

Energizing industrial development: Role of the state in 21st century greening strategies

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International seminar

The role of the state in the 21st century: Challenges for public management

ENAP, Brasilia

3-4 September 2015

Industrial dynamics perspective: Why renewables provide the best form of ‘energy security’

The green transition – in many ways, the biggest business transition there has ever been, the **biggest business opportunity of 21st century**

But what dominates debate is a mainstream economics perspective – carbon taxes; cap and trade; a cost-based perspective

Viewing green programmes solely as carbon emissions-reducing vehicles is self-defeating

Instead, can view greening as an industrial strategy – places programme in setting of market growth, finance/investment and cost reduction, with important role for policies like Local Content Requirements (LCRs)

Can view green growth as part of a larger transition

*Renewables are manufactured devices, and can be utilized anywhere -- energy is harvested, and captures increasing returns

*Renewable power viewed not as a carbon-reducing technology, but as based on manufacturing – thereby **enhancing energy security**

* The transition viewed as a technoeconomic shift

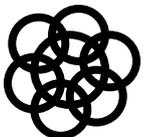
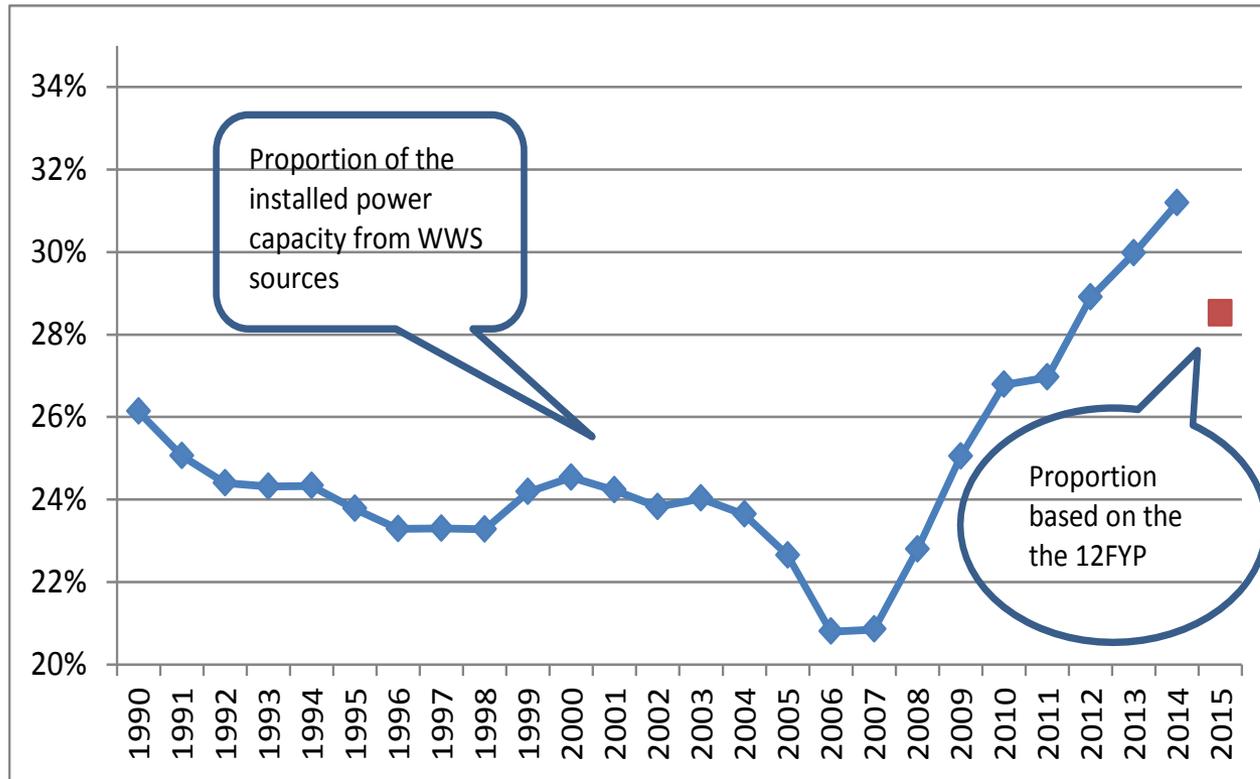


Economics: Manufacture renewables to build energy security

Nature 11 Sep 2014



Trends in WWS/electric generation capacity (%): China



The scale of China's transition

China now adding 50 GW of renewable power (water, wind, solar: WWS) each year – plus another 30-34 GW of thermal/nuclear power

Reverse of situation until recently, when thermal > WWS

Now, WWS > thermal (capacity)

Electric energy generated in 2013: 5,322 billion kW hours (TWh)

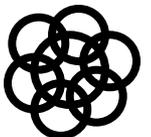
Of which, 20% comes from WWS (two years in advance of goal for 2015)

So China's renewable energy generation exceeds entire quantity of electricity generated by German and French power systems combined

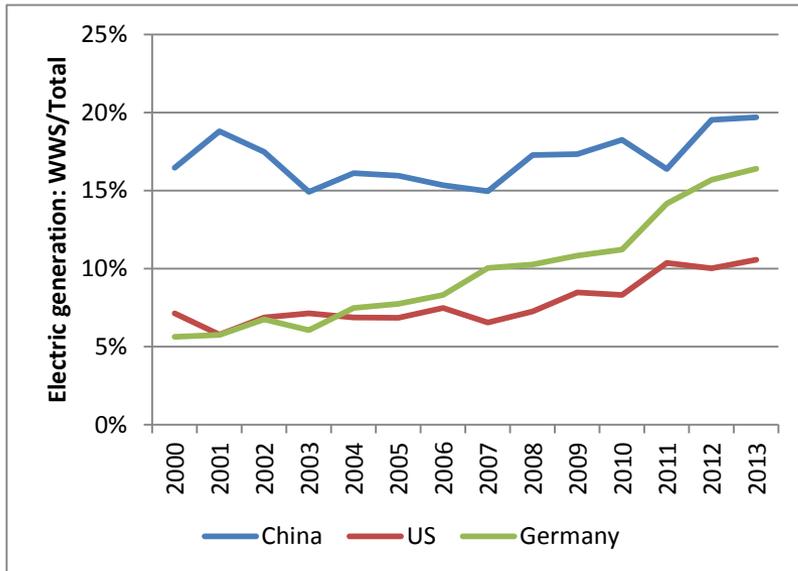
China's pursuit of renewables (to complement its coal-based power) is not so much a moral imperative, as an economic imperative

World's largest energy transition is under way

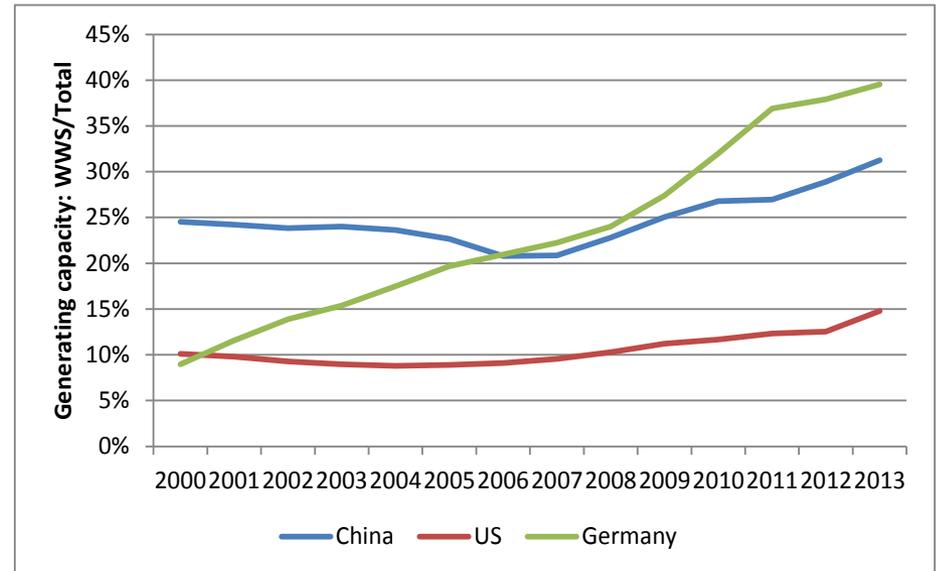
How? Why? What is the strategy?



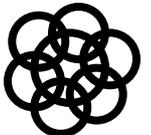
Historical trends in WWS/electric generation: US, China, Ger



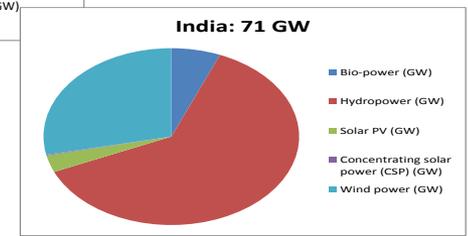
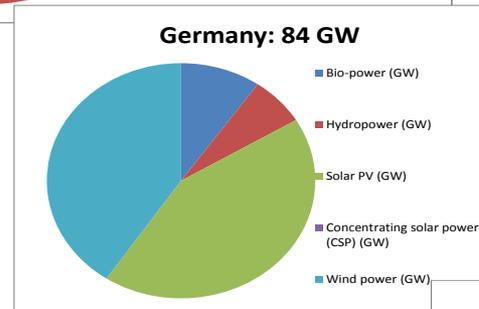
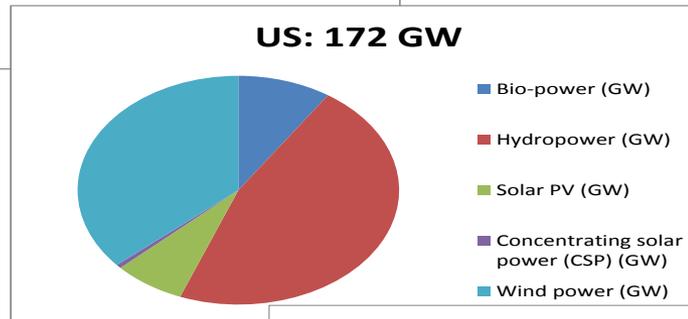
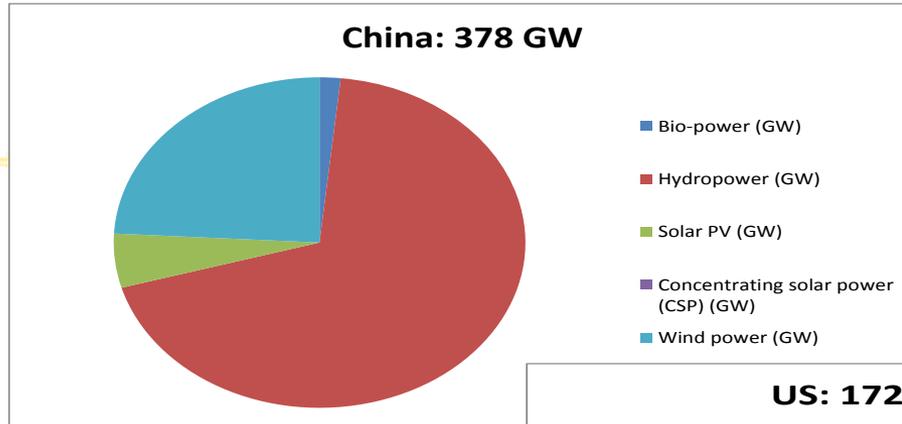
A. Electric energy generated



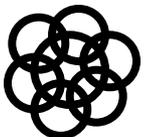
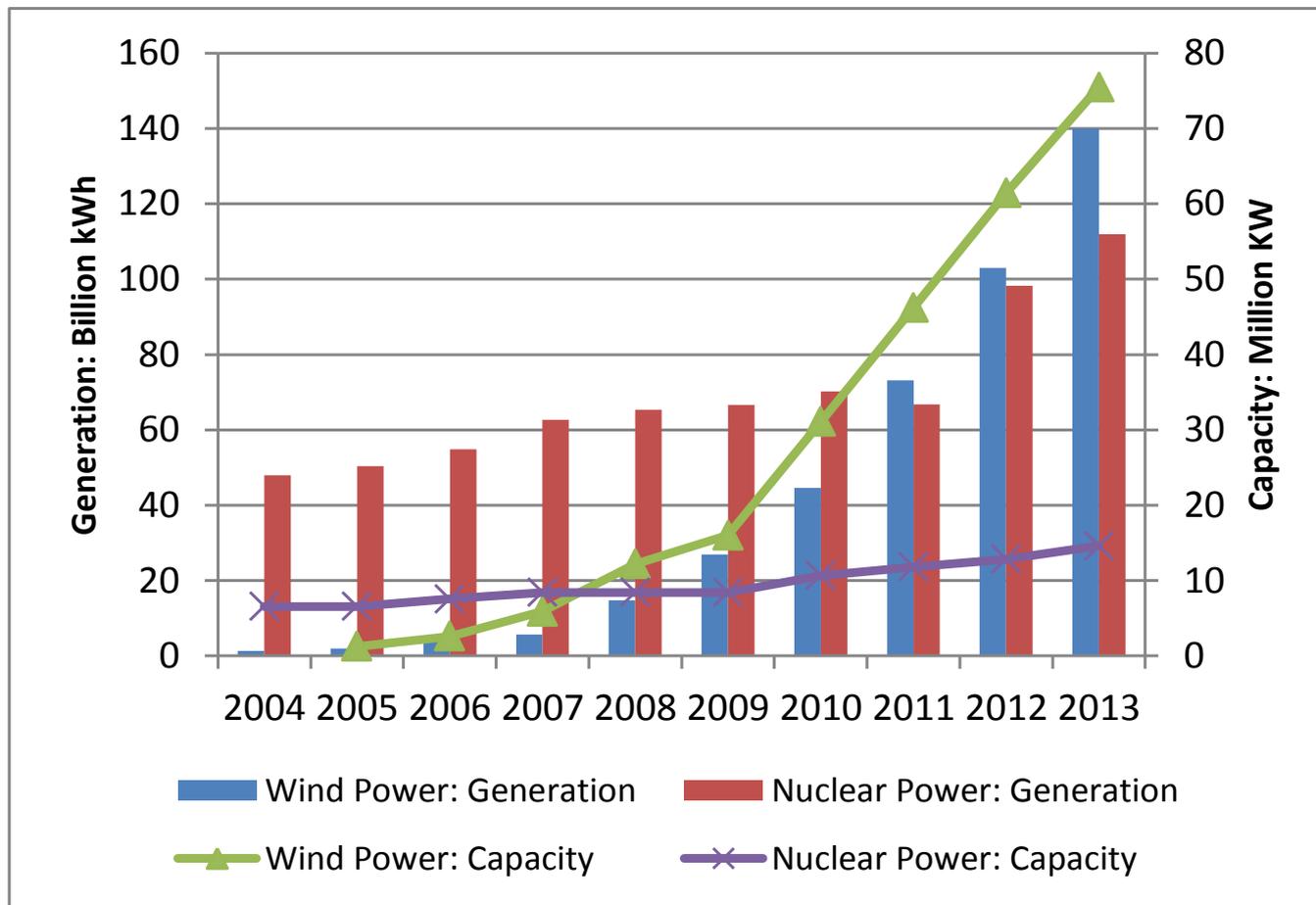
B. Power capacity



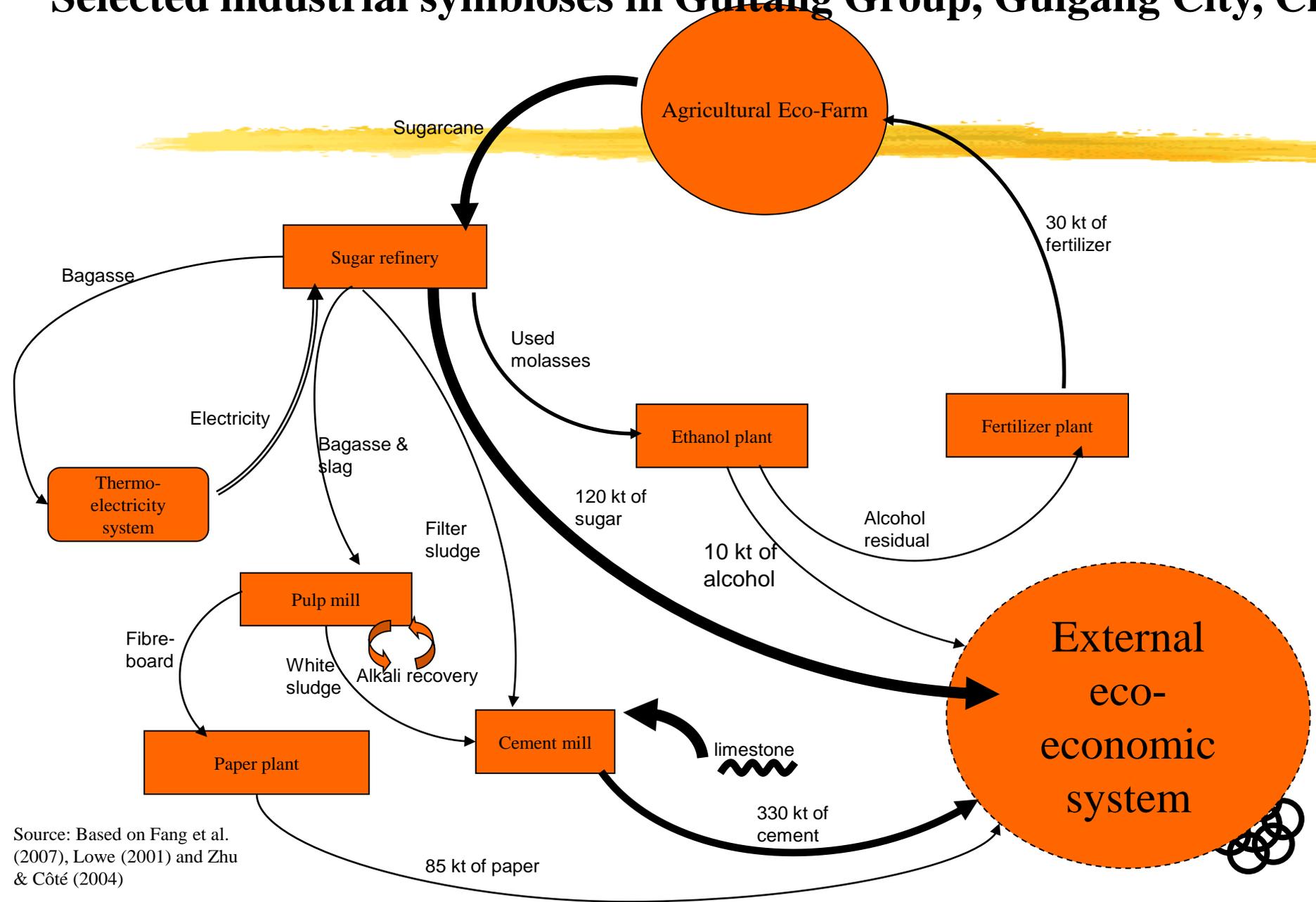
China's renewable power system cf others



China: wind vs nuclear power



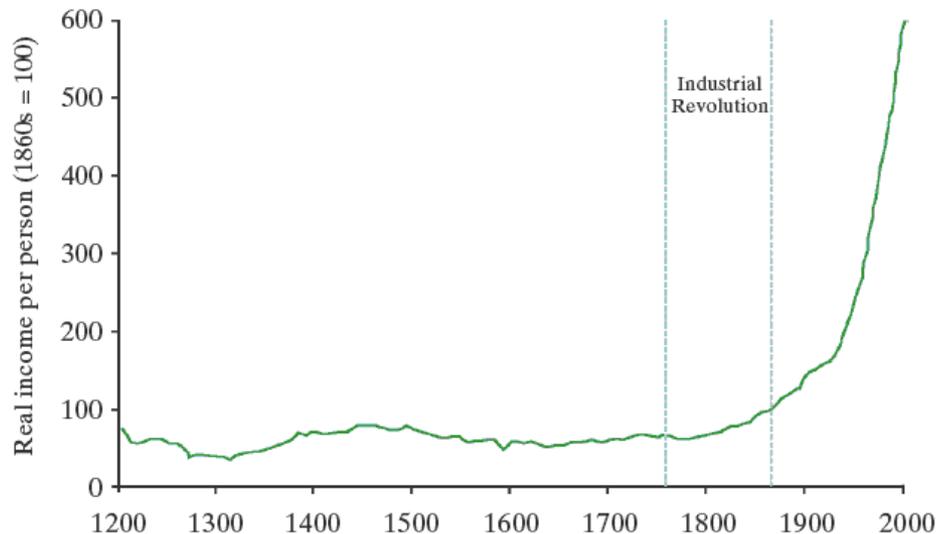
Selected industrial symbioses in Guitang Group, Guigang City, China



Source: Based on Fang et al. (2007), Lowe (2001) and Zhu & Côté (2004)

Why China wants to industrialize: Growth of per capita income, England, 1260s – 2000s

REAL INCOME PER PERSON IN ENGLAND,
1260s–2000s

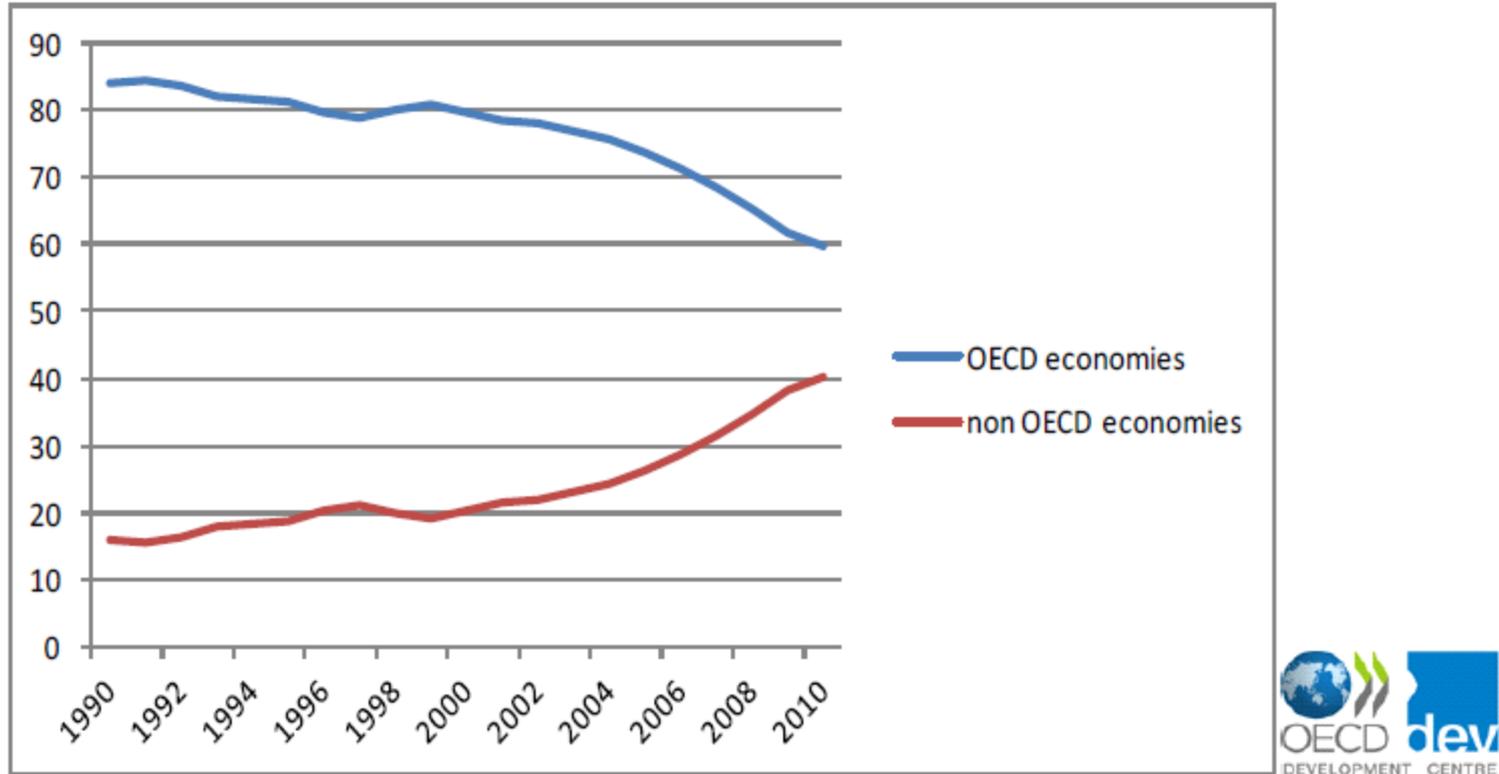


Source: Gregory Clark, *A Farewell to Alms: A Brief Economic History of the World*

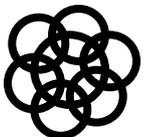
A view of the Industrial Revolution as escape from the ‘Malthusian trap’
Agrarian economy: as income rises, so does population
Industrial economy: can sustain endless rises in per capita income
So long as resource barriers are not infringed
Fortuitous role of fossil fuels: Created a ‘subterranean forest’ (Sieferle)

Shifting Wealth: Manufacturing is shifting East

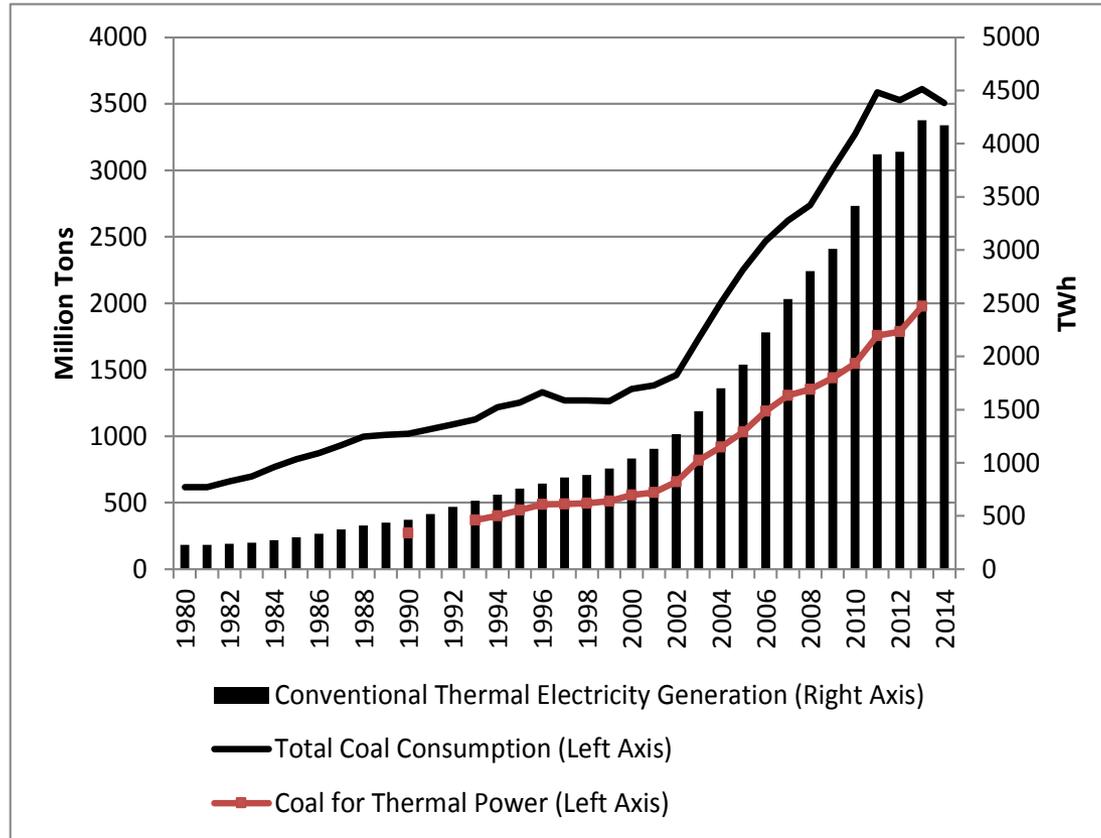
Share of manufacturing industry value added in total world manufacturing value added, 1990-2010



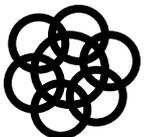
SOURCE: OECD Development Centre based on IHS Global Insight, special tabulations (2011) of World Industry Service database.
Note: OECD: no data for Austria, Estonia, Greece, Hungary, Iceland, Luxembourg, Portugal, Slovak Republic, Slovenia.



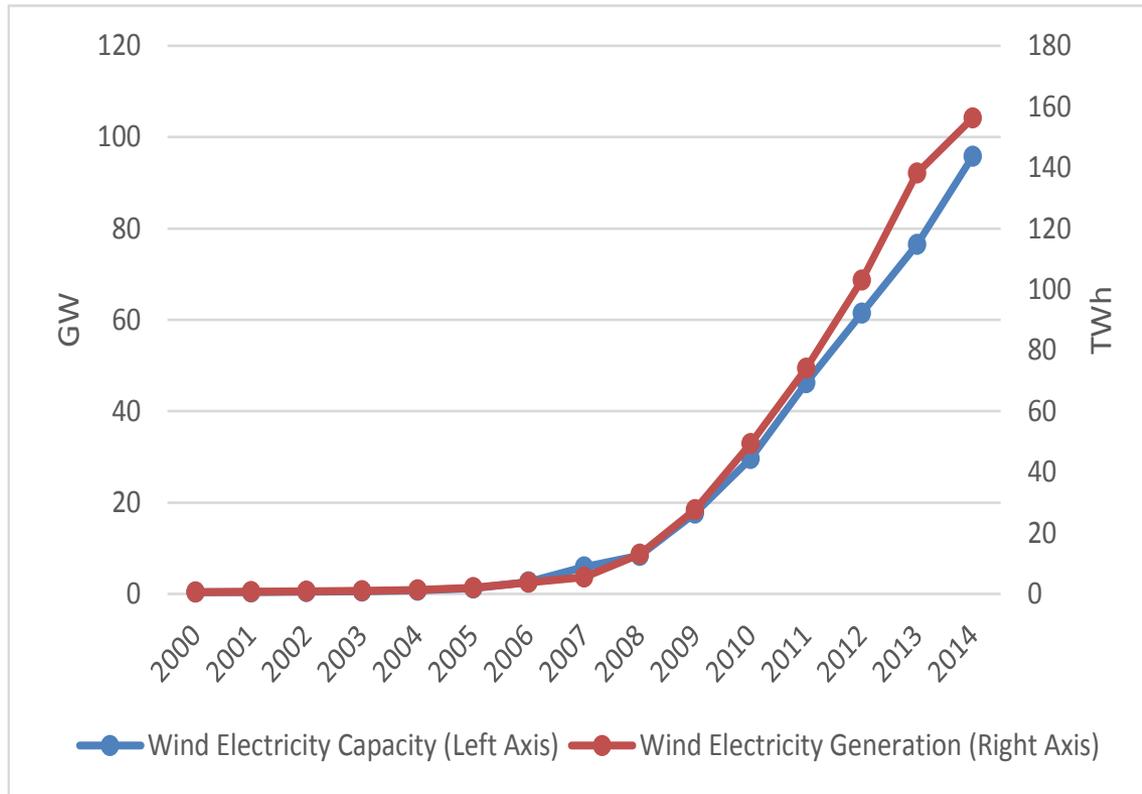
One face of China's transformation: Chinese power generation and rising coal consumption



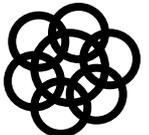
Source: Mathews & Tan; primary data: US EIA, China Electricity Council



A different (green) face of China: China's build-up of wind power



Mathews & Tan: Source of primary data: US EIA;
World Wind Energy Report



The issues

Can China (and then India) scale an industrial production system that will lift not just 1 billion people out of poverty, but 5-6 billion?

What would be the implications of China following a BAU pathway – using coal, oil, gas in the way that Western countries did?

Can the ‘western’ industrial model scale in this way? Answer: No

But can an alternative be built, and in time?

Can China go beyond building the largest renewable energy system on the planet?

Or will ‘carbon lock-in’ doom us all?

Can carbon taxes and carbon markets make a sufficiently strong difference?

Can corporate and social responsibility save the system?

How can state intervention drive the transition?

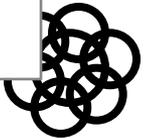
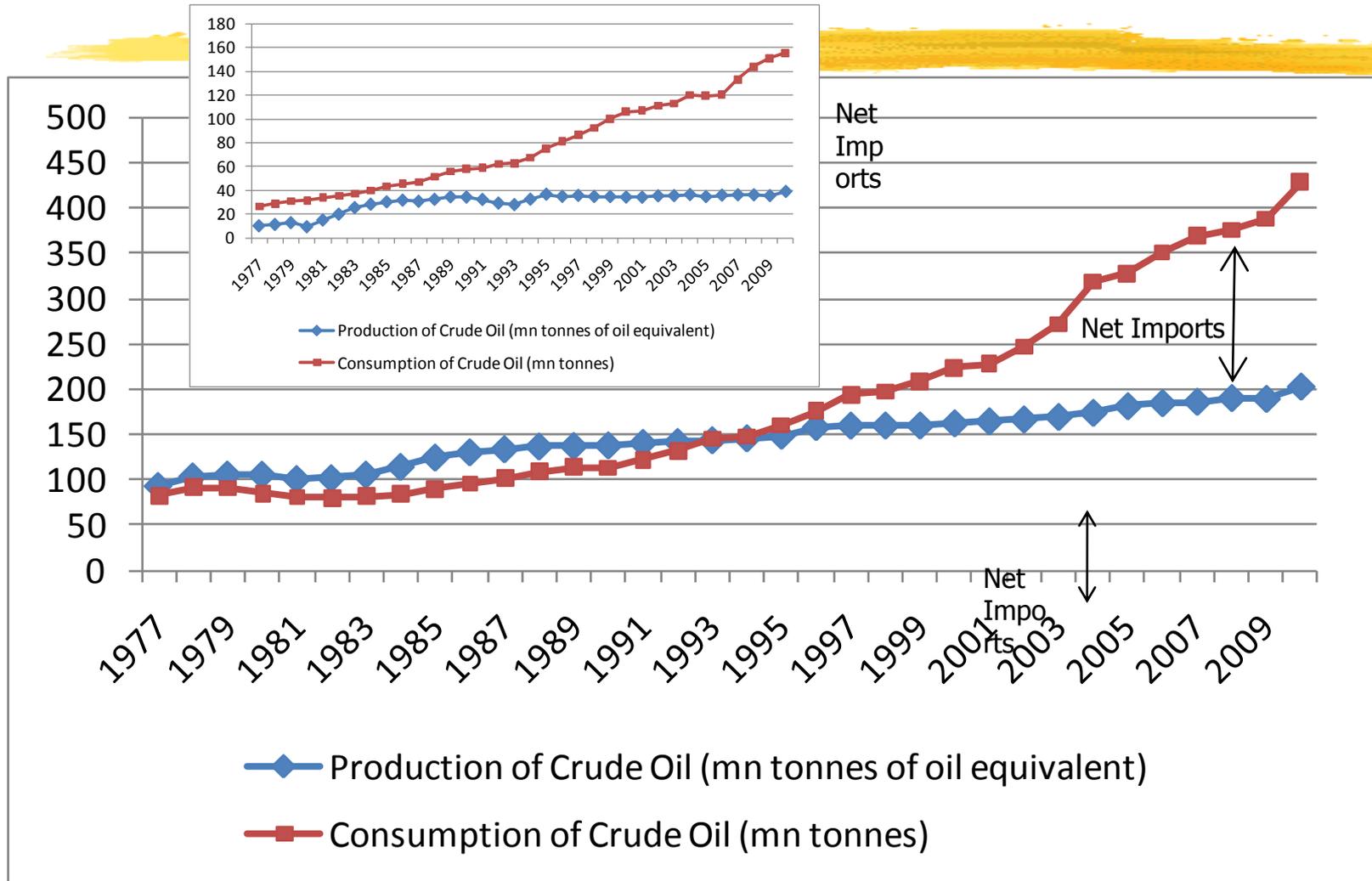
Big questions, big issues

Need ‘big’ social science research, to illuminate the ‘next’ Great Transformation’

First question: Is the fossil fuel era coming to an end?

How can China (and India) gain energy security?

The energy issue and development: China's (India's) looming oil/energy gap



Financial Times: China now world's largest oil importer

October 9, 2013

The new gas guzzler

By Ed Crooks and Lucy Hornby

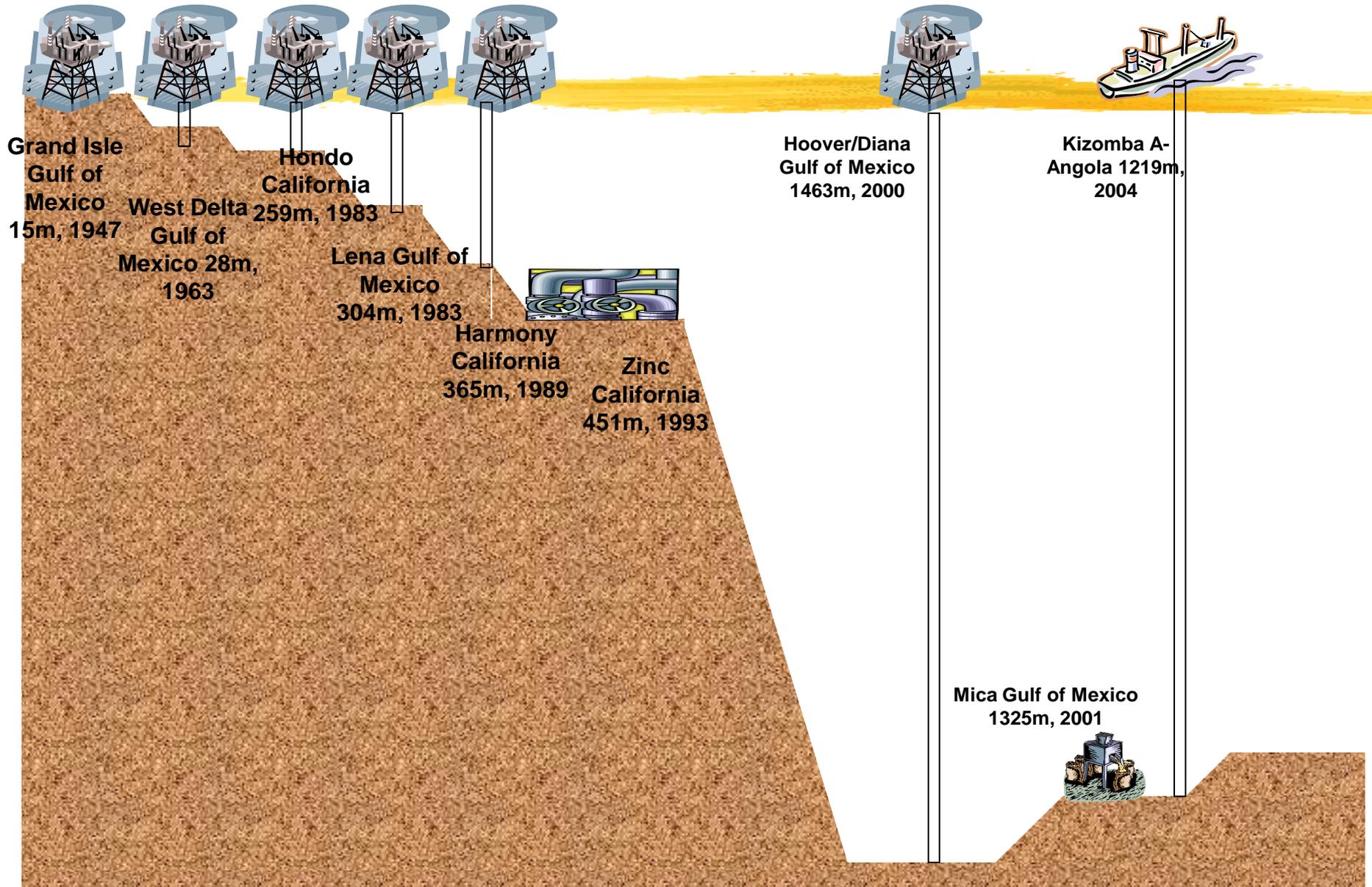
China has overtaken the US as the world's top oil importer.

Therefore – China most vulnerable to rise and fall of oil prices ...

Energy security counts as most important issue in China



Extracting oil is increasingly difficult and expensive



How world became dependent on the automobile – and

Ten years that changed the US



Changes needed: greening of capitalism

Changes called for beyond a mere 'technical fix'

Beyond the operation of 'Business as Usual'

Beyond corporate 'social responsibility'

Beyond the reach of simple instruments like a carbon tax

Changes are called for in the three great markets/institutions of industrial capitalism:

- Energy markets – from fossil fuels/nuclear to renewables
- Resources markets – from linear throughput to resource recirculation (Circular Economy)
- Finance – from generic to eco-finance

Business as Usual (BAU) by US and China would lead inevitably to a century of oil wars and resource wars

An alternative industrial model is mandated – even without climate change...

Why feasible? Consider the character of the transition

Renewable energies as technoeconomic transition

Six technoeconomic transitions since the Industrial Revolution

1. Factories; steam power (coal)
2. Railways, coal, iron
3. Electrification; steel; chemical
4. Oil; automotive
5. IT and IT applications
6. Renewables; smart grid

Freeman & Perez: **three criteria** for shift in technoeconomic paradigm

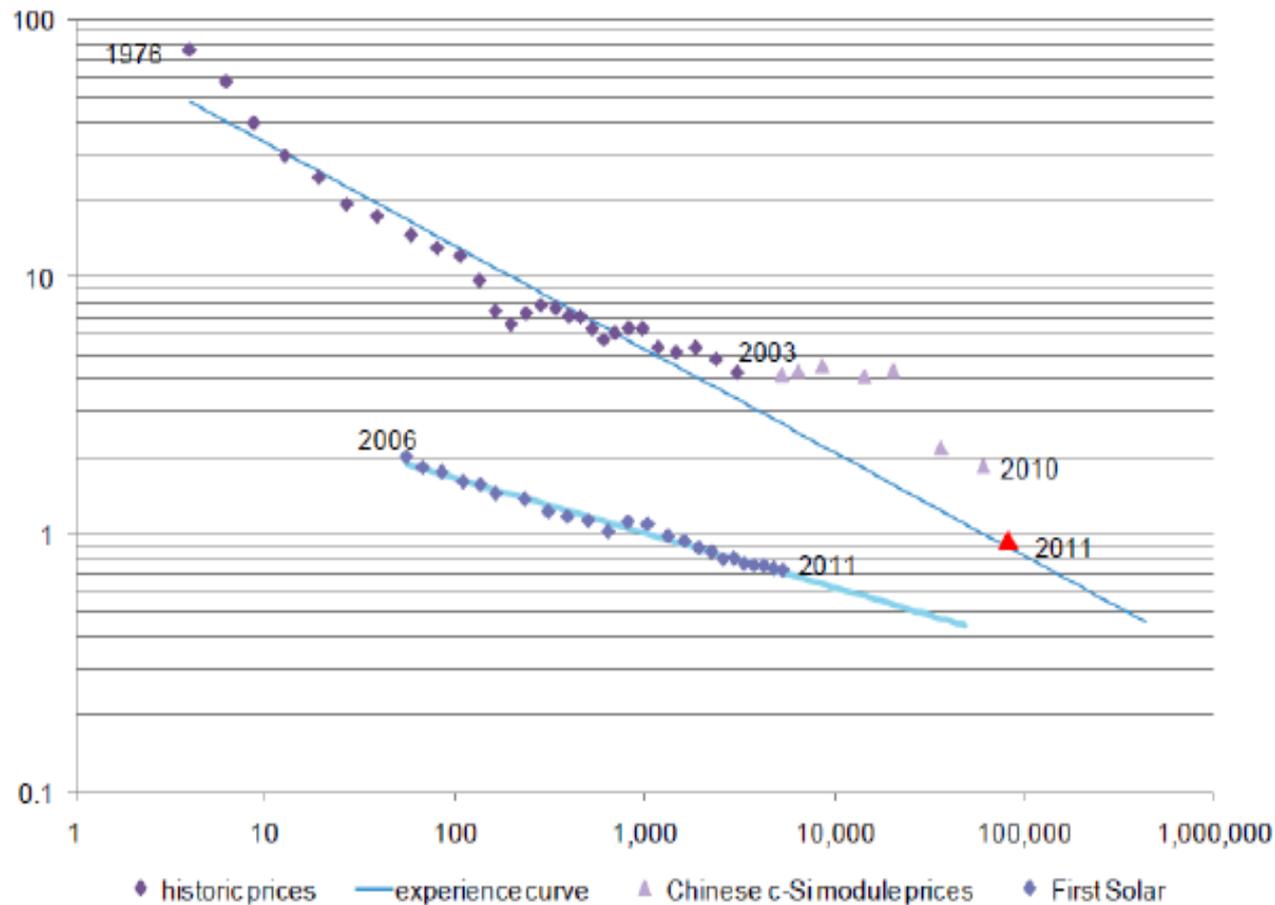
The new must satisfy:

- a) **Pervasive applications**
- b) **Falling costs**
- c) **Costs lower than incumbent technology**

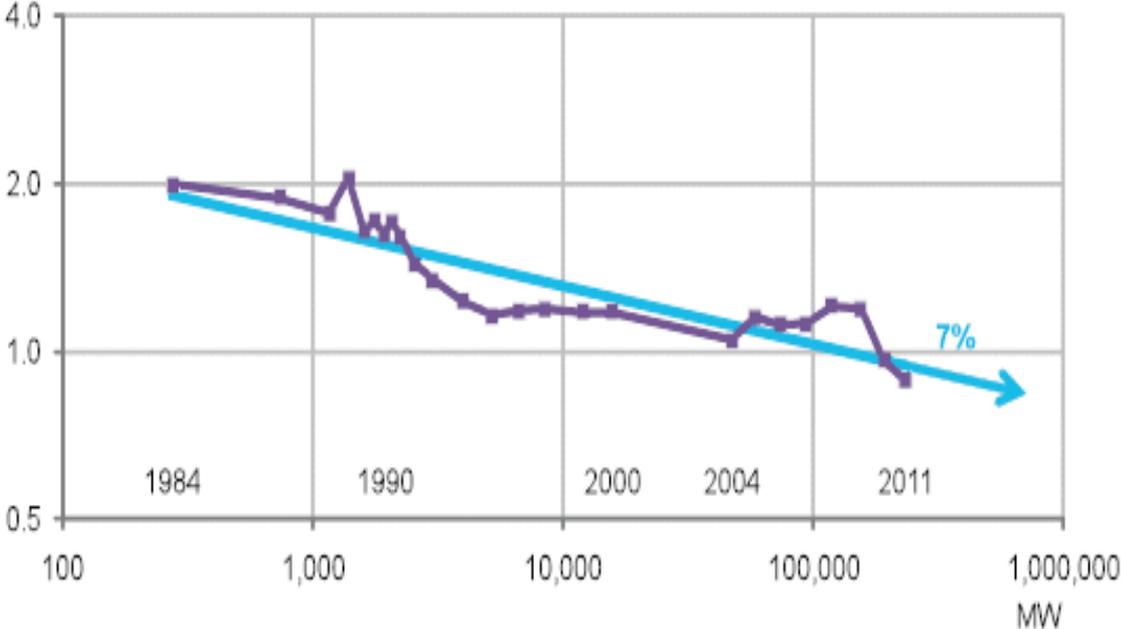
All previous five TE transitions satisfy these criteria

What about the 6th – renewables and application of IT to electric grids?

Reducing costs -- Solar PV becoming universal: Learning curve (BNEF)



Wind power learning curve



Note: Learning curve (blue line) is least square regression: $R^2 = 0.77$ and 7% learning rate.

Source: BNEF

Costs of renewables now lower than incumbent fossil fuels

Latest cost reductions mean that costs of renewables now undercutting costs of fossil-fuelled power

Auction staged by UAE in March 2015

Winning bids: 6 cents/kWh

Lower cost than coal-based power

This trend can only be expected to continue

- Power of the learning curve

Renewables now becoming pervasive

Complemented by equally important developments in **energy storage**

TeslaEnergy announcement May 2015:

the 10 kWh Powerwall ESU US\$3500

and the 100 kWh Powerpack ESU with 100 stacked to create 10 MWh ESU

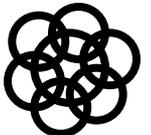
Then 2 billion of these utility-scale ESUs would deliver 20 trillion kWh – all the world's electric power system



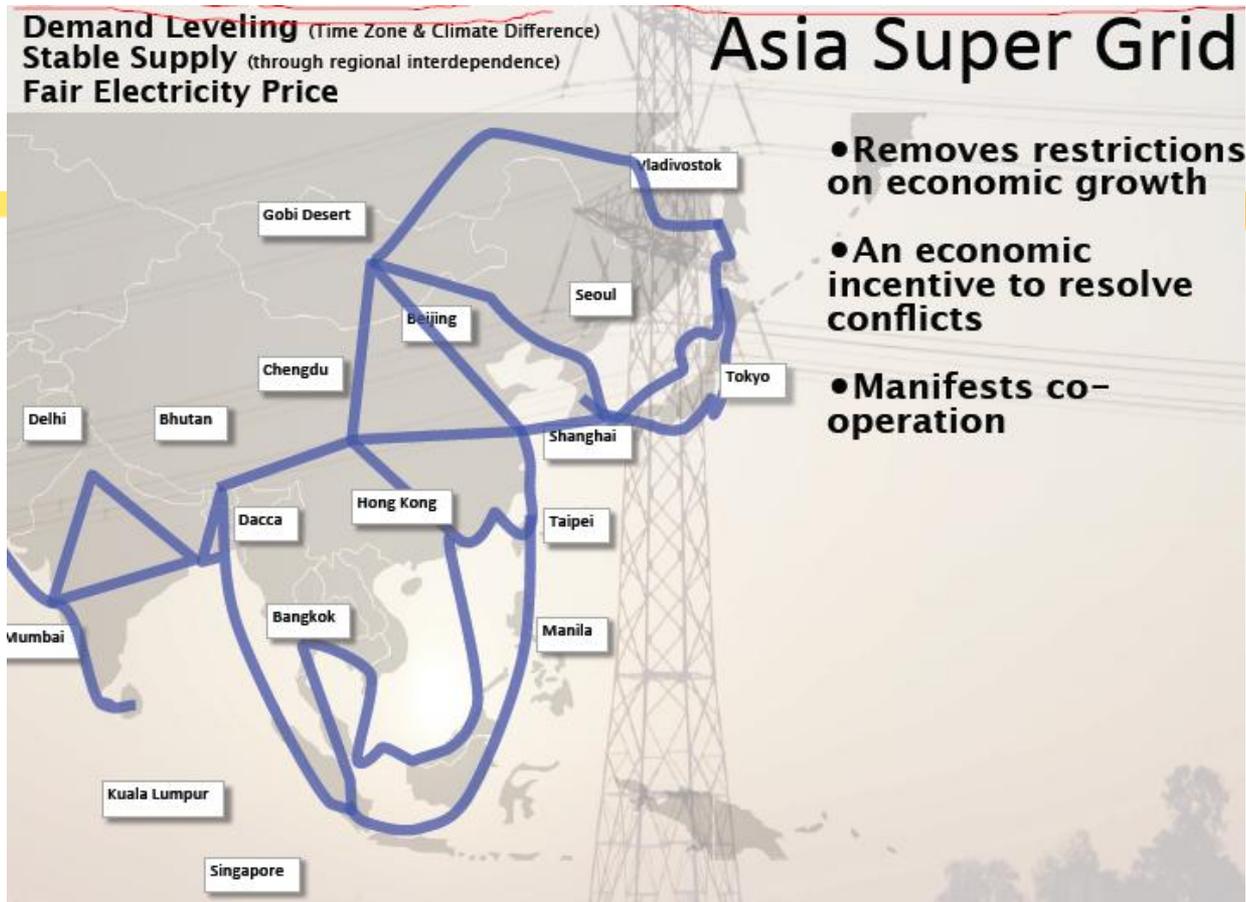
CSP Concentrated solar power

- China's new push – a third front in REs
- 1 GW target by 2015 (~ 50% global capacity)
- 3 GW target by 2020

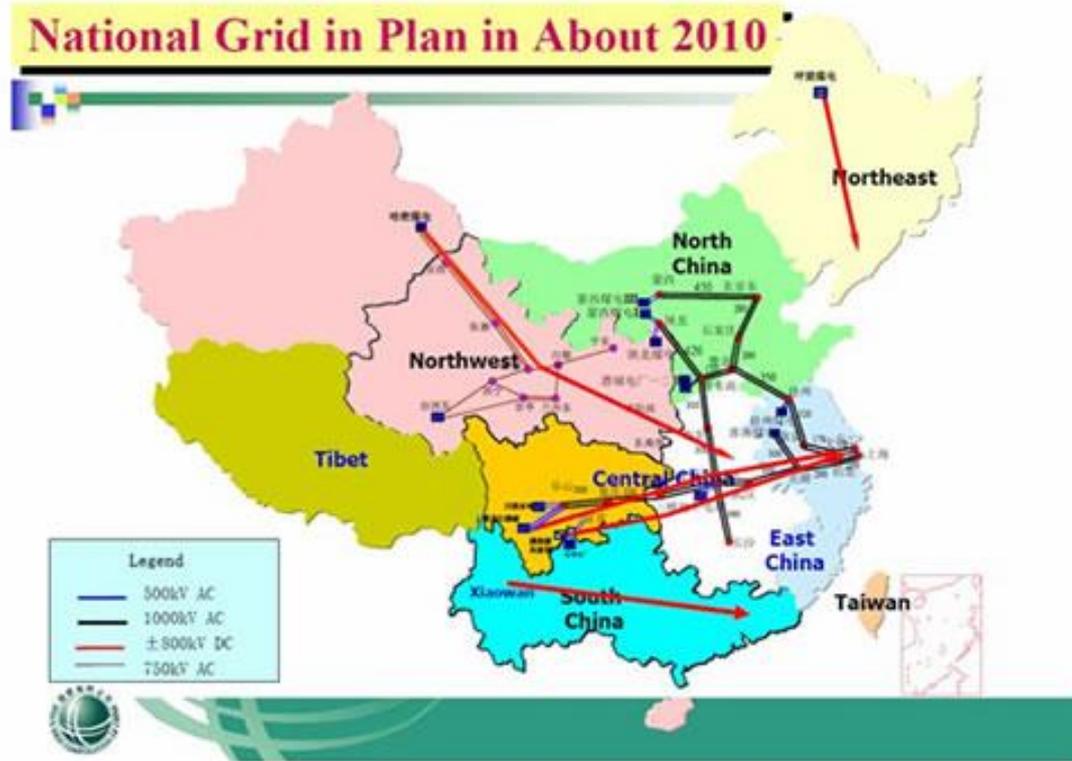
- Huge impact in driving down costs of solar power
- A new industrial revolution in producing mirrors, lenses, molten salts piping etc.
- High temperature achieved by CSP with molten salts ($>1000^{\circ}\text{C}$)
- Possibility of close loop industrial systems – no fossil fuel input



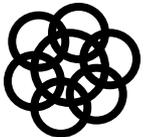
Asian Supergrid: Proposal from JREF



China's projected national grid with main HVDC lines



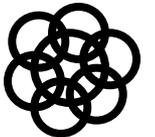
Source: State Grid Corporation of China



China's High-Speed Rail plans to 2020: North-south and East-west corridors

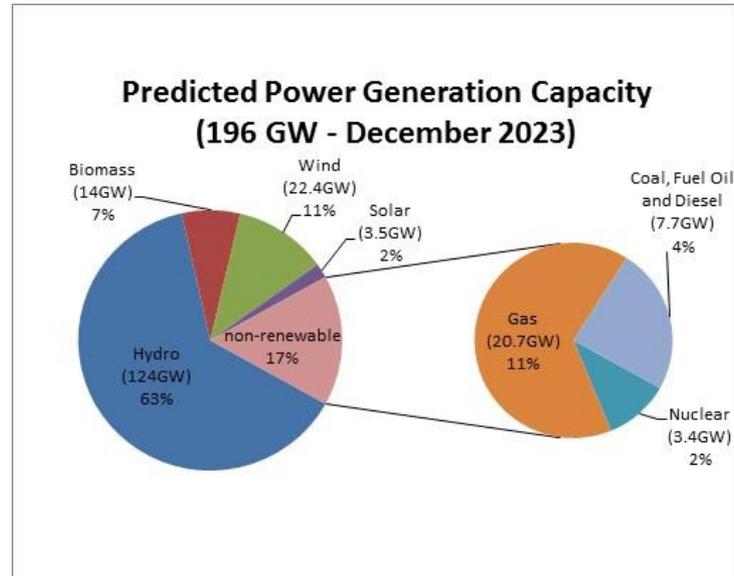
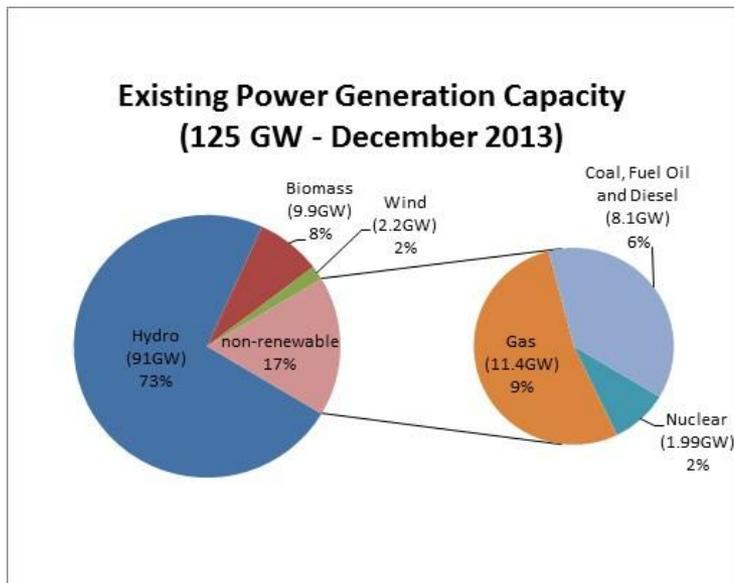


Source: Ministry of Railways, China



Focus now shifting to BICS countries – Brazil, India, China, South Africa

Brazil Now has 10-year rolling plan for renewables energy development



Brazil 3-fold strategy involving state agencies

MME – maintaining 10-year rolling plan (enhancing investment certainty) **market focus**

BNDES – targeted finance plus LCRs **finance/investment focus**

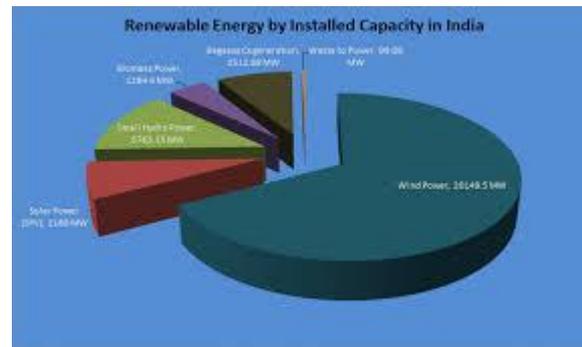
MME – public (reverse) auctions to drive down **costs**



India

Ministry of New and Renewable Energy – a world first

Target of National Solar Mission – 100 GW by 2019



Likely to be followed by National Wind Mission – 100 GW by 2020

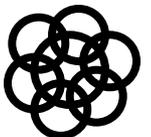
India now attracting FDI in renewables – subject to stringent LCRs

But challenged by US at WTO – ongoing dispute

Lacks National Development Bank – but can utilize services of

New Development Bank (NDB) launched by BRICS countries

in Shanghai July 2015



South Africa

Strong development of renewables – in legacy black economy

Now going for ambitious targets in wind, solar PV and CSP, under the Renewable Energy Independent Power Producer (REIPP) program
e.g. Kathu Solar Park (CSP) announced Molten salt energy storage

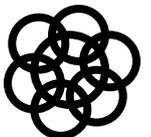


Again LCRs play prominent role

Plus public auctions that are driving down costs – now reaching 4.6 c/kWh for wind and 7.9 c/kWh for solar PV

Lower cost than cheapest coal!

Huge transition under way



Global impact of BICS renewable energy programs

China's expansion of scale drives down costs
Tumbling prices of solar PV, wind and soon CSP
Makes renewable energy a feasible source of power for new industries and for developing countries/regions

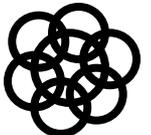


Renewables already being utilized for remote mining operations in Chile, now emulated in Australia (displacing diesel)

Renewables now being taken up widely in Central Asia and Africa, e.g. Actis to set up African RE business in Egypt

These new business deals are possible only because China and BICS have driven down the costs of renewables

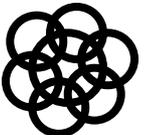
So – three criteria for technoeconomic paradigm shift are satisfied



World's biggest business opportunity – investing in green industries Who will join these entrepreneurs?



Elon Musk (Tesla Motors);
Wang Chuanfu (BYD);
Masayoshi Son (Softbank)



Solar PV: Market expansion drives down costs (adding to effect of cell efficiency improvements)

The expansion of the global market for solar PV cells, largely supplied from China, has been responsible for driving down costs by 80% since 2008.

A universal process: **as market expands, costs come down**

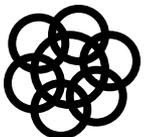
The learning curve

Nothing new here. The same principle of industrial expansion coupled with cost reduction established US supremacy in the automotive industry a century ago.

Between 1909 and 1916, Henry Ford reduced the cost of his Model T Ford from \$950 to \$360, a 266% drop over seven years. Each year, sales doubled – from just below 6,000 in 1908 to over 800,000 in 1917.

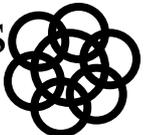
Same process is underway with solar PV cells – manufactured devices. Market expansion -> manufacturing efficiencies (division of labor) -> cost reduction -> further market expansion -> further efficiencies -> further cost reductions

A chain reaction: Circular and cumulative causation



FINANCE: Investments needed for a renewable energy upsurge 2015-2040

- A 10 trillion watt expansion 2015-2040
- Doubling or more of present global electric power levels
- To be driven by China and Germany (plus Japan?)
- At Euro 2 per Watt (\$2.50/W), investment of \$25 trillion needed – or \$1 trillion per year for next 25 years
- Dwarfs current investment (\$310 billion in 2014: BNEF)
- Dwarfs public resources, e.g. \$100 billion committed to Global Climate Fund (Cancun 2010)
- Private sector financial instruments needed on huge scale
Climate bonds; Green banks; China Development Bank; Asian Infrastructure Investment Bank (China)
Equity finance not helping – Stock Exchanges still promoting BAU
- BUT: global pension fund system and institutional investors have \$71 trillion under management
- How to tap these funds????????????????????



‘Climate bond’-like financial instruments

Green bond market taking off (\$40 billion in 2014)

European Investment Bank (EIB) Climate Awareness Bonds 2007

Euro 600m 5-year bond, issued 2007 by the EIB (EU financial arm) through the services of merchant bank Dresdner Kleinwort

World Bank Green Bonds 2009 - 2015

US\$350m 6-year bond issued 2009 by the World Bank

Second issue 2009: State of California purchased US\$300m

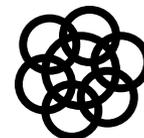
US Treasury: Green Bonds 2009

Oct 2009 US Treasury released \$2.2 billion in Green Bonds to power up the financing of renewable energy initiatives

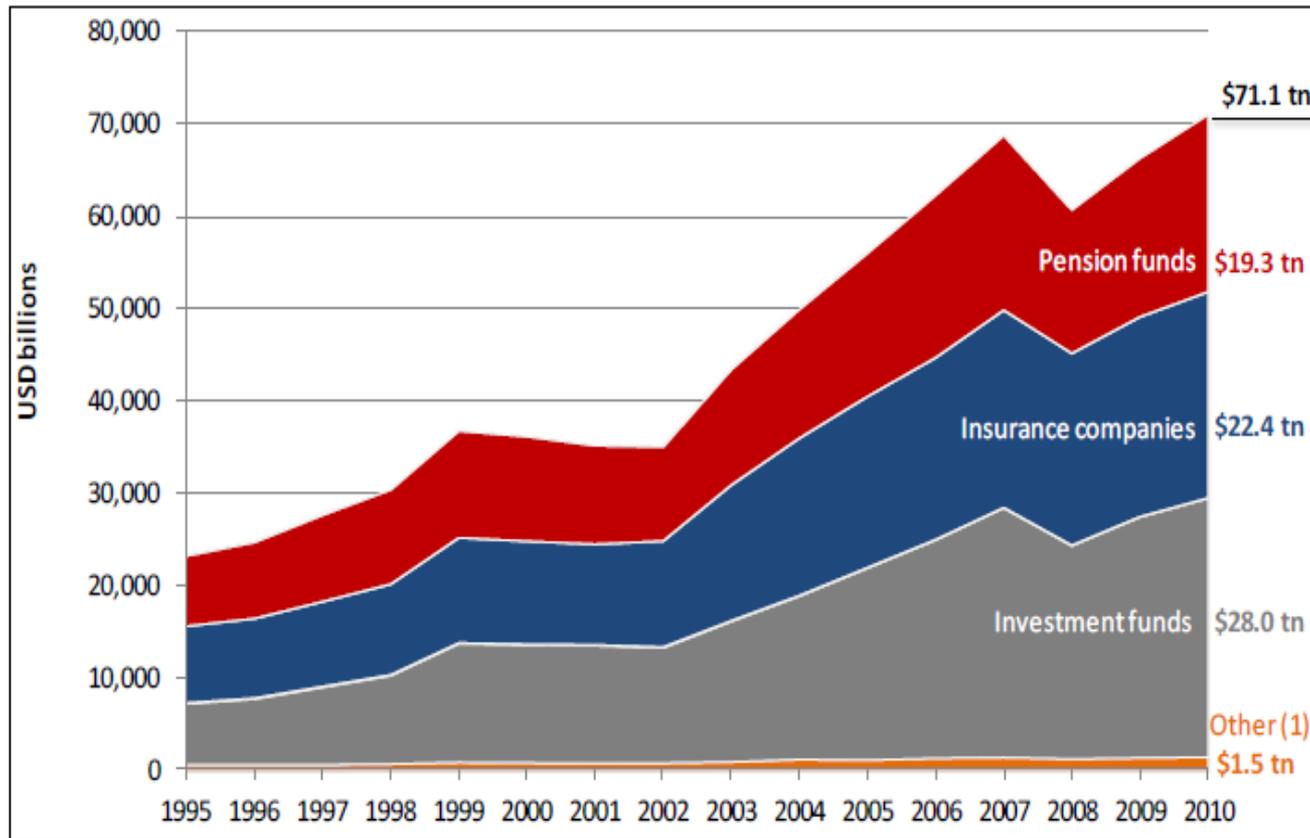
African Development Bank 3-year US\$500 million Green Bond
(Oct 2013) – for funding green growth projects

Many kinds of financial instruments available!

The key to the greening of capitalism ...



Funds available for investment (Institutional investors)



Source: OECD Global Pensions Statistics and Institutional Investors databases and OECD estimates¹⁵

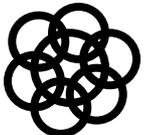
Source: Andersen (2002) Fig. 1, based on Mitchell, B.R. (1988) *British Historical Statistics*. Cambridge: Cambridge University Press, p. 541. [Data for Ireland are not included. The data for 1868–70 are lacking or are problematic.]

Kexim Green Bond issue, Korea

- March 2013 Korean Export Import Bank
- Floats \$500 million 5-year bond designated for climate investments
- Targeted at institutional investors (pension funds, SWFs)
- Oversubscribed
- Funds to be channelled to green projects, audited by 3rd party CICERO (Centre for Int Climate and Env Research, Oslo)
- US investors took 47%; European 32%; Asian 21%
- Kexim has AA3 credit rating – bonds carry little risk
- Projects involving Korean firms around the world
- Coupon payments to be made from consolidated revenues

Bonds are serious business – if there is default, this would be counted as sovereign Korean default

Strong discipline for holding to green investment promises



What is driving China's energy revolution – and why can we expect India, Brazil et al to pursue similar strategies?

Climate change is probably least of China's concerns

-- after all, US and Eur created around 80% of the problem

More pressing as a driver is to clean the skies of smog: BIG problem

And to solve China's energy security problem

Oil, gas etc. – from Russia, Saudi Arabia, Venezuela, Nigeria

All geopolitical hotspots – threaten war, revolution and terrorism

Alternative: Use **manufacturing industries** to build devices that tap into renewable energies and resource recirculation

Apply China's **latecomer catch-up strategy** to energy and resources

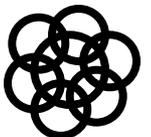
Building renewable energy industries creates export platforms

of tomorrow (12th Five Year Plan) and drives industrial development

This relieves energy insecurity

And it clears skies What is there to lose?

Oil companies can join the fun!



Role of state agencies in the greening transition

China – Exhibit #1 in state-guided industrial transformation

-- now applied to greening, at scale

India – replicating China, with lag

National Solar Mission 100 GW by 2020 with LCRs

National Wind Mission (exp) 100 GW by 2020 with LCRs

Public auctions under MN&RE driving down costs

Brazil – already a renewables giant (hydro, biofuels)

Now 3-fold strategy to build renewables (WWS)

Rolling 10-year plan for REs (MME)

Targeted finance with LCRs (BNDES)

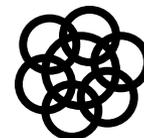
Public (reverse) auctions (MME) drive down costs

South Africa – now replication BIC countries

REIPP program; public auctions driving down costs

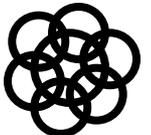
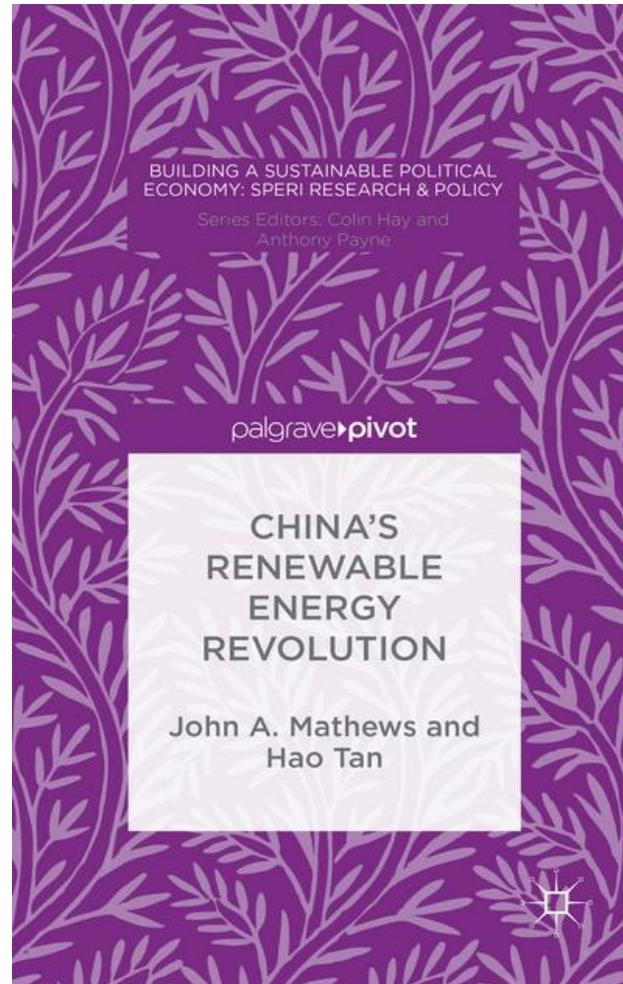
Wind power, solar PV plus CSP

All BICS countries pursuing targeted industrial strategies



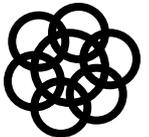
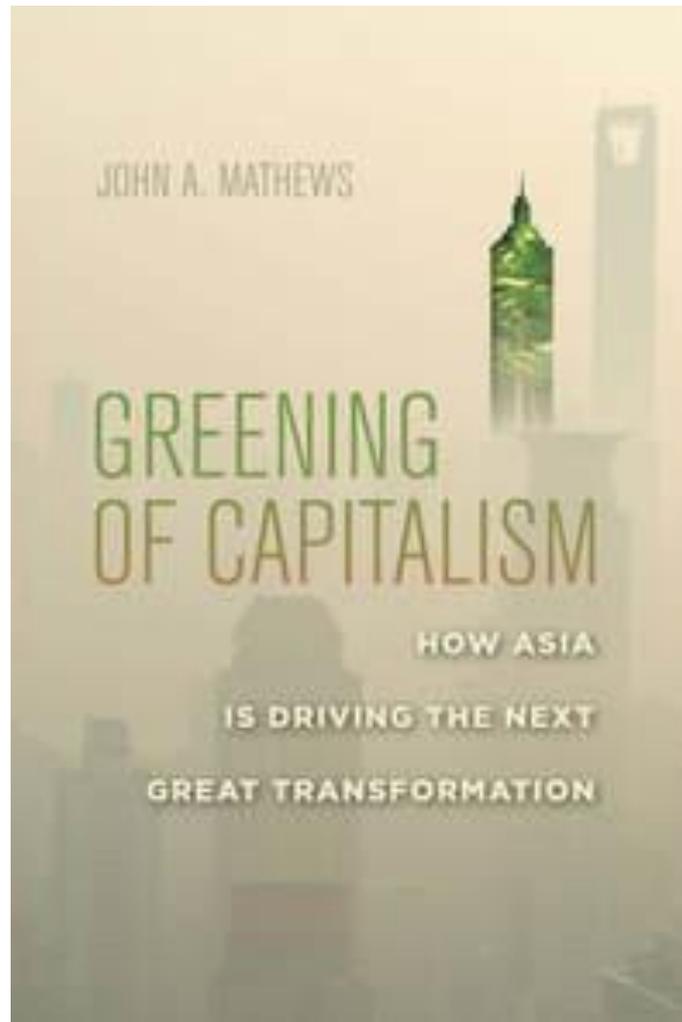
China's Renewable Energy Revolution

Palgrave Pivot Sep 2015



Greening of Capitalism: How Asia is Driving the Next Great Transformation

Stanford University Press Jan/Feb 2015





Renewables: manufacturing, increasing returns, energy security



Renewables, manufacturing and green growth: Energy strategies based on capturing increasing returns

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a Macquarie Graduate School of Management, Macquarie University, Sydney, NSW 2109, Australia

b Professor of Technology Governance and Development Strategies, Tallinn University of Technology

Dominant perspective frames energy futures and the case for renewables and cleantech in terms of their contribution to mitigation of climate change, as well as cleanliness and absence of carbon emissions. By contrast, energy security is generally discussed in terms of security of access to fossil fuels. In this paper we make a different case for renewables: we contrast the extraction of energy (fuels), which – in spite of technological change – takes place under diminishing returns, with the harvesting of nature’s renewable energy, which takes place in a process utilizing manufactured devices, where manufacturing generates increasing returns and costs decline along steep learning curves. This gives a fresh perspective on both renewables and energy security.

