The energy problem behind Trump’s election is not the one people have been looking for. Instead, it is an energy problem that leads to low wages for many workers in the US, and high unemployment rates in the European Union. (The different outcomes reflect different minimum wage laws. Higher minimum wages tend to lead to higher unemployment rates; lower minimum wages tend to lead to higher employment, but unsatisfactory wage levels for many.) The energy problem is also reflected as low prices of oil and other commodities.

To try to solve the energy problem, we use approaches that involve increasing complexity, including new technology and globalization. As we add more and more complexity, these approaches tend to work less and less well. In fact, they can become a problem in themselves, because they tend to redistribute wealth toward the top of the employment hierarchy, and they increase “overhead” for the economy as a whole.

In this material, I explain how inadequate energy supplies can appear as either low wages or as high prices. Basically, if energy supplies are inadequate, workers tend to be less productive because they have fewer or less advanced tools to work with. Their lower wages reflect lower productivity (Slide 20). Slide 6 offers some additional insights.

Trump’s election seems to reflect the cooling effect that our energy problems are having on the economy as a whole. Citizens are increasingly unhappy with their wage situation, and want a major change. Trump’s election may at least temporarily have a beneficial effect, since it may work in the direction of reducing complexity.

Long term, however, it is hard to see that the policies of any elected official will be able to fix our underlying energy problems.

I wrote up my post as a presentation. It can be downloaded at this link: The Energy Problem Behind Trump’s Election. I thought this might be a way of putting together quite a bit of material into one place. I have displayed the images of the PDF below the fold, for those who would like to read them as a post.

I hope the large number of images does not cause viewing problems. Let me know if you have suggestions for making this material more accessible.
Overview

- Trump’s election reflects winds of contraction
- The surprising role of energy
- Humans’ unusual use of energy
  - Allowed the growth of human population
  - Eventually runs into resource limits
- Role of complexity
- Current situation
- Trump’s approach and final thoughts

Section 1: Trump’s Election Reflects the Winds of Contraction
Trump’s election reflects winds of contraction blowing over world economy

- Rising productivity should be leading to rising wages
  - This isn’t happening
- Citizens feel that the current way of doing things has failed them
- Too many are working, but still poor
  - Current generation poorer than their parents

Falling world GDP* suggests major problem somewhere

*Notice that World GDP is in US dollars of the day, not adjusted for inflation. This is the way oil is priced. It reflects changes in the level of the US $.
What is going wrong?

- We think of world GDP as goods and services world can produce

- Perhaps we should think of world GDP as goods and services that citizens + businesses + governments can afford to buy

- Something seems to have gone wrong with affordability
  - Electorate may have a real concern
  - If wages too low, workers cannot buy the output of the economy
    - Economic growth slows, from lack of wages

US wages started dropping as % of GDP in 70s; corresponded to rise of globalization

US Wages as % of US GDP and US GDP as % of World GDP
Also: Top 10% has been getting a larger share of wages since 1980

Chart by economist Emmanuel Saez, based on an analysis of IRS data

Falling wage levels are a serious issue

- Issue becomes “too low a return on human labor”
- Falling return on human labor
  - Makes it hard for businesses to sell enough goods
  - Makes it hard for governments to collect enough taxes
  - Makes it hard to repay debt
  - Historically, it seems to lead to collapse, if not corrected
- Falling return on animal labor is what leads to collapse of animal populations
  - Fish that have to swim too far to get food can’t survive

Section 2: The Surprising Role of Energy
Economic growth is closely tied to energy consumption

World GDP Compared to Energy Consumption
1969 to 2013

\[ y = 6.8899x - 17.394 \]
\[ R^2 = 0.99313 \]

Energy Consumption in Billion Metric Tons Oil Equivalent

Physics explains reason for this close tie

- Activities generating GDP require the use of energy
- In fact, pretty much all operations of the universe can be explained by energy flows
  - Cosmic Evolution Theory – Eric Chaisson
- Flows of energy form dissipative structures in thermodynamically open systems – Ilya Prigogine
  - Examples: Hurricanes, plants and animals, ecosystems, economies
  - Require energy to grow; eventually “die”
Section 3: Humans’ Unusual Use of Energy

Human population growth has been very different from that of similar primates

[Diagram showing world population growth compared to chimpanzees]
Plants and animals form ecosystems that change relatively slowly

- Group of plants and animals share energy from the sun; water supply; minerals in the soil
  - No single species can eat all of its prey
  - Would soon be without food

- Carrying capacity remains fairly constant
  - Exception: May be reduced by change in climate, forest fire, insect invasion, etc.

- Primates similar to humans use territoriality to keep population within carrying capacity
  - Mark off very large territory
  - Fight any intruders

Why human population could grow so large

- Humans use stored solar energy, in addition to current solar energy
  - Examples: Wood, hydropower, coal, oil, natural gas
  - Gives an advantage over animals that use only food energy

- Humans burn fuels
  - Burning increases rate at which energy is consumed
    - Gives more power
  - Allows more diverse energy uses: cooking food; burning down forest to catch prey, heat to live in cooler areas

- Humans were able to develop bigger brains
  - First cooked food began 300,000 to 1 million+ years ago
  - Cooked food allowed smaller teeth, jaws, guts
    - Allowed higher metabolism and thus, bigger brains
  - Humans now adapted to eating some cooked food
Other reasons why human population growth so successful

- Learned to overcome **territoriality instinct**
  - Trade made co-operation beneficial
  - Instinct primarily needed when not enough to go around
    - As energy consumption increased, human carrying capacity kept increasing

- Humans learned to channel part of available energy into **complexity**
  - Complexity allowed humans to put supplemental energy to use
  - Allowed increasing concentrations of energy, and use over longer periods
  - Examples: Technology; hierarchical organizations; government and laws; education; capital goods; financial system

Human population growth is likely to eventually hit limits, even with complexity

- Many resources are depleting simultaneously
  - Fresh water per capita is falling
  - Soil is eroding; losing nutrients
  - High quality mineral ores are used first

- Greater quantities of energy resources can be used to work around these limits
  - Energy resources have their own limits

- Energy resources have limits, even if they appear renewable
  - High cost is a limit; amounts used are limited by impacts on ecosystems
Energy limits can appear as *high energy prices or low wages*

- **High energy prices**
  - If wages, in the aggregate, are high enough to support high energy prices
  - Or if wages *plus increased debt* are high enough to support high energy prices

- **Low wages**
  - Resources are needed for jobs that pay well
    - Examples: Oil to operate heavy machinery; electricity to operate computer
    - Can perhaps do job by hand, but output per hour worked is lower
    - Lower wages reflect lower output per hour
  - Low wages are likely to lead to low energy prices as well

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**Section 4: The Role of Complexity**

**Complexity is needed to solve problems**

- If people need water, perhaps a well can be dug

- If additional energy resources are needed, perhaps new technology can allow this to be done

- If complexity is successful, perhaps the carrying capacity of an area can be raised
  - Or the price of a product can be lowered
Elements of growing complexity

- Growing specialization
  - Advanced education for some people, but not others

- Growing technology
  - Capital goods used to support technology

- Growing debt needed to support these capital goods
  - Reasons for debt:
    - Need to pay the wages of all workers in the supply chain
      - Before the benefit of capital goods is actually delivered
    - Also, payment plan for debt makes capital goods affordable

Elements of growing complexity (continued)

- Inputs must meet high standards
  - Very pure metals
  - Electricity must meet precise grid standards
  - High energy density often the desired output

- Government support needed
  - Government sets rules
  - Provides roads, education, services for elderly, etc.

- Workforce ends up being much more hierarchical
  - Some are in charge, others are not
  - Some have advanced education, others do not
Hierarchical behavior redistributes income to the top of the hierarchy

- To wealthy;
- to biggest businesses;
- to governments

Another way of viewing impact of rising complexity (relative shares estimated)

Even if GDP is flat, workers' share keeps falling
Eventually, growing complexity reaches limits too

- Easiest-to-find inventions are found first
  - Later inventions are likely to have less benefit

- Falling wages of those lower in the hierarchy tend to slow the economy
  - Spending patterns differ for high, low wage earners
  - Low wage earners spend all of their wages
    - Buy goods that use commodities; keep prices up
  - High wage workers spend on education, financial services, with less benefit to the economy

- Growing debt, and interest on debt, become a problem

Several complexity transitions have occurred

- First complexity transition:
  - 1,000,000+ years ago, learned to control fire
    - Provided concentrated energy
    - Many applications: cooking, staying warm, better hunting
    - Individual hunter-gatherers “better off” than previous hominids
      - Bigger brains
    - Allowed hunter-gatherers to move out of Africa
      - Increase their total population
Transition to Farming – Second complexity transition

- Occurred about 10,000 years ago
- Allowed total population to rise
- Individual members not better off
  - Not enough variety of food supply in small area
  - More prone to catching diseases
  - Problems with tooth decay with new diet

Complexity transition after World War II

- Greatly ramped up debt after World War II
  - Based on John Maynard Keynes’ views
  - Led to huge rise in energy consumption
    - Allowed Europe, Japan to rebuild
    - Allowed homes, cars, rebuilt factories to be affordable
    - Population suddenly spurted

- Cost of fossil fuel extraction was cheap
  - What was needed was a way to pay for capital goods, over the life of those goods

- Complexity transition was successful
Evidence of success of post World War II complexity transition

Globalization starting in late 1970s was another way of adding complexity

- Allowed world energy use to rise, as US and EU lagged
Globalization was successful from world’s point of view

- Kept world economic growth growing, as growth in developed nations slowed
- Provided world with lots of cheap imported goods
- Allowed the illusion that developed nations were cutting CO2 emissions
  - Even as world CO2 emissions soared
- Big drawbacks: More wage disparity in US; more unemployment in EU

Now benefits of globalization have mostly run their course

- World growth in energy supply is slowing
- China’s cheap coal supply is no longer driving growth

China Energy Consumption by Fuel

- Renewables
- Hydroelectric
- Nuclear
- Natural Gas
- Coal
- Oil

Gail Tverberg
OurFiniteWorld.com
Section 5: Where we are now with respect to energy and the economy

Where we are now

- World economic growth is slowing
  - No matter how GDP is counted
  - PPP based GDP gives optimistic view of current situation
    - Omits impact of US dollar rise

- Many people believe that economic growth can be decoupled from energy consumption
  - True for individual countries, but not for world
  - Energy consumption determines carrying capacity for humans
  - Significant reduction in fossil fuel consumption is likely to reduce human population
Complexity solutions are working less and less well

- Globalization worked for world, but had job-related impacts for US and EU
  - Which job-related impact depends on level of minimum wage
    - Higher minimum wage leads to more unemployment problems
    - Lower minimum wage leads to low wage problems
  - Wind and solar PV aren’t working
- Push toward higher education for all is raising debt levels (US)
  - Many can’t find jobs after graduation, either
- More advanced health care is raising prices excessively (US)

Many people are convinced that wind, solar PV, and electric cars are a solution

- Early analyses often based on flawed “Peak Oil” narrative
  - Hubbert Curve overestimates future energy supply
  - EROI calculations for renewables are misleadingly favorable
    - Overlook need for electricity to match grid needs; impact of debt
- Solutions that depend on government support really aren’t solutions
  - Need solutions that add tax revenue, like fuels they replace
- Solutions need to be cheaper
  - $10,000 electric car may be a solution, not $70,000 Tesla
Section 6: Trump’s Solution and Final Thoughts

Donald Trump’s solution

- A few pieces of Trump’s solution:
  - Cut back on regulation of energy companies
  - Cut back on global warming efforts
  - Cut back on subsidies for renewables
  - Cut back on government spending
  - Reduce foreign commitments

- Joseph Tainter, in *The Collapse of Complex Societies*, says economies that are near collapse can perhaps delay collapse by reducing complexity
  - Above changes would seem to reduce complexity
Donald Trump’s solution (continued)

- Reduce imported oil; increase our own oil supply
  - This also seems to be an attempt at reducing complexity
  - Also tries to raise wages of US citizens

- Add infrastructure spending
  - Adding infrastructure requires the use of commodities, theoretically raising prices
  - But more debt for infrastructure will raise interest rates, undoing the price rise for commodities
  - Deficit spending is at least temporarily favorable for keeping the economy from collapsing—raises “demand”

Donald Trump’s solution (continued)

- Part of Donald Trump’s solution reminds me of the territoriality of our primate relatives

- In this case, what we are lacking is jobs that pay well.
  - The plan is to do well, at the expense of neighbors

- Our economies are so interconnected, it is hard to see that this approach will work well
  - But I can see why Trump might try
  - If there isn’t enough to go around, the plan is for the US to get as much as it can for itself