

Green growth and innovation

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What is green growth?

- A typical definition is that “green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. ”

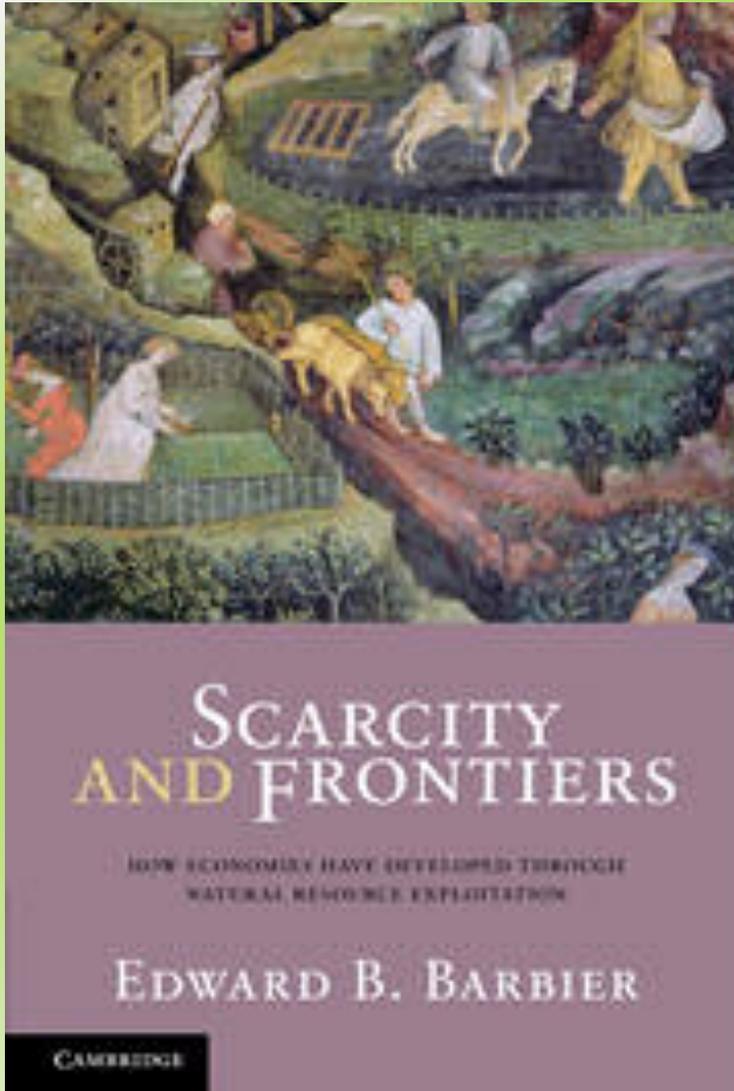
Organization for Economic Cooperation and Development (OECD). 2011. *Towards Green Growth*. OECD, Paris, p. 9.

- In effect, green growth implies a *transition* for an economy from its current economic development path of environmental and resource use to a more environmentally sustainable path, without any decline in overall welfare over time.
- Is this objective even possible, given the “path dependency” of past and current development?

"Dwell on the past and you'll lose an eye...Forget the past and you'll lose both eyes."

~ Russian Proverb

From the preface of Alexander Solzhenitsyn. 1963. *One Day in the Life of Ivan Denisovich*. Signet Classics, New York and London.



How have economies have benefited and developed through exploitation of the biosphere during the “Great Acceleration” of the Holocene?

Barbier, E.B. 2011. Scarcity and Frontiers: How Economies Have Developed Through Natural Resource Exploitation. Cambridge University Press, Cambridge and New York,

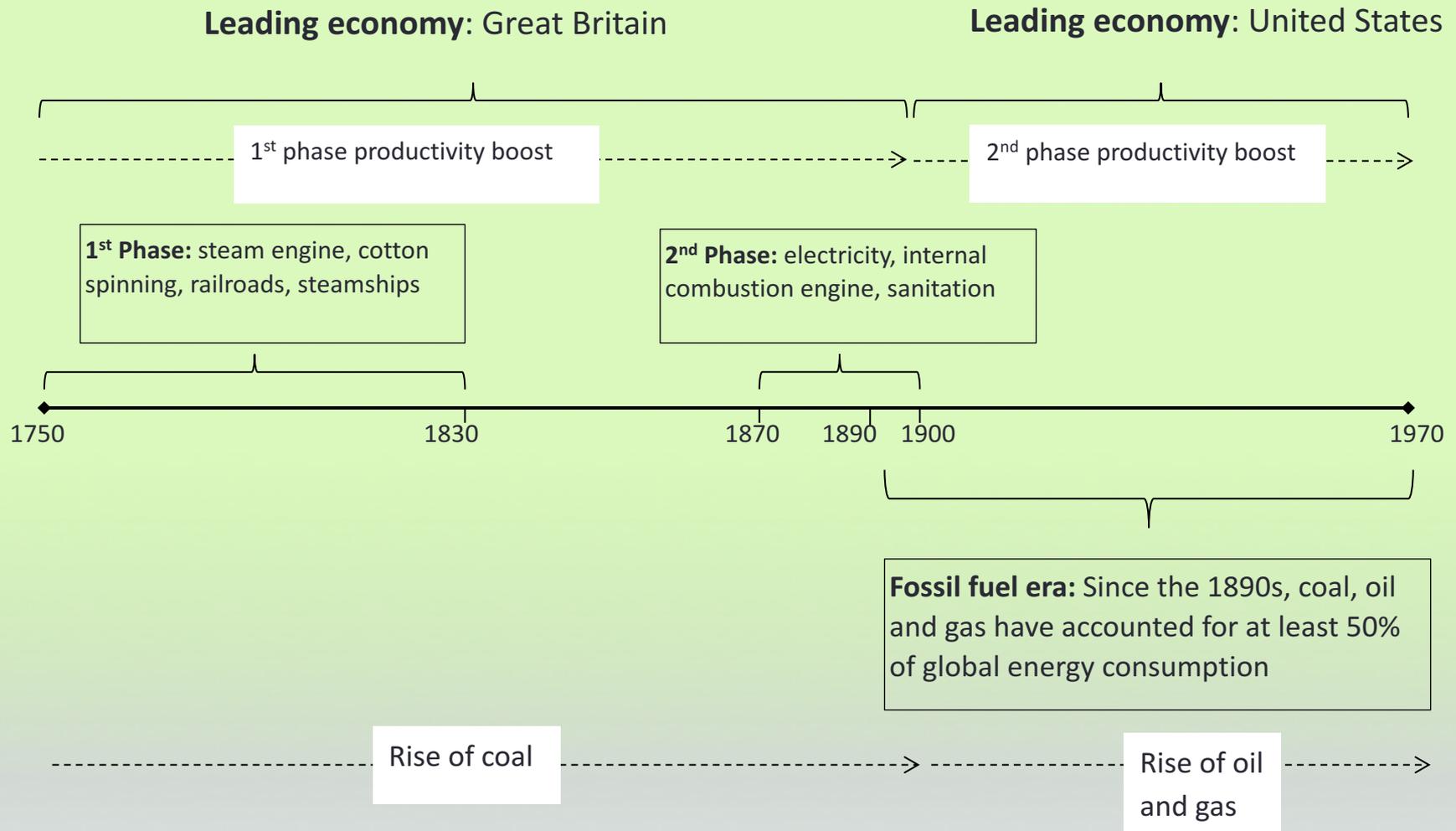
Scarcity and Frontiers Theme

- Throughout much of history, a critical driving force behind global economic development has been the response of society to the scarcity of key natural resources.
- Increasing scarcity raises the cost of exploiting existing natural resources, and will induce incentives in all economies to innovate and conserve these resources.
- However, human society has also responded to natural resource scarcity not just through conservation but also by obtaining and developing more of them.
- Since the Agricultural Transition over 12,000 years ago, exploiting new sources, or *frontiers*, of natural resources has often proved to be a pivotal human response to natural resource scarcity.

Eight key historical eras (plus one)

- Agricultural Transition (10,000 BC to 3000 BC)
- Rise of Cities (3000 BC to 1000 AD)
- Emergence of the World Economy (1000 to 1500)
- Global Frontiers and the Rise of Western Europe (1500 to 1914)
- Atlantic Economy Triangular Trade (1500 to 1860)
- Golden Age of Resource-Based Development (1870 to 1914)
- Age of Dislocation (1914-1950)
- Contemporary Era (1950 to present)
- **Age of Ecological Scarcity (Anthropocene), since late 20th**

Key timelines of the Industrial Revolution, 1750-1970

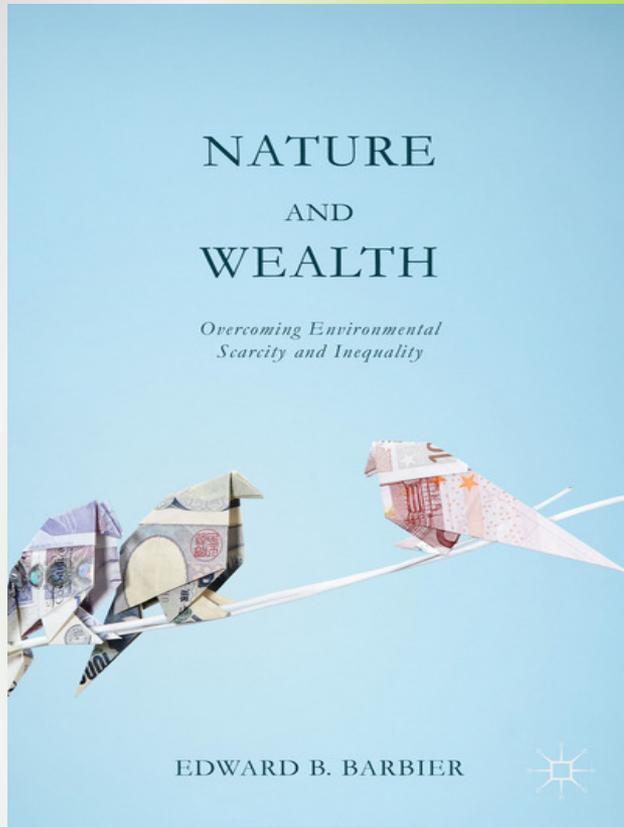


Barbier, E.B. 2015. *Nature and Wealth: Overcoming Environmental Scarcity and Inequality*. Palgrave Macmillan, London

Second phase “malaise”

- Since the 1970s, the world economy has remained in the midst of the fossil fuel age, the productivity boost of the second phase of innovations has waned, despite continuing skill-biased technological change, and the growth and structure of production has carried on using more resources and energy.
- The structural imbalance that has arisen since 1970s has worsened because of the chronic under-pricing of nature and under-investment in human capital:
 - rather than face the rising economic and social costs of increasing natural resource use and ecological scarcity, we hide these costs by perpetuating the under-pricing of natural capital; and,
 - rather than investing in sufficient human capital to keep pace with skill-biased technological change, we allow skilled labor to become scarce and thus attract excessive wages.

Barbier, E.B. 2015. *Nature and Wealth: Overcoming Environmental Scarcity and Inequality*. Palgrave Macmillan, London

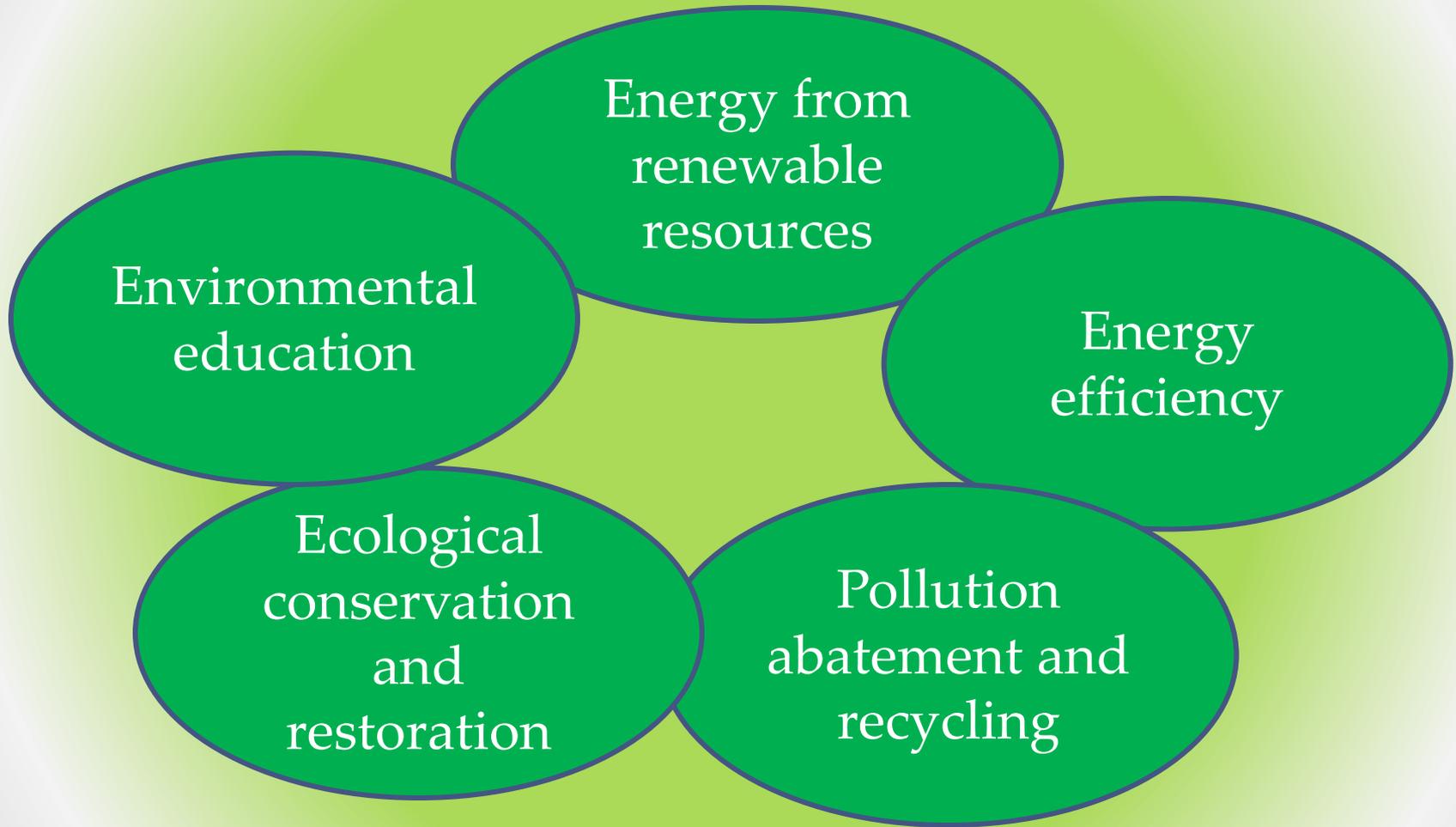


<http://www.palgrave.com/gb/book/9781137403377>

Nature and Wealth: Overcoming Environmental Scarcity and Inequality Edward B. Barbier (Palgrave Macmillan 2015), p. 172:

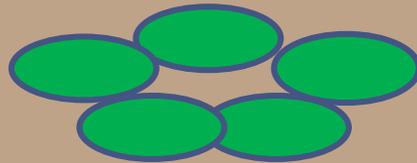
“Will ‘green’ sectors remain a small niche within an overall ‘brown’ economy, or will these sectors foster a new wave of sustainable industrial innovation, R&D and employment that ultimately replaces the brown economy?”

Five key green sectors



Which way will the economy go?

Brown economy



Which way will the economy go?

Green economy

Progress in the United States....

- In the past decade, US environmental entrepreneurs have founded or funded more than 2,500 companies, created more than 600,000 jobs, and manage more than \$100 billion in venture and private equity capital.
- Jobs and investments in clean energy continue to expand each year in the US.
- More than 2.2 million are currently employed in energy efficiency, and 475,000 in solar and wind.
 - About 2% of the total labor force.

Source: www.e2.org

...and Europe too

- The share of Environmental Goods and Services Sector (EGSS) gross value added in GDP is estimated to have grown from around 3% in 2000 to 5% in 2014 in the EU28.
- Over this period, full-time employment in the EGSS has grown by nearly 1.4 million, and has reached 4.2 million, approximately 2% of total EU employment.
 - Attributed to the growing demand for energy produced from renewable sources, the construction of wind and solar power stations and the production and installation of equipment for heat and energy saving.

Source: Eurostat Environmental goods and services sector

http://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_goods_and_services_sector#Main_statistical_findings

Green structural transformation

- Transition to a green economy requires structural transformation and industrial development well beyond just expansion of the current five “green” sectors.
- Fankhauser et al. (2013, p. 903):
“We interpret green growth as an economy-wide transformation, rather than the expansion of the environmental goods and services sectors”.

Sam Fankhauser, Alex Bowen, Raphael Calel, Antoine Dechezleprêtre, James Rydge and Misato Sato. 2013. “Who will win the green race? In search of environmental competitiveness and innovation.” *Global Environmental Change* 23:902-913.

Key strategic sectors for green growth

- Industrial processes, which need to become cleaner and more resource efficient (e.g. iron and steel).
- Sectors that are important for energy efficiency on the supply side (electricity distribution systems) and the demand side (domestic appliances).
- The energy supply chain for electricity generation and other industrial processes (steam generators; engines and turbines; electric motors and transformers).
- Car manufacturing (low-emission and electric vehicles) and key components (accumulators, primary cells and batteries).

The “green race”

- The “green race” to become global competitive leaders in these industries is between eight economies
 - China, France, Germany, Italy, Japan, South Korea, the United Kingdom and the United States.
- In Europe, manufacturing in Germany appears to have benefited from green innovation, whereas other economies, notably Italy, may be lagging behind.
 - Germany has used its existing capacity and innovations in high-precision machining to develop an early comparative advantage in wind turbines.
- After Japan, Germany has the strongest international record in green innovation, and continues to be well ahead of other European countries.
 - Germany is a leader in green innovation in motor vehicles.

Sam Fankhauser, Alex Bowen, Raphael Calel, Antoine Dechezleprêtre, James Rydge and Misato Sato. 2013. “Who will win the green race? In search of environmental competitiveness and innovation.” *Global Environmental Change* 23:902-913.

Under-pricing of fossil fuels (and other sectors)

- The environmental damages imposed by under-pricing fossil fuels are substantial, and include the costs of climate change, local pollution, traffic congestion, accidents and road damage.
- When these costs are added to fossil fuel subsidies, the overall global cost of under-pricing fossil fuels amounts to US\$1.9 trillion annually, or 3.5% of the world's GDP.
- Similar inefficient pricing of environmental damages and subsidies exists in other global sectors, including agriculture, water supply and use, natural resources and transport.
- The most efficient way of addressing these damages and cost is through:
 - Eliminating environmentally damaging subsidies.
 - Imposing environmental taxes and other market-based incentives to reduce damages.

Benedict Clements, David Coady, Stefania Fabrizio, Sanjeev Gupta Trevor Alleyne, and Carlo Sdalevich, eds. 2013. Energy Subsidy Reform: Lessons and Implications. International Monetary Fund (IMF), Washington, D.C.

Lack of support for private green R&D

- Under-investment in R&D is a serious obstacle to the development of the green economy
- “*Technology-push*” policies: research and development (R&D) subsidies, public investments, protecting intellectual property, and other initiatives.
- Complements market-based incentives that reduce pricing distortions.

Public policies for reducing carbon dependency

Direct emissions policies

Carbon taxes

Carbon quotas

Cap-and-trade for
greenhouse gas (GHG)
emissions

Subsidies to GHG emission
abatement

Technology-push policies

Subsidies to R&D in clean
energy technologies

Public-sector R&D in clean
energy technologies

Government-financed
technology competitions
(with awards)

Strengthened patent rules

Source: Adapted from Goulder, L. 2004. Induced Technological Change and Climate Policy. Pew Center on Global Climate Change, Arlington, VA, Box 1.

Two wrongs don't make a right...

- Growing use of environmentally motivated subsidies
 - To counter the price advantage that harmful subsidies and inefficient pricing gives the “brown” economy.
 - Promote green sector expansion and employment.
- Every green sector now has subsidies.
- May deter green economic development in the long run
 - Economic inefficiency
 - Lack of competitiveness
 - Over-use

Type of subsidy and activities supported	Australia	Canada	France	Germany	Italy	Japan	Mexico	South Korea	United Kingdom	United States
Grant										
Clean-up of earlier pollution		X						X		X
Energy saving	X	X		X	X				X	X
Investment in physical capital	X	X	X	X	X	X		X	X	X
Market penetration of clean products	X	X		X	X	X		X	X	X
Operation of treatment facilities						X			X	X
Research and Development (R&D)	X	X	X	X	X			X	X	X
Training of employees	X			X						X
Other		X		X	X	X			X	X
Soft Loan										
Clean-up of earlier pollution								X		
Energy saving	X	X	X							X
Investment in physical capital	X					X		X	X	X
Market penetration of clean products	X		X					X		X
Operation of treatment facilities						X		X		X
Research and Development (R&D)								X	X	
Other									X	X
Tax Reduction										
Clean-up of earlier pollution	X						X			X
Energy saving		X	X		X				X	X
Investment in physical capital	X	X	X		X	X	X	X	X	X
Market penetration of clean products		X	X		X	X		X	X	X
Operation of treatment facilities								X	X	X
Research and Development (R&D)			X					X		X
Other	X	X	X		X		X		X	X
Other										
Clean-up of earlier pollution		X								
Energy saving	X	X	X	X	X			X	X	X
Investment in physical capital	X	X	X	X	X		X	X	X	X
Market penetration of clean products	X	X	X		X				X	X
Operation of treatment facilities	X							X		
Research and development (R&D)	X							X		
Other		X		X					X	X
Total	16	16	12	9	12	8	4	17	18	24

A green growth strategy

- A comprehensive approach for promoting green innovation and structural transformation requires a three-part policy strategy.
- **Step one:** Phasing out environmentally harmful subsidies.
- **Step two:** Implementing market-based incentives
- **Step three:** Using financial savings and revenues to support green innovation

Barbier, E.B. 2015. *Nature and Wealth: Overcoming Environmental Scarcity and Inequality*. Palgrave Macmillan, London

Barbier, E.B. 2015. "Are There Limits to Green Growth?" *World Economics* 16(3):163-192.

Step one: subsidy removal

- Phase-out environmentally harmful subsidies, such as fossil fuels.
- Rationalize, and in some cases, phase out environmentally motivated subsidies.

Step two: market-based incentives

- Expand and use more effectively a wide range of market-based incentives.
- Examples:
 - Taxes, charges and payments for environmental services
 - Tradable permit schemes for pollution and resource use
 - Voluntary mechanisms

Step three: support green innovation

- Allocate revenues raised and generated from steps one and two to support economy-wide green innovation.
- Subsidy removal and implementing MBIs would raise globally
 - US\$1.9 trillion annually from ending the under-pricing of fossil fuels.
 - US\$485 billion annually from eliminating agricultural subsidies
 - US\$27 billion annually from eliminating subsidies to marine fisheries.
- **These revenues could be targeted towards:**
 - Public support for private sector green R&D
 - Public infrastructure and investments necessary for green growth.
 - Integrating renewables in electricity transmission; green-growth policies for urban areas; develop mass-transit systems.

A green growth strategy

Step One

Phase out environmentally harmful subsidies
Rationalize/phase out many environmentally motivated subsidies

Step Two

Expand and implement more effectively market-based incentives
(e.g., taxes, charges and payments for environmental services, tradable permit schemes, and voluntary mechanisms)



Step Three

Use any resulting revenues and savings to finance the necessary public support for private green R&D and investments

Final remarks

- Do we want green sectors to remain a niche or be a fulcrum for innovation and growth?
- Do we want a highly subsidized economy or a green one?
- The three-step strategy aims to enhance economy-wide green structural transformation and innovation.
- All three policy steps are essential to an integrated green growth strategy.

A systems approach to sustainability

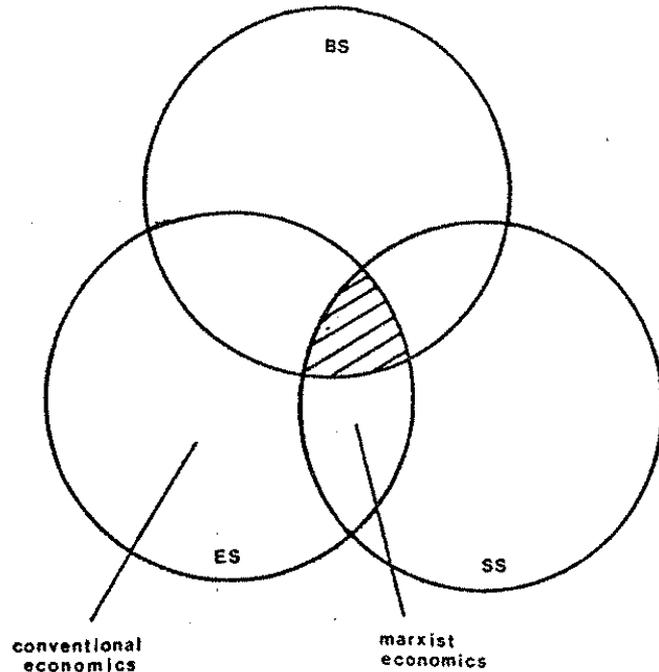


FIG. 1. Sustainable economic development maximizes the goals across the biological and resource system (BS), the economic system (ES), and the social system (SS), as illustrated by the shaded area. In contrast, conventional development approaches maximize only ES goals, and Marxist economics maximizes only ES and SS goals.

“In 1987 the economist Edward Barbier published the study *The Concept of Sustainable Economic Development*, where he recognised that goals of environmental conservation and economic development are not conflicting and can be reinforcing each other.”

https://en.wikipedia.org/wiki/Sustainable_development#Economics

Barbier, E.B., 1987, "The Concept of Sustainable Economic Development," *Environmental Conservation* 14(2):101-10.

Barbier, E.B. and J.C. Burgess. 2017. "The Sustainable Development Goals and the Systems Approach to Sustainability." *Economics* (2017-28):1–22. <http://dx.doi.org/10.5018/economics-ejournal.ja.2017-28>