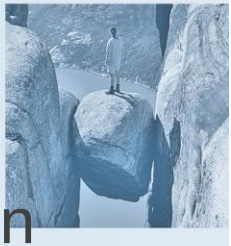
Green Politics China

Road Map

- By 2020, CO2 emission per unit of GDP will be 40-45 percent lower than in 2005
- Energy consumption per unit of GDP will drop by 16 percent from 2010
- China aims to increase the share of renewable energy in its energy mix to 15 percent by 2020.

Core green policy

- 2005: “the State Council’s Opinions on Speeding up the Development of Circular Economy”
- 2005: “Renewable Energy Law”
- 2007: National Action Plan on Climate Change
- 2008, “Circular Economy Promotion Law
- 2009; “The revision of the renewable energy law”
- 2011: Action plan to slow down greenhouse gas emissions in light of its national conditions



Source: Charlie McElwee

Circular Economy China

- The world's third law on circular economy (Germany and Japan)
- 178 pilot units are practicing CE
- In 2010, the output value of resources recycling industry exceeded 1 trillion yuan and the number of employees exceeded 20 million

Green Politics USA

Road maps

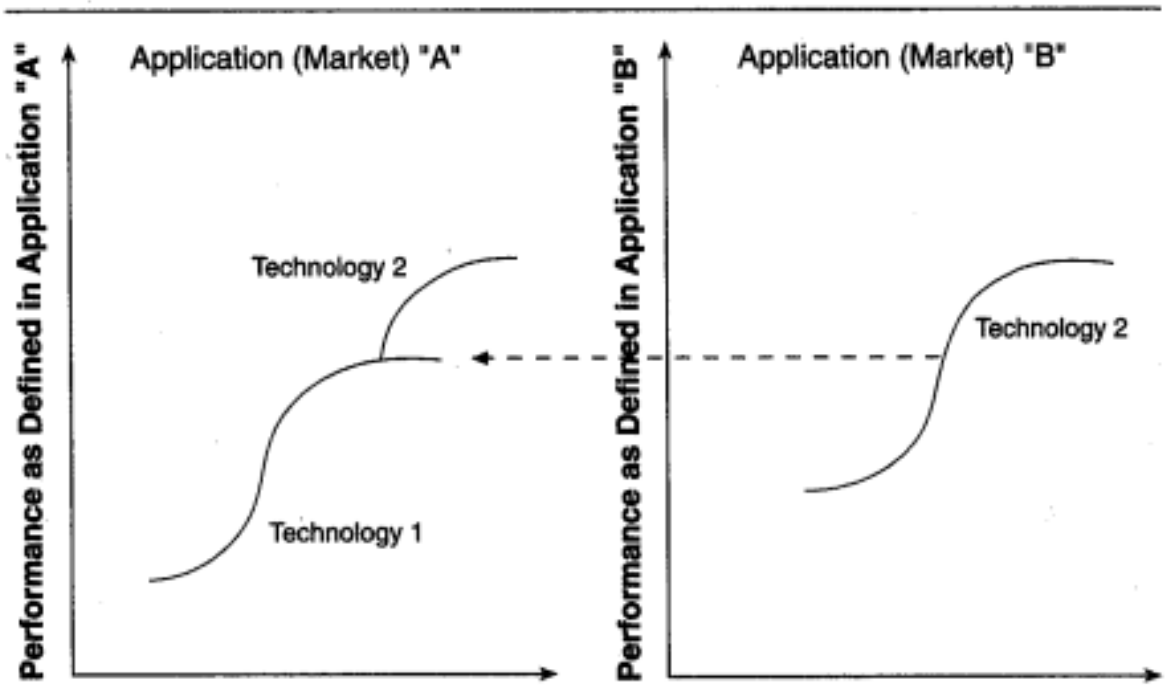
- Reduce greenhouse gas emissions to 17 per cent below 2005 levels by 2020.
- To doubling the share of clean energy in the electricity supply mix to 80 per cent by 2035.

Core green policy

- Clean Air Act; 1973
- 2007: The Global Warming Pollution Reduction died in committee
- 2009: The American Clean Energy and Security Act died in the Senate
- 2010: A federal budget to support clean energy development
- 2013: Obama's Climate Action Plan

Source: EIA & wikipedia

S- curve leaps for disruptive technologies



Source: Clayton M. Christensen, "Exploring the Limits of the Technology S-Curve. Part I: Component Technologies," *Production and Operations Management* 1, no. 4 (Fall 1992): 361. Reprinted by permission.

- Vertical axis DT different attributes of performance than ST
- Disruptive technologies emerge and progress on their own uniquely defined trajectories
- If and when they progress to the point that they can satisfy the level and nature of performance demanded in another value network, the disruptive technology can then invade it