(GS-4) Beware: The World Economy Is Beginning to Shrink

Speaker: Gail Tverberg, FCAS, MAAA

Moderator: W. James MacGinnitie, FCAS, FSA, MAAA

May 8, 2024

Antitrust Notice

- The Casualty Actuarial Society is committed to adhering strictly to the letter and spirit of the antitrust laws. Seminars conducted under the auspices of the CAS are designed solely to provide a forum for the expression of various points of view on topics described in the programs or agendas for such meetings.
- Under no circumstances shall CAS seminars be used as a means for competing companies or firms to reach any understanding – expressed or implied – that restricts competition or in any way impairs the ability of members to exercise independent business judgment regarding matters affecting competition.
- It is the responsibility of all seminar participants to be aware of antitrust regulations, to prevent any written or verbal discussions that appear to violate these laws, and to adhere in every respect to the CAS antitrust compliance policy.

Outline

- Introduction
- In physics terms, an economy is much like a human being
- How the world economy behaves when energy supply is too low
- How Advanced Economies respond to resource limits
- A transition to all electricity is wishful thinking
- Key take-aways for actuaries

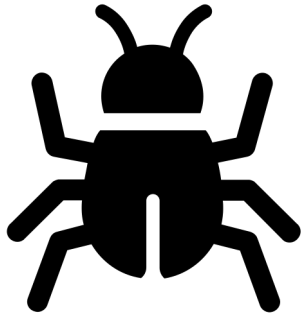
Party food image provided by Microsoft PowerPoint 365.

Would the length of food inadequacy make a difference?

- One hour
  - Can get along without
- Five days
  - People would get angry
- One year
  - Fights would break out
  - Strong people would take food from the weak
  - Alliances might form to take food from the weak
  - People might fight back against you, in charge of the party

Suppose we substitute dried insects and kale for party foods. Would that make a difference?

Kale bunch



Insect-based food

Energy for the economy is very much like food for humans

- Each country needs many kinds of energy resources to “feed” its existing infrastructure
- Each country needs to feed its own people
- We use fossil fuels in many ways
  - Cultivate food
  - Transport food to market
  - Pave roads
  - Cook food
- Substitution with different energy sources that don’t work in existing infrastructure isn’t feasible

A major problem is that population keeps growing rapidly

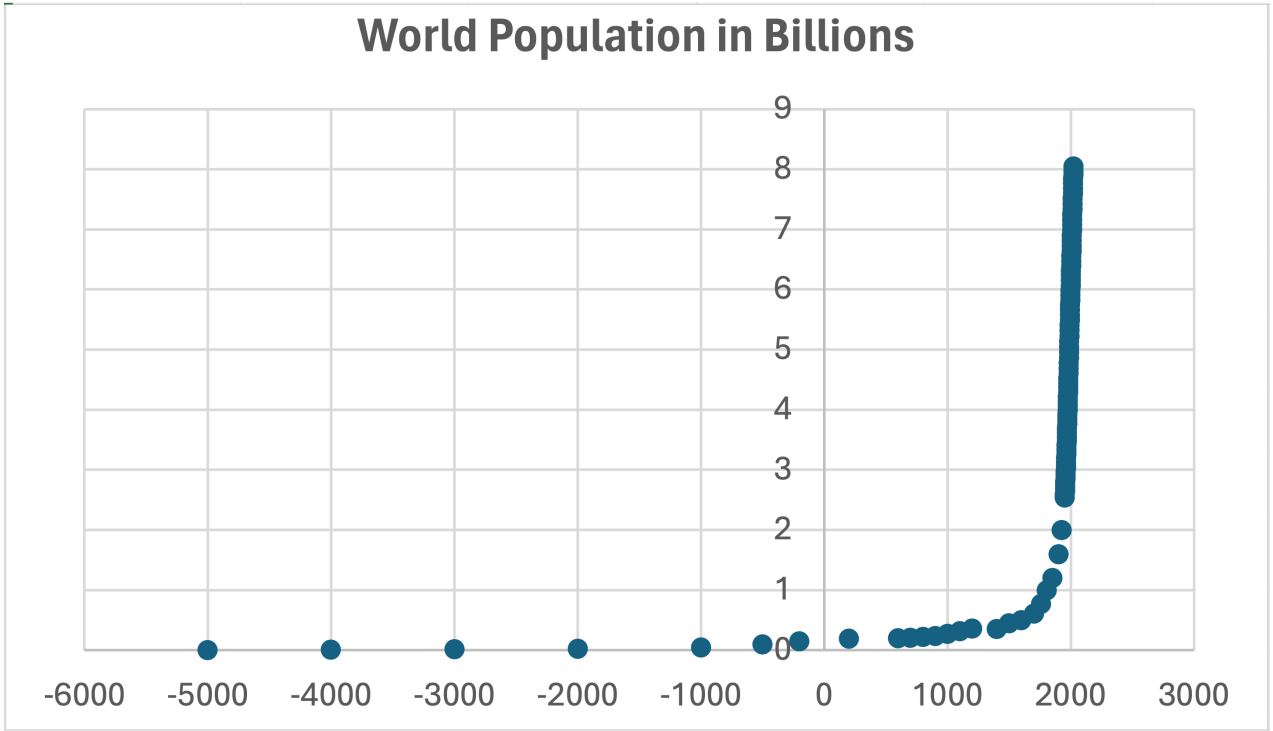


Chart of world population prepared by Gail Tverberg.

Thus, any analysis of energy supply must be on a “per capita” basis

- The issue isn’t, “Are we running out?”
- It is, “Do we have enough for our ever-rising population.”
- This is like, “Do we have enough food for all the guests?”
- Cutting back fossil fuel consumption is much like dieting
  - Not nearly as easy as it looks
  - We need huge, huge quantities of any substitute
  - Essentially **everything** we use today is made with fossil fuels!

In physics terms, an economy is much like a human being

There are many kinds of self-organizing systems that “grow” in the Universe.

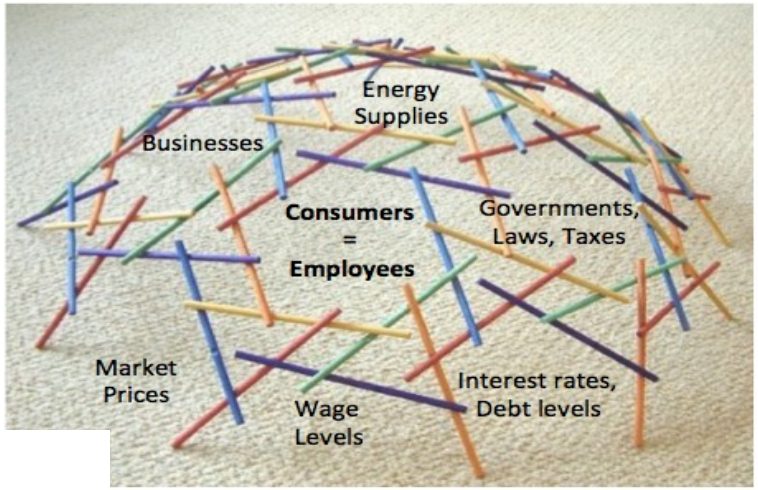
- Economies
- Ecosystems
- Humans and other animals
- Plants
- Hurricanes
- Businesses
- Governments
- Star systems

In physics terms, these are all *dissipative structures.*

- They need to “dissipate” energy of the right kinds to remain “alive”
- Humans dissipate food
  - Food allows humans to move
  - In early life, humans also grow
- Economies dissipate many kinds of energy
  - Human energy
  - Solar energy to grow crops
  - Burned biomass
  - Wind energy used by sail boats; wind turbines
  - Coal, oil, natural gas, and uranium
  - Electricity generated using devices made with fossil fuels

One way of viewing the interconnectedness of the economy

The economy gradually adds new layers and deletes unneeded layers



Gail Tverberg, OurFiniteWorld.com

Chart made by Gail Tverberg illustrating the way economies are built up in layers with a great deal of interconnectedness. Consumers need to be able to afford the finished products!

Many parallels between the human body and the economy

Human	Economy
• Arteries	• Highway system; pipelines
• Red blood cells	• Trucks carrying coal
• Human voice	• Telephone; telegraph
• Digestive system	• Furnaces; stoves; factories
• Food supply	• Energy products
• Appetite	• Promises made through the financial system

How the ***world economy*** behaves when energy supply is too low

Economists have a single view of inadequate fossil fuel energy supply.

- Too little supply means prices will rise
- Producers will produce more based on higher prices
- Or substitution will take place
  - Problem is soon over
- Conclusion: Any fossil fuel problem is temporary and easily solved
- Economists miss major points
  - Upside price limit: Affordability of food, transportation
  - Price can't fall too low: Oil producers will quit or start wars

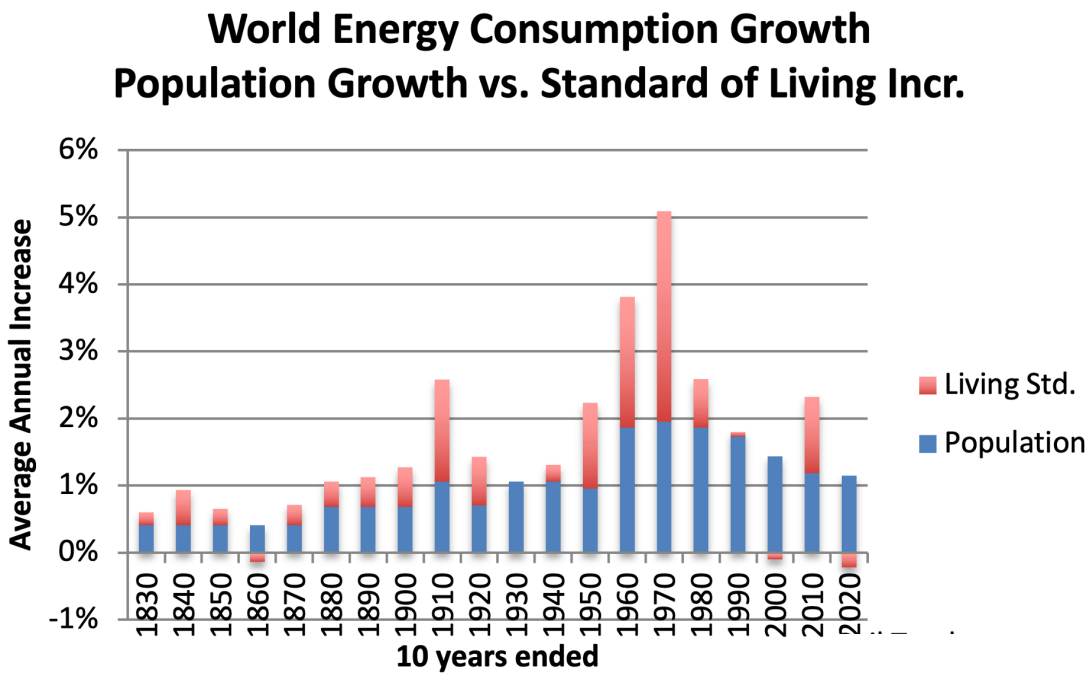
Interconnected economy acts in many other ways when energy supply is inadequate.

- Primary way: Increased wage disparity
  - Young people especially have low wages
  - In agricultural society, too having many children leads to farms getting smaller
  - Small farms can't provide a living wage
- These young people have a difficult time
  - Can't afford marriage
  - May turn to alcohol or drugs
  - Suicide rate higher

More wage disparity makes for a less stable society

- Fewer families; more single people living together
- Homeowners' risks are different
  - Steal from each other?
- Fewer people buying life insurance
- Less careful drivers
- Big push for Diversity-Equity-Inclusion doesn't fix the situation
  - High level of specialization means a few workers at the top get very high wages
  - Doesn't leave enough for the less skilled

My analysis shows a wide range of responses to low growth in energy supply between 1820 and 2020.



Growth in world energy consumption divided between (a) amount needed to support population growth and (b) amount left over to support increased living standards. Data by Vaclav Smil and BP.

Dips in growth of world energy supply lead to very bad economic times.

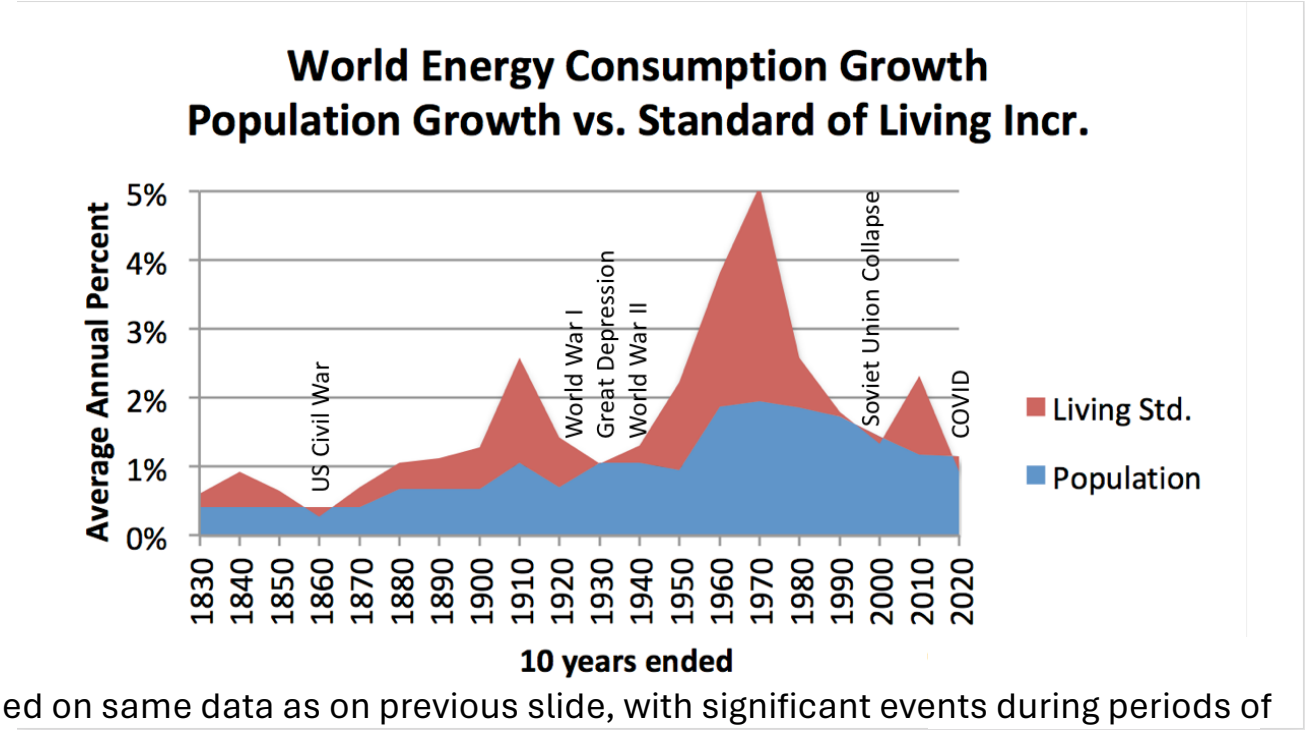


Chart based on same data as on previous slide, with significant events during periods of low growth indicated. Today's low growth is like the period between WWI and WWII.

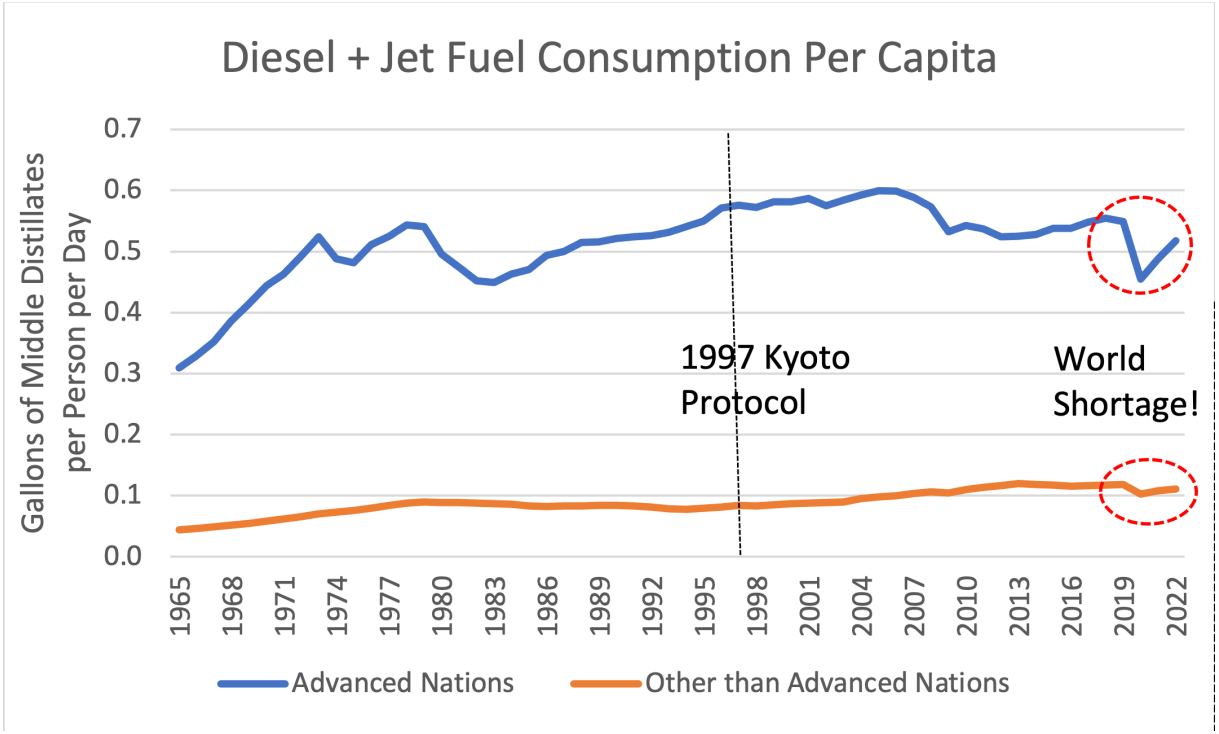
A wide range of bad outcomes have occurred when growth of energy supply was low

- US Civil War
- World War I – Peak Coal in UK
- Great Depression, German Holocaust
- World War II – Peak Hard Coal in Germany
- Collapse of Central Government of Soviet Union -1991
- Shutdowns related to Covid-19 - 2020

Summary of bad outcomes in last 200 years, when energy growth was low

- Armed conflict is typical
  - US Civil War, World Wars I and II
- Great Depression, German Holocaust
- Collapsing central governments
  - Country cannot collect enough taxes
  - Soviet Union government collapse - after many years of low oil prices
  - *Oil prices had been too low* for an oil exporter
- Shutdowns in 2020-2021 were a new disturbance
  - Many commodity prices fell very low
  - Helped hide a shortage of diesel and jet fuel

One shortage today: Heavy oil used for agriculture, road building, and transport

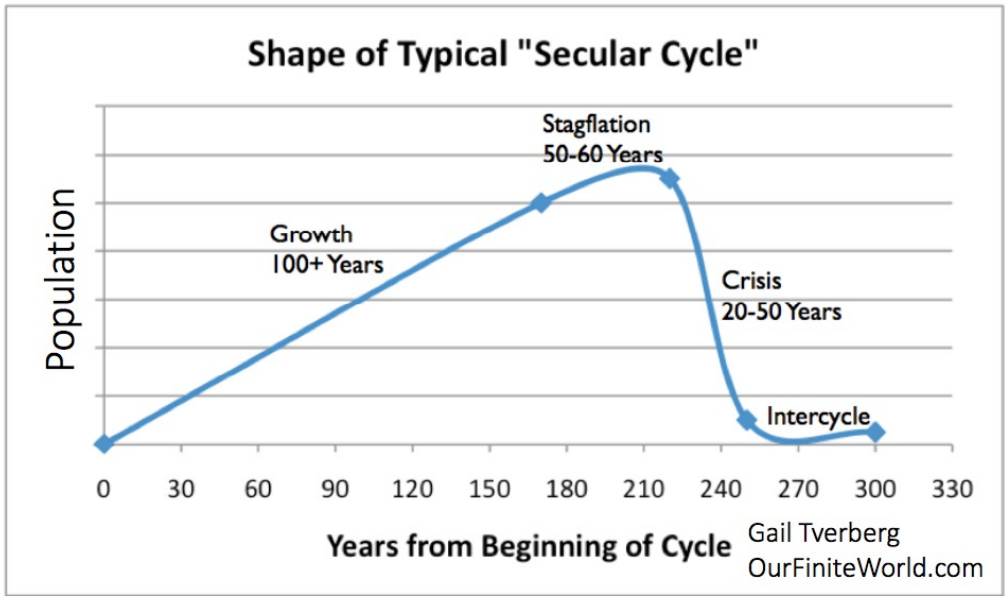


Based on data of the *2023 Statistical Review of World Energy* by the Energy Institute.

Sharp changes like these test the skills of any actuary

- Government controls become a problem
- Nothing in the past is quite representative of the future
- Actuary needs to think for himself/herself
  - Can the situation bounce back?
  - How soon will the bounce take place?
- Current situation something like the roaring 1920s
  - Things look good now
  - But financial collapse could be around the corner

Secular cycles of pre-fossil fuel economies, based on P. Turchin's analysis



Timeline of typical collapse, based on Turchin and Nefedov's "Secular Cycles."

Turchin's analysis:

- Underlying problem: Population outgrows resource base
- Pattern
  - Fast growth when new resource found
  - Then slower growth, as population limit reached
  - Stagflation
  - Crisis
- Economies ultimately decline in many ways: Lose at war, epidemic, climate fluctuation too great to be overcome, government overthrown

Actuaries should note: Patterns are likely to change greatly between periods.

- In rapid growth period
  - High interest rates on investments
  - Much optimism
  - Perhaps less interest in liability suits
- Stagflation
  - More debt among poor people
  - More difficulty repaying debt
- Crisis (Period we seem to be entering now)
  - Risk of losing at war, or from climate fluctuations, or epidemics
  - Large number of very poor citizens—leads to too low taxes
  - Governments are at risk of being overthrown

In crisis period, actuaries might expect

- More poor people will try to take advantage of insurance coverage
  - File questionable claims
  - Neglect replacing roof; try to get insurance to cover
- More theft
- More “burn down own shop to collect the insurance” claims
- More use of Artificial Intelligence to try to cheat others
- War sabotage, disguised so that the true cause looks insurable

How Advanced Economies respond to resource limits

Advanced Economies play a special role.

- Started using fossil fuels early
  - Encountered low supply issues early
- Have more people in research
  - Capable of building models, but don't understand nuances
- Leaders understand importance of obtaining disproportionate share of world's available resources
  - War possible
  - May be hidden

First response: Started outsourcing US industry in 1973

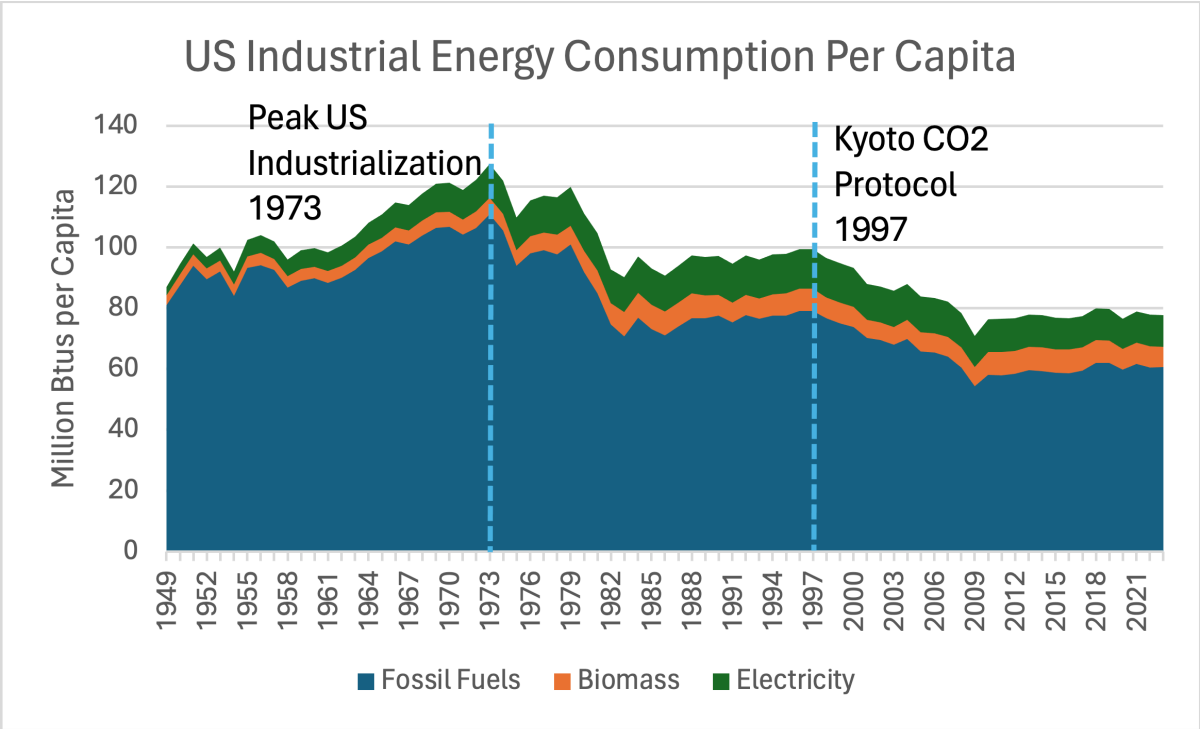


Chart showing that the quantity of energy per capita used by US industry has been declining since 1973 based on based on data of the US Energy Information Administration.

Outsourcing industry is only a temporary solution.

- Outsourcing works at first
- Many things can interrupt
  - Lack of products; lack of ships; lack of financing; lack of fuel
  - 2020 “empty shelf problem” is an example
  - Interruptions likely greater as resources deplete
- Temptation is to outsource too much
  - War materials
  - Computer and telephone manufacturing
  - Spare parts for practically everything

Insurers have already seen how badly outsourcing can work.

- Many “empty shelves” in 2020
- Auto repairs took much longer than usual
  - Owner needed to rent car while waiting for parts
  - Repair costs could be very high
- Problem is likely to get worse
- Hardly anything today is 100% US made!

Second major response by Advanced Economies was Kyoto Protocol of 1997.

- Ostensible reason: Limit CO2 emissions to prevent climate change
- Many side benefits:
  - Encourage development of less advanced economies
  - Help companies in US become truly international
  - Lower cost of imported goods for Advanced Economies
  - Encourage research on how to get along without fossil fuels
  - Provide reason for more debt; raise GDP of Advanced Economies
  - Provide an excuse for leaving fossil fuels, other than “fossil fuels are leaving us”

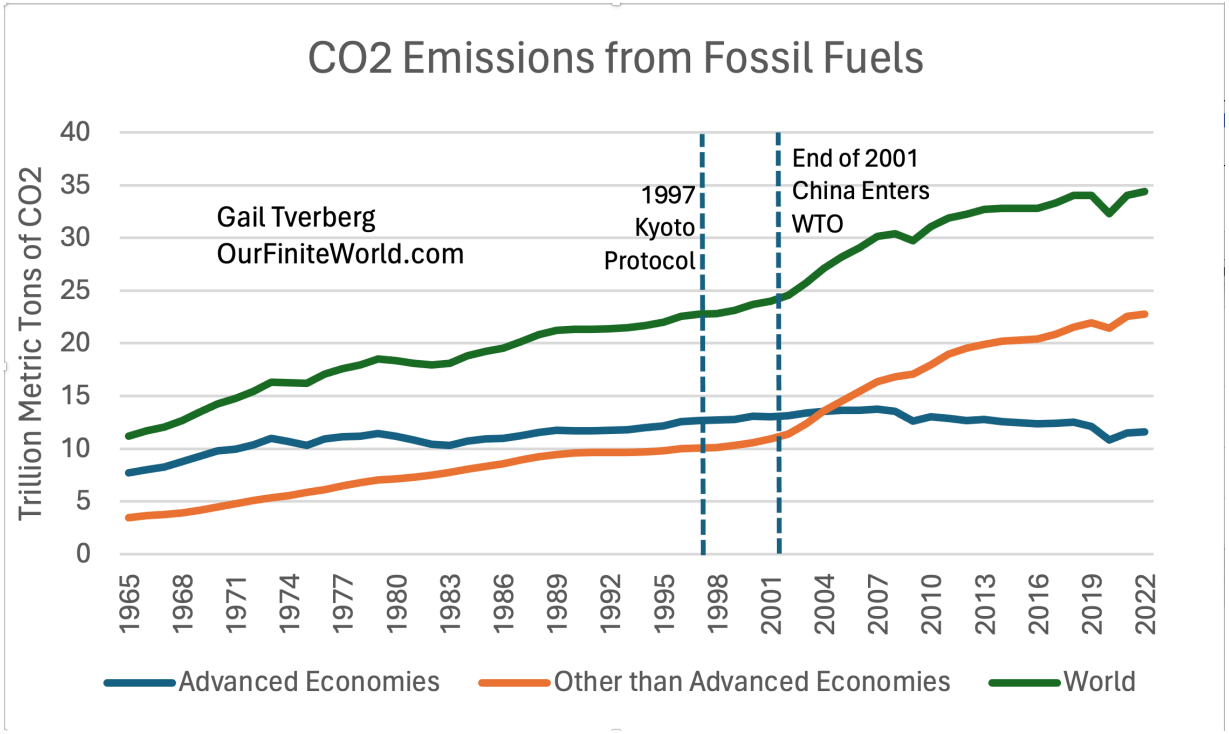
Need: “Provide an excuse for leaving fossil fuels, other than ‘fossil fuels are leaving us’”

- In 1997, there was a major controversy over the quantity of fossil fuels that could be extracted.
- Some said, “We are already reaching limits.”
  - Others said, “Prices can rise much higher, and we can extract more.”
- Both sides agreed that a substitute for fossil fuels was needed.
  - Kyoto Protocol would push researchers to find substitutes.
- No one wanted to tell citizens, ‘We are running out of fossil fuels.”
  - “You may soon be freezing in the dark and walking everywhere.”
- “Preventing climate change” sounds like a positive choice

There is indeed research indicating that CO2 affects climate

- But there are other things affecting climate, as well
  - Especially over the short term
- Global dimming – More coal dust in the atmosphere would keep temperature down
  - Shutting down factories may raise temperature for the short term
- Small changes in Earth's orbit
- More water in the upper atmosphere
  - 2022 Hunga Tonga volcanic eruption

Adoption of Kyoto Protocol didn't reduce world CO2 emissions. It moved them elsewhere!



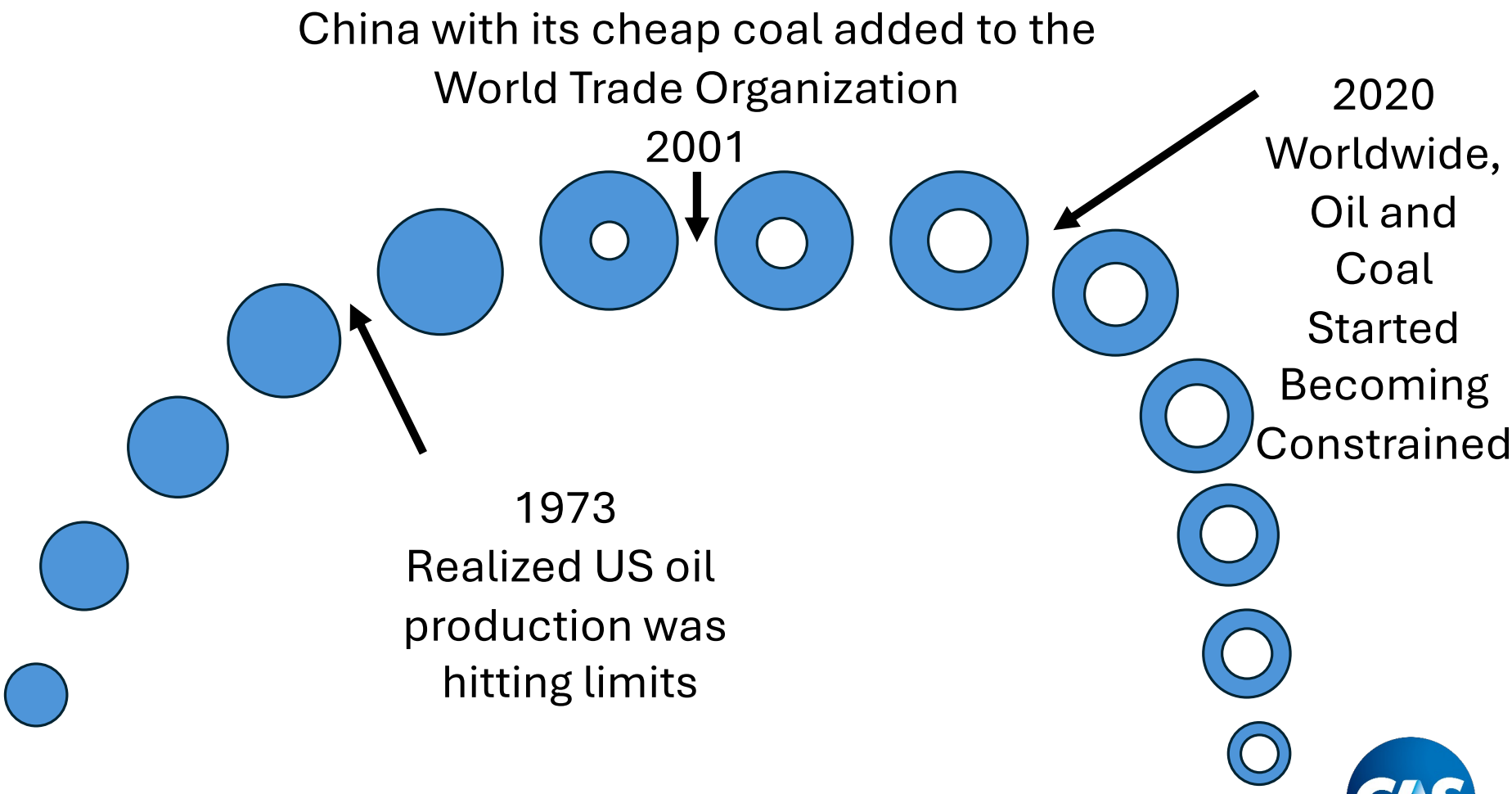
Based on data of the *2023 Statistical Review of World Energy*, by the Energy Institute.

Climate is indeed changing; it is blamed for many insured losses

- The losses are there, whatever the cause
- We don't really understand the recent spike in world temperatures
  - CO2 emissions last for 300 years in atmosphere
  - Hard for CO2 to create big spike in temperatures
  - Fossil fuels have become a scapegoat for many problems
- Politicians have many problems; it is convenient to have fossil fuels to blame
- Losses are rising for many reasons besides climate issues.

Advanced economies have been hollowed out and pushed toward collapse.

- Next slides show some ways Advanced Economies are shrinking
- Too little energy acts like starvation of the economy



Gail Tverberg's view of how Advanced Economies first tend to grow, then flatten out. When deterioration is too significant, population and standards of living both fall.

Another major shortage is in world coal production – prices have been spiking

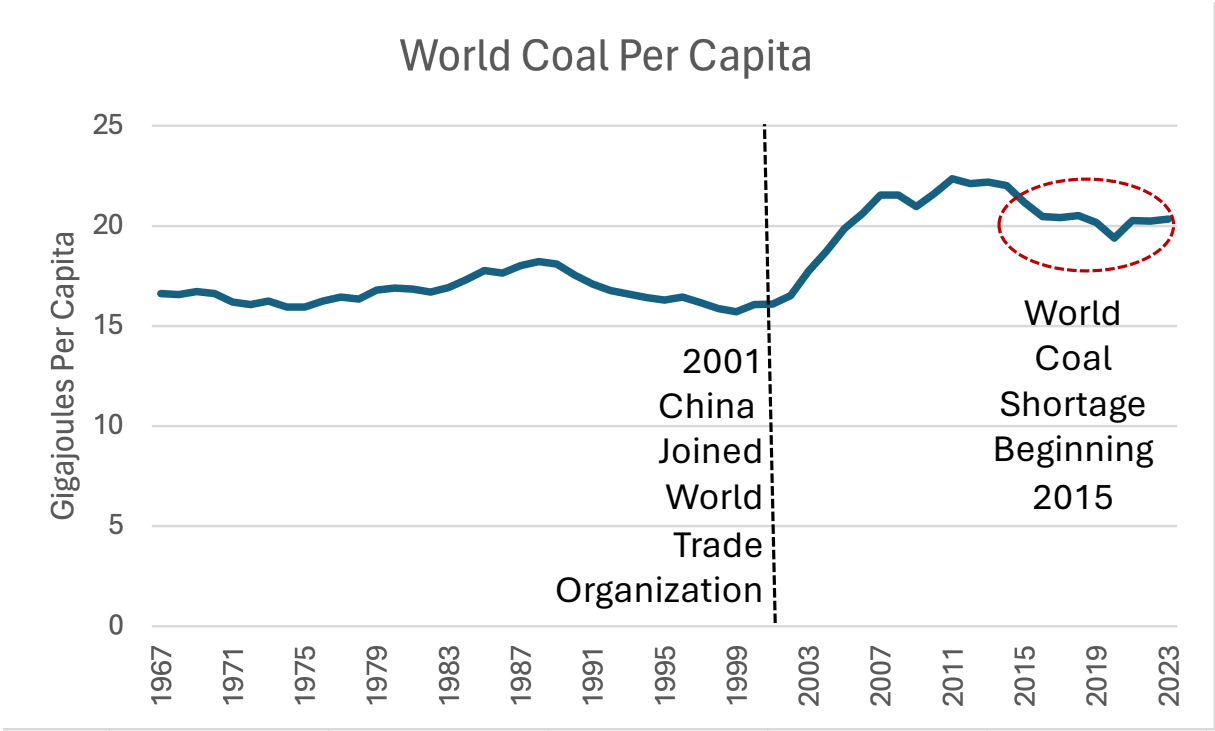


Chart based on data of the *2023 Statistical Review of World Energy* by the Energy Institute.

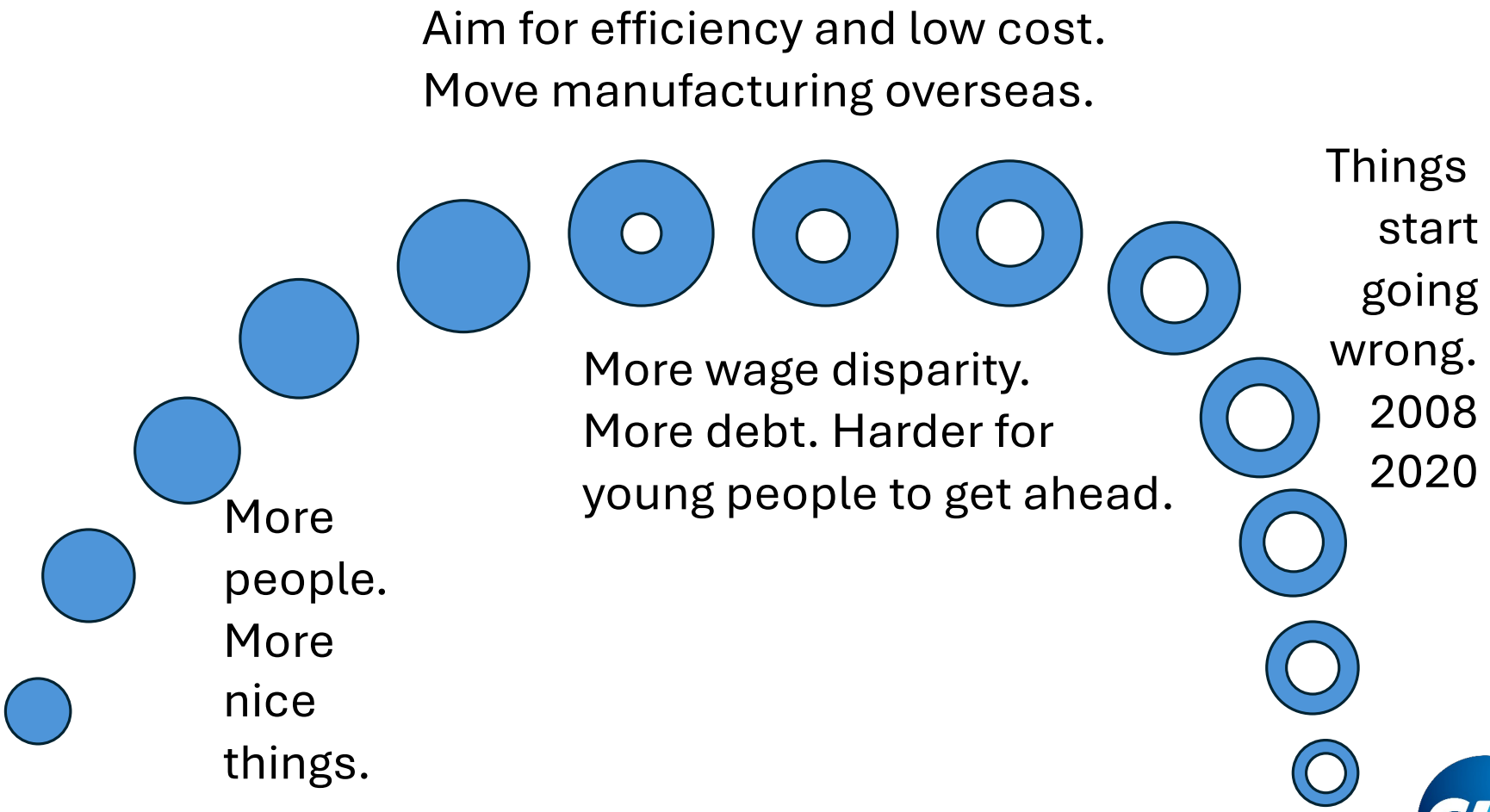


Chart similar to Slide 40, showing some of the things that have happened to date.

Making products more efficient and low-cost can hurt insurers

- Very efficient products may not be very repairable
  - Insurer may need to place damaged item, rather than repair
- Trying to save costs can lead to Boeing-type problems
  - Lots of safety issues
  - Cause whole product to fail
- Also, efficiency attempts may put workers out of jobs
  - Leaves more people with very low income
  - More inclined to antisocial behavior, drug abuse

A transition to all electricity is wishful thinking

Wind and solar seem to drive out other electricity generation in US. Caused by pricing approach.

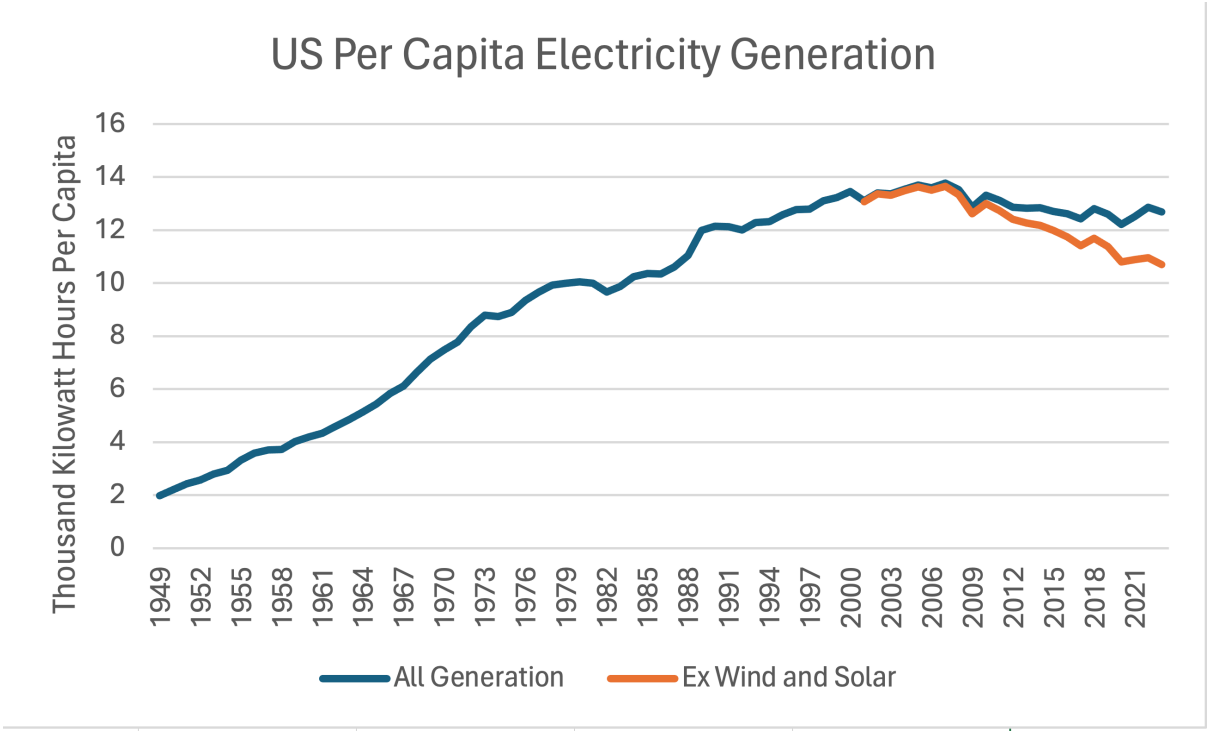


Chart based on data of the US Energy Information Administration.

Electricity consumption is still growing in poor countries, but not in Advanced Economies.

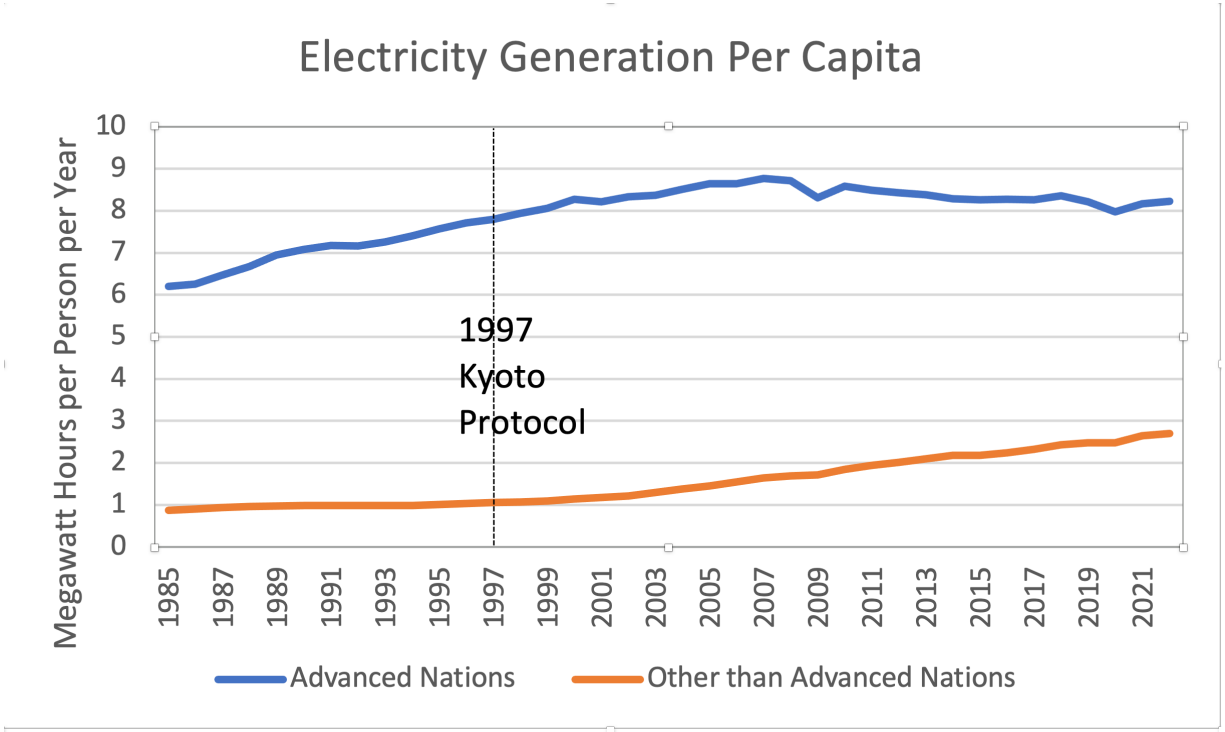


Chart based on data of the *2023 Statistical Review of World Energy* by the Energy Institute.

Fundamental problems

- Physics favors low-cost producers in the world economy
- Wind and solar, as used in Advanced Nations, is not low cost
  - High cost is hidden by subsidies, low tax revenue
- Both are made with fossil fuels
  - Depend on fossil-fuels for long-term upkeep
  - Not sustainable without fossil fuels!
- Quantity is way too low: 2.5% of US energy supply in 2023 using EIA data
- Potential for huge amount of malinvestment

Pricing system of Advanced Economies is a problem.

- Advanced Economy's pricing system allows wind and solar to "go first"
  - Pushes other generation off the grid
  - Nuclear is especially harmed
  - There is a net loss in electricity per capita
- China seems to use wind and solar to supplement stranded coal (same location)
  - This approach provides very inexpensive manufacture of solar panels
  - Manufacture is done near where coal and wind/solar are located
  - Doesn't push other generation out

It is wishful thinking that the world can transition to all electricity.

- World electricity supply is woefully inadequate
  - Especially in Advanced Economies
- Electricity doesn't have the characteristics needed to replace diesel and jet fuel
  - Electricity doesn't give the bursts of power needed for many uses
  - To power semi-trucks up hills
  - To power agricultural equipment through muddy fields
  - To power jets with big loads at takeoffs
- Early "Energy Return on Energy Investment" indications were misleading

There is the potential for a major financial crash for some or all Advanced Countries

- A great deal of investment has been malinvestment.
  - Wind and solar less helpful than people expected
  - Electric vehicles
- Higher recent interest rates have raised both home ownership and rental housing costs
  - Workers with low wages will especially be adversely affected
  - Cannot afford adequate housing
  - Push Advanced Economies toward recession
- Balance sheets of insurance companies may be affected
  - Could put some insurers out of business.

Key Takeaways for Actuaries

Key Takeaways, Page 1 of 2

1. Past trends can be expected to change dramatically.
2. More broken supply lines are likely in the future.
3. Growing conflict is likely, as countries indirectly fight over available supplies.
4. Financial problems are a distinct possibility. The current period is a little like the “Roaring 1920s,” which preceded a stock market crash and the Depression.
5. Intermittent wind and solar, with the pricing approach used in Advanced Economies, appear not to be of much overall benefit.

Key Takeaways, Page 2 of 2

6. A wide range of responses to inadequate energy supply can take place. The shutdowns in 2020 may indirectly have reflected a low supply of certain types of oil.
7. This is not business as usual. Actuaries will need to be seriously thinking about what is happening and how to model the situation.
8. Actuaries will need to monitor trends closely. It may be helpful to look for new indicators applicable to the changing situation.

Additional resources

1. OurFiniteWorld.com – My website, with hundreds of articles, all completely free to readers.
2. https://ourfiniteworld.com/2007/07/02/speech-from-1957-predicting-peak-oil/ - Speech by Hyman Rickover explaining the energy concerns of the US Navy in 1957.
3. *Economy as a Dissipative Structure* by Y. Shiozawa. May 28, 1996. First description of the economy as a dissipative structure. http://www.shiozawa.net/english/EconomyAsADissipativeStructure1996.pdf

Additional resources (continued)

4. *The Thermodynamics of Evolution* – by physicist Francois Roddier, published in 2020. (Originally published in French in 2012.) Writes about energy and the economy from the viewpoint of a physicist. I corresponded with Francois Roddier about his writings before they were published in English.

Questions?