NON-ENERGY BENEFITS: UNDERSTANDING THE IMPERATIVE AND THE OPPORTUNITY*

*REFLECTING THE COMMON GOOD RATHER THAN MERELY THE MARKET COSTS

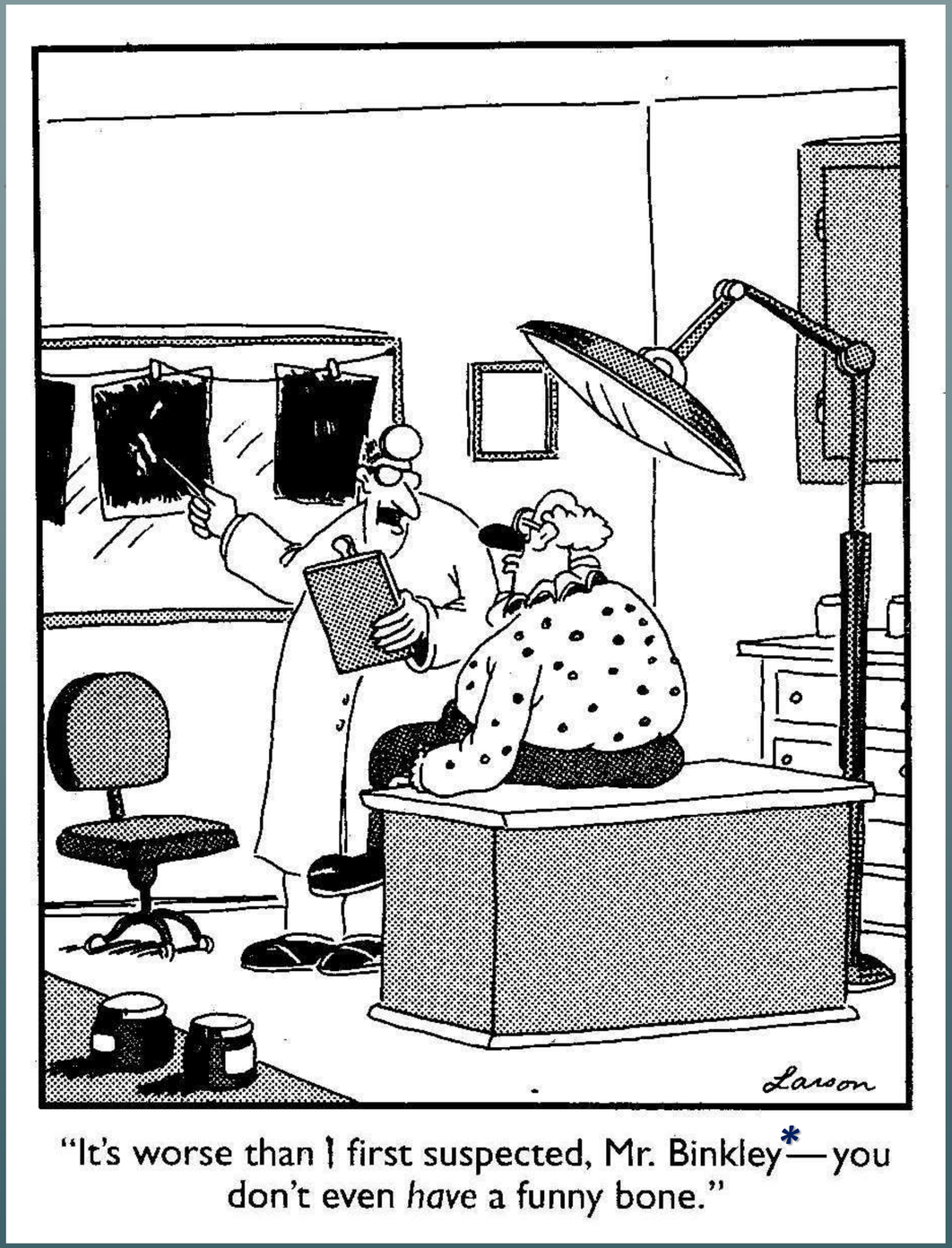
In conversation with Utility Energy Forum 2025 Participants
Cambria, California April 23, 2025

John A. "Skip" Laitner

With an insight from my very favorite American philosopher, Gary Larson. . .

****And would this likely be true?***

Might the clown, Mr. Binkley, be a surrogate for the UEF Participants here today???



Four Examples of the Many and Often Unexpected Array of Multiple Benefits. . .

(1) Insights on the Multiple Benefits of Trees

i-Tree Design v7.0
Tree Benefit Report - 04/28/2022
Tucson, AZ 85750, USA
Trees Evaluated: 1

Total Projected Benefits (2022-2061) - Over the next 39 years, based on forecasted tree growth, i-Tree Design projects total benefits worth $1,339:

- $951 of summer energy savings by direct shading and air cooling effect through evapotranspiration
- $36 of winter energy savings by slowing down winds and reducing home heat loss
- $23 of storm runoff savings by avoiding 2,576 gallons of stormwater runoff (intercepting 25,656 gallons of rainfall)
- $40 of air quality improvement savings by absorbing and intercepting pollutants such as ozone, sulfur dioxide, nitrogen dioxide, and particulate matter; reducing energy production needs; and lowering air temperature
- $289 of savings by reducing 12,415 lbs. of atmospheric carbon dioxide through CO_2 sequestration and decreased energy production needs and emissions

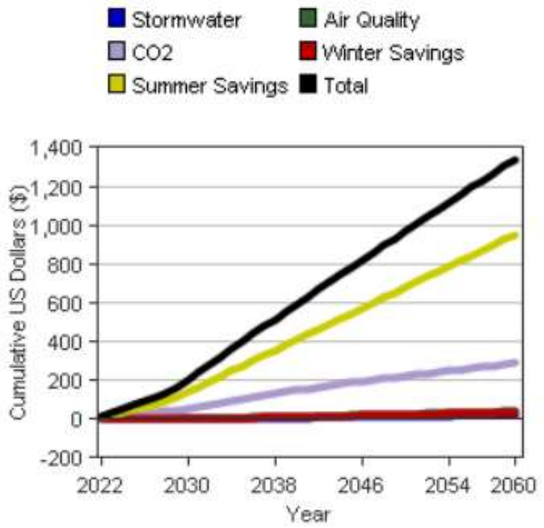


Figure 1. Tree benefit forecast for 39 years

Note: 5.63 tonnes implies a Social Cost of Carbon of ~$51/tonne, but if the SCC is more like $185/tonne, then a savings more like $1,042

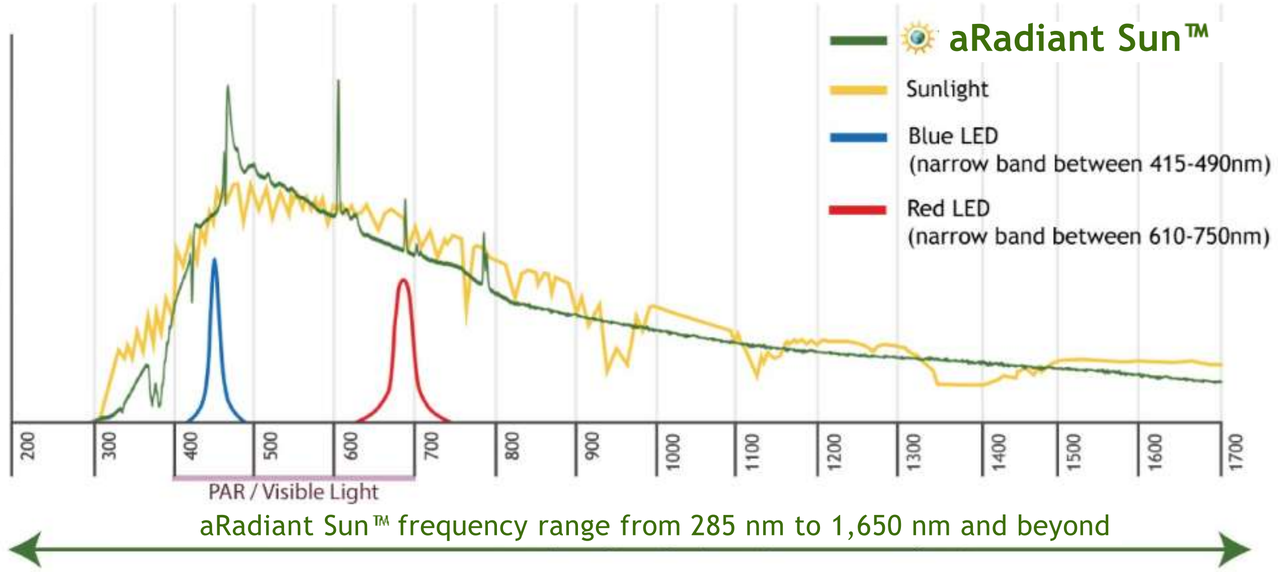
https://design.itreetools.org/ And see also – https://discovertheforest.org/resources/benefits

(2) And the Multiple Benefits of SunTechnology *

It's simple. It's the Sun. Indoors.

The Sun On-Demand™ is a hyper-efficient sunlighting technology that produces a true electromagnetic sunlight spectrum and frequencies. No other indoor light source can deliver the same.

AZENTIVE



The many benefits include: Lower capital costs, a much greater lighting efficiency than metal halide and LED lamps, with lower cooling costs, and a greatly improved, but also a healthier, indoor plant production – even as it also reduces material needs together with a smaller scale of greenhouse gas emissions and air pollution.

***In full disclosure, I am a small investor in, and on the advisory board of Azentive, the company which produces this technology. For more details see: https://www.azentive.com/**

(3) Also, Multiple Benefits of PV-Powered Solar Roadways*

SOLAR ROADWAYS
A REAL SOLUTION

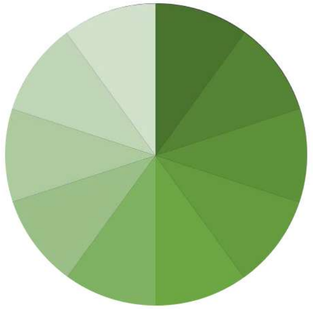
Instead of asphalt or concrete, PV panels that have been engineered for walking and driving surfaces.

Customer ROI *

Asphalt & Concrete

Toll Roads

Solar Roadways®



For Solar Roadways® customers, there are multiple ROI possibilities, such as:

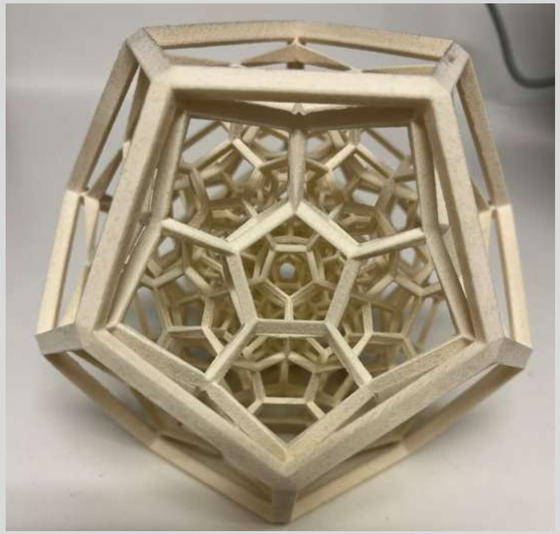
- Energy production
- No more snow removal
- Dynamic line/signage
- No more repainting
- Advertising
- Green your image
- No pothole repair
- Data collection
- Lease cable corridor
- Traffic management

An ROI that ensures many other social, environmental, and economic benefits

*Again, in full disclosure, I am a colleague of Scott and Julie Brusaw, owners of Solar Roadways: https://solarroadways.com/

(4) And. . . the Multiple Benefits of AI-Driven 3D Printing

As we've gone from a 3D nylon filament dodecahedron, given to me by the University of Texas-Austin engineering school in 2010. . .



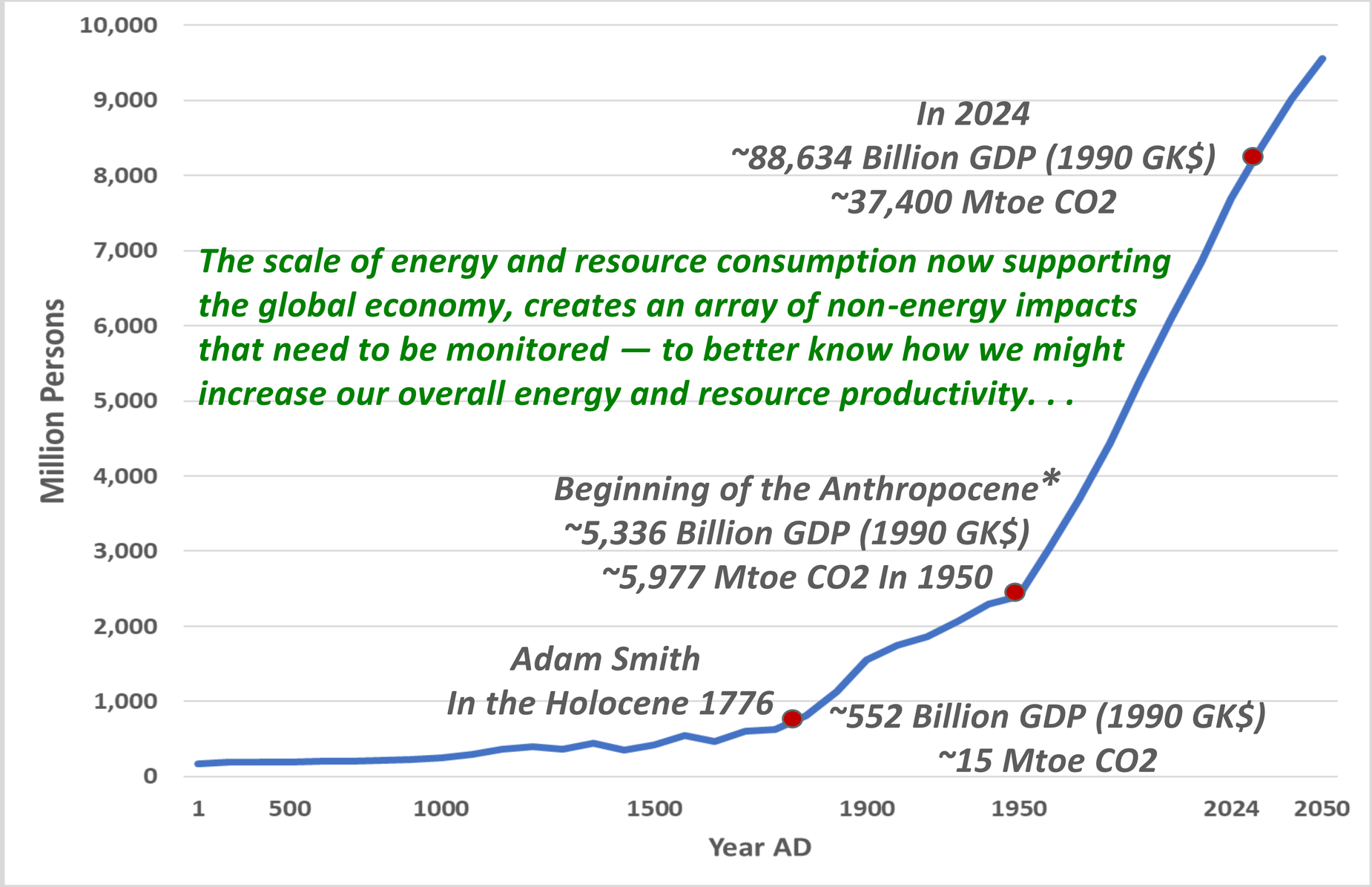
To now SUNLU 3D, a leading Chinese tech company specializing in materials for 3D printing, with a new range of filaments and dryers.

While just last month, Japan assembled a 3D-Printed rural train station in only 6 Hours*

And as we expand into buildings, automobiles, pharmaceuticals, and other needs, the advantages of 3D printing include reduced waste and energy, streamlined production, fewer materials needed, and local sourcing; among other benefits.

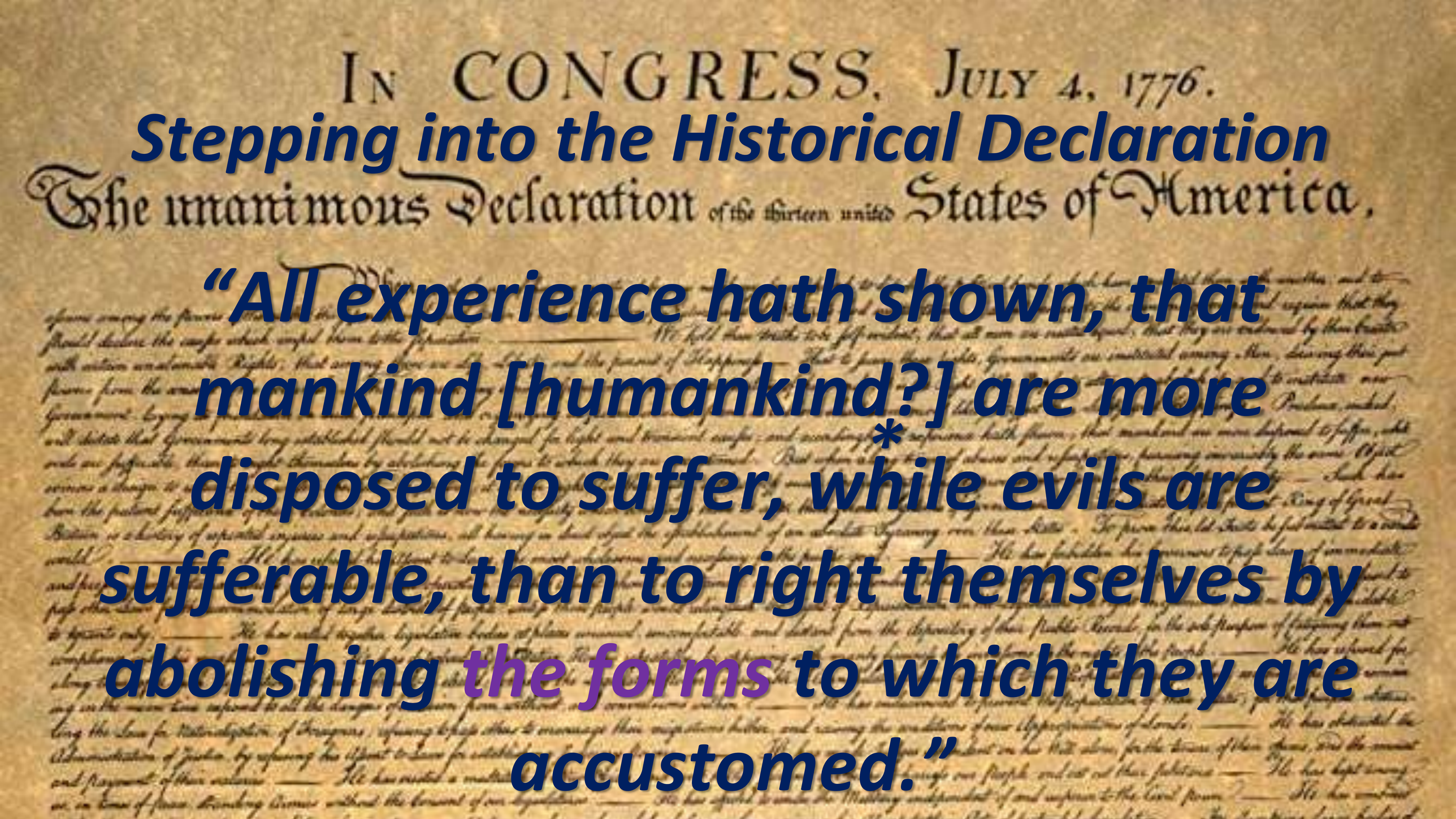
To check out even a single story: https://www.nytimes.com/2025/04/08/world/asia/japan-3d-station.html

Why the Imperative? Exploring the Scale and Impact of World Population



*Note: The year 1950 is only an indicative date which might be called the beginning of the Anthropocene.

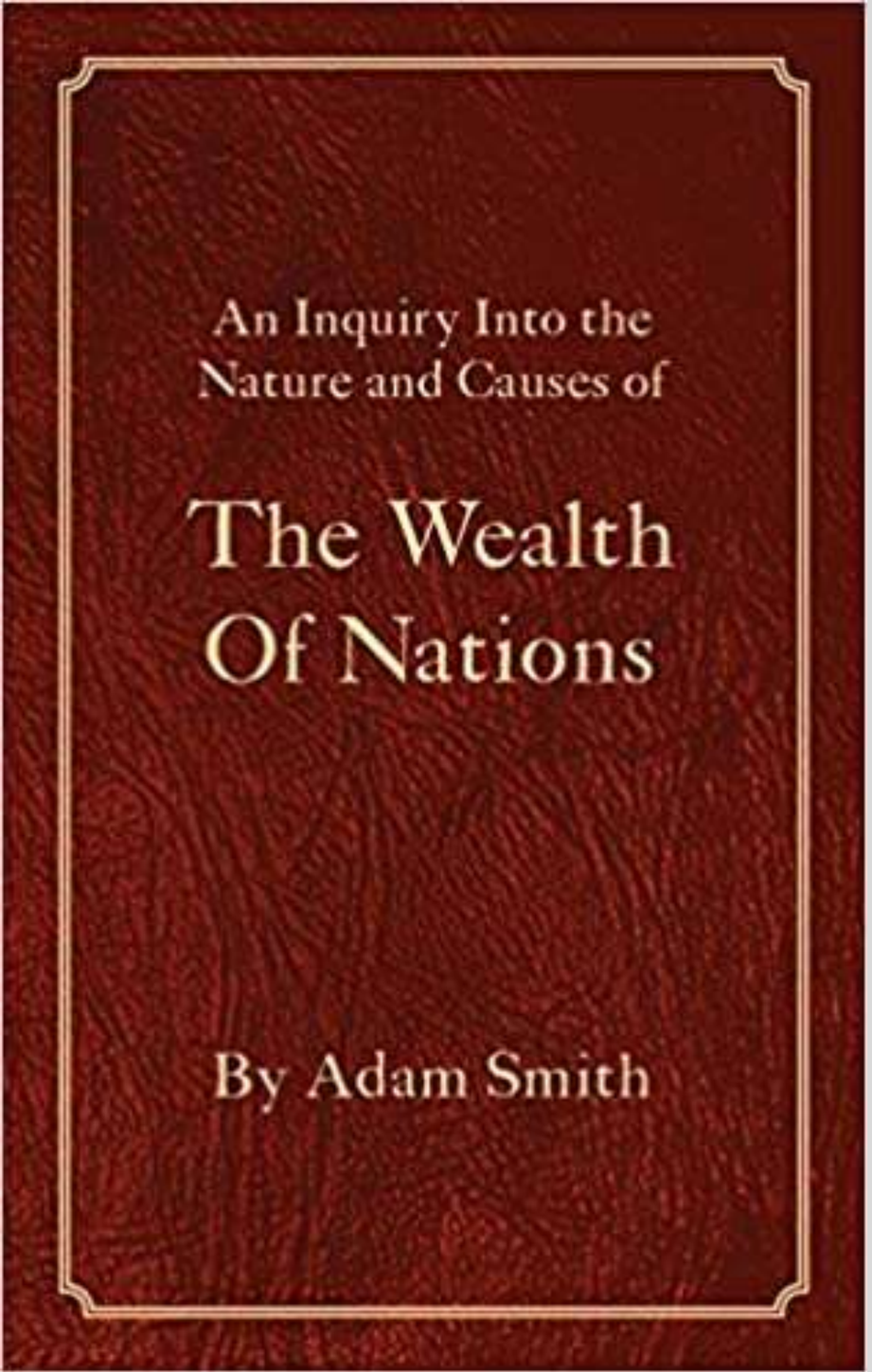
But from a more purely philosophical perspective???



Stepping into the Historical Declaration

"All experience hath shown, that mankind [humankind?] are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed."


IN CONGRESS, JULY 4, 1776.
The unanimous Declaration of the thirteen united States of America,
*
*And perhaps the need to move past the conventional economic forms as well?



Individuals intend only. . .

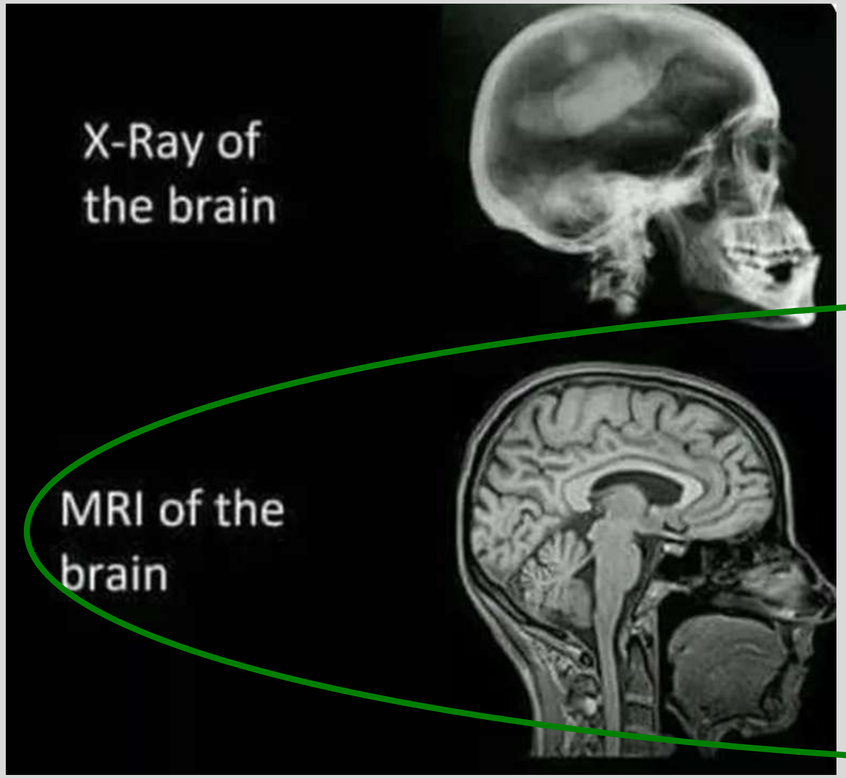
"[Their] own security; and by directing industry in such a manner as its produce may be of the greatest value, ***[they] intend only their own gain; and they are led in this by an invisible hand to promote [the common good] which was no part of [their] intention."***

Adam Smith (1776)

But as I might suggest, there are significant market failures which point to the need for what I call "the invisible foot." The market may need a swift kick to help it pay attention to the many, many non-energy impacts which too often are overlooked within pure market decisions.

Or, perhaps the need to "reboot our understanding" of the imperative and the opportunity as we proactively include both energy and non-energy benefits within our market or social decisions. . .

A Deeper Look at Economic Metrics for New Insights

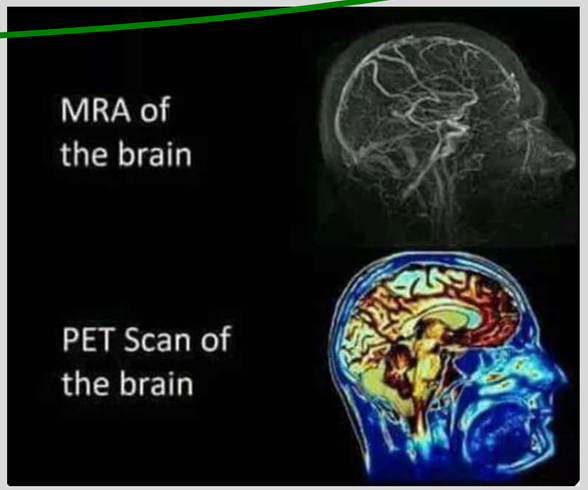


Not a perfect comparison, but if we think of standard economics as providing a mostly cost/quantity review of market dynamics, in some ways like X-Rays of the brain,

With today's focus mostly here…

Then we might perhaps think of non-energy impacts and non-energy benefits much like an MRI provides a more highly detailed set of images, and deeper insights of our social, environmental and economic well-being.

Even as MRAs and PET scans also help us understand the many health aspects of our ecosystems, and the species and plant/animal bio-diversities.

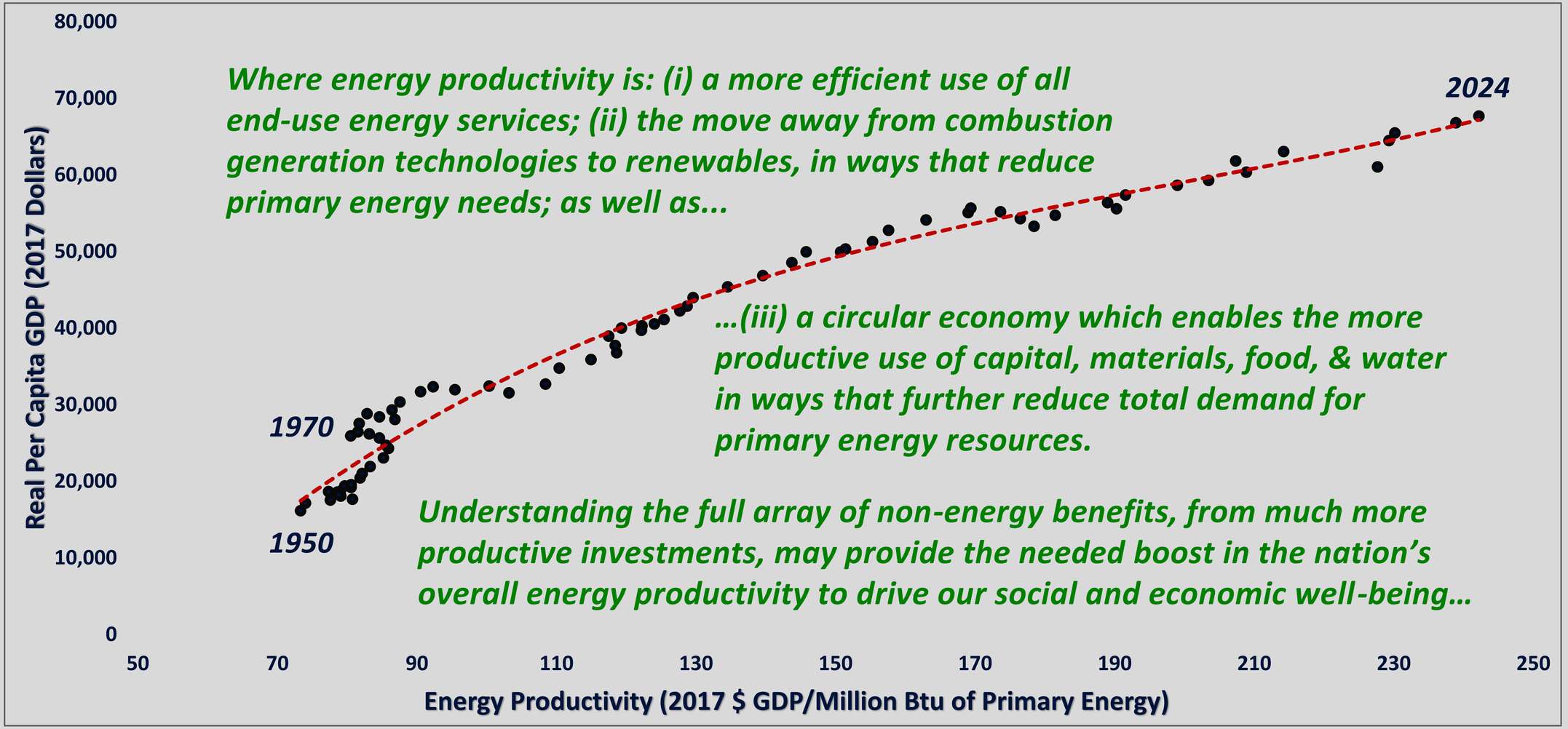


Understanding the Economic Imperative and the Benefits of a Greater Overall Energy Productivity by 2050*

- ***A Surprising But Lagging Rate of U.S. Energy Productivity Improvement***
  - *Yes, 2024 was our strongest level of energy productivity at $244 GDP/MBtu primary energy (in 2017$)*
  - *Our historical rate of improvement since the 1992 Rio Earth Summit was 2.1%/year; and*
  - *The preliminary AEO 2025, however, projects a lower rate of improvement of 1.7% per year through 2050*
  - *Ironically, the latest EIA data says the scale of U.S. energy productivity is slightly below global average*
- ***Why Does This Matter?***
  - *Per capita GDP steadily erodes from a historical increase of 2.4% down to 1.5% per year through 2050*
  - *Compared to previous forecasts, aggregate GDP might be $3 trillion smaller in 2050*
  - *With cumulative government spending, over the period 2024 through 2050, down by $5 trillion*
  - *Even as the U.S. population might grow yet another 36 million people*
- ***Hence, a Big Need for an Energy Productivity Stimulus with Non-Energy Benefits***
  - *Policies, programs, and investments to increase the lagging productivity of 105 primary energy quads in 2050 to a more productive (with non-energy benefits) 82 quads of "clean energy" in that same year*
  - *Even as a "misplaced and sliding baseline," **especially one that overlooks non-energy benefits**, may limit our future social, environmental, and economic opportunities, and our long-term overall social well-being*

*** Presentation for discussion purposes only. Do not quote without permission as these indicative results are subject to change. . .**

The Connection Between U.S. Energy Productivity and Real Per Capita GDP (1950-2024)



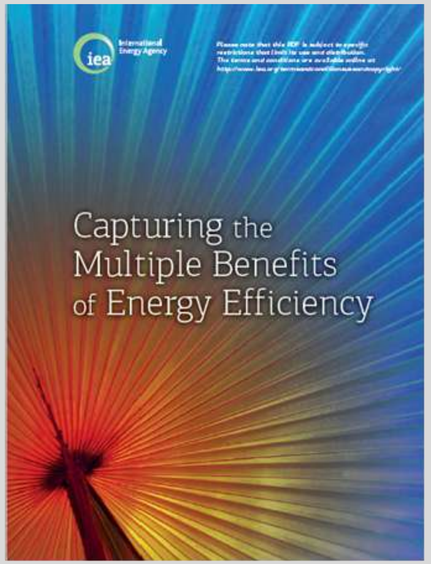
Source: *Calculations by John A. "Skip" Laitner using EIA and BEA data for the United States, March 2025.*

What are Non-Energy Benefits?

- Multiple or non-energy benefits (NEB or MBenefits) are additional cost savings and/or revenues that result from energy efficiency projects or upgrades
- Some NEBs are easily quantifiable:
  - Maintenance savings, higher output, better product quality
- Some NEBs are less easily quantifiable (though not impossible):
  - Improved safety, employee morale, community appreciation
- Most NEBs are not identified/quantified during energy assessments
- Because NEBs have not historically been integrated into evaluations of energy efficiency projects, the impact of greater energy productivity has been understated and underappreciated

A Timeline of Non-Energy Benefit Assessments*

1997	Elliott, Laitner, & Pye for Hawaii conference paper	* Early concept paper integrating energy & non-energy benefits for industry
1999	Pye & McKane white paper for ACEEE Summer Study	* Offered Strong Anecdotal information on NEBs
2003	Worrell, Laitner et al. study: Industry Productivity Gains from Energy Efficiency	* Early cost-curve/modeling framework to capture NEBs with 52 examples of payback falling from 4.2 to 1.9 years
2005	Lung, McKane et al. paper for ACEEE Summer Study	* Applied Worrell model to 81 DOE case studies (of energy efficiency projects) → Idea made to train energy auditors to identify NEBs
2015	IEA publishes "Capturing Multiple Benefits" book	* Includes suggestion to train energy auditors to find NEBs
2016	EU approves funding for "MBenefits" project to train energy auditors to find NEBs	* Bruce Lung invited to serve on the advisory board
2019	Interim results meeting in Berlin, Germany	* Demonstrated toolkit and training module for energy auditors and end users
2021	EU MBenefits project finishes	* 23 pilot assessments performed within the EU (plan was to do 50)
2024	Launch of DOE-NREL industry MBenefits project	* Build the JUSTIFI open-source Software for industry use

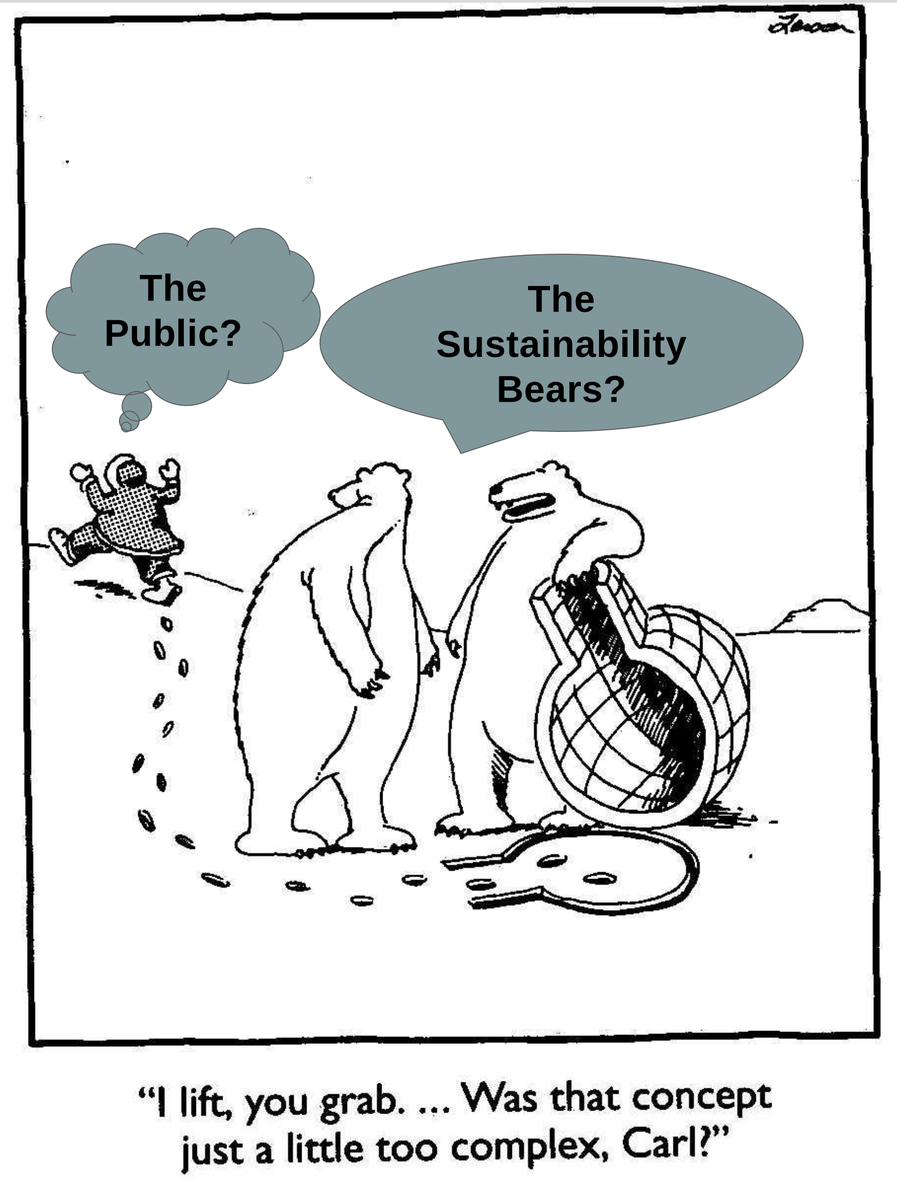


IEA report 2015

And perhaps today is the time to begin developing the tools that put non-energy benefits to real work

Multiple benefits of energy efficiency

***Source:** These and other references available from the DOE-NREL Multiple Non-Energy Benefits Industry Project. . .*



Another insight from favorite American philosopher, Gary Larson

How then, might we explain the energy and resource complexities in ways that better connect with members of the public?

And to illustrate the possible scale of energy productivity and non-energy benefits, let me introduce what I call. . . a "Fermi Thought Experiment" *

Using my "DEEPER Energy Modeling Framework" and assuming a 15% national electricity savings, with a 40% array of non-energy benefits which provide a benefit-cost ratio of 1.71 over the years 2022 through 2036. . .#

** Named after 1938 Nobel Laureate and physicist Enrico Fermi, what I call a "Fermi Thought Experiment" (or a "Fermi calculation") involves the computation of several factors to approximate a given impact (e.g., the potential scale of economic benefits).*

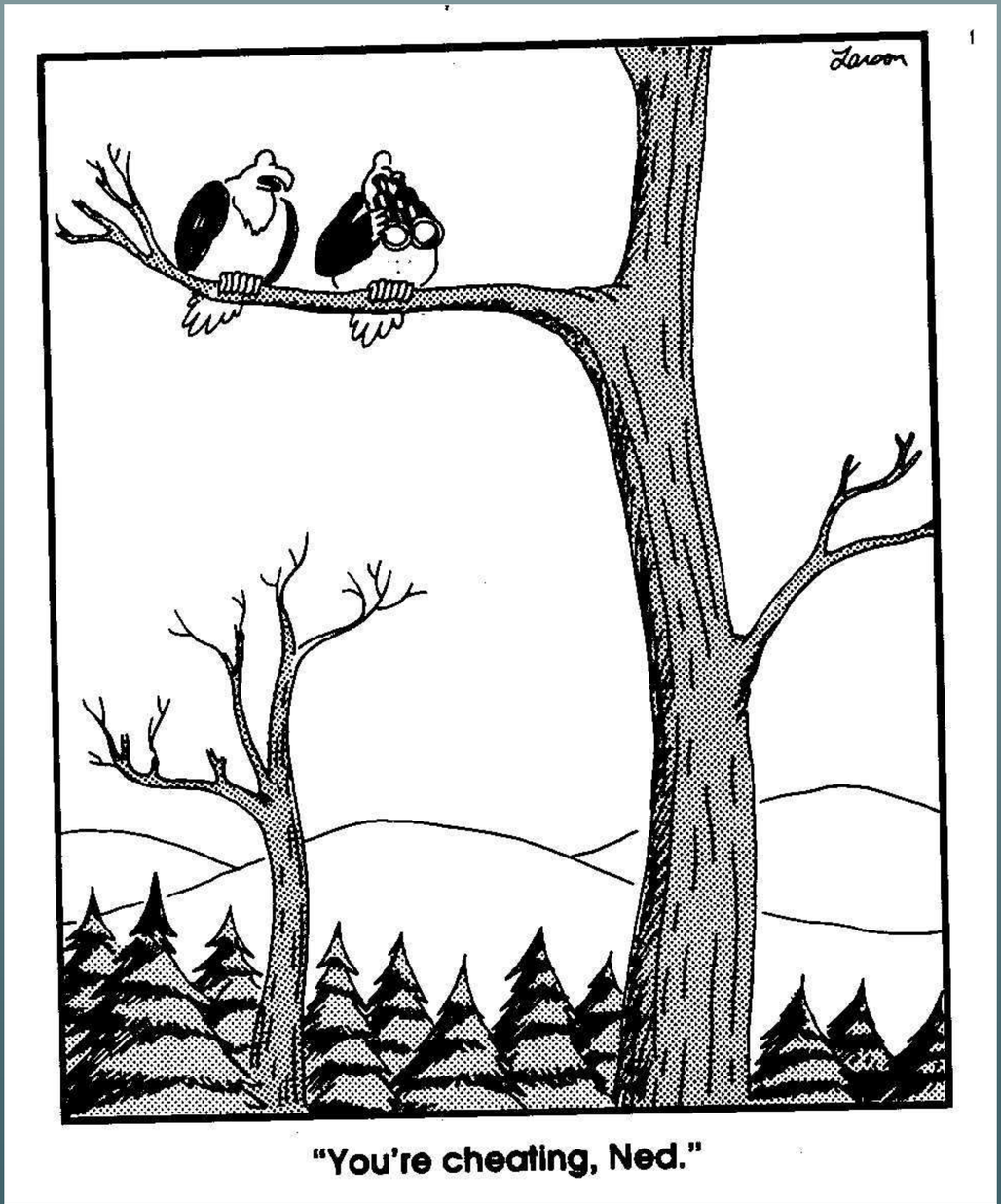
 # For those interested in a "DEEPER Dive" of this analysis, check out Appendix A and B. I can also provide more detailed set of analytics as might be useful.

Working Tool Highlighting Benefits – Average Year Impacts

Average Scenario Results 2022 through 2036 (15 Years)

Impact Category	$MM	Jobs
Policy Cost	$6,279	119,502
Investment	$28,256	509,864
Loan Payment	$17,182	50,507
Non-Energy Benefits	$29,302	177,431
Conventional Utility Revenues	($17,581)	-137,307
Net Consumer Savings	$5,841	84,350
Net Jobs	n/a	804,347
Implied Consumer Benefit-Cost Ratio		1.71

And it just may be the many non-energy benefits that persuade businesses, consumers, and communities to put many more projects over the top and encourage the needed and more productive scale of public and private investments!!!



So, is this really cheating???

Or. . . is it merely putting better analytics and metrics to better use?

With many thanks for your attention, but do also note:

For more information, contact:
John A. "Skip" Laitner at
EconSkip@gmail.com

Appendix A: Key Analytical Assumptions that Underpin the Fermi Thought Experiment

National Electricity Efficiency Scenario -- First Assumptions

1. Initial Scenario Assumptions	Key Assumption	Implied Year Spending $MM
Base Year Electricity Expenditures ($ Bln)	**$390**	n/a
First Year Electricity Savings (% Expenditure)	**1.15%**	$4,485
Assumed Simple Payback (Years)	**7**	n/a
Ergo First Year Investment	n/a	$31,395
Assumed Program Administrative Cost (% Investment)	**8%**	$2,512
Assumed Outreach Marketing Cost (% Investment)	**12%**	$3,767
Assumed Consumer Incentive (% Investment)	**30%**	$9,419
First Year Admin Implementation at 50% Yearly Cost	2022	$1,256
First Year Outreach Implementation at 50% Yearly Cost	2022	$1,884
First Year Investment at 50% Yearly Cost	2023	$15,698
Non-Energy Benefits as Percent of Electricity Savings	**40%**	n/a
Non-Energy Infrastructure Investment as % of Electricity	**0%**	n/a

2. Other Key Assumptions	Metric
Borrowing Interest Rate	**3%**
Years of Borrowing	**15**
Annual Rate of Loan Repayment	8.4%
Interest Rate as Share of Payments	1.7%
Interest Share	20.4%
Utility Loss Share	**60%**
Benefit Cost Discount Rate	**3%**
Implied Benefit Cost Ratio	1.71
Punch it Up	**1.00**
Average Savings of 2036 Electricity Bill	15.5%

*Note: Values are based on a simplified spreadsheet model and an exercise for a graduate economics course I taught in 2022 (hence, a little dated). Those data shown in **Bold-Faced Green** directly impact scenario assumptions. Other values on this page are calculated from these assumptions and, in various ways, can also feed into the impact scenario. The scale of non-energy benefits and benefit-cost ratio are highlighted in red. Again, I'm happy to explain in further detail as might be helpful.*

Appendix B: Key Job Coefficients Which Drive Net Job Impacts for the Fermi Thought Experiment

U.S. Job Coefficients (Jobs/$MM) for Key Economic Sectors

Key Sectors	Direct Jobs	Indirect Jobs	Induced Jobs	Total Jobs	Average Gains in Labor Productivity/Year
Construction	6.7	3.1	10.2	19.9*	0.91%
Manufacturing	2.1	4.1	8.5	14.7	1.89%
Energy	0.8	1.9	8.1	10.8	2.62%
Finance	3.0	4.0	10.1	17.0	1.32%
Government	8.8	0.5	11.5	20.8	0.91%
All Other Sectors	5.3	3.2	9.7	18.2	1.47%

Source: IMPLAN US Data 2021 for Year 2019 Coefficients. As summarized in Laitner (2021).

* *For a working evaluation on the impact of labor productivity within the construction sector, if the year 2019 shows a total of 19.9 jobs/$MM, an annual BLS or other labor productivity at the rate of, say, 0.91% would then result in perhaps ~17.1 total jobs/$MM in the year 2036.*

Again, thank you!!!