Financially Advantageous Approaches to Sustain the Ecosystem

Dennis M. Bushnell

ABSTRACT: This report considers the use of financial gain as incentive to accelerate sustainable approaches and the promotion and development of sustainability as a whole, including ecosystem preservation and climate-change mitigation. This approach has already yielded success in accelerating renewable energy generation and storage, as there had been little progress until costs dropped to the point of being the best solution financially. Here, we examine the particulars of this financially driven renewables success story, which enables us to collect and ideate similar approaches and technologies for ecosystem rejuvenation and sustainability.

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Introduction

Humans take short-term approaches to problems and solutions. For evolutionary or gradual changes and issues with less-than-major impacts in the longer term, such a tactical approach has been successful. Abetting such a prevalent near-term focus are two factors: the amygdala—the part of our brain that keeps us conservative—and the financial and political powers maintaining the current status quo. The result is an overall resistance to change, risk aversion, and fixation on the shorter term.

Although for decades we have extensively studied climate change and ecosystem degeneration driven by human activities, inertia and denial have been huge until serious impacts became readily apparent. Examples of such climate change impacts evident now include more prevalent and extreme floods, storms, disease, fires, ocean-level rise, species extinctions, ocean acidification, ocean circulation changes, and temperature increases.

In fact, during the Permian extinction (also known as the Great Dying), the changes in ocean circulation increased anoxic ocean conditions, leading to an overgrowth of cyanobacteria (or blue-green algae). This alga produces hydrogen sulfide, which in small percentages in the atmosphere is a poison and damages the ozone layer.

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Therefore, climate change means more than warm days and wet feet. Current impacts to ecosystems include freshwater shortages, species extinctions, pollution, deforestation, loss of topsoil, and wildlife habitat.

Humans are practicing anti-terraforming, with many and rapidly increasing costs to financial systems, human life and that of other species, quality of life, and so on. But there are potential solutions. *Drawdown* (Penguin Books, 2017), edited by environmentalist Paul Hawken, provides an extensive compilation of approaches to mitigate climate change, with more than 80 ways forward that could save an estimated $73 trillion over 30 years.[1]

Fundamentally, humans have been too successful as a species. We have pursued ever greater human numbers and a mantra of economic growth without considering the finite size and capacity of available resources. The ecosystem provides the essentials for life, including water, air, food, soil, plants, and minerals, and we are now seriously degrading it at our peril. Water regulation, pollution filtering, waste-sink functionality, soil retention, nutrient cycling, and waste decomposition are all becoming degraded. Ever greater growth with a fixed resource is only possible by using technologies and approaches to alter resource utilization, by controlling population, or both.

For many centuries, as humans depleted local resources, they have simply moved to other regions where resources were available. That is no longer an option as the present technologies and processes are degenerating the entire planet. We are now short by about a half a planet's worth of resources. As world population growth continues and living standards rise, that shortage will increase to some three planets' worth of resources. We will have to reduce ecosystem resource use and dumping considerably. Altering technology and approaches to adapt to such growth is termed *sustainability,* with various alternatives termed *green growth, reusability,* and the *circular economy.* It also involves valuing, protecting, and strengthening what we term *ecosystem services.*[2]

The purpose of this report is to consider financial-gain incentives that could greatly accelerate the development of sustainability as a whole. This financial approach is responsible for the now hugely successful growth of renewable energy generation and storage. During the last decades, technology has reduced the costs of renewables and storage to the point where they are below parity and still falling. There had been little progress toward the application of renewable energies until their costs reduced to the point of being the best solution financially. Financial gain, and not the climate downsides enumerated above, was the major determiner of renewables' application.

Inexpensive renewable electric generation and storage are also the key for climate-change mitigation, because electrification can be applied widely to the other major sources of

carbon dioxide besides electric generation, such as transportation, industrial and commercial operations, and building HVAC. Many functions and processes now producing CO_2 can be electrified, so the growth of renewables will have a major overall impact on climate.

It is useful to examine the particulars of this financially driven renewables success story and then to collect and ideate similar approaches and technologies for ecosystem rejuvenation and sustainability.

There are two obvious high-level sources of financial benefit for both the ecosystem and climate. These financially beneficial approaches strive to mitigate the trillions of dollars of negative effects from current trends continuing, and they strive to promote alternative technologies and approaches that have major profit potential.

We examine first the current financial approaches for climate and then a similar overall approach for the rest of the ecosystem that would enable sustainability, the circular economy, and green growth while obviating continued ecosystem degradation. The bottom line of business as usual is an average loss of some 7% (or more, depending upon actual temperature rise) of global gross domestic product per capita by 2100.[3] On the other hand, substantially mitigating ecosystem damage and climate change could increase global GDP per capita by some 5% by 2050.

It is not possible to change things for the good of the overall financial and ecosystem without, in fact, changing some things. There will be winners and losers. In the case of renewable energy for mitigating climate change, the winners are the public: reduced climate impacts across the board, reduced energy bills, cleaner air, and firms that successfully manufacture and sell various types of renewable energy. Losers thus far, due to the availability of lower-cost options, include coal and nuclear power.

As renewables and storage technologies continue to fall in cost and become more efficient, gas and petroleum will probably be significantly affected. Investors in these previously dominant industries will be left with stranded assets, even though the amounts invested in these fossil carbon industries have been major. Therefore, as we change our approaches to reverse the current climate and ecosystem trends, there will be financial difficulties associated with such losers that will have to be considered and worked out. For example, the stock market value of the U.S. coal industry in 2011 was approximately $37 billion. As of 2019, its worth was about $2 billion.[4]

Historically, there have been concerns regarding the costs of ecosystem and climate remediation. However, action has now shifted toward concerns about the even greater costs

of not taking action[5] and not taking advantage of the financial opportunities associated with those remediation approaches. As mentioned previously, there will be some cases where specific major industries and resources will be negatively impacted.

An indication of this 180-degree shift is mirrored in the increasing importance of climate and environmental performance upon the evaluation of top management. The governor of the Bank of England stated that companies that fail to respond to the challenges of climate change will go bankrupt without question. The value of the rapidly growing global green economy in 2015-16 was at least $7.87 trillion.[6]

I. A Look at the Climate Financials Story

We outline here the basic tools of understanding the financial impacts of climate change: costs of negative impacts and benefits of mitigating these impacts.

A. Negative Climate Change and Financial Avoidance

- Avoidance of huge insurance costs and personal, productivity, commercial, and industrial losses from phenomena induced or increased by climate change, including flooding, storms, fires, rising sea levels, droughts, disease, heat and increased temperatures, and landslides. (Note, insurance represents some 11% of the U.S. GDP.[5])
- Avoidance of negative impacts on sectors such as agriculture, fishing, health services, infrastructures, mining, supply chains, food systems, asset prices (including real estate), and land and labor productivity.
- Projections indicate that the U.S. economy could shrink on the order of 10% to 25% by 2100, depending upon the effects of positive feedbacks.
- Recent estimates of the social monetized cost per ton of CO_2 emissions is about $100 per ton in 2018, with 37 billion tons emitted, resulting in $3.7 trillion per year in societal costs, or approximately 4% of GDP.[7] Other recent estimates of the social cost of carbon range from $220 to $500 or more per ton of CO_2 emissions, depending upon what costs are included.[8]
- Given the cost of raising children, having one fewer child saves the most by far: 58 tons of CO_2 emissions per year.[9]
- Consumers are increasingly demanding climate-friendly operations and products across the board, producing loss of business for those that do not deliver such.
- Almost a quarter of all disease is caused by adverse environmental exposure.[10]
- Estimates indicate a 2 degree C temperature rise would reduce GDP by 15%, and a 3 degree C rise would reduce it 25%. In 2100, temperature is predicted to

rise 4 degrees C, producing a 30% reduction in GDP.[11]
- Since 1980, extreme weather has cost $1.6 trillion.[11]
- Yearly cost for unmitigated climate change would total at least 5% of GDP, and the yearly cost could be as high as 20% of GDP.[12]
- Warming of 6 degrees C could lead to present value loss of $43 trillion or 30% of the global total.[13]
- Over a decade, U.S. Environmental Protection Agency regulations cost $45 billion and produced $640 billion in benefits.[14]
- In the United States, $23 trillion will be lost if temperatures rise 4 degrees by 2100.[15]

B. Prospective Financial Gains from Mitigating Climate Change

- Due to technologies and economies of scale, renewable energy generation is now at or below cost parity with fossil carbon fuels and is still plummeting. Energy storage costs are reducing rapidly, leading to cheaper electricity and electric transportation, new markets, and reduced costs of living and manufacturing. Indicators show large job increases in related fields, reduced health issues from fossil fuel pollution, along with much reduced cooling water requirements.
- Less-costly energy enables more profitable desalinization, aluminum production, ocean mining, etc.
- Distributed energy, including at-home energy generation, constitutes a more reliable, robust, and less expensive system.
- Energy conservation developments enabled efficient buildings that produce energy versus constituting a sizable source of energy load major costs.
- There are potentially huge profits from switching from glycophyte (freshwater) agricultural approaches to halophyte (saline) agriculture.[16] It allows for utilization of massive currently unexploited planet resources such as deserts or wastelands and saline or seawater. This new approach would:
  - Produce biomass for replacing petroleum in petrochemical feedstock.
  - Produce massive amounts of food and free up a sizable portion of the 70% of the freshwater now used for agriculture.
  - Produce massive amounts of biofuels.
  - Sequester major amounts of CO_2.
  - Address resource challenges relating to land, water, food, energy, and climate.
  - Reduce costs of, and the need for, ever more courageous water conservation.
- This new approach would result in a wholly new agricultural industry with a huge environmental upside utilizing ultra-inexpensive land and water.
- Battery and energy storage markets are huge and increasing rapidly. Battery prices have fallen some 85% in a decade.[17]
- Renewable energy investments over the past decade are estimated at $2.5 trillion,

with a major growth in related employment.[18]
- Investing $1.7 trillion in climate change mitigation over the next 10 years could yield $7 trillion in economic returns, due to cost avoidance and increased productivity of new equipment.[19]

II. A Look at the Potential Ecosystem Financials Outlook

A. Negative Ecosystem Degradation Financial Avoidance

- Avoidance of major personal, commercial, industrial, and agricultural losses from ecosystem degradation due to loss of topsoil, freshwater shortages, species extinctions, pollution (including trash and industrial waste), deforestation, loss of fish stocks, and depletion of natural resources.
- Avoidance of some 9 million deaths per year from pollution (e.g. ozone, CO, NO_2, particulates, SO_2, ammonia, lead, chemicals), which is 15 times the number of deaths from wars and 16% of global deaths per year. Costs of pollution are some $4.6 trillion on the global economy.[20]
- Marine plastic pollution costs the world up to $2.5 trillion a year.[21]
- Nine out of 10 people in the world breathe highly polluted air.[22]
- Between 1997 and 2011, estimates indicate the world lost up to $21 trillion in ecosystem services due to land cover change and land degeneration.[23] (Note: certain references calculate ecosystem services loses differently based on certain variables.)
- Ecosystem services vital to human well-being (e.g., crop pollination, water purification, flood protection, and carbon sequestration) are evaluated at an estimated $125 trillion to $140 trillion per year, 1.5 times greater than the global GDP.[23]
- The cumulative loss of biodiversity and associated ecosystem services between 2000 and 2050 could be equivalent to 7% of the 2050 world GDP.[24]
- The world's terrestrial ecosystem services have been valued on an annual basis to be approximately equivalent to the annual GDP.[25]

B. Prospective Financial Gains from Approaches to Reverse Ecosystem Degradation

- The immense advantages of switching to halophytes—salt-loving plants cultivated on wastelands and deserts[16]—include:
  – Saline-tolerant plant biomass utilizing what we have a surfeit of (and what could be our last major play regarding the ecosystem): wastelands, deserts (which make up 44% of the land area), and seawater (97% of the planet's water resources).

– Seawater contains 80% of the nutrients needed to grow plants, and researchers are developing new techniques to extract nitrogen from the air, thus requiring little fertilizer.
– Advanced technology is not required and cultivation uses inexpensive land and water, so the economics are very favorable. The shift to halophytes could be accomplished in relatively short order.
– Halophyte cultivation for food would free up 70% or more of the total freshwater used for conventional glycophyte agriculture, and which we are now running out of for direct human use, thus solving both water and food problems.
– Cultivation of halophyte biomass would similarly obviate the necessity of using arable land and freshwater for biofuels and provide petrochemical feedstocks for plastics and other industrial products, essentially eliminating the need for petroleum feedstocks. It is literally green energy and chemicals.
– Halophytes sequester up to 18% of their carbon dioxide uptake in their deep roots (5 tons of CO_2 per hectare) removing CO_2 from the atmosphere.
– Seawater contains trace elements essential to healthy human physiology, which we have largely depleted from arable land due to overuse.

- Ocean mineral extraction using inexpensive renewable energy instead of hard rock mining, which is a major source of pollution.
- Recycling (aka the circular economy) for nearly everything, including solids, liquids, and gases. Tech companies to do this at ultra-low costs and increasingly local, including printers.
- The University of Nottingham is attempting to utilize atmospheric nitrogen for agriculture, incurring far less fertilizer costs, runoff, and reducing ocean O_2 loss.
- On less than a half-acre and with help from developing technologies, we could grow own food, print what we want or need, recycle on site, use distributed energy generation, conduct tele-education and telemedicine, and utilize five-senses virtual reality and teletravel.
- This could all be done with the need for far less physical travel. Many in the gig economy and those telecommuting can live just about anywhere. Going forward, some may not need a job since these opportunities could result in huge personal financial independence and minimal impacts upon the ecosystem.
- The ongoing major shift in wealth generation from exploiting natural resources to inventing things has a far smaller ecosystem impact in general.
- Various adaptations to ecosystem and climate changes have overall benefits estimated at $7 trillion.[26]
- McKinsey estimates business opportunities of $60 billion per year for new approaches to plastics recycling.[27]
- 3-D printing will transform manufacturing by allowing individuals to make their own products. This would reduce waste, enable use of new and different materials

and much more complex designs with optimized functionalities, while using 90% less material and at greatly reduced costs. 3-D printing is set to be an emerging, ecosystem-friendly evolving market.[28]

- U.S. green economy is estimated at $1.3 trillion per year, 6.8% of our $19 trillion per year economy. There are greater returns in the green economy than in the stock market. Estimated GDP climate losses per year are some 4% of GDP. Therefore, the total effect of mitigating the losses and the green economy is nearly $2 trillion.[29] The global green economy is approximately $8 trillion.
- From 2009 to 2019, there has been $10.4 trillion in private investment in the global green economy.[30]

Conclusion

Favorable financials and increased profits are, due to massive reductions in the costs of renewables and storage, currently on a path to mitigate negative climate change impacts in a few decades. It is more than conceivable, given the huge economic value of the ecosystem and the major financial upsides of various mitigation approaches, that the financials could also fix the rest of the ecosystem issues.

These considerations, options, and experiences refute the long-held conventional wisdom that fixing the ecosystem issues, including climate, would be extremely costly and anti-growth. In fact, considering both the avoidance of financial downsides and evolving markets for mitigation approaches and their offshoots, fixing the ecosystem and climate is the way forward to excellent financial growth and success.

It will require changes, which are either already underway or available for financial exploitation. So, yes, decarbonization and a circular economy (green growth) are both achievable in the medium term and very financially advantageous. In the case of climate, there was minimal progress until the financials became advantageous. That same power of the financials can, and should be, successful in regard to greatly improving the outlook for the rest of the ecosystem.

Notes

1. Paul Hawken (editor), *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming.* Penguin Books, 2017.

2. Jodi Newcome et al., "The Economic, Social and Ecological Value of Ecosystem Services," EFTEC, Economics for the Environment Consultancy, London, January 2005.

3. Matthew E. Kahn et al. “Long-Term Macroeconomic Effects of Climate Change: A Cross Country Analysis,” NBER working paper, No. 26167, University of Cambridge, 2019. http://imf.org/en/Publications/WP/Issues/2019/10/11/Long-Term-Macroeconomic-Effects-of-Climate-Change-A-Cross-Country-Analysis-48691

4. Renee Cho, “How Climate Change Impacts the Economy,” State of the Planet, Earth Institute, Columbia University, June 20, 2019. https://blogs.ei.columbia.edu/2019/06/20/climate-change-economy-impacts/

5. Joel Makower, “Capitalism’s Change of Climate,” GreenBiz, August 6, 2019. https://www.greenbiz.com/article/capitalisms-change-climate

6. University College London, “U.S. green economy worth $1.3 trillion per year, but new policies needed to maintain growth,” Phys.org, October 15, 2019. https://phys.org/news/2019-10-green-economy-worth-trillion-year.html

7. Kent D. Daniel et al., “Declining CO2 price paths,” *Proceedings of the National Academy of Sciences,* October 15, 2019. https://www.pnas.org/content/116/42/20886

8. Ker Than, “The economic damage from climate change may be more than you think,” Stanford Engineering Research and Ideas, February 26, 2016. https://engineering.stanford.edu/magazine/article/economic-damage-climate-change-may-be-more-you-think

9. Fiona Macdonald, “Here Are 10 Not-So-Obvious Things You Can Do to Help The Planet Today,” Science Alert, September 22, 2019. https://www.sciencealert.com/here-are-10-not-so-obvious-things-you-can-do-to-help-the-planet-today

10. World Health Organization, “Almost a quarter of all disease caused by environmental exposure.” 2006. https://www.who.int/mediacentre/news/releases/2006/pr32/en/

11. Kimberly Amadeo, “Climate Change Facts and Effect on the Economy,” The Balance, June 25, 2019. https://www.thebalance.com/economic-impact-of-climate-change-3305682

12. Maria Sandberg et al., “Green growth or degrowth? Assessing the normative justifications for environmental sustainability and economic growth through critical social theory,” *Journal of Cleaner Production,* January 2019 (Volume 206), pp. 133-141. https://www.sciencedirect.com/science/article/pii/S0959652618329044

13. Intelligence Unit of The Economist, "The cost of inaction: Recognising the value at risk from climate change," 2015. https://eiuperspectives.economist.com/sites/default/files/The%20cost%20of%20inaction_0.pdf

14. Hannah Liu, "Why Environmental Regulation Is Good for the Economy," Wharton School of The University of Pennsylvania, Public Policy Initiative, September 24, 2016. https://publicpolicy.wharton.upenn.edu/live/news/1380-why-environmental-regulation-is-good-for-the

15. Tom Kompas, "U.S. $23 trillion will be lost if temperatures rise four degrees by 2100," Phys.org., August 15, 2018. https://phys.org/news/2018-08-trillion-lost-temperatures-degrees.html

16. Edward P. Glenn et al., "Irrigating Crops with Seawater," *Scientific American,* August 1998, pp. 76-81. https://www.scientificamerican.com/article/irrigating-crops-with-seawater/

17. Lynn Doan et al., "What's Behind the World's Biggest Climate Victory? Capitalism," Bloomberg.com, September 15, 2019. https://www.bloomberg.com/graphics/2019-can-renewable-energy-power-the-world/

18. Brian Bienkowski, "Global renewable energy has quadrupled over past decade," Environmental Health News, September 6, 2019. https://www.ehn.org/renewable-energy-growing-2640193068.html

19. James Temple, "If we spend $1.7 trillion on climate adaptation we could make four times that much back," MIT Technology Review, September10, 2019. https://www.technologyreview.com/f/614291/if-we-spend-trillions-on-climate-adaptation-we-will-make-four-times-that-much-back/

20. Roy Ananya, "Pollution is responsible for 9 million deaths globally: Two-thirds are due to air pollution," Environmental Defense Fund, October 20, 2017. http://blogs.edf.org/health/2017/10/20/pollution-is-responsible-for-9-million-deaths-globally-two-thirds-are-due-to-air-pollution/

21. Kate Hodal, "Marine plastic pollution costs the world up to $2.5tn a year, researchers find," *The Guardian,* April 4, 2019. https://www.theguardian.com/global-development/2019/apr/04/marine-plastic-pollution-costs-the-world-up-to-25bn-a-year-researchers-find

22. Kimberly Amadeo, "How Air, Water, and Plastic Pollution Affect the Economy," The

Balance, August 3, 2019. https://www.thebalance.com/pollution-facts-economic-effect-4161042

23. OECD, "Biodiversity: Finance and the Economic and Business Case for Action," report prepared for the G7 Environmental Ministers Meeting, May 5-6, 2019. http://www.oecd.org/env/resources/biodiversity/biodiversity-finance-and-the-economic-and-business-case-for-action.htm

24. European Commission "The global cost of biodiversity loss: 14 trillion Euros?" Science for Environmental Policy, September 4, 2008. https://ec.europa.eu/environment/integration/research/newsalert/pdf/119na1_en.pdf

25. Almut Arneth et al., "Climate Change and Land," IPCC special report, summary for policy makers, 2019. https://www.ipcc.ch/report/srccl/

26. "Climate Change is now "Inevitable" and the World must Adapt, Warns the Global Commission on Adaptation in a New Report," Technology.org, September 10, 2019. https://www.technology.org/2019/09/10/climate-change-is-now-inevitable-and-the-world-must-adapt-warns-the-global-commission-on-adaptation-in-a-new-report/

27. McKinsey and Co., "Five ways to push sustainability forward," The Shortlist, September 20, 2019. https://www.mckinsey.com/~/media/McKinsey/Email/Shortlist/57/2019-09-20.ashx

28. Peter Diamandis and Steven Kotler, *The Future Is Faster Than You Think.* Simon & Schuster, January 28, 2020.

29. Lucien Georgeson and Mark Maslin, "Estimating the scale of the US green economy within the global context," Palgrave Communications, 5, Article number 121, 2019. https://www.nature.com/articles/s41599-019-0329-3

30. Hazel Henderson, "2019-2020 Green Transition Scoreboard® Report," 2019. http://www.ethicalmarkets.com/wp-content/uploads/2019/05/2019-2020-GTS-Full-Report.pdf

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